Tafila Wind Energy Project

Tafila Governorate

(Hashemite Kingdom of Jordan)

Final Report of the

Environmental and Social Impact Assessment Study (ESIA)

Report No. 11-1-3058a_rev.0
Project Company:

JWPC

Prepared by:
CUBE Engineering GmbH
Al-Rawabi Environment & Energy Consultancies

20th of December, 2012

Document List of Revision

Current Rev.	Date	Page Affected	Prepared By	Checked by (technical)	Checked by (quality assurance)	Released by
11-1-3058a_rev.0	20.12.2012	All	TM, AGÜ, REEC	ASC, JF, LK, SC, PR, MaB	AGÜ	REEC
Document: 12-12-20_ESIA_Tafila.pdf						

Overall Project Management:
CUBE Engineering GmbH (Germany)

Local Project Management:
REEC - Al-Rawabi Environment & Energy Consultancies (Jordan)

Project Developer and Sponsor:
JWPC - Jordan Wind Power Company (Jordan)

This report has been prepared independent by CUBE Engineering GmbH and REEC - Al-Rawabi Environment & Energy Consultancies with all reasonable skill, care, diligence and best practice on behalf and support from JWPC as the developer of this project.

Disclaimer

The contents of this report are confidential. CUBE Engineering GmbH ("CUBE") and Al-Rawabi Environment & Energy Consultancies *("REEC") have partly relied on information provided by third parties and cannot guarantee the accuracy of such information thereof.*

It is important to acknowledge that the information also contains some forward-looking statements on the environmental impact of the planned wind farm. Such statements are subject to risks, uncertainties, assumptions and other important factors, many of which are outside consultants' control that could cause actual economic performance to differ materially from the results discussed in the forward-looking statements, but will not interfere with or change the fundamental result of the report.

The work of CUBE and REEC was carried out on the assumption that the documentation and information provided to us is reliable, accurate and complete in all material respects.

CUBE and REEC accept no responsibility in the event that the documentation or information provided by the third party turns out to have been incomplete or inaccurate. Under no circumstances shall neither the authors nor CUBE nor REEC be liable for any damage or loss suffered or incurred as a result of the statements made in the ESIA or otherwise in connection with this study.

Table of contents

List of figures

List of tables

List of abbreviations

AD	Anno Domini / the year of Christ's birth
ACOR	Library of American center for oriental research
BC	Before Christ
BCRL	British council for research in Levant
BoP	Balance of Plant
CF	Capacity Factor
CPV	Concentrated Photovoltaic
CSP	Concentrated Solar Power
CUBE	CUBE Engineering GmbH
DAJ	Department of Antiquities of Jordan
DOS	Department of Statistics
DSTFS	Dead Sea Transform Fault System
EC	European Commission
EIA	Environmental Impact Assessment
ELV	Exceptional Load Vehicle
EPCM	Engineering, Percurement and Construction Management
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Mitigation and Management Plan
FIT	Feed-In Tariff
GDP	Gross domestic product
GHG	Greenhouse gas
HGV	Heavy goods vehicles
HSE	Health, Safety and Environment
IBA	Important Bird Area
ICT	Information and communication technology
IEA	Institute of environmental assessment
IFC	International Finance Corporation
IP	Immission point
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
ISP	Internet Service Provider
IUCN	International Union for the Conservation of Nature
JADIS	Jordan antiquities database and information system
JD	Jordan Dinar
JWPC	Jordan Wind Project Company
$LA_{90,10\ minutes}$	The A-weighted noise level exceeded for 90% of the measurement period
$LA_{eq,10\ minutes}$	Equivalent sound level over a specified measurement period (t)
LIA	Landscape impact assessment
LNG	Liquefied Natural Gas

LV	Light Vehicles
LVIA	Landscape and visual impact assessment
L_{WA}	Sound power level of the turbine or of the civil works machinery [dB(A)]
MEMR	Ministry of Energy and Mineral Resources
MM	Mitigation measure
MoEnv	Ministry of Environment
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
NEPCO	National Electric Power Company
NSA	Noise sensitive area
OECD	Organization for Economic Co-operation and Development
OHSAS	
PC	Personal computers
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
RD	Rotor Diameter
REEC	Al-Rawabi Environment & Energy Consultancies
RPS	Renewable Portfolio Standard
RSCN	Royal Society for the Conservation of Nature
SNH	Scottish natural heritage
TOR	Terms of reference
UN	United Nations
UNRWA	United Nations Relief Agency
VIA	Visual impact assessment
VOC	Volatile Organic Compounds
WAJ	Water Authority of Jordan
WBG	World Bank Group
WHO	World Health Organization
WSM	Wind Sector Management
WTG	Wind Turbine Generator
ZTV	Zones of theoretical visibility
ZVI	Zones of visual impact

1 Introduction

Jordan Wind Project Company PSC (“JWPC”) is proposing the development of a wind farm in the Governorate of Tafila in Jordan. The proposed site is comprised of 38 turbines with an installed capacity of 3.075 MW each. The total installed capacity of the proposed wind farm is 117 MW.

According the Jordan Regulation of Environmental Impact Assessment, No. 37 from 2005 and the European Union Directives 85/337/EEC and 97/11/EC, project developments require an Environmental and Social Impact Assessment (“ESIA”) including a number of technical studies which results are described in detail in the following chapters of this document. Initial analysis on this site commenced in late September 2011 and lead to more detailed surveys that continued until December 2012.

All of the studies in this assessment consider social and environmental impacts and mitigations during construction and operational phase of the planned wind farm.
After 20 years of operation the project will be dismantled. The impacts within this so called decommissioning phase are comparable to those during the construction phase, albeit shorter in duration and of less impact. As it is difficult to determine what methods will be used in 20 years’ time, this document does not attempt to anticipate details. JWPC commits to using best practice procedures during the decommissioning.

A scoping session gave the opportunity to national and international stakeholders to comment on the planned project and to discuss the relevant topics to be handled in the ESIA. Throughout the development of the ESIA, every person, stakeholder and NGO was invited to comment on the project and to suggest further assessments.

The studies conducted for the ESIA are based on national and international best practice methods in their respective fields. Different national and international regulations form the basis of the assessment. To establish a document with international good practice, special attention lied on the compliance with equator principles and IFC guidance notes 2012.

1.1 The developer

Jordan Wind Project Company was established as project company for the Tafila wind farm project and attempts to build the first large scale wind farm in Jordan. The Tafila wind farm project will be operated by Jordan Wind Renewable Energy LLC, a 100 % subsidiary of JWPC. The land on which the wind turbine generators (WTG) will be build is leased by another 100 % subsidiary of JWPC, named Twana Investments LLC.

The structure of the company’s integrated process within the project development is shown in Figure 1-1.

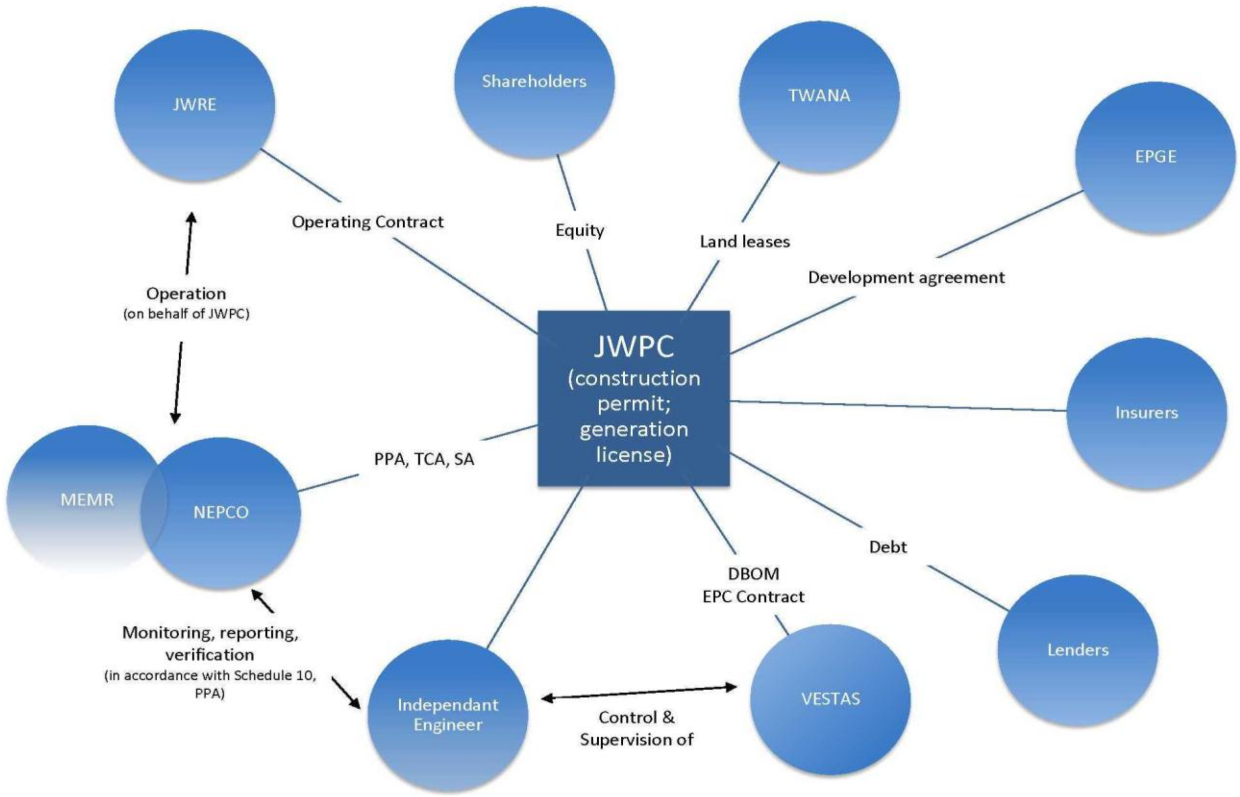


Figure 1-1: Project Development Structure

Once the project has been identified (site identification process with screening and scoping as well as prefeasibility study) the developer will enter the DESIGN phase in order to select the right WTG supplier and model, to evaluate the grid connection of the wind farm, to run a proper wind and site assessment, to render the wind farm layout process and to conclude finally the impact of the development within the ESIA.

Figure 1-2: Relevant Project Development Phases for ESIA

Getting positive feedback from the authorities and reaching final close with the lenders the developer will start the CONSTRUCTION phase which will last a couple of months. After successful implementation of the wind farm equipment the power plant is ready to go: the OPERATIONAL phase will start. After a general term of 20 years the wind farm reaches its end of lifetime. The last phase of a wind farm project will begin with the DECOMISSIONING of the equipment from the site. Within these four different phases there will be different aspects of the impact to the environment of the wind farm which has to be assessed in particular.

1.2 The consultant for this study

CUBE Engineering GmbH (CUBE) is an internationally renowned company in the management and development of wind energy projects. CUBE's professional staffs have experience of more than 20 years in the international wind business. ESIA work and management has been preliminary conducted in different countries like Germany, Scotland, England, Romania, Czech Republic, Hungary, Austria and the USA. To achieve a high quality ESIA CUBE's experience is joined with the local/national experience of the Jordan consultant Al Rawabi Environmental & Energy Consultant (REEC) with its network of subcontractors. The strong liaison with the project developer is essential to achieve a well understanding of project's specialties as well as the results of the assessment.

1.3 Purpose of the study

An ESIA is always required to describe, assess and balance the impact of a new (operational) construction to and within its environment. The study will be guided through an independent specialist assessment team as well as public participation and consultation in order to investigate advantages versus disadvantages, to elaborate opposition and to convince people with arguments as well as to define mitigation or compensation measures to reduce the impact of the construction. Its purpose is to provide the authorities with sufficient information on which a decision about whether planning permission for a proposed project should be granted.
Through the ESIA, potential negative and positive impacts are identified. In this assessment recommendations are made for avoiding or reducing negative impacts, and enhancing positive impacts, where appropriate. The findings of the ESIA are transferred into clear and measurable objectives that must be achieved during construction, commissioning, operation and closure of a proposed project. These objectives, and plans for achieving them, are contained in an Environmental and Social Mitigation and Management Plan (ESMMP).

An Environmental Impact Assessment[1] (EIA) is a procedure required under the Jordan Regulation of Environmental Impact Assessment, No. 37, Year 2005. It is also required under the terms of the European Union Directives 85/337/EEC and 97/11/EC on assessment of the effects of public and private projects on the environment.

The following objectives will be accomplished in the ESIA of the Tafila wind farm:

- Describe the existing baseline environmental and social conditions within the project area, covering the physical, biological, socio-economic, archeological and cultural elements likely to be affected by the project's construction and operations and/or likely to cause adverse impacts upon the project, including both natural and man-made environments;
- Identify the nature, extent and significance of any potential environmental, social and health impacts whether positive (beneficial) or negative (adverse), temporary or long term. This shall include routine and non-routine (planned) operations and unplanned (accidental) events;

[1] An EIA ist he same as an ESIA excluding the consideration of social aspects

- Design and specify appropriate mitigation and monitoring measures for these impacts;
- Identify any significant cumulative or trans-boundary impacts of the project and recommend appropriate actions to avoid or mitigate these impacts during the project execution, including monitoring, if necessary;
- Outline the management principles and controls which JWPC and its contractors will use to address any residual impacts as described and outlined within the Environmental and Social Mitigation and Management Plan (ESMMP).

1.4 Structure of this document

The ESIA is subdivided into 17 chapters, each of which focuses on a specific technical topic. The chapters have been produced by experts of the German company CUBE Engineering GmbH (CUBE) and the Jordanian Company Al-Rawabi Environment & Energy Consultancies (REEC) as well as supported by the local developer JWPC. The name of each company is given in association with the chapters and main authors listed as below.

The different chapters are based on national and international regulations, guidelines, standards and principles. These are listed in chapter 4.3.

- Chapter 1 – Introduction
  This chapter was written by Timo Mertens and Stefan Chun, CUBE;

- Chapter 2 – Need for this development
  This describes the background to the development. This was written by Timo Mertens and Andrea Gütschow, CUBE;

- Chapter 3 – Project description
  This chapter gives details of the proposed infrastructure and the different project stages. It was written by Timo Mertens and Andrea Gütschow, CUBE, as well as by Sean Miller, JWPC;

- Chapter 4 – Scoping and consultation
  This chapter describes the international, national and local policy relevant for a project of this scale. It was produced jointly by Timo Mertens, CUBE and Shorouq, REEC;

- Chapter 5 – Legislative and policy context
  This chapter describes the international, national and local policy relevant for a project of this scale. It was produced jointly by Timo Mertens, CUBE and by Ramia Ajarmeh, REEC;

- Chapter 6 – Biodiversity
  This chapter reviews the ecology, fauna and flora in the area of the planned wind farm. It was produced by Adnan Budieri, REEC;

- Chapter 7 – Geology, Hydrology and Hydrogeology
  This chapter provides the baseline information on water resources and geological settings. It was written by Naser Haswa, REEC;

- Chapter 8 – Noise
  This chapter examines the potential impact of noise on any dwellings close to the Tafila wind farm. It was produced by Andrea Gütschow, Peter Ritter and Timo Mertens, CUBE. The noise measurement was conducted by REEC;

- Chapter 9 – Shadow flickering
  This chapter describes the impacts of shadow flickering caused by rotating wind turbines. It was assessed by Timo Mertens, CUBE;

- Chapter 10 – Air quality
  This chapter describes the potential impacts and effects on air quality associated with Tafila wind farm. It was assessed by Timo Mertens, CUBE. The dust measurement was conducted by REEC;

- Chapter 11 – Safety of WTG
  This chapter describes the safety measures integrated in the WTG Vestas V-112. It was produced by Timo Mertens and Jonas Feja, CUBE;

- Chapter 12 – Landscape and visual impacts
  This chapter assesses the landscape and the visual impacts of the proposed project. It was produced by Timo Mertens and Alexandra Doba, CUBE;

- Chapter 13 – Cultural heritage and archaeology
  This chapter summarizes archaeological remainings on the project site. It was produced by Kalil Hamdan and Ramia Ajarmeh, REEC;

- Chapter 14 – Traffic and transport
  This chapter examines what the best route is for delivery and also discusses the impacts of construction traffic. The survey was performed by Jonas Feja, CUBE;

- Chapter 15 – Socio-economics
  This chapter looks at the effects a development of this scale will have on the local economy. The detailed study was performed by Yanal Abeda and Ramia Ajarmeh, REEC and by Timo Mertens, CUBE with additional input from JWPC;

- Chapter 16 – Assessment of alternatives
  Alternative projects with the same objectives but less impacts are assessed. This survey was performed by Timo Mertens, CUBE;
- Chapter 17 - Summary

This summarizes the findings of the ESIA. It was produced jointly by all authors listed above.

1.5 Evaluation of significance

The significance of an impact will depend on its predicted magnitude (scale, extent and duration), and on the value or importance of the affected receptors or resources. This is shown in Figure 1-3.

The importance of receptors will depend on the number of people affected and their vulnerability, so for example residents are considered more vulnerable to noise than employees who are only present during working hours. An impact is considered to be of major significance if it causes any legal standards to be breached or cause damages to human beings, animals, avifauna or the flora.

The criteria for evaluation of significance take local, national and international standards, norms and good practice into account and vary according to the type of impact. The details in each case are presented and discussed in the following relevant chapters.

Where significant adverse impacts remain after mitigation, these will be taken into account alongside other costs and benefits (such as environmental or social improvements, provisions of employment or economic development) by decision-makers, in determining the conditions under which the project should be allowed to proceed.

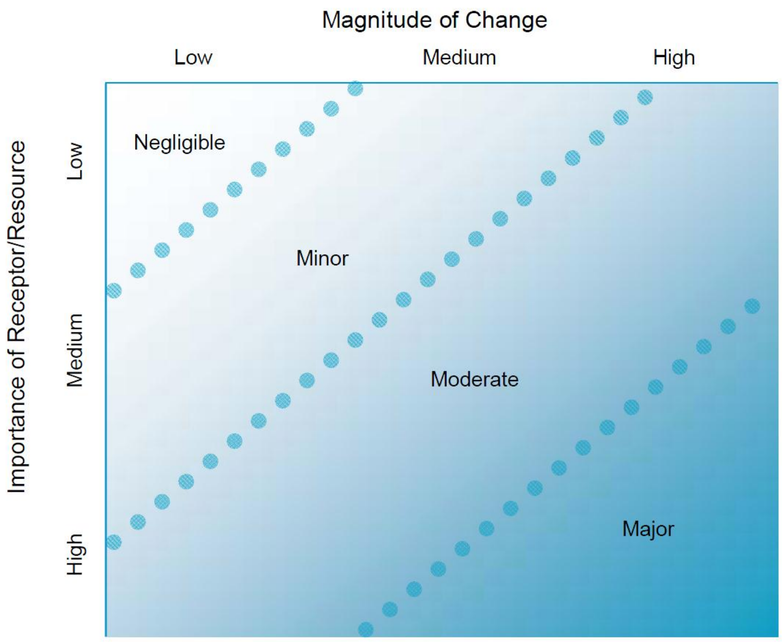


Figure 1-3: Matrix of significance

1.6 Mitigation

Adverse impacts will be avoided wherever possible. If adverse effects or impacts cannot be avoided, suitable mitigation measures will be developed to reduce or remedy them. In the case that no suitable mitigation measures can be found compensation will be provided in an appropriate amount.

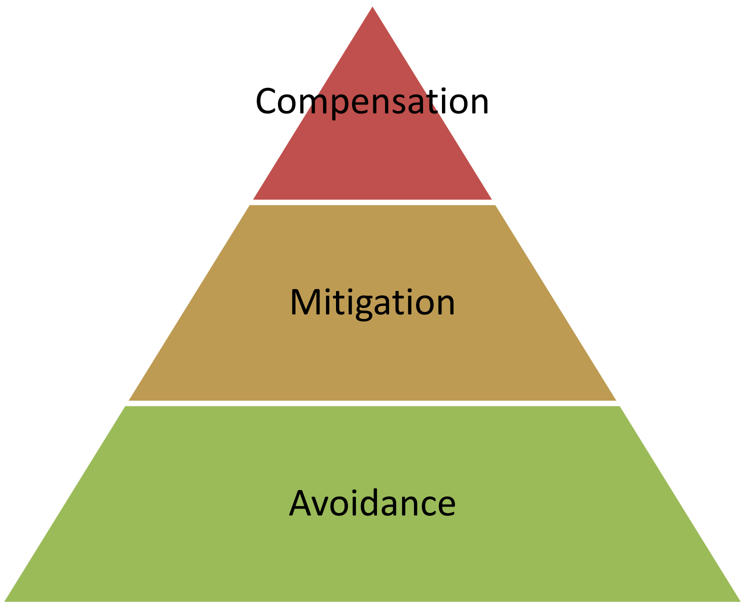


Figure 1-4: Mitigation pyramid

Where a detrimental impact is identified, measures to avoid or mitigate the impact will be implemented wherever possible. Mitigation through appropriate siting and design during all phases of a project is of key importance so that mitigation is likely to take the form of modifications to the layout of the wind farm, in terms of turbine micro siting, spacing and location. Other aspects of mitigation relate to the timing of construction works and methods are applied. Modifications to aspects of associated infrastructure, e.g. access roads, may be applied, as well.

A mitigation measure may require monitoring after its implementation to determine its effectiveness against agreed goals. A contingency plan will also be made, in the event of the measures not meeting those targets. The monitoring is handled in the ESMMP.

Compensation should be the last resort/consequence and should only be considered if mitigation measures will not reduce adverse impacts to an acceptable level and the project is consented as the benefits of the proposal are seen to outweight the environmental costs.

The mitigation measures of general minor impacts that might occur during construction and / or decommissioning are listed below:

- The contractor must display good workmanship and performance during construction by supervising engineers in order to assure adequate disposal of solid waste and waste water, to avoid or to collect spillages of used oils, greases, diesel, etc.;
- The contractor will not leave the construction site unless the area is in tidy conditions, and waste is adequately disposed of;
- Security systems, guarding and protection schemes have to be applied in order to comply with Health & Safety guidelines to avoid failures, accidents and material losses.

The mitigation measures of general minor impacts that might occur during operation are listed below:

- Regular disposal of domestic waste, e.g. in connection with the municipal waste collection scheme;
- Regular disposal of hazardous wastes, especially of used oils, which from time to time is generated during oil exchange at the wind turbines;
- Collection of domestic waste water, purification in a simply treatment plant (e.g. septic tanks) and rinsing of treated water into desert gravel for natural after treatment. Regular disposal of domestic sludge.

1.7 Assessment of alternatives

The assessment of alternatives compares the project and its purpose to alternatives ways of achieving the same objectives and output. The alternative ways comprise among others a different way of producing electricity, a different scale of the project or alternative locations of the WTGs, either a single one or the whole wind farm. The “do-nothing” scenario is considered as well. The focus lies on possible adverse impacts to secure that environmental and social impacts are reduced as much as possible.

1.8 Cumulative impact assessment

Cumulative impacts result through a combination of existing and planned projects and the project under assessment. The focus of cumulative impact assessment should be on the effects caused by all similar projects in the area of evaluation.

Cumulative impacts may result from various types of interactions:

- A combination of different types of effects at a specific location (which may also result from different elements of the project);
- A combination of effects of the same type at different locations, which are not necessarily significant individually, but which collectively may constitute a significant effect;
- The interaction of different effects over time;

- The cumulative interaction between effects from proposed development and other existing or planned projects in close proximity.

Combination effects and the interaction effects from different project elements are taken into consideration within the technical scope of this ESIA and are reported where appropriate within each chapter.

Other existing developments which may have cumulative impacts within the area of influence for this project are considered and their environmental and social impacts are taken into account in defining the baseline for the assessment. The cumulative effects of these projects with those of the proposed development are therefore incorporated into the assessment.

´Recently there is one other wind farm site known which is under development and located in the surrounding area of the planned Tafila wind farm (Figure 1-5). This facility is in the planning process and very little information is publicly available regarding the project. The available information is presented below:

Fujeij wind farm is approximately 11.5 km south of the Tafila wind farm project site. According to consultant's information the Fujeij wind farm is planned to have a scale of approximately 80 MW. The development status is less in progress than the one of the Tafila wind farm. This project has been tendered and will be financed through World Bank Group under a different support scheme than the IPP interest scheme.

Further bigger wind farm projects with significant planning progress are not known or information might be confidential at the present stage.

1.9 Limitation of the survey

The principal assumptions which have been made, and any limitations which have been identified in undertaking the ESIA are set out below. Assumptions specifically relevant to each topic have been set out in the relevant technical chapter.

- The assessments contained within each of the technical chapters are based upon the application drawings and plans submitted as part of the application (status as per 20.12.2012);
- Baseline conditions have been established from a variety of sources, including historical data, but due to the dynamic nature of certain aspects of the environment, conditions may change during the construction and operation of the proposed wind farm;
- The survey has been performed during the period of July 2011 until December 2012.
- The design, construction and completed development will satisfy environmental and social standards consistent with contemporary legislation, practice and knowledge;
- To ensure environmental protection, an Environmental and Social Mitigation and Management Plan (ESMMP) will be prepared providing a mechanism to prevent, reduce, and mitigate

environmental effects. The ESMMP will be discussed and agreed with JWPC and other stakeholders at a later stage, if planning consent is granted, and enforced and monitored during all key phases of the works (tracking).

1.10 On-going feedback process and review

Since summer 2012 the current status of the ESIA work and/or single chapters and topics at that time have been presented to and reviewed from third parties like shareholding partners, EPC contractors, WTG supplier, lenders (e.g. IFC, EIB) as well as their consultants and experts (e.g. Sgurr). These companies and institutions required an understanding of the ESIA process for a wind farm project in Jordan.

A lot of feedback have been collected and discussed so far in order to increase the quality and performance of the study. Due to lack of suitable guidelines and requirements (e.g. noise) these discussions lead to the best practice results as presented here in the study. It has been also practice to liaise/communicate with stakeholders and NGOs on Jordanian site to exchange experience and views to different topics within the scope.

Figures

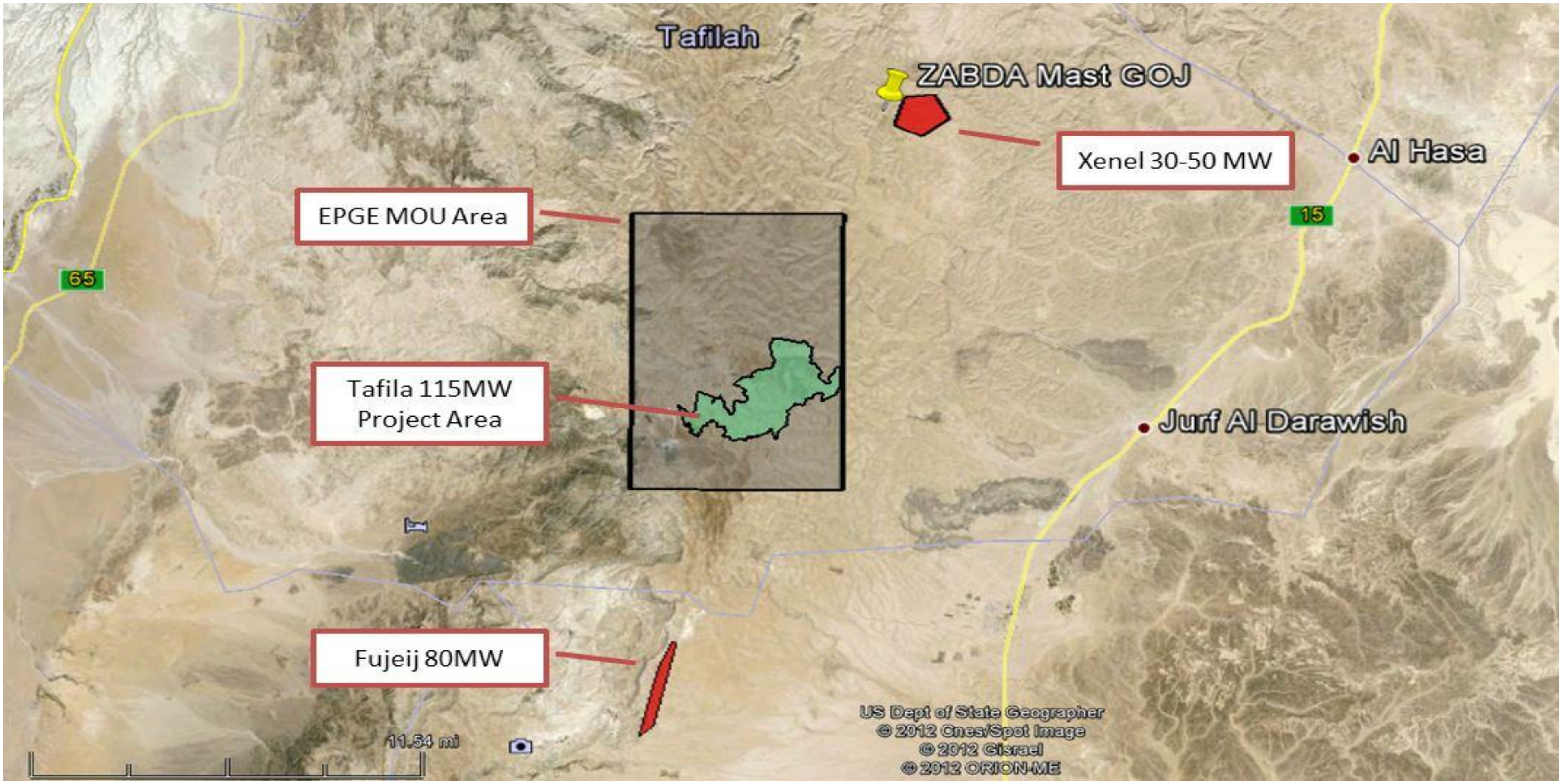


Figure 1-5: Wind farms in the vicinity of the planned Tafila wind farm

2 Need for this development

2.1 Introduction

Jordan faces specific and to some extent unique challenges with regards to electrical power generation. Jordan by today imports over 97% of its energy needs, and is also amongst the most water-deprived nations in the world. Jordan has relied predominantly on Egyptian gas for its needs, and the supply has been disrupted since the explosion of the gas pipeline in parallel with the political change of regime in Egypt. It seems unlikely that the resumption of gas supply, if it happens, would be at the old long term contract price, and could in fact be in line with international market prices. Jordan is looking right now for Liquefied Natural Gas (LNG) from Qatar starting from June 2014 on over the new LNG terminal in Aqaba.

In addition to these national and regional perspectives, the growing global concern about the effects of climate change and the rising prices for conventional fuel resulted in a substantial inclusion of renewable energy and energy efficiency strategies in Jordan's National Strategic Plan. Jordan's Renewable Energy and Energy Efficiency Law number 3 (2010) has made it possible for Independent Power Producers (IPPs) to submit direct proposals to the Ministry of Energy and Mineral Resources (MEMR) for power generation from wind, solar and other renewable sources.

MEMR's strategic framework aims to increase substitution of fossil fuels with renewable sources that can deliver the required energy in a more sustainable way while also ensuring security of supply.

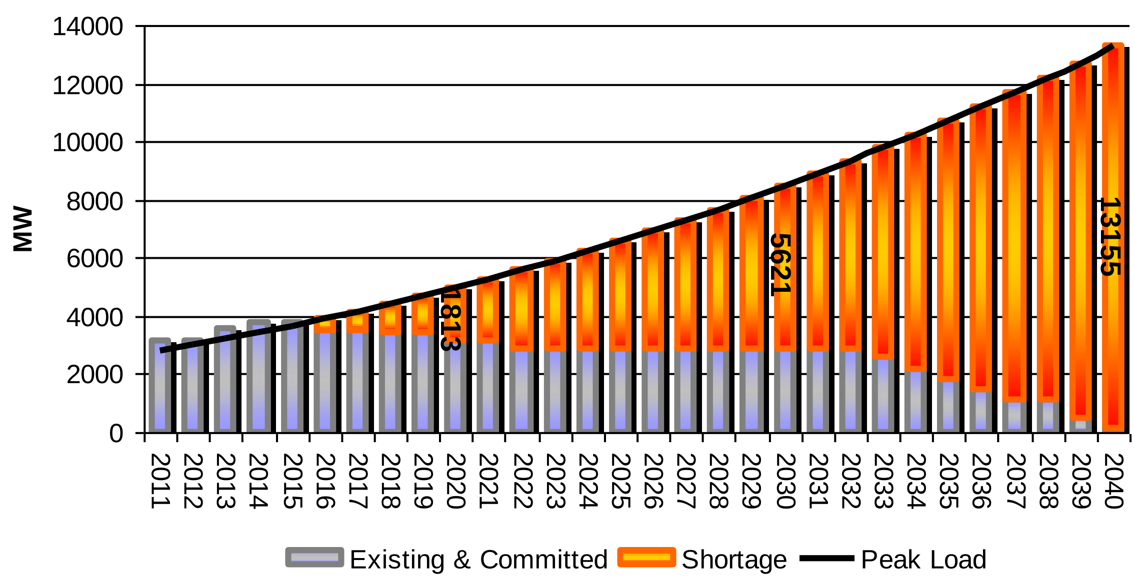


Figure 2-1: Projection of energy generation (existing and committed power plants) and demand [NEPCO]

This chapter examines the background behind this shift in policies and briefly discusses the alternatives to the current approach. Details of the national and international policies that have been put in place in recent years are not described in detail.

2.2 Renewable energy policy

Today's rapid growth of renewable energy production is principally driven by national and international renewable energy policies. Favorable policy conditions contributed demonstrably to the promotion and expansion of the renewable sector in recent times. Policies to promote renewable energies facilitate a steady and sustainable growth of the renewable energy market.

While in the 1980s and early 1990s only few countries politically supported the renewable energy sector, in 2012 more than 118 countries had some form of renewable energy policy target or support. At least 98 countries had proclaimed a future target for their green energy rate. There are even several individual targets to achieve a specific amount of renewable electricity and heat production at state, provincial or local level. Even though some targets could not be met or were later on scaled back, many countries achieved or exceeded their amount of renewable energy for 2010. Existing targets were raised in countries like Finland, Germany, Spain and Taiwan. Finland and Sweden already passed their ones for 2020.

The European's Union aimed to reach a capacity of 40 GW wind power, 3 GW photovoltaic, 1 GW concentrated solar power, 5 GW renewable heating and heat pumps by 2010. By the end of 2010 86 GW of wind power and more than 29 GW of solar power were installed all over Europe. It is expected that these strong growth trends are continuing so that the European Union could well surpass its 2020 targets, having a share of 20 percent of energy from renewable sources.

As the intense development led to continuing cost reductions of several renewable technologies, many governments reduced tax and financial expenditures on the sector. Thus, the state-level renewable energy support mechanism in France, Germany, Spain, Italy, the Czech Republic, and the United Kingdom saw funding cuts in 2010.

Chinas fortunate policy resulted in a significant increase in installed wind power capacity since 2005. China did not only surpass their expansion targets for wind, they even became the world's top installer of wind turbines as well as of solar thermal systems and the top producer of hydropower systems. Some countries like India, Spain, Chile and Israel missed their targets on the development of renewable energies or scaled them back.

Developing countries, which now represent more than half of all countries with policy targets and half of all countries with renewable support policies, are playing an increasingly important role in advancing renewable energy.

Renewable power generation policies today are passed in more than 118 countries, while half of them were implemented in developing countries. A report published by the UN Intergovernmental Panel on Climate Change (IPCC) notes that government policies play an essential role in accelerating the development of renewable technologies. Feed-in tariffs and Renewable Portfolio Standards (RPS) are the most common governmental promotion instrument. 65 countries and 27 states have a feed-in tariff in place in early 2012. 18 countries use quotas or RPS and at least 53 governments introduced other jurisdictions to promote renewable technologies (double namings are possible).

Successful policies depend on predictable, transparent, and stable framework conditions and on appropriate design. Not all policies have been equally effective in promoting green energy investment, but most of them significantly helped to expand the renewable energy market.

Trends show a continuing strong growth of the renewable energy sector and on-going investments all over the world. The total capacity of many renewable energy technologies grew at average rates from around 15 % up to 50 % annually from end of 2005 through 2010. The highest growing rate can be registered for wind power, followed by hydropower and solar photovoltaic. Wind power capacity worldwide increased by 20% in 2011 to approximately 238 GW. In 2010 more new wind capacity was added in developing countries and emerging markets than in OECD countries [2-9].

2.3 Jordan renewable energy policy

Jordan's Renewable Energy and Efficiency Law are considered to pave the way for the private sector to invest and participate actively in the implementation of renewable energy projects.

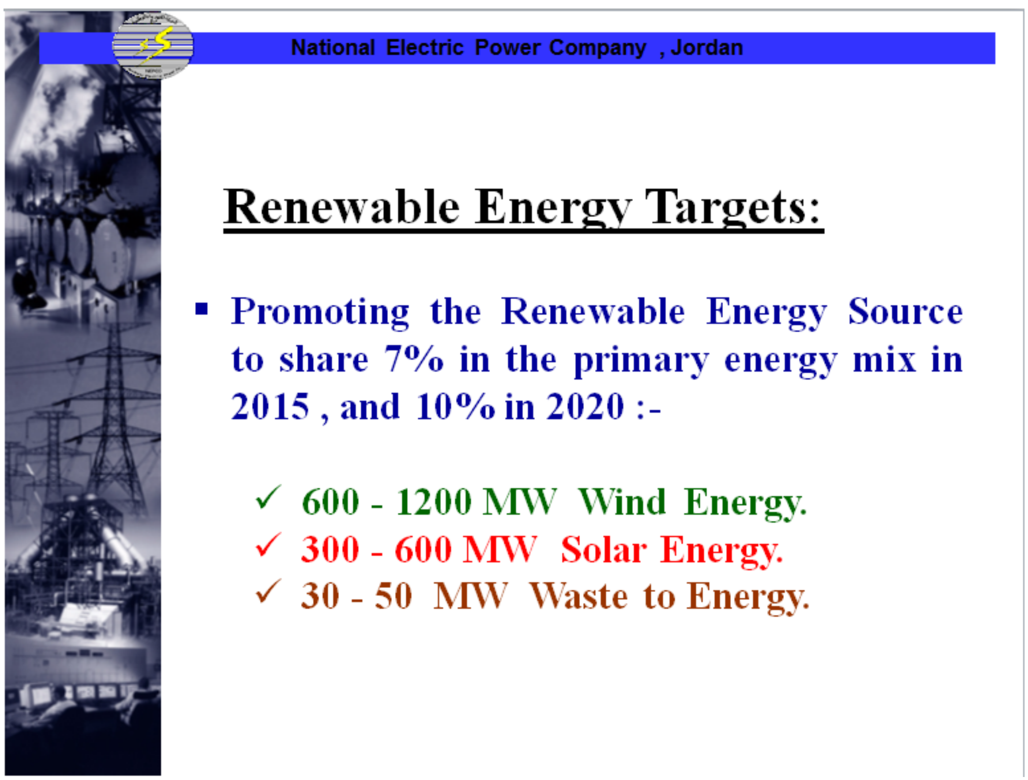


Figure 2-2: Renewable energy targets set by MEMR [NEPCO]

In accordance with provisions of the Renewable Energy Law the MEMR sought expressions of interest (EOI) from qualified investors interested in investment in renewable energy projects for power generation on building, owning and operation basis. Successful applicants have received a Memorandum of Understanding (MOU) from the government which enables them to proceed with preparing their proposals for their planned site based on milestone action plan for a bidding period.

The applicants are able to bid for ceiling tariff for Solar and Wind applications. Recently the tariffs are 85 JD per generated MWh for wind- and 120 JD per MWh for solar power plants.

A renewable energy and energy efficiency fund has been established to provide a good financial framework to planned projects [2-5]. Furthermore an Energy Feed-In Tariff (FIT) has been announced for private and industrial consumers to accommodate the situation of the high generation price.

2.4 Security and diversity of supply

The main three fossil fuels used for electricity generation in Jordan are natural gas, heavy fuel oil, and diesel, comprising about 58 %, 32 % and 10 % of the national fossil fuel use, respectively. Today, renewable energy sources account only for a minimal share of the electricity generated.

Jordan has no notable fossil fuel reserves; the only occurrence of a fuel reserve is a natural gas field in Al-Risha in the northeast of the country [2-3].When considering the security of supply, it is important to consider the following points associated with resource availability:

- If a resource is rare, its price will continuously increase. Availability and, therefore, costs of a resource depend on its geographic position and its external conditions. Not all technologies are equally suited for all locations;
- Even abundant resources can become difficult to obtain if the area in which it is sourced becomes politically unstable. Such restrictions will have an impact on the price;
- The production of fossil fuels is very often accompanied by serious and dangerous environmental impacts and problems.

It has to be mentioned that the dependency on the energy import lead to an high generation price of app. 188 JD per MWh while the average sales price is app. 88 JD per MWh to the consumers (mix). The government looses approximately 100 JD per generated MWh currently (December 2012).

These circumstances suggest that in the long term it would be advantageous to become less dependent on oil and gas and instead increase the electricity production by renewable energies.

2.5 Global climate change

The phenomenon of climate change is widely regarded as the most pressing environmental concern of the last and the current century. Even if the causes of climate change are successfully tackled over this century, it is generally accepted that the emissions already released will cause environmental and economic problems extending centuries into future.

Research has shown that an increased concentration of carbon dioxide in the atmosphere impacts the climate. The high amount of carbon dioxide can be explained by clearing and burning of forests, land use change and by the release of non-CO_2 gases from industry and private consumers (e.g. heating, cooling).

Especially, an increased use of fossil fuels which formerly stored carbon is released to the atmosphere to a great extent, causing severe problems for the world, nature, ecosystems and for mankind.

In the last century, various alternative energy sources were developed, but none were commercially viable (except of a few hydro power plants) until the oil crisis of the 1970s. However, only a decade later, rising oil prices increased the interest in alternative forms of energy production.

The topic of climate change was still highly controversial at that time, but it slowly gained more support, and research intensified on the subject. “The Brundtland Report” produced by the World Commission on Environment and Development (a United Nations commission headed by Gro Harlem Brundtland, Prime Minister of Norway) in 1987 is regarded as the first source for a definition of sustainable development [2-8]. Only five years later the United Nations (UN) held the “Earth Summit” in Rio de Janeiro which was followed by the UN Framework Convention on Climate Change in Kyoto in 1997, during which the Kyoto Protocol was agreed detailing targets for carbon dioxide emission reductions.

Since that time, research on the topic has continuously intensified and models have been improved allowing for a better understanding of the processes that bring about global climate change and its assumed consequences. The UN Inter-Governmental Panel on Climate Change concluded in a report published in 2007 that there is now indisputable evidence that human activity since 1750 has warmed the climate and that “Future warming is strongly dependent on our emissions.”

2.6 The international context

Despite lacking ratification by the congress of the United States of America and Canada’s formal withdrawal from participation in December 2011, the Kyoto Protocol is regarded as one of the major steps in the process of mitigating the climate change. The Kyoto Protocol has set the overall target to reduce greenhouse gases (GHG) and set the 1990 emission level as benchmark for each participating country.

2.7 The Jordan context

Jordan ratified the Kyoto Protocol on the 17th of January, 2003. In 2005 it came into force, setting emissions targets for the developed countries and creating flexible mechanisms that allow payments for GHG emission reductions to developing countries. Even though it's small contribution of 0.1% to the global GHG, Jordan is facing the consequences of the climate change as much as any other country. Therefore, Jordan is very concerned about this issue. Jordan's position is that the only way to deal with the climate change is to adhere to the agreements of the Kyoto Protocol [2-4].

2.8 Renewable energy

Renewable energy is defined as follows: Derived from resources that are naturally regenerative or are practically inexhaustible, such as biomass, heat (geothermal, solar, thermal gradient), moving water (hydro, tidal, and wave power), and wind energy. Municipal solid waste may also be considered as source of renewable (thermal) energy. Nuclear power is not a form of renewable energies. Many industrialized countries are increasing the use of renewable energies and decreasing the use of power plants burning fossil fuels. This model has been followed by many countries. Lower-middle-income countries, such as Jordan, have noticed that installations of renewable energies have several advantages such as:

- Reduced GHG emissions;
- Reliable energy source;
- Independency in relation to imported resources;
- Energy cost reduction in the long term;
- Job creation.

Even though energy exchange between different countries is inevitable in the existing regional system, the advantages listed above are regarded as triggers for a change in the worldwide energy supply. The correct mix of renewable energies leads to a stable energy system based on natural, endless resources such as:

- Wind energy;
- Solar energy (PV, Concentrated Photovoltaic (CPV), Solar thermal, Concentrated Solar Power (CSP));
- Biomass;
- Tidal energy;
- Wave energy;
- Geothermal energy.

Each of these renewable energy sources presents an array of possible applications and different sizes of generation plants.

2.9 Wind energy

Wind turbines have been used to produce electricity on a commercial scale since the 1990s and are established as a well-developed renewable energy technology.

Wind turbines harness the energy in the wind and convert it to electricity. The amount of energy produced by wind turbines under operation dramatically increase with wind speed. This is primarily due to the physics of wind power, which shows that the energetic yield of the wind increases in cubic relation to the wind speed. There are a few additional factors that influence the energy yield of wind, e.g. its frequency distribution, air density, flow inclination etc., but generally absolute wind speed is the pre-dominant factor up to the point of cut-out hysteresis of the turbines, where it is shut down in order to prevent it from damage at extreme wind speeds.

In general, wind speeds increase with height above ground whereas turbulence intensity decreases at the same time. This allows turbines with bigger hub-heights to produce more energy than a turbine with a lower height at the same location. In addition, the rotor diameter of a turbine is relevant. Longer blades increase the swept area significantly (by the square of the rotor blade length) in which the energy can be extracted from the wind.

Each turbine type has specific technical features (rotor diameter, generator type, blade type etc.) resulting in a power curve that is turbine specific, i.e. at any given location each different turbine type would produce a different energy yield. This power curve also shows the wind speeds at which the turbine starts and stops producing energy. It is therefore important to select the turbine model that is most appropriate for the proposed site.

By running one Vestas V112 turbine at the proposed project site in Tafila approximately 2,500 Jordanian households can be supplied with clean, renewable electricity.

2.9.1 The capacity factor

The capacity factor CF is a percentage value expressing how much energy has been produced in a year, in comparison to the energy that could have been produced if a specific turbine had been working at full capacity throughout the entire year.

A capacity factor of around 30 % is considered to be profitable in wind energy and represents favorable wind conditions. The reason that capacity factors are far below 100% is that a wind turbine produce energy mostly at wind speeds below rated power as the wind does not blow at a continuous speed throughout the year.

Table 2-1: Example for different capacity factors

Capacity Factor	0.10	0.20	0.30	0.40	0.50
Rating	poor	moderate	good	Very good	Excellent
Countries (example)	Slovenia	AT, DE, PL	DK, ES, F	UK, IR, LY	AR, Costa Rica

High wind speeds contribute the most to yield as the energy in the wind increases exponentially with wind speed, theoretically twice of wind speed would result in energy yield that is eight times higher. In reality this is not the case due to limiting factors as for example the instability of the wind’s frequency. A turbine that is able to produce lot of energy at high wind speeds (small rotor diameter – big generator) can generate more energy per year at a very windy site, but even less at a low wind site, where a turbine with big rotor diameter and small generator is preferable. At the proposed Tafila wind farm, a gross capacity factor of ~40% is expected to be achieved with the proposed V112 3.0 MW turbine. Most of the 20,000 WTGs in Germany are in the range of 0.25 to 0.35 in comparison.

Wind speed frequency forms a Weibull distribution, i.e. extreme wind speeds such as very high or very low winds occur less frequent than wind speeds between 6-8 m/s. Therefore a turbine must be adapted to efficiently extract energy from such wind speeds.

As wind speeds change, turbines are designed to utilize an entire range of wind speeds. A “cut-in” speed beginning at 3 m/s and “cut-off” speed of up to 25 m/s are common values for turbines. At different wind speeds they produce different amounts of electricity; the relation between wind speed and electricity production is defined in the turbine’s power curve. The efficiency of turbines is discussed in the section below.

2.9.2 Efficiency

The efficiency of any turbine is the ratio of the energy generated by an engine as an outcome of a process to the total amount of energy supplied to the process (e.g. fuel, primary energy sources, wind resources).

The energy used by the wind turbine is the gross energy content in the wind. The parameter of a wind turbine’s share that can be extracted from the wind is called cp-value and it is limited to a theoretical maximum of 59.3%. It is limited due to the physics of the process and known as “Betz’ Law” [2-1]. Like all other machines, wind turbines suffer from mechanical and electrical losses during the operation and therefore no turbine can reach the Betz maximum. The Vestas V112 3.0 MW reaches a maximum cp-value of 0,45 at a flat measurement location.

Most existing fossil fuel power stations have efficiencies of 30-40%; only some modern combined heat and power gas stations can reach up to 60% efficiency.

However, these values are based on the energy content of the fuel when it is available for extraction, it does not consider any losses of efficiency due to the fact that fuels need to be extracted and delivered to the power plant.

The benefit of wind energy is that turbines are situated “where the wind is” and using an energy source that is continuously reproduced, i.e. “renewable”. A continuous fuel production process with its own environmental implications and waste production is therefore avoided. However it is essential that turbines are placed in locations where the energy can be fed into the grid to be utilized by consumers.

2.9.3 Jordan’s potential

Wind power is a key part of Jordan’s strategy for more energy independence, expected to account 600 MW by 2015 and 1,200 MW by 2020 [2-7].

Jordan is pushing forward the development of this very feasible and reliable technology. The following objectives are set by the government:

- Conduct research, development and demonstration projects;
- Provide technical consultations (e.g. NERC wind measurement campaign);
- Transfer the know-how in wind energy field to the corresponding institutions and private companies in Jordan and other countries.

Wind energy is one of the most promising sources for renewable energy in Jordan. Generally, the most energetic wind is found at a distance of almost 400 km along the western border. At the same time, the lowest wind potential is found at the east, middle and southeast of Jordan. However, there are some areas in the northwest, middle, and southwest that have the highest wind speed in Jordan.

Currently there are two small wind farms connected to the grid in the northern part of the country. One, with a capacity of 320 kW in Ibrahimya, consisting of four stall-regulated Tellus wind turbines of 80 kW each. This wind farm was established in 1988 in co-operation with a Danish firm and considered as a pilot project. The other, more recent one, has a capacity of 1,125 kW in Hofa, consisting of five pitch-regulated Vestas wind turbines of 225 kW each, established in 1996 in co-operation with the German Government under the so-called ELDORADO program [2-2].

2.10 Summary and conclusion

The majority of the international scientific community agrees that man-made climate change is a concern that must be combated by reducing greenhouse gas emissions. In order to meet the future energy demands, the use of renewable energy sources will become increasingly important. The use of renewable energy also reduces dependency on resources and resource-rich countries. Therefore most governments, including Jordan, have implemented policies to address the issue.

Wind energy is a very promising renewable energy source. Therefore the Jordan government supports onshore wind energy projects to develop this technology in the Hashemite Kingdom of Jordan.

2.11 References

[2-1] Hau (2006), Wind Turbines, Fundamentals, Technologies, Application, Economics, 2nd Edition, Springer

[2-2] National Energy Research Center (NERC) (2012), http://www.nerc.gov.jo/, accessed in August 2012

[2-3] Loy, Detlef. 2007. Energy-Policy Framework Conditions for Electricity Markets and Renewable Energies. Eschborn: Deutsche Gesellschaft für Technische Zusammenarbeit GmbH

[2-4] Al-Dwairi, Mahmoud (2009), Jordan and climate change, http://www.climatemediapartnership.org/reporting/stories/jordan-and-climate-change/, accessed in September 2012

[2-5] Ministry of Energy and Mineral Resources (MEMR), Energy 2012 – Facts and Figures, www.memr.gov.jo, accessed in September 2012

[2-6] Oxford University Press (2006) Concise Oxford English Dictionary, 11th edition (revised), ISBN 978-0-19-929634-7

[2-7] Renewables 2010 Global Status Report, (REN21) Renewable Energy Policy Network for the 21st Century

[2-8] World Commission on Environment and Development (WCED) (1987), Our common future, http://www.un-documents.net/wced-ocf.htm, last accessed in September 2011

[2-9] Renewables 2012, Global Status Report, REN12, 2012.0611, http://www.ren21.net/Portals/97/documents/GSR/GSR2012_low%20res_FINAL.pdf, last access: 2012.10.30

3 Project description

3.1 Introduction

The proposed project is a 117 MW wind energy project ("wind farm" or the "project") to be located in rural land in the Governorate of Tafila. The project is located to the northeast of the existing Lafarge Rashidiya cement plant and east of the town Gharandil. The development group and sponsor for the Tafila Wind Project, Jordan Wind Project Company PSC (JWPC) executed a MOU with the Ministry of Energy and Mineral Resources in June 2011 to evaluate potential of a wind energy facility in the Tafila area. The area was selected based on its low intensity of human habitation, proximity to existing transmission infrastructure, expected favorable wind resource, and its low impact on the nature and environment.

This wind farm is aimed to supply Jordan with approximately 388 GWh/a of clean, renewable and environmental friendly energy and will save approximately 245,992 t CO_2/a compared to an oil-fired power plant [3-1]. In addition to CO_2 savings, the project will save approximately 1.3 million m^3 of water per year which equals the consumption of 400.000 households. The water savings are related to savings of fuel plants which consume a lot of water for cooling.

The project company, which owns the project and which will be named in all permits and authorizations, is Jordan Wind Project Company PSC (JWPC).

The project consists of the following major components:

- 38 wind turbine generators (WTG) with tubular steel towers;
- 38 reinforced concrete foundations;
- One project substation (electrical substation) (Figure 3-8), electrical protection, transformation, and metering equipment;
- Grid connection to existing 132kV overhead line via overhead cables
- Underground electrical & communication cables;
- Access roads;
- Crane pads and laydown areas;
- Permanent wind measurement tower(s);
- Temporary construction compound;
- Spare part compound and warehouse close to substation;
- Site operation building close to substation.

Construction of the project is planned to begin in 2013, and will continue for approximately 18 months. The project will operate for 20 years, after which the project will be decommissioned and the equipment fully removed. The turbine supplier Vestas will be contracted under a Design-Build-Operate-Maintain Contract and shall be responsible for the whole wind farm construction as a general contractor. Besides

Vestas NEPCO will execute the works required for the grid connection on the 132kV side of the substation.

The project will require maintenance and operations staff to ensure uninterrupted operation during its lifetime. Although the wind farm is operated remotely in general and can be considered as self-controlled power plant, permanent site facilities (site operation building) are foreseen enabling the technical operation and maintenance teams to operate the wind farm on site if this should be required. Whereas Vestas will be responsible for the maintenance of the whole wind farm, the overall responsibility for the safe and effective operation rests in JWPC's responsibility. To ensure JWPC will set up or hire an external technical operation team who shall supervise independently Vestas' performance and their compliance with all applicable regulations.
Wherever possible, local labor will be trained and employed to operate and maintain the facility.

3.2 Location

The project is located in the Governorate of Tafila, and the Directorates of Arady Busayra and Arady at Tafila. The project area is located east of the town of Gharandil and northeast of the Lafarge Rashidiya cement plant. The Dana Biosphere Reserve is located south west of the project area, with a distance of approximately 4,300 m between the reserve border and the project site border. The Lafarge Rashidiya cement plant lies in between the project area and the reserve.

3.3 Terrain description

The land in the project area is moderately hilly and rocky, with sparse vegetation. Elevation of the project area varies from 1,400 to 1,600 m.

There is some seasonal grazing activity in the area (sheep, goats), and wheat is grown in the small areas which support agricultural cultivation. There are no permanent dwellings or other structures in the project area that would be affected by the construction or operation of the project.
There are no water sources available at surface level. Water for the area is obtained from wells in the nearby town of Gharandil, and from wells located to the north of the project area.
The site is periodically used by farmers and shepherds (further definition is given in chapter 15) who camp in the region during summertime.

JWPC is acquiring private land through lease agreements with the owners which extend for the life of the project. Government land required for the project will also be acquired through a lease agreement, executed with the appropriate government department at market rates. All lease agreements which are required for the realization of the project are or will be concluded at market rates and on the same price level to avoid any overreaching among the involved parties.

3.4 Land use

The maximum total footprint of the project is approximately 13,44 km², which equates to approximately 100 land parcels. Each turbine requires approximately 1.25 Dunum or about 1,250 m², including crane pad; the actual land area affected by the installation of infrastructure will be a small portion of the total project footprint. The land which is not directly affected by project infrastructure will be left to its original state, allowing for continuation of current land use patterns, and minimal disturbance to flora and fauna in the area.

3.5 Time schedule

The Project will be developed and executed in four phases.

- Pre-construction, until first quarter of 2013 – e.g. site assessment, wind measurement, grid assessment, environmental and social impact assessment;
- Construction, until 2014;
  Figure 3-7 gives an overview on the preliminary timetable for the project construction.
- Operation until 2034;
- Decommission in 2034 – deconstruction of the entire wind farm and restoration of the area.

Figure 3-7 gives a general overview about the proposed activities and works which will be performed during the Wind Farm's construction period. This schedule is supposed to give an indication only and will be updated and agreed between the project parties prior to the start of construction.

3.6 Project components

3.6.1 Turbine

The turbine manufacturer and supplier for the Tafila wind farm will be Vestas. According to preliminary analysis, the best-suited turbine type for this location is the Vestas V112 with a capacity of 3.075 MW. 38 turbines will be installed in Tafila. Depending on the spatial wind conditions four turbines will have a hub height of 84m and 34 turbines will have a hub height of 94m. Information about the specifications of the turbine can be found in Table 3-1.

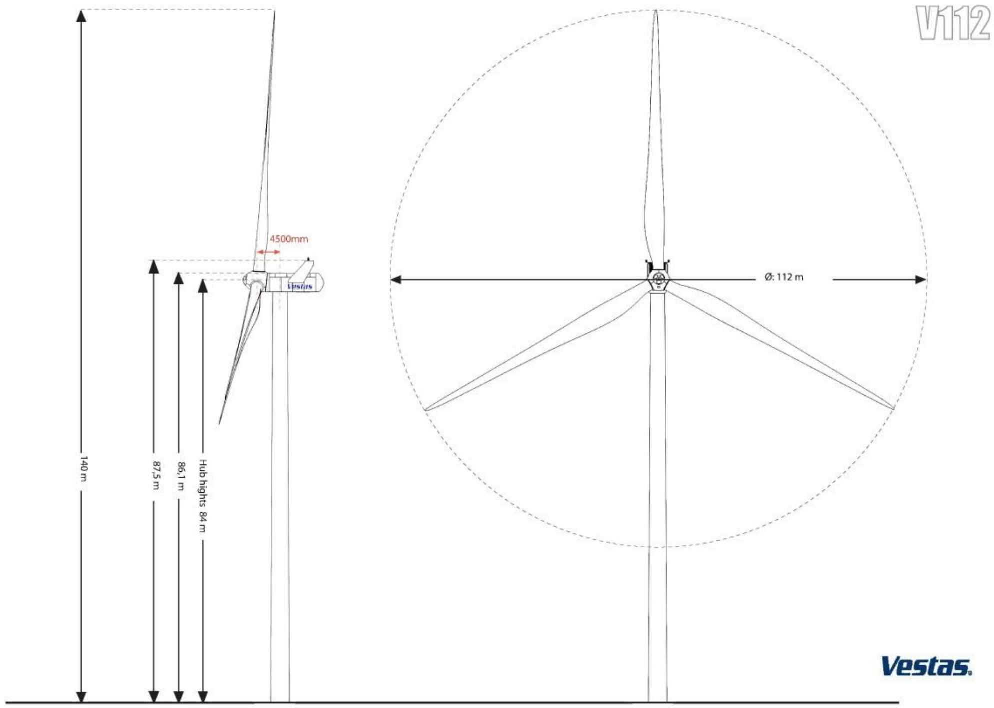


Figure 3-1: V112 side-view

Table 3-1: Specification of the chosen WTG

Specification	Vestas V112
Number of WTG	38
Capacity	3.075 MW
Hub height	84 m / 94 m
Rotor diameter	112 m
Blade length	54.65 m
Number of blades	3

The basic components of a wind turbine include:

- Conical tubular tower sections made of steel;
- Rotor blades, fiberglass, reinforced epoxy and carbon fibers;
- Nacelle, which houses the generator and the gearbox;
- Hub, which is the central point at which the three blades are connected to the nacelle;
- Generator, which converts mechanical energy into electricity;
- Gearbox;
- Converter;
- Transformer.

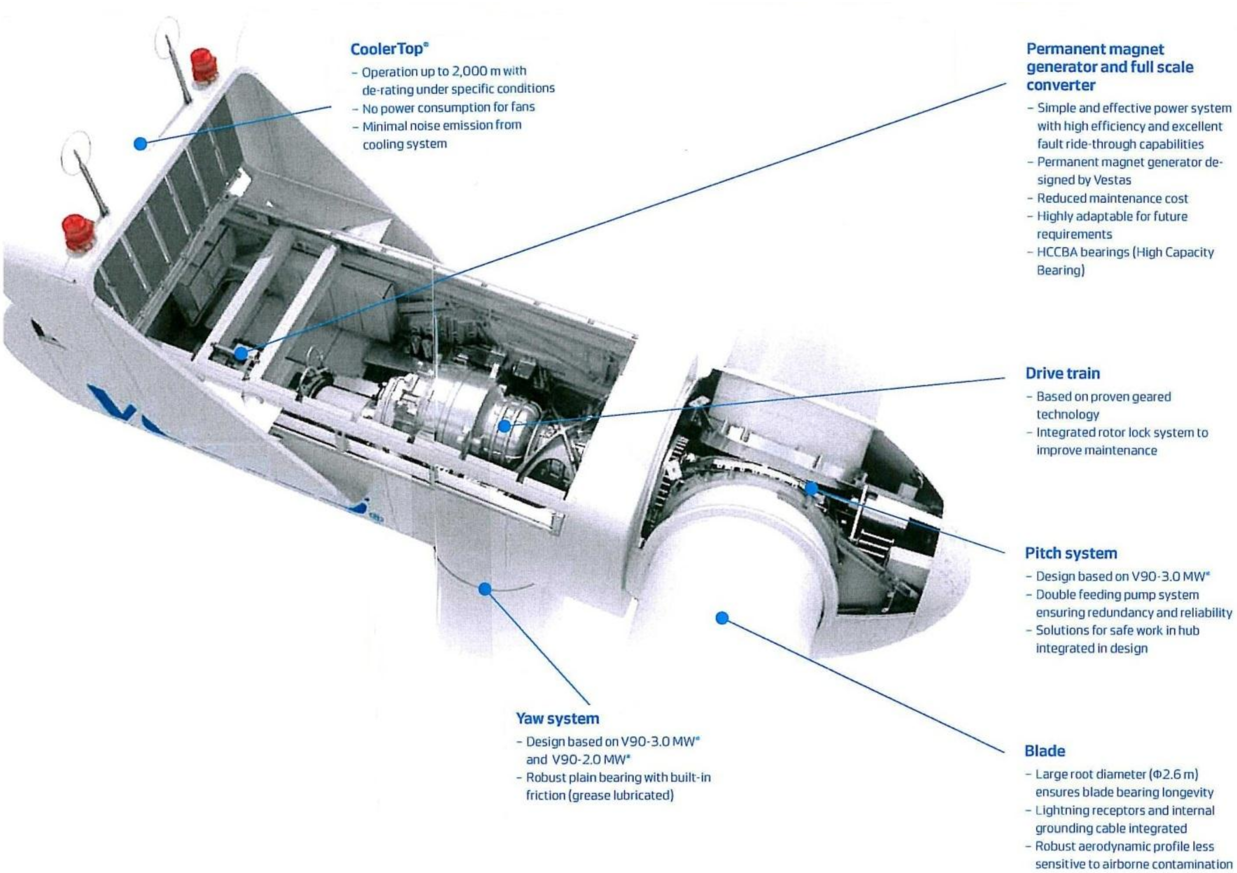


Figure 3-2: Vestas V112 nacelle

The turbine locations were identified using a wind flow model based on a local wind measurement campaign of the area. The interactions of the WTG's have been considered using a state-of-the-art computer model for the wake effect. Areas which are not suitable for turbine placement--due to environmental, topographic, geologic, or other issues--were excluded.

The turbines are spaced at around 4 times the rotor diameter (approx. 450 m) in primary wind direction towards WNW and 3 times the rotor diameter (approx. 350 m) in the secondary direction. Turbine spacing at turbines 4/5 and 35/36 in secondary wind direction is below 3 times the rotor diameter (due to several local constraints). Vestas applied Wind Sector Management (WSM) in order to reduce effective turbulences between turbines and thereby ensuring that the structural load limits of the machines are not exceeded.

The turbines will be painted light-grey, with aviation safety lights at the top of the nacelle. Upon request by the responsible authorities, the tips of the blades may be painted orange or red, to improve visibility during daytime.

Access for maintenance personnel is provided via a secured door at the base of the turbine. An elevator and a ladder are installed within the tower to enable the maintenance personnel access to the maintenance area in the nacelle.

3.6.2 Turbine foundations

The turbines will be fixed to the ground and stabilized via reinforced concrete foundations, which will ensure that the turbines remain stable under any foreseen conditions. The foundations will be constructed below ground level, and soil will be placed over the foundation to return the visible area to nearly its original condition.

A typical foundation diameter is 20m, with a depth of 2.5m, depending on the WTG and the subsoil. The actual final design of the foundations will be determined by a geotechnical study which is currently under performance.

3.6.3 Site substation

The project will require an electrical substation which serves as the central point for electricity collection and transformation of the electricity to the transmission system. This will also be the hub for the data collection and communication system.

Figure 3-3: Example of Substation

3.6.3.1 Electricity collection and transformation

The site substation's primary role is to collect the electricity from the turbines, measure the characteristics and quantity of electricity being produced, perform corrective or compensatory action where necessary, and transform the voltage from a medium voltage level (33kV) to 132kV before being injected into the adjacent National Electric Power Company (NEPCO) transmission line.

The existing 132kV NEPCO Rashidiya-Al Hasa transmission line runs on a north-south course through the center of the project area, and as such, the site substation is planned to be located in the center of the project area, and in close proximity to this NEPCO power line. This arrangement will minimize the amount of infrastructure required to connect the project to the NEPCO system, with a corresponding reduction in the environmental impact associated with transmission infrastructure. In order to connect the proposed substation to the 132kV portion of the substation, approximately 250 meters of overhead cable will be required to be added to the Rashidiya / Al Hasa circuit. One of the existing transmission structures will be removed, and replaced by two new structures to facilitate the connection.

3.6.3.2 Data collection / communication system

The project substation is the central point for the Supervisory Control and Data Acquisition System (SCADA System) and a limited amount of data communications and switching equipment will be located in the substation.

The project substation will address the following requirements and be secured with a fence:

- Transformation and transmission of electricity;
- Electrical protection (i.e. switchgear, breakers, grounding), metering, and control;
- Communication and monitoring (SCADA System, etc.);
- Weather protection where necessary;
- Lighting, security, and safety equipment.

3.6.4 Underground electrical and communication cables

The turbines will transmit electricity to the project substation via underground electrical cables. Typically, several turbines are connected in line to form a "string," with these strings converging to a centrally located site substation.

In addition to the cable required for electrical transmission, fiber-optic communications cable is typically buried parallel to the electrical cable. This communication cable allows for the high speed transfer of data and signals between the turbines and on to the sited substation.

The cables will be buried at a depth down to 1 m, depending on the soil conditions, and backfilled with sand and soil and the topsoil returned to its natural state. The cables will be buried in land that is leased by JWPC, or besides existing roads in the project area.

3.6.5 Overhead cables

In areas where it is impossible or impractical to bury electrical and communication cables, the project may be required to construct overhead structures on a limited basis.

Such overhead structures may be required in one of the following cases:

- Cables between turbines;
- Cables between turbines and project's substation;
- Cables between project substation and NEPCO transmission line.

If overhead structures are required the structures will be of either metal or concrete construction, with a height of 8 – 20 meters. In this case detailed planning will be required.

3.6.6 Access roads

The project will require appropriate roads for access and hauling of WTG during construction and operation. These roads will be made of compacted soil and gravel, and approximately 5 meters wide.

The roads will mostly follow the path of existing, legal roads in the project area. In situations where an existing road is not available or appropriate for the transportation of WTG, a new road will be

constructed on land which is leased by JWPC. After construction these roads will be available for use by locals for agricultural or grazing transportation requirements and will be an improvement for local residents.
At any time the best solution for the environment will be considered.

3.6.7 Crane pads and assembly areas

For the assembly of turbine components and the operation of a crane for erection of the turbines, a limited amount of flat, compacted ground, about 1.25 Dunum (1,250 m²), will be needed. These areas will be on land which is leased by JWPC.

The area for the crane operation (crane pad) will be cleared of rocks and vegetation, leveled, graveled and compacted to provide a stable base for the crane to operate on. Beside the crane pad, additional areas for temporary storage of the blades, the nacelle and the assembly of the crane are needed during the construction phase. These areas are temporary and will be cleared after the turbine installation. The land for the temporary crane pads will be returned to its original condition.

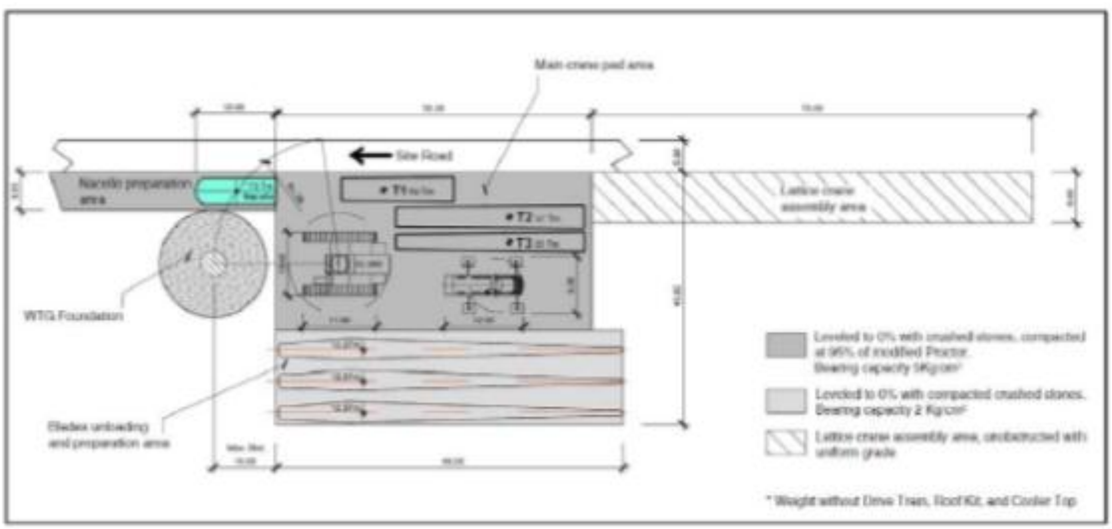


Figure 3-4: Standard V112 crane pad dimensions

3.6.8 Wind measurement tower

According to the Power Purchase Agreement (PPA) the wind farm will be equipped with one permanent wind measurement mast in the project area. This tower will be used to verify the wind speeds of the area, and set up a forecast model for the wind farm's generation for NEPCO's dispatch center (e.g. intraday or/and day ahead predictions).

Four to eight temporary masts might be installed 2-3 months prior to the installation of the turbine towers and will be dismantled latest nine months after commissioning of the Wind Farm. The masts are required for the purpose of turbine testing (site calibration and power curve measurements). These masts will be operated during a short period of time. Foundations or anchors will be removed.

Such masts will have 84 or 94 m of height (similar to the selected hub height), and of tubular steel or lattice steel construction. The towers will include measurement sensors, data collection and communication equipment, and aviation safety markings. The towers will be supported laterally by steel cables which are fixed into the ground around the base of the tower. These steel cables will be marked to avoided collisions with birds. Low voltage signal cables between these masts and its closest turbine (in a distance of 2-4 RD) will be temporary laid on the ground and removed after the measurements without any impact on the environment.

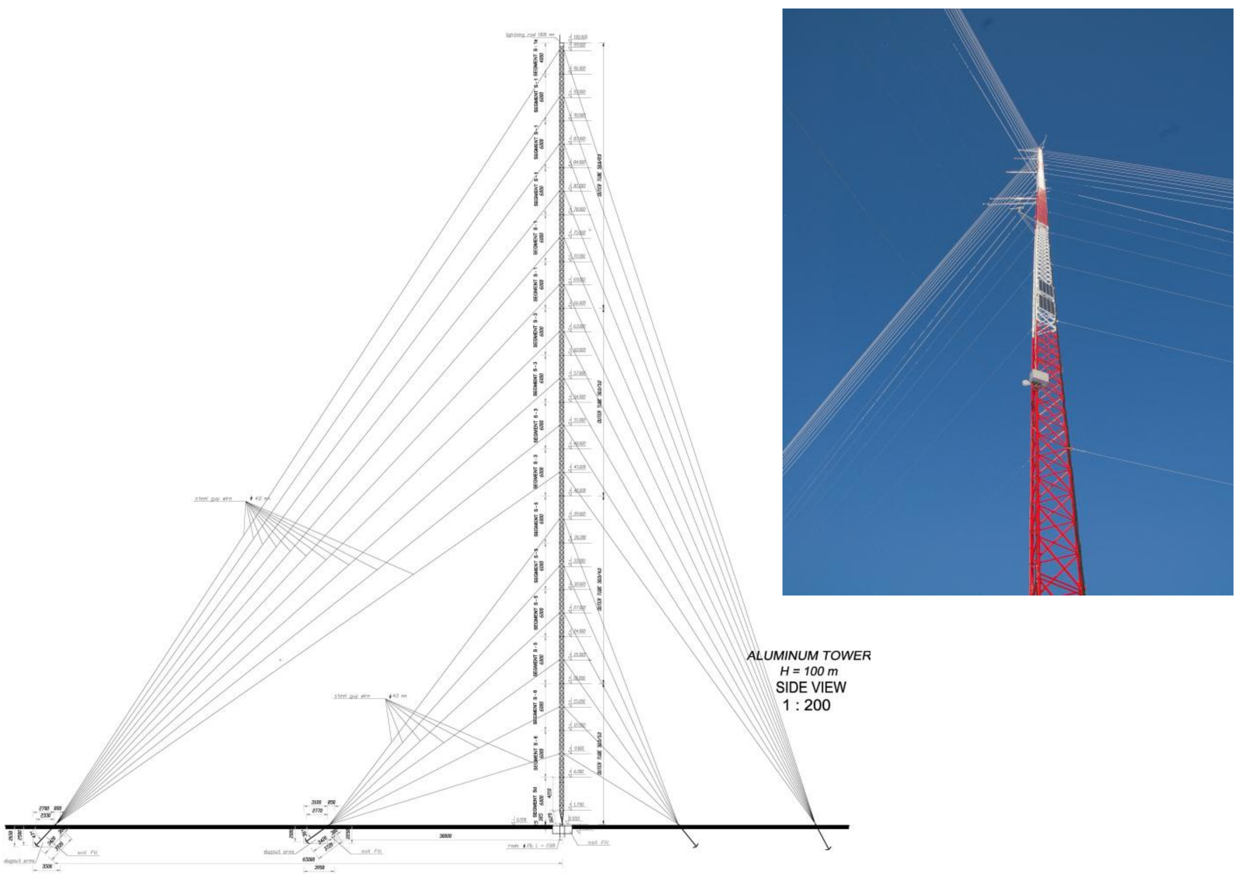


Figure 3-5: Schematic view of wind met mast

3.6.9 Construction compound

A temporary, central construction compound will be established which will contain the offices and temporary structures required to supervise construction. The required area will be cleared of rocks and vegetation, graveled, leveled and compacted. This compound will be securely fenced and guarded. Temporary items to be included in the compound include:

- Office containers;
- Storage areas for equipment;
- Parking areas;
- Bathroom and waste collection facilities;
- Equipment for power generation;
- Communications equipment;
- Other miscellaneous small items as required.

After completion of construction, the construction compound will be disassembled, and the area will be returned to its original condition.

3.6.10 Construction

Construction is planned to commence in mid-2013 and conclude in Q3 2014 (18 months estimated). Vestas as designated turbine supplier will be contracted under a Design-Build-Operate-Maintain Contract and shall be responsible for the whole wind farm construction as a general contractor. Although the works will partially be carried out by subcontractors, Vestas will be the only counterpart for JWPC during the construction for all turbine and Balance of Plant (BoP) related activities. Besides Vestas, NEPCO's subcontractor(s) will be responsible for the works that need to be performed on the high-voltage side of the substation. Besides these parties JWPC will hire an independent supervisor who shall be responsible for checking the works' compliance with the applicable regulations and provisions of this ESIA and the related documents.

Details about the number of on-site personnel are not available yet and are subject to final agreements between Vestas and their subcontractors. More detailed information about the expected traffic during the construction period is given in chapter 14 of this ESIA.

Construction methods will be conducted according to IFC, OHSAS 18001:2007 health and safety guidance and Jordanian Health & Safety guidelines. Vestas will establish a permanent security team on site during the construction period to ensure that possibilities for access to site facilities by 3rd parties are limited as much as possible. An HSE (Health, Safety and Environment) plan will be implemented and monitored throughout the whole construction period. More details are given in chapter 11 of this ESIA. On-site environmental, archeological, and safety monitoring will be in effect during the entire construction period. Further information on the monitoring is provided in the Environmental and Social Mitigation and Management Plan (ESMMP).

3.6.11 Operation

The project is anticipated to have an operational life of 20 years. During the operation period, the project will be operated and maintained by a team of technicians which will ensure safe, reliable operation of the turbines and other electrical equipment year round.
Similar to the construction phase Vestas will be the only contractual partner for JWPC for the maintenance services of the wind farm. Whereas Vestas shall be responsible for the WTG maintenance, its subcontractor will be responsible for the BoP maintenance. In addition JWPC will hire external consultants for the commercial, technical and operational services. The scope of this company shall be the supervision of Vestas' performance and the checking of Vestas' compliance with local and contractual regulations.
Permanent on site personnel is not foreseen during the operation period as wind farms are remotely operated and self-controlled power plants. Nonetheless some office facilities are planned in the substation and warehouse building enabling JWPC or Vestas to allocate adequate facilities in case this should be required in certain periods (e.g. maintenance substation, replacement of WTG components).

Environmental issues will be monitored during the operations period as required.

3.6.12 Decommissioning

Following the end of its operational life, the project will be decommissioned and all equipment and structures removed. The turbine foundation will be removed up to a depth of approximately 1 m and backfilled with soil. The entire site, including all flattened areas (e.g. storage areas and crane pads) will be reclaimed to a state nearly identical to their original condition.

3.7 Design optimization process

Throughout the development process, the results of the environmental surveys have influenced the wind farm layout, which has been continuously adapted and improved to mitigate potential impacts, where possible. The following principles were followed:

- Avoiding key habitats of flora and fauna;
- Avoiding of areas with archaeological interest;
- Avoiding impacts on residents;
- Complying with the overall project design strategy.

Of special interest were the designated turbine areas and the number of turbines. In order to prevent any negative impacts on the archaeological structures on the site, archaeological experts analyzed each preliminary turbine location for ancient constructions. In the case of a historical monument the archaeological expert proposed a new turbine location.

Ecologically valuable locations were considered and restricted for wind turbines. To avoid bird strikes, observed bird flight paths were taken into consideration while choosing the final layout. Turbines were

located at sufficient distance away from inhabited regions to minimize impacts from noise and shadow-flickering.
The turbine supplier Vestas was involved in the design optimization process as early as possible ensuring their approval for the suitability of WTG and wind farm layout with respect to the site and wind conditions.

The number of turbines was adapted due to the following reasons:

- To improve the visual impression from certain views;
- To optimize the energy yield;
- To avoid damaging archaeologically valuable sites;
- To avoid locations within ecologically valuable regions;
- To avoid impacts on domestic and migrant birds.

3.8 List of reference

[3-1] International Energy Agency, 2012: www.iea.org/media/freepublications/2012/CO2Highlights2012.xls, last access: 2012.12.10

Figures

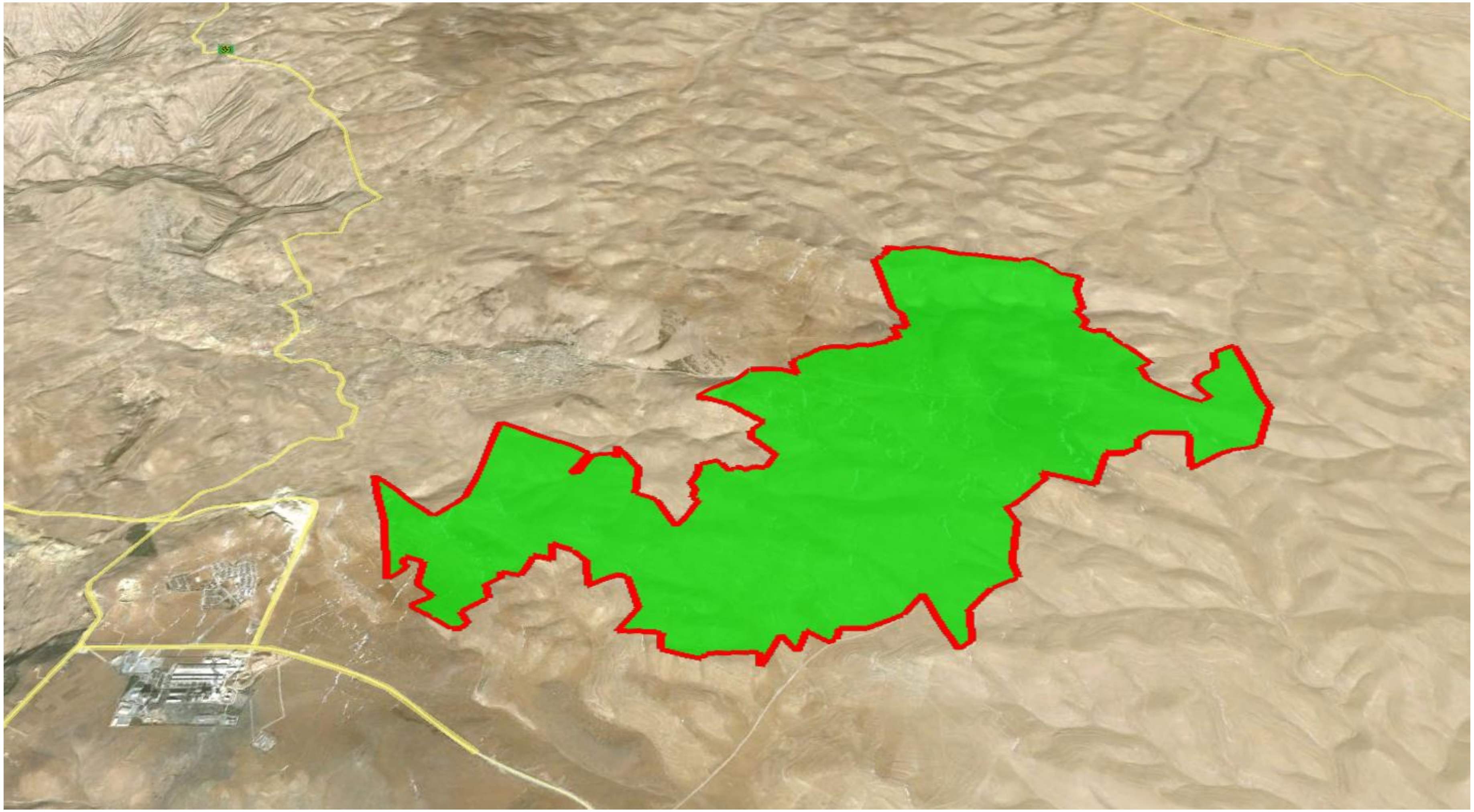
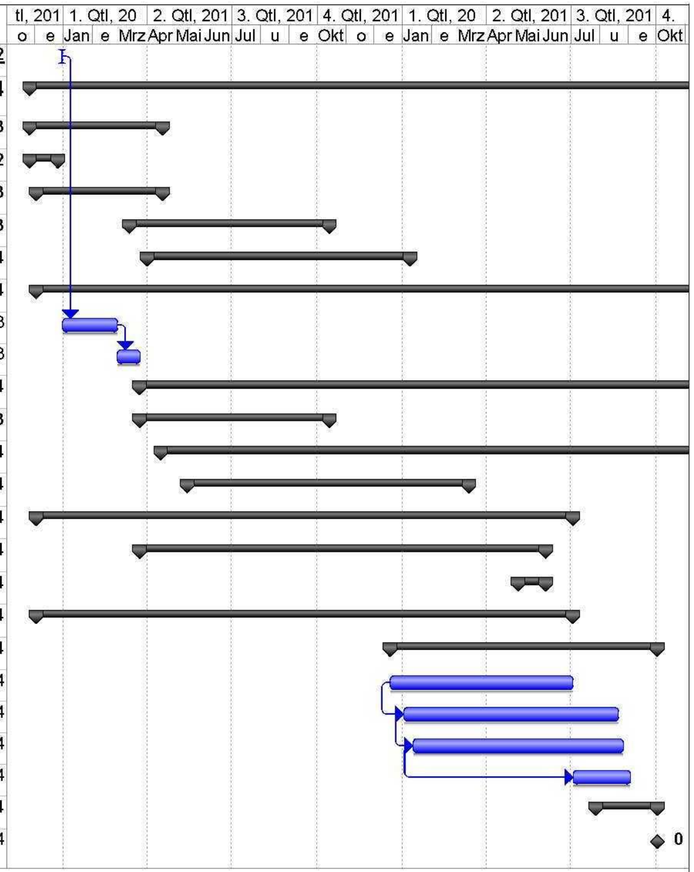


Figure 3-6: Project area

Nr.	Task Name	Dauer	Anfang	Ende
1	FC CONDITIONS FULFILLED - FINANCIAL CLOSE	1 Tag	So 30.12.12	Mo 31.12.12
2	**Design Build period**	**480,38 Tage**	**Mo 26.11.12**	**Do 20.11.14**
3	**ENGINEERING**	**95,5 Tage**	**Mo 26.11.12**	**Mi 17.04.13**
4	**PERMITS**	**21 Tage**	**Mo 26.11.12**	**Mi 26.12.12**
6	**CIVIL DESIGN**	**90,88 Tage**	**Mo 03.12.12**	**Mi 17.04.13**
10	**WTG MANUFACTURING**	**141,88 Tage**	**Mi 13.03.13**	**Mo 14.10.13**
25	**WTG TRANSPORT**	**187,88 Tage**	**Mo 01.04.13**	**Do 09.01.14**
45	**CONSTRUCTION**	**475,75 Tage**	**Mo 03.12.12**	**Do 20.11.14**
46	Mobilzation	2 Monate	Mo 31.12.12	Do 28.02.13
47	Site installation	3 Wochen	Do 28.02.13	So 24.03.13
48	**CIVIL WORKS**	**401,88 Tage**	**So 24.03.13**	**Do 20.11.14**
49	**ROADS**	**135 Tage**	**So 24.03.13**	**Mo 14.10.13**
54	**Crane Pads**	**386,88 Tage**	**Di 16.04.13**	**Do 20.11.14**
59	**FOUNDATIONS**	**201,13 Tage**	**Di 14.05.13**	**Do 13.03.14**
69	**ELECTRICAL WORKS**	**383,13 Tage**	**Mo 03.12.12**	**Do 03.07.14**
70	**MV Cabling**	**289,25 Tage**	**So 24.03.13**	**Mi 04.06.14**
77	**SCADA**	**20 Tage**	**Mo 05.05.14**	**Mi 04.06.14**
79	**SUBSTATION**	**383,13 Tage**	**Mo 03.12.12**	**Do 03.07.14**
90	**WTG erection & commissioning**	**190,38 Tage**	**Do 19.12.13**	**Do 02.10.14**
91	WTG preparation	130 Tage	Do 19.12.13	Do 03.07.14
92	Erection	152 Tage	Do 02.01.14	Do 21.08.14
93	Mechanical Completion	150 Tage	So 12.01.14	Di 26.08.14
94	Commissioning & Start-up WTGs	40 Tage	Do 03.07.14	Mi 03.09.14
95	**Testing**	**45 Tage**	**Mo 28.07.14**	**Do 02.10.14**
98	**TOC //COD**	0 Tage	Do 02.10.14	Do 02.10.14



Project: 121001_Tafila Project Schedu
Date: Mo 01.10.12

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

Figure 3-7: Timetable for the construction phase

Project·substation¶

Figure 3-8: Turbine locations and corresponding structures

Figure 3-9: Wind Farm Design

4 Scoping and consultation

4.1 Introduction

A scoping study has been carried out at an early stage in the process of environmental and social impact assessment. A study like this is designated to ensure that the environmental study provides all the necessary information on the potential impacts of the project, any possible alternatives to the project and any other relevant matters that the planning authority may require in order to determine the planning application.

4.2 Scoping

A scoping session was held on December 5th, 2011 in Amman. In the scoping session the project was described and general questions about the wind energy were responded to. Each environmental issue was discussed with the attending non-governmental organizations (NGOs), national and international stakeholders and ministerial representatives. A list of the participants is added in Annex 1.

On the 26th December 2011, a scoping report was submitted to the Jordan Ministry of Environment; at that time the wind farm was planned with an amount of 34 to 60 turbines of different types within the same site boundary as is currently proposed. Details of the former proposed layout are presented in Figure 4-1.

The scoping report was approved on the 8th January 2012 by the Ministry of Environment.

In compliance with the Jordan law sufficient time was granted to comment on the described project, the social and environmental issues to be addressed as well as on the laws and regulations to be complied with. All responses raised by the consultees have been considered and were addressed in the relevant chapters of the ESIA.

Table 4-1 lists the topics raised during the scoping session and refers to the relevant sections within the ESIA.

Table 4-1: List of scoping responses and associated actions by the project company

Topic	Consultee	Summary of consultee's response	Answered in chapter:
Public health	Randa aboid, civil defense	Fire hazardous	Chapter 11
Public health	Randa aboid, civil defense	Visual impact proximity to power line	Chapter 12 Chapter 6.9
Public health	Randa aboid, civil defense	Impact of destroying the fans	Chapter 11
Water resources		Oil change for the equipment	Chapter 7
Ecology	Abd Alrazaq Alhmound, RSCN	Habitat management plan	Chapter 6
Ecology	Ahmad Faouri, Albalqa Applied University	Impact of turbines movement on migration lines of birds	Chapter 6

4.2.1 Objectives

The main objectives of the scoping were:

- Identification of stakeholders and NGOs to be involved in the process of the ESIA;
- Introduction of the project to the public, regulatory authorities as well as national and international stakeholders and non-governmental organizations (NGO);
- Identification of the key environmental issues to be assessed in the ESIA;
- Identification of the legal requirements and framework for the project through its life cycle;
- Identification of the relevant component studies to establish the baseline conditions for the project area;
- Collect, acknowledge and incorporate comments and suggestions of the public, regulatory authorities and stakeholders into the scope of the ESIA;
- Determine the terms of reference (TOR) of the ESIA;
- Determine the relevant legal frameworks and legislations for the ESIA.

4.2.2 Methodology

The scoping process was conducted according to the following Jordanian methodology:

- The Ministry of Environment (MoEnv) decided to conduct a scoping session for the ESIA in accordance with the EIA- and MoEnv regulations for the assessment of projects;
- The MoEnv prepared a list of relevant stakeholders, NGO's and regulatory authorities. This list was complemented by the study team, especially to consult international stakeholders like BirdLife and the Royal Society for the Conservation of Nature (RSCN);
- The MoEnv issued an invitation for the scoping session on December 5th, 2011 in the Holiday Inn Hotel in Amman;
- Conducting of the scoping session;
- A fixed time period was set to comment on the projects, the TORs and the legal frameworks and legislations;
- A scoping report was submitted to the MoEnv;
- The MoEnv has approved the scoping report and the TORs listed in the scoping report.

4.3 Legal requirements and framework

The following regulations and guidance are the baseline of the ESIA. These were agreed on during scoping.

4.3.1 National

- Environmental Protection Law No. 52, year 2006;
- Environmental Impact Assessment Regulation No.37, year 2005;
- Regulation of Organizing and Management of the Ministry of Energy and Mineral Resources, No. 26, year 1985
- General Electricity Law, No. 64, year 2002 (temporary law);
- Renewable Energy and Energy Conservation Law No. 3, year 2010 (temporary law);
- Acquisition Law, No. 12, year 1987;
- Public Health Law, No. 47 Year 2008;
- Regulation of protection of birds, wildlife, and hunting (34/2003);
- The Antiquities Law No.21, 1988, and its amendment;
- Transport law 89/2003;
- Traffic Law (No. 49, 2008);
- Civil Defense Law (No. 18, 1999);
- Municipalities Law, No. 14, Year 2007
- Water Authority Law No. 18 of 1988;
- Underground Water Control By-Law No. 85 of 2002;
- Instructions of "Management of Waste Oils" 2003;
- Management of Solid Waste, No. 27, Year 2005;
- Protection of Air, No. 28, Year 2005;
- Jordanian Noise Regulations, 2003;
- The Labor Law, No. 8, Year 1996 and its amendment;
- Law of crafts and industries No. 16, 1953 and its amendment;
- Agriculture law No. 44, year 2002;
- Jordanian Standards for reclaimed domestic wastewater No. 893 year 2006;
- Ambient Air Quality (Standard No. 1140/2006)-(Dust only).
- Instructions No. (1/2006) for prevention of hygiene mishap which may result from the workers' assemblies. Civil Law No. 43 for the year 1976

4.3.2 International

As the Tafila wind farm will be financed by international lenders (e.g. IFC, EIB) international requirements and guidelines are used for a high quality ESIA:

- IFC Performance Standards, Year 2012
- IFC- Guidance notes
  - Guidance note 1: Assessment and Management of Environmental and Social Risks and Impacts
  - Guidance note 2: Labor and Working Conditions
  - Guidance note 3: Resource Efficiency and Pollution Prevention
  - Guidance note 4: Community, Health, Safety and Security
  - Guidance note 5: Land Acquisition and Involuntary Resettlement
  - Guidance note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
  - Guidance note 7: Indigenous Peoples
  - Guidance note 8: Cultural Heritage
- IFC Policy on Environmental and Social Sustainability, 2012
- IFC A Good Practice Manual for Companies Doing Business in Emerging Markets, 2007
- IFC/WBG Environmental, Health and Safety General Guidelines, Year 2007
- IFC/WBG Environmental, Health and Safety Guidelines for Wind, Year 2007

4.3.3 Key environmental issues

The following key environmental issues were discussed and agreed during the scoping process. Table 4-2, Table 4-3, Table 4-4, Table 4-5, Table 4-6 and Table 4-7 show the key environmental issues and the relevant project phase to which they refer to. The green boxes indicate for which topic and project phase the key environmental issues were anticipated. Accordingly, the project phases of the topics in the white boxes are of a lower concern and do not need to be assessed in detail.

Table 4-2: Public health key environmental issues

Issues	Construction phase	Operation phase	Decommissioning phase
Risk of accidents			
Air quality			
Noise			
Domestic wastewater			
Domestic solid waste			
Public safety			

Table 4-3: Water resources key environmental issues

Issues	Construction phase	Operation phase	Decommissioning phase
Impact on subsurface drainage systems			
Long term impacts on topsoil and erosion			
Wastewater disposal and its impact on groundwater resources			
Solid waste and its impact on surface and ground water resources			
Water requirements			
Floods and rainfall			

Table 4-4: Biodiversity key environmental issues

Issues	Construction phase	Operation phase	Decommissioning phase
Impact on flora			
Impact on wild life			
Impact on migratory birds			
Impact on habitats			

Table 4-5: Socio-economic conditions key environmental issues

Issues	Construction phase	Operation phase	Decommissioning phase
Employment			
Visual impacts			
Land use			
Land acquisition			
Business prosperity			
Stress on infrastructure			
Expected revenue to be received by the Governorate of Tafila			
Impact on tourism and hunting			

Table 4-6: Occupational health and safety key environmental issues

Issues	Construction phase	Operation phase	Decommissioning phase
Medical care and health insurance			
Domestic wastewater			
Domestic solid waste			
Air quality (dust)			
Noise			
Shadow flickering			
Accidents impact			
Employees accommodation			

Table 4-7: Archaeology key environmental issues

Issues	Construction phase
Remaining archaeology	
List if monuments / remains recorded	

4.3.4 Legal requirements and framework

National and international laws and regulations are considered in the ESIA. The designated laws and regulations result from the TORs agreed in the scoping process. The different regulations and laws are mentioned in the following relevant chapters below.

Figures

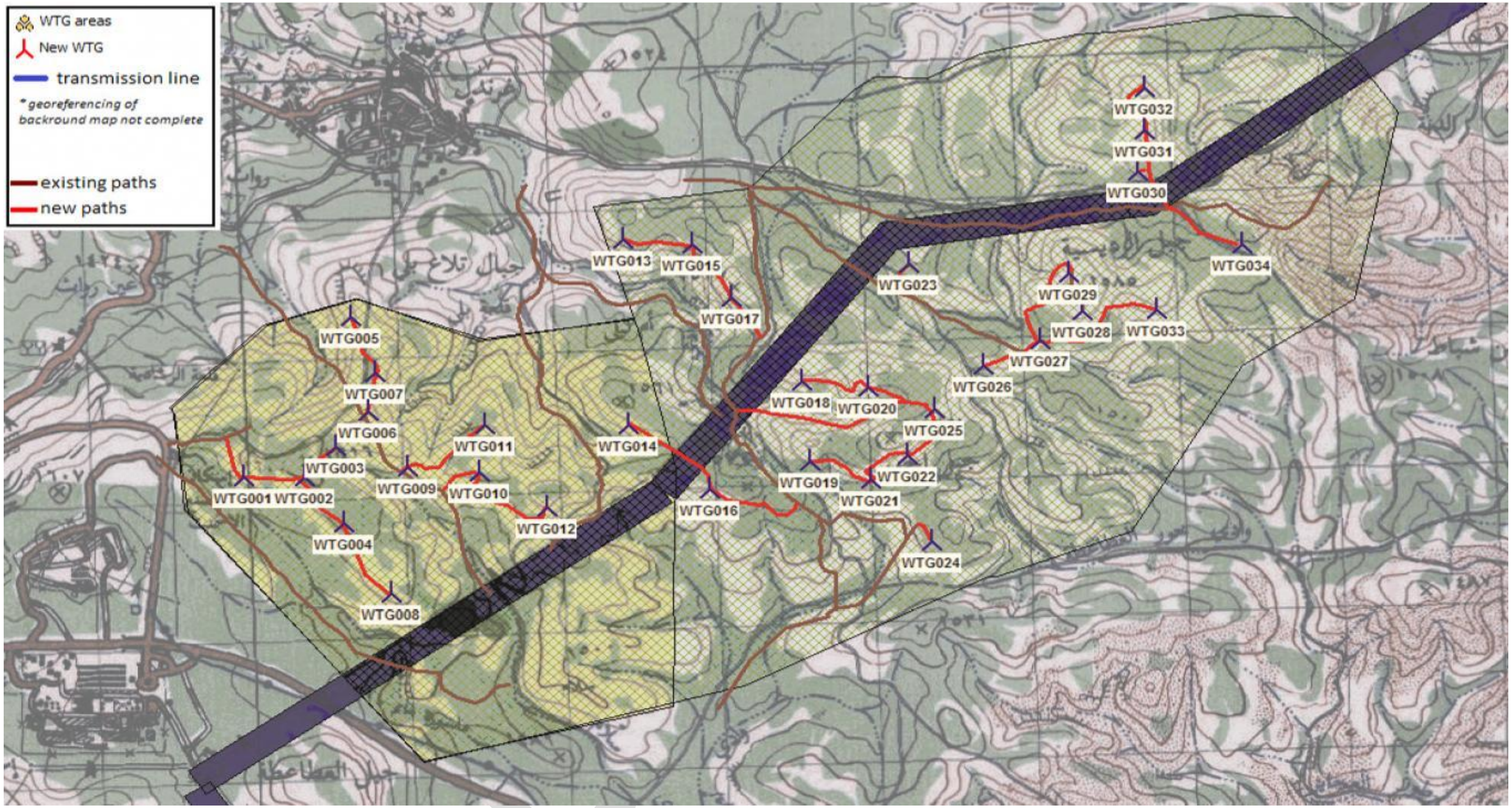


Figure 4-1: Proposed wind farm layout during the scoping session

5 Policy framework

5.1 Introduction

The purpose of this Chapter is to set out the regulatory and planning framework relevant for the proposed Tafila wind farm. The legislation is summarized in chapter 4.3.
The general permit flow of the ESIA is presented in Figure 5-1.

5.2 Institutional framework and mandate

This chapter summarizes the tasks of the Jordan authorities in relation to the wind farm development.

5.2.1 Ministry of Environment (MoEnv)

Article 13 of the Environmental Protection Law No. 52 of 2006 empowers the Ministry of Environment to ask any new establishment that might have potential impacts on environment to prepare an ESIA. The Ministry of Environment has issued the ESIA by-law (No. 37, 2005) which includes the procedures for conducting an ESIA in Jordan. The law gives the Ministry the responsibility to provide/review/approve terms of reference and review ESIA study reports.

The projects are referred to the EIA Directorate, and submitted to a Central Licensing Committee that consists of representatives of the relevant governmental authorities such as Ministries of Environment, Ministry of Health, Ministry of Water and Ministry of Agriculture. An approval from the committee is required for licensing, which may have conditions attached to it, before the relevant authorities can grant permission.
A flowchart of the general EIA process in Jordan is added in Figure 5-1.

Once construction/operation of the proposed wind farm commenced, it will be the Ministry’s responsibility for investigating any public complaints against the contractor or proponent.
In addition the Ministry will be responsible for ensuring that environmental monitoring is undertaken to ensure a sufficient standard to prove compliance with national legislation.

5.2.2 Soil examination

An examination of the soil by a licensed agency is required before the construction can begin.

5.2.3 Department of Antiquities

The department of antiquities needs to be contacted in case of archaeological findings. In case of any archaeological findings the department of Antiquities will give permission for the continuation of the project.

5.2.4 Water Authority

The Jordan Water Authority is responsible for water distribution network in the Kingdom. This authority needs to give permission for a project prior to construction. They will identify possible intersections of the project site with water pipes.

5.2.5 Ministry of Energy and Mineral Resources (MEMR)

The Ministry of Energy and Mineral Resources is responsible for the energy sector and will give permission for the electricity feed in into the national electricity grid.

5.2.6 Department of Land and Survey

The Department of Land and Survey will give permission for the project prior to construction.

5.2.7 Ministry of Housing and Public Works

The Ministry of Housing and Public Works will give permission for the project prior to construction.

5.2.8 Ministry of Labor

The Ministry of Labor will give permission for the project prior to construction.
During project operation the Ministry will inspect the wind farm for health and safety measures.

5.2.9 Directorate of Civil Defense

The Directorate of Civil Defense needs to give approval for construction plans. The Directorate issues its final approval after an inspection visit has taken place to the project site to ensure conformity with their requirements.

5.3 Compliance with guidance and policies

The project should fully comply with all relevant guidance and policies, agreed on in the scoping session and the scoping report (chapter 4).

Figures

arm", Appendix 2: "General
IA process in Jordan was
resented. "Suggest to include
his General EIA process
lowchart into this section 5.2.

Figure 5-1: Flowchart of the general EIA process in Jordan

6 Biodiversity

6.1 Introduction

The study focused on obtaining baseline data on the biological environment in the project area, assessing possible impacts of the wind farm and providing mitigation measures necessary to manage any impacts. The following methodology was applied:

- Review and analyze all available literature data related to habitats, flora, fauna and avifauna in the area of the planned wind farm;
- Conducting field survey of flora, fauna and avifauna in the proposed site;
- Assessing potential impacts, if any, due to the proposed activities to endangered species, rare and endemic flora, avifauna and bats;
- Recommending approaches to reduce (and monitor, if appropriate) such impact, if any, to flora, fauna, avifauna, bats and habitats, and to ensure compliance with existing national and/or international protection requirements.

The study was conducted between October 2011 and September 2012. A total of 31 field days form the base of the ecology study of the ESIA for the wind farm in Tafila. The study comprises of two methodology components (literature review and field observations) in accordance to the scoping session and in coherence with the Jordan Ministry of Environment, the EIA committee standards in Jordan [6-35] and the BirdLife international Standards for wind farms [6-31].

The ecological baseline research includes data from the following primary and secondary sources:

- Desktop data from secondary sources;
- On-site monitoring of the wind farm area and the surrounding as primary source.

Information on the flora and fauna of the area was derived from studies, published by universities, the Royal Society for the Conservation of Nature (RSCN), the Jordanian Government (Ministry of Agriculture) as well as from field information collected during the monitoring campaign. The investigation was carried out in linear transects of 500 meters and 20x20 meters of quadratic transects. Six fixed observation stations and four random observation areas were chosen.

As a result of the study, an impact assessment and a mitigation and monitoring plan (for the construction, operational and decommissioning phases) were prepared and are presented in this report.

6.2 Objectives

The study focused on obtaining baseline data on the biological environment in the project area, assessing possible impacts of the wind farm and providing mitigation measures necessary to manage any impacts. This is to satisfy the interest of basic planning for the area and highlight any environmental concern that may arise upon the implementation of the proposed project on the existing biological conditions.
Specifically, the study is focusing on:

- Review and analyze of available literature data related to habitats, flora, fauna and avifauna in the area of the planned wind farm;
- Conducting field survey of flora, fauna and avifauna in the proposed site;
- Identifying and listing all flora, fauna and avifauna species, and related habitats;
- Identifying and locating all plants, animals and avifaunal species and habitats which are endangered or rare;
- Assessing potential impact, if any, due to the proposed activities to endangered species, rare and endemic flora, avifauna and bats;
- Recommending approaches to reduce (and monitor, if appropriate) such impact, if any, to flora, fauna, avifauna, bats and habitats, and to ensure compliance with existing national and/or international protection requirements.

6.3 Guidance

The following national and international laws and regulations were considered:

- Jordan Environmental Law No 12 from 1995;
- Jordan Environmental Law No 52 from 2006;
- Jordan "Environmental Impact Assessment" Regulation No. 37;
- Jordan Agricultural Law no. 44 from 2002, Regulation No. Z/34 from 2003 concerning the protection of birds and wildlife and its management and trade;
- CONVENTION ON THE CONSERVATION OF EUROPEAN WILDLIFE AND NATURAL HABITATS Standing Committee 23rd meeting Strasbourg, 1-4 December 2003;
- Wind farms and Birds: An analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues report written by BirdLife International on behalf of the Bern Convention;
- IFC Guidance note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- IFC/WBG Environmental, Health and Safety Guidelines for Wind, Year 2007;
- BirdLife International Best Practice Guidance for Wind Farm Development for the Conservation of Birds in the Rift Valley – Red Sea Flyway (unpublished);
- Scottish Natural Heritage 2000, Guidance note Series: Wind farms and birds, Calculating a theoretical collision risk assuming no avoiding action.

6.4 Effects scoped out of the assessment

The wind farm project is split into three stages, the construction, operation and decommissioning phase. The impacts of the operation phase on the ecology of the wind farm site varies during construction and decommissioning phase. The impacts of the construction works and of the decommissioning works are similar, even though the latter one is expected to have fewer impacts. Therefore the biodiversity assessment concentrates on the construction and operation phase, describes possible impacts and proposes mitigation measures. The impact assessment and the proposed mitigation measures for the construction phase account also for the decommissioning phase even though the decommissioning is not described in further detail.

6.5 Methodology

6.5.1 Literature review

6.5.1.1 Flora literature review

The flora literature review is based on records in publications from universities, the Royal Society for the Conservation of Nature and the Jordanian Government (Ministry of Agriculture). Furthermore plant species were determined according to records published in the internet.

The literature which was used for the flora literature review is listed in chapter 6.12, under no. [6-1], [6-2], [6-3], [6-12], [6-13] and [6-16]

It should be noted that no official conservation status exists up to date for the flora of Jordan.

6.5.1.2 Fauna literature review

The review relied on previous studies and surveys conducted in the area, especially the national IBA inventory [6-19]. Literature review was conducted for reptiles, birds and mammals. The records are available in hard copies or published electronically presented in Chapter 6.12.

Currently, Jordan has no official conservation status for the fauna. However the conservation status of birds was defined according to IUCN international Red List. As for reptiles and mammals the conservation status was determined according to published data by Amer, Disi et al.

The literature which was used for the avifauna literature review is listed in chapter 6.12, under no. [6-4], [6-5], [6-7], [6-8], [6-9], [6-10], [6-17], [6-19] and [6-22].

6.5.1.3 Avifauna literature review

Literature review on the avifauna was conducted for local raptors and passerines, as well as for migratory birds based among others on records of BirdLife and RSCN, jointly with Jordanian Universities.

The literature which was used for the avifauna literature review is listed in chapter 6.12, under no. [6-11], [6-20], [6-21], [6-24], [6-25], [6-26], [6-27], [6-28], [6-29], [6-30] and [6-31].

6.5.2 Field surveys and observations

Before the start of the monitoring program, three days of field surveys (2nd October, 15th October and 27th October 2011) were used to characterize the site, its habitats and its biogeographic zones. Based on the habitats (flora and fauna) that were observed, six fixed observation points were chosen. Additionally four observation points were chosen randomly in the site to ensure that all habitats of the site were covered.
The coordinates of these ten observation points are shown in Table 6-1 and in Figure 6-3.

Table 6-1: Coordinates of the different observation stations

No.	Observation type	UTM WGS 84	
		X-coordinates	Y-coordinates
1	Station	754,250	3,402,379
2	Station	754,788	3,401,790
3	Station	753,769	3,399,105
4	Station	756,392	3,398,580
5	Station	758,867	3,398,685
6	Station	759,400	3,400,217
7	Random	756,519	3,402,335
8	Random	754,226	3,398,323
9	Random	757,474	3,398,981
10	Random	758,160	3,400,091

The flora, fauna and avifauna survey was carried out in parallel. The results of the field surveys were compared with the data gathered from secondary sources (literature review).

6.5.2.1 Flora filed surveys

A total of 15 field days are the base of the flora field survey dispersed over 12 month of survey. Details of the field days are shown in Table 6-2.

Table 6-2: Filed trips for the observation of flora

No.	Date of survey	UTM WGS 84		Observating persons
		X-coordinates	Y-coordinates	
1	2nd October, 2011	754,250	3,402,379	1
2	15th October, 2011	754,250	3,402,379	1
3	27 October, 2011	754,250	3,402,379	1
4	1st December, 2011	753,769	3,399,105	1
5	2nd February, 2012	758,867	3,398,685	1
6	1st March, 2012	759,400	3,400,217	1
7	14th March, 2012	759,400	3,400,217	1
8	25th March, 2012	759,400	3,400,217	1
9	4th April, 2012	754,788	3,401,790	1
10	15th April, 2012	754,788	3,401,790	1
11	1st May, 2012	753,769	3,399,105	1
12	5th June, 2012	759,400	3,400,217	1
13	16th July, 2012	758,160	3,400,091	1
14	2nd August, 2012	754,226	3,398,323	1
15	29th August, 2012	754,226	3,398,323	1

A quantitative approach of recording flora species was used in addition to the assessment of the species dominance.

Photos were taken of all species that were found. The identification was done using national and regional field guides and other scientific material published in the internet.

Linear transects of 500 meter and quadratic transects of 20 x 20 meters were used at the ten research points shown in Figure 6-3.

Line Transects were used to study changes in vegetation along a physical environmental gradient. In addition, it was also used to estimate overall density of cover values of species in the single type of vegetation that also can be correlated.

Quadratic transects were used to study the vegetation cover, species dominancy as well as land degradations. The size of the quadratic transect was chosen due to the opinion of the expert onsite as the area is very homogeneous of the flora species. Furthermore this size of the quadratic transect is the commonly used size for surveys in international standards.

In addition, satellite imagery was used to delineate habitat types, boundaries, edges and fragmentation areas. For terrestrial flora the vegetation communities were distinguished based on field observations and analyzed in terms of various parameters such as species dominance, coverage, height, species diversity, etc. Flora composition was determined, with emphasis on key species, based on documentation of specimens and identification of plant species.

6.5.2.2 Fauna filed surveys

As agreed in the scoping report the fauna survey investigates only reptiles and mammals. The avifauna is investigated separately.

A total of 8 field days are the base of the fauna field survey, four days for mammals and four days for reptiles, dispersed over 12month of survey. Details of these field days are shown in Table 6-3.

Table 6-3: fauna field survey

No.	Date of survey	UTM WGS 84		Observating persons	Time of observation
		X-coordinates	Y-coordinates		
1	15th June, 2012	759,400	3,400,217	2	06:00am – 12:00pm 04:00pm – 10:00am
2	30th July, 2012	758,160	3,400,091	2	06:00am – 12:00pm 06:00pm – 10:00am
3	18th August, 2012	754,226	3,398,323	2	06:00am – 12:00pm 08:00pm – 12:00am
4	29th August, 2012	754,226	3,398,323	2	06:00am – 12:00pm 08:00pm – 12:00am

Line transects

Line transect technique was applicable for mammals for the identification and counting of the species and recording them at the observation points listed in Table 6-1. During this field surveys footprints, spoors, spines, burrows and body remnants were recorded.

Line transect technique was also used to assess the herpeto-fauna of the project site and the surrounding area. It was used to identify and if possible to count reptile species and their abundance.

Night spot

The spotlight technique was used for the identification of large terrestrial mammals and snakes. This technique was used to identify nocturnal species.

Interviewing technique

This technique was used to study the historical record of the fauna in the area. Interviews were conducted with older residents of Gharandil, farmers and Bedouins using the site regularly to identify local mammals.

Spot Count

This technique was used on random spots allocated within the project area in order to count reptiles such as lizards and agamas. For this study an area of 20 x 20 meters was selected. It is a useful technique to estimate the reptile's density as well as its diversity in the study area and to record any burrows and spallax soil piles.

Bat survey

For bat studies, several caves were explored for detection of bats at the sites or adjacent areas to the planned wind farm. Furthermore night observations on the site were conducted to identify bat activities.

Further to the above explained techniques observations made by coincidence were recorded (e.g. live and dead snakes along access roads).

6.5.2.3 Avifauna filed survey

The avifauna field survey was conducted on 68 observation days as listed in Table 6-4.

Table 6-4: Avifauna field survey

No.	Date	UTM WGS 84		Persons	Time of observation	Observation method
		X-coordinates	Y-Coordinates			
1	2nd October, 2011	754,250	3,402,379	2	06:00am – 12:00pm 04:00pm – 10:00pm	VP, Radial, Linear, Night spot
2	15th October, 2011	754,250	3,402,379	2	06:00am - 12:00pm 04:00pm - 10:00pm	VP, Radial, Linear, Night spot
3	27th October, 2011	754,250	3,402,379	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Radial, Linear
4	5th November, 2011	754,788	3,401,790	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Radial, Linear
5	12th November, 2011	754,788	3,401,790	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Radial, Linear
6	30th November, 2011	754,788	3,401,790	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Radial, Linear
7	1st December, 2011	753,769	3,399,105	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Radial, Linear
8	14th December, 2011	753,769	3,399,105	1	07:00am - 02:00pm	Linear
9	27th December, 2011	753,769	3,399,105	1	07:00am - 02:00pm	Linear
10	3rd January, 2012	756,392	3,398,580	1	07:00am - 02:00pm	Linear
11	9th January, 2012	757,474	3,398,981	1	07:00am - 02:00pm	Linear
12	25th January, 2012	757,474	3,398,981	1	07:00am - 02:00pm	Linear
13	2nd February, 2012	758,867	3,398,685	1	07:00am - 02:00pm	Linear
14	17th February, 2012	758,867	3,398,685	1	07:00am - 02:00pm	Linear
15	26th February, 2012	758,867	3,398,685	1	07:00am - 02:00pm	Linear
16	1st March, 2012	759,400	3,400,217	1	07:00am - 02:00pm	Linear

No.	Date	UTM WGS 84		Persons	Time of observation	Observation method
		X-coordinates	Y-Coordinates			
17	14th March, 2012	759,400	3,400,217	2	06:00am - 12:00pm	VP, Radial, Linear
18	25th March, 2012	759,400	3,400,217	2	06:00am - 08:00pm 04:00pm - 08:00pm	VP, Radial, Linear
19	4 April, 2012	754,788	3,401,790	2	07:00am - 02:00pm 04:00pm - 10:00pm	VP, Linear, Night spot
20	15th April, 2012	754,788	3,401,790	2	06:00am - 12:00pm 04:00pm - 10:00pm	VP, Linear, Night spot
21	1st May, 2012	753,769	3,399,105	1	07:00am - 02:00pm 04:00pm - 08:00pm	VP, Linear
22	11th May, 2012	753,769	3,399,105	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Linear
23	29th May, 2012	753,769	3,399,105	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Linear
24	5th June, 2012	759,400	3,400,217		07:00am - 12:00pm 04:00pm - 08:00pm	Linear
25	15th June, 2012	759,400	3,400,217	1	06:00am - 12:00pm 06:00pm - 08:00pm	Linear, Night spot
26	1st July, 2012	756,519	3,402,335	1	07:00am - 02:00pm 04:00pm - 08:00pm	VP, Linear
27	16th July, 2012	758,160	3,400,091	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Linear
28	30th July, 2012	758,160	3,400,091	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Linear
29	1st August, 2012	754,226	3,398,323	1	07:00am - 02:00pm 04:00pm - 08:00pm	VP, Linear
30	18th August, 2012	754,226	3,398,323	2	06:00am - 12:00pm 04:00pm - 10:00pm	Linear, Night spot
31	29h August, 2012	754,226	3,398,323	2	06:00am - 12:00pm 04:00pm - 10:00pm	Linear, Night spot
32	1st September, 2012	754,250	3,402,379	1	07:00am - 02:00pm 04:00pm - 08:00pm	VP, Linear
33	16th September, 2012	753,769	3,399,105	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Linear
34	30th September, 2012	754,788	3,401,790	2	06:00am - 12:00pm 04:00pm - 08:00pm	VP, Linear

The following methods were used for the avifauna field survey.

Line transects
Line transects were used to study birds in open habitats in the project area. This method was used to identify and count the density of birds at the six fixed- and at the four random observation sites listed above.

Spot Count
This technique was used on the ten observation sites allocated within the project area in order to count residential and breeding birds. For this study a radius of 20m circle was selected where the expert is located in the center and searches for a period of 60 minutes. This technique was used to estimate the density of residential and breeding bird's as well as their diversity in the study area.

Night Spot
Night vision equipment (binoculars) and the spotlight technique were used for the detection of night birds like owls and night migratory birds.

Vantage points
The ten observation points were chosen as vantage points, located in and outside of the project area. The vantage points were located in an open area in order to detect and record the passage of migratory soaring birds during periods of peak migration. The duration of the vantage point observation varied from eight to ten hours a day, one to two days a month. This methodology was also used to document breeding and wintering birds as well as to determine the collision risk of birds with wind turbines.

By the above listed techniques the location, the species, the habitat and the activity of the avifauna was recorded. The frequency and the height of the flights were also noted.

6.6 Baseline

Currently the IUCN Jordan National committee - in cooperation with Jordanian universities, the Ministry of Environment, BirdLife International, RSCN and further national non-governmental organizations - is preparing a “National Red List for Jordanian Flora and Fauna (including avifauna).” Accordingly, there is currently no official conservation status for the flora or fauna of Jordan. Therefore the IUCN international red list species conservation status is used in this study for the flora and fauna of the site and its vicinity.

6.6.1 Area description

The area of the proposed wind farm is hilly, several wadis crossing the site. The vegetation type is degraded due to overgrazing, ploughing and wood collection by local residents. Neither forests nor aggregations of trees exist on the site, except for a planted pine forest near Gharandil town. These pine trees are outside the wind farm area. A public road to Gharandil crosses the wind farm site and causing nuisance on wildlife. Several farmers and Semi-Nomadic people (further definition is given in chapter 15) use the site for livestock grazing.

The planned wind farm site is heavily eroded due to continuous ploughing for rain fed, cereal cultivation and massive grazing activities. Signs of heavy degradation due to grazing and shrubs collection for fire are evident in some parts of the study area, where remains of the Thorny Saltwort can be found. The soil is a mixture of both calcareous and terra rossa. Crevices and rocky areas are common along gorges and wadi providing shelter for several medium sized animals such as foxes and porcupines. The site is characterized by lush vegetation of Thorny Saltwort and Wormwood with an abundance of annual flowering plants in high density.
The site exhibits both Irano-Turanian and Mediterranean features in many aspects (Figure 6-6).
The project area lies within the most western edge of the Irano-Turanian eco-zone at an attitude of about 1,267 m above sea level.

The wadi of Gharandil (Figure 6-5) shows relatively rich vegetation cover due to seasonal flooding where more flowering plants and animal signs were recorded.
Also Dana Biosphere Reserve area shows essential habitat conditions.

Two different protection zones are existent close to the planned wind farm site, the Dana Biosphere Reserve zone [6-32] and the Important Bird area (IBA) [6-33]. The IBA zone is larger than the one of the biosphere reserve.
The western edge of the project area slightly overlaps with the eastern border of the Dana IBA (Figure 6-4 and Figure 6-8).
The Dana IBA exists since 2001 and has a size of approximately 31,000 ha. Its altitude changes from -200 to 1,200 m above sea level. The IBA has several different habitats e.g. rounded mountains, sandstone cliffs, metamorphic rocks, mobile sand dunes, woodlands and extensive areas of herbs and shrubs. The area is mainly the same area as the Dana Biosphere Reserve. Therefore the main land use in the IBA is wildlife conservation research and tourism.
The avifauna species that can be observed in the Dana IBA are a very diverse assemblage of breeding birds and migratory birds. Especially the Arabian Babbler, the Sand Partridge, the Upcher's Warbler, the Tristram's Starling and the Pale Rosefinch are known to reside in the area. A list of species appearing in the IBA can be found in Annex 2 [6-36].

On its eastern borders, the study site is located approximately 4.3 km afar from Dana Biosphere Reserve. Dana Biosphere Reserve is Jordan's largest nature reserve, located in south-central Jordan. The reserve was founded in 1989 in the area in and around Wadi Dana. The area comprises 308 km² and sweeps down in a series of mountain ridges from approximately 1,500 m above sea level to the Jordan Rift Valley at approximately -200 meters above sea level. The Dana Biosphere Reserve is intersected by many steep-sided wadis, often lined with a lush growth of trees and shrubs. Its geology is as varied as its landscape, changing from limestone to sandstone and granite.

As the Biosphere Reserve is the only reserve in Jordan that includes all four bio-geographical zones of the country (Mediterranean, Irano-Turanian, Saharo Arabian and Sudanian), it is the most diverse nature reserve in the country in terms of habitats and species, hosting several vegetation types.
More than 703 plant species , 215 bird species and 38 mammal species can be found within the reserve. Three flora species of these have only ever been recorded in Dana.

6.6.2 Literature review

6.6.2.1 Flora

Several studies have been conducted to identify the flora of southern Jordan (Boulos, 1977; Boulos et al. 1977; Al-Eisawi 1980, 1982, 1983, Al-Oran, 1994, 1995). Moreover, several other works aimed to identify the bioclimatic subdivisions in Jordan and the corresponding vegetation types (Al-Eisawi, 1985, 1997, Long, 1957, Kruchner, 1986, Poore and Robertson, 1963). Recent studies by RSCN (1995 – 2009, updated Dana Biosphere Reserve Management Plan) refer that more than 800 flora species were recorded in Dana and its vicinity.

The mountainous parts of area belong to the Mediterranean bio-climate which occurs at altitudes between 1,200 and 1,500 m above sea level. Lower altitudes are considered to be Irano-Turanian bio-climate. Eastwards of the project site the Sahro-Arabian desert becomes evident for the arid desert climate.

Table 6-5 shows the flora species known to occur in the study area, especially in the Dana Biosphere Reserve.

Table 6-5: Flora species known to occur in the study area

Scientific name	Common name	Conservation Status
Leontice leontopetalum	Lion’s leaf	Unknown
Alkanna tinctoria	Dyer’s Alkanet	Common
Silene conoida	Catchfly	Common
Anabasis syriaca	Anabasis	Common
Noaea mucronata	Thorny Saltwort	Common
Helianthemum vesicarium	Sun rose	Rare
Achillea santolina	Yarrow Santolina	Common
Artemisia herba-alba	Wormwood	Common
Anthemis melampodna	Chamomile	Common
Tragopogon collinus	Goat’s Beard	Common
Cardaria draba	Hoary Pepperwort	Common
Eruca sativa	Garden Rocket	Common
Mathiola longipetala	Evening Stock	Common
Erodium hirtum	Strok’s Bill	Common

Scientific name	Common name	Conservation Status
Aegilops crassa	Wild crassa	Common
Avena sterillis	Wild Oat	Common
Hordeum glaucum	Wall Barley	Common
Hordeum spontaneum	Wild Barley	Common
Piptatherum holciforme	Grass	Common
Schismus barbatus	Mediterranean Grass	Common
Hypecoum procumbens	Hypecom	Common
Gynandriris sisyrinchium	Gynandriris	Common
Ajuca chia	Chian Bugle	Common
Salvia paleastina	Palestine Sage	Common
Salvia lanigra	Desert Sage	Common
Astragalus cretaceus	Milk Vetch	Common
Astragalus spinosus	Spiny Milk Vetch	Common
Astragalus sparsus	Sleber's Milk Vetch	Common
Gagea reticulate	Gagea	Common
Tulipa polychroma	Desert Tulip	Rare
Glaucium grandiflorum	Poppy	Common
Roemeria hyprida	Roemeria	Common
Plantago cylindirica	Plantin	Common
Adonis aestivalis	Pheasant's eye	Common
Reseda lutea	Yellow Mignonette	Common
Hyoscyamus reticulatus	Egyptian Henban	Common

6.6.2.2 Fauna

Some scattered information on the natural history of the area is published along with other studies on fauna. In a study on the reptiles of southern Jordan, El -Oran et al. (1994) collected several snake species in the vicinity (Table 6-6).

Reptiles

Disi et al. (2000) included records of various lizards from Shoubak area close to the project site, covering both the Irano-Turanian and the Mediterranean bio climates. Additionally, Disi & Hatough-Bouran (1999) reported one species of amphibians and 42 species and subspecies of reptiles belonging to two orders and twelve families. They indicated that two reptilian species--European Chameleon and Roth's Dwarf Snake (Table 6-6). RSCN updated records in the Dana Biosphere Reserve Management Plan and other research reports list the amount of reptilian species of Dana Biosphere Reserve and its vicinity.

Table 6-6: Reptile species known to occur within the study area

Species	Common Name	Conservation status
Family Gekkonidae		
Ptyodactylus hasselquistii	Fan-footed gecko	Common to Middle East and Jordan
Family Chamaeleonidae		
Chamaeleo chamaeleon	European chameleon	Endangered
Family Agamidae		
Laudakia stellio	Starred agama	Common
Family Lacertidae		
Acanthodactylus boskianus	Bosk's fringe-toad lizard	Common
Ophisops elegans	Snake-eyed lizard	Common
Family Scincidae		
Chalcides ocellatus	Ocellated skink	Common
Family Colubridae		
Coluber jugularis	Large whip snake	Common
Coluber rubriceps	Red whip snake	Common
Coluber nummifer	Coin snake	Common
Eirenis rothi	Roth's dwarf snake	Rare
Eirenis coronella	Crowned dwarf snake	Common
Malpolon monspessulanus	Montpellier snake	Common
Telescopus nigriceps	Black-headed cat snake	Common

Mammals

There are several studies available on the mammals of southern Jordan, particularly at Dana Biosphere Reserve. Amr et al. (1995) studied the carnivores of the reserve, where they reported on the occurrence of seven species. Some of these species (i.e. the Red Fox, *Vulpes vulpes*) have a wide home range that may extend several kilometers. Furthermore, Catullo et al. (1996) investigated the status of the Nubian Ibex, *Capra nubiana*, in Dana Biosphere Reserve with notes on its distribution within the area. Disi & Hatough-Bouran (1999) reported on the occurrence of 29 species of mammals belonging to six orders and 14 families that were found in the area of Petra (Table 6-7).

Table 6-7: Mammal species known to occur within the study area

Species	Common name	Conservation Status
Family Erinaceidae		
Erinaceus concolor	European Hedgehog	Common
Family Rhinolophidae		
Rhinolophus microphyllum	Shoe bat	Common
Family Leporidae		
Lepus capensis syriacus	Arabian Hare	Common game species
Family Cricetidae		
Gerbillus dasyurus	Gerbil	Common pest
Meriones tristrami	Tristram jird	Common
Meriones libycus	Libyan jird	Common
Family Spalacidae		
Spalax leucodon	Palestine mole	Common
Family Hystricidae		
Hystrix indica	Indian crested porcupine	Common
Family Canidae		
Vulpes vulpes	Red fox	Common
Family Hyaenidae		
Hyena hyena	Striped hyena	Endangered
Family Felidae		
Felis silvestris tristrami	Tristram wild cat	Common

Bats

Due to the ecology of bats and their flight patterns a special attention is paid in this literature section to these species.

Studies show that bat fatalities occur predominantly at wind farms that are located close to or in forests. Wind farms in the open space document fewer casualties [6-37].

From literature review and based on Petr BENDA et al, 2010 it seems that there are 18 bat species recorded in the southern plateau from Tafila to Shoubak, including the Wadi Araba region (Table 6-8). One of these species is listed as vulnerable in the IUCN red species list. Furthermore, according to RSCN, ten bat species are expected to occur in the Dana Biosphere Reserve.

Table 6-8: Bat species observed in the region of Tafila

Scientific name	Common name	Conservation status
Rousettus aegyptiacus	Egyptian Fruit Bat	Least concern
Rhinopoma microphyllum	Greater Mouse-tailed Bat	Least concern
Taphozous perforatus	Egyptian Tomb Bat	Least concern
Taphozous nudiventris	Naked-rumped Tomb Bat	Least concern
Nycteris thebaica	Egyptian Slit-faced Bat	Least concern
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	Least concern
Rhinolophus blasii	Blasius' Horseshoe Bat	Least concern
Asellia tridens	Geoffroy's Trident Leaf-nosed Bat	Least concern
Myotis blythii	LESSER MOUSE-EARED MYOTIS	Least concern
Myotis emarginatus	Geoffroy's Bat	Least concern
Myotis capaccinii	Long-fingered Bat	Vulnerable
Eptesicus bottae	Botta's Serotine	Least concern
Pipistrellus pipistrellus	Common Pipistrelle	Least concern
Otonycteris hemprichii	Desert Long-eared Bat	Least concern
Barbastella leucomelas	Eastern Barbastelle	Least concern
Plecotus christii		Data Deficient
Plecotus austriacus	Gray Big-eared Bat	Least concern
Tadarida teniotis	European Free-tailed Bat	Least concern

6.6.2.3 Avifauna

The area represents an important part of the Sharah mountain range in the south-west of Jordan. This important top-laying part of the Sharah series of highlands overlooks the southern Rift Valley, and provides the vast plain where the unique gorge of Dana extends to east-west.

The Rift Valley in general is part of the major routes for annual bird migrations between Asia, Europe and Africa. The area of Dana Biosphere Reserve is a huge resting habitat for migratory birds. It serves as a refueling stop during their fall migration to Africa and their spring migration to Europe and Asia. Being at the crossroads of Europe, Africa and Asia, Jordan serves as a natural bridge for birds migrating between their breeding areas in Europe and Asia, and their winter quarters in Africa.

Although many bird species migrate across broad fronts, several congregate along established corridors while migrating. As a result, enormous concentrations of tens of thousands of birds regularly and predictably occur at specific geographical features, especially along mountain ridges and passes, narrow coastal plains, isthmuses and peninsulas. Migration corridors usually occur along what are known as “leading lines”, which are geographic or topographic features such as mountain ranges and coastlines that are oriented along or near the preferred direction of travel.

The Great Rift Valley in Jordan forms such an important corridor for migration, where the adjacent mountain ridges are important and crucial leading lines for soaring migratory birds. The Sharah Mountains are an excellent example for a migration corridor.

According to BirdLife International, at least 500 million migratory birds of over 230 species pass through Jordan twice a year and rest in IBAs in the Middle East. Many of these species breed in mid and Eastern Europe and a significant portion of their entire population pass through the region. Indeed, the entire population of some species such as the Lesser Spotted Eagle and White Stork passes through the area twice a year. Moreover, dozens of these species are listed as globally threatened by the International Union for the Conservation of Nature (IUCN).

The boundary of the Tafila Wind Farm site is not within the boundaries of the Dana Biosphere Reserve and adjacent to the Dana Important Bird area. Only the most western turbine of the Tafila wind farm touches the boundary of the Dana IBA. All other turbines are away from the boundary. The Dana Biosphere Reserve and the Dana IBA are important resting/breeding areas as described above. Due to the proximity of Dana IBA to the planned Tafila wind farm, it is likely that the wind farm site offers resting breeding and foraging ecological services to many migratory and residentially threatened and globally threatened species listed in Table 6-9, Table 6-10, Table 6-11 and Table 6-12). Figure 6-4 shows the project site, Dana Biosphere Reserve and Dana IBA. Figure 6-8 shows the proximity of the project site to the Dana IBA in a close-up.

Table 6-9 through Table 6-12 list the birds that pass through Dana Biosphere Reserve and their regional and international status.

Table 6-9: Globally threatened species passing through Dana Biosphere Reserve

Scientific Name	Common Name
Falco naumanni	Lesser Kestrel [1]
Serinus syriacus	Syrian Serin [1]

[1] Species or population on Appendix 1 of the Bonn Convention

Table 6-10: Regionally threatened species passing through Dana Biosphere Reserve

Scientific Name	Common Name
Accipiter brevipes	Levant Sparrowhawk [1]
Pernis apivorus	Honey Buzzard [1]
Falco cherrug	Saker Falcon [1]
Neophron percnopterus	Egyptian Vulture
Ciconia ciconia	White Stork [1]

[1] Species or population on Appendix 1 of the Bonn Convention

Table 6-11: Species restricted wholly or largely to the Middle East

Scientific Name	Common Name
Ammoperdix heyi	Sand Partridge
Oenanthe monach	White-crowned Wheatear
Oenanthe finchii	Finsch's Wheatear
Carpdacus synoicus	Sinai Rosefinch

Table 6-12: Bird species known to occur within the study area

Scientific name	Common name	Conservation Status
Ciconia nigra	Black Stork	Least Concern
Ciconia ciconia	White Stork	Least Concern
Pernis apivorus	Honey Buzzard	Least Concern
Milvus migrans	Black Kite	Least Concern
Neophron percnopterus	Egyptian Vulture	Endangered
Gyps fulvus	Griffon Vulture	Endangered
Circaetus gallicus	Short-toed Eagle	Least Concern
Circus aeruginosus	Marsh Harrier	Least Concern
Circus cyaneus	Hen Harrier	Least concern
Circus macrourus	Pallid Harrier	Near Threatened
Circus pygargus	Montagu's Harrier	Least concern
Accipiter gentilis	Goshawk	Least concern
Accipiter nisus	Sparrowhawk	Least concern
Accipiter brevipes	Levant Sparrowhawk	Least concern
Buteo buteo	Buzzard	Least concern
Buteo rufinus	Long-legged Buzzard	Least concern
Aquila pomarina	Lesser Spotted Eagle	Least concern
Aquila clanga	Spotted Eagle	Vulnerable
Hieraaetus pennatus	Booted Eagle	Least concern
Hieraaetus fasciatus	Bonelli's Eagle	No sufficient data
Falco naumanni	Lesser Kestrel	Least concern
Falco tinnunculus	Kestrel	Least concern
Falco columbarius	Merlin	Least concern
Falco subbuteo	Hobby	Least concern
Falco concolor	Sooty Falcon	Near Threatened
Falco biarmicus	Lanner	Least concern
Falco cherrug	Saker	Endangered
Falco peregrinus	Peregrine	Least concern
Falco pelegrinoides	Barbary Falcon	Least concern
Alectoris chukar	Chukar	Least concern
Columba livia	Rock Dove	Least concern
Streptopelia decaocto	Collared Dove	Least concern
Streptopelia turtur	Turtle Dove	Least concern
Streptopelia senegalensis	Laughing Dove	Least concern
Clamator glandarius	Great Spotted Cuckoo	Least concern
Cuculus canorus	Cuckoo	Least concern
Tyto alba	Barn Owl	Least concern
Bubo bubo	Eagle Owl	Least concern

Scientific name	Common name	Conservation Status
Athene noctua	Little Owl	Least concern
Strix aluco	Tawny Owl	Least concern
Asio otus	Long-eared Owl	Least concern
Asio flammeus	Short-eared Owl	Least concern
Apus apus	Swift	Least concern
Apus pallidus	Pallid Swift	Least concern
Apus melba	Alpine Swift	Insufficient data
Apus affinis	Little Swift	Least Concern
Merops superciliosus	Blue-cheeked Bee-eater	Least Concern
Merops apiaster	Bee-eater	Least Concern
Coracias garrulous	Roller	Near Threatened
Upupa epops	Hoopoe	Least concerned
Ammomanes deserti	Desert Lark	Restricted to Middle east
Melanocorypha calandra	Calandra Lark	Restricted to Middle east
Melanocorypha bimaculata	Bimaculated Lark	Restricted to Middle east
Calandrella brachydactyla	Short-toed Lark	Restricted to Middle east
Calandrella rufescens	Lesser Short-toed Lark	Restricted to Middle east
Galerida cristata	Crested Lark	Common
Lullula arborea	Woodlark	Least Concern
Alauda arvensis	Skylark	Least Concern
Eremophila bilopha	Temminck's Horned Lark	Restricted
Riparia riparia	Sand Martin	Least Concern
Ptyonoprogne fuligula	Rock Martin	Least Concern
Ptyonoprogne rupestris	Crag Martin	Least Concern
Hirundo rustica	Swallow	Least Concern
Hirundo daurica	Red-rumped Swallow	Least Concern
Delichon urbica	House Martin	Least Concern
Motacilla alba	White Wagtail	Least Concern
Pycnonotus xanthopygos	Yellow-vented Bulbul	Least Concern
Prunella modularis	Dunnock	Least Concern
Prunella ocularis	Radde's Accentor	Least Concern
Cercotrichas galactotes	Rufous Bush Robin	Least Concern
Erithacus rubecula	Robin	Least Concern
Luscinia svecica	Bluethroat	Least Concern
Irania gutturalis	White-throated Robin	Least Concern
Phoenicurus ochruros	Black Redstart	Least Concern
Phoenicurus phoenicurus	Redstart	Least Concern
Cercomela melanura	Blackstart	Least Concern
Saxicola rubetra	Whinchat	Least Concern

Scientific name	Common name	Conservation Status
Saxicola torquata	Stonechat	Least Concern
Oenanthe isabellina	Isabelline Wheatear	Least Concern
Oenanthe oenanthe	Wheatear	Least Concern
Oenanthe hispanica	Black-eared Wheatear	Least Concern
Oenanthe deserti	Desert Wheatear	Least Concern
Oenanthe finschii	Finsch's Wheatear	Least Concern
Oenanthe lugens	Mourning Wheatear	Least Concern
Oenanthe leucopyga	White-crowned Black Wheatear	Least Concern
Monticola saxatilis	Rock Thrush	Least Concern
Monticola solitarius	Blue Rock Thrush	Least Concern
Turdus merula	Blackbird	Least Concern
Turdus philomelos	Song Thrush	Least Concern
Cettia cetti	Cetti's Warbler	Least Concern
Prinia gracilis	Graceful Warbler	Least Concern
Scotocerca inquieta	Scrub Warbler	Least Concern
Hippolais languida	Upcher's Warbler	Least Concern
Sylvia conspicillata	Spectacled Warbler	Least Concern
Sylvia cantillans	Subalpine Warbler	Least Concern
Sylvia mystacea	Ménétries's Warbler	Least Concern
Sylvia melanocephalus	Sardinian Warbler	Least Concern
Sylvia melanothorax	Cyprus Warbler	Least Concern
Sylvia rueppelli	Rüppell's Warbler	Least Concern
Sylvia hortensis	Orphean Warbler	Least Concern
Sylvia nisoria	Barred Warbler	Least Concern
Sylvia curruca	Lesser Whitethroat	Least Concern
Sylvia communis	Whitethroat	Least Concern
Sylvia borin	Garden Warbler	Least Concern
Sylvia atricapilla	Blackcap	Least Concern
Phylloscopus bonelli	Bonelli's Warbler	Least Concern
Phylloscopus sibilatrix	Wood Warbler	Least Concern
Phylloscopus collybita	Chiffchaff	Least Concern
Phylloscopus trochilus	Willow Warbler	Least Concern
Muscicapa striata	Spotted Flycatcher	Least Concern
Ficedula semitorquata	Semi-collared Flycatcher	Least Concern
Ficedula albicollis	Collared Flycatcher	Least Concern
Ficedula hypoleuca	Pied Flycatcher	Least Concern
Parus major	Great Tit	Least Concern
Remiz pendulinus	Penduline Tit	Least Concern
Nectarinia osea	Palestine Sunbird	Least Concern

Scientific name	Common name	Conservation Status
Oriolus oriolus	Golden Oriole	Least Concern
Lanius isabellinus	Isabelline Shrike	Least Concern
Lanius collurio	Red-backed Shrike	Least Concern
Lanius minor	Lesser Grey Shrike	Least Concern
Lanius meridionalis	Southern Grey Shrike	Least Concern
Lanius senator	Woodchat Shrike	Least Concern
Lanius nubicus	Masked Shrike	Least Concern
Corvus corax	Raven	Least Concern
Corvus rhipidurus	Fan-tailed Raven	Least Concern
Onychognathus tristramii	Tristram's Grackle	Least Concern
Sturnus vulgaris	Starling	Least Concern
Passer domesticus	House Sparrow	Least Concern
Passer hispaniolensis	Spanish Sparrow	Least Concern
Petronia petronia	Rock Sparrow	Least Concern
Fringilla coelebs	Chaffinch	Least Concern
Fringilla montifringilla	Brambling	Least Concern
Serinus pusillis	Red-fronted Serin	Least Concern
Serinus serinus	Serin	Least Concern
Serinus syriacus	Syran Serin	Least Concern
Carduelis chloris	Greenfinch	Least Concern
Carduelis carduelis	Goldfinch	Least Concern
Carduelis cannabina	Linnet	Least Concern
Rhodospiza obsoleta	Desert Finch	Least Concern
Carpodacus synoicus	Sinai Rosefinch	Restricted to Middle east
Emberiza citrinella	Yellowhammer	Least Concern
Emberiza striolata	House Bunting	Least Concern
Emberiza hortulana	Ortolan Bunting	Least Concern
Emberiza caesia	Cretzschmar's Bunting	Least Concern
Miliaria calandra	Corn Bunting	Least Concern

6.6.3 Field survey results

6.6.3.1 Flora

The studied site is classified to be an Irano-Turanian and Mediterranean bioclimatic subdivision of Jordan. However, it is influenced by the Saharo Arabian realm at the eastern end. Different flora species which represent the Saharo Arabian realm, such as Acacia and Ziziphus trees, were recorded. The Irano-turanian region in Jordan is classified as steppe and is best used as grazing lands. Vegetation can be classified as the Wormwood and Thorny Saltwort brush.

Table 6-13 and Table 6-14 show the different floral species found on the project site in the winter/autumn and in the spring/summer.

Table 6-13: Floral species recorded in autumn 2011

Scientific name	Common name	Conservation status	No.
Anabasis syriaca	Anabasis	Common	
Noaea mucronata	Thorny Saltwort	Common	More than 1000
Achillea santolina	Yarrow Santolina	Common	50
Artemisia herba-alba	Wormwood	Common	Wide spread, more than 100
Anthemis melampodna	Chamomile	Common	More than 100
Erodium hirtum	Strok's Bill	Common	More than 50
Aegilops crassa	Wild crassa	Common	More than 1000
Avena sterillis	Wild Oat	Common	More than 1000
Hordeum glaucum	Wild Barley	Common	More than 1000
Salvia palaestina	Palestine Sage	Common	50
Salvia lanigra	Desert Sage	Common	100
Astragalus cretaceous	Milk Vetch	Common	10
Astragalus spinosus	Milk Vetch	Common	1000
Astragalus sparsus	Sleber's Milk Vetch	Common	50
Glaucium grandiflorum	Poppy	Common	1000
Plantago cylindirica	Plantin	Common	50
Adonis aestivalis	Pheasant's eye	Common	100

Table 6-14: Floral species recorded in spring 2012

Scientific name	Common name	Conservation status	Number of plant
Gladiola spp	Gladiola	Endangered	30
Adonis dentate	Adonis	common	100
Silybum marianum	Milk thorn thistle	Common	100
Anchusa strigosa	Prickly Alkanet	Common	50
Artemisia spp	Silver wormwood	Common, medicinal	More than 1000
Atragalus spp	Milkvetch	Common	More than 1000
Astragalus spinosus	Spiny Milkvetch	Common, seeds edible	More than 1000
Calicotome villosa	Spiny broom	Common	50
Cardaria draba	Hoary Cress	Common	100
Ceratocephala falcata	St. Johns bread	Common	100
Euphorbia	Jerusalem Spurge	Common	100

Scientific name	Common name	Conservation status	Number of plant
heirosolymitana			
Gagea reticulata	Reticulate Gagea	Rare	1000
Geranium tuberosum	tuberous geranium	Common	1000
Hyoscyamus reticulatus	Poisonous henbane	Common	20
Hypoecum imberbi	-------------------	Common	100
Malcolmia sp.	Malcolmia	Common	1000
Scrozonera judaica	Jordanian viper's grass	Rare	20
Tragopogon dubius	Western Salsify	Rare	100
Tragopogon collinus	Salsify	Common	1000

The study site lacks floral key endemic species, such as irises, crocus and / or key forest species such as natural oak, pistachio, juniper and cypresses, which would indicate a rich and viable ecosystem. These represent the Mediterranean Forest and the non-forest zone. The area is overgrazed (Figure 6-7) and very arid fragmented by roads and constantly disturbed by local farmers, hunting and other unsustainable use.

Three rare species and one endangered specie were found during the field survey. These species are single plants and do not occur in a great extend at the same spot. They preferably grow in places where is no farming. Grazing of sheep and goats may threaten the species.

The Project will not effect the whole project area and the flora will remain not be harmed to a grweat extend. To secure that the flora, and especially endangered and rare species will not be threatened by the project, a preinspection of the turbine sites and the planned roads will be conducted identifying species that might be effected by the project. If possible these species will be relocated to a place with similar conditions.

6.6.3.2 Fauna

Reptiles

The area is heavily impacted by agriculture and grazing activities. Only the following five reptile species were recorded through observation at day time especially in the morning during summer and spring and at noon in winter.

One endangered specie, the European Chameleon (*chamaeleo chamaeleon)*, was observed on the site (Table 6-15).

Table 6-15: Recorded reptiles

Species	Common name	Conservation status	Number observed
Chamaeleo chamaeleon	European chameleon	Endangered	1
Laudakia stellio	Starred agama	Common	40
Acanthodactylus boskianus	Bosk's fringe-toad lizard	Common	5
Malpolon monspessulanus	Montpellier snake	Common	1
Telescopus nigriceps	Black-headed cat snake	Common	4

Mammals

Eight mammal species were recorded during the study as shown in Table 6-16. The endangered Hyena hyena was not observed by the research team, their presence was recorded through discussion with local residents and farmers at Gharandil.

Striped Hyenas are nocturnal, solitary and territorial. A hyena's territory is around 40 km^2. Each hyena can travel daily around 40 km for scavenging and rarely hunting. It is not anticipated that the project will affect the Hyena because they are scavengers and follow nomadic Bedouins to scavenge on their livestock. In addition to that the hyenas move in winter to lower areas and follow nomadic herders.

Table 6-16: Recorded mammals

Species	Common name	Conservation status	Observation type	Number observed
Lepus capensis syriacus	Arabian Hare	Game species	Local resident communications	More than 500
Gerbillus dasyurus		Common	Burrows	5 Borrows
Meriones tristrami	Tristram jird	Common	Burrows	7 Borrows
Meriones libycus	Libyan jird	Common	Burrows	20 Borrows
Spalax lecodon	Palestine mole	Common	Burrows all over site at foot hills	100 Borrows
Hystrix indica	Indian crested porcupine	Common	Spines at spring near village	3 spines
Vulpes vulpes	Red fox	Game species	Local residents and farmers	More than 10
Hyaena hyaena	Striped hyena	Endangered	Local residents and farmers	1-3

Bats

Night observations as well as the observation of several caves in the vicinity of the project site were conducted to identify bat activities.

Although the team did not detect any bat activities at the project site, local residents of Gharandil reported in viewing several bat activities in Wadi Gharandil and Wadi Dana. The type of specie cannot be identified at this stage. Further investigations with ultrasound signals have to be conducted.

6.6.3.3 Avifauna

The highland plateau on which the wind farm is planned supports a wide array of breeding and migratory birds. It represents a feeding area to the majority of breeding birds occurring in the area.

According to BirdLife International [6-11], the site is probably an important feeding area of the globally threatened Syrian Serin (Table 6-9).

According to studies of BirdLife International and RSCN (i.e. Important bird areas in the Middle East and Jordan Books published in 1995 and 2000), there is a significant raptor migration in Dana Area in spring, but less in autumn. The Honey and Steppe Buzzard, the White Stork and other soaring birds are mentioned examples for this migration in the above named studies.

Additionally, the ecology of the Dana IBA provides important habitats for a wide variety of bird species of restricted range to the project region (Table 6-9 and Table 6-10). Table 6-12 lists the bird species known to occur within the study area.

However, over the two observed migration seasons, researchers of this study did not observe or record heavy raptor or stork migration in both spring and autumn migration seasons. This may be due to the fact, that the area is heavily disturbed by farmers, local residents and roads. Furthermore the wind farm site is away from the edges of the rift valley and it is not heavily covered with vegetation. However this should not mean that resident and migrant threatened birds, such as vultures, eagles, buzzards, falcons, other raptors, storks, passerines, swallows, swifts and others mentioned in the avifauna literature review above, will not occasionally or accidentally use the project site and its vicinity for foraging, breeding, passing and resting.

Additionally, the ecology of the Dana IBA provides important habitats for a wide variety of bird species restricted to the Dana Biosphere Reserve and Dana IBA (Table 6-9 and Table 6-10).

Table 6-17: Bird species observed and recorded at the vicinity of the site, autumn and winter 2011

Common name	Scientific name	Status	Flight	Amount
Lesser Kestrel	*Falco naumanni*	Migrant endangered	Within the rotor diameter height	1
Kestrel	*Falco tinnunculus*	Migrant possible breeder on cliffs in Dana Biosphere Reserve	Within the rotor diameter height	2
Chukar	*Alectoris chukar*	Resident in Wadi Gharandil, flies very low	Below the lowest rotor tip	7
Rock Dove	*Columba livia*	Resident	Below the lowest rotor tip	30
Collared Dove	*Streptopelia decaocto*	Resident	Below the lowest rotor tip	14
Turtle Dove	*Streptopelia turtur*	Resident	Below the lowest rotor tip	8
Little Owl	*Athene noctua*	Resident	Below the lowest rotor tip	1
Tawny Owl	*Strix aluco*	Resident in wadi Gharandil	Below the lowest rotor tip	1
Swift	*Apus apus*	Migrant	Within the rotor diameter height	60
Pallid Swift	*Apus pallidus*	Migrant	Within the rotor diameter height	3
Alpine Swift	*Apus melba*	Migrant	Within the rotor diameter height	7
Little Swift	*Apus affinis*	Migrant	Within the rotor diameter height	1
Hoopoe	*Upupa epops*	Migrant	Within the rotor diameter height	3
Desert Lark	*Ammomanes deserti*	Resident	Below the lowest rotor tip	1
Calandra Lark	*Melanocorypha calandra*	Resident	Below the lowest rotor tip	1
Short-toed Lark	*Calandrella brachydactyla*	Resident	Below the lowest rotor tip	1
Lesser Short-toed Lark	*Calandrella rufescens*	Resident	Below the lowest rotor tip	3
Crested Lark	*Galerida cristata*	Migrant	Below the lowest rotor tip	Over 30
Sand Martin	*Riparia riparia*	Migrant	Below the lowest rotor tip	3
Rock Martin	*Ptyonoprogne fuligula*	Migrant	Below the lowest rotor tip	7
Crag Martin	*Ptyonoprogne rupestris*	Migrant	Below the lowest rotor tip	1
Swallow	*Hirundo rustica*	Migrant	Below the lowest rotor tip	1
Red-rumped Swallow	*Hirundo daurica*	Migrant	Below the lowest rotor tip	2
House Martin	*Delichon urbica*	Migrant	Below the lowest rotor tip	1
White Wagtail	*Motacilla alba*	Migrant	Below the lowest rotor tip	5

Common name	Scientific name	Status	Flight	Amount
Yellow-vented Bulbul	*Pycnonotus xanthopygos*	Migrant	Below the lowest rotor tip	34
Rufous Bush Robin	*Cercotrichas galactotes*	Migrant	Below the lowest rotor tip	1
Black Redstart	*Phoenicurus ochruros*	Migrant	Below the lowest rotor tip	2
Redstart	*Phoenicurus phoenicurus*	Migrant	Below the lowest rotor tip	1
Blackstart	*Cercomela melanura*	Migrant	Below the lowest rotor tip	6
Whinchat	*Saxicola rubetra*	Migrant	Below the lowest rotor tip	1
Stonechat	*Saxicola torquata*	Resident	Below the lowest rotor tip	1
Isabelline Wheatear	*Oenanthe isabellina*	Resident	Below the lowest rotor tip	17
Wheatear	*Oenanthe oenanthe*	Resident	Below the lowest rotor tip	13
Black-eared Wheatear	*Oenanthe hispanica*	Resident	Below the lowest rotor tip	5
Desert Wheatear	*Oenanthe deserti*	Resident	Below the lowest rotor tip	1
Finsch's Wheatear	*Oenanthe finschii*	Resident	Below the lowest rotor tip	5
Mourning Wheatear	*Oenanthe lugens*	Resident	Below the lowest rotor tip	10
White-crowned Black Wheatear	*Oenanthe leucopyga*	Resident	Below the lowest rotor tip	7
Rock Thrush	*Monticola saxatilis*	Migrant	Below the lowest rotor tip	1
Blue Rock Thrush	*Monticola solitaries*	Migrant	Below the lowest rotor tip	1
Blackbird	*Turdus merula*	Resident	Below the lowest rotor tip	15
Cetti's Warbler	*Cettia cetti*	Migrant	Below the lowest rotor tip	1
Graceful Warbler	*Prinia gracilis*	Migrant	Below the lowest rotor tip	7
Scrub Warbler	*Scotocerca inquieta*	Migrant	Below the lowest rotor tip	15
Upcher's Warbler	*Hippolais languida*	Migrant	Below the lowest rotor tip	3
Spectacled Warbler	*Sylvia conspicillata*	Migrant	Below the lowest rotor tip	1
Sardinian Warbler	*Sylvia melanocephalus*	Migrant	Below the lowest rotor tip	1
Lesser Whitethroat	*Sylvia curruca*	Migrant	Below the lowest rotor tip	1
Whitethroat	*Sylvia communis*	Migrant	Below the lowest rotor tip	1
Blackcap	*Sylvia atricapilla*	Migrant	Below the lowest rotor tip	7
Bonelli's Warbler	*Phylloscopus bonelli*	Migrant	Below the lowest rotor tip	2

Common name	Scientific name	Status	Flight	Amount
Wood Warbler	*Phylloscopus sibilatrix*	Migrant	Below the lowest rotor tip	8
Chiffchaff	*Phylloscopus collybita*	Migrant	Below the lowest rotor tip	14
Spotted Flycatcher	*Muscicapa striata*	Migrant	Below the lowest rotor tip	4
Semi-collared Flycatcher	*Ficedula semitorquata*	Migrant	Below the lowest rotor tip	1
Collared Flycatcher	*Ficedula albicollis*	Migrant	Below the lowest rotor tip	1
Pied Flycatcher	*Ficedula hypoleuca*	Migrant	Below the lowest rotor tip	1
Palestine Sunbird	*Nectarinia osea*	Resident	Below the lowest rotor tip	9
Lesser Grey Shrike	*Lanius minor*	Migrant	Below the lowest rotor tip	9
Southern Grey Shrike	*Lanius meridionalis*	Migrant	Below the lowest rotor tip	3
Woodchat Shrike	*Lanius senator*	Migrant	Below the lowest rotor tip	7
Masked Shrike	*Lanius nubicus*	Migrant	Below the lowest rotor tip	15
Raven	*Corvus corax*	Migrant	Below the lowest rotor tip	7
Starling	*Sturnus vulgaris*	Migrant	Below the lowest rotor tip	2
House Sparrow	*Passer domesticus*	Resident	Below the lowest rotor tip	Many
Spanish Sparrow	*Passer hispaniolensis*	Migrant	Below the lowest rotor tip	8
Rock Sparrow	*Petronia petronia*	Migrant	Below the lowest rotor tip	1
Chaffinch	*Fringilla coelebs*	Migrant	Below the lowest rotor tip	1
Serin	*Serinus serinus*	Migrant	Below the lowest rotor tip	7
Tristram's Serin	*Serinus syriacus*	Migrant	Below the lowest rotor tip	1
Greenfinch	*Carduelis chloris*	Migrant	Below the lowest rotor tip	10
Goldfinch	*Carduelis carduelis*	Migrant	Below the lowest rotor tip	30
Linnet	*Carduelis cannabina*	Migrant	Below the lowest rotor tip	1
Desert Finch	*Rhodospiza obsolete*	Migrant	Below the lowest rotor tip	3
House Bunting	*Emberiza striolata*	Migrant	Below the lowest rotor tip	100
Ortolan Bunting	*Emberiza hortulana*	Migrant	Below the lowest rotor tip	3
Cretzschmar's Bunting	*Emberiza caesia*	Migrant	Below the lowest rotor tip	1
Corn Bunting	*Miliaria calandra*	Migrant	Below the lowest rotor tip	10

Table 6-18: Bird species observed and recorded at the site during spring 2012

Common name	Scientific name	Status	Flight	Amount
Golden Eagle	*Aquila chrysaetos*	Resident, possible breeder in Dana Biosphere Reserve - least concern	Above rotor tip height	2
Kestrel	*Falco tinnunculus*	Migrant, possible breeder on cliffs in Dana Biosphere Reserve	Below rotor tip and within tip	1
Black Kite	*Milvus migrans*	Migrant	Above rotor tip height	1
Rock Dove	*Columba livia*	Resident	Below the lowest rotor tip	10
Collared Dove	*Streptopelia decaocto*	Resident	Below the lowest rotor tip	3
Turtle Dove	*Streptopelia turtur*	Resident	Below the lowest rotor tip	5
Little Owl	*Athene noctua*	Resident	Below the lowest rotor tip	1
Swift	*Apus apus*	Migrant	Within rotor range	10
Pallid Swift	*Apus pallidus*	Migrant		3
Alpine Swift	*Apus melba*	Migrant	Within rotor range	1
Little Swift	*Apus affinis*	Migrant	Within rotor range	1
Hoopoe	*Upupa epops*	Migrant	Within rotor range	2
Sand Martin	*Riparia riparia*	Migrant	Within rotor range	1
Rock Martin	*Ptyonoprogne fuligula*	Migrant	Within rotor range	7
Crag Martin	*Ptyonoprogne rupestris*	Migrant	Within rotor range	12
Swallow	*Hirundo rustica*	Migrant	Within rotor range	3
Red-rumped Swallow	*Hirundo daurica*	Migrant	Within rotor range	20
House Martin	*Delichon urbica*	Migrant	Below the lowest rotor tip	7
White Wagtail	*Motacilla alba*	Migrant	Below the lowest rotor tip	15
Yellow-vented Bulbul	*Pycnonotus xanthopygos*	Resident	Below the lowest rotor tip	More than 50
Black Redstart	*Phoenicurus ochruros*	Migrant	Below the lowest rotor tip	5
Redstart	*Phoenicurus phoenicurus*	Migrant	Below the lowest rotor tip	1
Blackstart	*Cercomela melanura*	Migrant	Below the lowest rotor tip	30
Whinchat	*Saxicola rubetra*	Migrant	Below the lowest rotor tip	4

Common name	Scientific name	Status	Flight	Amount
Stonechat	*Saxicola torquata*	Resident	Below the lowest rotor tip	3
Isabelline Wheatear	*Oenanthe isabellina*	Resident	Below the lowest rotor tip	45
Wheatear	*Oenanthe oenanthe*	Resident	Below the lowest rotor tip	3
Black-eared Wheatear	*Oenanthe hispanica*	Resident	Below the lowest rotor tip	1
Mourning Wheatear	*Oenanthe lugens*	Resident	Below the lowest rotor tip	10
White-crowned Black Wheatear	*Oenanthe leucopyga*	Resident	Below the lowest rotor tip	6
Rock Thrush	*Monticola saxatilis*	Migrant	Below the lowest rotor tip	1
Scrub Warbler	*Scotocerca inquieta*	Migrant	Below the lowest rotor tip	
Blackcap	*Sylvia atricapilla*	Migrant	Below the lowest rotor tip	7
Palestine Sunbird	*Nectarinia osea*	Resident	Below the lowest rotor tip	4
Lesser Grey Shrike	*Lanius minor*	Migrant	Below the lowest rotor tip	8
Woodchat Shrike	*Lanius senator*	Migrant	Below the lowest rotor tip	5
Masked Shrike	*Lanius nubicus*	Migrant	Below the lowest rotor tip	11
Raven	*Corvus corax*	Migrant	Above rotor tip and in range	7
Starling	*Sturnus vulgaris*	Migrant	Below the lowest rotor tip	
House Sparrow	*Passer domesticus*	Resident	Below the lowest rotor tip	20
Spanish Sparrow	*Passer hispaniolensis*	Migrant	Below the lowest rotor tip	4
Serin	*Serinus serinus*	Migrant	Below the lowest rotor tip	5
Goldfinch	*Carduelis carduelis*	Migrant	Below the lowest rotor tip	15
Linnet	*Carduelis cannabina*	Migrant	Below the lowest rotor tip	1
Corn Bunting	*Miliaria calandra*	Migrant	Below the lowest rotor tip	3

Migratory routes

As mentioned above the Rift Valley in general is part of the major routes for annual bird migrations between Asia, Europe and Africa. Being at the crossroads of Europe, Africa and Asia, Jordan serves as a natural bridge for birds migrating between their breeding areas in Europe and Asia, and their winter quarters in Africa.

As shown in Figure 6-1 the Jordan Rift Valley is one of the global major flyways for the annual migration route of Euraisan birds.

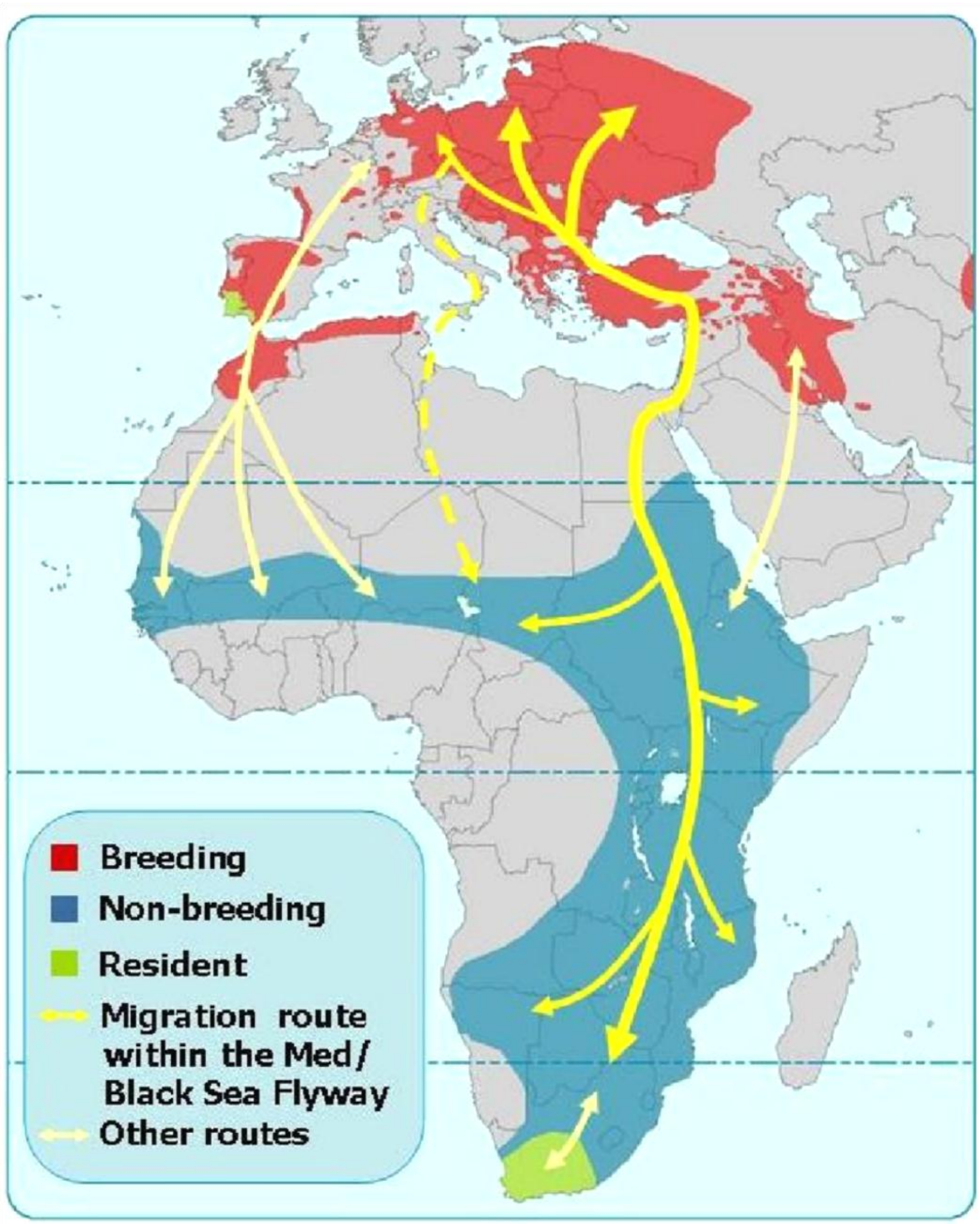


Figure 6-1: Global flyway through the Great Rift Valley

Although many bird species migrate across broad fronts, several congregate along established corridors while migrating. Migration corridors usually occur along what are known as “leading lines”, which are geographic or topographic features such as the Jordan rift valley where the adjacent mountain ridges are important and crucial leading lines for soaring migratory birds.

The field surveys indicate that the project site itself does not host important migratory routes. The reason for this is probably because the area is disturbed by farmers, local resident’s constant movements and roads. Additionally, the core of the wind farm site is away from the edges of the rift valley and it is not heavily covered with vegetation, which is very important for migratory species on their journey for roosting, feeding and resting.
Nevertheless past data show that some routes adjacent to the site seem to be passage and or feeding and or nesting areas for raptors such as the Vultures, Buzzards, Eagles, the Black Kite, Common Kestrel, Wheatears and other passerines.

6.7 Impact Assessment

6.7.1 Construction / decommissioning phase

The following expected impacts on biodiversity are expected during the construction phase of the wind farm.

6.7.1.1 Flora

<u>Removal of topsoil (habitat destruction)</u>
It is expected that during the construction activities the topsoil will be removed at the area of the foundations, crane pads and roads. Removing the topsoil, which has a high nutrient content, will cause a direct impact on the loss of micro-habitats for common vegetation, and also an indirect impact on reptiles, small mammals and local birds such as larks and other passerines.
In conjunction with the project, unpaved roads will be built where necessary but existing roads were used wherever possible. A high impact is not assessed since the site has already many existing roads which are also used by local residents.

<u>Collecting wood by workers</u>
This direct impact on the vegetation is quite low due to the lack of woods on the project site. Nevertheless some shrubs may be cut by workers during the construction period due to construction activities.

<u>Solid and liquid waste</u>
Solid and liquid wastes will be either domestically generated or result from earth-moving and assembly activities during construction. If such waste is not handled adequately, the wadi beds will be contaminated during water runoff which would also affect directly the flora in the area. Additionally such waste may indirectly attract animals to the area.

6.7.1.2 Fauna

Habitat loss

Excavation work for the turbine foundations, roads and substation could result in habitat loss during the construction phase. This could result in direct small reductions in populations of some reptilian species such as agama, chameleon and mammalian species such as Libyan Jird, foxes and porcupines. In extreme cases, the total loss of a species from the area is possible if an essential habitat area or feature is eliminated.

Habitat alteration and fragmentation

Habitat alteration resulting from wind energy projects include direct changes in plant communities that would directly affect avifauna resident birds such as larks, sirens , bulbuls, Palestine sunbird , Chukar and others from by:

- Invasion by weeds;
- Habitat conversion;
- Increased human disturbance due to changes in access;
- Noise while construction;
- Light disturbance at night.

Fragmentation

Habitat fragmentation occurs when large, continuous blocks of habitats are converted into smaller patches separated by project roads and features. The scale of the fragmentation and the tolerance of the species (or even local resident birds and individuals) determine the severity of this direct effect. In case of the Tafila wind farm the impact is anticipated to be low since the habitat is fragmented already.

Noise

Noise generated by construction activities may directly cause animals currently residing on the site to leave and / or dissuade new animals from coming onto the site. However the construction activities are for a limited period of time and the contractors is certified according to ISO 14001 standard of environmental management.

Light

During night-time large vehicles will bring the park components to the site. These vehicles generally drive during night-time to reduce the traffic disturbance by large trucks in the day. The light and noise may directly scare animals into leaving the site. These night activities on the site may have also the indirect effect that animals get killed by accident while moving equipment on the construction compound.

Hunting

Disturbances of species due to construction work may lead to changed living modes of wildlife such as chukars, porcupines and other. A possible indirect change may be the shifting of the normal feeding time to the day. Workers of the wind farm construction team may be tempted to hunt these animals on the site since hunting is very common in the area.

Solid and liquid wastes

Domestic wastes may indirectly attract some wildlife species to the site which may initially threat the workers on the site. The waste may threaten the animals as well, if it is contaminated with hazardous wastes produced by the construction activities.

6.7.2 Operational phase

According to the project description and the activities during the operation phase, the project is expected to have the following impacts on the biodiversity:

6.7.2.1 Flora

Solid and liquid wastes

Domestic wastes would be minimal during operation phase. The oily waste from maintenance work of the engines may be of importance. The operator must ensure proper and adequate management of such waste according to best practices.

Destruction of flora

During the operational phase the likelihood of having workers and vehicles leaving given routes and destroy the vegetation in doing so is very small due to the limited activities in comparison to the construction phase.

6.7.2.2 Fauna

Displacement and habituation

Displacement of resident birds such as larks, wheatears, warblers and other passerines is possible. Displacement could occur and the birds mentioned above keep away from feeding and breeding on the project site due to disturbance caused by the wind farm.

Displacement may be temporary (short-term) or permanent. There are numerous examples of birds becoming habituated to new disturbances according to BirdLife International. Habituation may occur over the longer term of wind energy projects.

Hunting by workers

This direct impact is expected to be of low magnitude level due to the infrequent interaction of workers during the operational phase with the surrounding environment during nighttime.

Accidental killing

Direct impact from accidental killing, disturbance and noise is of low magnitude level since its limited to the movement of machinery especially by vehicles moving around the site during the night-time.

Bat fatalities

Bats are as well as birds vulnerable to colliding with the rotor. Even though the reason for this is still under research, proper mitigation measures have to be implemented, if the wind farm site is a bat habitat.

6.7.2.3 Avifauna

It is well documented that the Jordan Rift Valley is the main and the only major migratory route for birds in the Middle East in general [6-11]. However, the suggested site does not belong to the major migratory route of birds. Nevertheless the Dana IBA as well as the Dana Biosphere Reserve is very close the proposed wind farm and birds might take other than the main and observed migratory paths via the project site.

Studies show that there will be a moderate impact from the wind farm especially on local birds and on migratory species that may have accidental or vagrant appearances at the site. Those impacts are anticipated as follows as approved by BirdLife International [6-31]:

- Collisions;
- Electrocution;
- Habitat removal;
- Habitat alteration and fragmentation;
- Displacement effects
- Barrier effect.

Collisions

Collisions between birds of prey, such as passerines, hoopoe, larks and shrike, which fly at low altitudes up to 100 m, and wind turbines can happen at wind energy projects. As with electricity projects in general, collisions with transmission lines also occur.
Depending on the specie, the theoretical estimated amount of on the project site observed birds that are killed by the project lies between 0.79 (Lesser Kestrel) and 42.28 (Swift) animals in 20 years of operation.

The Collision risk factor was calculated for birds that were observed during the field survey of the ESIA (listed in Table 6-17 and Table 6-18) and that are flying within the range of the rotor height of the wind turbines. All of these species are migrating birds.

The Collision risk factor was assessed according to the equation recommended by Guidance Wind farms and Birds: Calculating a theoretical collision risk assuming no avoiding action [6-30]. The results are shown in Table 6-19.

The probability of bird collision, for given bird and blade dimensions and speeds, is the probability, were the bird placed anywhere at random on the line of flight, of it overlapping with a blade swathe). It may therefore be calculated from simple geometric considerations. Where the angle of approach is shallow, it is the length of the bird, compared to the separation distance of successive swathes, which is the controlling factor. Where the angle of approach is high, it is the wingspan of the bird compared to the physical distance between blades, which is the controlling factor.
The important factors for the calculation of the collision risk are the size and the speed of the specie. Based on the data of rotor size and rotor speed of the WTG and the above named data on the avifauna the probability of a bird colliding with the turbine is determined. The result is a percentage on the risk for birds to be hit by a rotor blade when flying through the rotor. It should be noted that the calculation reveals the statistical risk of a collision and not the definite collision. Birds tent to evade the rotor when seeing it.
Table 6-19 shows the average collision risk for a bird passing through a rotor. The collision risk calculation is very complex including the pitch angle of the rotor blade, the position of the bird flying through the rotor, etc. Therefore the Guidance used for this calculation [6-30] provides a spreadsheet [6-34] that calculates the probability of a collision at intervals of 0.05 R[2] from the rotor center and taking a numerical integration from the point where the birds passes the rotor to the rotor tip.

The collision risk of the Red-rumped Swallow was not included in the calculation as it has the same weight, wing span and speed as the common swallow.
The Black kite, even though normally flying above the rotor tip height, was included in Table 6-19. Based on observations this specie might periodically fly within the range of the rotor.

Table 6-19: Calculation of collision risk for birds passing through the project site

Common name	Status	Bird length [cm]	Wing span [cm]	Bird speed [m/s]	Flapping Gliding	Upwind [%]	Downwind [%]	Average collision [%]
Lesser Kestrel	Migrant	33	72	13	Gliding	3.9 %	5.2 %	4.5 %
Kestrel	Migrant	37	78	15	Gliding	3.4 %	4.7 %	4.1 %
Swift	Migrant	15	30	15	Gliding	2.9 %	4.2 %	3.6 %
Pallid Swift	Migrant	17	46	17	Gliding	2.7 %	4.0 %	3.4 %
Alpine Swift	Migrant	23	58	15	Gliding	3.2 %	4.5 %	3.9 %
Little Swift	Migrant	15	39	13	Gliding	3.5 %	4.8 %	4.2 %
Hoopoe	Migrant	29	48	20	Flapping	2.6 %	3.9 %	3.3 %
Black Kite	Migrant	60	150	13	Gliding	4.7 %	6.0 %	5.3 %
Raven	Migrant	67	130	15	Gliding	4.0 %	5.3 %	4.6 %
Sand Martin	Migrant	14	29	10	Gliding	4.6 %	5.9 %	5.2 %
Rock Martin	Migrant	15	32	13	Gliding	3.4 %	4.8 %	4.1 %
Crag Martin	Migrant	15	34	15	Gliding	3.0 %	4.3 %	3.6 %
Swallow	Migrant	18	35	20	Gliding	2.2 %	3.5 %	2.8 %

[2] R = the outer rotor radius

The calculated collision risk for observed species on the project site shows that the risk for birds flying directly through the swept area of a rotor lies at approximately 4 % (depending on the specie). The highest average of bird collision risk is the one of the Black Kite (5.3%) and of the Sand Martin (5.2%).

Further to the calculation of collision risk a calculation for the amount of species flying annually through the wind farm site has to be conducted. As the observation of birds does not reveal the exact number of passing birds, the calculation has to be conducted based on further assumptions.
The guidance Wind Farms and Birds: Calculating a theoretical collision risk assuming no avoiding action [6-30] proposes a calculation method, calculating the flight risk volume based on the wind farm area and the turbine height. In addition the combined volume swept out by the wind farm rotors is calculated with the formula: $V_r = N * \pi R^2 * (d+l)$, where N is the number of WTG, d is the depth of the rotor blade and l is the length of the bird. By using these two values combined with the actual observation number of the birds and the approximate time of staying in the wind farm area, the bird occupancy in the swept area of the rotor is calculated. Divided through the time taken for a bird to make a transit through the rotor and completely clear the rotors the number of birds passing annually through the rotor is calculated.
By multiplying the estimated numbers of birds passing annually through the rotor with the average collision risk the annual number of colliding birds is calculated.

The result of the calculation for species observed on the project site is presented in Table 6-20.

Table 6-20: Estimated number of possibly colliding birds observed on the project site with the WTGs

Common name	No of birds passing through rotor annually	Average collision risk	Estimated No. of birds colliding with birds annually	Estimated No. of birds colliding with WTG throughout the project lifetime	Conservation Status according to IUCN
Lesser Kestrel	0,59 %	4.5 %	0.04	0.79	Least concern
Kestrel	0,62 %	4.1 %	0.11	2.17	Least concern
Swift	0,59 %	3.6 %	2.11	42.28	Least concern
Pallid Swift	0,59 %	3.4 %	0.17	3.44	Least concern
Alpine Swift	0,6 %	3.9 %	0.27	5.34	Insufficient data
Little Swift	0,59 %	4.2 %	0.07	1.41	Least concern
Hoopoe	0,61 %	3.3 %	0.14	2.86	Least concern
Black Kite	0,65 %	5.3 %	0.05	0.99	Least concern
Raven	0,66 %	4.6 %	0.61	12.16	Least concern
Sand Martin	0,59 %	5.2 %	0.17	3.48	Least concern
Rock Martin	0,59 %	4.1 %	0,48	9.63	Least concern
Crag Martin	0,59 %	3.6 %	0.39	7.85	Least concern
Swallow	0,59 %	2.8 %	0.09	1.89	Least concern

The calculation shows that there is a chance of bird casualties by the planned Tafila wind farm. Depending on the specie, the theoretical estimated amount of birds killed by the project lies between 0.79 and 42.28 animals in 20 years of operation.
This result involves many approximations, for example that birds can be modeled by a simple cruciform shape or that a turbine blade has width and pitch but no thickness.
The calculation does not include the fact that birds tend to evade the rotor. Therefore it is unlikely that the estimated amount of collision will be killed.

The IUCN status of all species observed on the site and observed to fly in the height of the rotor is "least concern". Therefore the total amount of mortalities should not threaten the species.

Further to the collision risk calculation of the observed birds, a collision risk calculation was done for species that are known to occur in the close by Dana IBA (Table 6-21). It is not clear whether these species come to the wind farm area or whether they stay at the Dana IBA.

Table 6-21: Calculated collision risk for birds known to occur in Dana IBA

Common name	Bird length [cm]	Wing span [cm]	Bird speed [m/s]	Flapping Gliding	Upwind [%]	Downwind [%]	Average collision [%]
Goshawk	57	105	17	flapping	4.0%	5%	4.6%
Sparrowhawk	34	64	16,4	Flapping	3.4%	4.7%	4.1%
Buzzard	54	128	9	Gliding	6.3%	7.6%	7.0%
Long-legged Buzzard	65	160	10	Gliding	6.0%	7.3%	6.6%
Lesser Spotted Eagle	65	165	4,4	Gliding	13.8%	15.1%	14.4%
Spotted Eagle	71	175	5	Gliding	12.3%	13.7%	13.0%
Booted Eagle	46	120	9	Flapping	6.8%	8.1%	7.4%
Bonelli's Eagle	72	160	9	Flapping	7.5%	8.8%	8.2%
Merlin	30	73	16	Flapping	3.6%	4.9%	4.3%
Hobby	35	92	13	Flapping	4.6%	5.9%	5.3%
Sooty Falcon	37	90	14	Flapping	4.3%	5.6%	5.0%
Lanner	50	105	9	Flapping	6.6%	7.9%	7.3%
Peregrine	58	120	9	Flapping	6.9%	8.2%	7.5%
Barbary Falcon	39	98	13	Flapping	4.7%	6.0%	5.4%
Black Stork	100	155	12,5	Gliding	5.2%	6.6%	5.9%
Griffon Vulture	122	280	9	Gliding	8.2%	9.5%	8.9%
Short-toed Eagle	68	195	6	Gliding	10.2%	11.6%	10.9%
Marsh Harrier	54	130	8,3	Gliding	6.9%	8.2%	7.5%
Hen Harrier	52	122	8	Gliding	7.0%	8.3%	7.7%
Pallid Harrier	48	120	9,6	Gliding	5.7%	7.1%	6.4%
Long Eared Owl	50	110	5,3	Flapping	11.0%	12.3%	11.7%
Short Eared Owl	45	105	10	Flapping	6.0%	7.3%	6.6%
Syrian Serin	12	24	6	Flapping	8.0%	9.3%	8.6%
Levant	30	63	14	Gliding	3.5%	4.8%	4.2%

Common name	Bird length [cm]	Wing span [cm]	Bird speed [m/s]	Flapping Gliding	Upwind [%]	Downwind [%]	Average collision [%]
Sparrowhawk							
Honey Buzzard	60	150	12,5	Flapping	5.7%	7.1%	6.4%
Saker Falcon	55	125	15	Gliding	3.9%	5.2%	4.6%
White Stork	115	200	12,5	Gliding	5.6%	6.9%	6.3%
Skylark	18	33	10	Flapping	4.8%	6.1%	5.5%
Blue-cheeked Bee-eater	29	49	12	Flapping	4.2%	5.6%	4.9%
Bee-eater	30	46	12,2	Flapping	4.1%	5.5%	4.8%
Roller	32	58	15	Flapping	3.6%	4.9%	4.2%

The calculated collision risk for birds known to occur in the Dana IBA is calculated in Table 6-21 above. Depending on the specie the collision risk lies at approximately 6.9%. The highest average of bird collision risk is the one of the Lesser Spottet Eagle (14.4%).
The amount of birds per specie is not known to the project team. Therefore the amount of birds potentially colliding with the turbines cannot be assessed. As soon as additional data from Dana is available for the project team the amount of birds potentially colliding with the turbines will be assessed and, if necessary, adequate mitigation measures implemented.

Barrier effect

The barrier effect occurs when several large wind farms are located close by to each other in a row, located between feeding / roosting areas and migration routes. Such a barrier causes additional stress on the basic foraging needs of migrating and residing birds as additional flight distances have to be taken. The Tafila wind farm is the first large scale wind farm in Jordan. In the closer area around the planned project there are no further wind turbines. Therefore it is expected that the Tafila wind farm will has a low barrier effect on the avifauna. If further wind farms are developed in the vicinity of the Tafila wind farm, the barrier effect has to be reinvestigated.

Electrocution

Wind power plants generate electricity. The electricity is transferred to a substation via distribution lines or underground cables. In the substation the voltage is stepped up and the electricity is transferred by transmission lines to another substation where the voltage is stepped down again and transferred by distribution lines to various customers.

Although lower in voltage, distribution lines are more often associated with bird mortality than transmission lines. The reason for this is the closer spacing of their electrical conductors (2 to 6 feet, versus 7 to 30 feet) [6-31]. Eagles, buzzards, vultures, storks, etc. are particularly susceptible to this danger because their body size and wingspan are large enough to span the distance between the conductors.

Underground cables are planned for the Tafila wind farm. Only the distribution cable from the substation to the transmission line (already existing on the project site) will be constructed with overhead cables. The distance of this overhead cable is approximately 250m.

Light disturbance

Nocturnally migrating birds might get attracted by aviation lights installed on WTGs. Especially red and orange aviation lights are attractive for birds.

According to the civil aviation regulations (naw No. 41, 2007 and its amendments) aviation lights are operating on each WTG above 150m in total height during night to protect from collisions with airplanes and helicopters. The WTGs of the Tafila wind farm are planned to have a maximum height of 149.9 m and require no aviation lights which would either disturb or attract the fauna.

Maintenance vehicles are not expected to be on the wind farm site during night.

6.8 Mitigation measures

6.8.1 General mitigation measures

6.8.1.1 Selection of appropriate turbines

Choosing a turbine type that is less attractive for birds reduces the risk of bird mortality through collision significantly. Turbines with a lattice tower offer many perch possibilities for birds, especially raptors and soaring birds. Choosing a tubular tower for the turbine reduces these possibilities to a minimum reducing the collision risk significantly [MM23].

The Vestas V112 has a tubular tower with no perch possibilities for birds and the impact, that the turbines are used as perch is avoided.

6.8.1.2 Use of a smaller number of larger turbines

Larger turbines have a greater distance to each other so that they do not screen each other from the wind. The greater distance between the WTGs is an advantage for the avifauna as the possibility for the avifauna to cross the wind farm without flying through the swept area of the rotor is greater. With a higher tower the rotor is gets larger and the rotation speed gets lower. Especially the slower rotation speed is reducing the potential bird collision as the time for evasion gets higher. [MM24]

6.8.1.3 Avoidance or marking of guy ropes on meteorological towers and other structures

A 100m high wind measurement mast is part of the Tafila wind farm (see chapter 3). This mast will be fixed to the ground by guy wire. These cables are almost invisible for birds and are a serious impact on birds. By marking the wires with barrier tape which is moving in the wind, birds are scared and avoid flying in direction of the measurement mast. [MM29]

6.8.1.4 Painting turbines

The rotor blades of WTG's are generally painted in light grey. To increase the visibility for birds, and also for aviation reasons, each tip of the rotor blades will be painted with two red stripes each of a size of 6 meter. This measure reduces the collision risk between birds and turbines (Wells 2010, US Fish & Wildlife Service 2010, Cook et al. 2011, Drewitt & Langston 2008). [MM27]

6.8.1.5 Use of good construction practices

During the installation of wind turbines, access roads, and transmission lines, good construction practices to minimize any adverse environmental impacts, and particularly to reduce the impacts of the wind farm on habitat loss and quality are applied. These include:

- Minimization of any clearing of natural vegetation during turbine installation; [MM5]
- Ensuring that locally obtained construction materials come from legal and environmentally sustainable sources; [MM6]
- Restore cleared areas with natural top soil where feasible. [MM7]

6.8.1.6 Use of good maintenance practices

Regular maintenance works and inspections are imperative for wind turbines. These maintenance works and inspections are used to identify and remedy environmental impacts directly coming from the turbines. For example holes in the WTGs are fixed that birds and bats are not able to enter the turbines for refuge or to nest there. [MM30]

6.8.2 Construction / decommissioning phase

6.8.2.1 Flora

Table 6-22: Impacts and mitigation measures for flora

Impact	Mitigation measure [MM]
Collecting wood from natural plants and vegetation for household fire by workers	• To prohibit workers from collecting wood especially in forested areas near villages; [MM8] • Vestas as a sole contractor during the construction period is working under the ISO 14001 Environmental standard and will strictly control its own workers as well as subcontracted worker related to environmental behavior on site. [MM9]

Impact	Mitigation measure [MM]
Habitat destruction by earth-moving and assembly activities for construction of roads, turbines and other buildings	- Reduce/ Optimize amount and size of new roads and transmission cables as much as possible; [MM2] - Shift natural vegetation and rich soil of the construction sites to nearby areas. [MM4] - Decommissioning of the temporary assembly areas and restoring the original conditions. [MM10] - Limit decommissioning activities to the excavation site where possible and replant site with native plants. [MM25]
Solid and liquid wastes littered in the site without any liquid or solid waste plans and measures	- Collect all wastes, solid and liquid, in sealed containers to be disposed in proper disposal sites [MM11] - Vestas is working under ISO 14001 accreditation for environmental management. It is forced to care also for all its subcontractors. [MM9]
Dust generated during construction phase	- Cover each spot where excavated material is stored when climate conditions requires to. [MM12] - Dust control by usage of dust suppression substances [MM13]
Removal of the topsoil during earth-moving and assembly activities	- To limit construction activities within the wind farm site; [MM1] - Reduce / optimize amount and size of new roads and transmission cables as much as possible; [MM2] - Store the natural soil at special sites and reuse it when back-fill activities are needed; [MM3] - Shift natural vegetation and rich soil of the construction sites to nearby areas. [MM4]
Removal of vegetation cover by earth-moving and assembly activities for service roads, turbine facilities or other buildings	- Shift natural vegetation and nutrient rich soil of the construction sites to nearby areas. [MM4]

6.8.2.2 Fauna

Table 6-23: Impacts and mitigation measures for fauna

Impact	Mitigation measure [MM]

Illegal hunting by workers of animals and birds and or contractors	• To prohibit workers from hunting and produce awareness materials such as: [MM18]
	  ◦ Signs
	  ◦ Training manuals and material
	  ◦ Posters
	  ◦ Brochures
	  ◦ Toolboxes
	• Vestas is working under ISO 14001 accreditation for environmental management. It is forced to care also for all its subcontractors. A Health and Safety and Environmental Manager must be on-site during the construction works. [MM9]

Accidental killing of animals by vehicles from service	• To report any accident to JWPC [MM16]
Solid and liquid wastes littered in the site without any liquid or solid waste plans and measures.	• To collect all wastes in sealed containers, to be disposed in proper disposal sites; [MM11] • To prevent feral and wild animals from using the solid waste sites for feeding. [MM19]
Light disturbance during night	• Limitation of drives during night [MM15]
Noise disturbance while construction	• Reduce loud construction activities to normal working hours during daytime as much as possible; [MM11] • Reduce vehicle movements to a minimum extent. [MM14]
Debris and construction materials from excavation activities can directly impact the fauna and flora and have an accumulative impact on the avifauna	• Good management of debris in allocated sites to be reused for fill activities; [MM83] • Avoid the creation of new landscapes. [MM82]

6.8.3 Operational phase

6.8.3.1 Flora

Table 6-24: Impacts and mitigation measures for flora

Impact	Mitigation measure [MM]
Solid and liquid wastes generated by turbines, or domestic activities from workers and staff	• Collect all wastes in sealed containers to be disposed in proper disposal sites [MM11]
Destruction of flora by maintenance activities	• Prohibit leaving the roads and crane pads with vehicles unless major maintenance works will have to be performed. [MM20]

6.8.3.2 Fauna

Table 6-25: Impacts and mitigation measures for fauna

Impact	Mitigation measure [MM]
Hunting of wildlife by workers during operational phases	• To prohibit workers from hunting and produce awareness materials such as: [MM18] ◦ Signs; ◦ Training manuals and material; ◦ Posters; ◦ Brochures; ◦ Toolboxes.
Accidental killing by cars and vehicles during operational phase	• Report any accident to JWPC [MM16]
Disturbance and noise by vehicles	• Reduce vehicle movements to a minimum extent [MM14]
Bat appearance on the project site was not recorded up to date. Nevertheless the literature review shows that bat habitats exist in the Dana Biosphere Reserve.	• To proof the appearance of bats on the project site further investigations have to be conducted. The project developer will place a bat detector on the project site to monitor any movements from these species. If the appearance of bats is proofed, adequate mitigation measures have to be implemented. [MM22]

6.8.3.3 Avifauna

Table 6-26: Impacts and mitigation measures for avifauna

Impact	Mitigation measure [MM]

Risk of electrocution to accidental occurrence of raptors	• Birds are often killed by overhead cables and transmission lines. To avoid bird mortality by overhead cables, the cables connecting the turbines with the substation will be underground cables.
	Only the cable connecting the substation to the transmission line, which is already running through the wind farm site, will be an overhead cable (approximately 250m long). For this connection raptor-safe power lines will be installed; [MM31]
	• Other mitigation measures that could be used to minimize the risk of mortality from collision with new transmission lines or during upgrades to existing distribution lines include [MM32]:
	  ◦ The installation of bird flight diverters where new transmission line crosses;
	  ◦ The use of perch guards or insulated cover-ups on new devices;
	  ◦ Inspection and insulation of jumper/ground wires;
	  ◦ Construction of new transmission lines such that all transmission conductors are a minimum of 60 inches apart;

Habitat loss for resident birds,	• Reduce footprint as much as possible [MM2]
Habitat alteration and fragmentation	• Minimize intervention as much as possible [MM22]
Displacement and habituation	• Conduct follow-up researches on the effects of the project on the avifauna. [MM21]
Collisions	• Choose wind farm layout with least impact on known avifauna flight paths; [MM25] • Underground cables instead of overhead will be constructed; [MM26] • Paint the blades by visible colors and equipping turbines with stroboscopic aviation lights; [MM27] • Conduct periodical bird monitoring throughout the project lifetime to analyze impacts of the wind farm on the avifauna. [MM28]

The project is monitored throughout the project lifetime by the Royal Society for the Conservation of Nature. Any impacts observed during monitoring will be evaluated and if necessary, adequate mitigation measures will be implemented retroactive.

6.9 Cumulative Impacts

Specie numbers decrease if impacts are not mitigated adequately. Cumulative impact will occur due to decrease of density and diversity of species and might end in the habituation of many faunistic species.

As described in chapter 1.7 there is one wind farm planned (Fujeij wind farm), but no operational wind farm, in the vicinity of the Tafila wind farm.
A proper biodiversity study conducted for Fujeij wind farm is not available for the project team.
As the two wind farms are located in a north-south direction (Figure 1-5), which comes along with the migration direction of the avifauna, there is a higher cumulative collision risk. Nevertheless it is assumed that the avifauna population will predominantly stay in the Dana Biosphere Reserve and will not fly through the wind farm sites as there are more comprehensive feeding and resting grounds.

Cumulative effects on the fauna are assumed to be minor. Effects on the fauna are assumed to be resulting from displacement and habituation, hunting and accidental killing by vehicles. Displacement and habituation is likely to happen into the Dana Biosphere Reserve. Species living in sparse, desert like environments will potentially resettle themselves to the north, east or south, where the environment is similar to the one on the project site. Therefore it is assumed that the habitats will only be influenced in a minor way.

Cumulative effects on the flora might come in combination between the Lafarge Rashidiya Cement plant and the planned Tafila wind farm. Especially during the construction phase airborne dust caused by the movement of vehicles and by the mining activities of the cement plant can cumulatively impact the efficiency of vegetation leaves to produce biomass which affects foraging needs of the mammifauna and herbetofauna which are the bases of the food web of raptors and other birds.
Furthermore dust fallout combined with the loss of soil humidity is thought to clog up crevices and cracks which are important shelters and refuge sites for invertebrates. These invertebrates consist of a major diet of many passerines i.e. shrikes and reptiles i.e. lizards, chameleon and bats, which are therefore effected by a raised dust level indirectly.

The wind farm site is crossed by a transmission line. As wind turbines the avifauna collides with the cables of transmission lines. By constructing the wind farm site in direct proximity to the transmission line, positive cumulative impacts as well as negative cumulative impacts may occur. The fact that these two constructions are located in direct proximity reduces the need of new transmission lines for a project that would be located further away. Therefore impacts like habituation or fragmentation are cumulated and do not effect further habitats.
The negative cumulative is the greater collision risk of the Tafila wind farm and the transmission line. Nevertheless studies show that the collision risk of power lines is far higher than the one of wind turbines (Figure 6-2). These studies also show that the collision risk of wind turbines is compared to other structures very low. This shows, that the added collision risk of the wind farm in combination with the existing power line is of minor significance.

Mortality source	Annual mortality estimate	Percent composition
Buildings[1]	550 million	58.2 percent
Power lines[2]	130 million	13.7 percent
Cats[3]	100 million	10.6 percent
Automobiles[4]	80 million	8.5 percent
Pesticides[5]	67 million	7.1 percent
Communications towers[6]	4.5 million	0.5 percent
Wind turbines[7]	28.5 thousand	<0.01 percent
Airplanes	25 thousand	<0.01 percent
Other sources (oil spills, oil seeps, fishing by-catch, etc.)	not calculated	not calculated

Figure 6-2: Summary of predicted annual avian mortality [6-38]

6.10 Monitoring plan for ecological resources on the site

- Monitor rehabilitation process of habitats and growth of replanted native species such as Anabasis, Ratem, Tamaris and others to maintain its IBA features;
- Monitor designated solid waste to avoid attraction of wildlife such as foxes, wolves, jackals, hedgehogs and wild cats to avoid transfer of diseases;
- Monitor any accidental death of fauna such as big mammals, reptiles and snakes mentioned in tables above. Report any incident to allocated authority directly;
- Monitor hunting activity at the site and inform law enforcement authority of any case. Monitor the level of awareness of the staff on hunting of wildlife issues;
- Monitor accidental death of bird species by turbines, traffic and hunting during the three project phases;
- Ensure that designated areas for collection and storage of natural soil and stones of the area are used in allocated areas;
- Monitor and ensure that dredged areas are backfilled with topsoil of the site to encourage the growth of natural plants;
- Monitor cutting of trees, shrubs and wood from the site and provide other sources of heating and cooking products for the workers;
- Monitor aesthetic and ecological features of the site such as wadis seasonal and permanent springs, the flora and the fauna;
- Monitor the activity of fauna species during construction- and operation phases to determine the level and the magnitude of the impact by the project;
- Monitor migration routes of birds on the project site and in the surrounding wadis Dana, Fujeij and Wadi Khanizira Bin Hammad;
- Monitor effectiveness of the ecological emergency plan using native species and their habitats as indicators of quality insurance;
- Monitor deforestation plans and insure that all planting efforts include natural plants to the area according to the bio geographic regions of the site to maintain the aesthetical and natural habitat features;
- Monitor and insure that vehicle movement on the site are within ecologically-sound and designated routes that do not cause any change in the natural habitats and wadi systems of the area’s natural and cultural features.

6.11 Summary

The baseline biodiversity of the area is highly degraded due to:

- Overgrazing practices;
- Soil erosion from farming, land and soil ploughing;
- Illegal hunting;
- Cutting of forest resources and shrubs for household uses;
- Urban expansion over semi-natural and rangeland areas.

Though the site is rich in resident birds and migrant passerines, few raptors were recorded due to high disturbance from urban expansion, farming, illegal hunting and overgrazing as mentioned above. Records show that more raptors and soaring birds were recorded in Wadi Dana and Fujeij due to the following reasons:

- Wadis in the Dana Biosphere Reserve are lush with vegetation, broader and closer to the desert. Therefore the wadis attract more migratory birds especially soaring birds such as eagles and buzzards;
- Several wadis adjacent to the site are lusher with vegetation and are inhabited with tall stand of forest trees of oak, pistachio and juniper;
- Due to good protection and less disturbance in Wadi Dana and Fujeij raptors and soaring birds tend to use these areas;
- The planned wind farm site is relatively far away from the main gorges and does not have dense vegetation. Accordingly, less prey such as reptiles, rodents for raptors and soaring birds are attracted to this area;
- According to 12 month of avifauna observations the site does not host important bird migratory routes on spring and autumn migration. Some routes adjacent to the site are passage, feeding and nesting areas for raptors such as Griffon Vulture, Buzzard, Golden Eagle, Black Kite and Common Kestrel, Wheatears and other passerines in very small numbers in spring migration.
- The Golden Eagle, although recorded as endangered in Europe, is not listed as endangered in Jordan and has an extensive distribution worldwide. Its global status under IUCN is LC which means “common and least concern”; Bats were recorded in the past however the caves that were examined did not show any bat activities. Human persecution and cave burning may be the reason;
- No dense vegetation or forests were recorded on the site except of afforested pine trees near Busaira village. These pine trees do not have any conservation value since pine trees are not native to the area;
- Mammals recorded or reported by local residents are endangered in Jordan. Their numbers are not high on site due to disturbances by local farmers and shepherds.

6.12 List of references

[6-1] Al-Eisawi, D. (1998): Field Guide to Wild Flowers of Jordan and Neighboring Countries. UNDP, Al-Rai Print shop, Amman. Pp. 290.

[6-2] Al-Eisawi, D. M. (1985): Vegetation of Jordan. In: studies in The History and Archaeology of Jordan II, A. Hadidi (ed.). Ministry of Archaeology, Amman: 45-57.

[6-3] Al-Eisawi, D. M. (1997): Vegetation of Jordan. UNESCO, Regional Office for Science and Technology for Arab States, Cairo.

[6-4] Amr, Z. S. (2000): Mammals of Jordan. United Nations Environment Programme. Amman. 116 pp.

[6-5] Amr, Z. S., Kalishaw, G., Yosef, M., Chilcot, B, J. and Al-Budari, A. 1996. Carnivores of Dana Biosphere Reserve (Carnivora: Canidae, Hyaenidae and Felidae), Jordan. *Zoology in the Middle East,* 13:5-16.

[6-6] Andrews, I. J. (1995): The Birds of the Hashemite Kingdom of Jordan. Andrews, I. J., Medlothian. Pp 185.

[6-7] Catullo, G. Ciucci, P. Disi, A. M. & Boitani, L. 1996. *Nubian ibex* in south-western Jordan (Dana Biosphere Reserve). *Oryx* 30 (3):222-224.

[6-8] Disi, A. M. Hatough-Bouran, A. 1999. Biodiversity of the terrestrial vertebrate fauna of Petra (Jordan). *Casopis Narodniho Muzea Rada Prirodovedna*, 168 (1-4):83-98.

[6-9] Disi, M. A., Moudry, D. Necas, P. & Rifai, L. (2001): Reptiles and Amphibain of the Hashemite Kingdom of Jordan: An Atlas and Field Guide. Chimara. Frankfurt.

[6-10] El-Oran, R. M., Al-Melhem, W. N. & Amr, Z. S. 1994. Snakes of southern Jordan. *Bollettino di Zoologia* 61(4):359-367.

[6-11] Evans, M. (1994): Important Bird Areas in The Middle East. BirdLife Conservation Series. Cambridge, 2:1-410.

[6-12] GCEP. (1998): Jordan Country Study on Biological Diversity. GCEP, Amman.

[6-13] GCEP. (2000a): Jordan Country Study on Biological Diversity: Plant Biodiversity and Taxonomy GCEP, Amman.

[6-14] GCEP. (2000b): Jordan Country Study on Biological Diversity: Jordan Ecology, ecosystems and Habitats. GCEP. Amman.

[6-15] Khoury, F. (1998): Habitat selection by Syrian serin in southwest Jordan. Ornithological Society of the Middle East, 98:87.

[6-16] Kurschner, H. (1986): A Physiogonomical-ecological Classification of the Vegetation of Southern Jordan. In: Contributions to the Vegetation of South West Asia, H. Kruschner (ed.) Beihefte Tubinger Atlas Voedere Orient, Rihe A (Naturwisseneschaften), Weisbaden (Dr. L. Reischert), 45-79.

[6-17] D. MODR´Y, L. RIFAI, M. ABU BAKER & Z. AMR Amphibians and reptiles of the Hashemite Kingdom of Jordan

[6-18] Poore, M., E. & Robertson, V. C. (1964): An Approach to the Rapid Description and Mapping of Biological Habitats. Sub-Commission on Conservation of Terrestrial Biological Communities of the International Biological Programme. 68 pp.

[6-19] Qumseyih, M. (1996): Mammals of the Holy Land. Texas Tech University Publication, Lubbock. RSCN and BirdLife International (2000): Important Bird Areas in The Hashemite Kingdom of Jordan. GEF Financial Support, UNDP Amman.

[6-20] Snow, D. W. & Perrins, C. M. 1998. The Birds of the Western Palaerctic. Oxford Univ. Press, Oxford.

[6-21] Zalles, J. I. & Bildstein, K. L. (2000): Raptor Watch: A global Directory of Raptor Migration Sites. BirdLife International and Hawk Mountain Sanctuary. Cambridge.

[6-22] ZUHAIR S. AMR 1 & AHMAD M. DISI 2 Systematics, distribution and ecology of the snakes of Jordan

[6-23] The world bank, 2006: Integrated Ecosystem and Natural resources Management

[6-24] The Israeli Birding Website, http://www.israbirding.com/, last access: 11th November 2012

[6-25] Shochat et. Al, 2010: Developing a Management Plan for Important Bird Areas in Southern Israel, http://www.israbirdcenter.org/research/Arava_report[1]_June2010.pdf, last access: 11th November 2012

[6-26] Bruderer, Blitzblau, Peter, 1994: Migration and Flight behavour of honey buzzards in southern Isreal observed by radar, http://www.avibirds.com/pdf/W/Wespendief1.pdf, last access: 11th November 2012

[6-27] Y LESHEM, Y YOM-TOV - Ibis, 1998 - Wiley Online Library

[6-28] YOSSI LESHEM1,2 & YORAM YOM-TOV' Society for the Protection of Nature in Israel, 4 HaShfella Street, Tel Aviv 66183, Israel Department of 4 4 Y. LESHEM & Y . YOM-TOV The thicker lines cast of the coastline arc Ilocks of migrating birds, some of which are 90 km long.

[6-29] Differential use of thermal convection by soaring birds over central Israel J Shamoun-Baranes, Y Leshem, Y Yom-Tov, O Liechti - The Condor, 2003 - BioOne Judy Shamoun-Baranes, Emiel van Loon, Dan Alon, Pinhas Alpert, Yoram Yom-Tov, Yossi Leshem. (2006) Is there a connection between weather at departure sites, onset of migration and timing of soaring-bird autumn migration in Israel

[6-30] Scottish Natural Heritage 2000, Guidance note Series: Wind farms and birds, Calculating a theoretical collision risk assuming no avoiding action

[6-31] Langston R., Pullan J., 2003: Wind farms and Birds: An analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues, BirdLife International

[6-32] The Royal Society for the Nature Conservation:_ http://www.rscn.org.jo/orgsite/Portals/0/maps/established%20reserves%20maps/Topography_Dana_en_B.jpg, last access: 06th December, 2012

[6-33] Border of the Dana IBA, 2009: http://globalspecies.org/kmlserver/getkml/8198/iba, Last access: 06th December, 2012

[6-34] Calculating the Birds collision: www.snh.gov.uk/docs/C234672.xls, last access: 06th December, 2012

[6-35] Jordan's EIA-committee standards: http://www.moenv.gov.jo/ArabicMOE/Users/PagesWithoutTemplate.aspx?pageId=141&type=1, last access: 06th December, 2012

[6-36] BirdLife International, http://www.birdlife.org/datazone/sitefactsheet.php?id=8198, last access: 17th December, 2012

[6-37] Kunz, T.H., et al, 2007: Ecological impacts of wind energy development on bats: questions, research needs and hypotheses

[6-38] Erickson, W.P. et al, 2005: A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on collision

Figures

OBSERVATION·STATIONS¶

Figure 6-3: Observation stations of the biodiversity field survey

Border·DaNA·IBA¶

Figure 6-4: Dana Important Bird Area

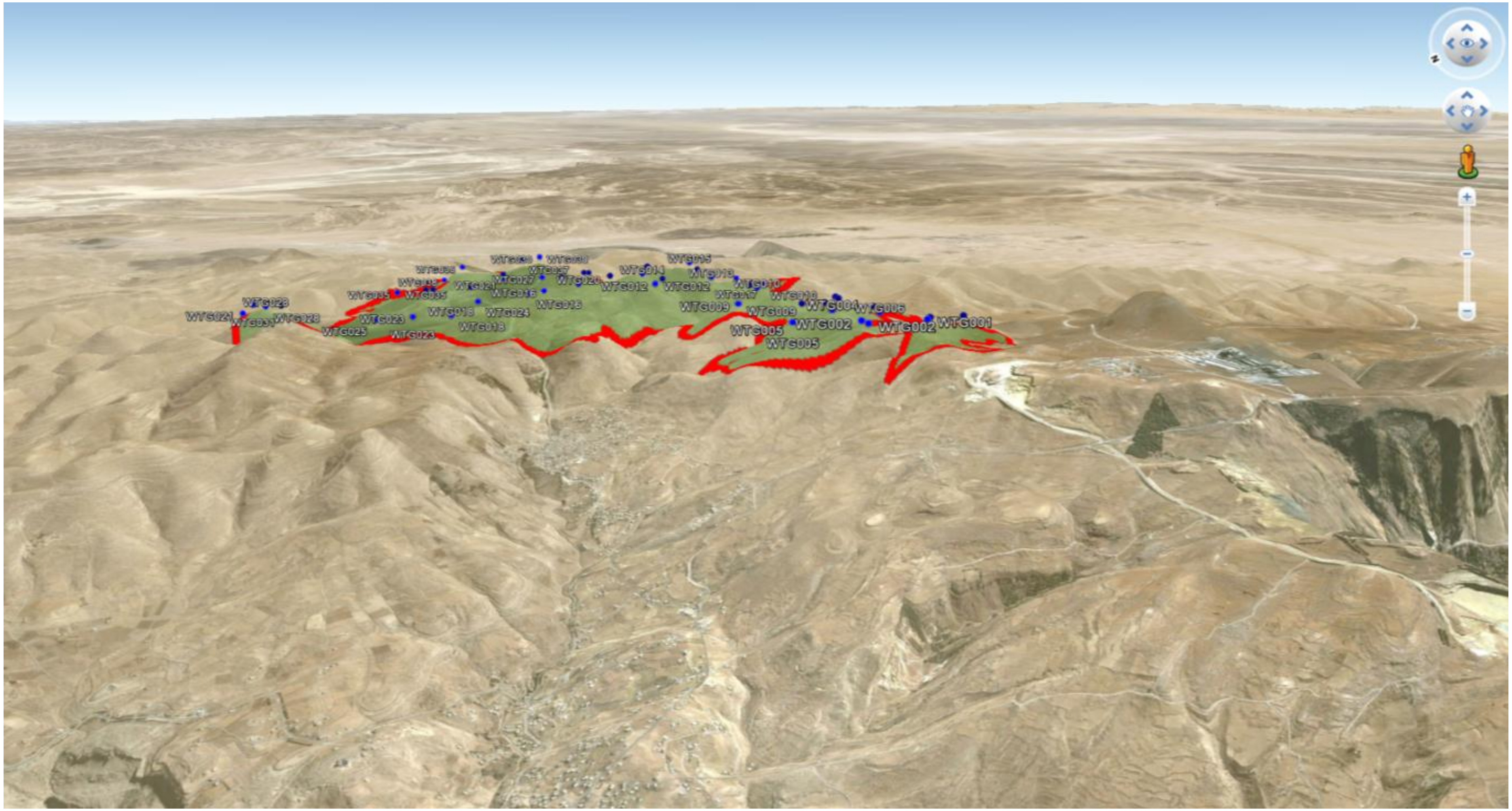


Figure 6-5: Locations of the site and of Wadi Gharandil

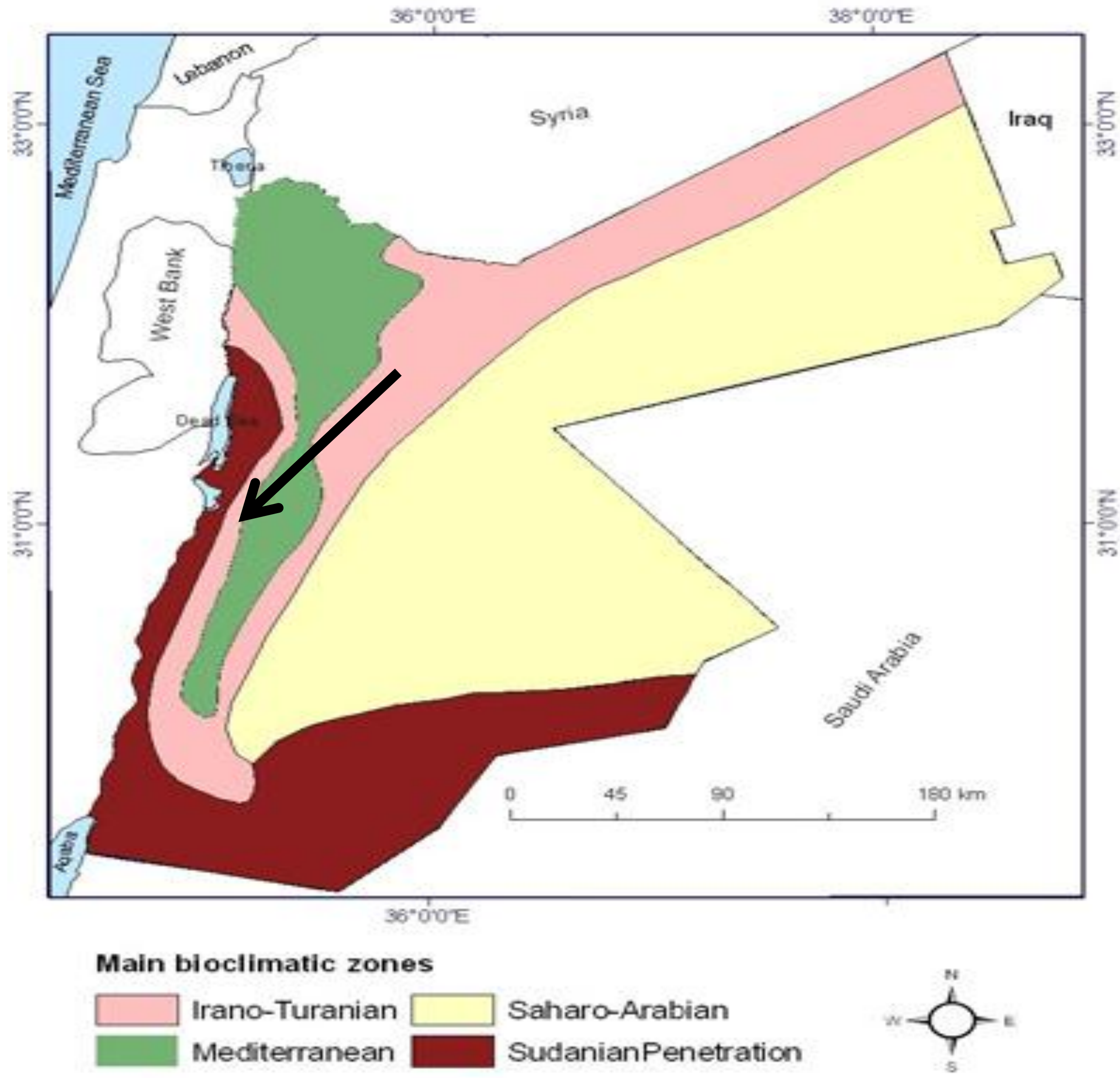


Figure 6-6: Vegetation types and biogeographic zones of the project site

Figure 6-7: Eroded and overgrazed site

ern·edge·of·the·p

·and·Figure·6-7.¶

Figure 6-8: Dana IBA and the project site

13¶

Figure 6-9: Dana Area, Wadi Hias, Wadi Bin Hammad

7 Geology, hydrology and hydrogeology

7.1 Introduction

This study provides the baseline information on water resources and geological settings to assist in assessing the environmental impacts of the Tafila Wind Energy Project. The project is located in the Governorate of Tafila (Figure 7-1) within the directorates of Arady Busayra and Arady Tafila, east of the town Gharandil and north-east of the LaFarge Rashidiya cement plant (Figure 3-6). The selected project site is located in a desert-like area with numerous hills composed of unconsolidated soil and rocky ground of different grain-sizes (sand, gravel, pebble-size and larger stones of at least 5-10 cm diameter, basically made of the mineral chert).

The bedrock outcropping in the investigation area is of sedimentary origin of the Upper Cretaceous (Campanian to early Tertiary). In some places, the bedrock is covered by superficial deposits coming from the Pleistocene through the recent age until today.

The study area is characterized by faulting of different types, trends and extent. However, the prominent trending faults are east-west trending. In addition to the previous fault trending, relatively small faults are heading from northwest to southeast.

The hydrogeology of the project area is controlled by the geological setting. Two major aquifers can be recognized in the project site area, the B2/A7 aquifer and Kurnub aquifer, which are separated by the A1/6 aquitard.

Water resources in the study area consist of three sources, namely groundwater resources, surface water and treated wastewater sources. Groundwater resources in the study area are represented by the pumped wells and the springs encountered in the catchment area, while surface water includes spring flow and flood flow.

7.2 Objectives

The geology, geohydrology and hydrology are sensitive ecological media that do not only affect the flora and fauna but also mankind. Therefore issues related to possible impacts on these media have to be considered carefully.
The objectives of chapter 7 are:

- To determine information regarding water resources in relation to the project;
- To assess impacts of project activities on water resources and any potential impact of water bodies on the project;
- To propose mitigation measures and to prepare a mitigation plan.

7.3 Guidance

7.3.1 Environmental Protection Law No 52 of 2006

This law outlines the responsibilities and duties of the Ministry of Environment as well as the tasks of the Minister. It outlines the laws for environmental protection including water, noise, air, materials, natural reserves, national parks and the consequences if these laws were not abided, as well as environmental impact assessment reports. Moreover, it outlines the duties of the Council of Ministers regarding the environment.

7.3.2 Water Authority of Jordan Law No. 18 of 1988

Water Authority of Jordan (WAJ) was originally established in 1983, pursuant to the Water Authority Law No. 34 of 1983 (temporary law), as an autonomous corporate body, with financial and administrative independence. It was directly linked with the Prime Minister. In 1988, Law No. 18/1988 was issued, from which the MWI was established and then WAJ was put under its umbrella. The main feature of this law mandates that WAJ takes over all responsibilities of the entities responsible for water and wastewater in the country. In accordance with Article (3) of this Law, WAJ bears full responsibility for public water supply systems, sanitation and related projects as well as planning and control, construction and maintenance of all water resources.

7.3.3 Groundwater Control Regulation No.85, 2002 and the Regulation for the Amendment of Groundwater Control By-Law No.79 of 2003

This regulation or by-law was issued in pursuance of Articles 6 and 32 of the Water Authority Law No. 18 of 1988. Thus, regulation for the Amendment of Groundwater Control for 2003 shall be read together with Regulation No. 85 for 2002, hereinafter referred to as the “original regulation,” as one regulation.

7.3.4 Drinking Water Resources Protection Guidelines, 2006

The water resources in the Hashemite Kingdom of Jordan are classified as ground and surface water resources. The priority in protection measures is given first to existing or potential drinking water resources and second to other resources that are allocated for other use taking into account the resource yield, water quality and the risk of pollution sources on the water source. In the process of delineation of a water resource protection zones, all the relevant data and information, studies, vulnerability maps and protection zoning maps should be revised, evaluated and examined to ensure that they are sufficient to identify the different signatures of the watershed under investigation.

7.4 Methodology

The baseline conditions at the Tafila wind farm were assessed by a desktop study. Available data focusing on the environmental settings was collected to establish baseline conditions across the site and within the surrounding area.

Based on the findings of the desktop study a field survey was not necessary. No surface water resources are located on the project site. Accordingly new findings from a field survey are not expected.

7.5 Baseline

7.5.1 Geological settings

Jordan lies in the northern area of the Arabian Shield and is divided into two main structural zones; the rift dividing these two zones is represented by the Wadi Araba-Dead Sea-Jordan Valley Graben (which is part of north-northeast to south-southwest faulting network along the African – Arabian Red Sea structure) and the Jordan platform. Rifting, northward movement, tilting and uplifting in the lower Miocene to Pleistocene formed the current Jordan landscape.

The outcropping rock units in Jordan are from pre-Cambrian to the recent times. Calcareous sediments of the Upper Cretaceous and Lower Tertiary are exposed in the eastern highlands of Jordan. Limestone, dolomite, limestone with marl, shale, chalk and chert of the same age occur in the eastern highlands and the eastern plateau covering an area of about 45,000 km^2 with 150-800 meters thickness (Abed, 2000). The geology of the study area was investigated by Barjous, 1992. The bed rock outcropping in the investigation area is of sedimentary origin of the Upper Cretaceous (Campanian to early Tertiary) as shown in Figure 7-2. In some places, the bedrock is covered by superficial deposits coming from the Pleistocene to the recent age until today.

The lithological formations of the study area are as follows (from old to young):

- Kurnub Group:

The lower Cretaceous Kurnub Sandstone Group overlies with a slight angular unconformity the Ram Group. The outcrops of this formation mainly appear in the north and the central parts shown in Figure 7-2.
It consists of white, medium-grained sandstone and violet sandstone with quartzite gravel. The thickness of this formation ranges from 174 m to 240 m (Barjous, 1992). This formation is present in the north western corner shown in Figure 7-2. The Kurnub group is not present in the study area;

- The Lower Ajlun Group (A1-A6):

This group is composed of the following formations:

- Nauar (A1 - A2);
- Fuhays (A3);
- Hummar (A4);
- Shua'ab (A5-6);
- the Ajlun Group.

These formations of the Cenomanian till the Lower Turonian age consist predominantly of carbonate sediments. The Lower Ajlun Group can be found in the north and middle part of the study area.
It consists of yellow, brown, blue-gray and black marls, marly and chalky limestone, sometimes pyrite with occasional thin crystalline and shelly limestone. The thickness of this formation ranges between 250 m and 400 m;

- The Wadi As Sir Formation (A7):

This formation, formed in the Turonian, outcrops in most parts of the study area. It consists of about 100 meters of thinly bedded limestone and chalky limestone with occasional chert beds and nodules. Its age is Turonian;

- The Belqa Group:

The Belqa Group, coming from the Cretaceous age, overlies the Ajlun Group and consists of five formations, namely:

- Wadi Umm Ghudran (B1);
- Amman-Al Hisa (B2);
- Muwaqqar (B3);
- Umm Rijam (B4);
- Wadi Shallala (B5).

Only two formations (Wadi Umm Ghudran and Amman-Al Hisa) of the entire series are present in the geology of the study area;

- Wadi Umm Ghudran Formation (B1):

The group, formed between the Santonian and the Coniacian, comprises mainly chalk with an average thickness of about 15 meters;

- Amman Silicified Limestone Formation (ASL) (B2):

The silicified formation is characterized by small to medium scale syn-sedimentary folds. It consists of thin to thick layers of massive, hard chert ranging in color from brown over grey to bluish grey and white. It is intercalated with grey limestone, marl and phosphatic chert. During the Campanian it was deposited in a marine shallow to deep water environment (Powell, 1989). The thickness of this formation ranges from 56-87 m (Tarawneh, 1988);

- Cenozoic Basaltic Volcanism:

Three separate volcanic events have occurred between the upper Neogene and the Pleistocene ages in Jordan. These volcanic events resulted in basalt rocks that can be found around the study area. The basalt is porphyritic, fine grained melanocratic rock (Barjous, 1992).

7.5.2 Structural settings

The study area is located on the eastern side of the Gulf of Aqaba-Dead Sea Transform Fault System on the north-western boundary of the Arabian Plate. The fault system is part of the East African Read Dead Sea rift zone which extends for about 6,000 km from north to south (Barjous, 1992). Faulting of different types, trends, extent and ages are shown on the geological map (Figure 7-3). However, the prominent trending faults are east-west trending (Figure 7-2). In addition to the previous fault trending, relatively small faults are heading from northwest to southeast (Figure 7-2).

7.5.3 Seismicity

Within Jordan, the major trend of earthquake and micro-earthquake activity lies in a wide zone along the Dead Sea Transform Fault System (DFTFS) (Figure 7-4) with a concentration along the major structures associated with this plate boundary. The distributed pattern of seismicity suggests that in the study area the shear due the differential motion of the Arabian Plate relative to Sinai Plate is accommodated in part by east to west and north-west to south-east trending faults in a board zone (Figure 7-4).

No active fault or any active morphological features, which are usually associated with active structures and have been created due to recent vertical and/or horizontal displacements, were found within the project area. This result is not surprising as the major plate boundary (DSTFS) is located at a distance, approximately 35 km to the west from the project site, which is not expected to affect the project site. However, it is advisable that detailed site investigation and reporting of any active faults should be carried out for any construction project within the Dead Sea Transform Fault System in order to check compliance with civil engineering codes.

7.5.4 Hydrology

The hydrogeology of the project area is controlled by the geological setting, which includes the piezometry, the occurrence and the movement of ground water. Based on their potential to contain water, the main aquifers in the study area are namely B2/A7, A4, A2 (see chapter 7.5). The aquifers are exploited by many wells as shown in Figure 7-6.

The geological formations can be regarded as producing or potentially productive aquifers, meaning that they can yield water and direct it to wells. The following list explains the main hydro-geological units in the study area:

- The B2/A7 aquifer system

Occurrence and extent

The B2/A7 aquifer system (Amman-Wadi Es-Sir aquifer system) has regional and economic importance for the groundwater development. This formation consists of limestone, dolomite limestone, marl and chert. It is mainly outcropped in the eastern and southern parts of the study area. The B2/A7 aquifer system has been considered to be a semi-uniform aquifer unit with hydraulic connections, which are widespread in the entire study area with a thickness of 100 to 300 m.

Groundwater flow pattern

Within the framework of the National Water Master Plan (BGR, 2004) principles on the piezometry of the groundwater in the B2/A7 aquifer have been elaborated. Figure 7-7 shows the groundwater flow path in the study area. It can be seen that the direction of flow is from the south-west towards the north-east. The B2/A7 is considered to be productive when it contains fissures and joints and when it is not massive and undisturbed. The hydrologic parameters in the B2/A7 aquifer are quite variable, as can be expected of a limestone aquifer. Based on WAJ drilling files, the horizontal hydrologic conductivity ranges from less than 0.5 m/d to more than 9 m/d. The majority of specific capacity values range from less than 3.8 m^3/h to more than 2,400 m^3/d. Moreover, the range of transmissivity lies between 100 and 400 m^2/d (BGR, 2004);

- The Kurnub aquifer system

Occurrence and Extent

This formation mainly crops out in the north-western corner of the project area. The thickness of this formation ranges from approximately 174 m to about 240 m.
Very few wells have been drilled in the Kurnub aquifer. Pumping test data are not available. Based on the lithology of this unit, its usability for water pumping can be regarded as minor. Howard Humphreys LTD., (1986) assumed that the permeability of the Kurnub Aquifer System ranges between 0.1 m/d to 1 m/d and that transmissivity reaches about 20 m^2/d to 80 m^2/d.

7.5.5 Hydrogeology

7.5.5.1 Climate

The climate in Jordan is predominantly influenced by the Mediterranean climate. It is characterized by hot dry summers and cold winters, with two short transitional periods in between. The first transitional period starts around mid-November and the second starts around the end of April. The study area is located in a hilly region. In winter, these regions experience cold weather with the lowest temperatures in January.

The main meteorological stations near the investigated area are Rashidiya and Tafila meteorological stations (Table 7-1). However, there is only data available from the Tafila meteorological station.

Table 7-1: The coordinates of the meteorological stations close to the study area

Code number	Station name	E-Coordinate[3]	N-Coordinate	Altitude [m]
DB001	Tafila	208000	1027500	1,000
CB002	Rashidiya	210000	1012500	1,500

The average annual minimum and maximum temperature at Tafila meteorological station range between 9.05 °C and 18.7 °C with an average value of 13.88 °C. The maximum sunshine duration occurs in June, with a maximum of about 13.3 h/d. The average minimum sunshine hours of about 5.3 h/d is recorded in December and January, owing to the short days at the time of the year and the cloudiness of the rainy season. Table 7-2 presents the long term average monthly parameters (1985-2007). The average relative humidity varies from 35% to 45% in summer and from 50% to 69% in winter.

[3] Palestine belt

Table 7-2: Long term monthly average of the meteorological data, 1985 – 2007 [7-4]

Climatic parameters	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Maximum Temperature [°C]	21.43	16.63	11.57	10.29	11.15	13.72	18.00	21.95	24.86	25.72	25.38	24.01
Minimum Temperature [°C]	11.15	7.72	4.46	3.17	3.60	5.23	7.54	10.20	12.86	14.58	14.49	13.72
Mean Temperature [°C]	16.29	12.17	8.06	6.77	7.54	9.43	12.86	16.12	18.86	19.72	19.98	18.86
Wind Speed [km/h]	2.93	3.24	3.56	3.87	3.77	3.87	3.56	3.24	3.35	3.45	3.35	3.03
Dominant Wind Direction	W	W	W	W	W	W	W	W	W	W	W	W
Sunshine Duration [h/day]	7.54	6.34	4.97	5.14	5.32	6.09	7.37	8.75	10.29	10.29	9.60	8.57
Relative Humidity [%]	42.01	49.73	57.44	59.16	56.59	51.44	42.87	36.01	35.15	36.87	39.44	42.87
Average Monthly Rainfall [mm]	1.37	28.55	46.98	66.88	60.02	52.30	19.72	0.34	0.00	0.00	0.00	0.00
Class A Pan Evaporation [mm/day]	7.29	4.46	3.52	3.43	4.37	5.49	6.94	9.17	10.29	11.15	10.12	9.43
Potential Evapotranspiration [mm/day]	3.17	1.89	1.37	1.29	1.80	2.74	3.94	4.80	5.66	5.40	5.32	4.20

The prevailing wind direction is west during summertime, shifting to the south during wintertime. The winds are cold and dry in winter, but hot, scorching and consequently harmful to the vegetation in summer. According to the Tafila meteorological station, the annual average wind speed on the ground is 3.4 km/h. According to CRA International (by their contractor, IT Power Company) wind at Tafila meteorological station has been measured at 40 m and 80 m above ground level. According to a 2009 statement from IT Power Company, “Initial indications of wind speed are that this is in excess of 8 m/sec, but consideration must be given to its variation over this large site, particularly as its complex terrain may lead to significant variations. Initial indications for current monitoring data indicate the prevailing wind is from the west (Figure 7-8).

7.5.5.2 Precipitation

The mean monthly rainfall distribution varies from one station to another, according to topography, climate and location. The rainfall in the study area occurs mostly in the winter months, October to May, while the summer months are dry and relatively hot.

The precipitation data for the different rainfall stations are obtained from the surface water division of WAJ. Figure 7-9 and Figure 7-10 show the annual rainfall at Tafila and Rashidiya rainfall stations from 1986 to 2007.

7.5.6 Water resources

Water resources in the study area consist of three sources namely, groundwater resources, surface water and treated wastewater resources. Groundwater resources in the study area are presented by the pumped wells and the springs encountered in the catchment area, while surface water includes spring flow and flood flow.

7.5.6.1 Groundwater resources

More than 113 wells and 26 springs located in Tafila province are used to meet the water demand of the area. These wells are presently used for municipal, agricultural and industrial purposes. 83 governmental wells are utilized for domestic governmental and 14 domestic private, 33 wells for agricultural and 38 wells for industrial purposes.

Table 7-3 presents the data with respect to the amount of yearly water abstractions for different uses in the study area. The governmental domestic sector is the major user of groundwater in the study area, followed by industrial purposes, which consumes annually more than 6 million m^3 (WAJ, 2008).

Table 7-3: Water extraction from B2 / A7 aquifer [7-7]

Production year/water uses	Pastoral	Irrigation	Industrial	Domestic - private	Domestic - governmental	Irrigation – governmental
	m³/year					
2000	74,814	3,780,156	6,886,092	1,094,880	18,624,644	2,419,239
2001	79,578	3,287,256	4,216,596	1,165,284	20,138,510	2,223,508
2002	45,363	3,993,180	6,613,728	616,272	23,647,588	2,303,203
2003	138,841	3,143,100	7,343,388	981,648	29,547,504	1,655,175
2004	75,733	2,656,176	6,651,156	1,005,420	34,243,542	2,177,487
2005	89,177	3,034,368	8,702,664	1,122,684	33,819,695	763,325
2006	125,737	2,940,120	8,967,648	1,218,240	27,330,133	2,370,252
2007	17,836	2,814,864	7,308,556	1,057,632	27,901,764	3,043,188
2008	1,976				6,422,352	444,458

In fact 57.89 % of the total groundwater withdrawal is used to governmental- domestic and 23.68 % is used for industrial purposes. Industrial water use increased from 689 million m³ in 2000 to 731 million m³ in 2007 in central Jordan as a result of phosphate mining development.

7.5.6.2 Springs

There are about 26 springs emerging from different aquifers in the study area (within the boundary of Gharandil, Busayra, and Al Baida), of which 14 springs emerge from the Hummar Aquifer (A4), one spring from the Kurnub Aquifer, two springs from the Na'ur Aquifer (Al/2) and five springs from the Amman-Wadi Es-Sir Aquifer (B2/A7). The average discharge of these springs ranges between 0.3 m^3/ h and 7.2 m^3/ h. No springs are found in the vicinity of the planned wind turbines.

7.6 Impact assessment

7.6.1 Construction phase

The construction activities that will be undertaken for the project are:

- Excavation of areas for turbine foundations and foundations for the electrical substation, followed by pouring concrete foundations and backfilling;
- Excavation of areas for temporary site compound and permanent roads and crane pads; followed by filling these areas with gravel and compacting the gravel;
- Construction of retaining walls or fences around site compound and storage area;
- Erection of wind turbine by the use of heavy duty mobile or crawler crane, light duty mobile cranes, and transformer pillars;
- Underground-cable laying.

Potential impacts on water resources during construction phase may include:

- Change in drainage patterns by establishing new access roads which may cross minor wadis;
- Water run-off from the construction areas;
- Wastewater run-off from the construction area;
- Water demand for the temporary site compound;
- Wastewater from the temporary site compound.

It is expected that the construction phase of the Tafila Wind Energy Project will have limited impacts on the surface water and groundwater resources in the area. The construction phase's impact on the area will be limited to relatively small pieces of lands and outside of the main wadis areas.

During the construction stage, the project demand for water will be limited to potable supply to the construction workers in addition to the use of water for dust suppression and building of reinforced concrete bases for the turbines. The needed water could be supplied by tanks from private suppliers in the area. As planned by the project, all wastewater, generated during the construction phase, will be hauled off site to the nearest municipal wastewater treatment plant.

Water quality could be affected by activities that cause soil erosion, weathering of newly exposed soils leading to leaching and oxidation that could release chemicals into the water, discharges of waste or sanitary water, and pesticide applications.

Storm water runoff could be considered to be the sole cause of impact on water quality by washing off sand/ suspended solids to wadis during excavation and backfilling. Erosion is a potential environmental problem that can be caused by construction activities of the wind farm project. Erosion impacts can include increased siltation of streambeds, alteration of stream courses, and increased flooding.

7.6.2 Operations phase

During the operational phase, no residual impacts on water resources are predicted to occur. The operational phase causes insignificant impact. It is to be noted that any waste material resulting from maintenance will be handled adequately. Hazardous waste is not expected to be an issue; in case of any generated oily or other waste, it will be handled according to national environmental regulations. Any waste will be contained, collected and transferred for treatment, reuse or final safe disposal.

7.6.3 Decommissioning phase

Typical activities during the wind farm decommissioning and site reclamation phase include turbine and facility removal, breaking up of concrete pads and foundations, recontouring the surface, and revegetation. Potential impacts from these activities are presented below, by the type of affected resource.

7.6.4 Water use

Water may be transported to the site from off-site or obtained from local groundwater wells or nearby surface water bodies, depending on availability. It will be used for dust control for road traffic, dismantling of towers, substations, and other buildings; and for consumptive use by the decommissioning/site reclamation crew.

7.6.4.1 Water quality

Water quality could be affected by activities that cause soil erosion, weathering of newly exposed soils leading to leaching and oxidation that could release chemicals into the water, discharges of waste or sanitary water, and pesticide applications. Upon completion of decommissioning, disturbed areas will be contoured and revegetated to minimize the potential for soil erosion and water-quality-related impacts.

7.6.4.2 Flow alteration

Surface and groundwater flow systems would be affected by withdrawals made for water use, wastewater and storm water discharges, and the diversion of surface water flow for access road reclamation or storm water control systems. The interaction between surface water and groundwater could also be affected if the two resources are hydrologically connected, potentially resulting in unwanted dewatering or recharging of any of these water resources.

7.7 Mitigation measures

The following mitigation measures should reduce the potential impacts of the wind farm construction, operation and decommissioning to an acceptable level. The Mitigation measures are listed in Table 7-4 and include:

- The use of draining pipes allowing sufficient flow of water in areas where roads are crossing wadis is needed to avoid flooding and damage to the existing roads and the wadis; [MM37]
- Minimize the consumption of water during construction by using water saving practices; [MM38]
- Ensure adequate handling of domestic wastewater resulting from workers during the construction phase. The cesspool should be completely closed and impermeable to avoid soil and ground water pollution. The wastewater should be hauled to the nearest wastewater treatment plant such as in Tafila or to the one in the LaFarge Rashidiya cement plant (if an agreement is reached in this respect); [MM39]
- Minimize the sedimentation of excess soil and debris to wadis during the wet season, by using sufficient drainage and the remove of excess soil and debris in a timely manner. The top soil can be reused for the landscape recultivation after construction, while limestone and debris that is excavated can be reused at stone processing sites; [MM41]
- Reduce the potential of erosion caused by water run-off by specially designed fences and sandbags around excavated earth; [MM46]

- Ensure adequate management of hazardous materials. Fuel and oily wastes shall be handled as hazardous materials. It must be collected separately in a proper manner avoiding spillages and contamination of soil and water. The materials are to be sent for reuse by licensed contractors; [MM51]
- Household waste from construction workers must be collected in the dedicated containers for household waste and transported to the assigned landfill by the municipality. Mixing of hazardous waste with domestic solid waste should be avoided. [MM11]

Table 7-4: Geological water resources impacts and management

Impact of	Scale	Duration	Positive / negative	Consequence	Probability	Significance	Mitigation measures [MM]	Expected residual level of impact
Wadi crossings by construction traffic	Local	Short term, during construction	Negative	Minor	Not Likely	Minor Adverse	Construction when no water flow is expected and allowance of drainage. [MM37]	Negligible
Water demand for construction camp	Local	Short term, associated with construction	Negative	Negligible	Certain	Minor Adverse	Minimize consumption / abstraction as much as possible. [MM38]	Minor Adverse
Wastewater production from construction camp	Local	Short term, during construction	Negative	Minor	Very Unlikely	Moderate Adverse	A completely closed cesspool should be built to collect domestic wastewater resulting from workers. It should be emptied frequently and transported to the nearest municipal wastewater treatment plant. [MM39]	Negligible

Impact of	Scale	Duration	Positive / negative	Consequence	Probability	Significance	Mitigation measures [MM]	Expected residual level of impact
Use of water on-site to suppress dust development during construction	Local	Short term associated with construction	Negative	Moderate	Likely	Moderate Adverse	In order to reduce the use of water for dust-reduction purposes, excavated piles of soil will be covered with tarpaulins, where possible, instead of being watered to reduce dust production [MM40] In addition special dust suppression material could be used instead of water. [MM13]	Minor Adverse
Rainwater and snowmelt runoff in the winter	Local	During construction work if coincide with heavy snow.	Negative	Moderate	Likely	Minor Adverse	Minimize the flow of excess and debris soil to wadis (sedimentation), manage drainage system. [MM41]	Negligible
Soil excavation for foundations and construction	Local	Short term associated with construction	Negative	Minor	Likely	Minor Adverse	Nutrient rich top soil can be used provided that erosion is avoided. Deeper parts, such as limestone, shall be transferred for reuse elsewhere in filling or stones crushing. [MM42]	Minor

Impact of	Scale	Duration	Positive / negative	Consequence	Probability	Significance	Mitigation measures [MM]	Expected residual level of impact
Erosion caused by heavy rainfall	Local / Regional	Short term during construction	Negative	Moderate	Likely	Moderate Adverse	Minimizing the amount of earth disturbed during construction; [MM44] Avoiding construction on steep slopes where appropriate; [MM45] Designing erosion-control structures adequate to the task by e.g. construction of adequate slopes for excavations; [MM46] Remove excess soil from sites of towers on a regular basis. Cover excavated soil with suitable tarpaulins. [MM47]	Minor Adverse

Impact of	Scale	Duration	Positive / negative	Consequence	Probability	Significance	Mitigation measures [MM]	Expected residual level of impact
Pollution of water through spills of leaks of fuels and oils	Local	During construction	Negative	Minor	Unlikely	Minor Adverse	Inspection of trucks that stay on-site for long periods (such as excavation machinery and cranes) [MM48] Special considerations for fuel trucks; [MM49] Spill clean-up procedures should be in place; [MM50] Ensure safe storage and transfer of oils and waste oil. [MM51]	Minor Adverse
Domestic solid waste resulting from workforce	Local	During construction	Negative	Minor	Likely	Minor Adverse	It must be collected in special containers and transported periodically to the nearest solid wastes disposal area. [MM11]	Minor Adverse

7.8 Residual impacts

Provided that the planned and designed mitigation discussed above is fully implemented, there are no significant residual impacts to be considered on the geological, hydrological and hydrogeological receptors identified in this chapter.

7.9 Cumulative impacts

At the time of writing this ESIA (November 2012), no operational wind farm fall within the same geological, hydrogeological and hydrological catchments as the proposed development site and therefore have the potential to generate cumulative geological, hydrological and hydrogeological impacts There are no surface water resources on the site or nearby to function as water extraction. Therefore it is anticipated that there are no cumulative effects between Fujeij wind farm and Tafila wind farm.

7.10 Summary

The wind farm has a planned life span of up to 20 years. Once the facility has reached the end of its life the turbines may be of a status to continue operation as a power generating facility, or the facility may be closed and decommissioned. If decommissioned, all the aboveground components of the wind farm would be removed and the site would be rehabilitated. The decommissioning and reinstatement of the site would involve activities that may have environmental and social impacts.

At the construction phase of the wind farm of Tafila, the project will have limited impacts on the surface water and groundwater resources in the area. The construction phase's effects on the area will be limited to relatively small pieces of lands and outside of the main wadi areas.

During the operational phase, no residual impacts on water resources are predicted to occur. The operational phase does not cause significant impacts. It should be noted that any waste material resulting from maintenance of the motors will be handled adequately. Hazardous waste is not expected to be an issue; in case of any generated oily waste, it will be handled according to national environmental regulations. Any waste will be contained, collected and transferred for treatment, reuse or final safe disposal.

A detailed decommissioning and rehabilitation plan will be developed prior to decommissioning the facility and associated infrastructure in accordance with the relevant environmental authority. This plan may include, but not be limited to, management of socio-economic aspects such as employment creation, removal, re-use and recycling of materials and vegetative rehabilitation to prevent erosion. This impact assessment focused on potential impacts associated with the construction and operational phase of the proposed wind farm. The decommissioning activities will be similar to construction activities and therefore recommendations outlined to manage construction phase impacts should be adhered to during decommissioning. Management actions should focus on the rehabilitation of disturbed areas and the removal of infrastructure

7.11 References

[7-1] Abed, A. 2000 Geology of Jordan, Water and Environment. (In Arabic) 571 pages.

[7-2] Barjous, M. (1992) The geology of the Ash Shawbak area. Map Sheet No. 3151 III. Bulletin 19, NRA, Amman

[7-3] BGR, WAJ, (1998) Groundwater Resources of Northern Jordan, 5, BGR-Archives No. 8921058 (GTZ) German Technical Cooperation (2004) National Water Master Plan, Groundwater Resources. Volume 1, p 44

[7-4] (JMD) Jordanian Meteorological Department (2008) Metrological data, Amman, Jordan www.met.jometeo.gov.jo

[7-5] (JMD) Jordanian Meteorological Department (2010) Metrological data, Amman, Jordan www.met.jometeo.gov.jo

[7-6] Powell J, (1988). The geology of Karak area Sheet No. 3152, NRA Geological Mapping Division, Bulletin 31

[7-7] (WAJ) Water Authority of Jordan (2008) Open Files. Amman.

Figures

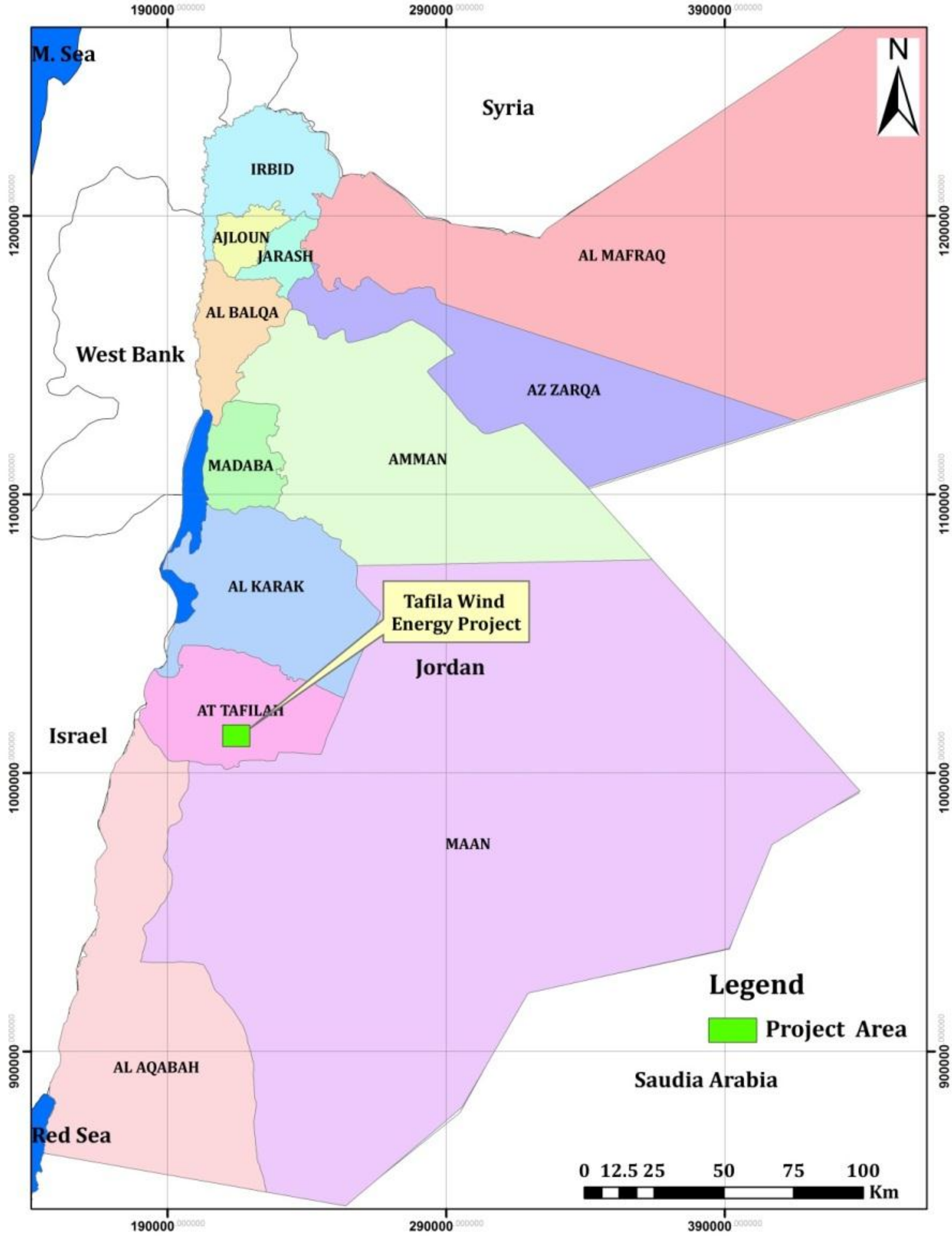


Figure 7-1: Project location

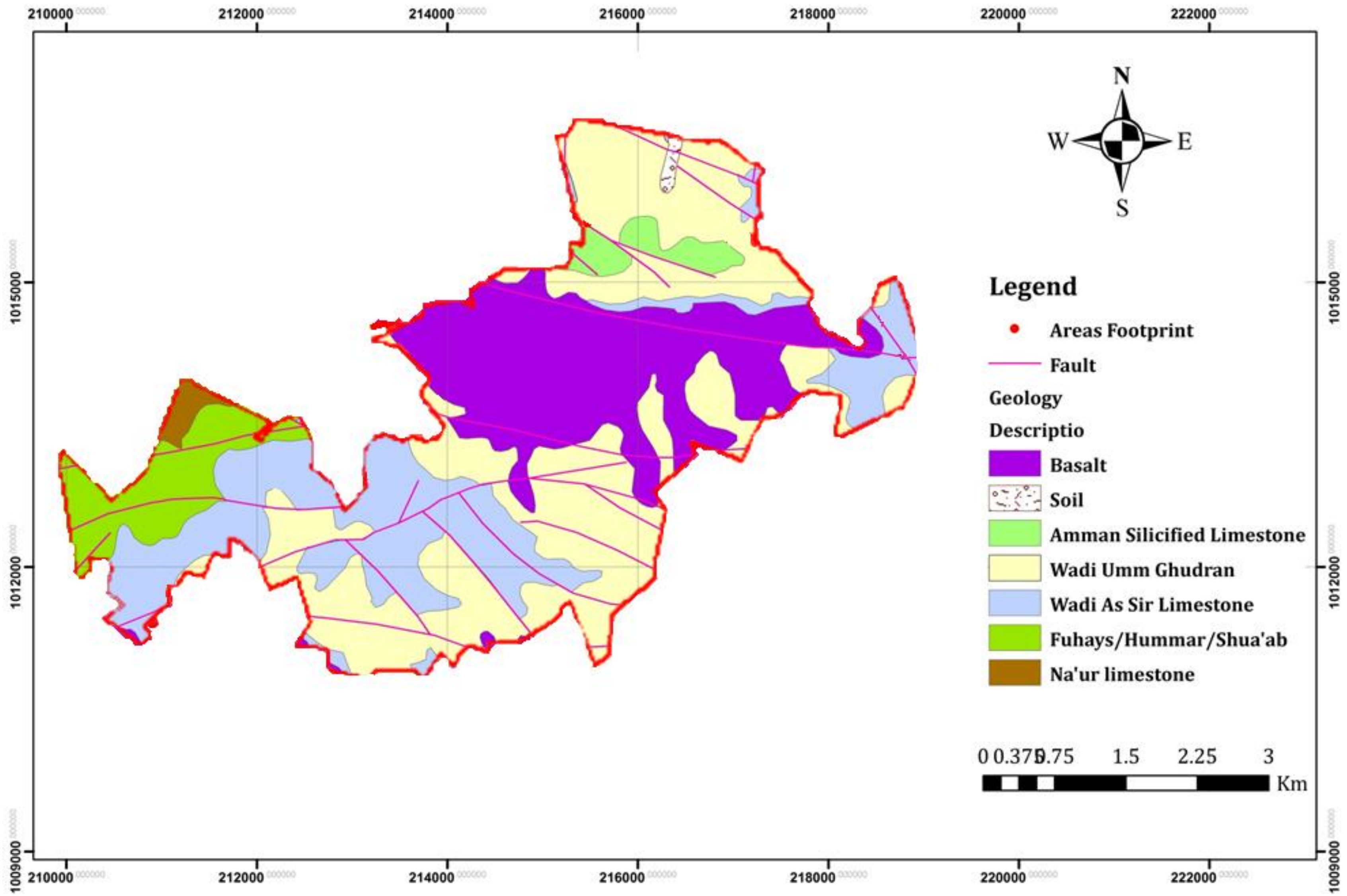


Figure 7-2: Geological map of the study area

Figure 7-3: Fault trends in the study area

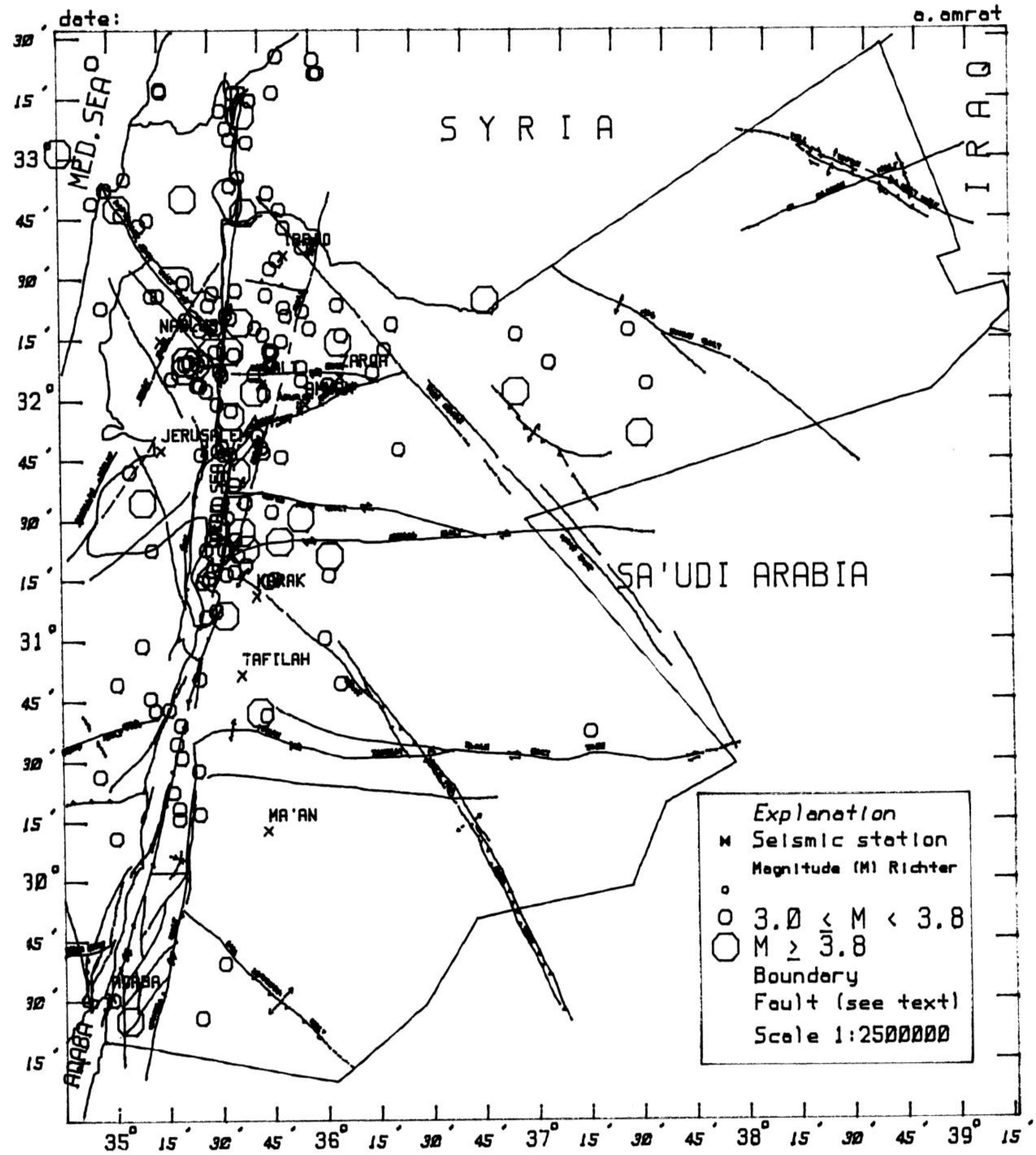


Figure 7-4: Epicenter location of local earthquakes (Barjous, 1992)

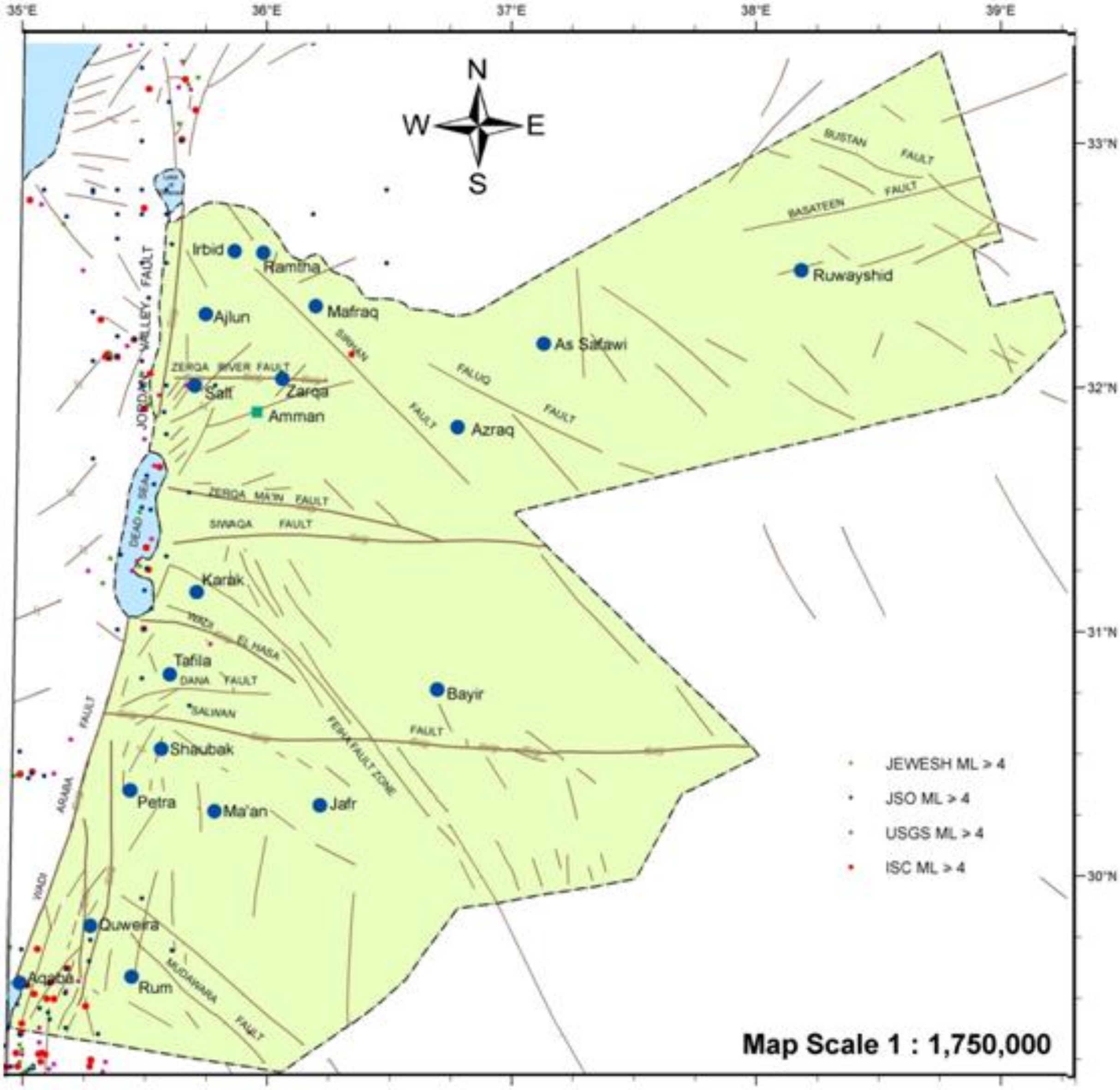


Figure 7-5: Epicenter location of local earthquakes (Natural resources Authority, 2006

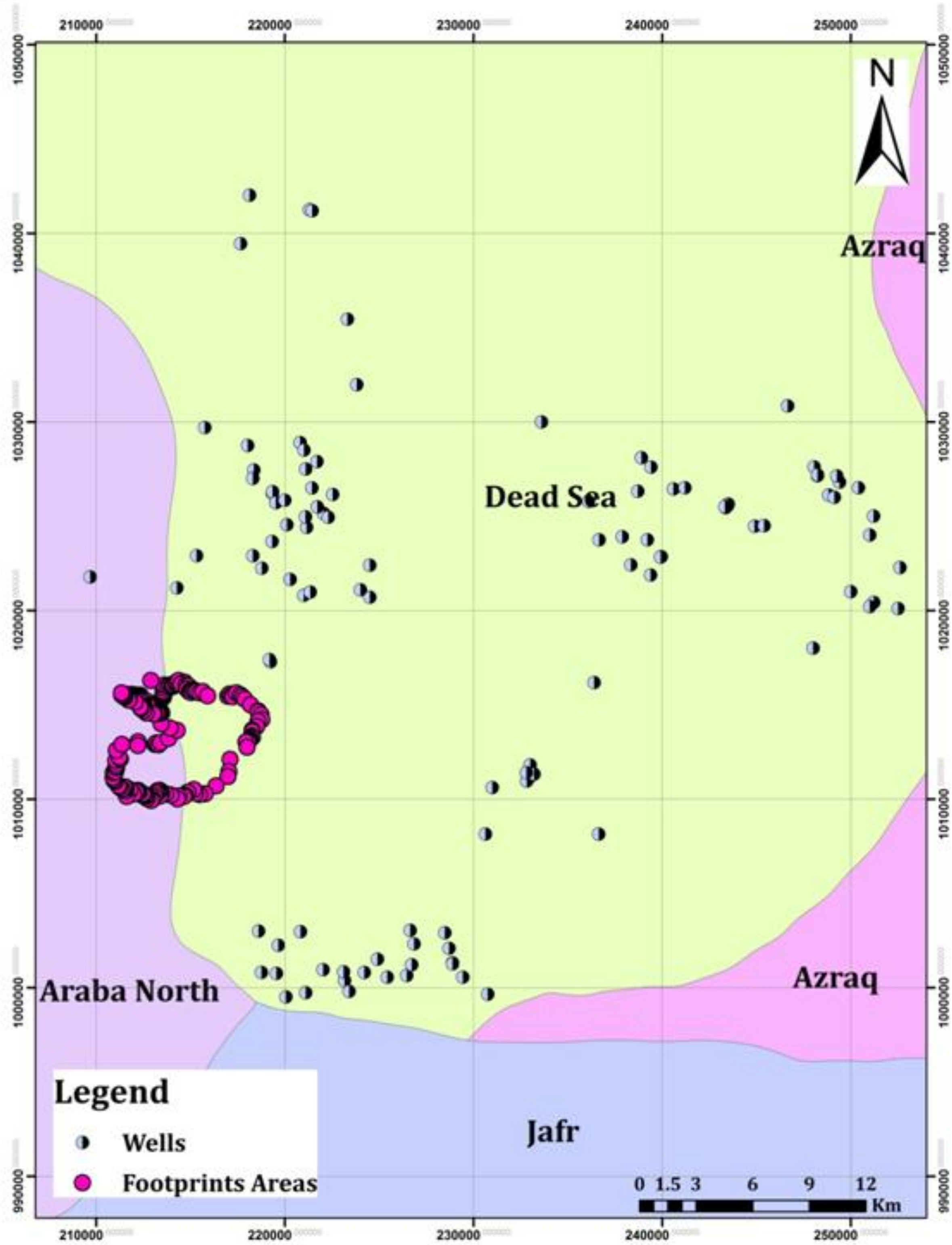


Figure 7-6: Wells from different aquifers

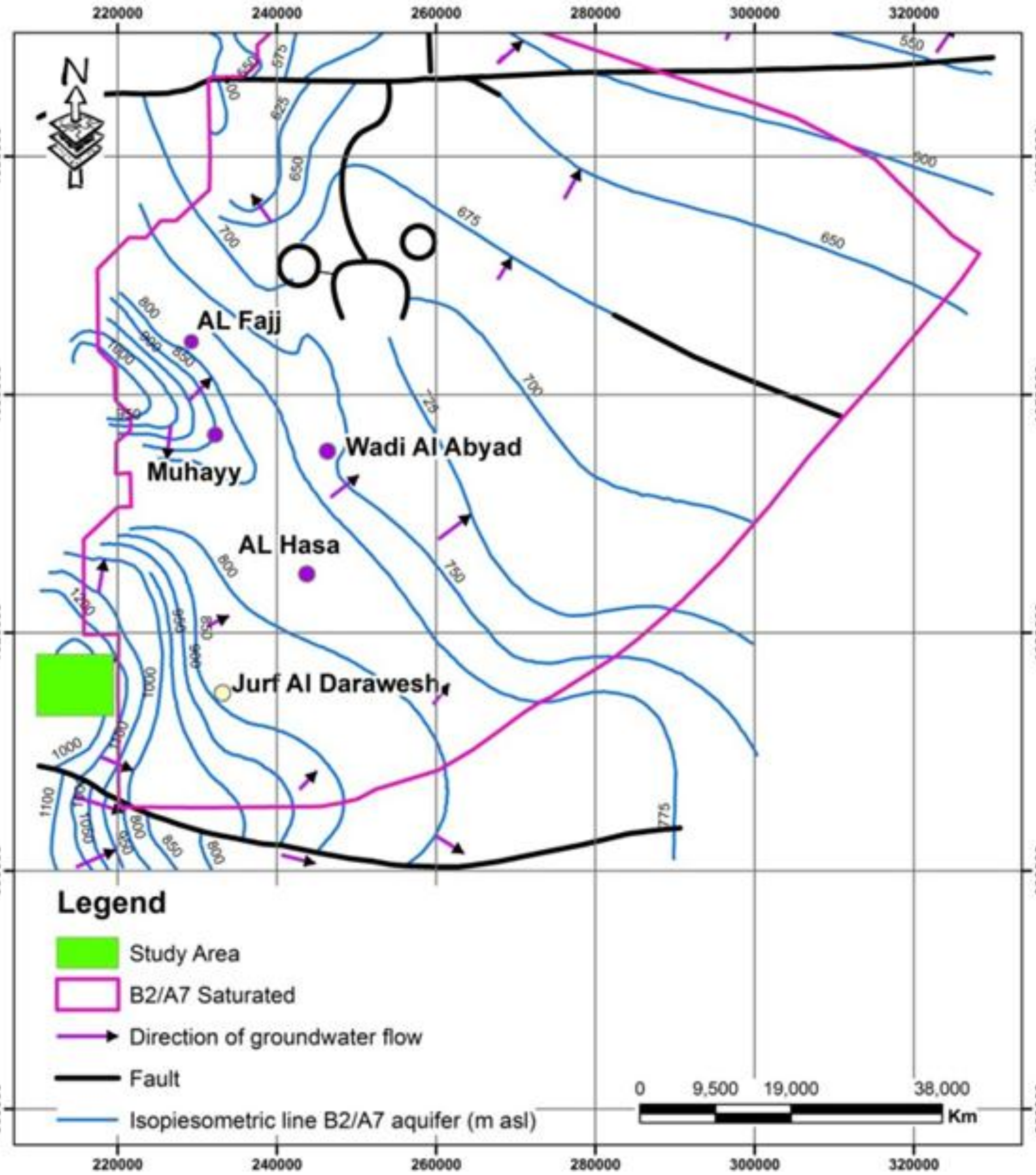


Figure 7-7: Groundwater flow (adapted from BGR, 1998)

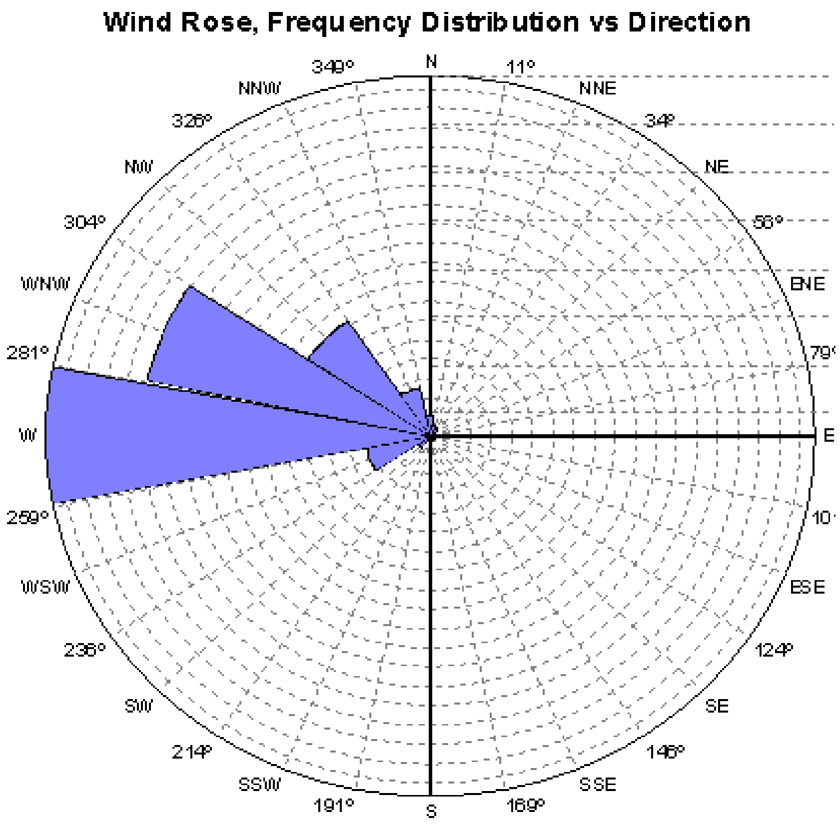


Figure 7-8: Wind rose diagram indicating the wind directions (IT-Power, 2009)

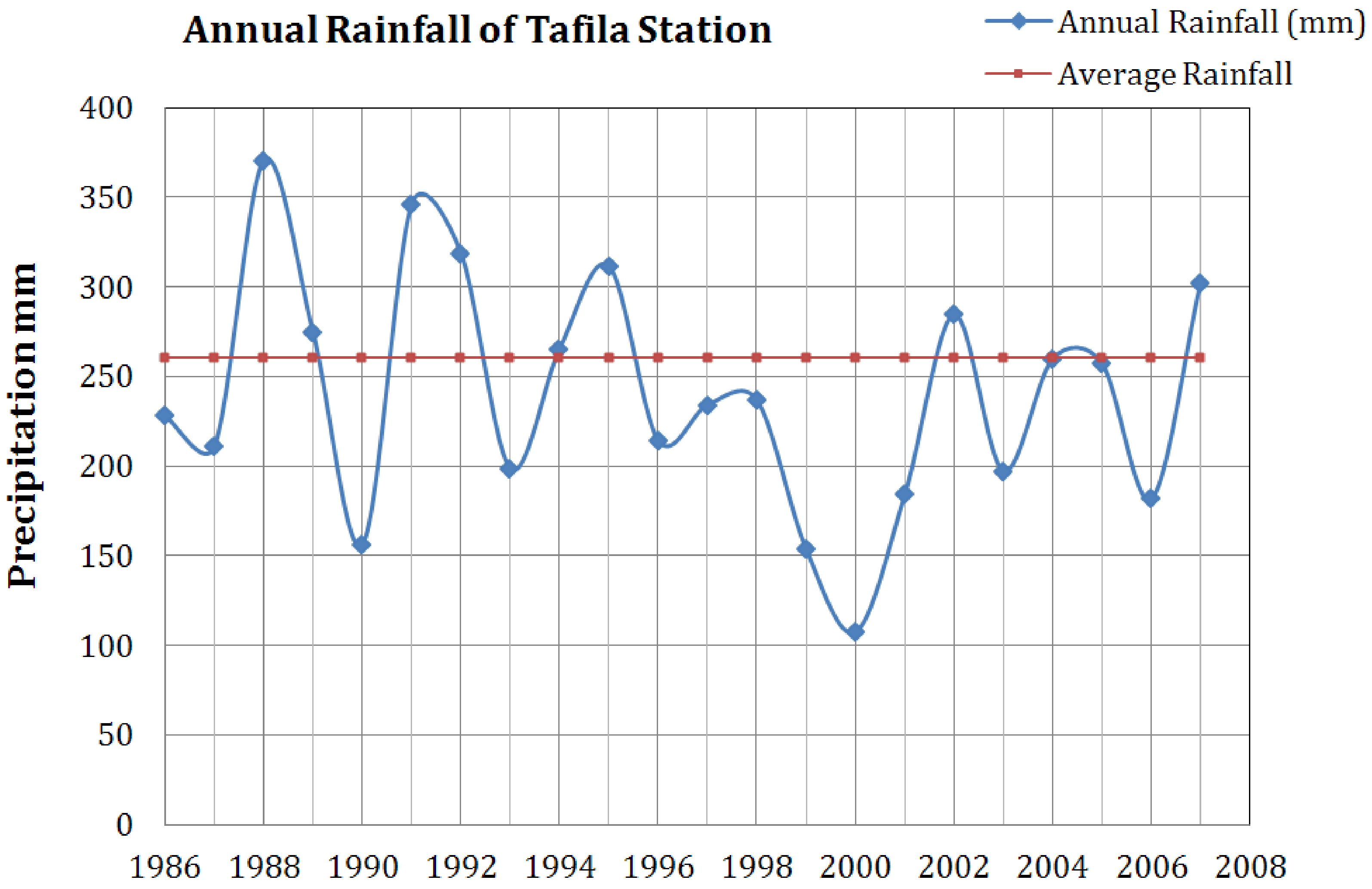


Figure 7-9: Annual rainfall at Tafila rainfall station, 1986 - 2007

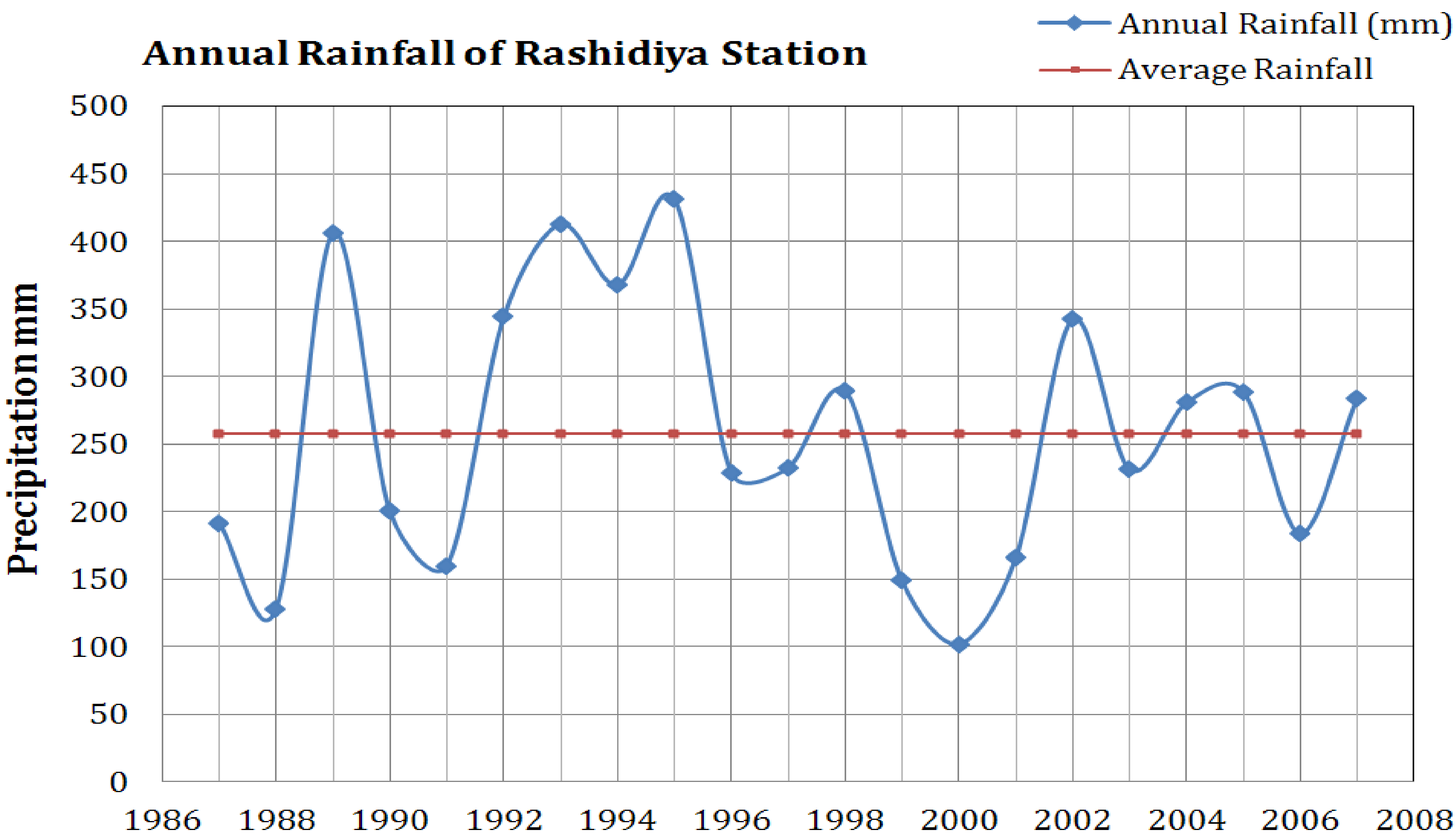


Figure 7-10: Annual rainfall at Rashuduya rainfall station, 1986 - 2007

8 Noise

8.1 Introduction

JWPC seeks planning permission from MoEnv to erect 38 wind turbines south- east of the town of Gharandil in Tafila Governorate. The planned turbine is the V112, a 3.075 MW turbine manufactured by Vestas. The hub height of the wind farm is 94 m for 34 of the turbines and 84 m for 4 of the turbines. The total height of the turbines, up to the highest blade tip, is 149.9 m and 139.9 m. CUBE Engineering GmbH was appointed to conduct an environmental noise impact assessment as part of the assessment process. This report presents the results from the noise measurement, which was carried out by local partner REEC, and the prediction assessment which was carried out by CUBE.

The locations of the WTG closest to residential areas are approximately 1,500 m from the east of the town and approximately 1,100 m from a small settlement belonging to LaFarge Rashidiya cement factory. The locations of the noise sensitive areas are shown in Annex 3 and Annex 4.
The V112 reaches its highest noise emission level (LWA) of 106,5 dB(A) at a wind speed of 7m/s; at wind speeds above 7 m/s the turbine does not become louder.

Noise from wind turbines has the potential to cause annoyance to people living near such installations. Noise sensitive areas are considered to be dwellings, but not roads or footpaths. The planned wind farm is located in a remote area, where no occupied dwellings exist within a distance of about 1 km.

Noise which may impact the surrounding dwellings will occur during:

- The construction phase (from machinery and traffic);
- The operational phase of the WTG;
- The decommissioning phase.

The results of the noise assessment are presented in chapter 8.7. Proposed noise mitigation measures are outlined in Section 8.8.

8.2 Methodology

As decided in the scoping session, December 5th, 2011 in the Holiday Inn Hotel in Amman, impacts during all three phases must be assessed. The below procedure regarding noise impact assessment was agreed.

Objectives

- To establish baseline noise levels;
- To identify potential noise sources and impacted areas relevant to project activities;
- To assess and understand the causes of such impacts.
- To propose proper mitigation measures to protect the public, residents and employees from such impacts.

Methodology

- Monarch 322 Data logging Sound Level Meter (general-purpose measurements of sound pressure levels in industrial and environmental applications) will be used. The standard compliance of the instrument is IEC651 Type 2, ANSI S1.4 Type 2;
- The noise level meter mentioned above will be used during one week of field measurement in different locations in the project sites to estimate baseline/background noise levels;
- Comparing the results with the local regulations;
- The data will then be modeled by CUBE to evaluate impacts of additional noise emitted by the proposed wind farm project and describe proper mitigation measures.

8.3 Turbine technology

Generally, the operational noise of a wind turbine has two sources: the aerodynamic noise produced by the rotating blades and the mechanical noise produced by the turbine's gearbox and generator. The intensity of the WTG noise depends on wind speed. At very low wind speeds no relevant noise emission is produced. WTGs become louder with increasing wind speed and power production. The planned Vestas V112 wind turbine has a guaranteed sound power level as presented in Table 8-1.

Table 8-1: Sound power level for Vestas V112, non-noise-reduced Mode 0 (source: Vestas, 2012)

Sound Power Level at Hub Height, Noise Mode 0			
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**		
Hub Height	**84 m**	**94/96 m**	**119 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.5 4.2	94.5 4.3	94.7 4.5
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.3 5.6	97.5 5.7	98.1 5.9
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.9 7.0	101.2 7.2	101.9 7.4
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.3 8.4	104.6 8.6	105.1 8.9
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 9.8	106.5 10.0	106.5 10.4
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 11.2	106.5 11.4	106.5 11.9
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 12.7	106.5 12.9	106.5 13.4
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 14.1	106.5 14.3	106.5 14.9
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 15.5	106.5 15.7	106.5 16.3
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 16.9	106.5 17.2	106.5 17.8
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 18.3	106.5 18.6	106.5 19.3

The presented sound power levels are valid for non-noise-reduced operation. The Vestas V-112 has several operational low-noise modes and can reduce noise levels at lower wind speeds by reduction of rotational speed. The predictions within this study are based on the highest output noise level of mode 0. The turbine hub heights are 94 m or 84 m above ground. The V112 has a maximum noise emission level (LWA) of 106.5 dB which is guaranteed by the manufacturer. An additional adjustment of +1 dB (A) was made for tonality KIT [dB] but is not regarded to be necessary for impulses KIN [dB]. The V112 shows neither tonality nor impulses based on information provided by the manufacturer but also measured by independent experts [GL Garrad Hassan]. GL Garrad Hassan has measured the noise level of a V112 (in its mode 0) at a turbine site located in Lem, Denmark. The resulting 105.0 dB is below the guaranteed L_{WA} of 106.5 dB. This provides evidence that the guaranteed level is not only reliable, but rather worst-case. For the noise modeling the guaranteed level of 106.5 dB plus 1 dB tonality penalty was used. Thus there is a sufficient amount of uncertainty applied to the noise model.

8.4 Definitions

Immissions	as used in chapter 8 related to noise: is immissions due to planned turbines or during construction or decommissioning of the wind farm
Background noise	also referred to “Ambient noise” which is existing noise occurring at a receptor

8.5 Guidance

The noise assessment is based on the following guidelines and regulations:

- General guidelines / operational noise
  - Jordanian Noise Regulations, 2003 [8-7];
  - IFC/ World Bank Group General Environmental, Health and Safety Guidelines for Wind, Year 2007 [8-3];
  - The World Health Organization (WHO) guidelines for community noise, 1999 [8-6];
  - ETSU R-97 (Working Group on Noise for Wind Turbines) [8-1].

- Noise calculation models

  - ISO 9613- (International Standards) : Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation [8-4]

- Construction noise

  - British Standard 5228 for noise and vibration control on construction and open sites [8-2]

8.5.1 General guidelines / operation noise

The Jordanian Noise Regulations (2003), set noise limits depending on the use of the noise sensitive areas (NSA). Table 8-2 gives an overview on the noise regulation and the noise limits depending on the type of land use. It was the objective of the study to measure the background noise and compare it with the local regulations.

Table 8-2: Relevant Jordanian noise regulation, 2003

Usage type / noise sensitive area (NSA)	Highest permissible limits of equivalent sound level (dB(A))	
	Day	Night
Residential, urban	60	50
Residential, suburban	55	45
Residential, rural	50	40
Small industries, offices public buildings and city centers	65	55
Industrial areas	75	65
Schools, hospitals, mosques and churches	45	35

8.5.1.1 IFC/WBG General Environmental, Health and Safety Guidelines for Wind, Year 2007;

The IFC / World Bank guideline address in chapter 1.7 the impacts of noise beyond the property boundary of the facility. Noise impacts should not exceed the levels presented in Table 8-3, or result in a maximum increase in background levels of 3 dB (A) at the nearest receptor location off-site.

Table 8-3: IFC/WBG noise level guidelines

Receptor	One hour LA_{eq} [dB(A)]	
	Daytime 07:00 – 22:00	Nighttime 22:00 – 7:00
Residential, institutional, educational	55	45
Industrial, commercial	70	70

These guidelines also address the measurement of noise as following:

“Noise monitoring may be carried out for the purposes of establishing the existing ambient noise levels in the area of the proposed or existing facility, or for verifying operational phase noise levels. Noise monitoring programs should be designed and conducted by trained specialists. Typical monitoring periods should be sufficient for statistical analysis and may last 48 hours with the use of noise monitors that should be capable of logging data continuously over this time period, or hourly, or more frequently, as appropriate (or else cover differing time periods within several days, including weekday and weekend workdays). The type of acoustic indices recorded depends on the type of noise being monitored, as established by a noise expert. Monitors should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface (e.g., wall). In general, the noise level limit is represented by the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation.”

The WHO guideline [8-6] for community noise was published in April 1999. These advise that noise impacts within dwellings include annoyance, speech interference and sleep disturbance. In 2009, WHO updated the guidance for night-time standards, proposing an external noise level of 40 dB(A) at night. This is intended as a long term target level to prevent sleep disturbance, such as results from long term exposure to road traffic noise. The noise level is intended to apply over the entire night-time period, typically between 23:00 – 07:00 hours (Table 8-4).

Table 8-4: Summary of WHO-criteria

Environment	**Critical health effect**	**Sound level [dB(A)]**	**Time [hours]**
Outdoor living area	Serious Annoyance Moderate Annoyance	–55 50	16 16
Outside bedrooms (long term average)	Sleep disturbance	40	8
Outside bedrooms	Sleep disturbance, window open	45	8
Inside dwellings	Speech intelligibility and moderate annoyance Sleep disturbance, night-time	35 30	16 8
Bedrooms	Sleep disturbance	30	8
School, playground outdoor	Annoyance external source	55	During play
Industrial, commercial shopping and traffic areas, indoors and outdoors	Hearing impairment	70	24

8.5.1.2 ETSU-R-97

ETSU-R97 sets out the method for assessing noise from wind turbines relative to the prevailing ambient noise. The main basis of ETSU-R-97 is to ensure that during both daytime and nighttime the predicted noise from a proposed wind turbine installation will not exceed the existing background noise by more than 5 dB(A). ETSU-R-97 gives a detailed method for deriving existing background noise.

ETSU-R-97 advises also that a simplified approach may be adopted where the predicted noise from the turbine is at around 35 dB(A). ETSU-R-97 specifies that if the noise is limited to an $LA_{90\text{-}10\,min}$ of 35 dB(A) up to wind speeds of 10 m/s at a 10 m height, than this condition alone would offer sufficient protection of amenity, and background noise measurements would be unnecessary.

ETSU-R-97 does not prescribe a noise prediction method. ISO 9613-2 was used for modeling.

In case of measuring ambient (or background) noise levels, day-time noise limits will be derived from background noise data taken during quite periods of the day and the night-time limits will be derived from background noise data collected during the night.

Quiet day-time periods (amenity hours) are defined as:

- all evenings from 6pm to 11 pm;
- plus Saturday afternoon from 1 pm to 6 pm;
- plus all day Sunday, 7am to 6 pm.

Night time is defined as 11 pm to 7 am.

Given that in Jordan the day of rest is Friday and for some businesses also Saturday, such periods of quiet day-time were shifted to these days.

8.5.2 Noise calculation models

Although ETSU-R-97 sets out a detailed method for the assessment of baseline noise, this Guidance does not prescribe a method for noise prediction, which in the past has led to disputes over the most appropriate noise prediction methods. This leads to the preferred noise prediction method in accordance 8.5.1.2 with ISO 9613-2.

8.5.2.1 ISO 9613-2

The calculation model of the International Standard ISO 96-13-2 ‘Acoustics – Attenuation of sound during propagation outdoors – Part 2 General method of calculation’ is used to predict the levels of noise generated by the wind farm.

This model predicts the sound pressure level by taking the source sound power level for each WTG in separate octave bands and subtracting a number of attenuation factors:

Predicted octave band noise level = L_w+D-A_{geo}-A_{atm}-A_{gr}-A_{bar}-A_{misc} with

L_{aw} = sound power level of each turbine
D = directivity correction factor (not used for worst case downwind propagation)
A_{geo} = losses due to geometrical divergence
A_{atm} = losses due to atmospheric absorption
A_{gr} = losses due to the ground effect
A_{bar} = barrier losses where the turbine hub is unsighted
A_{misc} =for miscellaneous effects (vegetation, buildings)

The predicted octave band levels from each turbine are summed up to give the overall ‘A’ weighted predicted sound level from all turbines under operation.

When calculating predicted noise levels with ISO 9613-2, it is assumed that the noise source is located upwind of the noise sensitive area (the location for which the noise level is calculated). For downwind situations, lower noise levels can be expected. When noise propagation for multiple sources in different directions is calculated, the results are always worst case assumptions. However, it should be noted that not all of the noise sources can be upwind from the receptor at the same time. This is relevant for calculations for dwellings that are located in close proximity to the wind farm.

For this assessment, predicted noise levels according to ISO 9613-2 were calculated using the WindPRO 2.8 DECIBEL commercial noise propagation software using the loudest sound power level up 95% of the rated power (which is the loudest / the worst in all cases). The meteorological coefficient C0 was set to 0 dB. This package does not use A_{bar} and the A_{misc} attenuation factors and thus, in case where these could be used, the calculation delivers worst case results. The height contours of the area were used in the calculations.

8.5.3 Construction noise

8.5.3.1 British Standard 5228:2009

British Standard 5228:2009 provides guidance on the impact of noise from construction activities. This standard is the basis for the majority of construction noise assessments in the United Kingdom. It contains methodologies for the calculation of construction noise from static sources e.g. construction works at the turbine sites, as well as for construction traffic along access tracks.

The calculation is performed using tables of typical noise output for typical items of plant. The application of this method allows the calculation of noise levels for different construction activities by summing up the noise levels of the respective plant and taking into account periods of operation, distances to the receiver and other factors that influence the noise propagation.

The significance criteria for determining the level of impact resulting from operational and construction noise is described herein by the “ABC method,” in which threshold values at time periods are put into categories labeled A, B and C. It shows examples of the threshold of significant effect at dwellings when the total noise level, rounded to the nearest decibel exceeds the listed values in Table 8-5.

Table 8-5: Example threshold of significant effect at dwellings (BS 5228:2009)

	Threshold value, in decibels (dB)		
Assessment category and threshold value (LA_{eq})	**Category A**	**Category B**	**Category C**
Night time (23.00 – 7.00)	45	50	55
Evenings and weekends	55	60	65
Daytime (7.00 – 19.00) and Saturdays (7.00 – 13.00)	65	70	75

A significant effect is deemed to occur, if the total LA_{eq} noise level of construction noise exceeds the threshold level for the category appropriate to the ambient noise level.

If the ambient noise level exceeds the threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total LA_{eq} noise level for the period increases by more than 3 dB due to construction activity.

The category A threshold values are applicable for Tafila wind farm since ambient noise level is less than these values.

8.6 Baseline

8.6.1 Measurement and evaluation of ambient noise

REEC, an independent environmental and noise consultant, conducted baseline noise measurements between 25th of February and 2nd of March 2012 and in a second period from 14th to 25th of April 2012. The location chosen for the measurement campaign is UTM WGS 84 x754488/y3401372 as shown in the map in Figure 8-1. The noise measurement was conducted at the vicinity of a residential building in the eastern part of the town of Gharandil. This measurement point was chosen due to its location in one of the closest NSAs (noise sensitive areas) to the wind farm.
The noise measurements were made by Monarch 322 Data logging Sound Level Meter (general-purpose measurements of sound pressure levels in industrial and environmental applications). The standard compliance of the instrument is IEC651 Type 2, ANSI S1.4 Type 2. The data was recorded every 30 seconds.

The data of the first period in February was ignored since the measurement interval was not every 30 seconds but hourly, thus could not be used for the calculation of $LA_{9010min}$. For that reason a second measurement was conducted in April in order to amend the quality of the measurements and to be compliant to the scoping report.

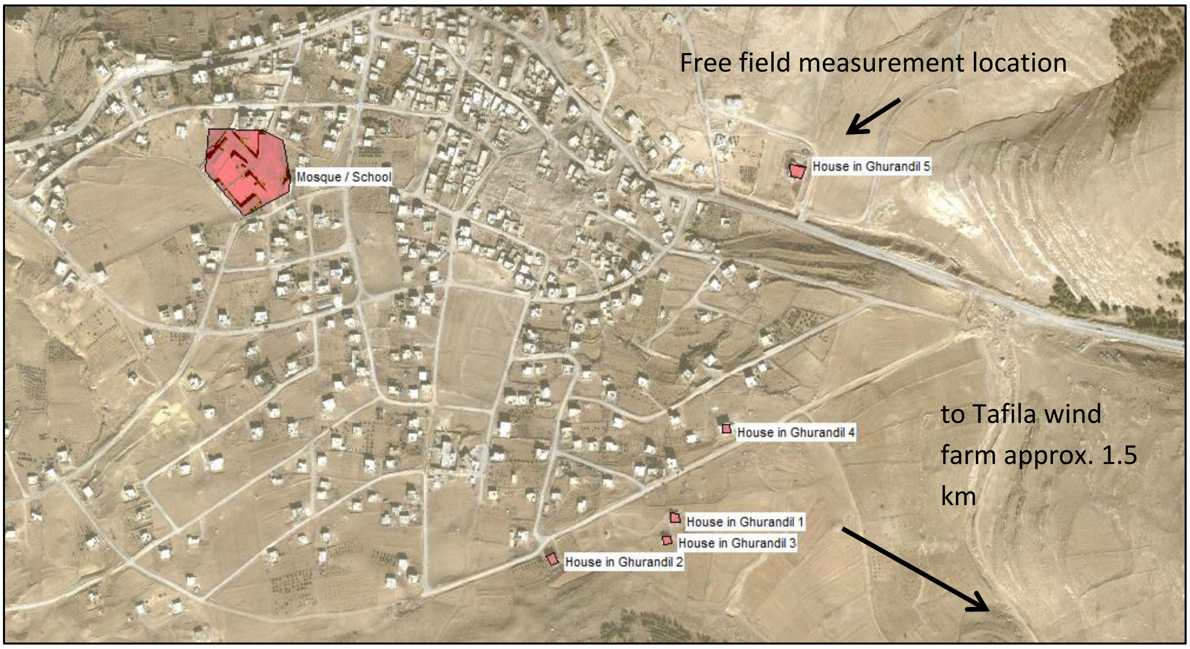


Figure 8-1: Map of Gharandil with its noise sensitive areas and measurement locations

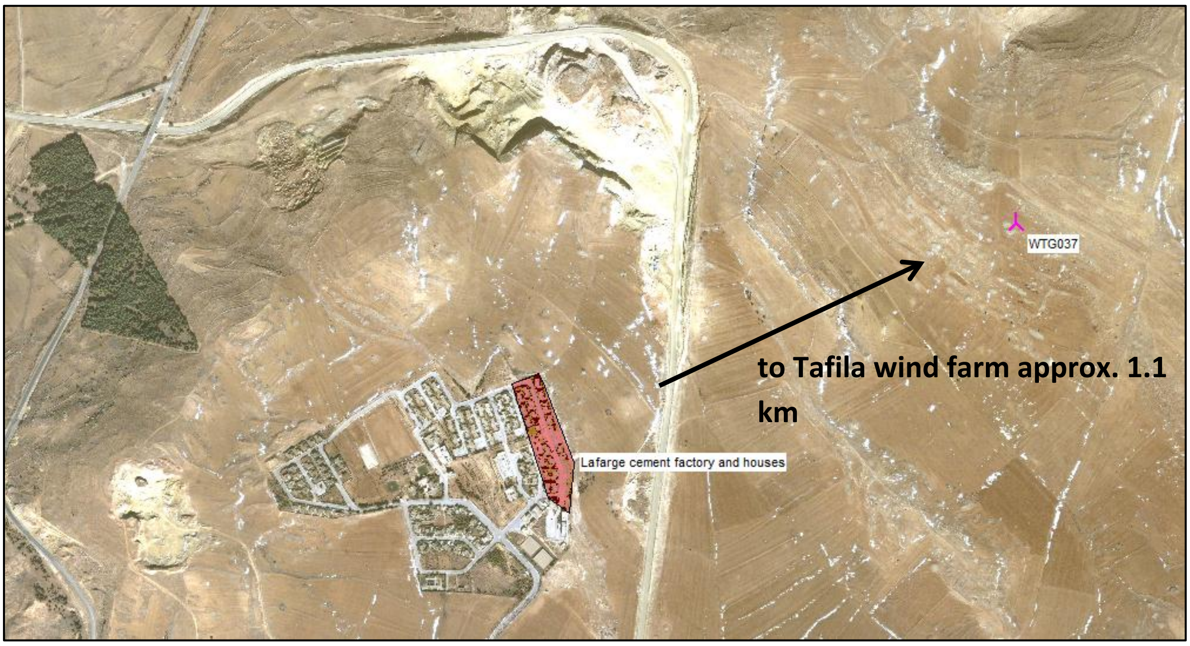


Figure 8-2: Map of LaFarge cement factory with its noise sensitive areas at the settlement

The parameters LA_{eq}, LA_{max} and LA_{min} were recorded continuously throughout the measurement campaign, both daytimes and nighttime. Wind speed data were not recorded at the measurement location but were taken from the meteorological mast in Tafila wind farm, which is approximately 1,300 m away from the measurement site.

Even though the measured background noise levels during quite-day times and night-times were tempted to be filtered for specific events occurred during the measurement period (e.g. due to celebrations (weddings) and barking of dogs, the data were not considered suitable with regard to determining the likely impact of noise from the wind farm on the nearest receptors. Noise from extraneous sources (e.g. mechanical ventilation) resulted in the data collected being too high with respect to actual background noise levels to enable an objective assessment of noise impact to be performed.

Results of the measurements are provided in the Annex 9. Even though best efforts were made to collect data in accordance with the requirements of the Scoping Study, the recorded data is regarded to be questionable in terms of quality and in terms of the chosen measurement location. The measured background noise level, especially at nighttime, was measured to be around ~ 35 dB(A) but was constantly influenced by extraneous sources throughout the second period of measurement. The gathered data are not regarded to be sufficient to gather a clear picture of background noise and to confirm the quiet ambient background noise levels.

A typical correlation between wind speed and background noise was not found in Tafila, as it is the case in most European countries. A scatter plot of the measurement data is presented in Annex 9.

8.7 Impact Assessment

8.7.1 Construction and decommissioning noise prediction

The following major activities will be required to be performed during the construction phase:

- Construction noise (breaker, excavator, dump truck etc.);
- Construction of access roads;
- Construction of electrical substation and associated structures;
- Construction of permanent met mast(s);
- Erection of turbines.

Normal hours of construction works could be Saturday to Thursday 7 a.m. to 7 p.m.. Some flexibility in working hours may be required, e.g. during the delivery of the main components of the turbines due to the use of Heavy Goods Vehicles (HGV) which would be normally at night.

Each of the construction activities includes working with heavy “balance-of-plant” machines with noise levels (L_{WA}) of up to 120 dB(A) taking into account the BS 5228:2009. They are usually carried out one after the other at each turbine location. For this assessment of construction, it will be assumed that all the works will occur concurrently at two turbine locations in the closest distance to the neighboring dwellings (a turbines WTG 37 – LaFarge and WTG 8 - Gharandil): This scenario represents a worst case which might not be expected or, even if, might occur only during a period of few weeks.

Table 8-6: Balance-of-plant items

Activity	Balance-of-plant item
Laying of access tracks	1 x excavator (107 dB(A)), 1 x compactor (107 dB(A)), 1 x bulldozer (109 dB(A)), 2 x dump truck (115 dB(A))
Excavation of foundations	1 x breaker (mounted on wheeled backhoe – 120 dB(A)), 1 x excavator (107 dB(A)), 3 x dump truck
Concreting of foundations	2 x concrete mixer (108 dB(A)), pumping (106 dB(A), or idling (99 dB(A)
Erection or dismantling of turbines	2 x mobile crane (106 dB(A)), 2 x flatbed truck (108 dB(A))
Decommissioning turbines - removal of the foundations	1 x excavator, 3 x dump truck

If a borrow pit will be created on site is not known at this stage of the project. Such information could be updated when a detailed construction schedule of the wind farm design is provided by the EPC contractor.

Construction noise was calculated for nine closest locations around the wind farm at the same noise sensitive areas that were used for the operational noise prediction. The positions of these locations are shown in Figure 8-1, in Annex 3 and in Annex 4. The equivalent continuous noise levels LA_{eq} were calculated and are presented in Table 8-7. The total sum in the below table shows is calculated under the assumption that all works will occur concurrently at the two nearest turbines. The allowed threshold according to Category A of the British BS 5228:2009 guideline is 65 dB(A) which is not exceeded.

Table 8-7: Construction noise levels [dB(A)]

Activity	Laying of access roads	Excavation of foundations	Concreting of foundations	Erection of turbines	SUM *(if works occur concurrently)*	Allowed threshold**
House in Gharandil 1	40,7	44,6	34,0	34,7	46,6	**65**
House in Gharandil 2	40,0	43,9	33,3	34,0	46,0	**65**
House in Gharandil 3	40,7	44,6	34,0	34,7	46,6	**65**
House in Gharandil 4	40,7	44,6	34,0	34,8	46,7	**65**
House in Gharandil 5	40,0	43,9	33,3	34,1	46,0	**65**
LaFarge cement factory and houses	44,0	47,9	37,3	38,0	49,9	**65**
Mosque / school Gharandil	37,2	41,1	30,5	31,2	43,1	**65**
Mosque Gharandil suburb	37,9	41,8	31,2	31,9	43,8	**65**
Mosque LaFarge	42,3	46,2	35,6	36,3	48,2	**65**

** According to BS 5228:2009 – Category A*

Table 8-8: Decommissioning noise levels L_{WA} [dB(A)]

Activity	Decommissioning turbines - dismantling	Decommissioning turbines - removal of the foundations	SUM *(if works occur concurrently)*	Allowed threshold**
House in Gharandil 1	34,7	41,6	42,4	**65**
House in Gharandil 2	34,0	40,9	41,7	**65**
House in Gharandil 3	34,7	41,6	42,4	**65**
House in Gharandil 4	34,8	41,6	42,4	**65**
House in Gharandil 5	34,1	40,9	41,7	**65**
LaFarge cement factory and houses	38,0	44,9	45,7	**65**
Mosque / school Gharandil	31,2	38,1	38,9	**65**
Mosque Gharandil suburb	31,9	38,8	39,6	**65**
Mosque LaFarge	36,3	43,2	44,0	**65**

** According to BS 5228:2009 – Category A*

Access to the construction site is described in Chapter 14. The most intensive transport activity will take place during the concreting of the foundations with up to 10 concrete trucks per hour during approximately 1 working day per turbine foundation. These transports will lead to additional noise at the properties along the public roads (as described in chapter 14). At a distance of 15 meters from the access road, this is likely to lead to equivalent continuous noise level LA_{eq} of 64 dB(A). At properties within approximately 700 m of the closest construction activities, the abovementioned construction noise is added to this. At greater distances construction noise from the wind farm site will be clearly below the transport noise and will therefore be masked by this. It should be noted that this transport intensity, and therefore the noise, will only last for the concreting phase of the overall construction works which is assumed to last for a total of circa 40 days for all 38 turbines.

8.7.2 Operational noise prediction

The selected wind turbine for the Tafila wind farm is the Vestas V112 with 3.0 MW and a hub height of 94 m, 84 m respectively. A computer model has been used to predict noise from the turbines assuming a hub height of 84 meters / 94 meters above local ground level where each turbine is assumed to be a simple elevated point source. The heights above ground level were considered. A tonality penalty of + 1 dB(A) was applied in the calculations even thought it was not measured at the Vestas V112.

A typical correlation between wind speed and background noise was not found in Tafila, as it is the case in most European countries. This is a necessary precondition for application of the British ETSU approach including the consideration of background noise. Due to the missing correlation, a full adaption of the ETSU approach to the conditions in Tafila was not possible. It was jointly decided by the consultants and the developers that instead of applying equivocal background data to the noise model it is more reliable to assess noise impact by a simplified approach without background data. The noise levels from the wind turbines predicted to be around 35 dB(A) are sufficiently low to enable the Simplified Assessment method proposed in the ETSU guideline .

Predictions were made according to the noise propagation model ISO 9613-2 for the operational noise of the wind farm using WindPRO 2.8 DECIBEL module for noise calculations. The table below shows the calculated $LA_{90\text{-}10min}$ levels as resulting from the noise prediction model.

The noise emission generated by the planned turbines is calculated at the closest noise sensitive areas. The immissions forecast considers the terrain shape and worst-case downwind noise propagation conditions: 70% humidity and 10°C air temperature.

The noise emission levels refer to the maximum noise emission of the wind turbine type for a wind speed of ≦ 10m/s respectively at 95 % rated power. The source sound power levels of the individual turbines are summed up at the noise sensitive areas. The results of the prediction model were compared with the Jordan noise limits as shown in Table 8-2.

The residential area at the receptors in Gharandil is assessed to be of rural character whereas the mosques and the school in Gharandil are recreational areas with lower limits of noise. The housing area at LaFarge cement factory is assumed to be classified as small industrial areas as it is close to LaFarge cement factory but has also residential character. Detailed information on zonal classification was not available. Requests to the MoEnv and at Tafila authorities were made.

For the calculation of the noise immissions, the site was examined using maps and aerial pictures. Furthermore a site visit was conducted to get an ideal impression of the project area and close dwellings. Noise sensitive areas were set at the nearest dwellings.

The predicted noise from the turbines is summarized in the Table 8-9.

Table 8-9: Predicted noise level $LA_{90-10in}$ from the wind turbines in comparison with local and international noise regulations

No.	Noise sensitive area (NSA)	coordinates (UTM WGS 84)	Predicted noise level (dB(A)) from turbines			Highest permissible limits of equivalent sound level (dB(A)) acc. to Jordan Noise Regulations (Rural Areas)		ETSU-R-97 - simplified method fixed limit of 35 dB(A) only from turbines	IFC / WB Guidelines (55 day, 45 night or, if ambient noise already higher, ambient noise + 3 dB(A)		WHO criteria	
			Day (Amenity hours)	Night		Day	Night	Day / Night	Day	Night	Day*	Night**
C	House in Ghurandil 1	754485 / 3400569	36,9	36,9		50,0	40,0	35,0	55,0	45,0	50-55	40
D	House in Ghurandil 2	754310 / 3400507	36,7	36,7		50,0	40,0	35,0	55,0	45,0	50-55	40
B	House in Ghurandil 3	754473/3400538	37	37		50,0	40,0	35,0	55,0	45,0	50-55	40
F	House in Ghurandil 4	754556 / 3400701	36,6	36,6		50,0	40,0	35,0	55,0	45,0	50-55	40
G	House in Ghurandil 5	754649 / 3401071	35,7	35,7		50,0	40,0	35,0	55,0	45,0	50-55	40
E	Lafarge cement factory and houses	752355 / 3397964	36,1	36,1		65,0	55,0	35,0	55,0	45,0	50-55	40
A	Mosque /School Gharandil Center	753904 / 3401036	34,2	34,2		45,0	35,0	35,0	55,0	45,0	50-55	40
H	Mosque Gharandil suburb	753266 / 3400495	34,5	34,5		45,0	35,0	35,0	55,0	45,0	50-55	40
I	Mosque Lafarge	752248 / 3397898	35,3	35,3		45,0	35	35,0	55,0	45,0	50-55	40
			noise from 38 wind turbines (V112); Day and night are equal, since there is no nightly noise reduction			passed	slight exceedance Jordan guidance of 0.3 dB(A)	slight exceedance of British ETSU Guideline			* 50 dB(A) = moderate annoyance 55 dB(A) = serious annoyance	** long-term average

The above table shows if the resulting noise from the turbines meets the requirements of local and international guidelines.
The noise caused by the planned turbines is low and falls significantly below the Jordan limits of rural areas both at daytimes and nighttime. The requirements at recreational areas (mosques, schools) are met with the exception of an additional exposure of 0.3 dB(A) at the mosque in LaFarge. The exceedance is regarded to be negligible as the exposure is so small that it lies within the uncertainty of the modeling approach. Under German law such result would be rounded down to the next integer.

According to the simplified approach of British ETSU guideline, there is additional exposure of a max of +2 dB(A) at the houses in Gharandil and LaFarge housing area. This exceedance is assessed to be acceptable under consideration if the modeling uncertainty. A total uncertainty of 2.5 dB(A) is applied on the model as explained in the following chapter.

8.7.3 Model uncertainty and validation

The noise predictions for the proposed installation cannot be validated until the project is built. After erection, noise emission and immissions measurements can be carried out by accredited and independent international experts. There is sufficient buffer in the modeling parameters, as the modeling was carried out under worst-case assumptions. The model predictions are based on a widely validated prediction algorithm and manufacturer's published data and detailed design layout. The norm ISO 9613-2 is also used in Germany and has been validated by measurements of the local authorities and several institutes. The sound power level of the turbines of 106.5 [dB], which was used for the model, was already proven by expert measurements at the prototype of the Vestas V112. The measurement results show significant lower results at the V112 of 105.0 dB(A) . The additional 1.5 dB(A) can be regarded as additional uncertainty which was applied to the turbine noise. As additional uncertainty buffer, a penalty of 1 dB(A) was added for tonality.

8.7.4 Impact assessment construction noise

With reference to Table 8-7 and Table 8-8 construction noise has no significant impact during the whole construction phase of the project, since the thresholds of the BS 5228:2009 standards are kept considering the construction noise plus the ambient noise measured at the receptors.

8.7.5 Impact assessment operational noise

With reference to **Fehler! Verweisquelle konnte nicht gefunden werden.**, it can be stated that for all noise sensitive areas (during the day-time) the wind farm noise is assessed to be within the limits of local and most international regulations (IFC and WHO). According to the simplified approach of British ETSU guideline, there is additional exposure of a max of +2 dB(A) at the houses in Gharandil and LaFarge housing area. This exceedance is assessed to be acceptable under consideration if the modeling uncertainty.

There is also little very little exceedance of the local limit of 35 dB(A) at the mosque in LaFarge. Given the fact that the conditions of most international limits are kept and the mosques are not attended at night this exceedance is regarded to be negligible.

As a final suggestion it is stated that follow up background noise measurements can be undertaken at the discretion of the ministry to confirm quiet ambient background noise levels.

It should be noted that, under consideration of German and other regulations, accumulation of the background noise level and the turbine noise is not applicable at all. Only the noise of the planned plant is considered if no other significant industrial noise is existent.

IFC and WHO guidelines set a limit of 55 dB(A) during daytimes and 45 dB(A) or 40 dB(A) during nighttime or, if already exceeded by the background noise, an additional exposure of +3 dB(A). The modeled turbine noise falls below these limits and is in full accordance with these guidelines, The propagation calculation using ISO 9613-2 always assumes that the receptor is downwind of the source of the noise. As all noise sensitive areas are during the main periods upwind of the turbines, this assumption is provides a comfortable safety margin.

8.8 Mitigation measures

8.8.1 Construction noise

In order to organize the construction works with as little nuisance as possible under the circumstances, it is recommended to limit the working hours from Saturday to Thursday 7 a.m. to 7 p.m., if possible [MM52]. Some flexibility in working hours may be required during the delivery and erection of turbines and depending on weather conditions. Final time schedule of the transport movements will be clarified with the authorities and communities.

Experience on other sites has shown that adopting an open information policy can reduce the perceived nuisance for residents and commercial premises within the vicinity of the site. As a result, it is proposed that during construction, local residents and businesses will be kept informed by post or other comparable means of communication [MM53].

8.8.2 Operational noise

The wind farm layout in Tafila was optimized in order to minimize the impact of noise by keeping a sufficient distance to the surrounding properties. This has been one of the key factors during the design process [MM59].

Following the results from the noise prediction model, noise reduction of the turbines is not a necessary mitigation, because the specific noise produced by the planned wind farm does not exceed the Jordan noise regulation standard. There is very little exceedance at some receptors following the strict and simplified British ETSU standard. Further additional noise measurements with first class equipment could be undertaken at several noise sensitive areas to allow proper determination of the background noise levels at various receptors. The proper determination of background noise would allow final identification of adherence to further international guidelines including consideration of background noise.

If it would become necessary for any unknown reason to reduce the noise output of the wind farm, the selected turbine type offers the possibility to run in a noise-optimized mode, albeit at the expense of power output. This allows reduction of the sound power levels once the wind farm is operational.

8.9 Cumulative Effects

The potential for cumulative impacts from other proposed developments for construction and operational noise was also considered. There are no other existing wind turbine installations within 10 km of the planned wind farm. JWPC has secured the land in the northern area of the wind farm for further planning. Thus, additional turbines close to the town of Gharandil cannot be constructed by other parties.

Definite information about other wind farm planning in the vicinity is not available, but even if a wind farm in the southern surrounding would be built (e.g. wind farm of Fujeij), any influence on the operational noise immissions in the town of Gharandil is cannot be expected, since it is too far away. There is no official information available on Fujeij wind farm but it is assumed that the distance is approximately 11.5 km to the planned Tafila wind farm. This wind farm is still under planning and it is not known when the project will be started. Cumulative noise impacts during the construction phase will not occur since the wind farm is too far away. For transportation cumulative effects could occur on the way from LaFarge cement factory to the wind farm entrance of Tafila wind farm which is a distance of ~ 3.5 km but without any noise receptors along the way.

8.10 Summary

During the construction and decommissioning period, equivalent continuous noise levels (LA_{eq}) at neighboring properties will remain well below the threshold of 65 dB(A) as given in the BS 5228:2009 guideline.

Best efforts were made to collect and determine the background noise in the town of Gharandil by measurements in accordance to the Scoping report. Even so it was found that the gathered data are not considered suitable with regard to determining the likely impact of noise from the wind farm on the nearest receptors as noise from extraneous sources (mechanical ventilation and wedding celebrations) resulted in the data collected being too high with respect to actual background noise levels to enable an objective assessment of noise impact to be performed. Thus it was jointly decided by the consultants to follow the simplified approach of modeling the noise from turbines. Subsequent measurements can be undertaken, if required by the MoEnv, in order to derive a more reliable result of background noise levels showing also a correlation with wind speed.

The noise levels predicted at around 35dB(A) and are sufficiently low to enable the attached Simplified Assessment method of noise impact assessment and to get confidence that there is no significant impact on the receptors when the wind farm is under operation.

Due to sufficient distance of the wind turbines to the nearest dwellings, the impact of operational noise of the planned turbines is low and remains below Jordan limits and limits of most other international guidelines and regulations as specified in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

There is little exceedance of +0.3 dB(A) of the local limit of 35 dB(A) at the mosque in LaFarge This exceedance is regarded to be negligible under consideration of the uncertainty of the model. There is also slight exceedance of the British ETSU limits, which falls also below the overall uncertainty of 2.5 dB(A).The fact that the used model type is a worst case approach there is enough confidence that no exceedance of the noise limits is expected when the wind farm is operational.

If additional confidence is required for the background noise level, follow up background measurements will be carried out before the erection of the wind farm.

The findings of the construction and operational noise assessment show that the proposed Tafila Wind Farm is acceptable in term of noise emissions.

Noise impact of the wind farm can be verified by noise emission and immissions measurements after the construction of the wind farm. Details thereto are described in the stakeholder engagement plan that was issued together with this study.

8.11 References

[8-1] ETSU, 1996: Working Group on Noise from Wind Turbines. ETSU-R97 `The assessment and Rating of Noise from wind farm

[8-2] HMSO, 2009: British Standard 5228: `Noise and Vibration control on Construction and Open Sites`.

[8-3] IFC/WBG, 2007: General Environmental, Health and Safety Guidelines for Wind, Year 2007

[8-4] ISO, 1996: International Standards Organization, 1996. ISO 9613-2: `Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation‘

[8-5] Vestas, 2012: General Specification V112–3.0 MW 50/60 Hz, Document no.: 0025-7553 V03 2012-04-17

[8-6] WHO, 1999: Guidelines for Community Noise, World Health Organization, Geneva

[8-7] MoEnv, 2003: Jordan Noise Regulations, Ministry of Environment, Amman

9 Shadow flickering

9.1 Introduction

Shadow flicker may occur when the rotating blades of a wind turbine pass through the sun's rays seen from a specific location. This creates a fast-moving shadow with a "flicker" effect. This impact depends on conditions such as weather, topography, or the distance between the turbine and the receptor. Receptors in case of the shadow flickering effect are the inside of houses and other buildings.

The shadow flicker exposure naturally decreases with increase in distance from the wind farm. Predicted exposure of a particular building to this shadow flicker effect is measured in minutes per day and cumulative yearly hours.

9.2 Objectives

The following objectives concern the shadow flickering assessment:

- To identify the areas that are affected by the shadow of the WTG;
- To assess impacts of the project on residential areas;
- To assess impacts on regional tribes.

9.3 Guidance

Due to the lack of national and international standards the following German guideline was used:

- Bund/Länder Arbeitsgemeinschaft für Immissionsschutz (LAI); Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windenergieanlagen; Stand: 13.03.2002 (German regulation for the evaluation of optical immissions by WTG)

9.4 Methodology

Following the German guideline, two thresholds need to be considered:

- Accumulated exposure on residential properties should not exceed a total of 30 hours per year;
- Exposure on residential properties should not be longer than 30 minutes per day.

If one of these thresholds is exceeded, mitigation methods such as turning off turbines during critical times must be considered.

Relevant for the shadow flickering effects are only residential houses that one or more windows in the direction of the wind farm. The windows must belong to rooms of daily use. "Abstellräume" with a window are not considered for this assessment.

The probability of shadow flickering occurrence and the extent of its effect on the residents depend on a number of factors such as the direction of the windows relative to the turbine, the distance from the turbine, the turbine hub height and the rotor diameter, the speed of blade rotation, the time of year and the time of day.

Shadow flicker exposure decreases with increasing distance from the wind farm.
Shadow flicker length naturally decreases till noon and increases again till sundown.

Nearby residential houses, in the further called immission points (IP), where detected as receptors of shadow flickering caused by the planned wind farm. These locations are indicated in Figure 9-1.

Shadow flicker at the chlosestIPs has been calculated and mapped with the software WindPRO 2.8.563 (Figure 9-2 and Figure 9-3). These results show the approximate hours of shadow flicker which accumulate at locations near the wind farm during a year. A map for each thresholds listed in chapter 9.4 has been calculated to maintain the regulations.

Based on these maps the closest effected residential houses are identified and the shadow flickering duration for these so called immission points (IP) is calculated. Only the closest residential properties to the WTGs are considered in this study as relevant receptors. When shadow flickering is not exceeding the limits at these receptors it is neither at receptors with a greater distance to the WTGs.

In the modeling software the sun is represent by a single-point source of light - whereas in reality the sun is a sphere and there are shading areas in which the sunbeams or part of the sunbeams are covered by objects. Also the model assumes clear sky during 100% of the year. Due to these reasons the modeling software can be regarded to be a worst-case approach.

When less than 20 % of the sun is being covered by the passing rotor blade, the resulting shadow intensity at a neighboring property will not be strong enough to account for a nuisance. For the Vestas V-112, this corresponds in theory a maximum distance of 1,711 m from the wind turbine (which will only be applicable at sunrise and sundown due to the geometry between the sun, the WTG and impacted properties).

9.5 Baseline

No baseline shadow flickering is existent neither at planned wind farm area nor at the town of Gharandil or at the LaFarge housing area.

9.6 Impact assessment

The maximum possible duration of shadow flickering was calculated at the closest resident houses. An annual limit of accumulated 30 hours and a daily limit of accumulated 30 minutes are set as threshold.

Table 9-1 shows the duration of shadow flickering at the IPs (Figure 9-1), calculated as worst case scenario with the astronomically highest possible shadow duration (Figure 9-2 and Figure 9-3).

Table 9-1: Duration of shadow flickering at immission points

	Astronomical maximum possible shadow flickering [Hours per year]	Astronomical maximum possible shadow flickering [Minutes per day]
IP A	10:14	0:17
IP B	5:14	0:18
IP C	4:42	0:17
IP D	4:36	0:17
IP E	0:00	0:00
IP F	21:00	0:21

The WindPRO calculation results are added in Annex 3.

The limits for shadow flickering are not exceeded at the closest residential areas.

Deducting from the above results the IPs will not suffer from shadow flickering if:

- The weather is overcast;
- The rotor plane of the turbine is in parallel with the imaginary line between the location of the sun and the respective IP;
- There is a non-transparent obstacle between the respective dwelling and the sun in the direction of the wind turbine;
- The wind turbines are not under operation;
- There is poor visibility due to fog.

9.7 Mitigation measures

The assessment of the shadow flickering at residential areas concludes that the development will have no significant effect on the residents, therefore no mitigation measures are proposed.

Even though the regulations are not exceeded at the IPs, Semi-Nomadic people might be affected by shadow flickering when living in tents in the wind farm area (as further described in chapter 15). For this reason a calculation was conducted to determine more realistic shadow flickering impacts based on the meteorological likelihood instead of on the astronomical maximum hours of sunshine. This calculation is based on the sunshine duration of a regional meteorological station and on the wind direction measured on the wind farm site.

Besides permanent dwellings Semi-Nomadic people are moving through the project area to rear sheep and goats between the WTG. For the Semi-Nomadic people, shadow maps indicating the best spots to build up their tents without being highly exposed to shadow flicker can be published on boards in the wind farm. This map shows areas outside and between the turbines where the impact of shadow flickering is low.
The map is presented in Figure 15-10.

9.8 Cumulative impacts

The closest wind farm is Fujeij, approximately 11.5 km to the south of the planned Tafila wind farm. Fujeij wind farm is still under development and it is likely that its operation phase starts later than the one of Tafila wind farm. As the wind farm is too far away from Tafila wind farm, cumulative shadow flickering will not occur.

9.9 Summary

Shadow flicker may occur when the rotating blades of a wind turbine pass through the sun's rays seen from a specific location. This creates a fast-moving shadow with a "flicker" effect, which can be seen inside of homes and other buildings. The impact on nearby dwellings depends on conditions such as weather, topography, or the distance between the turbine and the building. The shadow flicker exposure naturally decreases with increase in distance from the wind farm.

The effect of shadow flickering is simulated for the closest receptors to the project site with the simulation tool WindPRO. The guidelines used to evaluate the effect of shadow flickering are the guidelines of Germany, saying:

- Accumulated exposure on residential properties should not exceed a total of 30 hours per year;
- Exposure on residential properties should not be longer than 30 minutes per day.

The annual and the daily astronomical possible shadow flickering are calculated.
The limits are not exceeded.

For Semi-Nomadic people shadow flickering boards will be published within the wind farm site. No further mitigation measures are proposed.

Figures

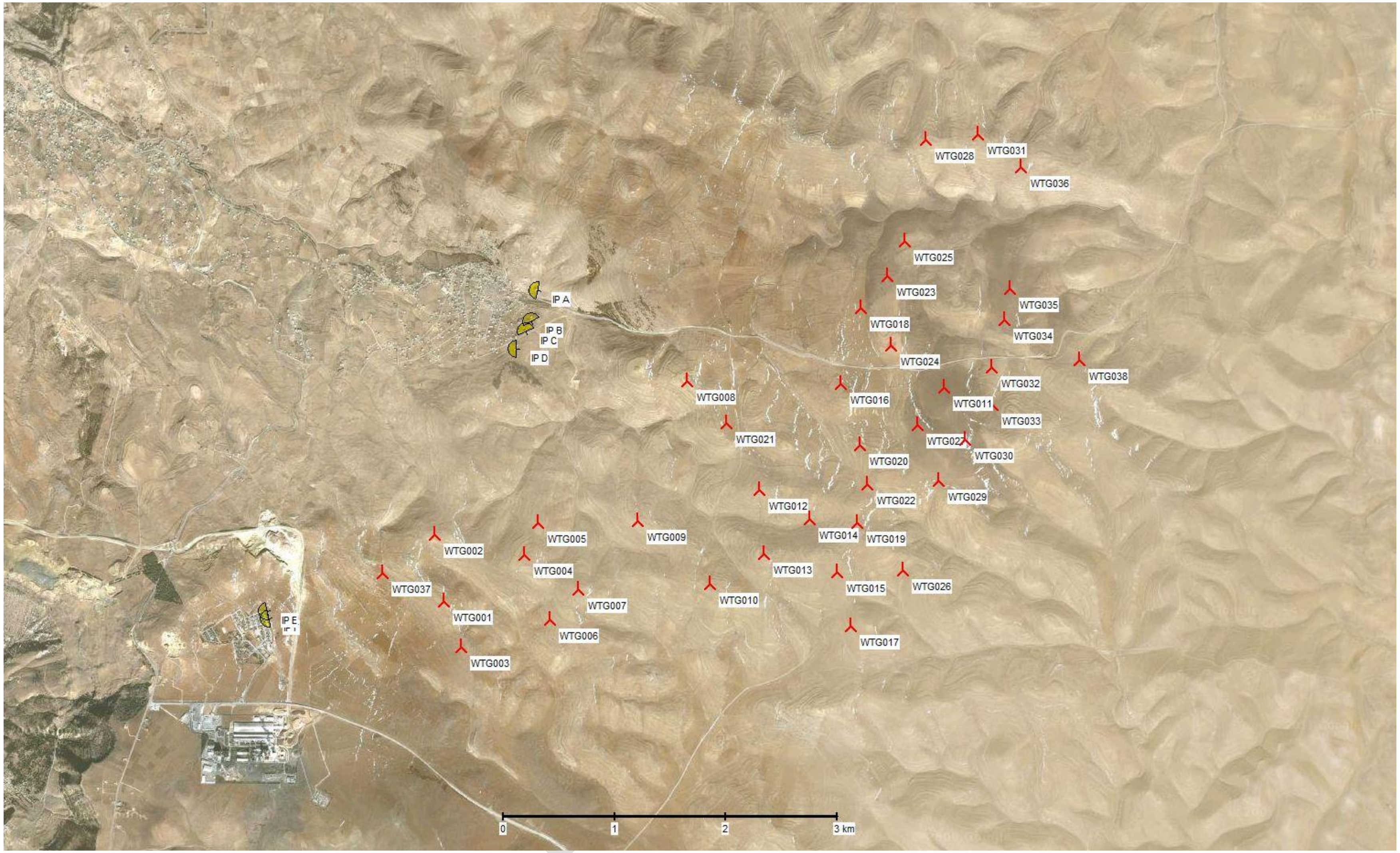


Figure 9-1: Location of immission points

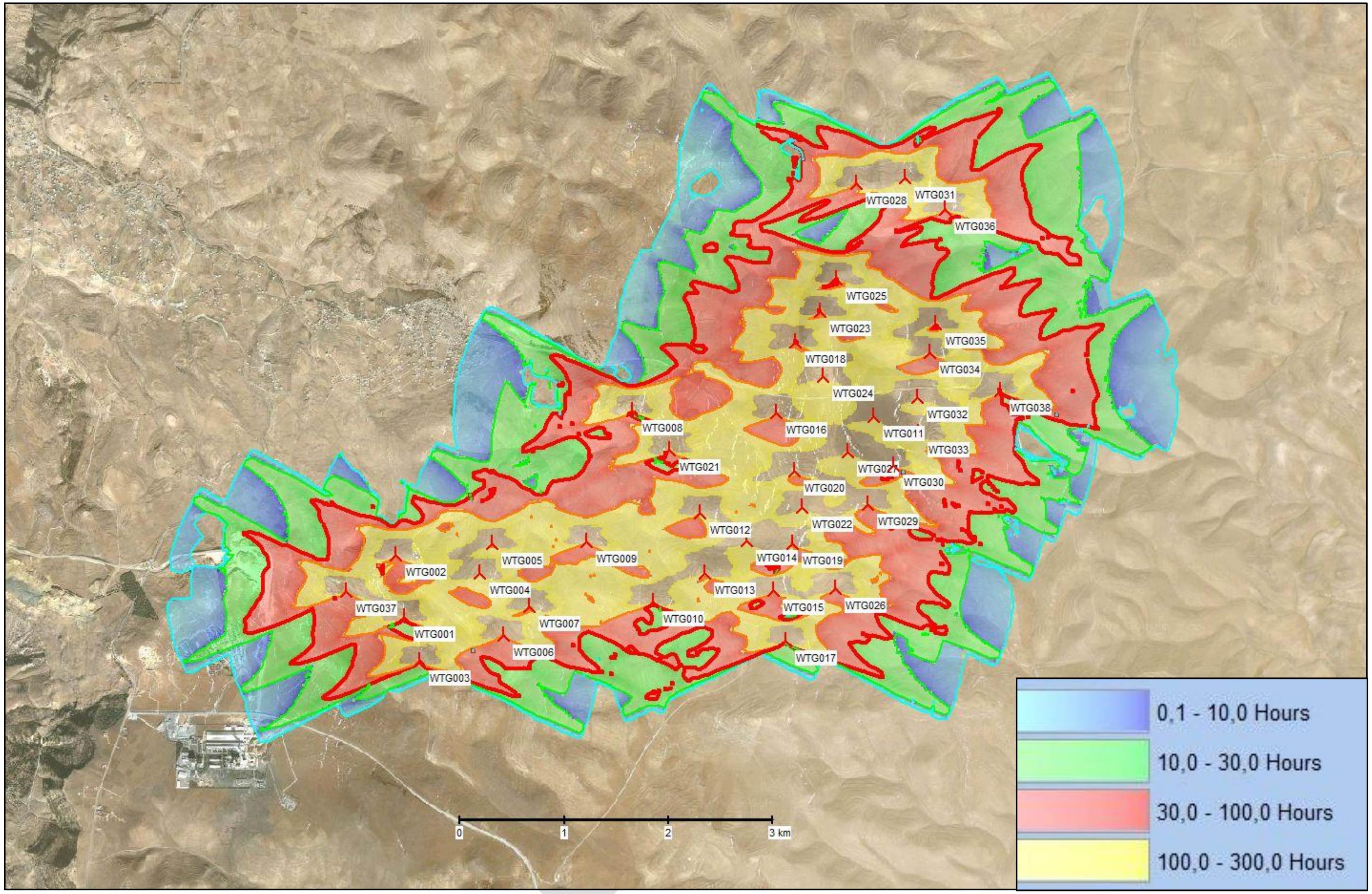


Figure 9-2: Shadow flickering map of the Tafila wind farm, astronomically possible, hours per year

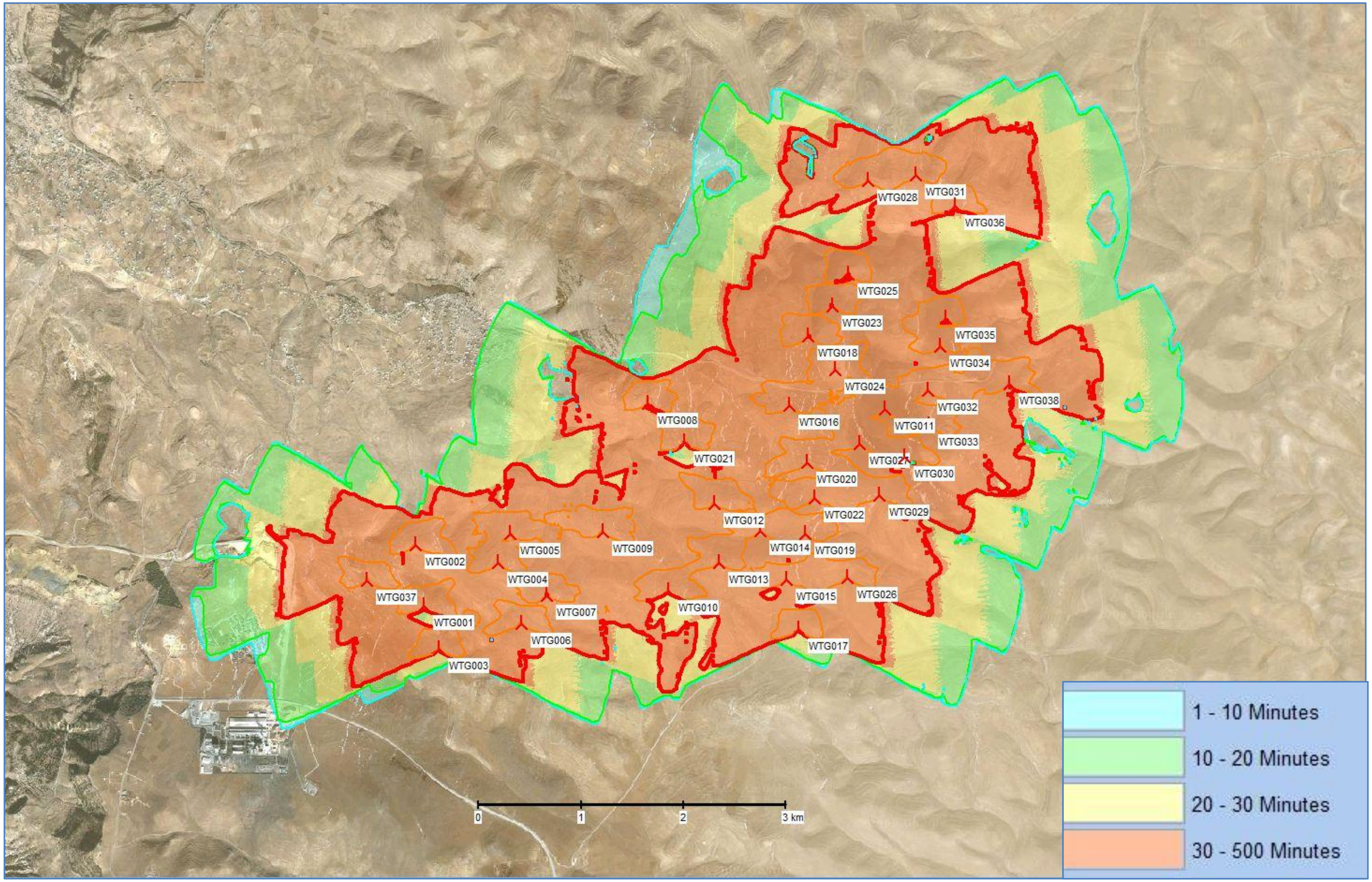


Figure 9-3: Shadow flickering map of the Tafila wind farm, astronomically possible, minutes per day

10 Air quality

10.1 Introduction

This chapter describes the potential impacts and effects on air quality associated with the planned Tafila wind farm. WTGs do not create any emissions during the construction, operational and decommission phase. The primary impact on air quality will be dust which is created and dispersed during the construction and decommissioning phases of the project by construction / decommissioning works and vehicle movements.

Dust may be created when excavations and works expose soil to the wind, which may be blown away as dust. Vehicles driving on the gravel roads on the site may also generate dust. This dust is distributed by the air and may come to rest on nearby houses or other buildings, creating a nuisance or health problem for residents. The production and distribution of dust depends mainly on the weather conditions. Dry and windy conditions encourage dust production and distribution, whilst wet weather or low wind speeds discourage the production of dust.

This chapter will present the methodology, the relevant baseline conditions, the derived impacts and the avoidance or mitigation measures for the proposed Tafila wind farm site.

10.2 Objectives

The objectives of the Air quality assessment are the following:

- To establish the baseline data for total suspended material (TSP), the inhalable particle matter (PM10) and the respirable particle matter (PM2.5).
- Such values will be compared to local air quality standards and specifications;
- To identify potential sources and interactions with project activities (especially during construction period) / facilities;
- To propose proper mitigation measures to protect the public and employees from such impacts.

10.3 Guidance

The following guidelines were used for the Air quality assessment:

- The Jordanian standard JS1140/2006 has been used as guidance for this chapter. The same standard sets the daily limits for the TSP, PM10 and PM2.5. These are the following:
  - TSP: 260 µg/m^3
  - PM10 120 µg/m^3
  - PM2.5 65 µg/m^3
- The Law of Public Health, No. 47 Year 2008

10.4 Effects to be assessed

The effects of dust generation and distribution on dwellings and other important locations near the wind farm will be determined in this chapter.

10.5 Effects scoped out of assessment

The construction of the wind farm will cause additional traffic of fossil-fuel-powered motor vehicles, in order to transport the various components from the manufacturing or any relevant logistic point to the wind farm site. These effects are covered in chapter 14.

Burning of fossil fuels results in in emissions containing such gases as nitrogen oxides (NOx), particulates (PM10), volatile organic compounds (VOC), carbon monoxide (CO) and carbon dioxide ($C0_2$). The emissions contributed by the traffic during the construction are temporary and will be such a small fraction of the total emissions caused by vehicles on these routes that it is not practical to quantify it. This also applies to emissions during the decommissioning of the wind farm.

During construction and decommissioning, machinery and facilities on site will be powered by fossil fuels, but the impact of this is also expected to be small and, as with all emissions, temporary. During the operational phase, small service vans will make occasional trips to the wind farm. The effect of these trips in terms of overall emissions can be considered negligible.

The 388 GWh/a energy produced by the wind farm will be “clean” energy, free of the emissions associated with fossil fuels, which are conventionally used for energy generation in Jordan. In this respect, the planned wind farm will significantly contribute to an improvement of the air quality.

Therefore, the net impact of Tafila Wind Farm on air quality throughout its lifetime can be considered as strongly positive and the effects of fossil fuel emissions related to the wind farm will not be included in the scope of this chapter, while saving approximately 245,992 t CO_2/a compared to an oil-fired power plant.

10.6 Methodology

The potential impacts and effects on air quality from dust emissions due to the planned Tafila wind farm project have been assessed by use of the following methodology:

- Identification of any potentially dust sensitive locations by assessing the sensitivity of the surrounding area;
- Measurement of the baseline air quality in relation to dust;
- Assessment on dust generation by site activity;
- Recommendation of avoidance or mitigation methods.

Dust-producing sites within the planned wind farm are considered to be roads, due to the dust from excavations and use, and turbine locations, due to the dust from excavation. The delivery of light minerals, for instance sand, could also be a source of dust when escaping from vehicle loads in high winds.

The United States Environmental Protection Agency conducted a study showing that 90 % of airborne pollutants (“dust”) come to rest within 100 m of their source and 98% within 250 m [10-1]. This is confirmed by a report from the Department of the Environment report, which states that the “zone of the most concern” related to dust dispersion is limited to an area of 175 m radius [10-2].

Based on these distances, a sensitivity matrix was developed in order to determine the sensitivity or dust receptors based on their proximity to the dust source. This matrix is shown in Table 10-1.

Table 10-1: Sensitivity matrix for dust receptors

Distance from dust source	0m – 100m	101m – 250m	<251m
Receptor sensitivity	High sensitivity	Moderate sensitivity	Low to negligible sensitivity

The distance from each receptor point to the nearest dust-producing source has been considered. Whether a high sensitivity is likely to result in a high impact depends on a number of factors. Dust production requires certain environmental conditions to become a nuisance (dry & windy weather).

10.7 Baseline

10.7.1 Dust receptors

Potential dust receptors are:

- Private homes;
- Schools;
- Hospitals;
- Mosques, churches;
- Workplaces;
- Recreation areas;
- Ecological valuable sites / nature conservation sites;
- Tourist attractions.

No dust receptors are located closer to a road on the site than to a turbine. All turbine locations are at least 1,094 m away from the nearest dust receptor. The turbine locations and the significant distances according to Table 10-1 are shown in Figure 10-13.

The site of the Tafila Wind Farm is crossed by a road leading to the town of Gharandil, but it is not likely that vehicles will use this road to enter the project site. The relevant routes for project transportation are described in Chapter 14.

10.7.2 Dust measurement

The current dust conditions at the site have been tested to judge the sensitivity of the region and to evaluate potential effects. Dust was monitored in a continuous manner between December 17th – 30th, 2011 and during April the 14th – 26th, 2012. The monitoring site was close to a residential location in Gharandil opposite to the project site. The measurements were done using high volume samplers.

The measured data was the total suspended particulates (TSP), the inhalable particulate matter (PM10) and the respirable particulate matter (PM2.5). The monitoring site in Gharandil was the same as it was for the noise measurements at a residential location opposite to the project site (Figure 8-1). The measurements were done using high volume samplers.

10.7.2.1 Total suspended particulates (TSP)

For the first monitoring period during the 17^{th} – 30^{th} December, 2011, results showed that the total suspended particulate concentration is more or less constant, except of one outlier on the 24^{th} December, 2012 (Figure 10-1). The relevant daily limit of 260 µg/m^3 (specified in the Jordanian standard (JS1140/2006)) is not affected by this exceedance. This exceedance is probably a measurement error as it is the only outlier in a constant period.

For the second monitoring period during the 14^{th} – 26^{th} April, 2012, results showed that the TSP concentration exceeded for a longer period during the measurement time (Figure 10-3). Between the 18th of April 01:00 pm and the 19th of April 12:00am a constantly high TSP concentration was measured. Accordingly on the 18th of April 2012 the daily limit of 260 µg/m^3 was exceeded with an average of 349.2µg/m^3. This exceedance can be explained by a sandstorm occurring at this day in the area of Tafila.

10.7.2.2 Inhalable particulate matter (PM10)

For the first monitoring period during the 17^{th} – 30^{th} December, 2011, results showed that the daily inhalable particulate matter average concentration had a maximum value of 58 µg/m^3 (Figure 10-6). No exceedances were recorded to the daily limit of 120 µg/m^3 specified in Jordanian standard (JS1140/2006).

For the second monitoring period during the 14^{th} – 26^{th} April, 2012, results show that the daily PM10 average concentration had a maximum value of 213.1µg/m^3 (Figure 10-7). Two exceedances (213.1

$\mu g/m^3$ and 166.0 $\mu g/m^3$) were recorded to the daily limit of 120 $\mu g/m^3$ specified in Jordanian standard (JS1140/2006) on the 18^{th} and 19^{th} April, 2012.

10.7.2.3 Respirable particulate matter (PM2.5)

For the first monitoring period during the 17^{th} – 30^{th} December, 2011, results showed that the daily respirable particulate matter average concentration had a maximum value of 16$\mu g/m^3$ (Figure 10-9). No exceedances were recorded to the daily limit of 65 $\mu g/m^3$ specified in Jordanian standard (JS1140/2006).

For the second monitoring period during the 14^{th} – 26^{th} April, 2012, results show that the daily PM2.5 average concentration had a maximum value of 110.4$\mu g/m^3$ (Figure 10-11). One exceedance was recorded to the daily limit of 65 $\mu g/m^3$ specified in Jordanian standard (JS1140/2006) on the 18^{th} April, 2012.

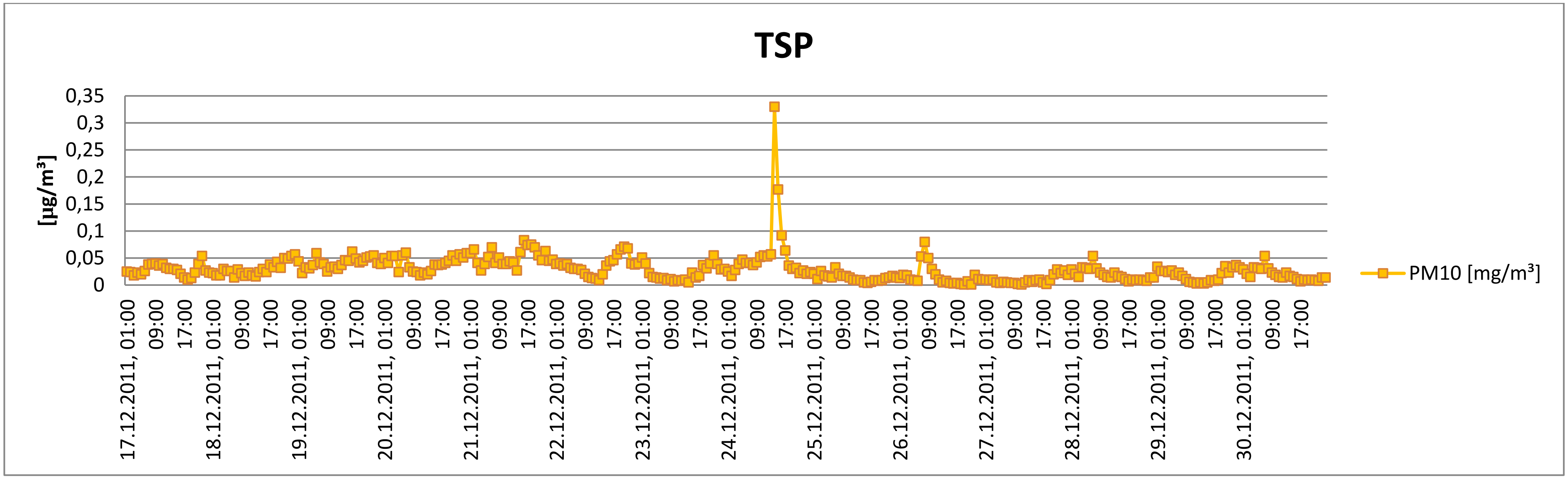


Figure 10-1: Hourly TSP measurement (17th – 30th December, 2011)

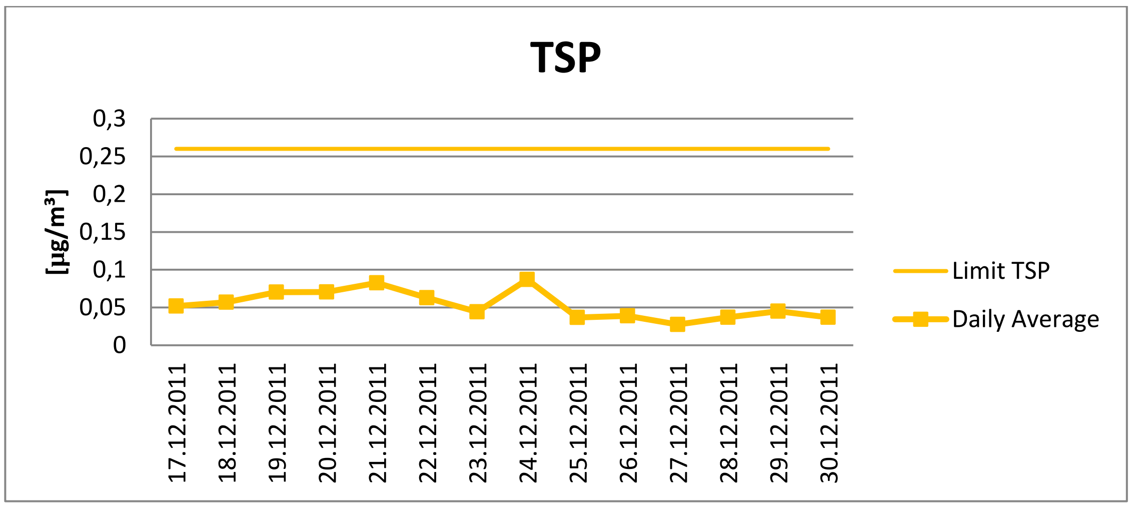


Figure 10-2: TSP measurement daily average (17th – 30th December, 2011)

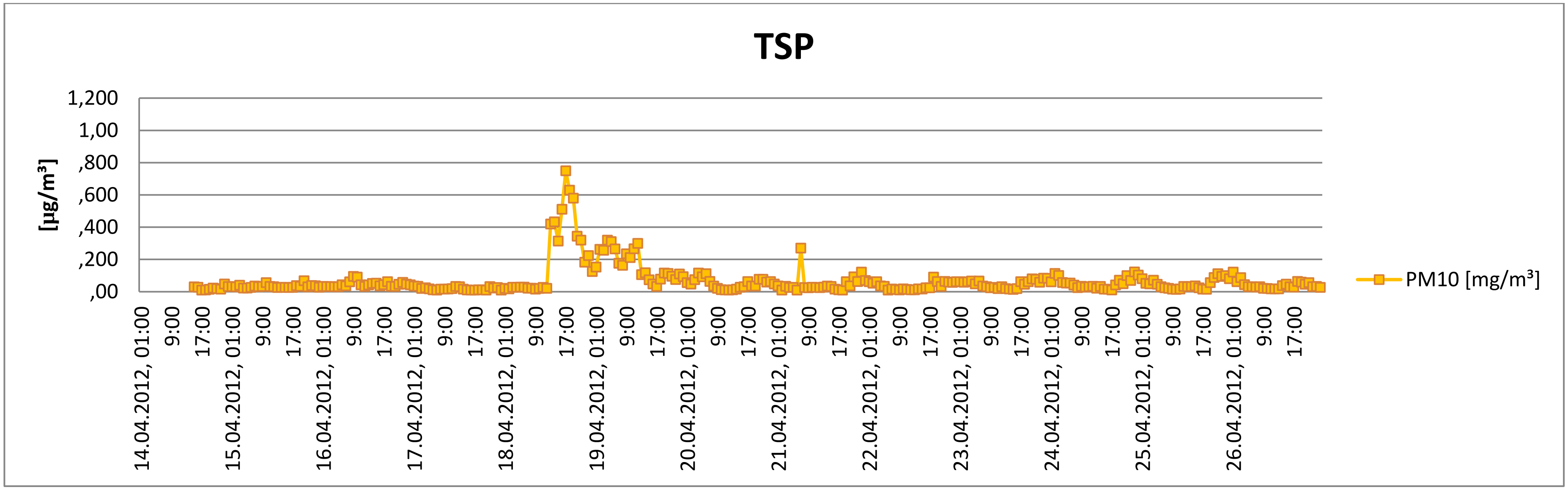


Figure 10-3: Hourly TSP measurement (14th – 26th April 2012)

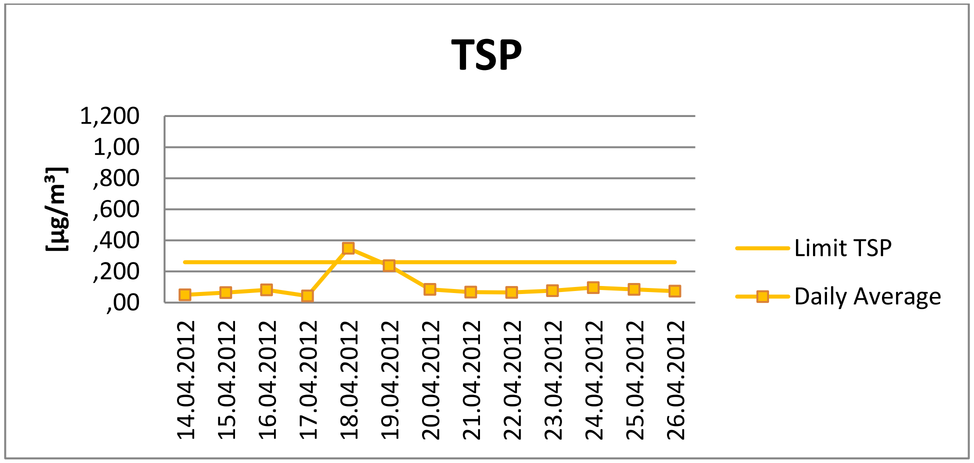


Figure 10-4: TSP measurement daily average (14th – 26th April 2012)

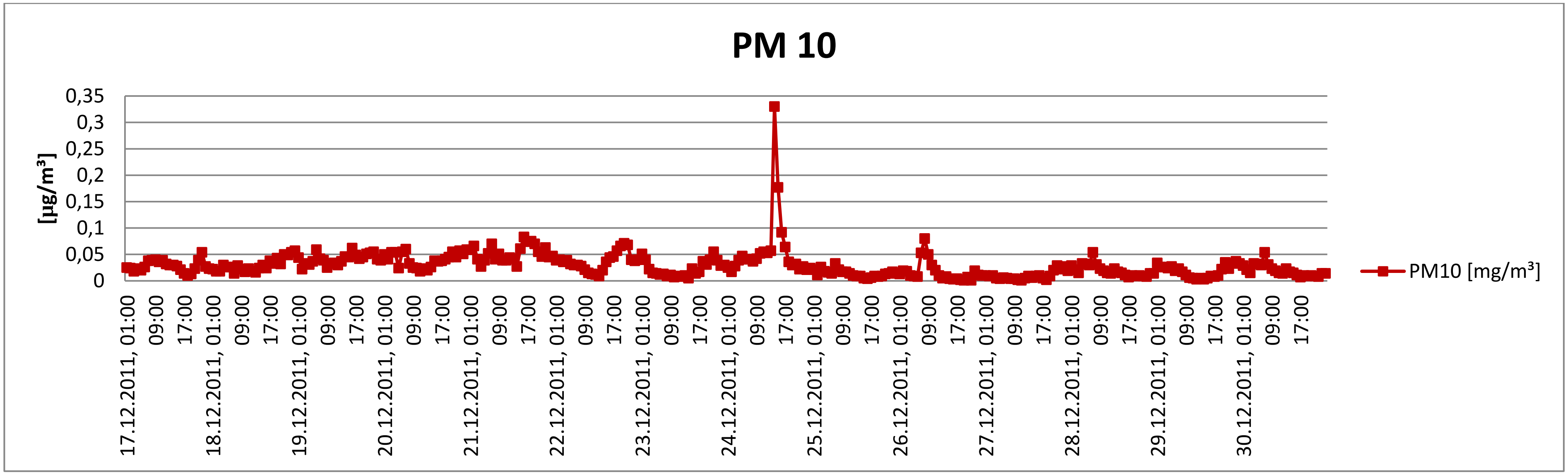


Figure 10-5: Hourly PM10 measurement (17th – 30th December, 2011)

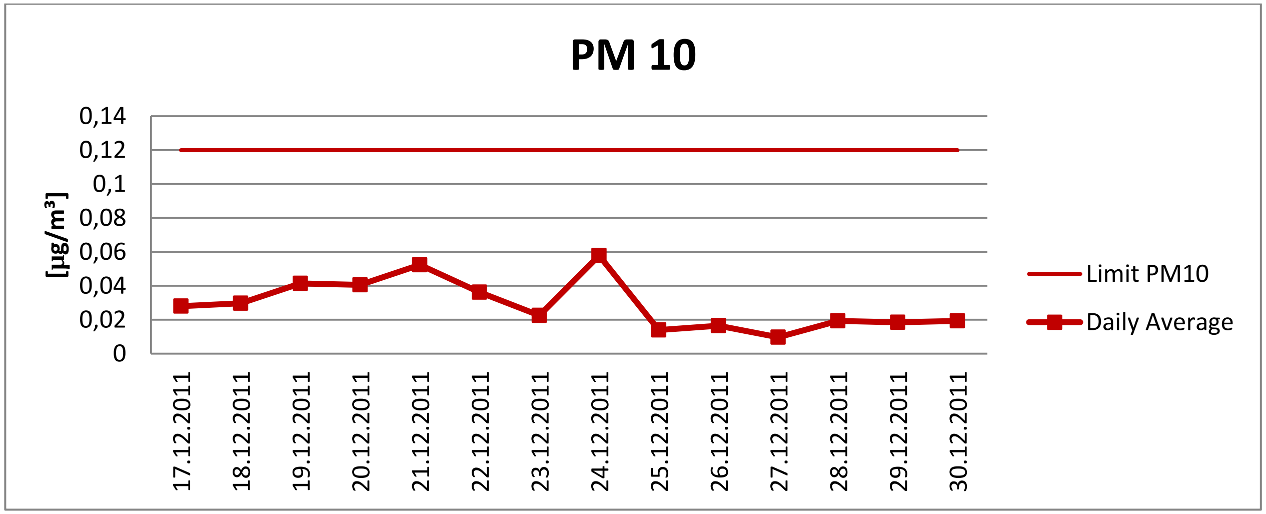


Figure 10-6: PM10 measurement daily average (17th – 30th December, 2011)

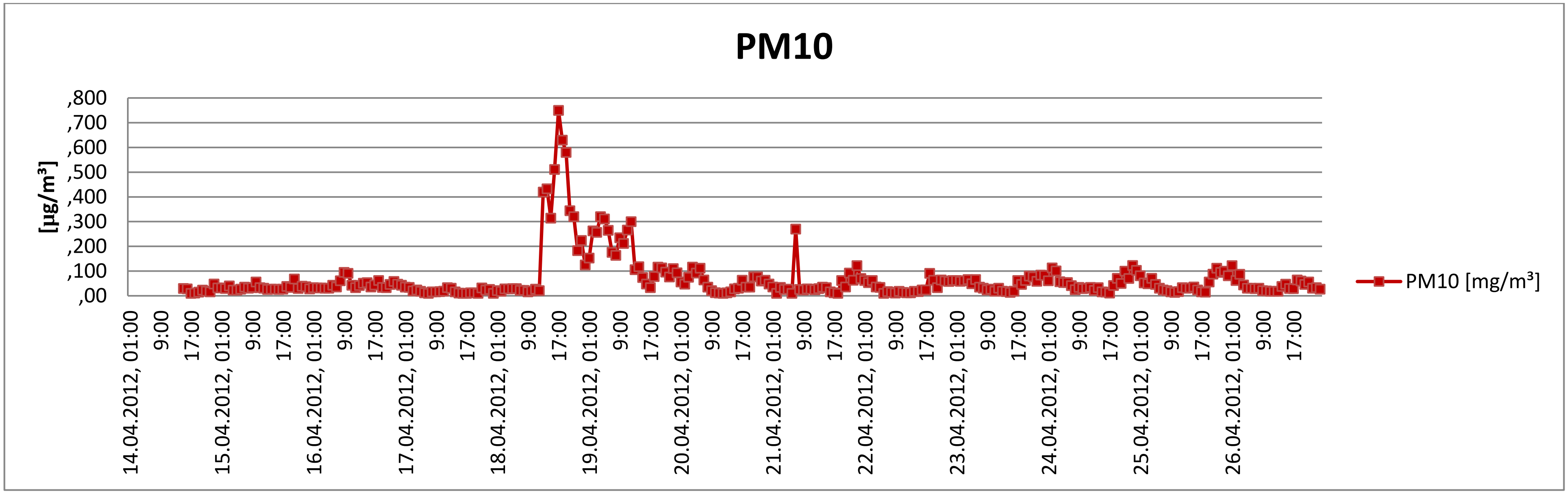


Figure 10-7: Hourly PM10 measurement (14th – 26th April 2012)

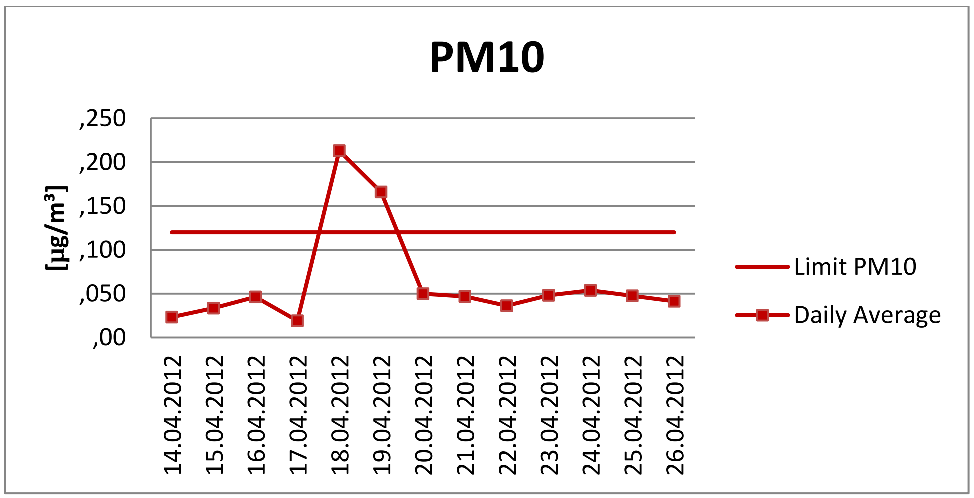


Figure 10-8: PM10 measurement daily average (14th – 26th April 2012)

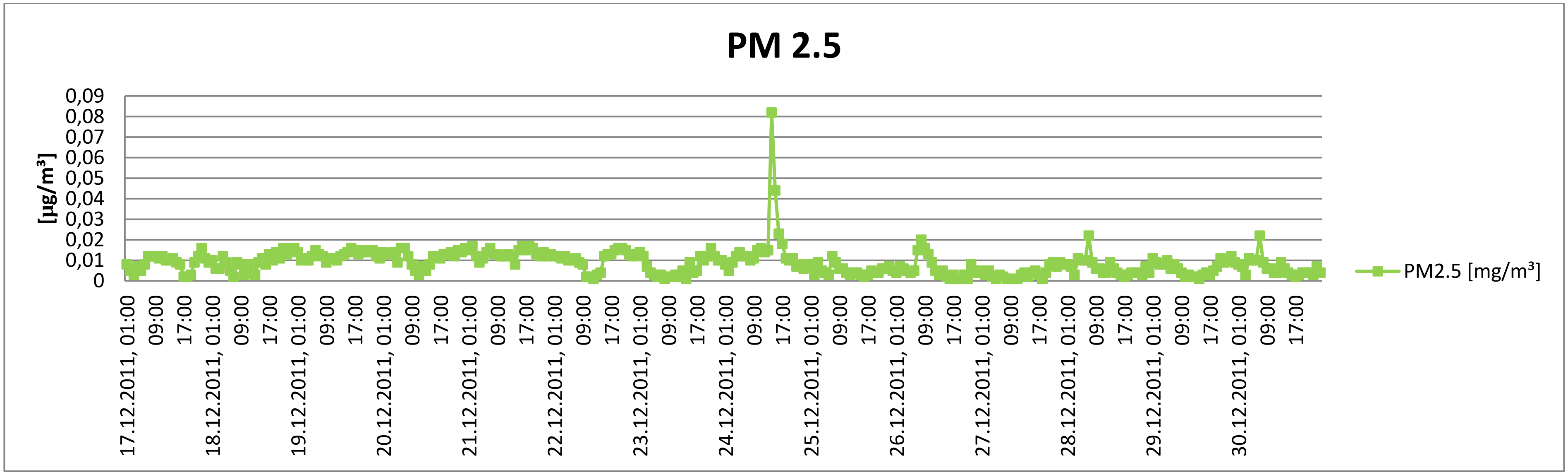


Figure 10-9: Hourly PM2.5 measurement (17th – 30th December, 2011)

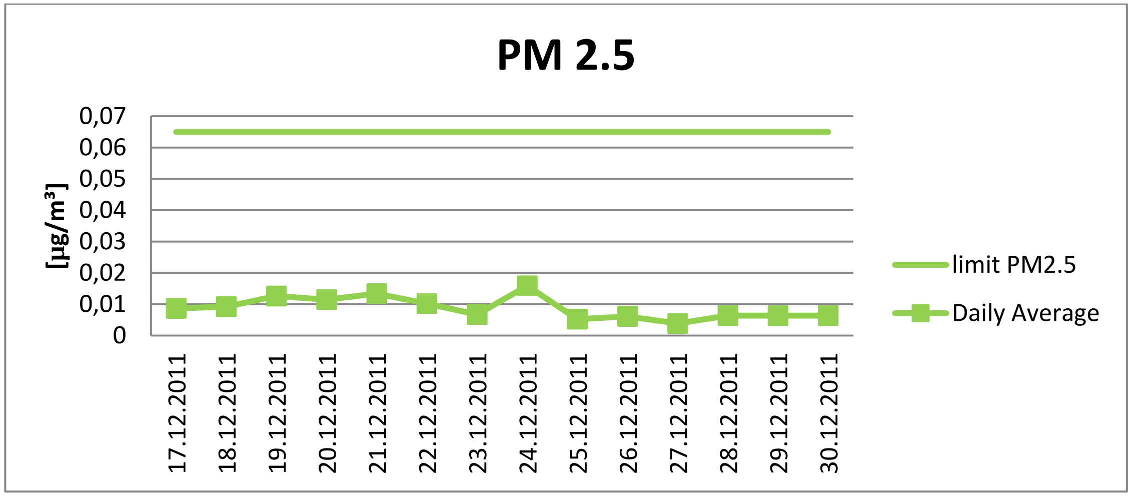


Figure 10-10: PM2.5 measurement daily average (17th – 30th December, 2011)

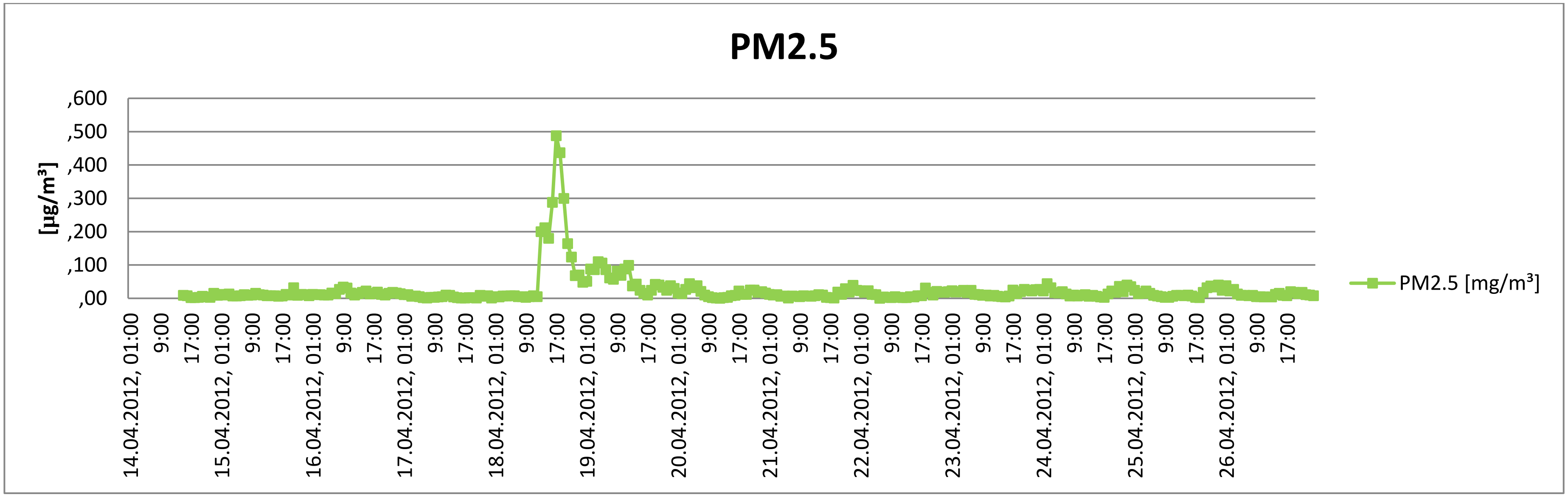


Figure 10-11: Hourly PM2.5 measurement (14th – 26th April 2012)

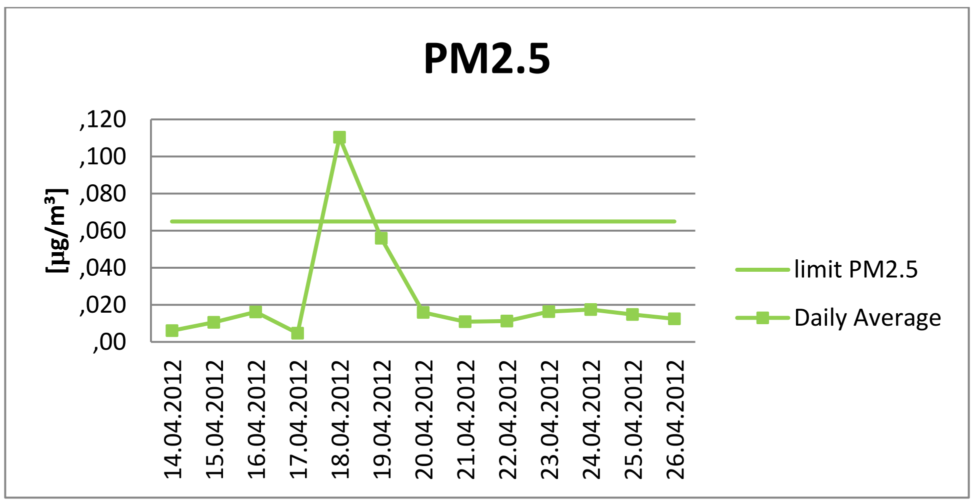


Figure 10-12: PM2.5 measurement daily average (14th – 26th April 2012)

10.8 Impact assessment

The monitoring results of the recorded dust levels showed one exceedance in the daily TSP concentrations, two exceedances in PM10 and one exceedance in PM2.5 concentrations to the daily limits specified in the Jordanian standard (JS1140/2006). However, the exceedance was possibly caused by a sandstorm (occurring a few times a year, especially in desert regions), incidents were rare and the values resulting from the monitoring were generally in compliance with Jordanian standards. Therefore it can be concluded, that the project area is not affected by high levels of dust concentrations in general.

In the following chapter the possible impact of each phase of the wind farm on the baseline conditions is described.

10.8.1 Construction phase

The severity of impact is correlating with the dust receptor's proximity to the dust source; receptors located more than 250 m away from the source have a low to negligible impact to dust emissions. The following dust sources were identified for the construction phase of the wind farm:

- Construction of internal roads and crane pads;
- Excavation of foundations;
- Construction of substation;
- Construction of cable trenches;
- Traffic on internal roads (see also chapter 14 "Traffic and transport").

All dust receptors near Tafila wind farm are separated from their respective dust source by least 1 km, approximately four times the distance at which the impact is considered to be negligible. Consequently, any works performed on the site would have a negligible impact on these receptors. The effect caused by the construction works would therefore be not significant.

In extreme cases of dry, windy weather, there is always the possibility that receptors beyond the threshold may be affected. Should this be the case, mitigation of the dust levels by covering exposed soil mounds or spraying exposed soil or roads with water is a mitigation measure which can be applied whenever required.

10.8.2 Operation phase

Dust production during the operation phase can be caused by cars and vans driving on the site roads. Transport to the site will be limited to a few trips per year and therefore this impact is regarded to be negligible.

10.8.3 Deconstruction phase

Decommissioning would be similar to the construction phase, but smaller in scale. As the foundations will only be removed to a level of 1 m below ground, less excavation will be needed for each turbine, compared to the construction phase. Like the construction phase, the impact here is considered to be negligible due to the large distance between dust sources and receptors and the possibility of quick mitigation, if necessary.

10.9 Mitigation measures

Dust sources on the project site are located approximately four times far-off the sensitive area. In addition to this, baseline measurements show that the air quality in the vicinity of the project site is of good quality, which decreases the sensitivity of the receptors. Therefore, no impacts are anticipated and, consequently, no mitigation measures are proposed.

The site can be described as desert-like, with long periods of dry and windy weather, therefore it is possible that unforeseen, extreme weather cases could require dust mitigation measures. In such cases any or all of the following measures may be implied at the discretion of the construction supervisor:

- Minimize dust production by spray water in the operational areas when climate conditions require it; [MM13]
- All vehicles carrying bulk, dust-producing materials into or out of the site will be covered to prevent dust emission [MM61];
- Any storage on site of aggregate or fine materials will be properly enclosed and screened so that dust escape from the site is avoided [MM60];
- Vehicles shall keep to a speed limit of 20 km/h on gravel access roads on site to minimize dust generation; [MM62]
- Drivers of construction vehicles should be instructed not to leave them idling, in order to reduce the emission of exhaust fumes; [MM63]
- Earth moving works should not be conducted at times with strong easterly winds that dust is not blown in direction of the close residential areas Gharandil and Lafarge Rashidiya settlement. [MM65]

10.10 Cumulative impacts

Potential impacts on air quality are limited to the construction and decommissioning phases as these are times were traffic volumes are increased. Cumulative impact on air quality from several developments in the area would therefore require construction and / or decommissioning phases to coincide. JWPC is aware of other wind farms being suggested in the area, but the public information on these projects is rare and it is unknown whether construction is likely to occur at the same time as for the Tafila wind farm. Consequently, no cumulative impacts could be anticipated. The concrete plant LaFarge Rashidiya is located in a distance of approx. 1.7 km to the closest dust source (WTG location) of the wind farm, therefore no cumulative impacts are anticipated from potential dust immissions by the plant.

10.11 Summary

Dust may be generated during the construction and decommissioning stages of the project, when excavations works expose soil to the wind, which may be blown away as dust. Vehicles driving on the gravel roads on the site may also generate dust. The delivery of light minerals, for instance sand, could also be a source of dust when escaping from vehicle loads in high winds.

A dust measurement, conducted in the vicinity of the Tafila wind farm, concluded, that the project area does not encounter high levels of dust concentrations except for times when sandstorms occur.

90 % of airborne pollutants (“dust”) come to rest within 100 m of their source and 98% within 250 m. All dust receptors near the Tafila wind farm are at least 1 km away from the next potential dust production sites and therefore significance is considered to be low to negligible.

As the project site can be described as desert-like with potential dry strong winds from west and north-west directions, mitigation measures were proposed for extreme weather conditions for dwellings and urban settlements.

10.12 References

[10-1] Cowheard, C., Englehart, P., Muleski, G.E., Kinsey, J.S. and Rosbur, K. D. (1990) Control of Fungitive and Hazardous Dusts, Pollution Technology Review, Noyes Data Corporation.

[10-2] Department of the Environment (1996), The Environmental Effects of Dust from Surface Mineral Workings - Volume 1; Stationery Office Books.

Figures

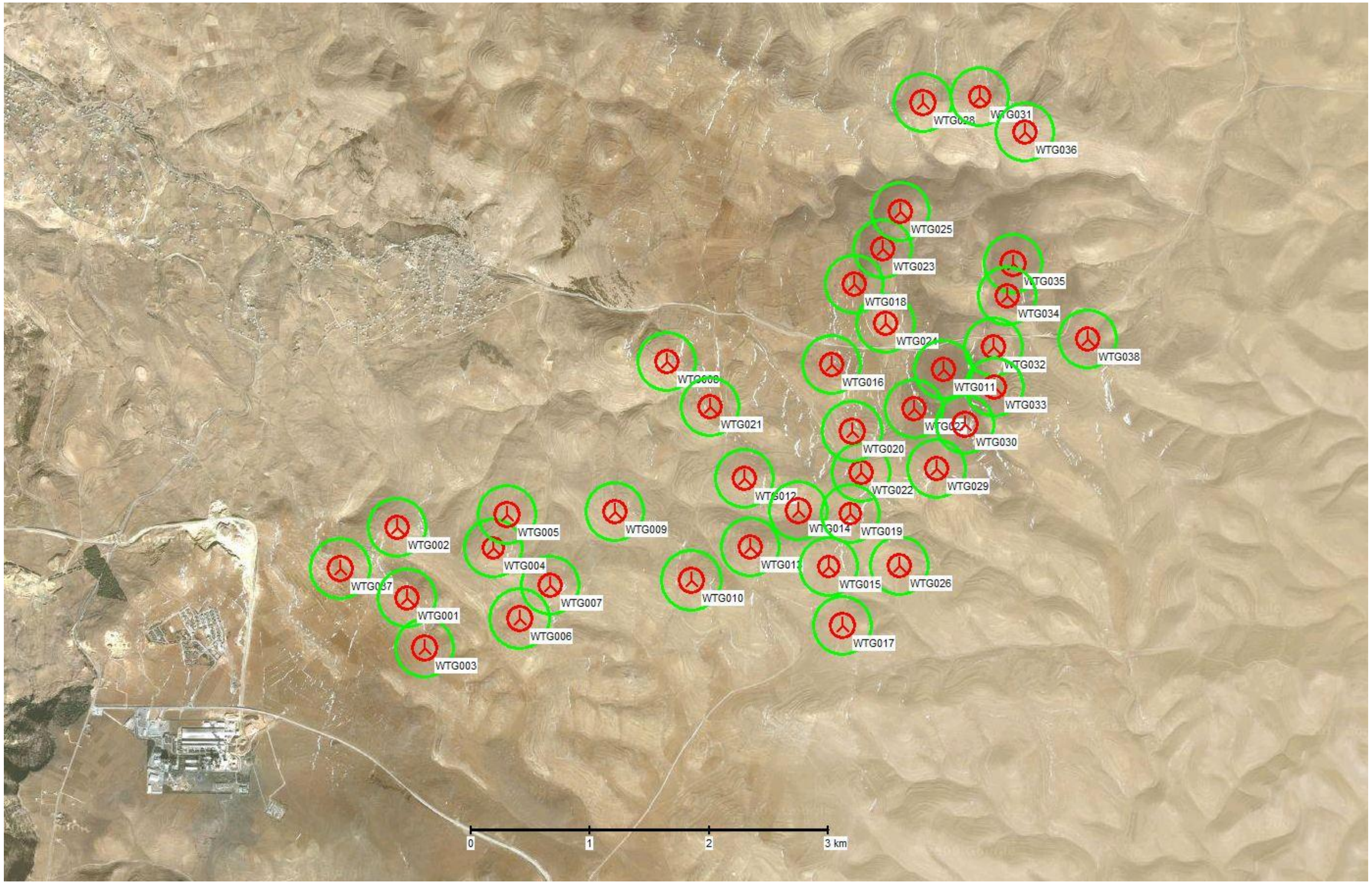


Figure 10-13: Distance circles around planned WTG; red circle 100m, green circle 250m

Figure 10-14: Air quality measurement locations

11 Safety Measures

11.1 Introduction

It is required to implement safety measures for the construction and operation of a wind farm. Especially in the construction phase accidents can occur due to the extensive works on site. The aim of JWPC and its contractors is to secure the project participants and other persons safety and to prevent the projects components from greater damages.

11.2 Objectives

The objectives concerning the safety measures are the following:

- To identify the potential safety risks for project participants;
- To identify the potential safety risks for third parties.

11.3 Guidance

- ISO 14001:2004;
- BS OHSAS 18001:2007.

11.4 General safety measures

As common for wind farms and other large scaled projects, a Health, Saftey & Environment (HSE) plan will be set-up prior to the start of construction works and another one prior to the start of wind farm operation which adherence is then binding for all project participants.

The HSE plan describes the general project aspects like location, execution time schedule and climatic conditions, general behavioural rules in the project area and particalur precautionary measures for individual tasks during the project phases. JWPC will hire an independent HSE manager who will supervise the adherence to the rules defined in the HSE plan or otherwise requested by law.

To ensure a fast reaction time in case of an emergency all required information (exact location, best access, wind farm layout) will be submitted to the ambulance and fire department prior to construction start.

Whereas Vestas, their subcontractors and the contractors of NEPCO will be obliged to follow the above described rules, those obligations do not apply to third parties such as visitors or local residents. To ensure that non project participants are not endangered by the wind farm works, several precautionary measures will be implemented which are described in more detail in chapter 11.5 below.

11.5 Safety of third parties

As the wind farm area is accessible by third parties and partly public roads are used for the wind farm exploitation, several safety measures need to be implemented to avoid injuries or accidents to third parties.

Due to the size of the project area and the fact that public roads are passing through it, a fencing of the whole wind farm is not possible. To ensure that third parties cannot access areas which may cause injuries for untrained persons among others the following measures are foreseen:

- Fencing and guarding of substation area;
- Security personal in wind farm area;
- Clear signaling in dangerous areas;
- Placing of warning tapes around dangerous areas (such as excavation areas);
- Securing of areas where dangerous activities are performed (such as WTG erection activities)

11.6 Safety of workers

11.6.1 Vestas employees

Since Vestas as Engineering, Procurement and Construction Management (EPCM) contractor will be the largest employer on the construction site, its human resources policies will be applied which are summarized in the section below. In addition to the regulations given by these policies the conditions and obligations defined in the HSE plan are binding as well.

According to Vestas' Code of Conduct humans are the most critical element in maintaining a safe workplace. To minimize this risk each Vestas employee is therefore obliged to:

- Participate in all mandatory safety trainings;
- Only undertake work for which he or she is trained, competent and fit;
- Follow Vestas' safety rules and procedures at his or her workplace, including the use of all relevant standards and instructions;
- Demonstrate safe working practices, and stop any work that is potentially unsafe;
- Help to make sure that other people who work with them – employees, contractors and other third parties – follow Vestas' safety rules and procedures;
- Not undertake work when his or her performance is impaired by illness, alcohol, or any other drug, legal or illegal, prescribed or otherwise.

Moreover Vestas ensures for any of its employees that it:

- Does not use compulsory or forced labor in any of its operations;
- Does not use child labor in any of its operations;
- Maintains a framework of fair and just remuneration, fair working hours, sick leave and parental leave;
- Respects freedom of association and the right to collective bargaining for Vestas employees, according to the laws or practices of the countries in which it operates.

Vestas seeks to support a single common culture. This culture is one of inclusion and mutual trust, however, in which everyone who works for Vestas is treated equally with dignity and respect regardless of race, color, religion, political conviction, gender, age, national origin, sexual orientation, marital status or disability, or any other characteristic protected by national or local laws. Vestas will not tolerate discriminatory treatment of any kind. Every Vestas workplace should be characterized by mutual trust and respect. Therefore Vestas does not tolerate:

- Sexual harassment;
- Any other kind of harassment, whether direct or indirect, physical or psychological, verbal or non-verbal;
- Any other kind of abuse of its employees.

11.6.2 Subcontractors of Vestas

Subcontractors of Vestas are obligated to:

- Ensure that legislation regarding occupational health & safety and environment is observe;
- Ensure that health and safety conditions at a work place are assessed and that the necessary steps are taken prior to starting up any work onsite. This includes the handing over of work clothes, shoes and other protective equipment e.g. gloves, masks, eye protection, head protection, etc.;
- Ensure that their subcontractors are informed of the health and safety risks, which can be faced when performing the work;
- Ensure that employees receive the necessary training and instruction to be able to perform the work in a safe way;
- Report deviations from Vestas requirements as well as environmental and safety legislation applicable to Vestas;
- Give information about particular safety rules applicable to the area in which the work is to be performed;
- Contribute to safe working conditions within his/her own field of activity and take efficient safety precautions by:
    - Using the personal protective equipment (PPE) and by respecting signs and warning signals;
    - Pointing out faults and shortcomings to Vestas or the employer;

- Following the rules agreed on between more companies at a common place of work;
- Informing the employer and Vestas if an industrial accident, a near-miss, an environmental accident or fire takes place;
- Keeping the work place clean and tidy;
- Being familiar with the occupational health & safety instructions in the manufacturer's instructions for the products used in the work at Vestas;
- Being able to document that compulsory inspection of cranes, hoists, anchorage equipment, etc. has been performed on own equipment;
- Being able to document that statutory training necessary in relation to the work assignment has been completed.

11.7 Safety of WTG operation

Turbines from different manufacturers vary considerably in technical aspects; this is the case even for different models of the same manufacturer. However many technical aspects have been standardized and their function is comparable between different turbine types. This section gives a general overview of how safety is ensured in modern wind turbines. Where model-specific details are given reference is made to the Vestas V-112 turbine that is suggested for this wind farm development.

11.7.1 Methodology

Technical standards of modern turbines are designed to determine lowest impacts during the operation on public safety. A general overview of safety measures in modern turbines is given in the following sections.

11.7.2 Baseline

The components of a WTG are designed to last for at least 20 years. Therefore, they must survive more than 150,000 operating hours, often under stormy weather conditions. Large wind turbines are equipped with a number of safety devices to ensure safe operation.

Industrial-scale wind turbines, like the Vestas V112, are tested and certified for their safe design and operation according to the applicable international standards as the IEC 61400-22 or other standards as set by organizations such as IEC, Germanischer Lloyd, etc. This ensures public safety throughout the turbine lifetime.

The V112 is certified by an independent organization such as IEC or Germanischer Lloyd. Detailed safety instructions will be developed, published in the turbine and supplied to the staff and client in form of the construction and operation health and safety manuals.

The following sections are taken from the safety manual for the Vestas V112:

11.7.2.1 Organization of safety-related work

Safety meetings

The responsible safety manager must conduct regular safety meetings with employee safety representatives and representatives from relevant subcontractors and other co-operation partners at the site. Issues to be discussed at the safety meetings must be listed on the agenda for the meetings. The agenda must, as a minimum, address the following issues:

- Follow-up on problems and solutions since the last safety meeting;
- Results from inspections;
- Incidents of lack of compliance with laws and regulations;
- Safety alerts;
- Summary of incident reports (e.g. reported industrial injuries and near misses) and investigation reports;
- Activities not covered by the current occupational health and safety (OH&S) plan and risk assessment.

Planning of work

The responsible safety manager must be informed of any turbine-related task that is carried out on the site, and the manager must give permission before the task can be carried out.

Before starting any task, the person in charge of the task must discuss the task in detail with all persons involved. This will ensure that employees have a good understanding of what they are permitted to do, and the risks involved in each task.

The status of the tasks in progress will be discussed on a daily basis to ensure coordination of all the parties involved. In the event of a serious accident, all the involved parties must be informed of the accident and involved in the efforts to prevent similar incidents from happening. “Near misses,” incidents where no person or property was injured, but would have been if events had happened just slightly differently, are also recorded, discussed and acted upon to prevent future re-occurrence.

11.7.2.2 Safety training requirements

General

All employees, subcontractors and other relevant cooperation partners must have the necessary competences to be allowed to carry out a specific task. The safety manager is responsible for ensuring that competences are evaluated and that documentation for competences are available before starting the work.

All Vestas service technicians must be trained sufficiently in proper use of safety equipment, climbing equipment, fire extinguishers, first aid equipment and descent equipment.

All Vestas service and installation technicians and other Vestas employees performing work in the turbines are required to complete the Basic Safety Training program before they can start the work. The Basic Safety Training program consists of four modules:

- Basic safety training, theory;
- First aid;
- Fire Fighting and fire prevention;
- Fall arrest and rescue from heights.

When the basic safety training program is completed the technician is required to pass the basic safety test. When the test is passed the technician will receive a certificate. All training, induction to the OH&S plan, certificates and licenses required to perform the task must be recorded.

Employees working at heights
Before any employee starts to work at heights the employee must complete the following courses:

- Safety course (course in the use of a full body harness, a lanyard with energy absorber, a work positioning rope and a fall arrester);
- Course in rescue from heights (use of descent device). As a minimum, the rescue course must be renewed every fourth year.

Employee working with electricity and high voltage
Before any employee starts to work with electricity and high voltage, the following training must be completed:

- The person must have completed supplementary training courses and be authorized to work with high voltage/low voltage (>1000/1500 AC/DC volt / <1000/1500 AC/DC volt – the limits may vary in different countries).

11.7.2.3 Training on-site
The safety manager is responsible for ensuring that all personnel, including salaried employees, hourly-paid employees, subcontractors and visitors are introduced to the safety guidelines, and the emergency response plan for the sites.

The induction must, as a minimum, consist of the following, for groups of visitors and others:

Visitors

Any visitor that enters the site during the construction period shall be instructed by the responsible site or HSE manager to observe the following:

- Safety rules of the site;
- Safety equipment on the site;
- Restricted areas;
- Emergency response plan.

Employees, subcontractors and other relevant co-operation partners

Any employee, subcontractor or other co-operation partner that enters the site shall be instructed by the responsible site or HSE manager to observe the following:

- Safety rules of the site;
- Safety equipment of the site;
- Restricted areas;
- Emergency response plan;
- Driving rules (on the site and off the site);
- Hazardous substances;
- The importance of complying with environment and health & safety procedures;
- Responsibilities in general.

The safety manager is responsible for the maintenance.
Training on the site is a continuous activity which must be supplemented when required.

11.7.2.4 Safety inspection on construction site

The safety manager must ensure regular inspection of the relevant environment, health & safety issues and procedures on the site, including the scope of work by subcontractors and other co-operation partners.
Some of the essential issues are described below:

- Waste storage, waste handling and cleaning of the site;
- Hazardous substances (including hazardous waste) must be inspected for correct storage and handling on-site. It must be inspected that Material Safety Data Sheet (MSDS) for the specific chemicals and oils are available on-site.
- The established marking of the restricted areas;
- The location and condition of spill kits for environmental emergencies;
- That the personnel is wearing the correct personal protective equipment (PPE);
- Location, condition and quality of fire extinguishers;
- Is climbing, electrical, lifting and safety equipment and safety devices inspected on a regular basis? Is defective equipment found in service?

11.7.2.5 Safety alerts

When a serious and acute safety concern is identified, a ‘Safety Alert’ is issued by the responsible manager. Safety alerts must be complied with and safety alerts supersede any other work instruction and remain in effect until the risk is eliminated or reduced to an acceptable level.

11.7.2.6 Risk assessments

The safety manager is responsible for the implementation of risk assessments before performing installation and maintenance tasks that are not identified in work instructions, transport, installation and service manuals and if any irregular conditions are related to the work to be carried out. A work instruction must be developed on the basis of the risk assessment. It is not allowed to perform a task of this nature until both the risk assessment and the work instruction are complete.

Activities, which have been evaluated to involve an unacceptable risk, must be avoided until a safe procedure or work method has been developed.

11.7.2.7 Communication

For safety reasons there must always be a way to communicate with relevant personnel both on site and outside the site. It is the responsibility of the safety manager to make sure that this is provided for each site they have a service contract on.

Mobile phones

In most cases, cell phone coverage on the wind farm site is adequate for mobile phone use. This is the case for Tafila Wind Farm site as well.

11.7.3 Personal Safety

11.7.3.1 Two person teams

- Tasks are usually assigned to teams of at least two competent persons;
- It is important to prevent the isolation of any team member;
- If team members work in isolation from each other and do not have visual contact during the work, there must be a clear procedure about communication among team members;
- Team members must be in possession of two-way communication equipment which as a minimum has battery capacity for the duration of the work;
- A team member must never stop a work task or leave the work area without informing the other team members;
- Work in the hub requires that at least one person stays in the nacelle until the person working in the hub is finished and back in the nacelle.

11.7.3.2 Working alone in the turbine

Employees are permitted to work alone only in exceptional cases and at the bottom of the tower only.

In such cases employees are allowed to:

- Read and record meters;
- Paint or clean the surface of the tower base without using scaffolds.

Only competent and educated personnel are allowed to carry out lone working. Communication between the lone worker and a contact/base person must be established. An emergency plan must be agreed on between the lone worker and the contact/base person.
The definition of lone-work is when an employee is the only one present at a turbine site or in a turbine. Planning of the work must consider a thoroughly performed risk assessment that shows the lone work does not introduce hazards that cannot be controlled to an acceptable level.

Emergency plan for lone working

- The person working alone must call the contact/base person with agreed intervals not longer than 15 minutes;
- The person working alone must contact the base/contact person when arriving at the site;
- If the person working alone does not contact the base/contact person, this person must contact the person working alone;
- Start the emergency plan if the person working alone cannot be reached.

<u>Before work start</u>

- The person working alone must contact the base/contact person before the task is started;
- The person working alone must ensure that communication lines work properly;
- The person working alone and the base/contact person must agree on a time estimate for the task;
- The contact person and the person working alone must go through the emergency plan before the task is started.

<u>During Work</u>

- The person working alone must contact the contact person with intervals as agreed;
- The person working alone must contact the contact person if he/she has to leave the turbine unexpectedly.

<u>Finishing Work</u>

- The person working alone must contact the contact person when the task is finished and before leaving the site.

11.7.3.3 Weather conditions

Before Starting-up any Work

- An updated weather forecast must be checked before starting any work on the turbine site or inside the wind turbine;
- Local circumstances and local regulations must always be taken into consideration.

During Work

- Be particularly aware of changing weather conditions;
- Note that site locations can determine weather conditions. For example, special gusts of wind can arise in mountainous areas.

Wind speed

In general, the following work should not be performed if the average wind speed measured over 10 minutes exceeds:

- Maximum 15 m/s for work on hub, main shaft, gearbox, generator or yaw system;
- Maximum 15 m/s for work on the nacelle roof or in the nacelle if there is a failure on the wind turbine aerodynamic break system;
- Maximum 25 m/s for ordinary service work, e.g. lubrication, etc. (without rotor lock).

In special circumstances permitted wind speeds may be determined which deviate from general limits. Such circumstances are described in the wind

Strong Wind and Tornados

In storms, hurricanes and extreme winds in general, access to the turbines is strictly prohibited.

Working in Cold and Freezing Conditions

Precautions

- A wind turbine covered in snow and ice must not be approached.
- For work outside it should be taken into consideration that high winds have a strong cooling effect so that it will feel significantly colder than the temperature indicated by a thermometer.

Sufficient food and drink must be brought along to withstand prolonged working hours in cold conditions.

Particular Snow and Ice Hazards

- In cold weather and heavy snow, there is a risk of ice or snow falling from the wind turbine.
- When a turbine starts up, especially after a period with cold weather, there is a risk of snow and ice falling from the blades and the nacelle.
- It is not allowed to approach a turbine if there is any risk of falling ice or snow.

Precautions at Turbine Installation

On turbine parts lying on the ground, large amounts of ice and snow can build up on blades, nacelle and both inside and outside the tower. It is therefore important to check individual parts thoroughly and clear of snow and ice both inside and outside before lifting off the ground is commenced.

Prevention of Hypothermia

When working in air, most heat is lost through the head, so hypothermia can be most effectively prevented by covering the head. Wearing the appropriate clothing for the environment is important to prevent hypothermia. Fluid-retaining materials, e.g. cotton, can result in hypothermia if a person is sweaty on a cold day and then later on cools down, the person will be wearing sweat-soaked clothing in cold air. For work in cold conditions it is advisable to wear fabrics which can transport sweat moisture away from the body quickly. These include wool or synthetic fabrics designed specifically for rapid drying.

Working in High Temperature Conditions

Precautions

High temperatures and humidity may cause the body to dehydrate, the blood sugar will drop and the body will loose minerals.

- It is important to bring and drink plenty of drinking water;
- It is important to go to a ventilated place whenever possible.
- If a person feels unwell then the person must be brought to a ventilated place, offered water and maybe cool the person’s head and body down with water. Consult a doctor.

Working in Sunny Conditions

Precautions

Working many hours in the sun may hurt the eyes and skin and result in heatstroke. The persons working in or around a wind turbine site must take the following precautions.

Humidity and direct sunlight may cause the temperature to be significantly higher than the temperature indicated by a thermometer.

It is important to drink plenty of clean water.

When the skin is exposed to the sun, a good sun protection lotion must be used. Eyes must be protected by sunglasses and the head must be protected by a cap or hat.
It is important to find shadow whenever possible.

- If a person feels unwell the person must be brought into the shadow, offered water and maybe cool their head and body down with water. Consult a doctor.

Thunder Storms and Lightning

Note that special precautions apply to offshore work, cf. site-specific safety manuals.
In the event of a thunder storm at the site, all personnel must immediately leave the wind turbine, if not stated otherwise in the wind turbine specific manual.

Also Remember:

- All work in turbines and with cranes is strictly prohibited during thunder storms and lightning.
- Local circumstances and local regulations must always be taken into consideration.
- Standing close to wind turbines is not permitted.
- Entering the substation is not permitted.
- Using the substation telephone is not permitted.

If the turbine has been struck by lightning, and visible damage is found, the power supply must be disconnected and the manager must be contacted to carry out further inspection.

Re-entering the wind turbine is not permitted until it has been ensured that the storm has passed.

Approaching the wind turbine is not permitted until at least one hour after the storm has passed. Even then, the turbine should not be approached if there are rustling or hissing noises coming from the turbine blades due to static electricity.

11.8 References

[11-1] Vestas Corporate OH&S Manual, Vestas Wind Systems A/S, 29.03.2010

12 Landscape and visual impacts

12.1 Introduction

Landscape and visual impact assessment (LVIA) is the part of the ESIA that evaluates the landscape and visual amenity changes that will occur as a result of the planned project. This section of the ESIA will allow a better understanding of both short and long-term effects that will appear during the lifetime of the project.

The entire assessment is comprised of two parts: the landscape impact assessment (LIA) and the visual impact assessment (VIA), which together form the LVIA. The landscape impact assessment describes and evaluates modifications on land character resulting from construction, operation and decommissioning of the project, which means predicting the impact to the landscape of adding, modifying or eliminating elements of the existing landscape. On the other hand, the visual impact assessment (VIA) describes and evaluates human perception in regard to the physical elements of the project.

The assessment of the relevant parameters has been undertaken on an objective basis using specific methodology as described below.

The landscape and visual impact assessment concentrates on the construction, operation and decommissioning phases of the proposed Tafila wind project, according to preliminary design of the components described in chapter 3.

12.2 Objectives

The objectives of the landscape and visual impact analysis are the following:

- To describe modifications on the landscape character;
- To assess human perceptions in regard to the physical elements of the project.

12.3 Guidance

As no relevant guidelines at national level are available for Jordan, the following international guidelines were consulted in order to perform the landscape and visual impact assessment. These guidelines represent current best-practice in the field of LVIA:

- Visual Assessment of Wind farms. Best Practice, Scottish Natural Heritage (elaborated by the University of Newcastle), 2002;
- Guidance for landscape and visual impact assessment, Landscape Institute and Institute of Environmental Management and Assessment;
- Visual Representation of wind farms: Good Practice Guidance, Scottish Natural Heritage, 2006;
- Environmental, Health and Safety Guidelines for Wind Energy, IFC, 2007;
- Siting and Designing wind farms in the landscape, Scottish Natural Heritage, 2009;
- Assessing the cumulative impact of onshore wind energy developments, Scottish Natural Heritage, 2012.

12.4 Methodology

12.4.1 Scoping and consultation

According to the scoping report prepared for Tafila Wind Energy Project in December 2011, the objectives of the landscape and visual impact assessment are:

- To describe modifications on the landscape character during all phases of the project (construction, operation, decommissioning);
- To assess human perceptions in regard to the physical elements of the project.

The methodology of the landscape and visual impact assessment will consist of the following steps:

- Assess the visibility of the project;
- Determine the zones of visual impact (ZVI);
- Preparation of different photomontages to predict the scenery in combination with WTG;
- Propose mitigation measures to reduce negative impacts.

12.4.2 Assessment methodology

The assessment of landscape and visual impact consists of three main steps:

- Baseline study;
- Landscape and visual impact assessment;
- Mitigation measures.

12.4.2.1 Baseline study

The baseline study first establishes the area of interest and then describes the existing conditions in the study area. The purpose of this part of the chapter is to fully describe the existing situation in the project area. Included in this sub-chapter is the description of:

- Landscape character, land use, landscape sensitivity;
- General visibility;
- Other wind farms already existing in the project area.

12.4.2.2 Visibility

The visibility and visual impacts of a wind farm are affected by the distance from which it is viewed, as well as other aspects such as weather conditions and siting. In the past, guidance notes have offered generic categories of visibility and visual impact in relation to distance, suggesting the following: in an open landscape at distances of up to 2 km, a wind farm is likely to be a dominant feature; between 2–5 km it will less dominant; between 5–15 km only in clear visibility seen as part of the wider landscape; and over 15 km it will only be seen in very clear visibility and as a minor element in the landscape. However, in practice these guidelines are limited in their application because the heights of turbines being built today are significantly larger than those considered in the guidances and because visual impacts are not directly proportional to distance, as the nature of a view (e.g. a framed view, open view or skyline view) and its context are as important as the size of a development within that view.

12.4.2.3 Landscape and visual impact assessment

Landscape impact assessment consists of predicting and evaluating the impact of the project on landscape characteristics such as soils, settlement patterns, cultural history and land use.

After identifying the landscape resources in the studied area, the sensitivity of the landscape must be established. Landscape sensitivity is based on the landscape character and its components, as well as the impact of the proposed change. In this way, various impact receptors are taken into consideration in their number and nature.

The main characteristics on which the landscape sensitivity depends on are:

- Topography;
- Landscape elements and features;
- Density and characteristics of settlements;
- Cultural heritage;
- Tranquility;
- Initial level of visual impact.

The sensitivity levels and their characteristics are presented in Table 12-1.

Table 12-1: Landscape sensitivity criteria

Sensitivity levels	Characteristics
High	Landscape highly sensitive to changes due to one or more combinations of the following factors: - Features forming the basis of a landscape designation are vulnerable; - Little topographic variation or lack of enclosure means impacts would be widely experienced; - Scale of the landscape is such that the development would have significant visual influence; - Landscape type is nationally valued and/or unique and/or would be difficult to replicate; - Landscape type is of cultural value with strong historical or topical cultural associations e.g. important with tourists.
Medium	Landscape moderately sensitive to change due to one or more of the following factors: - Topographic variation or enclosure patterns means impacts would be somewhat limited; - Difference of the landscape is such that the development would have a moderate visual influence; - Landscape type is regionally or locally valued and/or is reasonably widespread and/or would be moderately easy to replicate; - Some cultural value or associations; - Landscape type is locally scarce but regionally or nationally common and/or is moderately easy to replicate.
Low	Landscape less sensitive due to one or more of the following factors: - Topographic variation or enclosure patterns means impacts would be well-contained; - Scale of the landscape is such that the development would have a minor visual influence; - Landscape type is common and widespread and/or would be moderately easy to replicate; - Absence of cultural value or associations.

The magnitude of change can be described as very high, high, medium, low and very low (Table 12-2) and depends especially on:

- The size of the project;
- The landscape characteristics (initial level if visual impact);
- Distance from the landscape resources to the project.

Table 12-2: Criteria for magnitude of landscape and visual amenity change

Magnitude	**Characteristics**
Very high	Very high changes in landscape characteristics over an extensive area
High	Notable changes in landscape characteristics over a wide area, to very intensive change over a more limited area
Medium	Moderate changes in landscape characteristics in a localized area
Low	Minor change in landscape characteristics
Very low	Very minor change in landscape characteristics

The purpose of visual impact assessment is to evaluate and predict the impact of the project on the human receptors. The visual impact assessment followed the conceptual model given by the University of Newcastle (2002) in the report "Visual Assessment of Wind farms Best Practice" (Scottish Natural Heritage Commissioned report F01AA303A). The scheme of visual impact assessment is listed in Figure 12-1.

Visual impact is evaluated according to the sensitivity degrees presented in Table 12-3.

Table 12-3: Degrees of sensitivity for visual receptors

Sensitivity	View from
High sensitivity	Public views from: • Settlements or groups of dwellings; • Public open space; • National trails or named recreational paths; • Designated Tourist Routes; • Outdoor recreational and tourism spaces/activities; • Private views from residential properties.
Medium sensitivity	Public views from: • Main railways; • Local railways; • Other public footpaths/bridleways.
Low sensitivity	Public views from: • Low usage roads; • Private views; • Commercial properties; • Industrial properties; • Agricultural land; • Very modified / disrupted land.

The magnitude of change in what visual impact implies can be defined with the same levels as magnitude of landscape changes. The magnitude of visual amenity change depends upon:

- Landscape characteristics (topography, vegetation, etc.);
- The distance of the viewpoint from the proposed project;
- General visibility (weather, obstacles);
- Angle of view;
- Skyline.

The magnitude of visual amenity change is characterized in Table 12-4.

Table 12-4: Criteria for magnitude of visual amenity change

Magnitude	Characteristics
Very high	Very large changes in landscape characteristics over an extensive area
High	Range from notable changes in landscape characteristics over a wide area to very intense change over a more limited area
Medium	Moderate changes in landscape characteristics in a localized area
Low	Minor change in landscape characteristics
Very low	Very minor change in landscape characteristics

To assess the project's impact on the landscape and visual receptors, the magnitude of change and the landscape and visual sensitivity must be considered. By combining these two aspects the following matrix is obtained (Table 12-5).

Table 12-5: Significance matrix

Receptor sensitivity / **Impact magnitude**	Low	Medium	High
Very high	Moderate to substantial	Substantial	Substantial
High	Moderate	Moderate to substantial	Substantial
Medium	Slight to moderate	Moderate	Moderate to substantial
Low	Slight	Slight to moderate	Moderate
Very low	Negligible	Slight to negligible	Slight

The two tools used to evaluate the visual impact were zone of theoretical visibility and viewpoints.

Zone of theoretical visibility (ZTV) is used to describe the area over which a development can theoretically be seen, and is based on a digital terrain model (DTM) and overlaid on a map base. The distance of a ZTV should extend far enough to include all those areas within which significant visual impacts of the wind farm are likely to occur.

The recommendations of the various consulted guidelines were taken into consideration and the distance of the ZTV for Tafila wind farm was defined as 35 km from the outer limit of the wind farm.

The second tool for assessing the visual impact is represented by the viewpoints. Viewpoints are selected as being those places from where a proposed development is likely to be visible and would result in significant effects on the view and the people who see it. These viewers are known as receptors.

For some of these viewpoints, photomontages were also made which predict the visual change that will take place once the wind turbines are erected.

12.5 Baseline

The baseline studies provide a general description of the variety of landscape and visual resources within the wind farm site and study area (as considered for the ZTV assessment).

12.5.1 The site

The project is located in the Governorate of Tafila, and the Directorates of Arady Busayra and Arady at Tafila. The project area is east of the town of Gharandil.

The land in the project area is moderately hilly and rocky, with sparse vegetation. Elevation of the project area varies from 1400 to 1600 m. Significant slopes can be found in the eastern part of the site.

There is some grazing activity in the area (sheep, goats), and seasonal, low intensity crop production (wheat, cereals) is present in the small areas of agricultural cultivation. There are no occupied dwellings in the area. There are no permanent structures in the project area that would be affected by the construction or operation of the project. The agricultural fields which surround most of the turbine locations are of very low surface roughness. There is an existing 132kV transmission line in the project area which will be the connection point for the project.

12.5.2 The study area

The study area for the baseline evaluation covers a 35 km radius area considered from the outer limit of the wind farm.

12.5.3 Settlement and communications

The closest dwelling to the wind farm site, the housing for workers of the cement factory Lafarge, is approximately 1,100 m to the west. A bit further to the north is the town Gharandil. It lies in a distance of approximately 1,500 m to the project site.
The city of Tafila lies approximately 13 km to the north west of the wind farm site.
In approximately 14 km to the south east of the project site lies another village called Husseiniya.

The housings of Lafarge Rashidiya cement plant are approximately on the same height level as the wind farm. Gharandil lies approximately 200m below the wind farm and Tafila, is approximately 500 m below the project site.

12.5.4 Landscape

The landscape can be characterized as relatively sparse or desert-like. Nearly no high-growing plants are found on the site and its vicinity. Close to the Lafarge Rashidiya cement plant is the Dana Biosphere Reserve. In this nature reserve the terrain drops down in direction to the Jordan valley. In this potentially rich and nutrient area, a richer vegetation than the area around is growing which serves as feeding and resting area for migrating birds.

In the west of the site the landscape is influenced by two previous industrial impacts. On the one hand there exists a stone quarry approximately 3.5 kilometers southeast of Gharandil. And on the other hand 3 kilometers south of Gharandil is located the cement factory Lafarge Rashidiya.

The area is moderately hilly and elevations of ± 200 meter are normal. As described above the elevation loses its height to the west and reaches into the Jordan valley.

12.6 Impact assessment

12.6.1 Visibility

The ZVI calculation of the area around the wind farm shows how many turbines are visible from the different locations. Two maps, one with a radius of 10 km and one with a radius of 35 km are shown in Figure 12-4 and Figure 12-5.
Table 12-6 shows the sum of square meters according to how many turbines are visible.

Table 12-6: Sum of visibility of the turbines (10m radius)

WTG visibility	Area [m^2]	Area [Dunum]	Area [%]
0	262,014,167	262,014	53,2
1-4	60,055,326	60,055	12,2
5-10	51,421,694	51,422	10,4
11-20	70,590,798	70,591	14,3
21-38	48,877,481	48,877	9,9

12.6.2 Settlements

The effect of the proposed development on residential settlements within the 35 km study area is assessed in this section. Table 12-7 will outline the effect on the settlement in this radius.

Table 12-7: The visual effect of the WTG on nearby settlements

Settlement	Sensitivity	Magnitude of change	Effect and significance
Rashidiya - Lafarge Housing Area	High	In the middle of this housing area no turbine will be seen. In the outskirts of this settlement up to 37 turbines will be visible.	Moderate and not significant This is considered as not significant. In direction to the wind farm the dwellings are surrounded by relatively close standing trees that limit the visibility of the WTG.
Gharandil	High	In Gharandil the visibility of the wind farm differs to a great extent. In most locations only 2 turbines are visible. The closest area where at least 16 turbines are visible is over 2 km away from the WTG	Moderate and not significant This is considered as not significant. The WTG are relatively far away and are mostly masked by houses. Therefore the wind farm is not considered as relatively prominent structure.
Bsaira	High	In Bsaira the visibility of the WTG differs to a great extent. In approximately 50% of the locations no turbines are visible. In almost all other locations at least 10 turbines are visible.	Moderate and not significant This is considered as not significant as the WTG are relatively far away (approximately 5 km).
Qadissiya	High	The visibility on the WTG in this settlement is limited. Only in smaller areas more than 16 WTG will be seen.	Moderate and not significant This is considered as not significant as the predominant building in the visual field in direction of the turbines is the Lafarge Rashidiya cement plant, which is considered as initial level of visual pollution.
Eyn al Baida	Medium	In most parts of this settlement the WTG will not been seen, only in small parts up to 23 WTG will be visible.	Moderate and not significant This is considered as not significant as the WTGs are at least 14 km away from Eyn al Baida. As the visibility is limited, the wind farm cannot be regarded as a prominent feature in the landscape.

Settlement	Sensitivity	Magnitude of change	Effect and significance
Husseiniya	Low	Depending on the area 24 to 26 WTG are seen from this settlement.	Moderate and not significant This is considered as not significant as the WTG are at least 14 km away from Husseiniya. As the landscape is relatively hilly, the visibility is limited and the wind farm cannot be regarded as a prominent feature in the landscape.
Tafila	Low	The wind farm is not visible from Tafila	No Effect

12.6.3 Nature reserves

One nature reserve, the Dana Biosphere Reserve, is located close to the Tafila wind farm. The nature reserve lies in a steep valley stretching from east to west. Accordingly the Tafila wind farm is not visible from the nature reserve. Therefore the impact of the wind farm project is considered to be not significant.

12.6.4 Roads

This section identifies any effects resulting from the proposed wind farm upon the major transport routes in the vicinity of the project site.
There are several elements that affect how views of the proposed wind farm are experienced from the transport routes. These include:

- The direction of travel in relation to the wind farm;
- The landscape of the transport route; for example, a wind farm in a panoramic view will generally have a lesser effect than a wind farm in an enclosed or small scale view;
- The distance of the view; generally, the effect of the wind farm will diminish over distance;
- The backdrop of the turbines; generally, turbines seen against a backdrop of sky or sea will have a lesser effect than those seen against a backdrop of land, if the turbines are front lit. The converse is true if the wind farm is back lit, i.e. silhouetted

The Desert Highway lies approximately 13 km to the east of the Tafila wind farm. It is a north south alignment connecting Jordan's capital Amman with the harbor city of Aqaba.
Within 65 km there is theoretical visibility all along the route, even though not all turbines are visible at the same time. Depending on the location some of the turbines are located behind hills.

The sensitivity to change is considered to be Medium. The magnitude of change is considered to be low due to the distance of the wind farm to the highway, due to the change of theoretical visibility and due to the general travel direction of north-south resulting in a field of view into the same direction. Therefore, the level of visual effect is assessed to be Moderate/Minor.

12.6.5 External lightning

According to the Civil Aviation rules No. 77.33 a 1 existing objects higher than 150 m above ground level are regarded as object affecting navigable airspace. The total height of 34 WTG is 149,9m. Therefore these turbines will require no aviation lights during the operation phase.

12.6.6 Construction and decommissioning

The physical effects of the construction phase of the proposal on the landscape fabric of the application site will be limited due to the relatively small footprint of the turbines, and will be reversible at the end of the operational life of the project. In addition, a series of tracks will be built to provide access to the turbines.

The changes that will occur in the landscape will be the introduction of more human activity together with the short-term introduction and movement of large construction vehicles and associated construction. These activities will affect a small proportion of the overall application site leaving the majority of the existing landform and associated vegetation and soil structure unaffected.

For the above reasons, the construction phase of the proposed development is considered to have a minor and not significant effect on the landscape fabric of the application site.

Effects during the decommissioning phase of the work will be similar to the construction stage, involving an increase in the human activity and heavy plant over a short period of time. Therefore the effects arising at this stage of the project are considered to be minor and not significant.

12.6.7 Visualization

WTGs are often placed at exposed locations to generate the best possible energy yield. Therefore the turbines may get dominant buildings in the landscape. To judge the visual consequences on residents and on the landscape, visualizations are generated. These visualizations give a realistic impression on how the landscape will look like after the wind farm construction.

The visualizations are presented in Figure 12-6 through Figure 12-9.

12.6.8 Impacts of ancillary permanent elements of the proposed wind farm

12.6.8.1 Meteorological mast

A 100 m meteorological mast will be installed in the area of the wind farm. This lattice mast has a diameter of approximately 40 cm. It is fixed into the ground by guy wires. Compared to the WTG this construction will get into a visible background. Therefore a significant effect on the landscape appearance is not expected.

12.6.8.2 Tracks

New tracks connecting the 38 proposed turbines will be required. The material used for the tracks is of the same type of material as the currently existing bedrock. Therefore the new tracks will not silhouette itselves from the surrounding. Furthermore the project area is moderately hilly. Therefore the visibility of the new tracks will be hindered partly.
The magnitude of change is considered to be low given that the tracks fit itselves into the surrounding and that most tracks are hidden. The new tracks will not be adding a new element to this landscape. Therefore the effect of new tracks on the landscape and visual resource is considered to be minor and not significant.

12.6.8.3 Cabling

The cables between turbines and linking to the substation will be undergrounded and routed along the line of new tracks. Only the connection from the substation to the transmission line will be built with overhead cables. A transmission line is running directly through the project site, this overhead cable connection will be approximately 250 meter long.
As the overhead cables string is relatively short and a large scale transmission line already exists on the project site, this visual impact is regarded as minor.

12.7 Residual impacts

12.7.1 Short term impacts during operation

Occasional maintenance work has to be conducted during the operation. This will requires maintenance vehicles and personnel on the wind farm site for a short time.
Once the Tafila wind farm is operating there may be occasional infrequent requirements to repair or replace defective turbines or generators. This will result in large vehicles and cranes being shortly present on site.
Because of their short term nature these impacts are considered to be of small magnitude and not to constitute significant landscape or visual impacts.

12.7.2 Long term impacts

The 38 turbines of the Tafila wind farm will add man-made elements of considerable scale to the landscape establishing a new landmark feature and a point of reference in views from the wider area. Each turbine will be visible permanently in the landscape, accompanied by a crane pad and a road system.

As the area is partly used as farmland, a limited area of agrarian land will be lost. Nevertheless the land in between the WTGs can be utilized on the same usage as before.

The other part of the surrounding landscape is sparse vegetated land with no water bodies.

Table 12-8 lists the residual impacts on the surrounding landscape.

Table 12-8: Residual impacts on the landscape

Regional landscape character area	Sensitivity to the proposed change	Magnitude of change	Impact significance
Agrarian land	Medium	Medium	Moderate
Sparse vegetated land	Low	Medium	Minor

12.8 Mitigation measures

The following mitigation measures have been addressed within the design to mitigate elements of potential landscape and visual impacts.

- The layout of the wind farm was designed to have a minimum visual impact to the landscape;
- Tracks have been designed, as far as possible, to follow and fit with contours in the land. Permanent tracks take the shortest route to the turbine where possible;
- The turbines and all the other aboveground structures will be removed at the end of the operational lifetime.

12.9 Cumulative impacts

The closest planned wind farm is Fujeij wind farm, approximately 12 km south of the planned Tafila wind farm. The planned layout of Fujeij wind farms is not known to the project team.

The whole area south of the Tafila wind farm is moderately hilly. Even though the turbines of Fujeij wind farm will be visible from the Tafila wind farm, the visibility will be limited due to topographic features and the distance.

Therefore cumulative impacts are considered to be minor and not significant.

12.10 Summary

Landscape and visual impact assessment (LVIA) is the part of the ESIA that evaluates the landscape and visual amenity changes that will occur as a result of the planned project.

Given the amount of receptors within the study area, there are relatively few significant effects identified.

Resulting from the topography in more than 50 % of the areas around the project site the WTG will not be seen. The impacts on villages in the surrounding of the project site are judged as not significant as the WTG will only partly be seen. The turbines will not take a predominant building in the visual field of the inhabitants.

The Desert highway, passing the Tafila wind farm in approximately 13 km distance east is not influenced by the turbines. The main viewing direction for the drivers is the north/south direction. Furthermore the turbines will rarely be seen from the Highway.

Dana Biosphere Reserve lies on a slope directed from east to west. The WTG will not be visible from the nature reserve.

The construction phase of the proposed development is considered to have a minor and not significant effect on the erection of the application. The changes that will occur in the landscape will be the introduction of more human activity together with the short-term introduction and movement of large construction vehicles and associated construction. These activities will affect a small proportion of the overall application site leaving the majority of the existing landform and associated vegetation and soil structure unaffected.

To mitigate elements of potential landscape and visual impacts the following mitigation measures have been addressed within the design:

- The layout of the wind farm was designed to have a minimum visual impact and the landscape;
- Tracks have been designed, as far as possible, to follow and fit with contours in the land. Permanent tracks take the shortest route to the turbine where possible;
- The turbines and all the other aboveground structures will be removed at the end of the operational lifetime.

Figures

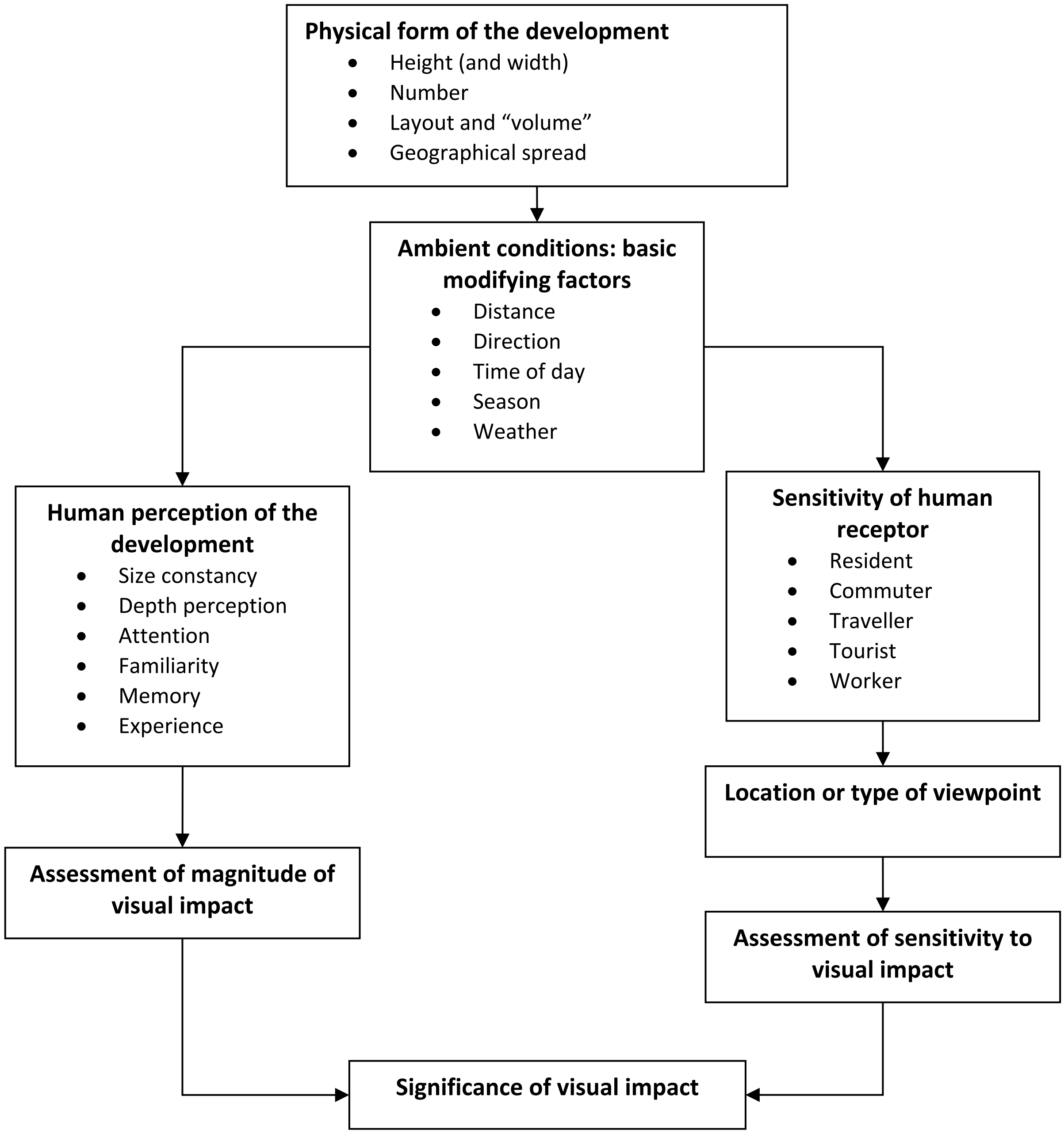


Figure 12-1: Scheme of visual impact assessment

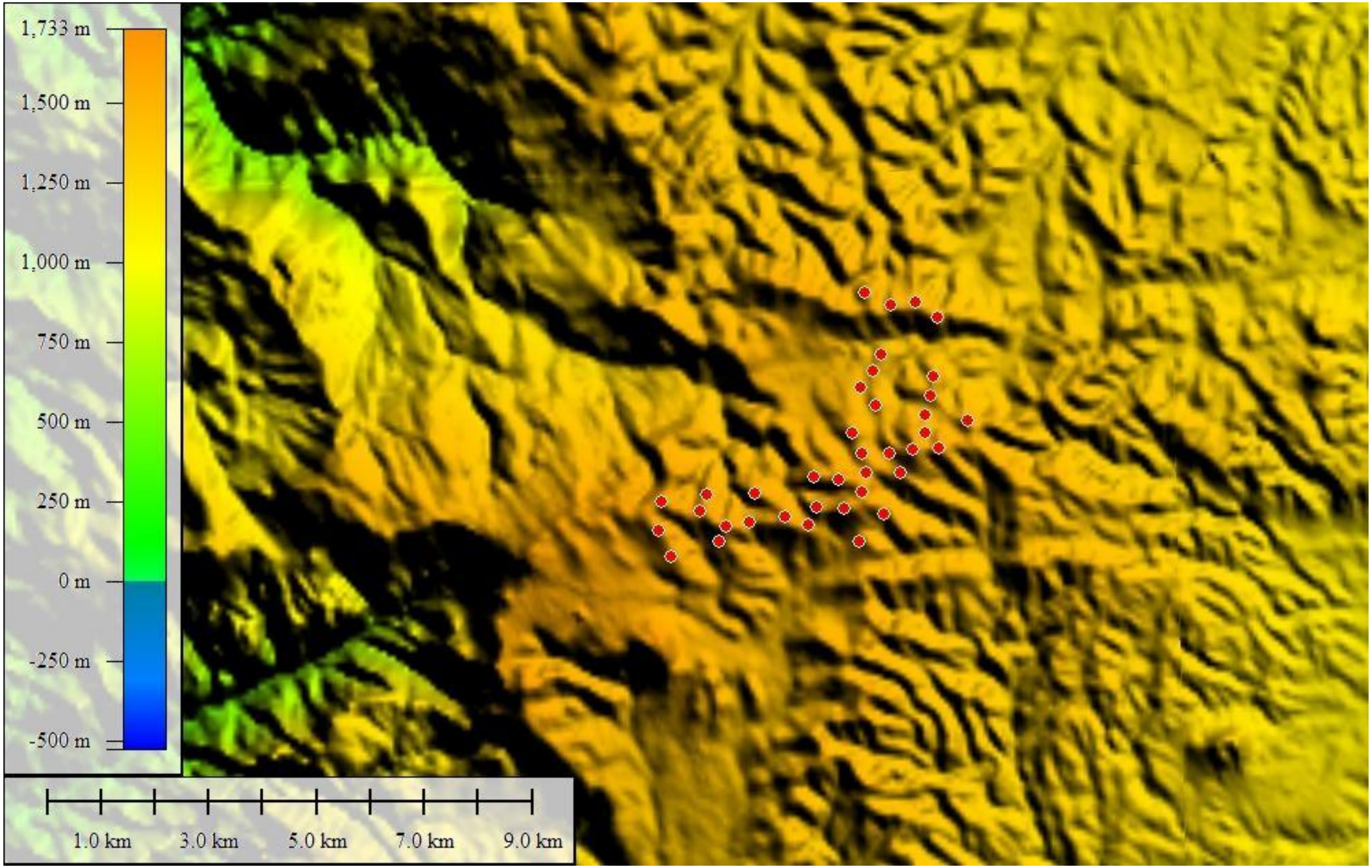


Figure 12-2: Digital elevation model in the Tafila wind farm area

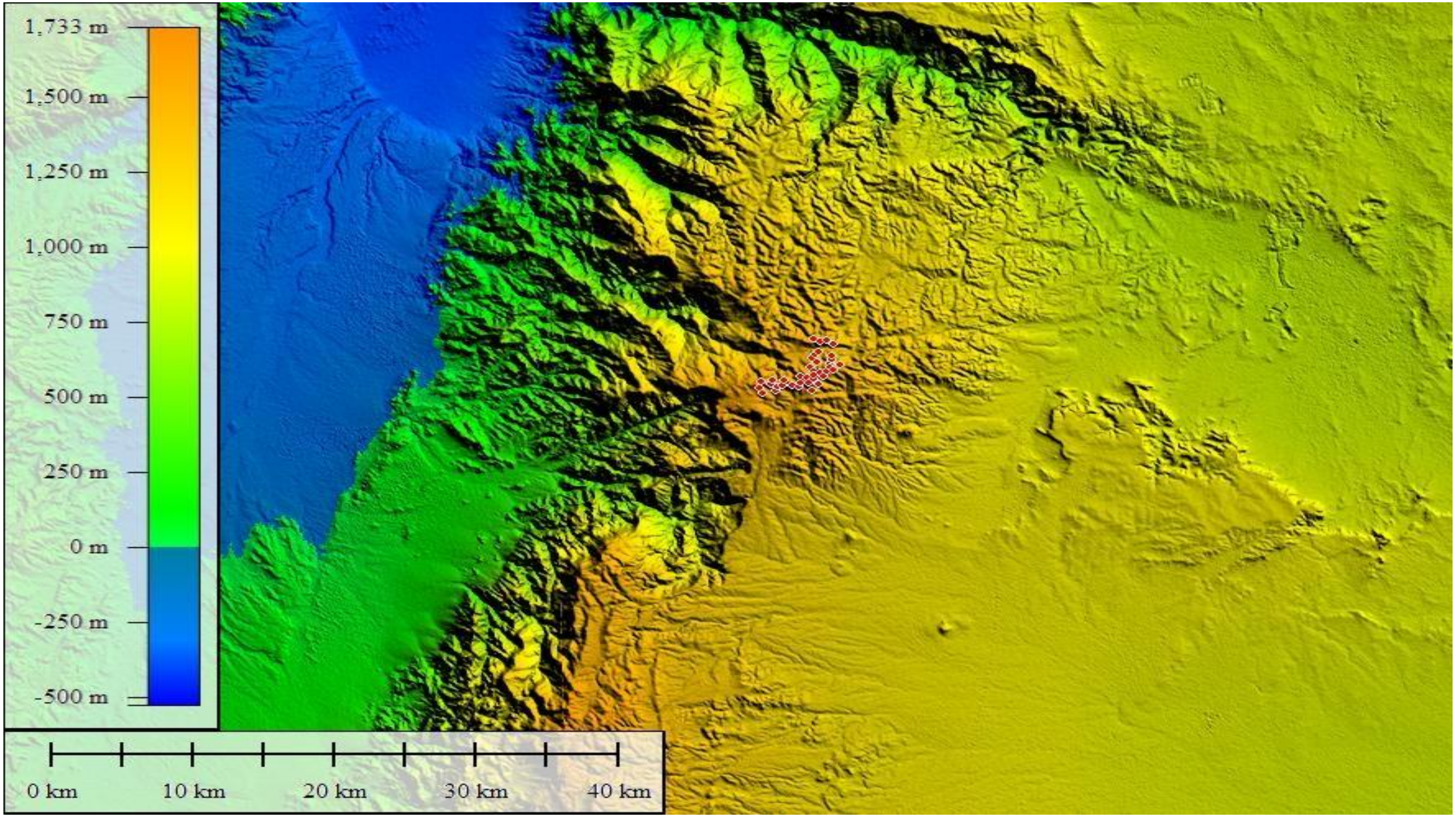


Figure 12-3: Digital elevation model in the study area

Picture·ZVI·10·KM¶

Figure 12-4: Zones of visual impact, radius 10 km around project site

Picture·ZVI·35·KM¶

Figure 12-5: Zones of visual impact, radius 35 km around project site

Visualisation·1¶

Figure 12-6: Visualisation 1

Visualisation·2¶

Figure 12-7: Visualisation 2

Visualisation·2¶

Figure 12-8: Visualisation 3

Visualisation·2¶

Figure 12-9: Visualisation 4

13 Cultural heritage and archaeology

13.1 Introduction

An archaeological survey was carried out by a team of specialists from REEC in order to establish the archaeological baseline data. The baseline is required in order to help the ESIA team to assess actual impacts on the valuable cultural component. Additionally, it is needed to provide relevant authorities with the proper information about archaeological and cultural heritage sites. The collected data, as well as data from a literature review, was used to evaluate the wind farm’s potential impact on cultural heritage and archaeology issues.

The main objectives of the archaeology and cultural heritage study are:

- Survey and investigate the entire project area for archaeological sites;
- Predict and characterize and evaluate the intensity of impacts;
- Determine proper measures necessary to avoid or mitigate likely impacts.

The results of the archaeological survey show that archaeological artifacts and remains are widely spread and common on the wind farm site. Accordingly, the former locations of a number of WTG are in conflict with archaeological findings. Therefore, alternative locations have been proposed and proper mitigation measures to protect all the archaeological sites will be implemented adequately during the construction phase.

13.2 Objectives

The objectives of the cultural heritage and archaeology survey are:

- To identify the archeological sites and collect data about cultural heritage of the study area within the area of the project;
- To identify the sites and cultural heritage aspects that may be affected by the project;
- To define the necessary avoidance or mitigation measures to minimize the potential impacts on from the project.

13.3 Guidance

Based on Antiquities Law No. 21 of 1988 and its amendment, it is important to comply with articles 13 and 14, which relate directly to the current project. These articles will be considered in the project construction phase.

Article 13 of the law states that:

- It is prohibited to license the establishment of any structure including the buildings and walls from any antiquities. No compensation is accepted for that. Also, such buildings and walls should be approximately 5-25 meters away from any antiquities;
- It is permissible, by a recommendation from the director and the decision of the minister, to increase the distance mentioned in paragraph "a" of this article if necessity requires in any of the following cases:
  - The protection or maintenance of the antique site;
  - The expansion of the antique site;
  - To ensure that the antique site is not obscured by any construction;
  - It is prohibited to set up any heavy or dangerous industries, lime furnaces or stone quarries at a distance less than one kilometer from the location of the antique site. In all cases, prior approval of the department shall be given before inviting offers or awarding tenders for engineering services, design and sketches and preparing the documents of public and private projects tenders".

Article 14 of the Law states that, “despite the priority of any other law, no person or entity will be allowed to carry out any excavations in antique sites in search of gold or other hidden treasures".

13.4 Methodology

The basic methodology for this section consisted of the following steps:

- Scoping and consultation to

decide which effects to exclude from the scope of the assessment:

- Assess baseline status of non-excluded effects;
  - Literature review;
  - Field investigation;
  - Documentation, including photographs;
  - Data analysis;
- Assess impact of effects;
- Recommend avoidance or mitigation measures.

In the impact assessment, the law of antiquities is adhered to. The law states that any kind of finding is considered important and should be treated as cultural heritage. An archeologist should be involved and his knowledge should be used to evaluate the level of importance according to the status/significance of the discovered site in terms of its uniqueness, completeness and damage level.

13.4.1 Scoping and consultation

The major issues and concerns raised at the scoping session regarding archaeology and cultural heritage during construction phase were:

- Possible damage of cultural heritage sites due to construction activities;
- The discovery of archaeological remains while excavation in the project sites;
- Impact of the workers' accommodation and the movement of vehicles on cultural heritage sites.

The following baseline date was compiled for the ESIA:

- Location, nature and extent of historical valuable sites;
- An evaluation of the sensitivity and value of historical sites.

Measures were already made since the individual turbine locations were adjusted in order to avoid archeological sites (see chapter 13).

13.4.2 Effects scoped out of the assessment

Impacts during decommissioning have been scoped out of the archaeological assessment, since possible impacts during decommissioning are considered to be similar to those in the construction phase, but much smaller in scale. As the decommissioning stage is approached, the situation will be reassessed and proper measures will be set.

13.4.3 Literature survey

The available references that are related to the study and database and information were reviewed, including:

- Jordan Antiquities Database and Information System (JADIS)-Department of Antiquities of Jordan (DAJ);
- Library of American Centre for Oriental Research (ACOR);
- British Council for Research in Levant (BCRL).

13.4.4 Field survey

The study team investigated the project area on 23rd July, 2012 with focus on the locations of the wind turbines. The excavations for the foundations of the towers will be the deepest and largest excavations on site. These were surveyed on foot for a diameter of 50 m. If a planned turbine site was found to be important from an archaeological perspective, the archaeologist proposed a nearby site with lesser impacts.

13.4.5 Photographic documentation

To document any findings, photos and GPS-coordinates were taken of each archaeological site that was found.

13.4.6 Data analysis

The different sites where analyzed according to the following criteria:

- Age of each cultural heritage finding;
- Historical use of finding.

Where archaeological finding on the site of a planned wind farm are found important, a different site is recommended; either by shifting the turbine to an acceptable distance or selecting an alternative and acceptable site.

13.4.7 Impact assessment

The likely impact of the project on all findings was determined. Where these impacts were found to be significant, a different turbine location is recommended.

13.5 Baseline

13.5.1 History of the project site

As in other parts of the Levant[4], signs of habitation in Tafila Governorate have been found dating from the Paleolithic periods. Human presence in the area has been continuous since the Roman age. Further villages can be dated back to the Byzantine and Islamic times, including burial sites and farmsteads.
The oldest known civilization which established a kingdom in Tafila was that of the Edomites. The city of Tafila lies on the ruins of the Edomite city of Tophel. The capital of Edom was at Bseira, 23 km south of the place where Tafila is today. The Edomites often allied with their neighbors in Moab.

[4] The Levant is a geographic and cultural term referring to the region of the "eastern Mediterranean littoral between Anatolia and Egypt". The Levant includes most of modern Lebanon, Syria, Jordan, Israel, Palestine, Cyprus, Turkey's Hatay Province and sometimes Iraq or the Sinai Peninsula, and corresponds roughly to the historic area of Greater Syria.

The current Tafila Governorate was annexed to the Nabatean kingdom, with its capital at Petra. This city became prosperous during the Nabatean period. After the Roman invasion, the former capital was ruled by the Ghassanids, under Rome's authority. During the Roman period the area around Tafila was called Dee-Tifolis. Tafila then came under Muslim rule and afterwards it was for a brief period of time under the Crusader's reign [13-2]. Table 13-1 shows the above historical sequence.

Table 13-1: The historical sequence of Tafila province

Periods	Years
Lower Palaeolithic period	500,000 – 90,000 B.C
Middle Palaeolithic period	90,000 – 43,000 B.C
Upper Palaeolithic period	43,000 – 18,000 B.C
Epi Palaeolithic period	18,000 – 10,000 B.C
Natufian period	10,000 – 8,000 B.C
Neolithic period	8,000 - 4,250 B.C
Chalcolithic period	4,250 – 3,300 B.C
Bronze Ages period	3,300 – 12,000 B.C
Iron Ages period (Edomites period)	12,000 – 539 B.C
Persian period	539 – 332 B.C
Hellenistic period	332 – 63 B.C
Nabataean and Roman period	63 B.C – 324 A.D
Byzantiane period	324 – 640 A.D
Umayyad period	661 – 750 A.D
Ababasid period	750 – 969 A.D
Fattmd period	969 – 1161 A.D
Crusaden period	1044 – 1291 A.D
Ayyobid period	1174 – 1263 A.D
Mamluk period	1250 – 1516 A.D
Turkish / Ottoman period	1516 – 1918 A.D
The Hashemite Period	1918

The historical development of the region has resulted in a number of cultural heritage sites. The best-known sites are (Figure 13-1 through Figure 13-8):

- Kurbat Al-Tannoor, a volcanic mountain with Kurba and Nabatean temples at the summit;
- Kurbat Al-Dareeh, a former Nabatean settlement that has provided many discoveries, such as a Nabatean temple, tombs, and homes;
- A castle of Edomites origin, later it was rebuilt by the Nabateans. After occupation by the crusaders, the Mamluks expanded it to a high castle;

- Bseira, the capitol of the Edimotes. It is located 22 km to the south of Tafila city and was home to the tomb of Al-Harith Bin Al-Omeir. He was the messenger of Mohammad the Prophet to Sharhabil Bin Amr Al-Ghassani (the King of Basra). Al-Ghassani ordered the messenger to be killed, which lead to the battle of Mu'tah;
- Al-Jodammi Tomb, the tomb of Farwa Bin Amra Al-Joddami, who died as martyr at the hands of Al-Harith Al-Ghassani and Hercules, the Roman Caesar;
- Al-Sal', a castle east of Tafila city. Some Edomite ruins as well as Nabatean tombs were found in the castle of Sal';
- The Mosque of Al-Hameedi, located in the town center. It was built in the late Ottoman period;
- Wadi Feenan, a valley that meets at the end of the Dana Valley (Wadi Dana). This valley was used as a copper mine during the Bronze and Iron Ages as well as during the time of the Nabateans, the Romans, and the Byzantines;
- Gharandil, a name which was mentioned in Islamic sources. It is an area located a short distance south of Tafila. After its discovery, Gharandil was reused by Muslims. A church covered with mosaics was later discovered during excavations in Gharandil. It also includes a small Roman fort and bath complex.

13.5.2 Gharandil area

As previously mentioned, the project area is east of the town of Gharandil. Gharandil is located to the south of Tafila city at a distance of 23 km. It was called Arndela in the Romanian period, Ardila in the Byzantine period and Gharandil in the Islamic period. It is located on a hill comprised of five archaeological layers and can trace its assets back to the Nabatean period. The archaeological excavations conducted in the area revealed a Byzantine church covered with colorful mosaic floors. Recently, excavations discovered a Roman castellum, bath and aqueduct at 'Ayn Gharandil.

13.5.2.1 'Ayn Gharandil

The site of 'Ayn Gharandil (Figure 13-9 and Figure 13-10) is located 100 km north of the gulf of Aqaba and some 40 km south-west of Petra on the eastern edge of the Wadi Arabah. The ruins rest alongside a modern paved road running east from the nearby Dead Sea Highway. The presence of an artesian spring in the mouth of the nearby Wadi Gharandil, which still flows abundantly today, presumably served as the reason for human occupation at the site. The site was inhabited in the Roman/Byzantine, Nabatean, Early Islamic periods.

13.5.3 Field surveys

The archaeological survey around the project site revealed the remains of watch towers on the top of the mountains and remains of a castle in the western area of the project area. In such areas one can easily see the remains of pottery, likely from the Byzantine era (see Figure 13-11 through Figure 13-13).

On the other hand, the archaeological survey revealed the existence of a number of archaeological sites, which would be distributed if the planned turbine positions were not changed.

According to Antiquities Law, No.21, Year 1988 and its amendment, the disturbance of archaeological sites by any building activity is prohibited. Therefore, alternative locations have been proposed to 16 planned turbine sites (see Table 8-2). In general it can be said that the project area is rich in historical artifacts. Thus, proper mitigation measures will be implemented adequately during the construction phase (particularly during the excavation processes) for building the concrete base of the towers, for building new roads and for building the transmission line and transformer station.

13.6 Impact assessment

It is most likely that the project will be visible when standing at archaeological- and cultural heritage sites. Therefore it may affect their settings, which is evaluated in chapter 12. Other potential effects on cultural heritage locations during construction include:

- The presence of building material and construction equipment in the landscape is not considered to have significant effects on the cultural heritage. No mitigation measures are proposed;
- The access roads to the turbines have been planned upon the presence of archaeological remains. Therefore mitigation measures are not needed except for monitoring during construction phase, where excavations may unearth archaeological artifacts not visible during this field survey;
- It is possible that further archaeological remains will be found during excavations. Therefore archaeological supervision of excavation activity is proposed. Once work has progressed to the point where no archaeology will be affected the supervision will cease.
- Direct effects on presently unrecorded archaeology are possible. Although there is some potential for remains to exist within the site, it is likely that direct effects on any important remains identified will be avoided through mitigation.

During operation the site could be disturbed by maintenance and repair activities, if maintenance personnel do not use the provided access roads. Personnel will, therefore, be instructed to not stray from the access roads and, therefore, significant impacts on cultural heritage are not likely. Mitigation measures are not considered.

Table 13-2 presents the determined archaeological sites and their effects of the project as well as giving a solution for an alternative position, if the current turbine location has been determined to be of cultural value. Turbine 21 and 37 were completely relocated to another site.

Table 13-2: Archaeological survey findings and recommendations

Point	Original coordinates		Proposed coordinates		Remarks/ mitigation measures where required
	X	Y	X	Y	
WTG 001	753803	3398340	753873.711	3398269.3	The point is located on the archaeological wall back to the early Bronze period. It is recommended to shift the turbine 100 meters to the southeast
WTG 002	753876	3398861	753776	3398861	Point surrounded by four destroyed burials: three from the east and one from the west. It is recommended to shift the turbine 100 meters to the west of the western burial site.
WTG 003	754032	3397860			There are no archaeological remains.
WTG 004	754586	3398705			There are no archaeological remains.
WTG 005	754700	3398990			There are no archaeological remains.
WTG 006	754926	3398125	754826	3398125	There are no archaeological remains directly on the site. Nevertheless the site is clasped by archaeological sites, just 200 meters from the point. It is recommended to shift the turbine 100 meters to the west.
WTG 007	755024	3398402	755074	3398402	No archaeological remains except of two grubbed burials to the north and south of the point. It is recommended to shift the turbine 50 meters to the west.
WTG 008	755491	3398488	755349.579	3398346.6	There are remnants of ancient destroyed walls. It is recommended to shift the turbine200 meters to the south-west.
WTG 009	755601	3399032	755601	3399032	No archaeological remains. There is an ancient destroyed burial site 70 meters to the east of the point and another one 50 meters to the west. It is recommended to shift the turbine to the given coordinates.
WTG 010	756153	3398585	756259.066	3398478.9	There are no archaeological remains except of remnants of buildings visible on the surface, approximately 50 meters to the west. We recommend a displacement of 150 meters to the south-east. The access to the site should be from the east.
WTG 011	756576	3398450			No archaeological remains.
WTG 012	756686	3399337			No archaeological remains.
WTG 013	756744	3398762			No archaeological remains.
WTG 014	757143	3399281	757143	3399081	There are ancient destroyed burial sites, probably from the bronze age. It is recommended to shift the turbine 200 meters to the south.

Point	Original coordinates		Proposed coordinates		Remarks/ mitigation measures where required
	X	Y	X	Y	
WTG 015	757263	3398754	757404.422	3398612.6	Grubbed burial sites are around the proposed turbine position. It is recommended to shift the turbine 200 meters to the southwest.
WTG 016	757396	3400152	757396	3400302	There are some destructive fences and piles of rocks with no clear historical remains. It is recommended to shift the turbine150 meters to the north.
WTG 017	757538	3398132			No archaeological remains.
WTG 018	757562	3400984			No archaeological remains.
WTG 019	757575	3399060			No archaeological remains.
WTG 020	757581	3399756			No archaeological remains.
WTG 021	757635	3402751	Do not build any turbine close to this site.		Land with remains of complete settlement. It is not recommended to start any activity at this site.
WTG 022	757658	3399410			No archaeological remains.
WTG 023	757794	3401282			No archaeological remains.
WTG 024	757835	3400659			No archaeological remains.
WTG 025	757941	3401596			No archaeological remains.
WTG 026	757997	3398642			o archaeological remains.
WTG 027	758092	3399750	758092	3399950	The point is located 400 meters from an archaeological quarry. It is recommended to displace the turbine200 meters to the north to secure the distance from the quarry.
WTG 028	758106	3402511			No archaeological remains.
WTG 029	758296	3399404	758296	3399454	An excavated burial site is located at a distance of 30 meters. It is recommended to shift the turbine50 meters to the north.
WTG 030	758526	3399833			No archaeological remains.
WTG 031	758577	3402570			No archaeological remains.
WTG 032	758745	3400485			No archaeological remains.
WTG 033	758763	3400147			No archaeological remains.
WTG 034	758854	3400844	758854	3400914	There are remnants of graves and remains of destroyed walls. It is recommended to shift the turbine 70 meters to the north.
WTG 035	758896	3401187			No archaeological remains.
WTG 036	758969	3402282			No archaeological remains.

Point	Original coordinates		Proposed coordinates		Remarks/ mitigation measures where required
	X	Y	X	Y	
WTG 037	759018	3399873	Do not build any turbine close to this site.		There is a complete archaeological site and remains of Roman walls and burial sites. It is not recommended to start any activity at this site. Furthermore the project should stay away for a distance of 1 km to the southwest of the point.
WTG 038	759533	3400367	759533	3400567	There is a fence of a grubbed burial. It is recommended to shift the turbine 200 meters north.

13.7 Mitigation measures

The turbine locations found to effect cultural heritage and archaeological remains are relocated to areas with no archaeological valuable remainings. The recommendations, proposed in Table 13-2, were considered in the final layout, for the turbines as well as for the site roads.

Any archaeological finding must be treated with care and may not be moved, destroyed or somehow differently handled. Special caution should be exercised during construction activities in order to reduce the potential indirect negative impacts on archaeological and heritage sites.

Table 13-3 and Table 13-4 list the effects and mitigation measures for the construction and the operation phase.

Table 13-3: Assessment of effects during construction

Effect	Timescale of effect	Mitigation measure	Significance of residual effect
Direct vehicle impact on archaeological remaining, such as compaction, disturbance, wheel-slip, collision.	Throughout the life of the project.	Identification of sensitive areas to contractors [MM66]; Keep vehicles on the construction site and on the tracks. [MM67]	High if an item of National or International significance is found.
Removal of archaeological layers by excavation	Permanent	Avoidance of known sensitive areas [MM68] Watching brief on excavations [MM69]	High if an item of National or International significance is found.
Vibration from vehicles	Permanent	Keep vehicles on the construction site and on the tracks. [MM67]	Medium
Visible presence of construction compounds, crane pads, substations, machinery and vehicles	Temporary		Low
Creation of tracks and routes	Temporary	Instruct contractor to stay on the construction site and on the tracks [MM71]	Low

Table 13-4: Assessment of effects during operation

Effect	Timescale of effect	Mitigation measure	Significance of residual effect
Visible presence of turbines, track-ways, crane pads, etc.	Throughout the life of the project.	Design features for minimum impacts [MM72]	Medium
Direct impacts on archaeological sites	Throughout the life of the project.	Keep vehicles on the construction site and on the tracks. [MM67]	Very low

In addition to relocation of turbines sites to non-historic valuable sites it is essential to provide strict instructions to the contractor. Graveled areas such as roads, crane pads and site compound are not to be left by any worker unless this is required during the construction (e.g. movement of cranes, laying of cables). In cases where activities besides the graveled areas are necessary, supervision will be ensured.

Historical artifacts are plentiful in the project area. Therefore, any disturbance must be kept to a minimum. The new construction of roads has been considered carefully and the extent of any construction activity will be constructed as non-destructively as possible.

Any activities will be immediately stopped in case of discovering any antiquities or archeological items during construction. A professional opinion will be obtained on whether the remains can be removed, or whether the find is so significant that the works must be suspended, relocated or even be cancelled. Furthermore each activity must be done carefully to prevent damage on valuable historical artifacts.

Any discoveries will be reported directly to the Director of Department of Antiquities or to the nearest Public Security Center. The Department of Antiquities may in such cases recommend measures to protect the discovered items. Furthermore, to ensure proper management of this aspect, it is recommended to coordinate directly with the local department of antiquities on every stage of construction work involving excavations.

13.8 Cumulative impacts

Cumulative effects are long-term changes that may occur as a result of the combined effects of successive actions on the environment. These effects may be significant even though, when independently assessed, they are considered insignificant.

The assessment of cumulative effects is best practice in conducting environmental assessments. At the time of this study, one further wind farm in the vicinity is in the development process. The archaeological discoveries on the Tafila wind farm site are of small scale, being so far fully located within the boundary of Tafila wind farm. Large findings with effects on a large area are not expected. Nevertheless these might be found during construction work. Therefore the current expected cumulative effects are regarded as negligible.

13.9 Summary

This chapter of ESIA has addressed the environmental effects of the construction and operation phases of the wind farm on the archaeology and cultural heritage. The information to date has shown that a number of archaeological sites were avoided for turbines or roads by relocating both to other sites. Alternative locations have been proposed for 14 of the planned turbine sites. Two turbines have been relocated completely. In general, it can be said that the project area is rich in historical artifacts and that there is, consequently, a chance of finding archaeological remains during the project construction. Thus every effort will be made to do monitoring during the construction phase and to mitigate the impacts on archaeological artifacts.

13.10 References

[13-1] 'Ayn Gharandil Archaeological Project, American Center of Oriental Research (ACOR), Amman , 2011, Department of Antiquities of Jordan

[13-2] Al-Anbat, Bait, 2012: The Arab Forum For Cultural Interaction, http://www.baitalanbat.org/home.asp?mode=page&pageID=105&lang=eng, Last access: 27th September, 2012

Figures

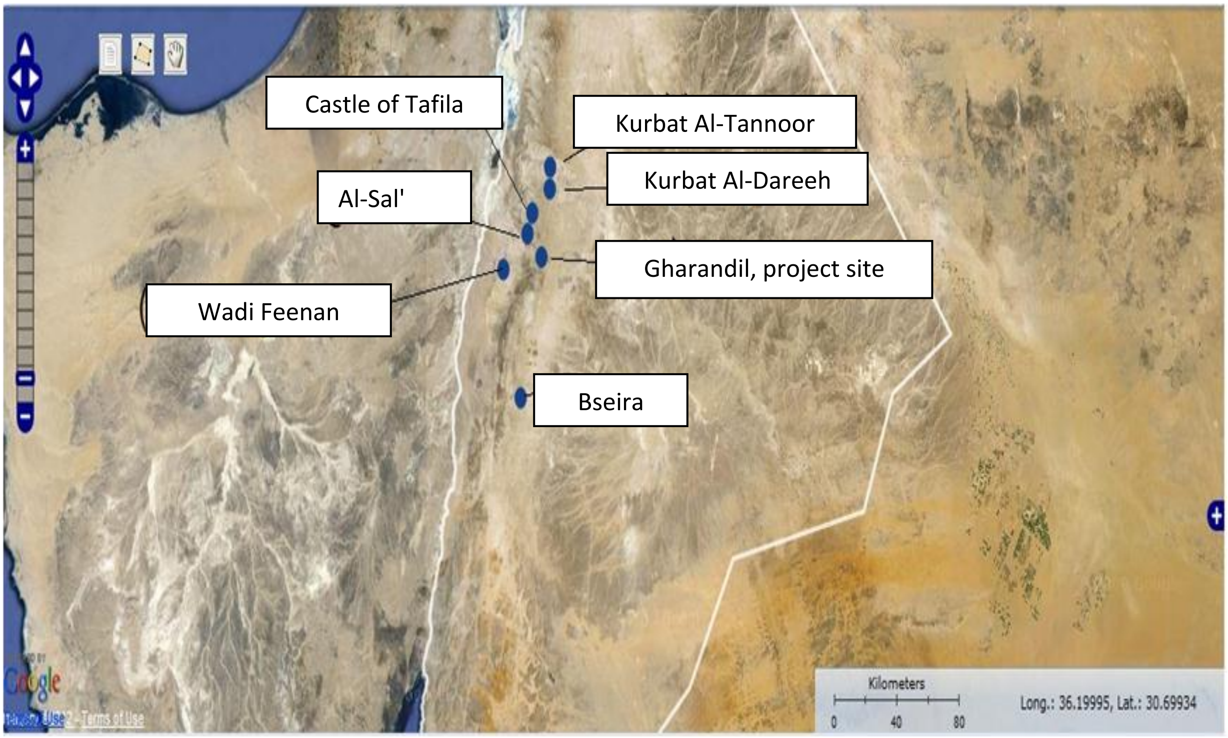


Figure 13-1: The best-known archaeological sites at Tafila

Figure 13-2: The location of Kurbat Al-Tannoor

Figure 13-3: The location of Kurbat Al-Dareeh

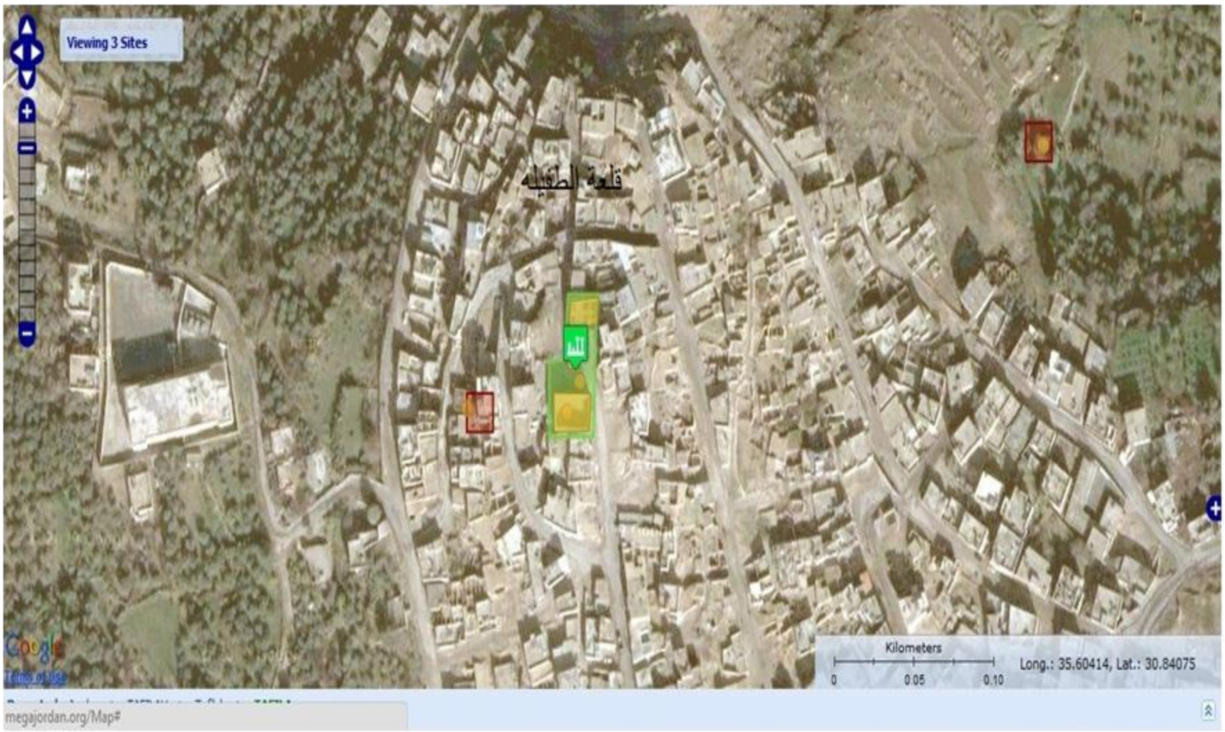


Figure 13-4: The castle of Tafila

Figure 13-5: The location of Bseira

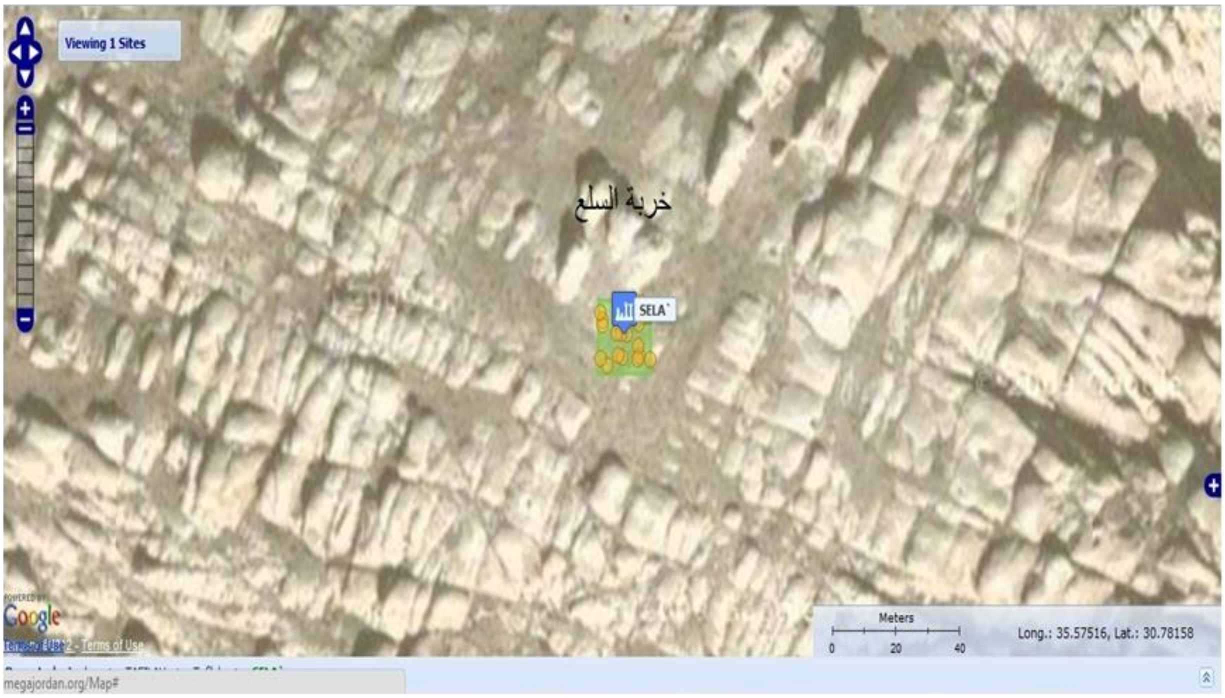


Figure 13-6: The location of Al-Sal'

Figure 13-7: The location of Wadi Feenan

Figure 13-8: The location of Gharandil


Figure 13-9: ´Ayn Gharandil Oasis

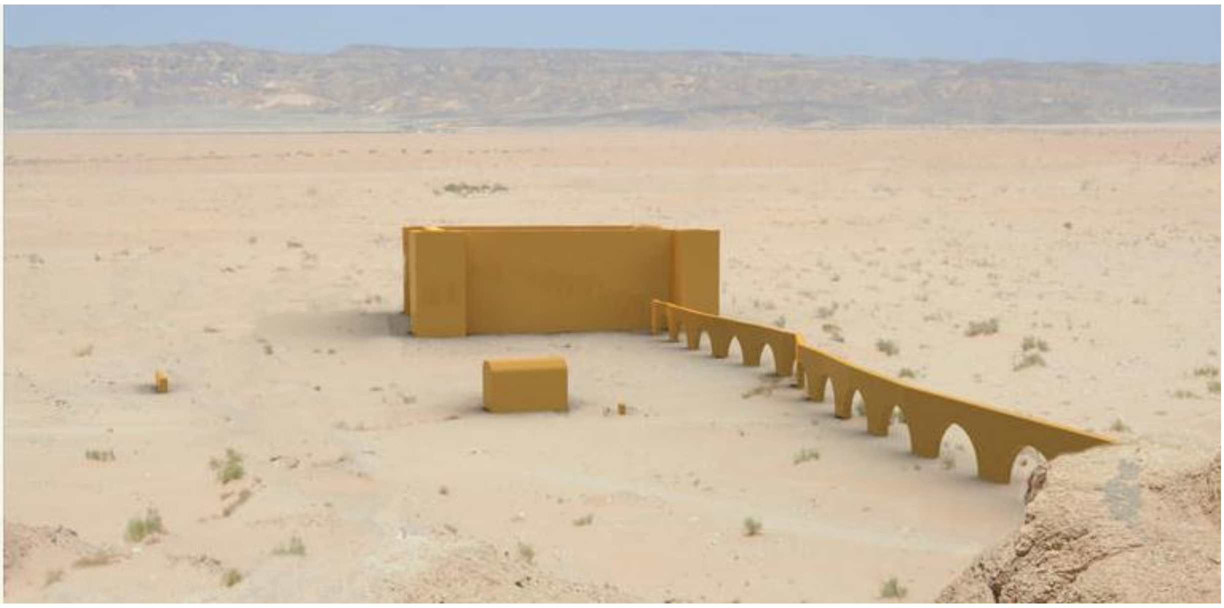


Figure 13-10: 3-D model of a Roman castellum, bath and aqueduct at ´Ayn Gharandil

Figure 13-11: Remains of pottery

Figure 13-12: Remains of a castle in the study area

Figure 13-13: Remains of a castle in the study area

14 Traffic and transport

14.1 Introduction

This section of the ESIA assesses the social and environmental impact of traffic and transportation in relation to the proposed wind farm. This is done for the construction, operation and decommissioning phases.

The main effects in this respect will be due to the heavy goods vehicles (HGV) which will enter and exit the site during the construction and decommissioning phases of the wind farm. Consequently, these vehicles represent the focus of this assessment.

Once the wind farm is operational, the amount of traffic associated with the wind farm will be minimal and HGV will appear on site only in exceptional cases. During the operational phase, only occasional maintenance and repairs will generate a small amount of traffic. At end of the wind farm's lifetime, the turbines will be dismantled and removed from the site. The traffic will likely be less than during the construction phase, due to fact that some of the construction materials will remain on site. The study, therefore, focuses on the transportation of the large turbine components to the site and the HGV traffic generated by transporting the buildings materials to the site.

14.2 Objectives

The following objectives were agreed for the assessment on traffic and transport:

- To identify the access routes to the proposed project area and the internal roads;
- To assess impacts of project activities on traffic issues.

14.3 Guidance

On a national level there is no guidance on the environmental and social impact assessment of traffic and transportation. Therefore, the methodology for this study was derived from the "Guidelines for the Environmental Assessment of Road Traffic (1993)" elaborated by the Institute of Environmental Assessment (IEA). These guidelines are industry-standard and internationally accepted.

14.4 Policy context

The following national policies relevant to the transport assessment were identified:

- Environment Protection Law, No.52, year 2006;

Relevance for proposed wind farm: the project must comply with the act [Environment Protection Law, No.52, year 2006], which outlines the necessity of preserving living and non-living environmental components.

- Regulation of Environmental Impact Assessment (EIA), No.37, Year 2005;

Relevance for proposed wind farm: Regulation [Regulation of Environmental Impact Assessment (EIA), No.37, Year 2005] establishes the requirement(s) to perform an EIA, based on the type and size of a project. It lists the elements that should be included in an EIA report and the steps that will be followed in preparing an EIA. It also organizes the reviewing process of the EIA study.

- Transport Law, No. 89, Year 2003;

Relevance for proposed wind farm: Article (3/C) of the above mentioned law indicates that the Ministry of Transport will contribute to the protection of the environment, in cooperation with the relevant authorities, and raise the level of public safety awareness surrounding transport.

- Law of Traffic, No. 49, Year 2008.

Relevance for proposed wind farm: Law of Traffic, No.49, Year 2008 outlines how vehicles should be licensed, characterized, and described, particularly as it relates to transport of materials and goods.

14.5 Scoping and consultation

The following points were considered during the scoping meeting on the 5th December, 2011 in the Holiday Inn Hotel in Amman as potential environmental and social impacts, which can be triggered by the movement of vehicles and transportation of large components.

- Noise;
- Stress on infrastructure;
- Air quality.

14.6 Effects to be assessed

The assessment focuses on potential effects during the construction phase of the wind energy project. Derived from the IEA guidelines the following effects were considered:

14.6.1 Noise

Noise levels are greatly influenced by the volume of the traffic. As a simple rule, it can be assumed that a 100 % increase of the traffic flow produces a 3 dB (A) change in noise level [14-1]. In the case of high existing traffic flows, an increase in traffic flows is unlikely to produce noticeable changes in perceived noise stress.

14.6.2 Vibration

Airborne vibration may lead to effects like window rattling. Its effects are geographically limited to people living adjacent to roads with a substantial increase of HGV traffic. However research studies have so far been unable to link vibrations conducted through the ground to structural damage to nearby properties [14-1].

14.6.3 Visual effects

Visual effects in terms of traffic refers to blocking of views by structures but also covers the more subjective impact by traffic on an area of scenic beauty.

14.6.4 Severance

Severance is defined by the IEA guidelines as „the perceived division that can occur within a community when it becomes separated by a major traffic artery“ [14-1]. Severance can result from the difficulty of crossing a road with high traffic or by a physical barrier created by the road itself. Severance effects can apply for residents, motorists or pedestrians.

14.6.5 Driver delay

Additional traffic generated by a development may cause delays to non-development traffic. According to the IEA guidelines these delays are only likely to be significant, when the traffic in the study area is already at, or close to, the capacity of the system.

14.6.6 Pedestrian delay

Changes in traffic volume may affect the ability of pedestrians to cross roads. In general terms, increases in traffic levels are likely to lead to greater increases in delay. The IEA guidelines state as the lower threshold of hindrance to pedestrians a two-way flow of about 1,400 vehicles per hour on a roadway with no dedicated pedestrian crossing.

14.6.7 Fear and intimidation

The impact of fear intimidation depends on the volume of traffic, its composition in terms of HGV, its proximity to people or lack of protection caused by factors as narrow pavements etc. The IEA guidelines state that there is no commonly agreed threshold for estimating this effect.

14.6.8 Safety

Changes in traffic flow and composition may have implications on the local road network and may elevate or lessen the risk of accidents.

14.6.9 Hazardous loads

Loads which are classified as hazardous must be subjected to under special handling procedures.

14.6.10 Air pollution

Air polution considers the exhaust produced by vehicles. It depends on the volume, speed and operational chracteristics of the individual vehicles.

14.6.11 Dust and dirt

Dust and dirt is produced by particles dispersed from the ground by vehicle monements. The impact of dust and dirt depends on the nature of the roads, the materials to be transported, the frequency of vehicle movements and the weather conditions.

Increased wear on roadways is also a possible impact of the wind farm, but it is not possible to quantify the magnitude of impact in relation to wear on the roads [14-1]. Wear on the physical structure of a road is a result of vehicle axle weight (the weight imposed by each axle, rather than the overall vehicle weight), the frequency of the effect and the condition of the roads themselves. It is assumed that the preferred routes are considered to be suitable for the regular passage of HGV and that each change in routes considers the suitability for regular HGV.

14.7 Effects scoped out of assessment

The lifetime of a wind farm is split into three stages: construction, operation and decommissioning. Each of these varies in the way it impacts traffic of the surrounding area.

The main impact is to be expected during the construction and the decommissioning of the wind farm. However, it is assumed that traffic generated by the decommissioning of the wind farm will be of smaller scale compared to the construction traffic. This is due to the fact that the construction materials will not be fully removed from the site. For instance, the concrete for the foundation which accounts for the high peaks of vehicle movements during the construction will not be fully removed from the site. As stated in the scoping report, the turbine foundation will be removed to a depth of approximately 1 m and backfilled with soil.

The operation phase will, however, have a much smaller impact than construction and decommission. Maintenance vehicles are standard passenger vans that can access the site easily. The passenger vans typically come to the site about twice per year for scheduled maintenance, which does not represent a noticeable effect on the total number of vehicles. HGV will appear on site only in exceptional cases in case main components of the wind farm need to be replaced or repaired. Consequently, the assessment will focus on the construction phase and the other two phases are scoped out of this report.

14.8 Methodology

14.8.1 Overview

The assessment methodology was derived from the IEA's "Guidelines for the Environmental Assessment of Road Traffic (1993)" which also addresses the points raised at the scoping meeting. In accordance with this guideline, the methodology employed focuses on:

- Potential impacts on local roads and the users of those roads;
- Potential impacts on land uses and environmental resources adjoining those roads, including relevant residents and users.

Demographic groups, locations and areas which may be sensitive to changes in traffic conditions are defined in the IEA guidelines, as these should be especially carefully considered in the assessment.

Table 14-1: Affected demographic groups, locations and areas

Affected demographic groups	Affected locations and areas
Sensitive groups: children, elderly, disabled	Private homes
People at home	Schools
People at workplaces	Hospitals
Pedestrians	Mosques, churches
Cyclists	Historical buildings
	Recreational areas
	Sites of ecological/ nature conservation value
	Sites of visitor/tourist attraction
	Site where traffic accidents are known to occur frequently

To determine the impacts of traffic, different aspects must be assessed:

- Type of loads to be transported (dimensions, weights);
- Which route will be used by vehicles approaching the site;
- The estimated number of vehicles which travel the access route at any given point in time.

The traffic on the internal wind park roads is not assessed in detail in this chapter. Since the wind farm roads are located at a distance of more than 1_km to the closest dwelling, no impacts are anticipated.

Potential impacts due to dust are covered in Chapter 10. In parts of the wind farm area there are agriculture related activities and livestock farming. However, these activities cannot be assigned to a certain location and therefore not assessed using the IEA guidelines. Therefore, only a general assessment of potential impacts can be made for the entire internal road layout.

14.8.1.1 Route

When determining the access route to a wind farm site, a number of issues must be considered in order to reduce the impact as far as possible:

- Determine a suitable port or train station for delivery of turbine components;
- Minimize the length of the route where possible;
- Where possible, use established and large roads and avoid smaller and less frequented roads, as these are often more sensitive to an increase in vehicle numbers;
- Determine technical conditions of roads and bridges with regard to load-bearing capacity;
- Assess the feasibility of delivering turbine components with exceptional load vehicles.

The routes are considered from the point of origin to the site entrance of the wind farm. In case the goods will be brought to Jordan by vessel, the nearest port will be considered as point of origin.

14.8.1.2 Number of vehicles

The number of vehicles that travel to the site at any point in time depends on the type of works being performed on site at that time. Consequently, the first step is to determine the amount of work required on the site itself. This means determining the length of new roads to be constructed, the size and number of the foundations to be built and the length of cable to be laid and estimating the number of transports for delivery of WTG and electrical components. In those instances where precise information is not yet available, standard conditions have been assumed. Construction materials which are considered in order to establish the vehicle numbers include gravel, concrete, reinforcement steel, electric cables, cranes and components for the wind turbines as well as electrical substation.

14.8.2 Effects evaluation - methodology

The construction of the wind farm will generate traffic. This traffic will be comprised of:

- **Light Vehicles(LV):** In this report, this term refers to all passenger vehicles as well as light vehicles used to transport goods, i.e. the European Commission (“EC”) vehicle categories M1, M2, M3 and N1 (European Commission website). N1 are vehicles for the carriage of goods with a maximum weight of 3.5 t. M1-M3 are small to large passenger vehicles;
- **Heavy Goods Vehicles (HGV):** This term refers to vehicles of the EC category N2 and N3, i.e. vehicles for the carriage of goods with the maximum mass exceeding 12 t but that fall within the permissible weights and dimensions of goods vehicles, i.e. generally do not exceed a maximum load of 40 t and a maximum axle weight of 10 t;

- **Exceptional Load Vehicles (ELV):** These are vehicles larger than stipulated in the Jordan Traffic Law No.47 Year 2001 and, therefore, require permission from the Minister of Public Works and Housing in order to operate. For the purposes of this ESIA, exceptional load vehicles are all vehicles which transport abnormally large or heavy loads.

The peak flows of vehicles during the construction period will be identified for HGV and Exceptional Load Vehicles. Impact receptors are defined in order to qualify the impact of these transportation movements on locations and/or demographic groups of interest. Criteria are then applied to establish whether significant environmental effects are likely.

Effects arising from light vehicles are not considered in this assessment since they are of a small scale and set routes for these vehicles will not be used.

14.8.2.1 Receptor sensitivity

Settlement receptors were identified through categorizing the location of the settlement and the existing traffic situation at the settlement. Settlements were classified by size and function, presence of school/community facilities, traffic calming or traffic management measures and position on the roads hierarchy (Table 14-2).

Table 14-2: Receptor selection criteria and sensitivity classification

Selection Criteria for Receptors	Low	Medium	High
Location	Small rural settlement, few communities, public facilities or services.	Intermediate sized settlement, containing some community or public facilities and services.	Large settlement containing a high number of community, public services and facilities.
Existing traffic situation	Little or no traffic calming or traffic management measures.	Some traffic calming or traffic management measures.	Traffic control signals, waiting and loading restrictions, traffic calming measures.

14.8.2.2 Impact magnitude

The magnitude of the impact of increased traffic volume will be measured against IEA guidelines. The magnitude of the change (perceived or actual) on road safety will be considered against traffic volume and composition. These magnitudes will be classified using the following criteria proposed by the IEA identified in Table 14-3.

Table 14-3: Magnitude of increased traffic volume impacts

Impact Magnitude	**Effect**
Low	Increase in HGV traffic up to 60%
Medium	Increase in HGV traffic between 60% and 90%
High	Increase in HGV traffic of over 90%

14.8.2.3 Effects Significance

The results from the receptor sensitivity analysis and the impact magnitude classification will be combined into an "Effects Significance Table," (Table 14-4) which represents the final determination of the magnitude of the impact.

Table 14-4: Effect significance

	Low magnitude	Medium magnitude	High magnitude
Low sensitivity	Not significant	Low significance	Moderate significance
Medium sensitivity	Low significance	Moderate significance	Significant
High sensitivity	Moderate significance	Significant	Highly significant

14.8.3 Limitations of assessment

Due to the fact that recorded traffic data was not available for the routes examined, the baseline traffic conditions in this assessment are based on professional judgment. Accidents statistics were also not available for the preferred routes.

14.9 Baseline

The routes to the site vary depending on the type of good and its point of origin. This assessment differentiates between two main routes – those for the delivery of turbine and main electrical components and those for the delivery of concrete.

14.9.1 Routes

Standard vehicles are considered to be all vehicles that are allowed to travel on roads without any additional licenses or permissions. These are average cars, vans and HGV which may have a total weight of up to 40 t. Various types of goods will be brought to the site with HGV. As their sources vary, so will the routes. Ideally, the resources would be obtained from as close to the site as possible, thus minimizing any impacts caused by transportation of these goods.

14.9.1.1 Routes currently not known

Currently, the source of gravel, cabling, reinforcement steel, cranes and construction machinery is not known. The origin of the goods, therefore, is also unknown. Consequently, in routes for these materials could not be established. However, the source for concrete was assumed since the LaFarge Rashidiya concrete plant is located in close proximity to the planned wind farm.

14.9.1.2 Route 1 - concrete delivery

The route for concrete delivery (Route 1) is presented in Figure 14-1. Route 1 has a length of 2.8km and represents the distance from the site entrance to the concrete plant. The route is on the local road which connects the national road 15 with the national road 35. The current baseline traffic on this route is assumed to be very low since the location of the site is remote and the road does not link areas with high population.

14.9.1.3 Route 2 - route for exceptional load vehicles

Turbine components and some electrical components will be delivered using exceptional load vehicles. Depending on the component, the loads can be particularly long and/or heavy. Consequently, identifying the most appropriate route is of high importance.

According to turbine manufacturer Vestas, the WTG components will be shipped to the port at Aqaba, which is located in the south of Jordan. From Aqaba to the wind farm site, the turbine components will be transported with exceptional load vehicles. The route from the harbor to the site was established by supplier`s transport experts and takes the following route 2 (see Figure 14-2):

- From the storage area in the harbor to national road 15, avoiding the city center of Aqaba;
- Following the national road 15 northward, passing the town of Ma`an;
- The route leaves the national route 15 at the intersection located at 30° 34.392' N - 35° 47.933' E and continues westward;
- The last section of the road does not pass any settlements and leads directly to the wind farm entrance.

The route follows mainly the road 15 which connects south of Jordan with the capital Amman in the north. Therefore, it is assumed to have a high traffic volume in Jordan. However, the road is well developed and maintained, consisting of two and three lanes. Unfortunately, no official traffic data was available for this route. The total length of Route 2 is about 180km.

14.9.1.4 Internal wind farm roads

Dirt roads already exist on the wind farm site. These are mainly used for accessing the fields and livestock. The existing tracks on the wind farm site do have extremely low baseline traffic. Further to these existing roads the project will require appropriate roads for access and hauling of WTGs during construction and operation. These approximately 5 meters wide roads will be constructed of compacted soil. In order to reduce the environmental impact, the existing tracks will be used where possible. A layout of the internal roads can be seen in Figure 14-5.

14.10 Impact assessment

14.10.1 Basis of assessment

The lifetime of a wind farm is split into three stages which are the construction, operation and decommissioning phases. Each of these varies in the way it impacts traffic of the surrounding area.

The main impact is to be expected during the construction and the decommissioning of the wind farm. However, it is assumed that traffic generated by the decommissioning of the wind farm will be of smaller scale compared to the construction traffic, due to the fact that the construction materials will not be fully removed from the site.

Operation will, however, have a much smaller impact than construction and decommission. The frequency and type of maintenance vehicles will not have a noticeable effect on the total number of vehicles or stress on the roadways. HGV will appear on site only in exceptional cases in case main components of the wind farm need to be replaced or repaired. Consequently, the assessment will focus on the construction phase and the other two phases will be scoped out of this report. Within this phase of the project there are two aspects that have an influence on transport – the route that is selected for the vehicles delivering goods to the site and the numbers of vehicles that approach the site.

Any impact of dust formation is dealt with in chapter 10.

14.10.2 Construction-generated traffic

This section details the types of traffic which each material used in the construction phase will generate. Each delivery trip stands for two vehicle movements; approaching the site and leaving the site.

14.10.2.1 General equipment

For general construction on the site, it is necessary to transport various small construction machines, such as earth-movers, steamrollers and excavators to the site with HGV. The exact number of these machines is determined by the general contractor Vestas. According to experience gained in other projects of similar size, 50 HGV deliveries at the commencement of the works and 50 HGV deliveries at the completion of the works are estimated for this study.

14.10.2.2 Concrete

The current preliminary design of the WTG foundation requires 460 m³ of concrete for each turbine. Assuming 38 WTG, a total volume of approximately 17.500m³ of concrete will be required, plus a small amount of concrete for the foundations of the electrical substation. The nearest concrete plant is located in a distance of 2.8 km of the site entrance. For this study it is considered that the concrete will be sourced from this plant. With a standard capacity of 6m³ for each concrete truck, a total of 2,920 deliveries will be necessary.

14.10.2.3 Reinforcement steel

In order to construct the cage of the foundations, reinforcement steel is required. According to the preliminary foundation design each turbine requires approximately 36.6 t of steel which results in 1,390t being needed for 38 turbines. Assuming a HGV can deliver 21t of steel per trip, approximately 70 deliveries will be required.

14.10.2.4 Gravel for internal roads

Approximately 35km of internal roads (Figure 14-5) will be required of the project. This includes new roads and existing roads which must be improved. At this stage of the project it is not decided yet where the stones for access roads and crane pads sourced from. Stones can either be extracted on site or transported to the site and sourced from a local contractor. As a worst case scenario it is considered that gravel will be transported to the site. According to the preliminary design submitted by Vestas approximately 99,100 t of gravel will be required. Assuming a HGV can deliver 21t of gravel per trip, approximately 4,720 trips will be required. Since the delivery of gravel will be spread over 150 days the peak traffic will be considerably lower compared to the delivery of the concrete for the foundations.

14.10.2.5 Cabling

Cable will be installed on site underground, largely in parallel to the roads, in order to connect the WTG with the substation. Based on the current preliminary cable layout, the total cable length is approximately 150km. Assuming that cables are delivered in 500m drums and one HGV can carry 3 drums per trip, 100 HGV will be required.

14.10.2.6 Crane delivery

Cranes required for the erection of the WTG will be also delivered by HGV. It is assumed that 15 HGV deliveries will be necessary in order to bring all necessary cranes and ballast to the site and 15 HGV at the completion of the crane works.

14.10.2.7 Turbine delivery

The turbine layout consists of two different turbine set-ups. There are 34 Vestas V112 with a hub height of 94m and 4 Vestas V112 with a hub height of 84m. The 94m tower consists of four sections; the 84m tower consists of three sections. In addition to the 38 turbines, one extra WTG will be transported to the site which will be used for spare parts.

In total, 152 tower sections must be transported to the site with exceptional load vehicles. For each of the 39 turbines three blades, one nacelle, one drive train and one hub will also be delivered with exceptional load vehicles to the site. In total, 386 exceptional loads will be delivered.

14.10.2.8 Substation

The components of the substation include concrete, steel and electrical devices. It is assumed that 50 HGV deliveries will be necessary in order to bring all necessary equipment to the site.

14.10.2.9 Traffic generation summary

Figure 14-5 summarizes the predicted traffic generation associated with the activities during the construction stage of the wind farm.

Table 14-5: Predicted traffic generation

Loads	Total Number	Total Duration of work process (Days)	Delivery Days	Average per Day
Gravel for roads and crane pads	4720	240	150	32
WTG foundation concrete	2920	200	40	73
Reinforcement steel	70	200	65	1
Cables and earthing system	122	200	40	3
Optical fiber cable	84	200	40	2
Substation	50	100	10	5
Wind turbines tower V112, 94m	140	150	40	4
Wind turbines tower V112, 84m	12	150	40	3
Wind turbine nacelle	39	150	40	1
Wind turbine drive train	39	150	40	1
Wind turbine blade	117	150	40	3

Loads	Total Number	Total Duration of work process (Days)	Delivery Days	Average per Day
Wind turbine hub	39	150	40	1
Crane	30	150	6	5
General equipment (without Toolbox)	100	540	300	3
Total	**8482**			

The construction period is estimated for 18 months (Table 14-6).

Table 14-6: Separation of transport on different construction months

Activity	1	2	3	4	5	6	7	8	9	10	11	123	13	14	15	16	17	18	Total
Gravel for roads and crane pads			**450**	**787**	**787**	**787**	**787**	**787**	**64**									**271**	4720
WTG foundation concrete				150	150		1275	1275	70										2920
WTG foundation reinforcement steel				12	15	15	15	13											70
Cables and earthing system			31	31	30	30													122
Optical fiber communications cable			17	17	17	17	16												84
Substation									30	20									50
Wind turbines tower V112, 94m										30	30	30	25	25					140
Wind turbines tower V112, 84m										3	3	3	2	1					12
Wind turbine nacelle										8	8	8	8	7					39
Wind turbine drive train										8	8	8	8	7					39
Wind turbine blade										24	24	24	23	22					117
Wind turbine hub										8	8	8	8	7					39
Crane										15								15	30
General equipment (without Toolbox)	20	10		10				10	15	10					15			10	100
Total	**20**	**10**	**498**	**1007**	**999**	**849**	**2093**	**2085**	**179**	**126**	**81**	**81**	**74**	**69**	**15**	**0**	**0**	**296**	**8482**
Working days	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**374**
Daily average	**1**	**0**	**23**	**46**	**45**	**39**	**95**	**95**	**8**	**6**	**4**	**4**	**3**	**3**	**1**	**0**	**0**		**23**

14.10.3 Selection of receptors

This section provides the level of sensitivity to the increase in vehicle movements associated with the construction phase of the wind farm.

In order to identify the receptors, the preferred routes were scanned for locations and areas which may be sensitive to changes in traffic conditions as described in Table 14-1. There are no highly sensitive areas and location in close vicinity to the two preferred routes. Route 1 does not pass any settlements at all. On the course of route 2, which will be used for transportation of the WTG components, Aqabar is the only settlement which will be directly passed by the route. The route passes the town Ma'an in the west but not passes directly any sensitive location or area. Therefore, only three receptors were set on the routes.

Settlements and places which lie on the two main routes are identified in Table 14-7. In Figure 14-3 and Figure 14-4 the sensitive areas around these settlements and places are displayed.

Table 14-7: Settlements and places along the two main routes to the project site

Receptor Sensitivity	Low	Medium	High	Comments
Apaba Harbor area (Route 2)	**x**			Area dimensioned for commercial activity and transporting large goods
Outskirts of Apaba (Route 2)		**x**		No direct passing of residential estates, there are no traffic management measures.
Local road between concrete plant and site (Route 1)	**x**			No residential estates along the road, farming and livestock in vicinity of the road possible

14.10.3.1 Impact magnitude

The routes which were considered in this assessment are very different in its nature.
On route 1 the current HGV baseline is very low, so any small increase in HGV traffic volumes is likely to result in a large percentage increase. The course of Route 1 does not pass any housing area; only one house could be identified which is located in a distance of approximately 30m to the road.

Route 1 is the route which is used for transporting the concrete from the factory to the site and therefore is the route with the highest traffic generated by the construction phase of the wind farm. In total 2,920 concrete deliveries will make use of Route 1 with an average of 73 deliveries per day.

Materials like reinforcement steel, cables and parts for the substation are not expected to be transported on this route. These goods are likely to be delivered from Aqaba or Amman and therefore do not add to the traffic on Route 1.

Route 2 has a length of approximately 180km and mainly follows the course of the national route 15 which is extremely well developed and consists of several lanes. On this route, the WTG components will be transported from the harbor to the site. In total, 386 exceptional load delivers will be necessary in order to transport the WTG to the planned wind farm site. These transports will be conducted in convoys [MM70] and will be escorted by the police. In relation to the traffic volume on this route the additional volume is very low. However, non-development traffic may be affected by the large dimensions of the WTG components.

The source of cabling, reinforcement steel, cranes, substation components and construction machineries cannot be defined at this project stage. Depending on which supplier is chosen by Vestas the materials will come from different places. However, it is expected that different routes will be used and that deliveries will take place at different phases of the construction stage. Consequently, the routes which were analyzed in depth are not likely to be affected by the delivery of these materials.

Due to the fact that the route of the workers to the site is not known yet and that the impact of a limited amount of light vehicles is not likely to generate a significant impact, this topic was not considered in this assessment.

14.10.4 Traffic related social and environmental effects

14.10.4.1 Noise

On the local road between concrete plant and site (Route 1) a slight increase in noise levels are predicted. On average 73 concrete deliveries will take place per day over period of 40 days. However, during the casting of the foundations, peak flows of 95 deliveries (190 HGV movements) are predicted.

The effect will be limited to the concrete delivery which is assumed to be spread over a time period of five months (see Table 14-6).These effects are assessed to have a low significant effect. The additional traffic on Route 2 will be minor, therefore no significant effect is assessed on this route.

14.10.4.2 Vibration

The traffic increase on Route 1 may have a slight increase in vibration levels but is limited to the time of the concrete delivery (five months). However, no properties are in vicinity to the route, therefore these effects are assessed as having a no significant effect. The additional traffic on Route 2 will be minor, therefore no significant effect is assessed on this route.

14.10.4.3 Visual effects

Visual effects by the construction traffic of the planned wind farm are temporary in nature and occur in large part where such effects are already present. Therefore, the effect is considered to be negligible. Other visual effects of the wind farm are covered in chapter 12.

14.10.4.4 Severance

The traffic increase on Route 1 may have a slight increase in severance related issues but is limited to the time of the concrete delivery (five months). On average 95 delivers (190 HGV movements) are predicted as peak flow during the construction stage. Since there is no residential area other than the roads residents are not likely to be effected. However, severance may apply for shepherds moving livestock. These effects are assessed as having a low significant effect. The additional traffic on Route 2 will be minor, therefore no significant effect is assessed on this route.

14.10.4.5 Drivers delay

Driver delay is possible during the delivery of the WTG components when roads are temporally blocked by the police in order to negotiate difficult sections of the transport route (Route 2). These effects are assessed as having a low significant effect as the transportation of the main components will take place during nighttime, to avoid exactly this impact.

14.10.4.6 Pedestrian delay

The IEA guidelines state as the lower threshold of pedestrian delay a two-way flow of about 1,400 vehicles per hour on a link with no crossing. The traffic flow on the Route 1 is significantly less than the lower threshold value. On Route 2 pedestrian delay may occur. However, only 3-5 exceptional load vehicles per day will be added to the baseline traffic flow. Therefore, it is assessed that no delay may arise from the development.

14.10.4.7 Fear and intimidation

Due to the fact that pavements are absent on the routes and the routes do not directly pass housing areas, it is envisaged that no effect on pedestrians will arise from this development.

14.10.4.8 Safety

No accident data could be obtained for the chosen route. Moreover, no specific accidents problems or accidents hot spots were known. Accidents and safety are assessed as having a low significant effect.

14.10.4.9 Hazardous loads

The potential increase in hazardous loads being transported on the routes is considered to have no significant effect as the transportation of such loads is considered to occur regularly on the routes considered. Potential hazardous of the development will be fuel trucks which provide oil and petrol for the machinery used on the construction site. All associated activities will be subject to strict health and safety controls.

14.10.4.10 Air pollution

Air pollution depends on the volume of traffic, its speed and distance to the source. The increase of the traffic on Route 1 may have a slight increase in air pollution levels. These effects are assessed to have a low significant effect. The additional traffic on Route 2 will be minor, therefore no significant effect is assessed on this route.

14.10.4.11 Dust and dirt

Dust and dirt can have a moderate effect on the Route 1. Due to the fact that the internal wind farm roads will consist of compacted gravel roads, it is very likely that vehicles visiting the site collect dirt on their wheels and chassis. IEA guidelines state that problems associated with dust and dirt are unlikely to occur at distances greater than 50m from the road. The additional traffic on Route 2 will be minor, therefore no significant effect is assessed on this route.

14.10.4.12 Ecological effects

Ecological effects are covered in chapter 6.

14.10.4.13 Heritage and conservation

Effects Heritage and conservation areas are covered in chapter 13.

14.10.4.14 Summary of traffic related social and environmental effects

The criteria used in evaluating the effects are described in section 14.6. Three receptors on the potential construction traffic routes to site were identified. The predicted increase in total traffic volume due to the proposed development construction traffic differs between the routes. While the baseline of the traffic volume of Route 1 is very low, the traffic flow of Route 2 is considerably higher since the national road 15 is an important link in Jordan.

The introduction of a low number of additional HGV movements on a route that does not currently have a large number of HGV trips will be recorded as being highly statistically significant, even though the actual numbers of additional trips could be very small. The effects are summarized in Table 14-8 below.

Table 14-8: Traffic related social and environmental effects

Effects	Impact	Receptor	Sensitivity	Impact Magnitude	Effects Significance
Noise	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Low
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Vibration	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Not Significant
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Visual Effects	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Not Significant
	Increase in	Aqaba Harbor area	Low	Low	Not Significant

Effects	Impact	Receptor	Sensitivity	Impact Magnitude	Effects Significance
	exceptional load traffic	Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Severance	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Low
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Driver Delay	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Not Significant
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Low
		Outskirts of Aqaba (Route 2)	Medium	Low	Low
Pedestrian Delay	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Not Significant
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Fear and Intimidation	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Not Significant
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Accidents and Safety	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Not Significant
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Hazardous Loads	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Not Significant
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Air Pollution	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Low
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant
Dust and Dirt	Increase in HGV traffic	Local road between concrete plant and site (Route 1)	Low	Medium	Moderate
	Increase in exceptional load traffic	Aqaba Harbor area	Low	Low	Not Significant
		Outskirts of Aqaba (Route 2)	Medium	Low	Not Significant

14.10.5 Exceptional loads review

A road survey of the access to the development site has been completed by the turbine supplier. Aqaba has been considered as harbor for the delivery of turbines, as it is the nearest harbor for landing the turbines. The most viable hauling route for the wind turbine components is given in the chapter 14.9.1.3. Route 2 was assessed in detail through site visits. Potential constrains such as such as low structures, existing bridge crossings, sharp bends, adverse gradient and obstructions have been reviewed, identified and assessed by the turbine supplier.

According to the Ministry of Public works several bridges are restricted for cargo exceeding 60t, therefore the exceptional load vehicles must bypass the critical sections. Detailed references of the proposed bypasses are stated in the document “Transport Road Survey Report, Project Tafila, Jordan” authored by Vestas. The report also discusses options of reinforcements of roads and bridges which will be necessary in order to negotiate the WTG components to the site.

The turbine V112 with a hub height of 94m will result in ten exceptional loads (4 tower sections, 3 blades, 1 nacelle, 1 drive train, 1 hub), the turbines V112 with a hub height of 84m will result in nine exceptional loads (3 tower sections, 3 blades, 1 nacelle, 1 drive train, 1 hub).

The exceptional loads will be transported in convoys escorted by the police to warn ongoing traffic of the advancing loads. In case the transport must pass under or very closely near overhead electrical lines, the representative from the owner of the electrical lines will also escort the convoy.

14.10.6 Internal wind farm roads

During the construction phase, particularly at the time when concrete pouring takes place, the traffic volume on the internal wind farm roads will be high and therefore driver delay can occur for farmers accessing their fields and livestock. However, the concrete delivery is limited to only 40 days. In the rest of the construction period and in the operational phase the farmers will benefit from improved access roads. Consequently, no significant impact is assessed.

There is a possibility that lifestock will be scared by the increased construction traffic. Therefore, it is proposed to set a speed limit of 20 km/h for the internal wind farm roads. At sharp bends and blind summits the speed should be reduced even more.

14.10.7 Operational and decommissioning impacts

The operational traffic and transport impacts associated with the wind farm will mainly be limited to those arising from occasional maintenance trips using light goods vehicles and are considered to be negligible. HGV will appear on site only in exceptional cases in case main components of the wind farm need to be replaced or repaired. Therefore no further assessment is included.

The predicted lifespan of the wind farm is 20 years. The decommissioning phase will require fewer vehicles than the construction phase and as such the traffic and transport impact of the construction phase is estimated to be less in the decommissioning phase.

14.11 Mitigation measures

The following section establishes the measures that will be employed in order to avoid or mitigate various traffic-related effects.

14.11.1 Route selection

The first mitigation measure is the careful consideration of the roads network to identify the most suitable route to the site entrance. This has been considered by the transport experts from the turbine supplier which have established the route for the exceptional load vehicles. However, amendments to the route are possible by the haulage company which will finally conduct transportation of the WTG components. For the HGV it was considered that the construction materials will be sourced as close to the site as possible in order to reduce the length of the route.

14.11.2 On-site stone extraction

The construction of internal roads and crane pads will require crushed stones. These may be sourced on the site in order to reduce HGV trips. This measure will significantly reduce the number of HGV travelling to the site but it needs to be clarified with the contractor and any responsible authorities first whether this is possible or not.

14.11.3 Traffic safety measures

In addition, to the specification of the preferred access route and the detailed phasing of construction traffic additional measures will be introduced to minimize the negative effects of construction related traffic. Where appropriate, additional warning and speed control signs will be installed with the agreement of the relevant authority. On the wind farm site a speed limit of 20 km/h will be established. At sharp bends and blind summits the speed should be reduced even more. In order to reduce driver delays lay-bys will be constructed to enable the passing of vehicles. Drivers breaking safety rules will be removed from the project site.

14.11.4 Traffic related effects mitigation

This section indicates the proposed mitigation measures for traffic and transport related social and environmental effects.

14.11.4.1 Noise

The assessment of noise effects on traffic concludes that the development will have a low significant effect, therefore no mitigation measures are proposed.

14.11.4.2 Vibration

The assessment of vibration effects on traffic concludes that the development will have no significant effect, therefore no mitigation measures are proposed.

14.11.4.3 Visual effects

The assessment of visual effects on traffic concludes that the development will have no significant effect, therefore no mitigation measures are proposed.

14.11.4.4 Severance

The assessment of severance effects on traffic concludes that the development will have a low significant effect, therefore no mitigation measures are proposed.

14.11.4.5 Driver delay

The assessment of effects on hindrance to drivers of other motor vehicles concludes that the development will have a low significant effect, therefore no mitigation measures are proposed for HGV traffic.

For Route 2 a transport management plan will be elaborated [MM63] with the relevant authorities and the police in order to minimize disturbance to non-development traffic. The exceptional loads will be transported in small convoys escorted by the police. The delivery will be timed in order to avoid peak traffic movements so driver delays will be minimized, therefore transportation is envisaged for night times [MM75].

14.11.4.6 Pedestrian delay

The assessment of pedestrian delay on traffic concludes that the development will have no significant effect, therefore no mitigation measures are proposed.

14.11.4.7 Fear and intimidation

The assessment of fear and intimidation on traffic concludes that the development will have no significant effect, therefore no mitigation measures are proposed.

14.11.4.8 Accidents and safety

The assessment of safety effects due to the additional traffic generated during the construction phase of the wind farm concludes that the development will have no significant effect, therefore no mitigation measures are proposed.

14.11.4.9 Hazardous loads

The assessment of hazardous loads on traffic concludes that the development will have no significant effect, therefore no mitigation measures are proposed. The transportation of hazardous loads will be subjected to strict health and safety controls and specific handling procedures.

14.11.4.10 Air pollution

The assessment of air pollution effects on traffic concludes that the development will have a low significant effect, thus no mitigation measures are proposed.

14.11.4.11 Dust and dirt

The entrances from construction sites onto public roads often becomes dirtied with soil, mud or small stones, which may present a hazard for the users of the public road. In order to avoid this, the last few meters of on-site access road before the connection with the public road will be covered with asphalt, to minimize dirt and dust on wheels by entering public roads. [MM77]

14.11.4.12 Summary of traffic-related effects mitigation

Table 14-9: mitigation of traffic related effects

Effect	Significance	Mitigation measure proposed
Noise	Low	None proposed.
Vibration	No effect	None proposed.
Visual effects	No effect	None proposed.
Severance	Low	None proposed.
Hindrance to drivers of other motor vehicles	Low	Set up of traffic management plan for transporting abnormal loads. [MM73]
Hindrance to pedestrians	No effect	None proposed.
Fear and intimidation	No effect	None proposed.
Safety	No effect	None proposed.
Hazardous loads	No effect	None proposed.
Air pollution	No effect	None proposed.
Dust and dirt	Moderate	Construct last meters of project site roads as asphalted road to minimize dirt and dust on wheels by entering public roads. [MM77]

14.12 Cumulative impacts

At the time of producing this report, there is one other wind farm in planning in the vicinity: Fujeij wind farm. Not enough information about this wind farms is publicly available in order to make a judgment of possible cumulative impacts. In general, it is unlikely that the exact transport routes used in Tafila would also be followed by this two wind farm. Because the large component transports will be coordinated with the police, however, the possibility of conflicting large component transports can be excluded. Therefore, no cumulative impacts are anticipated. Moreover, no further major construction sites are known in the vicinity of the wind farm site and thus no increased traffic caused by the LaFarge Rashidiya concrete plant is anticipated.

14.13 Summary

This section of the ESIA assesses the traffic and transport impacts related to the proposed Tafila Wind Farm during the construction phase. During the 20-year operational phase of the development, the amount of associated traffic will be very small. Therefore, the effects arising of the operational traffic are considered to be negligible. Effects arising from the decommissioning of the wind farm are likely to be similar to the construction stage but of a smaller scale as vehicle numbers and peak flows will lower compared to the construction phase.

A route survey was conducted by transport experts of turbine supplier Vestas, identifying the preferred route for exceptional load vehicles. In addition, a route for the HGV was established on which the peak flows of the construction traffic are expected.

The methodology applied in this assessment was derived from the IEA guidelines for the environmental assessment of road traffic. As a first step two routes were identified, which are most likely to be used for the transporting of the construction material to the site. Subsequently, receptors sensitive for traffic and transports effects were identified along the routes. These were classified in terms of their sensitivity by settlement size, function, presents of community facilities, traffic management measures and road hierarchy.

The impacts are likely to cover changes in traffic, changes in road safety and vehicle delay. The magnitude of impacts of the increased traffic was measured against the IEA guidelines. The results from the receptor sensitivity and the impact magnitude classification was correlated by applied a five point significance scale. Effects were considered in the range of highly significant, significant, moderate, low or not significant. Professional judgment was used to assess the findings in relation to each of the criteria used in evaluating the significance of the effects.

The traffic on the internal wind farm roads is not assessed in detail in this chapter.

Average-sized cars and vans bringing workers on the construction site are not considered in depth since the effects are expected to be minor.

This section of the assessment considers the transportation impact of constructing the turbines, foundations, access roads, including the associated activities such as site clearance and delivery of raw materials. For the baseline of the existing traffic on the surrounding road infrastructure, no traffic data could be obtained from the relevant authorities, thus the amount of baseline traffic was estimated.

The preferred routes for HGV (route1) and for abnormal load vehicles (route2) are shown in Figure 14-1 and Figure 14-2.
The impact assessment is based on the following assumptions:

- The construction excluding the preparation of the access roads will take 18months;
- The highest peak flow will occur during the concrete delivery ;
- Materials like reinforcement steel, cables and parts for the substation are not expected to be transported on the same route as the concrete.

The receptor sensitivity is provided in Table 14-2. The outskirts of Aqaba were identified as moderately sensitive receptor. The Aqabar harbor area and the route 1 are identified as low sensitive receptors.

The IEA guidelines recommend that the environmental effects could be considered as potentially significant whenever a new development is likely to give rise to changes in traffic flows. The significance of each effect is considered in this assessment using the IEA guidelines, where possible.

The main effects of construction related traffic is the potential increased congestion within the existing road network and potential increased wear and tear on the existing roads. However, it is not possible to quantify the magnitude of impact in relation to wear and tear on the local roads. Congestion is not considered to have a significant effect as the existing traffic volumes on the road network are very small, and the potential increases during the construction phase is not considered to be significant.

During the concrete pouring the traffic volume on the internal wind park roads will be high and therefore driver delay can occur for farmers accessing their fields and livestock. However, this effect is only limited to a short time period and the farmers will benefit long-term from improved access roads.

Though the introduction of a low number of additional HGV movements Route 1 will result in a high percentage increase in traffic volume, since Route 1 does not currently have a large number of HGV trips. In terms of absolute vehicle numbers, however, the additional traffic associated with the construction of the wind farm (including exceptional loads) is very low, as can be seen in Table 14-5.

An assessment of the access to the wind farm for exceptional load vehicles has also been undertaken. Aqabar has been considered as suitable port for landing the turbine components. Subsequently a route (Route 2) was established considering potential constrains such as low structures, existing bridge crossings, sharp bends, adverse gradient and obstructions. The following mitigation measures will be employed in order to reduce the adverse traffic and transport effects:

- Route selection;
- Traffic managing measures.

The primary mitigation measure is the careful consideration of the roads network in order to identify a preferred route from and to the site access. A preferred route for the delivery of the turbine components has been identified by the transport experts of the manufacturer.

By using stone from on-site borrow pits the number of HGV vehicles using the local road network during the construction phase can be substantially reduced. However, it is currently unclear if this measure can be executed and this will be thoroughly discussed with the authorities and contractor of the wind farm. Dirt and dust has been categorized as potential moderate significance. In order to mitigate this, weather-appropriate measures will be taken to minimize the dispersion of dust, such as covering exposed soil mounds with plastic or spraying affected areas with water. In addition, a low speed limit will be imposed for all vehicles on site, so as to limit the dust produced from driving on the roads.

On the internal wind park road there is the possibility that lifestock will be scared by the increased construction traffic, therefore a speed limit is proposed.

A summary of the traffic and transport related effects and the proposed mitigation measures are indicated in Table 14-9.

14.14 Conclusion

The potential effects which may arise during the construction phase of the wind farm were identified and their magnitude evaluated. During the construction phase, the relatively low numbers of HGV which are added to the baseline traffic of the local road network are unlikely to result in significant traffic and transport issues. Some increased wear on the roadways used is possible. However, it is not possible to quantify the magnitude of impact on the existing road network. In order to accommodate the exceptional load vehicles some works will be required to ensure safe delivery. Traffic effects generated by the operational phases of the wind farm were scoped out of the assessment since significant effects are unlikely to arise. Effects of the decommission stage have been scoped out as well because they are of similar nature to the construction but of smaller scale.

14.15 References

[14-1] Guidance Notes No. 1 Guidelines for the Environmental Assessment of Road traffic. The Institute of Environmental Assessment, 1993

[14-2] Transport Road Survey Report, Project Tafila, Jordan. Vestas, 2012

Figures

Figure 14-1: Route for concrete delivery

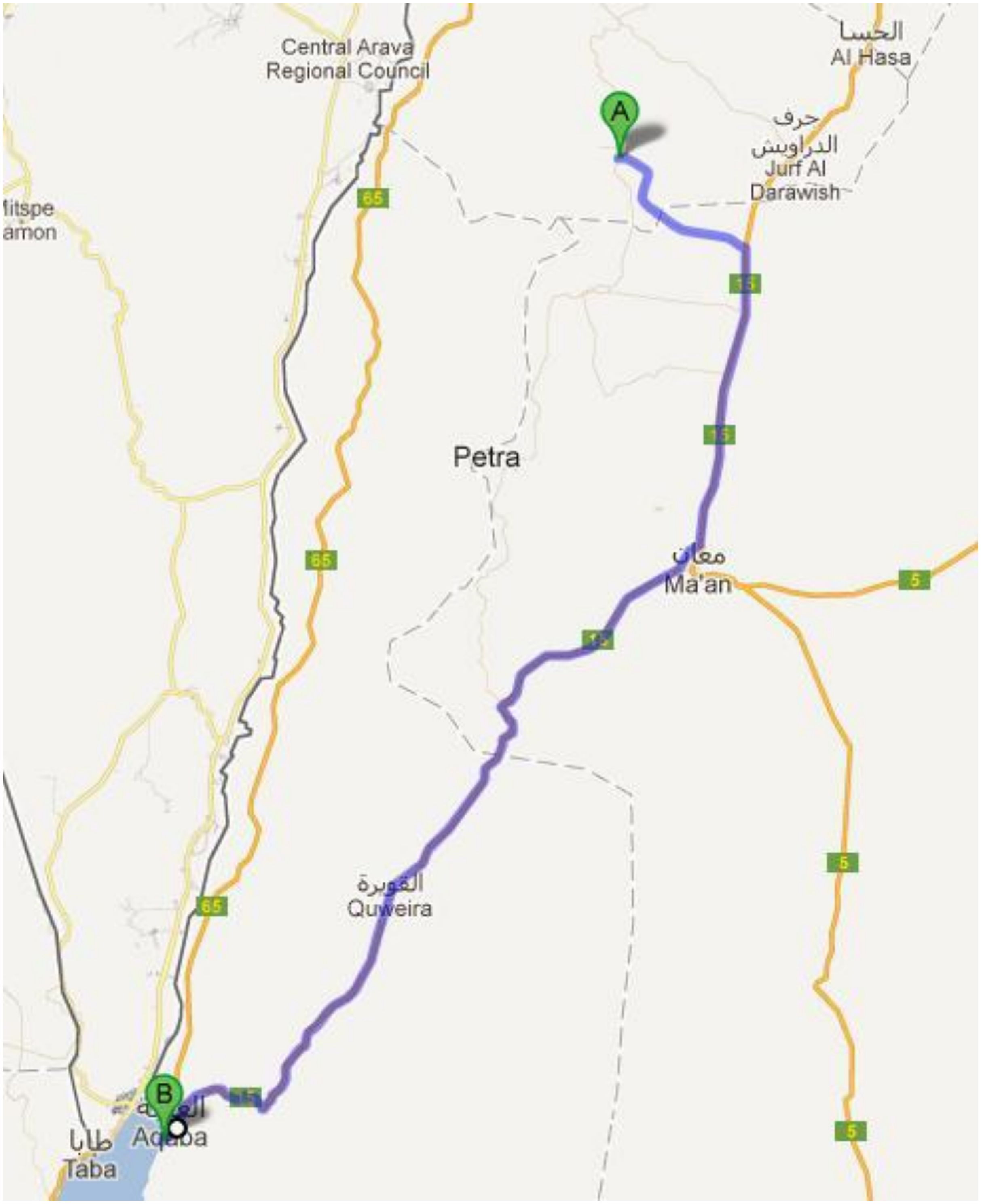


Figure 14-2: Route from Aqaba harbor to the project site

Sensitive·area¶

Figure 14-3: Traffic and transportation sensitive area route 1

Sensitive·area¶

Figure 14-4: Traffic and transportation sensitive area route 2

Internal·roads¶

Figure 14-5: Internal roads

15 Socio-economics

15.1 Introduction

This section considers the socio-economic effects of the proposed wind farm at Tafila. The potential positive and negative impacts on the local community and on the economy of the surrounding area are evaluated.

The socio-economic impacts considered focus on the quality of life of local residents and both local and regional business activity. Economic effects on a higher level may occur nationwide, e.g. through the Jordan energy or consumer industry.

15.2 Objectives

The main objectives of this section are:

- To collect the baseline data on socioeconomic conditions;
- To assess potential impacts, positive and negative, of the project activities on the existing socio-economic conditions;
- To propose proper mitigation measures to enhance possible positive impacts of the project and reduce the possible negative ones.

15.3 Guidance

The following laws and guidelines have been used as guidance's for this study:

- Jordanian Acquisition Law, No. 12, year 1987;
- The Jordanian Labor Law, No. 8, Year 1996 and its amendment;
- Jordanian Standards for reclaimed domestic wastewater No. 893 year 2006;
- IFC Guidance note 2: Labor and Working Conditions
- IFC Guidance note 5: Land Acquisition and Involuntary Resettlement
- IFC Guidance note 4: Community, Health, Safety and Security
- IFC Guidance note 7: Indigenous Peoples
- IFC Policy on Environmental and Social Sustainability, 2012
- IFC A Good Practice Manual for Companies Doing Business in Emerging Markets, 2007

15.4 Methodology

To achieve the above-mentioned objectives, a specific database must be established to enable assessment socio-economic impacts of the focus in relation to Jordan area with regard to the following aspects:

- Demography: information on the employment, housing and education of the population for Jordan and the focus area;
- Health: statistics of hospitals and care facilities in Jordan and the Governorate of Tafila;
- Land use plans and patterns: agriculture (types of crops, annual productions), industrial facilities;
- Infrastructure: educational institutions, transportation corridors (road, rail, air), water resources, communication.
- Semi-nomadic tribes, their characterization and impact.

For this purpose, the required data were identified; and available data were collected from the Jordan Department of Statistics (DOS) annual reports, relevant institutions annual reports and previous studies assessed by the project team. The results were analyzed and tabulated to present the socio-economic conditions at the focus area.

15.5 Baseline

15.5.1 Demography

15.5.1.1 Population

Based on the information published by the Department of General Statistics of Jordan [15-2] the estimated population of Jordan was about 5,723,000 inhabitants at the end of the year 2011 with a population density of 70.4 inhabitants per km^2. The urban population in Jordan counts for about 80 %, while rural population is about 20 %.

The estimated population, the area and population density of Tafila Governorate are shown in Table 15-1. The population of Tafila Governorate according to administrational divisions as well as the gender is shown in Table 15-2 and Table 15-3.

Table 15-1: Estimated population, area and population density in Tafila and Jordan, 2011

Governorate	Population	Area [km²]	%	Population density [capita / km²]
Tafila	87,500	2,209	2.49	39.6
Jordan	5,723,000	88,794	100	70.4

Table 15-2: Estimated population by administrative division for Tafila Governorate, 2011

Administrative division	Total population	Rural population [%]	Urban population [%]
Tafila Governorate	87,500	37	63
Tafila District	54,510	32	68
Tafila Town	29,102		
Basira-District	22,490	64.5	35.5
Basira	8,166		
Gharandil	3,575		
Dana	280		
Al-Hessa District	10,200	0.1	99.9
Al-Hessa	9,130		

Table 15-3: Gender distribution in Tafila Governorate and project area, 2011

	Males [%]	Females [%]
Tafila Governorate	51.5	48.5
Tafila city	51.7	48.3
Bsaira district	51.0	49.0
Gharandil	50.3	49.7
Dana	48.7	51.3

15.5.1.2 Employment

As published by the Department of General Statistics of Jordan-Population and Social sector in November 2012 [15-2] the workforce of Jordan includes all economically active citizens above the age of 15 years. About 40 % of all Jordanians are above this age. Since Jordan has a quite young population, the workforce will increase rapidly in the future. A list of occupational fields in Jordan during the period from 2008 to 2010 is shown in Table 15-4.

Table 15-4: Relative distribution of employed Jordanians over 15years of age [%]

Occupation	2008	2009	2010
Legislators and senior officials	0.1	0.2	0.5
Professionals	21.9	21.4	23.5
Technicians	11.1	11.0	8.3
Clerks	6.3	6.2	6.2
Services and sales workers	13.8	14.9	27.4
Skilled agricultural workers	1.5	1.6	1.5
Crafts and related workers	15.1	15.5	15.2
Mechanical operators and assemblers	11.4	12.1	11.6
Primary occupations	18.7	17.1	5.9

During the period 2001 – 2010, unemployment rates in Jordan declined by a total of 2 %. For males, the decrease was slightly larger than for females. It reached 3.2 %. Figure 15-1 shows the average unemployment rate for Jordan work force 15+ during that the same period. It can be noticed that unemployment among females is much higher than among males. This can usually be attributed to social status as well as to education levels. In 2005, unemployment among females increased up to 25.9 % and decreased to 21.7 % in 2010.

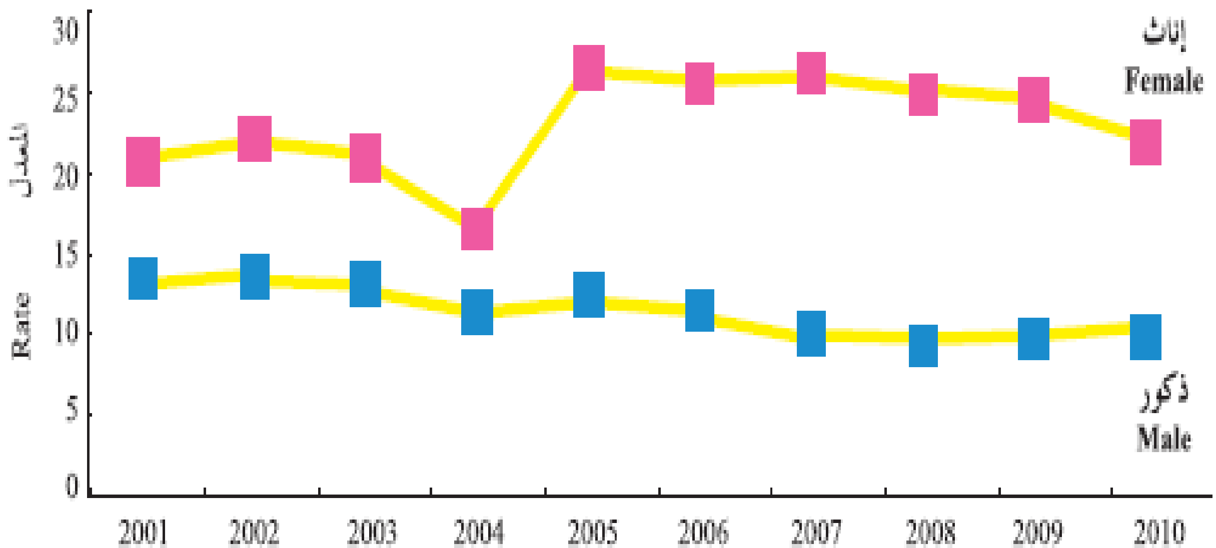


Figure 15-1: Unemployment rates among Jordan work force over 15 years of age (2001 – 2010)

In 2007 unemployment in the Tafila Governorate was about 11.4 % for males and 31.0 % for females. Figure 15-2 shows a comparison to other Governorates in Jordan. As shown in Figure 15-3, higher levels of unemployment exist among the younger people between 15-24 and decreases with age levels. This is basically due to the higher numbers of students in schools and higher education.

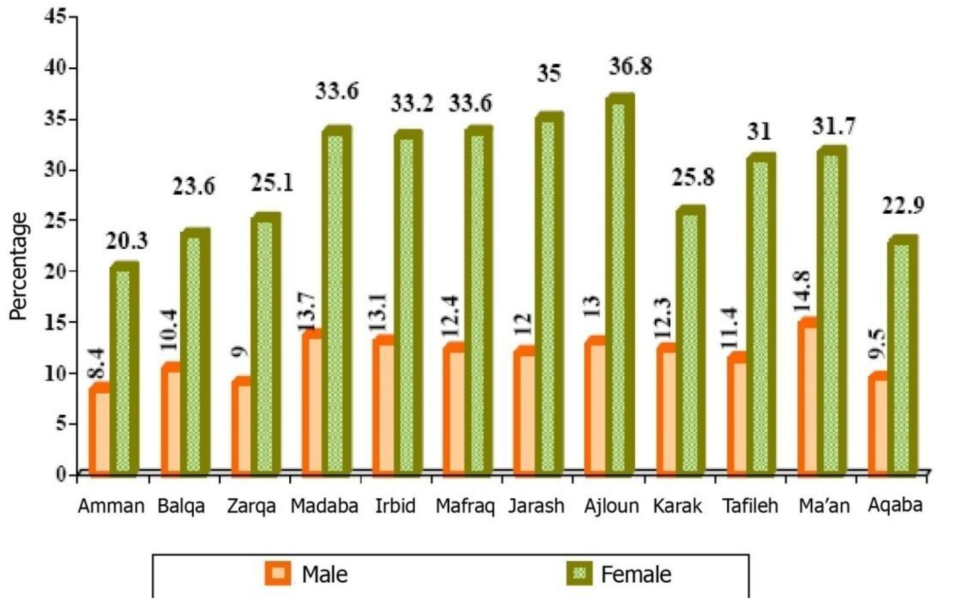


Figure 15-2: Unemployment in Jordan according to Governorate and gender (2007)

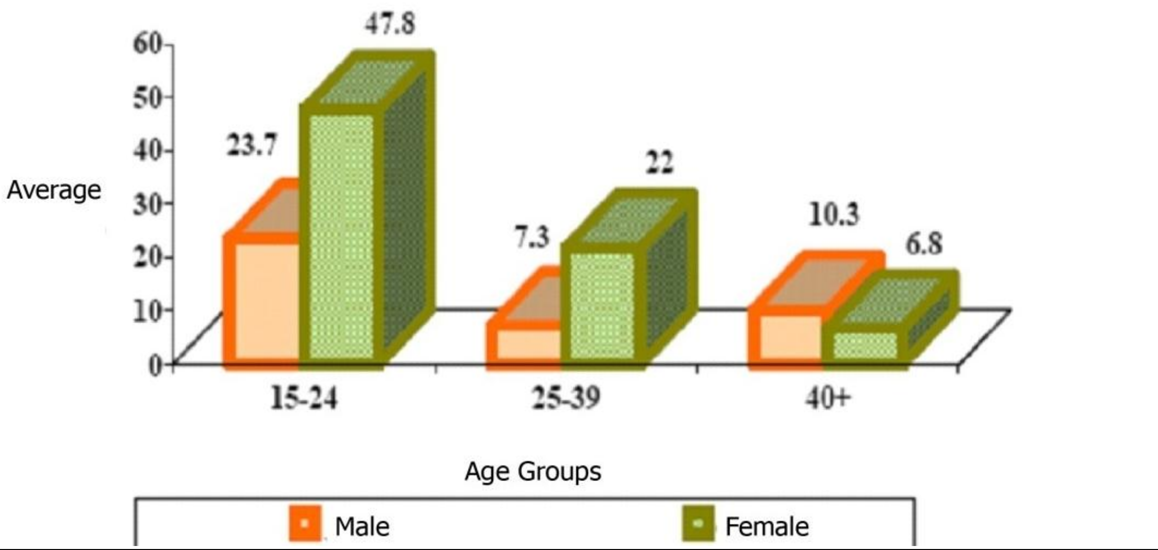


Figure 15-3: Unemployment in Jordan according to age and gender (2007)

15.5.1.3 Education

The main educational institutions in Jordan are the Ministry of Education, the private sector and the Armed Forces, which provide this service to the remote areas in the country. Furthermore, the United Nations Relief Agency (UNRWA) provides educational services to Palestinian refugees in Jordan. The distribution of schools, students, and teachers among such providers during 2007 - 2008, are shown in Figure 15-6.

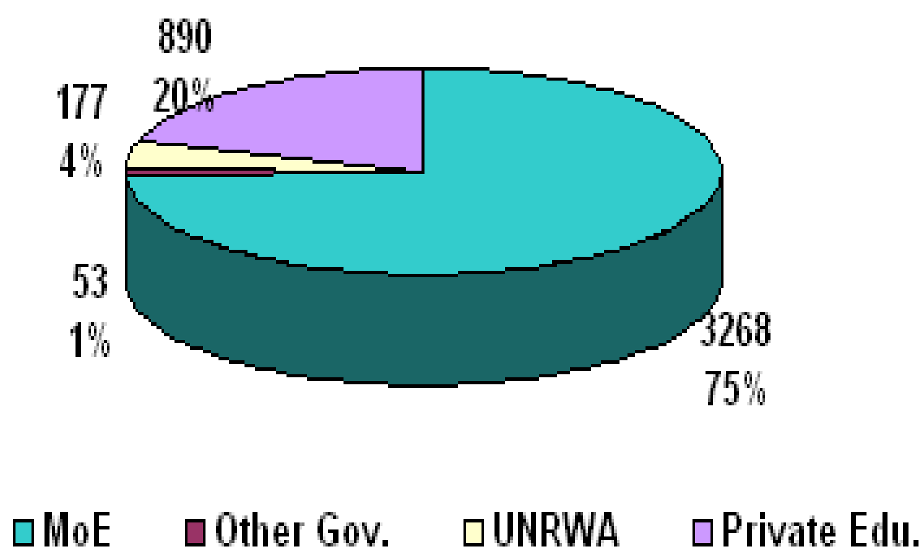


Figure 15-4: Distribution of schools in Jordan by controlling authority (2007/2008)

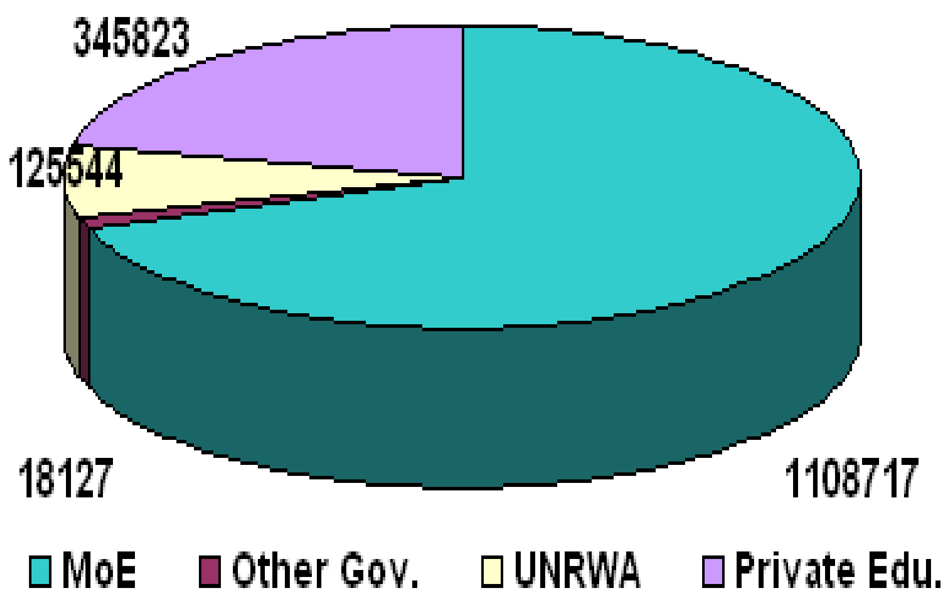


Figure 15-5: Distribution of students in Jordan by controlling authority (2007/2008)

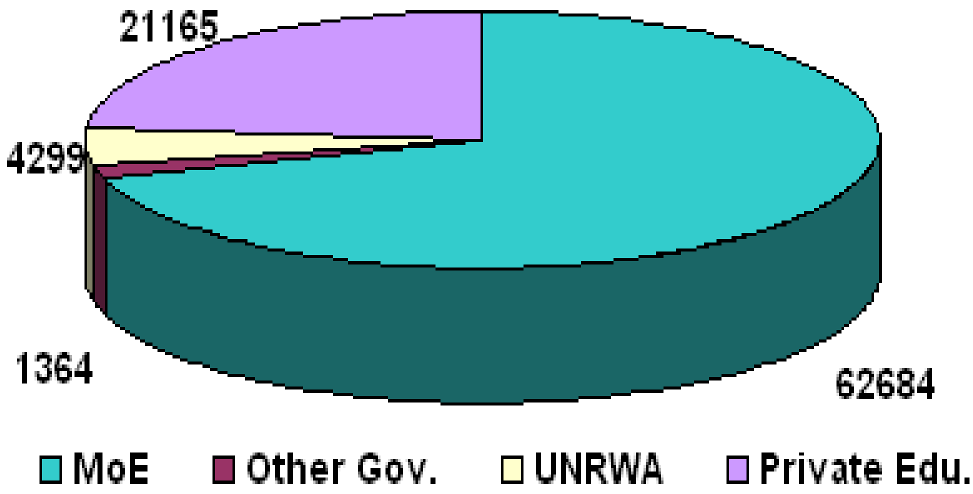


Figure 15-6: Distribution of teachers in Jordan by controlling authority (2007/2008)

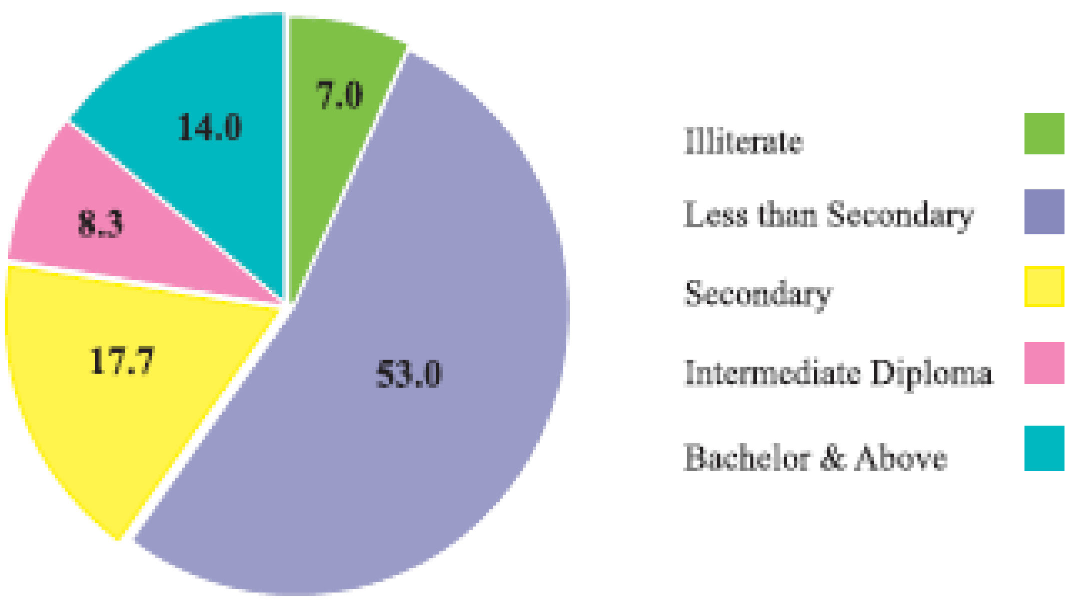


Figure 15-7: Relative distribution of education levels among 15+ population in Jordan (2010)

The educational levels in Jordan consist of:

- Kindergarten (2 years);
- Basic education (10 years);
- Secondary education (2 years);
- University education (length varies with degree).

In Tafila the distribution of students, teachers and schools is shown in the Table 15-5 through Table 15-8, as stated by Jordan Ministry of Education [15-3].

Table 15-5: Distribution of schools in Tafila Governorate, 2010/2011

Directorates	Kindergarten			Basic.			Secondary		
	Male	Female	Combined	Male	Female	Combined	Male	Female	Combined
Tafila	0	0	12	15	1	48	13	5	9
Bsaira	0	0	3	5	3	18	5	0	3

Table 15-6: Distribution of teachers in Tafila Governorate, 2010/2011

Directorates	Kindergarten		Basic.		Secondary	
	Male	Female	Male	Female	Male	Female
Tafila	0	65	405	866	185	193
Bsaira	0	13	132	269	61	59

Table 15-7: Distribution of students in Tafila Governorate, 2010/2011

Directorates	Kindergarten		Basic.		Secondary	
	Male	Female	Male	Female	Male	Female
Tafila	785	723	7,928	7,491	1,253	1,368
Bsaira	201	165	2,687	2,593	420	487

Table 15-8: Distribution of schools in Tafila Governorate

	Ministry of education		Private schools		Total	
	Urban	Rural	Urban	Rural	Urban	Rural
Male	23	15	0	0	23	15
Female	3	6	0	0	3	6
Co-ed	29	45	10	9	39	54

15.5.1.4 Housing

Housing in Jordan varies from small dwellings to large villas, with the total number of housing units in Jordan being estimated at about 1,221,055 in the year 2004. According to [15-2], in Tafila Governorate, the total number of housing units reached 16,785 for the same year. The details are provided in Table 15-9. It should be noted that as far as can be seen, no permanent tribal settlements exist in Tafila Governorate. As in most of the Jordanian and Arabian deserts, seasonal crossing of nomadic tribes may occur.

Table 15-9: Distribution of housing units in Tafila Governorate, 2004

Type of housing	Total
Conventional (House, Apartment, Villa)	16,209
Mobile (tents)	236
Marginal (Barracks)	2
Business establishment	12
Under construction	326
Total	16,785

The cost of living in Jordan is increasing rapidly but it is still less than in more industrially-developed countries in the Middle-East North Africa (MENA) area with an inflation rate of 5.0% (2010). According to the Jordan government, the utility prices as of January 2012 are as follows: unleaded gasoline (90) 0.620 JD per liter, super unleaded gasoline (95) 0.785 JD per liter, diesel JD 0.560 per liter, kerosene JD 0.560 per liter and gas 6.500 JD per cylinder (17 kg). Electrical current operates at 220 volts/50 Hertz.

Table 15-10: Water prices, January 2012*

Water quantity	Water consumption	Sewage produced
Household monthly consumption level [JD/m³]	[JD / m³]	[JD / m³]
0 – 6	0.700	0.200
7 – 12	0.145	0.040
13 – 18	0.500	0.250
19 – 24	0.850	0.450
25 – 30	1.000	0.600
31 – 42	1.400	0.700
43 and more	1.600	0.800

* Water is subsidized; average consumers pay about 50 % of the above costs

Table 15-11: Electrical prices as of January 2012

Consumption [kWh / month]	Price [fils / kWh / month]
Household consumption	
1 – 160	32
161 – 300	72
301 – 500	86
501 – 750	114
751 – 1,000	135
1,000 and more	174
Commercial consumption	
1 – 2,000	91
2,001 and more	106
Industrial consumption	57
Agricultural consumption	60
Water supply	54
Hotels	98

15.5.2 Health services

The standard of health services in Jordan is among the best in the region. As per year 2006, there were 13727 doctors, which represented a rate of 24.5 doctors per 10,000 of population. Other health indicators are included in Table 15-12and Table 15-13, as indicated in the annual statistics report 2010 of the Jordan Ministry of Health [15-4].

Table 15-12: Medical human resources in Jordan and Tafila, 2006

Personnel	Tafila	Jordan
Doctors	252	13,727
Dentists	35 (Ministry of Health only)	4,597
Pharmacists	19	6,722
Nurses	136	9,578
Assistant nurses	624	7,382
Legal midwives	62	1,525

Table 15-13: Health services distribution in Jordan and Tafila, 2010

Indicator	Tafila	Jordan
Hospitals	1	106
Hospital beds	120	11,273
Comprehensive health centers	4	84
Primary health centers	10	368
Village health centers	8	368
Maternity centers		432
Dental clinics (MOH)	14	369

15.5.3 Land use

This section will cover the major land use in Jordan including the Tafila Governorate as extracted from [15-2] as follows:

15.5.3.1 Agriculture

The total area of suitable land for agriculture in Jordan is 8.7 million dunums, about 10 % of the total area of Jordan (89 million dunums). Only 2.6 million dunums (31 %) of suitable land and only 3% of the total Jordan are used for agriculture due to scarcity of water resources. Jordan is considered one of the ten poorest countries in the world in terms of water resources. Characteristics of land which supports agriculture, forests or grazing in Jordan and the Governorate of Tafila for the year 2010 are shown in Table 15-14.

Table 15-14: Comparison of green land use between Jordan and Tafila Governorate, 2010

Area	Total area	Irrigated planted land area	Non-irrigated planted land area	Designated as forest land area	Grazing land reserves
Jordan	88,747,500	1,021,863.5	2,266,857	1,305,490	741,700
Tafila	2,253,500	20,409	27,018	114,570	20,000

It should be noted that land designated as forested land is not necessarily fully covered by forests.

Table 15-15 shows the planted areas in Tafila Governorate in comparison to Jordan and highlights irrigated land and non-irrigated land.

Table 15-15: Distribution of planted areas (dunums) in Jordan and Tafila Governorate, 2010

Crop	Jordan		Tafila	
	Irrigated	Non-irrigated	Irrigated	Non-irrigated
Fruit trees	270,705	236,273	3,560	3,908
Grain crops	40,938	958,433	60	7,450
Vegetables	415,087	32,883	8,557	0
Olive trees	295,134	1,010,036	8,195	15,660

The challenge facing the agricultural sector is its low contribution to the gross domestic product (GDP) while at the same time consuming about 60 % of the water resources in Jordan. Such contribution is boosted by irrigation and technological advancement in farming methods and the use of other water resources such as reclaimed water in irrigation. Reclaimed water reuse is not yet practiced in Tafila.

In Jordan, natural grazing lands, as well as barley and hay production from grains and legumes comprise the main forage production to maintain livestock during winter. In 2010 there were almost 3,188,470 animals in Jordan, of which 67,790 were cows, 2,258,680 were sheep, 849,000 were goats and 13,000 were camels. In Tafila Governorate, livestock included 91,060 sheep, 36,210 goats and 180 cows during 2010.

15.5.3.2 Industry

Large-scale industries in Jordan include mining and the industrial production of cement, fertilizers and refined petroleum.

For 2010 the overall contribution of the industrial sector in Jordan to the GDP was about 25 %. The industrial exports represent about 90 % of the national exports. The industrial enterprises are estimated to 16,000 enterprises, of which the small and medium size businesses represent 98.7 %. This industry employs more than 186,172 workers representing about 15 % of the total Jordan work force.

During the year 2010, the size of industrial production based on fixed prices reached about 2102.00 million JDs at a rate of 4.67 % of the year 2009. That was due to the increase in mining industry production by about 32.4 %. On the other hand and based on current prices, industrial production have reached about 4,548.2 million JDs during 2010 as compared to 4,161.7 million JDs during 2009 which was about 9.29 %. In the year 2011, industrial production quantities decreased by 0.3 % and prices rose by 14.7 %.

Table 15-16: Industrial activities in Tafila Governorate, 2010

Type	Number
Mining and cement	6
Food and drinks	34
Textiles and clothing	22
Wood industry for construction	14
Copying and printing	1
Non-metal and glass products	18
Metal and metal electroplating products	30
Furniture manufacturing and assembly	15
Construction and building assembly	6
Automotive mechanics, service and trade	91

15.5.3.3 Tourism

In recent years, tourism has been the focus of study and research in Jordan. In the analysis of tourism, economists emphasize the economic effects of tourism on the economy. The speedy growth of tourism causes an increase of household incomes and government revenues through multiplier effects, improvements in the balance of payments and growth of the tourism industry. In Jordan, tourism industry has grown significantly. The industry makes a substantial contribution to the Jordanian economy accounting for 10.6 % of the GDP in 2009. Employment in the tourism cluster, including direct and indirect employment, was estimated at around 130,000 in the year 2009, about 11 % of the work force.

Tourism development in Jordan is aided by the existence of many internationally well-known historical sites, for example Petra and the Dead Sea. Important historical and touristic sites, such as the Afra Mineral Spa Area are also located in Tafila Governorate. In addition to its well-known therapeutic value, the spa area has a historical perspective due to the existence of an old Byzantine church from the sixth century. A total of 23,570 visitors were registered during the first nine months of the year 2010, where about 1,828 visitors were non-Jordanians. In comparison, for the same period during the year 2011, about 32,509 visitors were registered, of which about 4,268 were non-Jordanians. This represents an average increase of 37.9%. Another historical site is the Sala'a Castle which is located about 15 km to the southwest from Afra Spa and about 1 km west of Ain Al Baidaa. The castle overseas the Sala'a traditional village which is built using mud and stone and which is surrounded by fruit and olive trees.

One site in Tafila reflecting ecotourism is Dana Biosphere Reserve. This nature reserve (further described in chapter 6) was established in 1989 as the largest and first natural reserve in Jordan. Its total area is about 300 km² near Al-Kadesiya. It lies about 4.1 km from the location of the planned wind park project. It constitutes the only reserve containing all four biodiversity geographical regions, namely, Mediterranean, Irani-Torani, Arab desert and Sudanese. It is considered that about 800 plant species, of which 3 only exists in Dana Biosphere Reserve, are growing in this area. The reserve contains lodging services within its Guest House, Al-Rummana Camp, and Finan lodge. In 2010, visitor numbers reached 3.2 million.

15.5.4 Infrastructure

The following infrastructure key indicators are considered to be relevant to establish economic conditions.

15.5.4.1 Transportation

Different transportation types are available in Jordan and they are categorized and published in the Central Traffic Directorate annual statistics report 2009 [15-5] as follows:

- Air transportation: Jordan has three airports; two of them are in Amman (Queen Alia International Airport and the Amman Civil Airport). The third is the King Hussein International Airport in Aqaba. Total airplane movement in the three airports have reached a total of 71,241 airplanes in and out during the year 2009 which is an increase of about 108% compared to the year 2000.
- Sea transportation: Aqaba is the only port in Jordan. Most of the imported and exported cargo is transported through this port. In addition, the port is used for passengers traveling by boat in and out of the country. A total number of 2,933 ships have moved in and out through Aqaba carrying total cargo of approximately 16,383 tons in 2005.
- Land transportation: The road network in Jordan has progressed in terms of design, construction and maintenance. The total length of the network in Jordan was about 7,891 km in 2009; divided into three types of roads (highways, secondary roads and village roads) as shown in Table 15-17 for Jordan and Tafila. Part of that network is a major desert highway that runs between Amman and the port at Aqaba. It serves as the main route through Jordan to the sea and is used to transport many goods for export.

Table 15-17: Length of roads network in Jordan and Tafila, 2009

Type of road	Jordan [km]	Tafila [km]
Highway	3,249	195
Secondary	2,173	93
Village	2,469	151
Total	7,891	439

The number of vehicles operating in Jordan has reached about 994,561 in the year 2009. The number of operating vehicles in Tafila Governorate was about 3,097, including private vehicles. The number of service transportation vehicles in Jordan was about 7,891 as compared with Tafila, where about 488 vehicles including taxis, mini-buses, and buses were in operation (Table 15-18).

Table 15-18: Number of vehicles with respect to type in Jordan and Tafila, 2009

Type of vehicle	Jordan	Tafila
Service taxi	3,739	--
Mini bus	3,017	97
Buses	488	--

Railway transport in Jordan is managed by the Hijazi Railway and the Aqaba Railway Corporation. The length of the railway network in Jordan is about 452 km. Currently, the railway is not a very effective transport system, but Jordan is aiming to expand its railway system to integrate it into the transnational ones. Hijaz Railway is used for transporting merchandise between Jordan and Syria and for tourism purposes. This included about 32 trips taking about 905 passengers as well as 169 school trips carrying about 22,986 students in 2009. On the other hand, the Aqaba Railway (292 km in length) is used for the transportation of Jordanian phosphate from Hasa to Aqaba. The total number of loaded trains with phosphate was about 1,641 during 2009.

A planned light railway system is under consideration to connect Amman with Zarqa, the second largest city in Jordan. It will be designed mainly for passenger transportation.

15.5.4.2 Water resources

It is the role of the Water Authority of Jordan to manage the distribution of water according to set schedules. In 2010, the quantity of the water production in Tafila Governorate was around 5,011,528 m^3 as compared to the water supply of 4,971,139 m^3 leading to about 159 liters per day per person. In comparison the average share per capita per day in Jordan as a whole was 147 liters.

Water resources within the Governorate of Tafila consist basically of about 74 springs and one dam, Al-Tanour. The dam is located in Wadi (Valley) Al-Hessa and has a storage capacity of 16.8 million m^3. The amount of water flow in the dam was about 4,753,390 m^3 and the amount flowing out of the dam was approximately 2,691,524 m^3. Its water is basically used for irrigation as well as the industrial process of potash chemical plants in the Jordan Valley through Wadi Al-Hessa. An estimated amount of 27,447 m^3 flowed through Wadi Al-Hessa into the Jordan Valley during the year 2010.

The amount of rain in Tafila was at an average of 152.9 mm with a range between 70.3 mm in Jurf Al-Daraweesh and 240 mm in Al-Rashadeya.

15.5.4.3 Telecommunication

Jordan has a highly developed telecommunication infrastructure; it is growing at a very rapid pace and is continually updated and expanded. Jordan's telecom industry remains the most competitive in the Middle East. More than 96 % of the households have at least one main line telephone. Main lines in use have reached 622,600 (as of 2003). On the other hand about 103 % of the population has a mobile phone and 15 % have more than one. The number of mobile phones in the country reached 6,250,000 in September 2010.

More than 40 % of Jordanian households have a personal computer (PC). This is expected to double in the coming years when the government reduces the sales tax on PCs and internet services in an effort to make Jordan the high-tech capital of the Middle East. The Jordanian Government is also providing every university student with a laptop in partnership with the private sector. All Jordan schools are connected with internet service. The Jordanian Government is heavily investing in the purchase of computers and advanced technology to equip Jordan's classrooms.

In March 1996, Jordan joined the information superhighway with the launching of on-line Internet services through Sprint Telecommunication. Jordanian companies have been providing Internet services through local networks since 1994. The number of subscribers among individuals and companies is growing very rapidly. The trend has caught on quickly in the country, and many local companies are turning to the Internet as a solution to their communication strategy and for access to the wealth of information available on-line.

About 45 % of Jordan's population has access to the internet as of September 2011, a high figure for the region. Internet usage more than doubled from 2007 to 2009 with the rapid growth expected to continue. Jordan has more internet start-up companies than any other country in the Middle East. The Jordanian government has recently announced that the sales tax on computers and internet connection will be removed in order to stimulate the information and communication technology (ICT) industry in Jordan further. There were 3,160 Internet Service Providers (ISPs) in Jordan in 2004. Internet users have reached about 2.8 million in Jordan (as of September 2011). By 2011, Jordan will have a 50% internet penetration rate, 35,000 employed in the ICT sector, and over $3 billion revenues.

15.5.4.4 Economy

Due to the international financial crisis of 2009, Jordan was forced to decrease the deficit in its budget and total debt by decreasing its capital expenditures. During 2010 economic activity showed signs of modest recovery of about 3.15% during 2010 as compared to 2.3% during the year 2009, due to developments in the industrial and transportation sectors. Industry has provided about 25 % of the total GDP. The service sector, which is comprised of financial services, trade, transportation, communication, tourism, construction and education, as well as agriculture contributed 75 % of the GDP and employed two-thirds of the labor force, as estimated by the economic situation evaluation committee.

The main economic indicators in Jordan for the year 2010 are shown in Table 15-19.

Table 15-19: The main economic indicators for 2010 [15-2]

Indicator	2010
Growth rate of GDP at fixed producer prices	3.1 %
Growth rate of GDP at current producer prices	9.6 %
Total production at fixed prices	98,086 Million JDs
Total production at current prices	195,279 Million JDs
Inflation rate	5.0 %

Table 15-20: Indicators of national trade balances, 2010 [15-2]

Indicator	2010
Trade balance (goods only)	-5,849.8 Million JDs
Net trade balance (goods and service)	-3,993.9 Million JDs
Exports of goods and services	8,650.8 Million JDs
Imports of goods and services	12,644.7 Million JDs
Percentage coverage of the exports to imports	46.0 %
GDP per capita	3,194.5 JDs

Table 15-21: Average growth rates according to economic sectors in fixed prices, 2010 [15-2]

Sector	Rate
Agriculture	8.2 %
Industry	4.7 %
- Mining industry	32.4 %
- Other industry	2.3 %
- Energy (water & electricity)	-0.2 %
Construction	-8 %
Trade, restaurants and hotels	5.7 %
Transportation and communications	2.6 %

15.5.5 Semi-nomadic tribes

In Ghazi bin Muhammad's 1999 study " The tribes of Jordan," he defines semi-nomadic tribes as "all Jordanians of east bank origin who are ethnically Arab and either Muslim or Orthodox Christian belong to a tribe, be it traditionally Settled (that is, urban dwellers and / or farmers and peasants) Semi-Nomadic (that is, who move only twice a year and within a limited area, and rear sheep / goats / camels) or Bedouin (that is ´fully nomadic´, i.e. who move thousands of miles into the inner deserts of Arabia and rear camels)" [15-1].

The material above is partly reflective of the breakdown of lifestyles, with a few important corrections:

- There are very few, if any "fully nomadic" people, either in Jordan, or anywhere throughout the Arabian Desert area. "Fully nomadic" was essential at a time when people were entirely dependent on their natural surroundings, for example the prevalence of water for livestock. In current times, this need to be "fully nomadic" has been reduced or eliminated, as the advent of water wells / pumping, permanent structures (i.e. houses, some of which were provided by the government), and bagged food for livestock has reduced the requirement to fully transplant one's presence into a different area in order to support a living during different seasons.
- Traditionally settled and semi-nomadic are the prevalent types of lifestyle, with the vast majority being "traditionally settled." Even those considered "semi nomadic" may own a house in one or all of the areas which they choose to settle in for the year. The choice to settle in a tent does not in any way imply that these people do not have access to permanent dwellings of their own.

- Semi-nomadic is actually a lifestyle borne of economic necessity, specifically livestock raising (sheep and/or camel herding), and again is not the only option, or even preferred option for the people which do choose to reside in tents in the area. The residents of these tents in the summer months usually live for a day or two in the tent, after which being replaced by another family member who assumes the duties of maintaining the livestock which is being raised, confirming that this is in fact a living situation connected to a business operation.
- The term “Bedouin” now represents a culture, not necessarily a lifestyle. Families that identify with Bedouin roots are now in fact often very urbanized. While they still identify with their origins in the Bedouin lifestyle, most are urban-dwelling, own homes and businesses in major cities, and for all purposes are identical in socioeconomic status to other Jordanians.

15.5.5.1 Semi – nomadic and Bedouin characterization

Given the above, the terms “fully settled” and “semi-nomadic” are used to describe the people in the area throughout the ESIA and the corresponding documents, although “semi-nomadic” in itself overstates the transience of the lifestyle.

“Bedouin” is a difficult term to define and apply in the current socioeconomic makeup of Jordan, and given that families affiliating with Bedouin roots have chosen to pursue urban lifestyles, there is no precise definition of how a Bedouin’s lifestyle in Jordan is actually characterized. Nevertheless, In Ghazi bin Muhammad’s study [15-1] gives on overview on the different groups of Jordan regional tribes.

The people in the Tafila wind farm area are known to be mostly fully settled, with occasional groups choosing to live a semi-nomadic lifestyle. The leaders of the tribes which these people identify with, along with several of the actual people who reside seasonally in the tents in the project area were contacted and invited for the public exhibition during which their views were gathered on the project and their thoughts regarding the potential impact from construction and operations of the project, such as visual and noise impact. Seven tribal leaders (some of them were elected as head of the local council), attended the public exhibition. Three of these tribal leaders reside periodically at the area of the Tafila wind farm in tents. The general consensus, after the impacts were explained, was that the wind farm would bring far more positive impacts to the area than negative, and that the semi-nomadic people of the area would actually benefit from the increased economic activity, improved roads, and social programs that the project is intending to implement.

It was also confirmed in discussions with these tribal leaders and residents of the area that during winter these semi nomadic people live in dwellings e.g. in the towns of Gharandil, Jurf Al Darawish, Bsaira, or elsewhere in Tafila, with some preferring to move to Ghohr area, in the Dead Sea Valley. During summer some of the people work as shepherds in the open space of the Governorate of Tafila and also in the area of the planned wind farm. Some live in tents in the summer time close to the grazing areas, as this is a choice of living conditions which brings them closer to their seasonal occupation, and saves them from having to commute back into the nearby town with their livestock.

In general the semi-nomadic people, or the tribes which they identify with, are not assumed to be vulnerable since they already settled down and most of them have other occupations beyond livestock raising (e.g. in military, civil service, etc.), almost all own houses or other permanent dwellings in towns and villages, and many are quite prosperous.

Further, Semi-Nomadic peoples, such as those which are seasonally present in the project area are considered not to be dependent on the natural resources existing in the wind farm area. The erection of the wind farm is not considered to destroy their livelihood, as the size of the agricultural / grazing areas will not be at all reduced due to the construction of the turbines, and a net benefit will actually be created from the jobs and additional revenue brought in the form of local spending.

15.5.5.2 Impact

The impact of the individual WTG to their environment is mainly characterized due to visual impact as well as noise and shadow flickering if the semi-nomadic people are on the land. For shadow flickering, a map was produced showing areas with low and high impact. The issue of shadow flicker, as well as turbine noise was explained on the public consultation, and the general consensus from those attending was that these impacts, while they are relevant impacts, they do not see the impacts as being a material impediment to the lifestyle of the semi-nomadic people in the area.

The wind farm is not considered to significantly affect the semi-nomadic tribes, again as was discussed and confirmed with the leaders of the tribes to which these semi nomadic people belong to, as well as conversations with the people who had erected tents in the area. The erection of the wind farm is not considered to destroy their livelihood because the size of the grazing areas will not be reduced due to the construction of the turbines, their crane pads and the roads. The access to the area is unrestricted and can be further used by the people for their livestock grazing operations.

For the purpose of protection from shadow flickering, a map was produced showing the areas where the impact is low. This map will be erected on signs in the vicinity of the wind farm the tribes can identify the best spot to reside.

15.6 Public consultation

Three different ways of participation procedure were used throughout the ESIA, to integrate stakeholders and residents into the process of the Tafila wind farm development:

- Scoping session and scoping report;
- Questionnaire in Gharandil;
- Public consultation meeting.

15.6.1 Introduction

In order to allow the public to contribute to the environmental assessment process, a scoping session was held in Amman at the Holiday Inn Hotel on December 5th, 2011. The scoping stage is the first step of the ESIA process. The results of the scoping session were presented and submitted to the Ministry of Environment in a separate scoping report. The results of the scoping related to socio-economic conditions are summarized in the following key points

- Land rehabilitation;
- Impact on land value;
- Economic benefits to local towns;
- Economic feasibility;
- Future housing plans for the area.

15.6.2 Socio-economic survey in Gharandil

With reference to the scoping session, a survey was conducted in Gharandil. A questionnaire was distributed among the residents of the surrounding area of the project. 22 families were consulted and filled the questionnaire concerning their socioeconomic status as well as their knowledge and understanding of the project and its consequences. The need for resettlement of any families or land acquisition, were discussed. The results of the survey are summarized in Table 15-22, Table 15-23, and Table 15-24.

From the sample of 22 families, it is seen that the local residents' main jobs are in the military or civil service. Few are self-employed. Most have a side work in the agriculture by growing wheat and barley in the land that they own within or close to the project area. The interviewed persons have different educational levels, ranging from junior high school to master's degree.

The collected data showed that the average monthly income is quite modest (350 JD average), while the average family size reaches up to 14 members.

The energy cost can form a significant part of the expenses during winter, reaching up to 100 JD per month. Finally, there is a quite large number of family members (males and females) attending schools and higher education. The residents in general do not believe that the use of land for wind power will hinder their use of the land for agriculture (Table 15-24).

Results of energy matters showed no clear understanding of climate change and its effects (Table 15-23), however, all participants considered themselves environmentally friendly. All of them accept and encourage the use of renewable energy including wind energy and consider Tafila as a suitable location for such project due to its natural high wind speeds.

Table 15-22: Results of the socio-economic field survey

No. of persons interviewed	Total: 22	Male: 16	Female:6		
Age range		Males: 11 – 57	Female: 20 - 26		
Education	Junior high school: 12	High school: 6	Bachelor of science: 3	Master of science: 1	
Most recent job	Retired: 5	Military: 8	Civil worker: 6	Student: 1	Self–employed: 2
Family size	1 - 14	Male: 46 %	Female: 54%		
Individuals above age18	52	Workers: 22			
Level of education of family members	JR. High: 24 Male: 15 Female: 9	High School: 44 Male: 21 Female: 23	BS.: 17 Male: 4 Female: 13	MS.: 2 Male: 1 Female: 1	Illiterate: 9 Male: 1 Female: 8
Average monthly income	210 – 450 JD (avg. 350 JD)				
Main energy source	Electricity: 22	Winter costs: 15 – 100 JDs	Summer costs: 10 – 50 JDs		
No. of family members attended a technical college / training	None				

Table 15-23: Feedback of local residents on current energy issues and renewable energy use

Question	Answer
Would you consider the common energy use in Jordan as "environmentally friendly"?	Yes: 22
How do you suggest we can improve?	• Pollution prevention using solar energy; • Pollution prevention using natural resources.
What is your opinion regarding renewable and cleaner energy, mainly wind?	Excellent and clean source of energy: 22
Do you support the use of wind energy in Jordan?	Yes: 22
Do you like the way wind farms look? What do you know about the "Wind Energy Project" to be constructed near Gharandil in Tafila Governorate?	Yes: 22; I think it looks good. Yes: 22; I heard about the project since I own a piece of land within that area.
Do you feel that the wind farm site in Tafila is a good location for a wind farm?	Yes: 22 because of the mountainous area with high winds.
Are you in favor of using wind energy in Tafila Governorate? Why/why not?	Yes: 22 because it is expected to rejuvenate the area and decrease pollution.
Would you support the project?	Yes: 22
List key points you consider as advantages of the project.	• Economic benefits and reduction of costs to the country, citizens, and area; • Energy savings; • Clean and environmental friendly by avoiding using other polluting sources; • Permanent and natural; • Renewable and natural source; • Area rejuvenation.
List key points you consider as disadvantages of the project.	None (Negative)
Are you interested in further information on wind energy	Yes: 22
Are you interested in further information on the wind farm project in Tafila	Yes: 22

Table 15-24: Local residents answer to land use matters

Question	Answer
Do you own land within the designated project area or close to it?	Yes: 22
Do you use land within the designated project area or close to it?	Yes: 8
If yes, what is the main use to it?	Wheat and barley production
Would the project significantly hinder your use of the land?	No: 8
Would it improve the land use pattern and comfort?	Yes: 8
Would the project affect your choice in using the land? Would it cause you to look for other places?	No: 8

15.6.3 Public consultation meeting

On the 12th November, 2012 a public consultation was conducted in the Dana RSCN Visitor Center in the vicinity of the Tafila wind farm area.

All interested persons were welcome to join this consultation and to ask questions on the project. The invitation for this event was commenced in three ways:

- Personal invitation of residents (Figure 15-11);
- Invitation via telephone;
- Public announcement (Figure 15-12).

On the consultation, the project was described and effects, either positive or negative, were discussed. An informative presentation was held in the Arabic language. The participants raised several questions which were directly responded and let to further discussions. The questions, answers and discussions were documented in minutes of the meeting, which can be found in Annex 11.

A questionnaire with seven project related questions was handed out. The questions were:

- What is your opinion of renewable energies?
- What is your opinion of wind energy?
- What is your opinion of a wind farm in Tafila?
- Please provide your comments and suggestions on the planned wind farm in Gharandil.
- Which effects do you expect of the planned wind farm?
- List key points that you regard as advantage of the planned wind farm in Tafila.
- List key points that you regard as disadvantage of the planned wind farm in Tafila.

The completed questionnaires are attached in Annex 4. The answers on the questionnaire are summarized in Table 15-25. The overall impression on the project was very positive. The planned wind farm is regarded to be beneficial for the area as it will provide clean renewable energy and create jobs. Some concerns were raised with reference to impacts on migratory birds.

Photos of the public consultation are attached in Annex 4.

Table 15-25: Answers on questionnaire during the public consultation meeting

	What is your opinion of renewable energies?	What is your opinion of wind energy?	What is your opinion of a wind farm in Tafila?	Please provide your comments and suggestions on the planned wind farm in Gharandil.	Which effects do you expect of the planned wind farm?	List key points that you regard as advantage of the planned wind farm in Tafila	List key points that you regard as disadvantage of the planned wind farm in Tafila
Questionnaire 1	It is a beneficial project for the region, because it part of an underserved region economically, and the population is low.	It is like an oil well for Gharandil.	It is very good, mainly for livestock growers and the population	It will be beneficial for the region in scence / agricultural aspects, and attract people who left Tafila back into the area.	We wish you luck.	This project will establish new knowledge for students in the field of energy	
Questionnaire 2	It is the only solution for environmental protection and to bring foreign investment to the area.	It depends on the wind movement and speed which generates energy.	It provides job opportunities for the local people, raises awareness for local residents, and important for the future.	It will increase awareness of wind energy importance and is very important for the local community.	It provides energy without pollution and reduces the maximum generation required from the other power plants in the country	Road paving in the wind farm area, local jobs, more purchases in local market for maintenance / supplies, etc.	Some birds will build their nests on the turbine

	What is your opinion of renewable energies?	What is your opinion of wind energy?	What is your opinion of a wind farm in Tafila?	Please provide your comments and suggestions on the planned wind farm in Gharandil.	Which effects do you expect of the planned wind farm?	List key points that you regard as advantage of the planned wind farm in Tafila	List key points that you regard as disadvantage of the planned wind farm in Tafila
Questionnaire 3	Very good concept, hard to capture though.	A very efficient way to generate electricity.	Good idea, if it is done properly.	Public awareness should be elevated to generate positive feedback	Lower energy bill	Provide a source of income for the local residents. Reduce dependency on fossil fuels Help the environment.	If the project failed to materialize.
Questionnaire 4	It is the safest alternative to conventional generation	Safe source for energy and considered as lowest impact on environment among all types of energy sources	I am a supporter of wind energy in my area, but as an environmentalist, I have some concerns regarding its impacts on migrating birds.	To assess the impact on birds, as close to the project area there is the 2nd most important route for bird migration.	Most of them are positive, first top is saving money on Jordan's energy bill.	Lowering energy bill in Jordan. Employing local people.	It may have a negative impact on the biodiversity, esp. birds of prey.
Questionnaire 5	It is safe energy, and the country is suffering from a lack of energy, so I wish to see it implemented all over the country.	Safe, lower costs,	It is a good experiment. I wish it to succeed because the area under consideration is far from houses.	Great idea. In my experience in the region I don't think that area will have development soon.	It will supply energy continuously and with low cost	Easy to connect electricity (!?) Lower cost Continuity of generation (no blackouts).	

	What is your opinion of renewable energies?	What is your opinion of wind energy?	What is your opinion of a wind farm in Tafila?	Please provide your comments and suggestions on the planned wind farm in Gharandil.	Which effects do you expect of the planned wind farm?	List key points that you regard as advantage of the planned wind farm in Tafila	List key points that you regard as disadvantage of the planned wind farm in Tafila
Questionnaire 6	It is clean energy, sustainable and reliable. It is the energy that will be used to generate electricity in case Jordan runs out of oil and gas.	Clean energy, available and cheap	In that farm (area), wind is available most days of the year, and it is not too strong.	Creates job opportunities for local community and helps in community development.	The effect will be positive, with good return for the region.	The citizens will be interested in establishing the project, on the condition that more information is provided.	The effect on the land, and reducing the agricultural area, and possible problems from not including the local residents
Questionnaire 7	We think it is a new thing (wind energy), but people have been using it for ages. Thank god!	It's the perfect alternative for energy, and has positive impact / results	Choosing Tafila for choosing this Project …(sentence was not completed)	It's OK, and we welcome it. (the wind farm in Gharandil)	Each action has a positive and negative, but this project has many more positive than negative parts.	Helping the local people, mainly in the form of jobs and scholarships.	Almost no negative side or very neglible compared to the positive.
Questionnaire 8	It is a good project, and Jordan is in desperate need of the project.	We hope that this valuable project will be finished ASAP.	It is a good project.	I have no comment, other than that we should go forward with this project.	There are no negative effects of the project.	All points are very good.	The owner should have shares in the project according to their land ownership.
Questionnaire 9	It is a good project for the area.	A future benefit	Good project in Gharandil and Tafila				

	What is your opinion of renewable energies?	What is your opinion of wind energy?	What is your opinion of a wind farm in Tafila?	Please provide your comments and suggestions on the planned wind farm in Gharandil.	Which effects do you expect of the planned wind farm?	List key points that you regard as advantage of the planned wind farm in Tafila	List key points that you regard as disadvantage of the planned wind farm in Tafila
Questionnaire 10	It is a creative and constructive idea; it will reduce the energy bill if actually implemented. It will reduce the effect of fossil fuel on the government. All this will help to reduce the deficit, which will enhance the living standards for people.	It's a successful, safe, and right technique for the environment and its components	It's a successful project and constructive. It will have a positive outcome.	No comment, except move forward and may you succeed!	Reducing the electricity bill, reducing fossil fuel impacts, reducing the imported energy from abroad.	See what is mentioned in #5	There are no negatives, esp. if the public safety is accounted for and kept in mind.
Questionnaire 11	It's a good and beneficial idea.	It is a successful process, safe, and good for the environment	Successful project.	Successful project with a good aim, and promising	Creating job opps for the region, and local community benefit. Reducing the electricity bill, too.	See my other answers	No negative points.
Questionnaire 12	I have a positive opinion, and I say continue with this important project.	Wind energy is excellent, cheap, serves the country, and reduces the oil bill for the country.	The wind energy project is a successful project.	The project contributes to the alternative energy in the country, and it is an inexpensive project because land is cheap.	I don't see any negative sides to the project – Serving Bsaira area and local community	Renewable energy availability	No negative points

	What is your opinion of renewable energies?	What is your opinion of wind energy?	What is your opinion of a wind farm in Tafila?	Please provide your comments and suggestions on the planned wind farm in Gharandil.	Which effects do you expect of the planned wind farm?	List key points that you regard as advantage of the planned wind farm in Tafila	List key points that you regard as disadvantage of the planned wind farm in Tafila
Questionnaire 13	We welcome the project and thank all the people who are serving humanity.	The essence of the smart ideas to serve humankind.	It is a positive and excellent project.	To recruit local residents first before people from outside of Tafila.	Serving people, the homeland, and the environment	Everything about this project is beneficial, and people who are working on it will be compensated by god.	There is no harm from the project, and the project is full of benefits.
Questionnaire 14	We should produce renewable (wind) energy, which is available in the mountains of Bsaira and Tafila.	Wind Energy serves humankind good health, and clear minds. So, it will give humans clear minds and create smart ideas to serve humanity.	It is a sustainable development project, to serve local communities and help the country to generate power.	I hope this project will get through and be developed to open new job opps and have a clean environment	Public awareness and preserving human safety, esp. that Bsaira is a promising area.	Using the new technology to serve humanity, and find new jobs for the local community. Preserving the environment, as well.	All what the project aims for is positive, and I wish that the project will continue on. ‘if you try to count the gifts of life, you will never be able to do so’ [Quote from Koran]

	What is your opinion of renewable energies?	What is your opinion of wind energy?	What is your opinion of a wind farm in Tafila?	Please provide your comments and suggestions on the planned wind farm in Gharandil.	Which effects do you expect of the planned wind farm?	List key points that you regard as advantage of the planned wind farm in Tafila	List key points that you regard as disadvantage of the planned wind farm in Tafila
Questionnaire 15	It is a type of energy that does not require fuel, and it is environmentally friendly. But we have to focus on the biodiversity and do the required studies for that.	It is a new type of energy, which can be used to generate electricity for Jordan, which is important for investment.	It's very important, mainly to help serve local communities and creates economic benefits for the people and job opportunities.	No comment, but I wish that the company will do socioeconomic study for the region and to include community development programs.	The region will be famous for energy production, and it may affect immigrant birds.	Good reputation for the region Creating job opportunities Development programs for the local residents	Noise, aesthetics, effect on birds.
Questionnaire 16	Excellent.	Beneficial for the region	Beneficial for the citizens	We hope to preserve the tents in the area.	Priority for local residents in jobs.	Creating energy resource	There are none.
Questionnaire 17	Clean energy that helps the community	Sustainable source of energy	Helps the community to develop	To preserve the livestock resources in the area.	To provide help for livestock owners.	Energy conservation and the benefit of having electricity.	To use guards for the project?

15.6.4 BirdLife International

BirdLife International (BirdLife), one of the stakeholders attending the scoping session, was highly interested in the project. Another meeting took place in January 2012 and further cooperation in the project has been discussed.

Throughout the planning process of the Tafila wind farm, BirdLife was invited to comment on the different ecological aspects of the project. BirdLife was invited to the Lenders meeting in October, where first comprehensive results of the environmental study were presented. Before submission of the ESIA, BirdLife and RSCN were asked to comment on mitigation and avoidance measures as listed in the biodiversity chapter of the environmental and social impact assessment.

15.7 Impact assessment

15.7.1 Issues and concerns

The evaluation covers all phases of the project including construction, operation and decommissioning. Additionally the following interactions resulting from the surveys will be accounted for:

- Land rehabilitation;
- Impact on land value;
- Economic benefits to local towns;
- Economic feasibility;
- Future housing plans for the area.

15.7.2 Evaluation of impacts

A summary of the evaluation of potential impacts on socio-economic conditions is presented in Table 15-26.

Table 15-26: Evaluation of impacts on socio-economic conditions

Impact	Geographic extent	Level	Frequency	Duration	Direct (D) Indirect (ID)	Reversible (R) Irreversible (IR)	Likelihood	Significant	+ / -	Remarks
Employment and benefits	H	M	H	H	D	-	M	Yes	+	Encourage where possible
Business prosperity	M	M	M	H	ID	-	M	Yes	+	Encourage where possible
Land acquisition	L	L	L	L	L	-	L	No	+	No Mitigation
Expected revenue to the Governorate of Tafila	L	M	H	H	H	-	H	Yes	+	No Mitigation
Stress on infrastructure	L	M	M	L	D	R	M	Yes	-	Mitigation measures are required. A dedicated study is being carried out
Land use	L	L	L	L		-	L	No	+	No Mitigation
Visual impact	L	M	H	H	D	R	H	No	+	No Mitigation
Impact on tourism and hunting	L	L	L	H		-	L	No		No Mitigation

Table 15-27: Significance criteria for Table 15-26

Geographic extent	L	Limited to project site	M	May reach outside the project site	H	Will reach outside the project site
Level	L	Will not change existing level	M	Will change existing level slightly	H	Will change existing level severely
Frequency	L	Occurs only once / rarely	M	Occurs during abnormal conditions	H	Occurs continuously
Duration	L	During specific activity	M	During construction phase	H	During operational phase continuously
Likelihood	L	Impact is not likely to occur	M	May occur	H	Will occur

15.7.2.1 Employment

During the construction phase, the proposed project is expected to employ skilled and unskilled laborers. It is expected that construction contracts related to the project site preparation, installation of infrastructure, construction of internal roads and such works will be awarded to regional contractors. Therefore, opportunities for regional employment during the construction phase are expected. As it was stated in a letter from the developer to the Ministry of Labor, dated the 4th of November 2012, the following benefits are expected in terms of Employment:

- 4 local Tafila residents already working full time on land acquisition and equipment security during the development phase
- This number is anticipated to increase as the project develops further.
- In addition to these full time staff, the project contracts for local labor for equipment installation, local materials, office space and assistance in field studies.

For the protection of the turbines security guards for the wind farm, as well as few local people for supporting the operation of the turbines hired. There will definitely be direct opportunities for local employment. At the construction and operation stage it is anticipated that the following amount of staff will be hired. Up to 50 employment opportunities for local residents are expected to be available. This contributes to a positive social and economic impact.

Construction Period Employment [Tafila Area]		
	Local	**Foreign**
Construction Mgmt., Engineering	3	4
Erection Works	5	15
Construction Works	45	5
Support, Security, Other	20	5
Commissioning Works	3	10
Total	**76**	**39**
Note: Different phases may require different numbers of workers, therefore the above numbers are given as a total of the number of workers on different phases, not the number of workers on site at a given time.		

Figure 15-8: Social benefits of the Tafila wind Farm during the construction phase (as presented in a letter from the developer to the Ministry of Labor)

During the operation phase, the wind park will be designed to operate automatically. Still, it will require permanent staff, such as technical specialists. It is expected that local skilled technicians will be given the opportunity for employment as much as possible, as shown in Figure 15-9.

Operations Period Employment [Tafila area]		
	Local	**Foreign**
Technical Operations	3	3
Commercial Operations	3	0
Maintenance works	4	2
Support, Security, Other	8	1
Total	**18**	**6**

Figure 15-9: Social benefits of the Tafila wind farm during the operation phase (as presented in a letter from the developer to the Ministry of Labor)

15.7.2.2 Land use and future housing plans in the area

The project site is vacant of residential houses. A large portion of the land is owned by the Government of Jordan while some parcels of land are privately owned. Local residents use the land for wheat and barley production. Such land will not be affected and their owners will continue its use for that purpose. This has been agreed upon in the land leasing agreements.

The land use and future expansion in housing shall not be an issue for the project area as it is designated an agricultural land where densely housing is not expected. However, the municipality should take the location of the wind turbines in any future permission of buildings even within the agricultural area. Possible negative impacts such as shadow flickering and noise on residential areas will be handled in other chapters of this ESIA. Impacts are not expected.

15.7.2.3 Business prosperity

It is planned to award construction works for the wind farm to local contractors. Therefore, good opportunities for employment from the local people during the construction phase are expected.

Local suppliers of goods and services will generate further economic activity and indirect employment benefits in the area. Small shops, food and beverage stores, tool suppliers, vehicle maintenance workshops and other local businesses will likely be positively affected.

In addition, the access road to access the towers will enable the local residents to have accessibility and ease of use of their land. This will positively affect the land value. The access roads will be established by the project to serve both the project and the local residents.

The planned minimum budget for land lease payments to local landowners and the government during the operational phase of the wind farm was presented in a letter from the developer to the Ministry of Labor on the 4th of November, 2012.

15.7.2.4 Stress on infrastructure

Since the project site lies in an undisturbed area, the effects on infrastructure will be minimal. Nevertheless, transportation of construction materials and vehicles during the construction phase will expand the traffic loads on surrounding roads. A traffic study will be done to provide solutions to accommodate such impacts (chapter 14).

15.7.2.5 Visual impacts and aesthetics

To assess the visual impacts of wind turbines, a study has been undertaken. The details of the visual impacts study is given in chapter 12.

It is worth noting that the reception of visual effects varies from one person to another. The survey conducted with local people revealed that the majority considered that a landscape with wind towers would “look good” (Table 15-23).

15.7.2.6 Expected revenue to the Governorate of Tafila

The basic expected revenue will include returns from taxes in addition to increasing the micro economy in Gharandil and the surrounding areas. The power generation will feed the national network and thus will impact the power availability and cost in all areas of Jordan. The cooperative links between the project and the local institutions in Tafila will certainly result in indirect long term benefits for both parties.

15.7.2.7 Impact on tourism and hunting

In Tafila Governorate, historical and touristic sites are rare but important. One of these sites is the Afra Mineral Spa Area which contains an old Byzantine Church from the sixth century. One site in Tafila reflecting a special kind of tourism, ecotourism, is Dana Biosphere Reserve. The presence of the wind turbines may have indirect positive impacts on ecotourism in the area. The project concept goes well with the concept of sustainable production and consumption echoed by the local nature conservation projects in Tafila such as Dana.

Except for some local hunters, Tafila is not a well-known area for hunting. But Jordan is known to be visited by tourists aiming for legal hunting trips, who might also pass the Tafila area. On the other hand legal hunting is governed by strict regulations and monitored by the Royal Society for the Conservation of Nature (RSCN). Based on the above, the existence of the wind farm is not expected to affect legal hunting activities in the area. The workers on the project site should be prohibited from illegal hunting.

15.7.2.8 Land acquisition

Land acquisition is done by leasing from government and privately owned lands. This was done through consultation and reaching to an agreement on the land rent with the local residents. The local residents will maintain the right to use the land as they are practicing at present. Such matter is discussed in detail within the attached “Resettlement Policy Framework and Plan” required by the International Finance Commission.

15.8 Mitigation measures

As was presented before, much of the impact upon the local socio-economic conditions will be positive. JWPC will seek to maximize the positive socio-economic impact of the plant, where practical, in all stages of the project. This includes:

- Construction works related to project site excavation and leveling, construction of buildings and internal roads should be assigned to local contractors and workers;
- To enhance the positive impact of employment, it is highly recommended to give priority for qualified local people in recruitment for skilled and non-skilled construction and operation staff [MM78];
- To strengthen the micro-economy close to the project area, it is recommended and inevitable to acquire all necessities such as food and beverages from local stores and restaurants during all phases of the project [MM79];
- It is recommended to use local vehicle maintenance workshops and oil change stations at the area during the operation phases of the project [MM80];
- To protect the roads, trucks which will be used for transporting activities should have a gross weight within the axial permissible load. Any occurred damaged must be repaired by the construction company. All materials shall be transported according to the project health and safety manual and the local regulations;
- A recultivation concept will be prepared prior to the decommissioning of the wind farm to identify activities for bringing back the original ecological status of the project site. This shall be done for reclamation of land as well as for any residual impacts that may occur at that stage.

Furthermore, JWPC will conducts a program of social improvements. These improvements will be administered by the Dana Biosphere Reserve and oversight from RSCN. The social programs are the following:

15.8.1 Partnership with the Royal Society for the Conservation of Nature (RSCN)

The RSCN is Jordan’s foremost environment and sustainability organization, and operates the Dana Biosphere Reserve, located approximately 5 km southwest of the project area. RSCN’s focus on environmental issues and their presence at the nearby Dana Biosphere Reserve makes RSCN a natural choice for partnership with the Tafila Project.

The partnership with RSCN would bring expertise from the foremost Jordanian NGO into quantifying and documenting the presence of the project on the local and regional environment, particularly the bird population. Findings from RSCN could be used to predict and analyze the impact of future wind farms on the Jordan environment. RSCN could also expand its environmental data collection for the Tafila area.

This partnership would see services and support provided by RSCN, and financial contributions and other inputs from the project.

15.8.2 Environmental awareness center at the Dana Biosphere Reserve for school children

Following discussions with the Dana Biosphere Reserve administration, JWPC will provide funds for the center to implement a unit for training the visiting school children on the environmental issues. This effort will be linked to be managed in conjunction with the Wind Farm Visitor Center (described below) so that the center can organize supervised visits to the Wind Farm.

15.8.3 Visitor information center

The project is planning to locate a visitor center in the vicinity of the project, which will also serve as a classroom area for local students visiting the project site. The visitor center will be staffed by JWPC and possibly RSCN representatives who will provide information on the features of the project, as well as the process of wind energy generation, and the local environment of the project area.

The visitor center would be located in the vicinity of the operations compound of the project, so as to minimize impact on the area, and share in utilities and communication infrastructure already present at the site.

15.8.4 Local schools and municipality improvements

Improvements to local town infrastructure, in the form of high efficiency heating / cooling / lighting, solar rooftop installations, communication equipment, and other possible improvements are planned to be provided by the project sponsor. These improvements will be scoped and finalized with the local municipalities following discussions on the specific needs of these groups.

15.9 Summary

Socio-economic impacts were considered relating to the quality of life of local residents and both local and regional business activity. Wider economic effects may well be felt nationally by the Jordan renewable energy industry. Economic effects on a higher level may occur nationwide, e.g. by the Jordan energy or consumer industry.

The total potential economic effects during the construction and operation of the proposed Tafila wind farm could be expected to generate a moderately beneficial effect for local economic activity and employment.

In addition economic support measures include the implementation of an environmental awareness center at the Dana Biosphere Reserve in cooperation with RSCN. This will be added to improvements in local infrastructures and support for local schools and the municipality.

15.10 References

[15-1] Muhammad, Ghazi bin, 1999: The tribes of Jordan

[15-2] Department of General Statistics of Jordan-Population and Social sector, www.dos.gov.jo, last access: 12th November 2012

[15-3] Statistics Report 2010/2011 of the Ministry of Education, www.moe.gov,jo, last access: 12th November 2012

[15-4] Annual statistics report 2010 of the Ministry of Health (www.moe.gov.jo), last access: 12th November 2012

[15-5] Central Traffic Directorate annual statistics report 2009

Figures

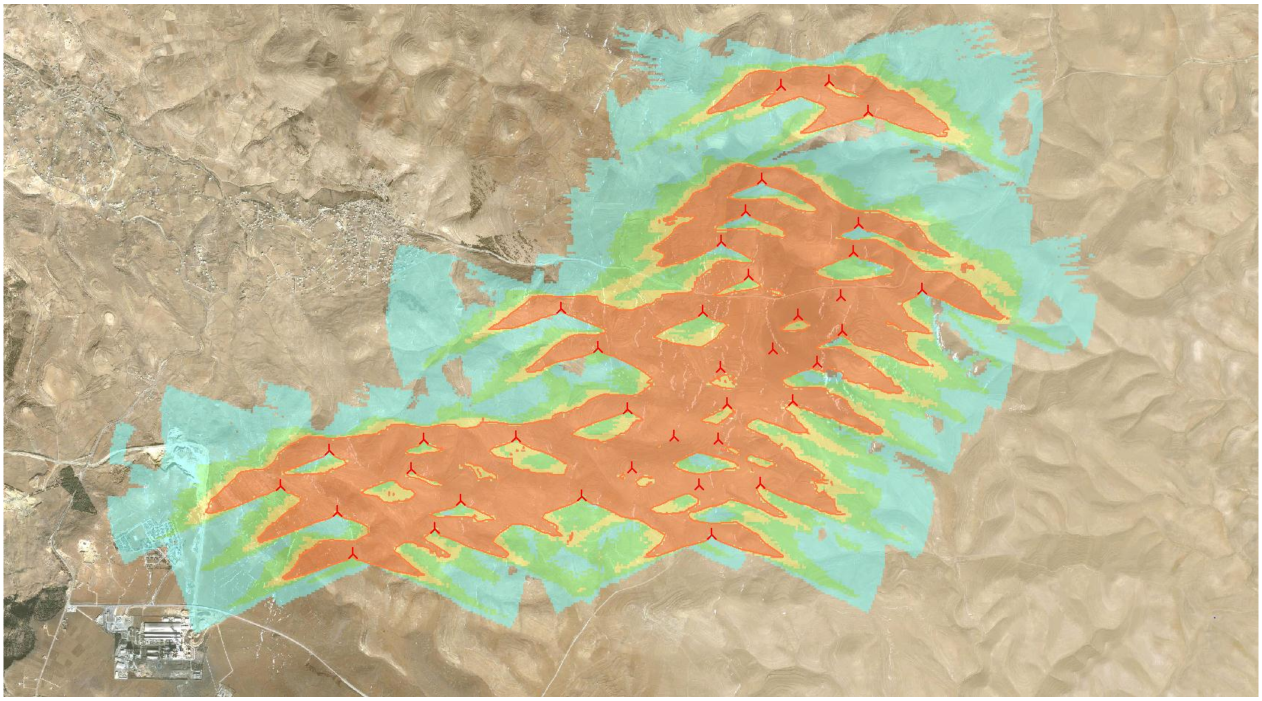


Figure 15-10: Shadow map for Semi-Nomadic tribes

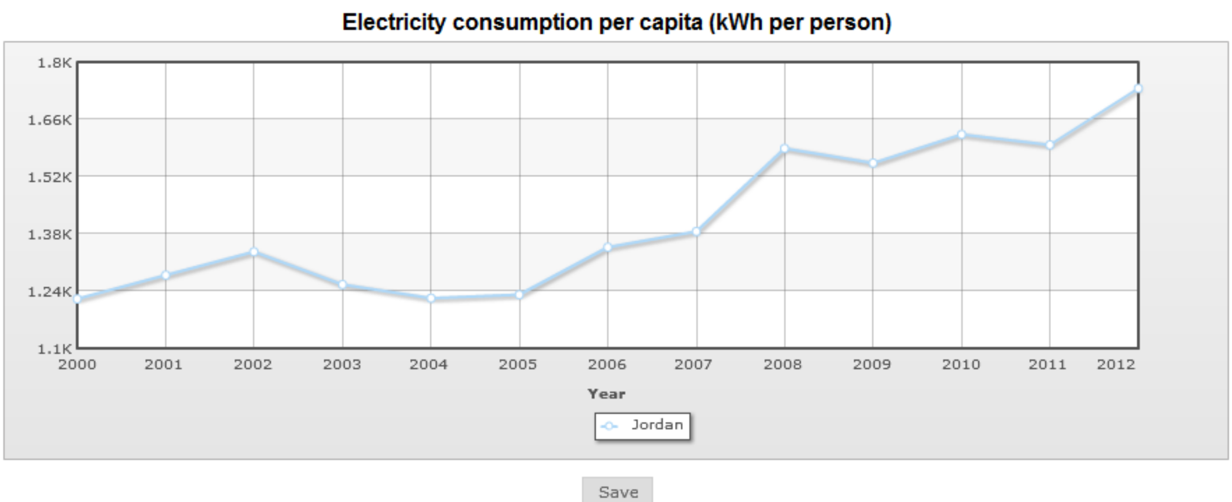
Figure 15-11: Personal invitation

Figure 15-12: Public announcement

16 Assessment of alternatives

Even though the Jordan is lacking for these natural resources, the country's energy system is based predominantly on fossil fuels. As natural resources have to be imported, the by this resource generated energy is very expensive. If a resource is rare, its price will continuously increase and will bring higher costs, finally to the consumer.

Jordan's energy use will increase in the next years (7% p.a. recently) . The electricity consumption per capita has grown over 30% within the last decade (2003 to 2012). The maximum power demand in 2011 was 2,660 MW and is forecasted to increase to 3,317 MW in 2014 and 4,939 MW in 2020 [16-1]. This raises the need for more power plants accompanied by a higher need for natural resources.



Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jordan	1,220.75	1,279.55	1,336.23	1,256.35	1,222.55	1,231.66	1,347.44	1,385.55	1,589.37	1,553.22	1,623.2	1,597.97	1,736.09

Figure 16-1; Electricity consumption per capita (source: CIA Factbook)

The Government of Jordan (GoJ) is searching for alternative ways of generating energy in connection with efficient cost reductions. Renewable energies are regarded to be an adequate replacement of fossil energy.

16.1 Alternative generation type

According to the Jordanian overall energy strategy, it is expected that the installed capacity of all power generation plants will be app. 4,000 MW by 2015 and app. 5,600 MW by 2020 according to NEPCO. The share of renewable power generation capacity is expected to be 600 MW by 2015 and 1,800 MW by 2020 according to NEPCOs projections. Assuming an average of 1,700KWh/kWp for PV solar plants and an average capacity factor of 0.36 for Wind Farms the energy contribution will rise over 7% of the overall energy generation mix by the year 2015 and reach 16.5% by 2020. This goal is achievable by the use of

1,200 MW installed capacity for wind energy and 600 MW from CPV/PV or/and solar thermal power (CSP) according to the plan. A combination of these energy sources will balance natural fluctuations e.g. during nighttime (solar energy) or calm times (wind energy) and is therefore necessary to balance the energy distributed to the Jordanian grid. Based on internal assessments of different time depending wind data the differences between windy seasons and periods in the North and South of Jordan are significant. So, also in terms of geographical locations the use of wind energy makes sense to enhance the energy system in terms of levelization and security.

Table 16-1: Expected power generation in Jordan (NEPCO, CUBE)

	Installed Capacity			Energy Generation		
YEAR	total [MW]	RES [MW]	Share of RES	total [GWh]	RES [GWh]	Share of RES
2011	3.200	1	0,0%	14.600	2	0,0%
2015e	*4.000*	*600*	*15,0%*	*18.900*	*1.400*	*7,4%*
2020e	*5.600*	*1.800*	*32,1%*	*28.500*	*4.700*	*16,5%*

Jordan has excellent conditions for the use of solar energy with more than 300 clear days during the year and a high irradiation. The solar potential increase from north to south by a factor of at least 1.5. Considering the comparatively low investment costs for PV plant installations of less than 1,400 USD/kWp recently at a larger scale (> 1MWp), the development of private and industrial solutions with PV applications will rise more significant. According to the potential CUBE assumes that the amount and share of total RES capacity will be much higher than in NEPCOs projection.

The main disadvantages besides security aspects of PV plants are the huge demand of land resources (factor of 150-200 in comparison to wind energy), the harsh environment (temperature, dust) which will decrease the modules efficiency significant as well as the impact to the grid (connection on low/medium voltage level with high penetration as well as peak times). The generation of solar energy follows the demand of cooling systems very well in general, which might support the quality and stability of the grid especially in urban areas.

As mentioned before wind energy has to be regarded the primary and adequate solution for Tafila region, where the wind resources are one of the best in the whole Kingdom of Jordan. The developer made an initial assessment (e.g. based on historic information, NERC measurement program and Jordanian wind atlas) where to start with a new wind farm development in Jordan. The existing tender projects in the North and South have been evaluated as well as new locations from North to South. Wind resources are not the only criteria: good infrastructure, grid connection capacity as well as impact to the environment are important as well. Due to the amount of settlements and urban area in relation to the wind resources the North is not really suitable for an utility scaled wind farm project. In the South close to Aqaba there might be harsher conditions. So, the area within the Governorate of Tafila has been very attractive from the beginning: An area almost free of settlements and urban activities, with existing industrial impact (e.g. LaFarge cement factory, power line), excellent wind conditions as well as high grid capacity is absolutely designated for the use of wind energy.

Different other forms of sustainable energy sources such as hydro power in all its kinds are no alternatives for Jordan. The country is already suffering from lack of water. Biomass/-gas is also very depending on water resources and therefore no major alternative for the Jordanian energy production.

Using geothermal energy from the deep soil as well as Concentrated Solar Power (CSP) might be options for the future. The assessment of the potential is quite more complex and expensive. The feasibility of those projects has to be investigated carefully and compared to wind and solar applications which can be developed and installed in a much faster way.

Power generation from conventional energy sources like crude oil and gas is no real option for Jordan due to the lack of own resources and its dependency of import. Jordan is looking right now for Liquefied Natural Gas (LNG) from Qatar starting from June 2014 on over the new LNG terminal in Aqaba and pipeline to the North. Contracts have been made so far. The gas would be used e.g. in the Qatrana gas power plant to improve the efficiency. The "Manhaker" power plant (IPP4) with 250 MW has been contracted for coming online in 2014 as the next larger power station. The power plant is prepared to use tri-fuel ignition compression engines for either Heavy or Distillated Fuel Oil (HFO / DFO) or Natural Gas once available. Another 600MW plant, which will the biggest diesel station in the country, will be located in Almanakher, 30km East of Amman. Commercial operations are scheduled to begin in March 2014.

Jordan oil shale power station is a project to build an oil shale-fueled power station in Jordan. The agreement between the Ministry of Energy and Mineral Resources and National Electricity Power Company of Jordan, and Estonian power company Eesti Energia was signed on 30 April 2008. According to the agreement, Eesti Energia has exclusive rights to build an oil shale-fired power station. The project is developed in the partnership with YTL Power International and Near East Investments of Jordan. The power station will have two units with 230 MW capacity both. The tender was announced in 2012 and it is expected to be operational by 2016. When constructed, it will be among the largest power stations in Jordan (the largest being Aqaba Thermal Power Station), and the largest oil shale-fired power station in the world after Narva Power Plants in Estonia. [16-2]

The big power stations are the development result of the energy demand and long term based contracts (e.g. 25 years) on fixed tariffs for the energy generation between NEPCO and MEMR as well as the IPPs based on BOO contracts. These tariffs are even higher than the consumer average sales price from NEPCO and beyond 90 JD/MWh. The Electricity Regulatory Commission (ERC) announced that it has set buy-back rates at 120 fils per kilowatt/hour (kWh) for electricity produced by solar power and 85 fils per kWh by wind energy. The National Electric Power Company (NEPCO) currently sells electricity to consumers at an average rate of 88 fils per kWh, less than half of its 188 fils per kWh generation costs. Energy officials say the tariff is aimed at encouraging citizens to take advantage of recent energy ministry regulations allowing consumers with renewable energy projects to sell surplus electricity back to the

national grid. “With rising international oil prices, the government has been looking for ways to reduce electricity demand and costs,” ERC Chief Commissioner Mohammad Hamid told reporters. “We found that the best way to achieve both is by encouraging Jordanians to go solar. “Under the feed-in-tariff system, individuals and small and medium businesses will be able to sell electricity back to power companies when production exceeds consumption, with citizens standing to save between 32 and 70 per cent of their monthly bills. [16-3]
Production of electricity using wind energy based on the 85 fils tariff (equal to 85 JD/MWh) is at present the most feasible economic option under consideration with today's increasing prices for renewable energies and existing contracts as well as commitments to IPPs with conventional technology.

16.2 Alternative locations

A number of advantages make the project site suitable for the power generation. The area has very promising wind conditions and is therefore a perfect fit for a wind farm and electricity generation based on renewable energy sources. The beneficial wind conditions at the Tafila wind farm are proofed by several wind measurement campaigns conducted during the scoping and design phase of this project as well as previous assessments from NERC. The different spots of the individual WTGs have been selected during a design and optimization process considering wind resources, distances in-between the WTGs and to the existing environment and infrastructure (e.g. roads, power line), constraints of archeology, noise and shadow flickering, land access, landscape etc. In general WTGs will be located on top of the mountain and ridges to harvest the best winds.

The area in general offer more space and capacity to host further wind farms like the two further known wind farms planned in approximately 12 km distance to the north (Excel) and south (Fujeij). But these locations have to deal with more environmental issues and infrastructure developments (e.g. grid connection) than the Tafila Wind Farm Project.

A further advantage of the site is the transmission line leading directly through the wind farm. Therefore a transmission line to connect the project to the grid is not necessary and avoids further environmental impacts. The area around the Tafila wind farm is not very populated. Dwellings around the wind farm site lie mainly in wadis or far enough away, that visual impacts are negligible.

16.3 Alternative WTG turbine type

The suggested turbine type represents state of the art and proven technology from the world leading wind turbine manufacturer VESTAS. Within the design phase CUBE has created different layouts with different turbine types and manufacturer in order to reach best performance. For the tender process six different turbine suppliers (Goldwind, GE, SIEMENS, Acciona, GAMESA, VESTAS) of the most suitable WTG models and layouts have been selected. The best performance figure (produced energy yield based on CAPEX and OPEX numbers) besides other parameter (e.g. experience, track record, references in comparable countries/markets/environments) has been the main criteria for the selection.

16.4 Decommissioning of the wind farm

Once the lifetime and operational period of 20 years for the wind farm ends the WTGs will be removed and decommissioned from the field. Almost the identical equipment (e.g. cranes, trucks) similar during the construction period will be on site to take the different components down. The components will be put on trucks and HGVs to ship them to their next destination. All general procedures and guidelines like for the construction will remain almost the same. The foundation will be cleared up to 1m beyond the surface. Once this site is not used for wind energy utilization anymore the area will be recovered to the shape as it has been before the installation started. The turbines might be re-used at new locations.

16.5 No action alternative

Under the no action alternative the Tafila wind farm would not be built and would not support the development of the renewable energies in Jordan. The building of the first large-scale wind farm in Jordan would be postponed to undefined time.
The project site would stay the same overgrazed land with sparse vegetation and little agriculture and project related adverse impacts would be averted. The positive environmental and social benefits of the project would also not be realized. Land lease agreement would be cancelled and the Jordanians owning land in the project site would not earn money with mostly fallow lying land.
The following positive effects would not occur by choosing the no action alternative:

- Reduction of reliance on fossil fuels;
- Securing national energy supply;
- Limitation of potential impacts arising from the production and the transport of natural resources;
- Reduction of CO_2 emmission by approximately annually 245,992 t CO_2;
- Economic benefits for the inhabitants of Gharandil and the dwellings around;
- Lease payments for people owning land on the project site;
- Development of an environmental awareness center at the close Dana Biosphere Reserve
- Development of a visitor information center to inform interested persons more on renewable energies
- Supply local schools and municipalities with improved high efficiency heating/cooling/lightning, solar rooftop installations, communication equipment etc.

Due to the impacts of the construction phase is anticipated to be of short term nature, and due to the impact during the operation of the project is anticipated to be mostly of minor nature, the no-action alternative is absolutely not preferable.

16.6 References

[16-1] National Electric Power Company NEPCO, 2011: Annual Report 2011, http://www.nepco.com.jo/PDF%20Documents/annual_report_2011_en.pdf, last access: 2012.12.10

[16-2] WIKIPEDIA package of References

1. "Jordan's first oil shale power plant expected in 7 years". *Jordan Times*. 2008-05-01. http://www.menafn.com/qn_news_story_s.asp?StoryId=1093194908. Retrieved 2008-07-19.
2. Taimre, Sandra (2008-04-30). "Eesti Energia signed an exclusive contract with Jordan". BBN. http://bbn.ee/Default2.aspx?ArticleID=0d384ae3-a6b1-4d8a-be73-a743fa935797. Retrieved 2008-07-19.
3. "Estonia to build oil shale plant in Jordan" (PDF). *The Baltic Times*. 2008-05-08. http://www.tgplegal.ee/upload/doc/ee/BT,%208-14mai08.pdf. Retrieved 2008-07-19.
4. "Enefit consortium starts tendering process for Jordan oil shale fired power plant". Jordan News Agency. 2012-06-30. http://www.petra.gov.jo/Public_News/Nws_NewsDetails.aspx?Site_Id=1&lang=2&NewsID=76248&CatID=13&Type=Home&GType=1. Retrieved 2012-06-30.
5. (PDF) Fuel Switching Project of the Aqaba Thermal Power Station (ATPS) (Report). UNFCCC. 2006-06-28. http://cdm.unfccc.int/UserManagement/FileStorage/KT3LT48K5R7PW3OIE9IPFEM0OS2INT. Retrieved 2008-07-19.
6. Bains, Elizabeth (2008-06-01). "Jordan orders oil shale plant". ArabianBusiness.com. http://www.arabianbusiness.com/520830-jordan-orders-oil-shale-plant. Retrieved 2008-07-19

[16-3] “Regulatory commission sets electricity ‘buy-back’ rates” – Jordan Times Press Release from 2012-12-4, http://mideastenvironment.apps01.yorku.ca/?p=6467

17 Summary

Jordan Wind Project Company PSC ("JWPC") is proposing the development of a wind farm in the Governorate of Tafila in Jordan. The proposed site comprises 38 turbines with an installed capacity of 3.075 MW each. The total installed capacity is 117 MW.

According the Jordan Regulation of Environmental Impact Assessment, No. 37 from 2005 and the European Union Directives 85/337/EEC and 97/11/EC, project developments require an Environmental and Social Impact Assessment ("ESIA") including a number of technical studies which results are described in detail in the following chapters of this document. Initial analysis on this site commenced in late September 2011 and lead to more detailed surveys that continued until December 2012.

The technical topics discussed are complex in nature and the surveys that were performed to assess the significance of effects were in many cases extensive. Consequently, a full appreciation of the assessments can only be ensured if the results of the environmental and social impact assessment are considered in their entirety. However, this chapter endeavors to give an overview of the main findings. All chapters are summarized in brief, giving information on impacts and mitigation measures. Cumulative impacts are listed in each chapter.

All of the studies in this assessment consider social and environmental impacts and mitigations during construction and operational phase of the planned wind farm as well as during decommissioning phase were applicable.

17.1 Renewable Energy Policy Need for this development

Jordan faces specific and to some extent unique challenges with regards to electrical power generation. Jordan by today imports over 97% of its energy needs, and is also amongst the most water-deprived nations in the world. Jordan has relied predominantly on Egyptian gas for its needs, and the supply has been disrupted since the explosion of the gas pipeline in parallel with the political change of regime in Egypt.

In addition to these national and regional perspectives, the growing global concern about the effects of climate change and the rising prices for conventional fuel resulted in a substantial inclusion of renewable energy and energy efficiency strategies in Jordan's National Strategic Plan.

Wind power is a key part of Jordan's strategy for more energy independence, expected to account 600 MW by 2015 and 1,200 MW by 2020 [2-7]. It is one of the most promising sources for renewable energy in Jordan. Generally, the most energetic wind is found at a distance of almost 400 km along the western border.

By running just one of the turbines at the proposed project site in Tafila approximately 2,500 Jordanian households can be supplied with clean, renewable electricity. The project has a total amount of 38 turbines.

17.2 Biodiversity

The baseline conditions within the development area were assessed in two phases. The first was a desktop study by use of literature review. The second was a targeted field survey of the likely important and legally protected bird species identified in the desk study.

The baseline biodiversity of the flora the area can be summarized to be highly degraded due to:

- Overgrazing;
- Soil erosion from farming, land and soil ploughing;
- Illegal hunting;
- Cutting of forest resources and shrubs for household uses;
- Urban expansion over semi-natural and rangeland areas;
- No dense vegetation or forests are existent on the site except of afforested pine trees near Busaira village. These pine trees do not have any conservation value since pine trees are not native to the area;
- Three rare species and one endangered specie were found during the field survey. These species are single plants and do not occur in a great extend at the same spot. They preferably grow in places where is no farming. Grazing of sheep and goats may threaten the species.

The baseline biodiversity of the avifauna can be summarized as follows:

- Rich in resident birds and migrant passerines,
- Few raptors were recorded due to high disturbance from urban expansion,
- The Jordan rift valley is an important global flyway. Even though the field surveys indicate that the project site itself does not host important migratory routes. The reason for this is probably because the area is disturbed by farmers, local resident's constant movements and roads. Additionally, the core of the wind farm site is away from the edges of the rift valley and it is not heavily covered with vegetation, which is very important for migratory species on their journey for roosting, feeding and resting.
- The Golden Eagle, although recorded as endangered in Europe, is not listed as endangered in Jordan and has an extensive distribution worldwide. Its global status under IUCN is LC which means "common and least concern";
- Bats were recorded in the past however the caves that were examined did not show any bat activities. Human persecution and cave burning may be the reason;
- According to studies of BirdLife International and RSCN (i.e. Important bird areas in the Middle East and Jordan Books published in 1995 and 2000), there is a significant raptor migration in Dana Area in spring, but less in autumn. The Honey and Steppe Buzzard, the White Stork and other soaring birds are mentioned examples for this migration in the above named studies.

- Additionally, the ecology of the Dana IBA provides important habitats for a wide variety of bird species of restricted range to the project region (Table 6-9 and Table 6-10)..
- However, over the two observed migration seasons, researchers of this study did not observe or record heavy raptor or stork migration in both spring and autumn migration seasons.
- Illegal bird hunting is reported.
- Collisions between birds of prey, such as passerines, hoopoe, larks and shrike, which fly at low altitudes up to 100 m, and wind turbines can happen at wind energy projects. As with electricity projects in general, collisions with transmission lines also occur.
  Depending on the specie, the theoretical estimated amount of on the project site observed birds that are killed by the project lies between 0.79 (Lesser Kestrel) and 42.28 (Swift) animals in 20 years of operation.

<u>The baseline biodiversity of the reptiles and mammals can be summarized as follows:</u>

- The planned wind farm site is relatively far away from the main gorges and does not have dense vegetation. Accordingly, less prey such as reptiles, rodents for raptors and soaring birds are attracted to this area; Mammals recorded or reported by locals are endangered in Jordan. Their number is not high on site due to disturbances by local farmers and shepherds.
- One endangered specie, the European Chameleon (*chamaeleo chamaeleon)*, was observed on the site.
- Eight mammal species were recorded. The endangered Hyaena hyena was not observed by the research team, their presence was recorded through discussion with local residents and farmers at Gharandil.
- Although the team did not detect any bat activities at the project site, local residents of Gharandil reported in viewing several bat activities in Wadi Gharandil and Wadi Dana. The type of specie cannot be identified at this stage. Further investigations with ultrasound signals have to be conducted.

A very ambitious stakeholder engagement was carried out with RSCN, BirdLife and Dana in order to assess whether there are significant objections on the planned wind farm which could be show-stopper for project. General agreement was reached with RSCN as a Jordan arm of BirdLife. Agreement on mitigation measures and methodology was found and is documented in signed minutes of meetings and a general agreement on the project. An Memorandum of understanding was signed with RSCN for the future monitoring program of the construction and operational phase of the wind farm.

To proof the appearance of bats on the project site further investigations have to be conducted. The project developer will place a bat detector on the project site to monitor any movements from these species. If the appearance of bats is proofed, adequate mitigation measures have to be implemented.

17.3 Geology

The wind farm has a planned life span of up to 20 years. Once the facility has reached the end of its life the turbines may be of a status to continue operation as a power generating facility, or the facility may be closed and decommissioned. If decommissioned, all the aboveground components of the wind farm would be removed and the site would be rehabilitated. The decommissioning and reinstatement of the site would involve many activities that may have environmental and social impacts.

At the construction phase of the wind farm of Tafila, the project will have limited impacts on the surface water and groundwater resources in the area. The construction phase's signature on the area will be limited to relatively small pieces of lands and outside of the main wadi areas.

During the operational phase, no residual impacts on water resources are predicted to occur. The operational phase causes insignificant impact. It should be noted that any waste material resulting from maintenance of the motors will be handled adequately. Hazardous waste is not expected to be an issue; in case of any generated oily waste, it will be handled according to national environmental regulations. Any waste will be contained, collected and transferred for treatment, reuse or final safe disposal.

A detailed decommissioning and rehabilitation plan will be developed prior to decommissioning the facility and associated infrastructure in accordance with the relevant environmental authority. This plan may include, but not be limited to, management of socio-economic aspects such as employment creation, removal, re-use and recycling of materials and vegetative rehabilitation to prevent erosion. This impact assessment focused on potential impacts associated with the construction and operational phase of the proposed wind farm. The decommissioning activities would be similar to construction activities and therefore recommendations outlined to manage construction phase impacts should be adhered to during decommissioning. Management actions should focus on the rehabilitation of disturbed areas and the removal of infrastructure

17.4 Noise

Best efforts were made to collect and determine the background noise in the town of Gharandil by measurements in accordance to the Scoping report. Even so it was found that the gathered data are not considered suitable with regard to determining the likely impact of noise from the wind farm on the nearest receptors as noise from extraneous sources (mechanical ventilation and wedding celebrations) resulted in the data collected being too high with respect to actual background noise levels to enable an objective assessment of noise impact to be performed. Thus it was jointly decided by the consultants to follow the simplified approach of modeling the noise from turbines. Subsequent measurements can be undertaken, if required by the MoEnv, in order to derive a more reliable result of background noise levels showing also a correlation with wind speed.

The noise levels predicted at around 35dB(A) and are sufficiently low to enable the attached Simplified Assessment method of noise impact assessment and to get confidence that there is no significant impact on the receptors when the wind farm is under operation.

Due to sufficient distance of the wind turbines to the nearest dwellings, the impact of operational noise of the planned turbines is low and remains below Jordan limits and limits of most other international guidelines and regulations as specified in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

There is little exceedance of +0.3 dB(A) of the local limit of 35 dB(A) at the mosque in LaFarge This exceedance is regarded to be negligible under consideration of the uncertainty of the model. There is also slight exceedance of the British ETSU limits, which falls also below the overall uncertainty of 2.5 dB(A).The fact that the used model type is a worst case approach there is enough confidence that no exceedance of the noise limits is expected when the wind farm is operational.

If additional confidence is required for the background noise level, follow up background measurements will be carried out before the erection of the wind farm.

During the construction and decommissioning period, equivalent continuous noise levels (LA_{eq}) at neighboring properties will remain well below the threshold of 65 dB(A) as given in the BS 5228:2009 guideline.

17.5 Shadow flickering

Shadow flicker may occur when the rotating blades of a wind turbine pass through the sun’s rays seen from a specific location. This creates a fast-moving shadow with a “flicker” effect, which can be seen inside of homes and other buildings. The impact on nearby dwellings depends on conditions such as weather, topography, or the distance between the turbine and the building. The shadow flicker exposure decreases with increasing distance from the wind farm.

The effect of shadow flickering is simulated for the closest receptors to the project site with the simulation tool WindPRO. The guidelines used to evaluate the effect of shadow flickering are the guidelines of Germany, saying:

- Accumulated exposure on residential properties should not exceed a total of 30 hours per year;
- Exposure on residential properties should not be longer than 30 minutes per day.

The annual and the daily astronomical possible shadow flickering are calculated.
The limits are not exceeded.

For Semi-Nomadic people shadow flickering boards will be published within the wind farm site. No further mitigation measures are proposed.

17.6 Air quality

Dust may be created during the construction and decommissioning stages of the project, when excavations works expose soil to the wind, which may be blown away as dust. Vehicles driving on the gravel roads on the site may also cause dust emission. The delivery of light minerals, for instance sand, could also be a source of dust when blowing down from vehicles during the transportation..

A dust measurement, conducted in the vicinity of the Tafila wind farm, concluded, that the project area has no high dust concentrations at all-
90 % of airborne pollutants ("dust") come to rest within 100 m of their source and 98% within 250 m. All dust receptors near the Tafila wind farm are at least 1 km away from the next potential dust production sites and therefore significance is considered to be low to negligible.

As the project site can be described as desert-like with potential dry strong winds, mitigation measures are prepared to grant a low impact during the construction phase.

17.7 Landscape and visual impacts

Landscape and visual impact assessment (LVIA) is the part of the ESIA that evaluates the landscape and visual amenity changes that will occur as a result of the planned project.

Given the amount of receptors within the study area, there are relatively few significant effects identified.

Resulting from the topography in more than 50 % of the areas around the project site the WTG will not be seen. The impacts on villages in the surrounding of the project site are judged as not significant as the WTG will only partly be seen. The turbines will not take a predominant building in the visual field of the inhabitants.

The Desert highway, passing the Tafila wind farm in approximately 13 km distance is not influenced by the turbines. The main viewing direction for the drivers is to north/south direction. Furthermore the turbines will rarely be seen from the Highway.

Dana Biosphere Reserve lies in a valley west of the wind farm. The WTG will not be visible from the nature reserve.

During the construction phase of the planned wind farm only temporal effects on the landscape will occur. There will be more human activity and temporal movement of large construction vehicles and associated construction. After the end of the construction phase the majority of the temporal activities and machinery will leave the site without major subsequent impacts on the landform, the associated vegetation and soil structure. Only the turbines, the unpaved roads, the warehouse and the substation building will remain on-site during the whole operation phase.

To mitigate elements of potential landscape and visual impacts the following mitigation measures have been addressed within the design:

- The layout of the wind farm was designed to have a minimum visual impact and the landscape;
- Tracks have been designed, as far as possible, to follow and fit with contours in the land. Permanent tracks take the shortest route to the turbine where possible;
- Usage of brightness reducing aviation lights
- Synchronization of aviation light
- The turbines and all the other aboveground structures will be removed at the end of the operational lifetime.

17.8 Cultural heritage and archaeology

As there has been continuous human presence in Tafila Governorate since the Roman age, it is not surprising that the field study conducted for this ESIA found that the project site is rich in historical artifacts. In accordance with good construction practice and with Jordan's Antiquities Law No. 21 of 1988, these historical finds must be protected.

To this end, a major mitigation measure has already been completed in the design phase: the relocation of 16 turbines which were found to be too close to visible cultural artifacts or remains. After field investigations revealed that 16 turbine locations were located at such a distance to a visible historical site so that the construction of the turbine would endanger the site. Alternative locations for all of these turbines have been found.

Two further major mitigation measures will be undertaken during the construction and operation phases of the wind farm. The first of these measures, which will take place only during construction, is the thorough supervision of excavation works. During the excavation of all foundations, which are the widest and deepest excavations during construction, a qualified archaeological supervisor will be on site and observing the process. Any activities will be immediately stopped in case of discovering any antiquities or archeological items during construction. A professional opinion will be obtained on whether the remains can be removed, or whether the find is so significant that the works must be suspended, relocated or even be cancelled. This will be done in cooperation with the Department of Antiquities. Furthermore each activity must be done carefully to prevent damage on valuable historical artifacts.

The second major mitigation measure will apply during construction and operation. This measure is to give strict instructions to all workers that graveled areas such as roads, crane pads and site compound are not to be left by any worker unless this is required during the construction (e.g. movement of cranes, laying of cables). In cases where activities besides the graveled areas are necessary, supervision will be ensured. If these instructions are followed, no impacts are expected

In terms of cumulative impact assessment, Tafila wind farm is not expected to have any adverse impacts. At the time of this study, two wind farms are in the development process in the vicinity of the Tafila wind farm. The archaeological discoveries on the Tafila wind farm site are of small scale, being so far fully located within the boundary of Tafila wind farm. Large findings with effects on a large area are not expected.

17.9 Traffic

This section of the ESIA assesses the impacts caused by transporting construction materials for the foundations, access roads and crane pads and components for the wind turbines and electrical installations.. Only the construction phase is considered. During the 20-year operational phase of the development the amount of associated traffic will be very small. Therefore, the effects arising of the operational traffic are considered to be negligible. Effects arising from the decommissioning of the wind farm are likely to be similar to the construction stage but of a smaller scale as vehicle numbers and peak flows will lower compared to the construction phase.

The first mitigation measure to protect the environment and population from unnecessary impacts due to the traffic caused by the wind farm project is the careful selection of delivery routes. After considering several routes, two routes were decided upon for the delivery of concrete and exceptional loads. Route 1 will be used for the delivery of concrete. Route 1 has a length of 2.8km and represents the distance from the site entrance to the concrete plant. The route is on the local road which connects the national road 15 with the national road 35. The current baseline traffic on this route is assumed to be very low since the location of the site is remote and the road does not link areas with high population. Route 2, used to the delivery of turbine and electrical components, is about 180 km long and connect the site to the port at Aqaba, mostly using the national road 15. The third route will be used for the delivery of raw construction material, such as gravel or cabling. Since the suppliers of these materials are not yet known, it is not possible to determine their route.

In order to identify the receptors, Routes 1 and 2 were scanned for locations and areas which may be sensitive to changes in traffic conditions. Route 1 does not pass any settlements or otherwise sensitive areas. On the course of Route 2, three possible traffic disruption receptors were identified, with only the outskirts of Aqaba city being considered moderately sensitive, because no residential areas are directly passed. The impacts of increased traffic on Route 1 are considered to be low because, even though the highest volume of increased traffic will be found on this road, no receptors are located along the route which would be impacted. The impact from increased traffic volume on Route 2 is also considered to be low because the road is extremely well-developed and already has a relatively high traffic volume. In addition, mitigation measures are planned for the 376 exceptional load deliveries that will take place along this route. These transports will be conducted in convoys [MM70], will be escorted by the police and likely take place at night, when traffic on the route is typically at its lowest level.

A possible mitigation measure to reduce the number of transports for concrete would be to source to necessary gravel on-site, though it can only be decided at a later stage if this is possible. The decision will be made in consultation with the relevant authorities and based on the advantages and disadvantages in terms of civil engineering and the protection of cultural heritage.

Other traffic-related effects were evaluated and found to be of low or no impact. These effects and their predicted impacts are given in the table below.

Effect	Significance	Mitigation measure proposed
Noise	Low	None proposed.
Vibration	No effect	None proposed.
Visual effects	No effect	None proposed.
Severance	Low	None proposed.
Hindrance to drivers of other motor vehicles	Low	Set up of traffic management plan for transporting abnormal loads. [MM69]
Hindrance to pedestrians	No effect	None proposed.
Fear and intimidation	No effect	None proposed.
Safety	No effect	None proposed.
Hazardous loads	No effect	None proposed.
Air pollution	No effect	None proposed.
Dust and dirt	Moderate	Construct last meters of project site roads as asphalted road to minimize dirt and dust on wheels by entering public roads. [MM72]

At the time of producing this report, not enough information about the other wind farm in planning in the vicinity - Fujeij wind farm - is publicly available in order to make a judgment of the possible cumulative impacts. In general, it is unlikely that the exact transport routes used in Tafila would also be followed by these two wind farms. Because the large component transports will be coordinated with the police, however, the possibility of conflicting large component transports can be excluded. Therefore no cumulative impacts are anticipated.

17.10 Socio-economics

Socio-economic impacts were considered relating to the quality of life of local residents and both local and regional business activity. Wider economic effects may well be felt nationally by the Jordan renewable energy industry. Economic effects on a higher level may occur nationwide, e.g. by the Jordan energy or consumer industry.

Feedback from the local residents in the area was solicited through a survey of 22 families in Gharandil and a public consultation, the results of which were overwhelmingly positive. In the survey, the families filled in questionnaire concerning their socioeconomic status as well as their knowledge and understanding of the project and its consequences. From the sample of 22 families, it is seen that the local residents' main jobs are in the military or civil service. Few are self-employed. Most have a side work in the agriculture by growing wheat and barley in the land that they own within or close to the project area. The interviewed persons have different educational levels, ranging from junior high school to master's degree. All 22 respondents wrote that they supported the use of wind energy in Jordan and the Tafila wind farm, in particular. Of the 8 families who used land close to or within the designated project area, all answered that the presence of the wind farm would not discourage them from continuing to use the land as they currently do.

At the public consultation meeting, a presentation and discussion about the project was held before participants responded to questions about the wind farm in written form. As with the socio-economic survey, the results were positive. Opinions of wind energy in general were high, with one participant remarking that wind energy "… is like an oil well for Gharandil" and that the location of the project was well-chosen ("It is a good experiment. I wish it to succeed because the area under consideration is far from houses.") Often, the respondents noted that positive aspects of the project include "helping the local people, mainly in the form of jobs and scholarships." Concerns were raised about the possible impact on birds, especially in connection with the nearby biosphere reserve. One respondent neatly summarized the general tone of all the responses when he or she wrote that "each action has a positive and negative, but this project has many more positive than negative parts."

Various socio-economic impacts were studied, based on Jordanian law and IFC guidelines and the impacts were found to be positive on the whole. These impacts are detailed in the table below.

Impact	Geographic extent	Level	Frequency	Duration	Direct (D) Indirect (ID)	Reversible (R) Irreversible (IR)	Likelihood	Significant	+ / -	Remarks
Employment and benefits	H	M	H	H	D	-	M	Yes	+	Advance where possible
Business prosperity	M	M	M	H	ID	-	M	Yes	+	Advance where possible
Land acquisition	L	L	L	L	L	-	L	No	+	No Mitigation
Expected revenue to the Governorate of Tafila	L	M	H	H	H	-	H	Yes	+	No Mitigation
Stress on infrastructure	L	M	M	L	D	R	M	Yes	-	Mitigation measures are required. A dedicated study is being carried out
Land use	L	L	L	L		-	L	No	+	No Mitigation
Visual impact	L	M	H	H	D	R	H	No	+	No Mitigation
Impact on tourism and hunting	L	L	L	H		-	L	No		No Mitigation

As the majority of these effects are positive JWPC will seek to maximize the positive socio-economic impact of the plant where practical/possible in all stages of the project. This may include:

- Construction works related to project site excavation and leveling, construction of buildings and internal roads should be assigned to local contractors and workers;
- To enhance the positive impact of employment, it is highly recommended to give priority for qualified local people in recruitment for skilled and non-skilled construction and operation staff [MM73];
- To strengthen the micro-economy close to the project area, it is recommended and inevitable to acquire all necessities such as food and beverages from local stores and restaurants during all phases of the project [MM74];
- It is recommended to use local vehicle maintenance workshops and oil change stations at the area during the operation phases of the project [MM75];
- To protect the roads, trucks which will be used for transporting activities should have a gross weight within the axial permissible load. Any occurred damaged should be repaired by the construction company. All materials shall be transported according to the health and safety manual and the local regulations;
- A recultivation concept will be prepared prior to the decommissioning of the wind farm to identify activities for bringing back the original status of the project site. This shall be done for reclamation of land as well as for any residual impacts that may occur at that stage.

In addition to the above listed measures on the local society, JWPC conducts a program of social improvements. These improvements will be administered by the Dana Biosphere Reserve and oversight from RSCN. In a partnership with RSCN, Jordan's foremost environment and sustainability organization and operator of the Dana Biosphere Reserve. The partnership with RSCN would bring expertise from the foremost Jordanian NGO into quantifying and documenting the presence of the project on the local and regional environment, particularly the bird population. Findings from RSCN could be used to predict and analyze the impact of future wind farms on the Jordan environment. RSCN could also expand its environmental data collection for the Tafila area. This partnership would see services and support provided by RSCN, and financial contributions and other inputs from the project.

An environmental awareness center at the Dana Biosphere Reserve for school children will also be built, following discussions with the Dana Biosphere Reserve administration. JWPC will provide funds for the center to implement a unit for training the visiting school children on the environmental issues. This effort will be linked to be managed in conjunction with the Wind Farm Visitor Centre so that the center can organize supervised visits to the Wind Farm.

The wind farm Visitor Information Centre, which is planned to be locates in the vicinity of the project, will be staffed by JWPC and possibly RSCN representatives who will provide information on the features of the project, as well as the process of wind energy generation, and the local environment of the project area. It will also serve as a classroom area for local students visiting the project site.

Lastly, Improvements to local town infrastructure, in the form of high efficiency heating / cooling / lighting, solar rooftop installations, communication equipment, and other possible improvements are planned to be provided by the project sponsor. These improvements will be scoped and finalized with the local municipalities following discussions with these groups on the specific needs of these groups.

Annex 1 List of attendees of the scoping session

No. الرقم	Name of participant أسم المشارك	Participating organization الجهة المشاركة
1	Rashid Mohammad Hashiem	Natural Resources Authority
2	Lieutenant colonel Mohammad Lotfi Al-Ja'abrah	Traffic Department
3	major Omar Yosief Al-Mashahreh	National Society for the protection of Environment
4	Sherif Al-Jbour	Birdlife Institution
5	Ibrahim Khaleel Al-Husseini	Birdlife Institution
6	Eng. Randa Abdurrahman Obaid	Civil Defense
7	Eng. Emad Musa Al-Dara'awi	Ministry of Environment
8	Eng. Tamara Azzam Halaseh	Ministry of Labor
9	Rasha Hymour	Royal Society for the Conservation of Nature
10	Dr. Fares Khoury	American University
11	Baraa Al-Otaibi	Jordan Environment Society
12	Abdalraqaz Al-Hmoud	RSCN
13	Eng. Nader Al-Hshoosh	Ministry of Agriculture
14	Mohammad Al-Sawafeen	Department of Land and Survey
15	Eng. Omar Al-Momani	Ministry of Energy
16	Aref Abdullah Al-Ajarmeh	Jordan Armed Forces
17	Eng Tariq Mustafa Al-Khshman	Synaptic
18	Eng. Husam Bisher Al-Qur'an	Synaptic
19	Bayan Awaad	Ministry of Health
20	Samer Bawa'aneh	Ministry of Transport
21	Mohammad Salman	Tafila Environmental Health Department
22	Abdullah Ali Al-Kasbi	JISM
23	Eng. Sherif Bani Hani	Ministry of Environment
24	Eng. Mona Mohammad AL-Hababheh	Ministry of Trade and Industry
25	Eng. Manal Al-Louzi	Natural Resources Authority
26	Eng. Ahmad Al-Faouri	Albalqa Applied University
27	Jihad Adeeb Hadadd	Jordan Atomic Energy Commission

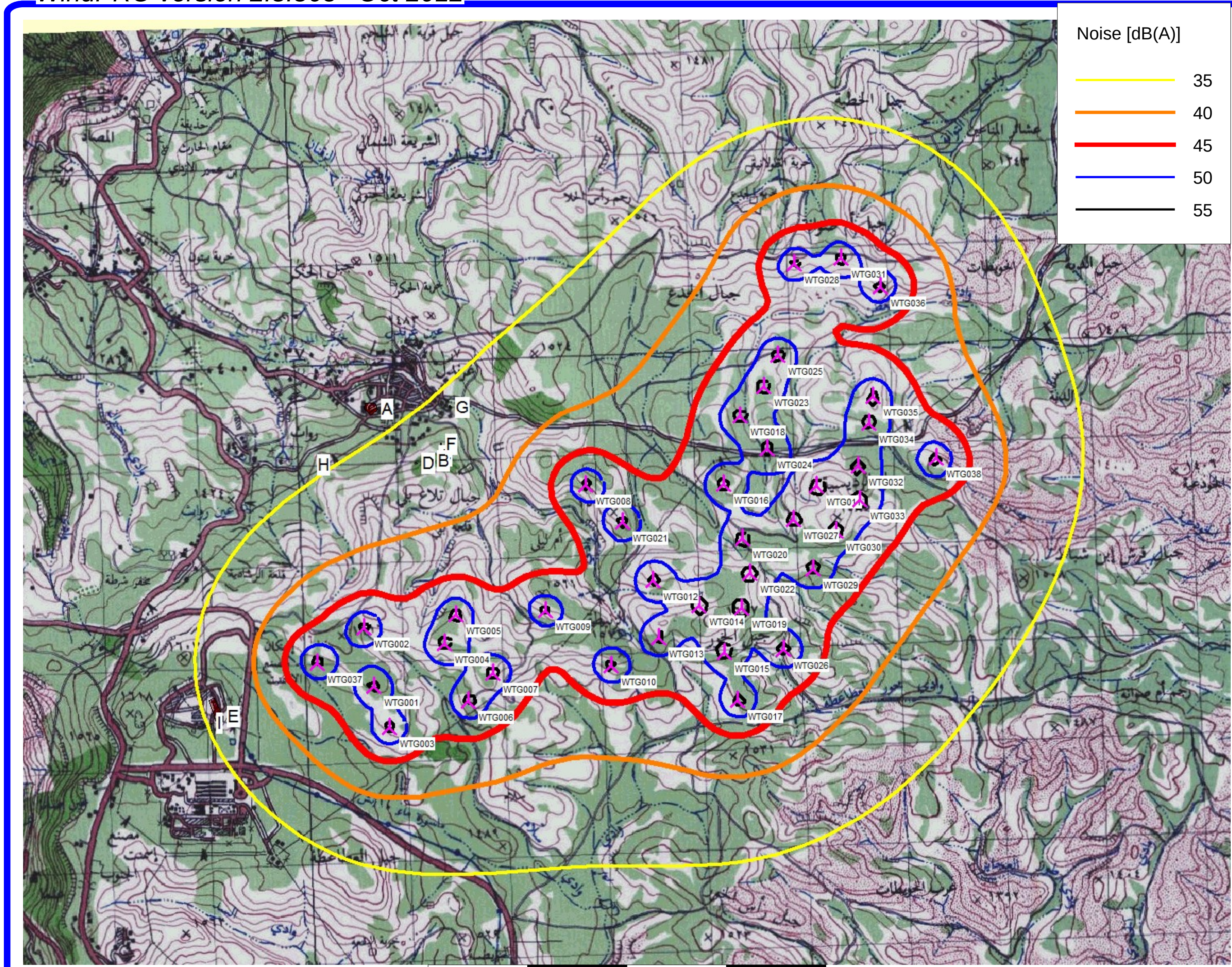
Annex 2 Avifauna species in the Dana IBA

Species	Season	Period	Population estimate	Quality of estimate	IUCN Category
Sand Partridge *Ammoperdix heyi*	resident	1995	100-500 breeding pairs	poor	Least Concern
Lesser Kestrel *Falco naumanni*	breeding	1995	24-28 breeding pairs	medium	Least Concern
Sooty Falcon *Falco concolor*	breeding	1995	5 breeding pairs	medium	Near Threatened
Lammergeier *Gypaetus barbatus*	non-breeding	1985	1 individuals	poor	Least Concern
Egyptian Vulture *Neophron percnopterus*	non-breeding	1995	1-3 individuals	medium	Endangered
Griffon Vulture *Gyps fulvus*	resident	1995	6-12 breeding pairs	medium	Least Concern
Lappet-faced Vulture *Torgos tracheliotos*	non-breeding	1981-1993	1 individuals	poor	Vulnerable
Cream-coloured Courser *Cursorius cursor*	breeding	1995	present [units unknown]	-	Least Concern
Spotted Sandgrouse *Pterocles senegallus*	resident	1995	frequent [units unknown]	-	Least Concern
Crowned Sandgrouse *Pterocles coronatus*	resident	1995	frequent [units unknown]	-	Least Concern
Pharaoh Eagle-owl *Bubo ascalaphus*	resident	1995	2-4 breeding pairs	medium	Least Concern
Hume's Owl *Strix butleri*	resident	1995	10-20 breeding pairs	poor	Least Concern
Brown-necked Raven *Corvus ruficollis*	resident	1995	present [units unknown]	-	Least Concern
Pale Crag-martin *Hirundo obsoleta*	resident	1995	present [units unknown]	-	Least Concern
Greater Hoopoe-lark *Alaemon alaudipes*	resident	1995	common [units unknown]	-	Least Concern
Bar-tailed Lark *Ammomanes cinctura*	resident	1995	common [units unknown]	-	Least Concern
Desert Lark *Ammomanes deserti*	resident	1995	present [units unknown]	-	Least Concern
Dunn's Lark *Eremalauda dunni*	resident	1995	frequent [units unknown]	-	Least Concern
Streaked Scrub-warbler *Scotocerca inquieta*	resident	1995	present [units unknown]	-	Least Concern
Upcher's Warbler *Hippolais languida*	breeding	1995	200-400 breeding pairs	poor	Least Concern
Arabian Warbler *Sylvia*	resident	1995	1-10 breeding	poor	Least Concern

Species	Season	Period	Population estimate	Quality of estimate	IUCN Category
leucomelaena			pairs		
Sardinian Warbler *Sylvia melanocephala*	resident	1995	present [units unknown]	-	Least Concern
Spectacled Warbler *Sylvia conspicillata*	resident	1995	present [units unknown]	-	Least Concern
Arabian Babbler *Turdoides squamiceps*	resident	1995	100-500 breeding pairs	poor	Least Concern
Tristram's Starling *Onychognathus tristramii*	resident	1995	50-500 breeding pairs	poor	Least Concern
White-tailed Wheatear *Oenanthe leucopyga*	resident	1995	present [units unknown]	-	Least Concern
Hooded Wheatear *Oenanthe monacha*	resident	1995	5-20 breeding pairs	poor	Least Concern
Mourning Wheatear *Oenanthe lugens*	resident	1995	present [units unknown]	-	Least Concern
Black-eared Wheatear *Oenanthe hispanica*	breeding	1995	present [units unknown]	-	Least Concern
Desert Wheatear *Oenanthe deserti*	resident	1995	common [units unknown]	-	Least Concern
Blackstart *Cercomela melanura*	resident	1995	present [units unknown]	-	Least Concern
Dead Sea Sparrow *Passer moabiticus*	non-breeding	1995	10-100 individuals	poor	Least Concern
Pale Rock Sparrow *Petronia brachydactyla*	breeding	1995	1-10 breeding pairs	poor	Least Concern
Syrian Serin *Serinus syriacus*	resident	1995	800 breeding pairs	good	Vulnerable
Trumpeter Finch *Bucanetes githagineus*	resident	1993	present [units unknown]	-	Least Concern
Pale Rosefinch *Carpodacus synoicus*	resident	1995	500-1,000 breeding pairs	poor	Least Concern
Cretzschmar's Bunting *Emberiza caesia*	breeding	1995	present [units unknown]	-	Least Concern
House Bunting *Emberiza striolata*	resident	1995	present [units unknown]	-	Least Concern
A4iv *Species group - soaring birds/cranes*	passage	1994-1995	6,866-8,637 individuals	medium	

Annex 3 Noise Map – Noise from turbines - Day-Time and Night-Time

WindPRO version 2.8.563 Oct 2012



0 1000 2000 3000 4000 m

Map: Bitmap map: 3530N_K.tif , Print scale 1:65.000, Map center UTM WGS84 Zone: 36 East: 756.422 North: 3.400.215

New WTG Noise sensitive area

Noise calculation model: ISO 9613-2 General. Wind speed: Loudest up to 95% rated power

Height above sea level from active line object

Project:
121219_Tafila_Agu_ESIA

Description:
Layout 9f_v2

DECIBEL - Map Loudest up to 95% rated power

Calculation:
Tafila (Day)

Printed/Page
20.12.2012 00:19 / 1

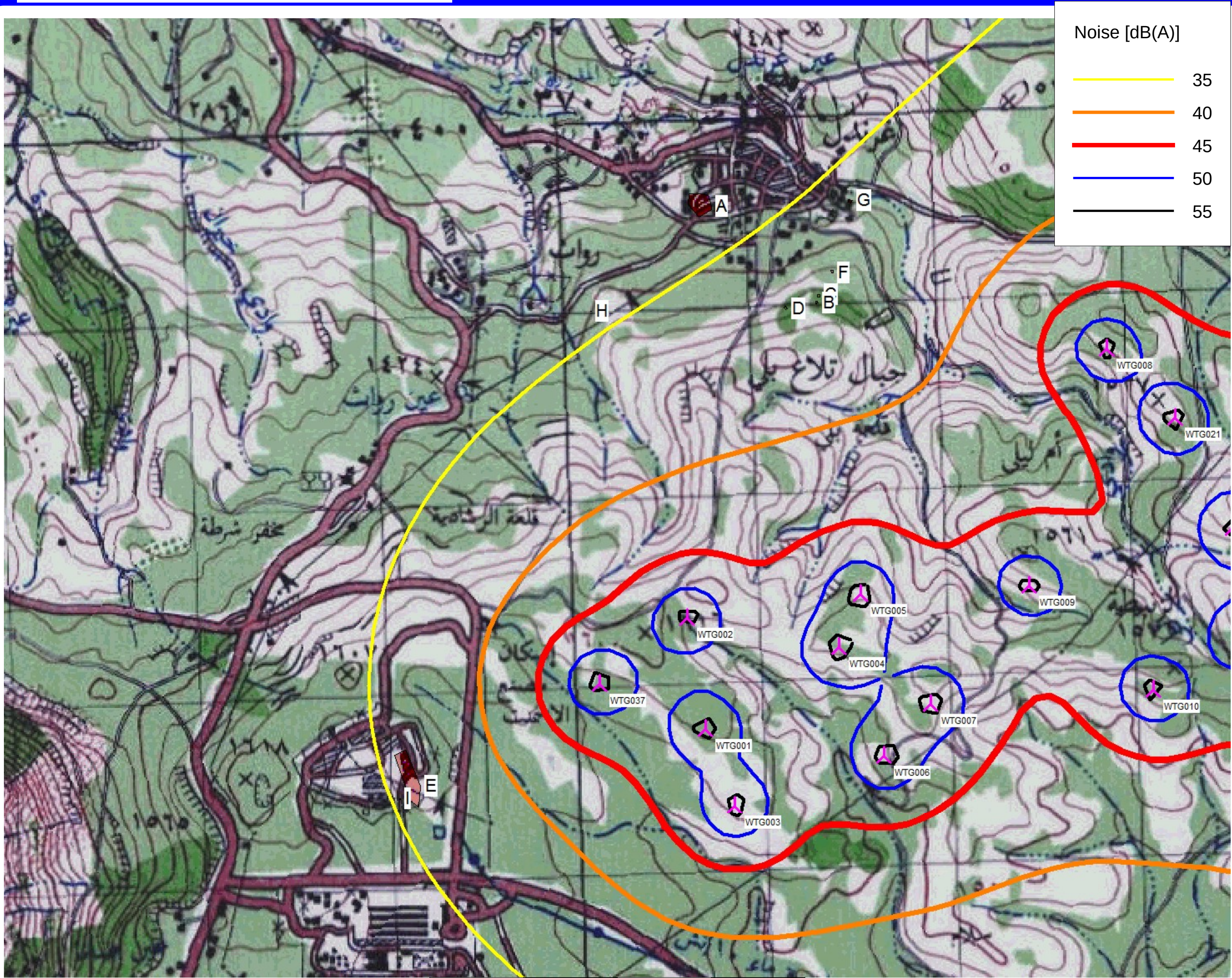
Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 22:54/2.8.563

Annex 4 Noise Map– Noise from turbines Day-Time and Night-Time (zoomed)

Project:
121219_Tafila_Agu_ESIA

Description:
Layout 9f_v2



0 500 1000 1500 2000 m

Map: Bitmap map: 3530N_K.tif , Print scale 1:35.000, Map center UTM WGS84 Zone: 36 East: 753.405 North: 3.399.496

New WTG   Noise sensitive area

Noise calculation model: ISO 9613-2 General. Wind speed: Loudest up to 95% rated power

Height above sea level from active line object

DECIBEL - Map Loudest up to 95% rated power

Calculation:
Tafila (Day)

Printed/Page
20.12.2012 00:17 / 1

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 22:54/2.8.563

Annex 5 Main result of noise prediction model – Day-time operation (2 pages)

Project:
121219_Tafila_Agu_ESIA

Description:
Layout 9f_v2

Printed/Page
20.12.2012 00:22 / 1

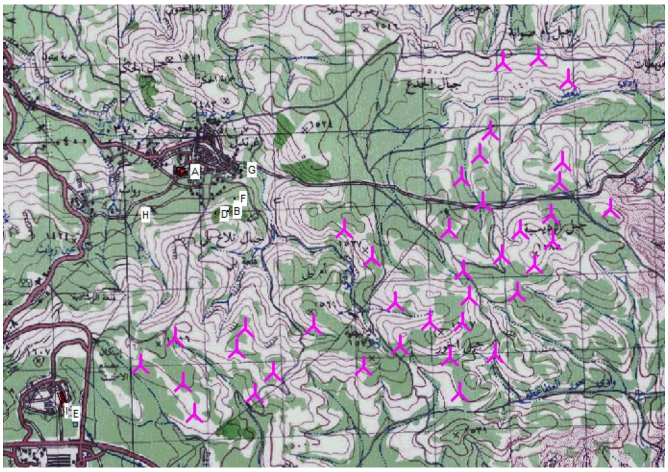
Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 22:54/2.8.563

DECIBEL - Main Result

Calculation: Tafila (Day)

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, Ground factor: 0,3
Meteorological coefficient, C0:
0,0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Pure and Impulse tone penalty are added to WTG source noise
Height above ground level, when no value in NSA object:
1,5 m Allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0,0 dB(A)



Scale 1:100.000
New WTG   Noise sensitive area

WTGs

	UTM WGS84 Zone: 36				WTG type						Noise data				
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	753.874	3.398.269	1.588,7	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
2	753.776	3.398.861	1.598,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
3	754.032	3.397.860	1.573,1	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
4	754.586	3.398.705	1.585,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
5	754.700	3.398.990	1.547,8	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
6	754.826	3.398.125	1.542,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
7	755.074	3.398.402	1.582,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
8	756.011	3.400.294	1.519,8	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
9	755.601	3.399.032	1.559,6	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
10	756.260	3.398.479	1.560,3	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
11	758.328	3.400.289	1.517,3	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
12	756.686	3.399.337	1.560,1	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
13	756.744	3.398.762	1.580,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
14	757.143	3.399.081	1.550,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
15	757.404	3.398.613	1.557,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
16	757.396	3.400.302	1.517,2	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
17	757.538	3.398.132	1.510,6	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
18	757.562	3.400.984	1.456,2	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
19	757.575	3.399.060	1.569,7	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
20	757.581	3.399.756	1.526,2	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
21	756.378	3.399.926	1.515,4	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
22	757.658	3.399.410	1.544,7	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
23	757.794	3.401.282	1.450,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
24	757.835	3.400.659	1.478,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
25	757.941	3.401.596	1.440,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
26	757.997	3.398.642	1.500,5	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
27	758.092	3.399.950	1.530,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
28	758.106	3.402.511	1.500,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
29	758.296	3.399.454	1.526,1	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
30	758.526	3.399.833	1.580,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
31	758.577	3.402.570	1.478,1	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
32	758.745	3.400.485	1.476,4	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
33	758.763	3.400.147	1.503,3	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
34	758.854	3.400.914	1.476,8	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
35	758.896	3.401.187	1.465,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
36	758.969	3.402.282	1.447,4	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
37	753.310	3.398.507	1.589,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
38	759.533	3.400.567	1.464,6	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h

h) Generic octave distribution used

Calculation Results

Sound Level

Noise sensitive area		UTM WGS84 Zone: 36				Demands	Sound Level	Demands fulfilled ?
No.	Name	East	North	Z [m]	Imission height [m]	Noise [dB(A)]	From WTGs [dB(A)]	Noise
A	Mosque / School	753.904	3.401.036	1.350,2	1,5	35,0	34,2	Yes
B	House in Ghurandil 3	754.473	3.400.538	1.424,9	1,5	50,0	37,0	Yes
C	House in Ghurandil 1	754.485	3.400.569	1.419,2	1,5	50,0	36,9	Yes

To be continued on next page...

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

DECIBEL - Main Result

Calculation: Tafila (Day)

...continued from previous page

Noise sensitive area		UTM WGS84 Zone: 36				Demands	Sound Level	Demands fulfilled ?
No.	Name	East	North	Z [m]	Imission height [m]	Noise [dB(A)]	From WTGs [dB(A)]	Noise
D	House in Ghurandil 2	754.310	3.400.507	1.420,1	1,5	50,0	36,7	Yes
E	Lafarge cement factory and houses	752.355	3.397.964	1.600,0	1,5	65,0	36,1	Yes
F	House in Ghurandil 4	754.556	3.400.701	1.424,9	1,5	50,0	36,6	Yes
G	House in Ghurandil 5	754.649	3.401.071	1.424,9	1,5	50,0	35,7	Yes
H	Mosque Gharandil Suburb	753.266	3.400.495	1.393,7	1,5	35,0	34,5	Yes
I	Mosque Lafarge	752.248	3.397.898	1.594,7	1,5	35,0	35,3	No

Distances (m)

WTG	A	B	C	D	E	F	G	H	I
1	2729	2342	2376	2273	1549	2522	2907	2307	1668
2	2137	1810	1844	1723	1658	1993	2374	1712	1806
3	3143	2711	2744	2656	1680	2886	3270	2744	1784
4	2411	1836	1867	1819	2350	1995	2367	2224	2473
5	2184	1564	1594	1564	2559	1717	2082	2079	2684
6	3037	2438	2468	2434	2476	2590	2952	2837	2588
7	2874	2219	2246	2238	2754	2357	2703	2766	2870
8	2233	1557	1550	1714	4306	1511	1568	2752	4461
9	2625	1881	1899	1960	3417	1970	2250	2755	3539
10	3476	2726	2742	2813	3938	2801	3052	3609	4054
11	4486	3862	3852	4023	6409	3794	3757	5066	6533
12	3259	2518	2522	2648	4543	2530	2675	3611	4665
13	3638	2883	2893	2995	4461	2924	3118	3886	4578
14	3783	3041	3046	3171	4916	3053	3191	4127	5036
15	4256	3506	3514	3627	5090	3532	3692	4546	5205
16	3568	2932	2923	3092	5552	2868	2850	4134	5682
17	4651	3896	3906	4007	5185	3936	4121	4882	5295
18	3656	3121	3104	3286	5997	3020	2908	4324	6145
19	4168	3436	3439	3571	5333	3437	3550	4542	5452
20	3893	3205	3201	3356	5524	3170	3213	4378	5647
21	2711	2001	1999	2148	4468	1980	2074	3164	4601
22	4090	3379	3378	3523	5496	3360	3437	4524	5617
23	3893	3402	3383	3569	6344	3289	3144	4596	6497
24	3948	3364	3351	3528	6097	3280	3208	4572	6232
25	4070	3624	3603	3790	6630	3500	3324	4803	6789
26	4741	4001	4006	4132	5682	4010	4136	5081	5797
27	4326	3666	3659	3822	6071	3615	3619	4857	6194
28	4439	4130	4104	4292	7279	3981	3732	5243	7456
29	4668	3973	3971	4122	6125	3943	3989	5137	6245
30	4775	4114	4107	4269	6447	4064	4068	5302	6569
31	4905	4576	4550	4739	7695	4431	4192	5702	7867
32	4872	4272	4261	4435	6869	4195	4133	5479	6993
33	4939	4308	4298	4467	6769	4244	4213	5508	6892
34	4949	4397	4382	4562	7133	4304	4202	5604	7262
35	4991	4470	4453	4636	7282	4367	4241	5672	7417
36	5208	4820	4796	4985	7865	4685	4475	5976	8024
37	2546	2334	2367	2227	1090	2517	2889	1988	1224
38	5647	5060	5048	5223	7635	4979	4905	6267	7758

Annex 6 Main result of noise prediction model – Night-time operation (2 pages)

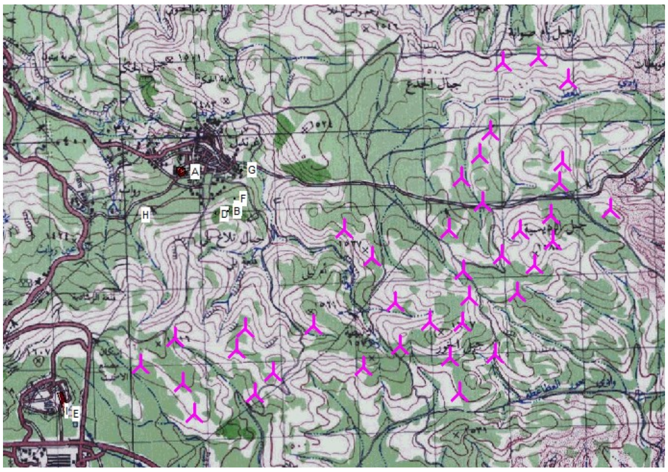
Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 20:58/2.8.563

DECIBEL - Main Result

Calculation: Tafila (Night)

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, Ground factor: 0,3
Meteorological coefficient, C0:
0,0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Pure and Impulse tone penalty are added to WTG source noise
Height above ground level, when no value in NSA object:
1,5 m Allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0,0 dB(A)



Scale 1:100.000
New WTG   Noise sensitive area

WTGs

	UTM WGS84 Zone: 36				WTG type						Noise data				
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	753.874	3.398.269	1.588,7	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
2	753.776	3.398.861	1.598,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
3	754.032	3.397.860	1.573,1	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
4	754.586	3.398.705	1.585,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
5	754.700	3.398.990	1.547,8	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
6	754.826	3.398.125	1.542,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
7	755.074	3.398.402	1.582,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
8	756.011	3.400.294	1.519,8	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
9	755.601	3.399.032	1.559,6	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
10	756.260	3.398.479	1.560,3	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
11	758.328	3.400.289	1.517,3	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
12	756.686	3.399.337	1.560,1	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
13	756.744	3.398.762	1.580,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
14	757.143	3.399.081	1.550,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
15	757.404	3.398.613	1.557,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
16	757.396	3.400.302	1.517,2	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
17	757.538	3.398.132	1.510,6	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
18	757.562	3.400.984	1.456,2	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
19	757.575	3.399.060	1.569,7	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
20	757.581	3.399.756	1.526,2	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
21	756.378	3.399.926	1.515,4	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
22	757.658	3.399.410	1.544,7	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
23	757.794	3.401.282	1.450,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
24	757.835	3.400.659	1.478,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
25	757.941	3.401.596	1.440,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
26	757.997	3.398.642	1.500,5	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
27	758.092	3.399.950	1.530,9	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
28	758.106	3.402.511	1.500,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
29	758.296	3.399.454	1.526,1	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
30	758.526	3.399.833	1.580,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
31	758.577	3.402.570	1.478,1	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
32	758.745	3.400.485	1.476,4	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
33	758.763	3.400.147	1.503,3	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
34	758.854	3.400.914	1.476,8	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
35	758.896	3.401.187	1.465,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
36	758.969	3.402.282	1.447,4	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
37	753.310	3.398.507	1.589,0	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h
38	759.533	3.400.567	1.464,6	VESTAS V112 3000 112.0 !O...	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	USER	Noise mode 0 _tonality 1dba_ V0025-7553	10,0	106,5	1 dB h

h) Generic octave distribution used

Calculation Results

Sound Level

Noise sensitive area		UTM WGS84 Zone: 36				Demands	Sound Level	Demands fulfilled ?
No.	Name	East	North	Z [m]	Imission height [m]	Noise [dB(A)]	From WTGs [dB(A)]	Noise
A	Mosque / School	753.904	3.401.036	1.350,2	1,5	35,0	34,2	Yes
B	House in Ghurandil 3	754.473	3.400.538	1.424,9	1,5	40,0	37,0	Yes
C	House in Ghurandil 1	754.485	3.400.569	1.419,2	1,5	40,0	36,9	Yes

To be continued on next page...

Project:
121219_Tafila_Agu_ESIA

Description:
Layout 9f_v2

Printed/Page
20.12.2012 00:22 / 2

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 20:58/2.8.563

DECIBEL - Main Result

Calculation: Tafila (Night)

...continued from previous page

Noise sensitive area		**UTM WGS84 Zone: 36**				**Demands**	**Sound Level**	**Demands fulfilled ?**
No.	Name	East	North	Z [m]	Imission height [m]	Noise [dB(A)]	From WTGs [dB(A)]	Noise
D	House in Ghurandil 2	754.310	3.400.507	1.420,1	1,5	40,0	36,7	Yes
E	Lafarge cement factory and houses	752.355	3.397.964	1.600,0	1,5	55,0	36,1	Yes
F	House in Ghurandil 4	754.556	3.400.701	1.424,9	1,5	40,0	36,6	Yes
G	House in Ghurandil 5	754.649	3.401.071	1.424,9	1,5	40,0	35,7	Yes
H	Mosque Gharandil Suburb	753.266	3.400.495	1.393,7	1,5	35,0	34,5	Yes
I	Mosque Lafarge	752.248	3.397.898	1.594,7	1,5	35,0	35,3	No

Distances (m)

WTG	A	B	C	D	E	F	G	H	I
1	2729	2342	2376	2273	1549	2522	2907	2307	1668
2	2137	1810	1844	1723	1658	1993	2374	1712	1806
3	3143	2711	2744	2656	1680	2886	3270	2744	1784
4	2411	1836	1867	1819	2350	1995	2367	2224	2473
5	2184	1564	1594	1564	2559	1717	2082	2079	2684
6	3037	2438	2468	2434	2476	2590	2952	2837	2588
7	2874	2219	2246	2238	2754	2357	2703	2766	2870
8	2233	1557	1550	1714	4306	1511	1568	2752	4461
9	2625	1881	1899	1960	3417	1970	2250	2755	3539
10	3476	2726	2742	2813	3938	2801	3052	3609	4054
11	4486	3862	3852	4023	6409	3794	3757	5066	6533
12	3259	2518	2522	2648	4543	2530	2675	3611	4665
13	3638	2883	2893	2995	4461	2924	3118	3886	4578
14	3783	3041	3046	3171	4916	3053	3191	4127	5036
15	4256	3506	3514	3627	5090	3532	3692	4546	5205
16	3568	2932	2923	3092	5552	2868	2850	4134	5682
17	4651	3896	3906	4007	5185	3936	4121	4882	5295
18	3656	3121	3104	3286	5997	3020	2908	4324	6145
19	4168	3436	3439	3571	5333	3437	3550	4542	5452
20	3893	3205	3201	3356	5524	3170	3213	4378	5647
21	2711	2001	1999	2148	4468	1980	2074	3164	4601
22	4090	3379	3378	3523	5496	3360	3437	4524	5617
23	3893	3402	3383	3569	6344	3289	3144	4596	6497
24	3948	3364	3351	3528	6097	3280	3208	4572	6232
25	4070	3624	3603	3790	6630	3500	3324	4803	6789
26	4741	4001	4006	4132	5682	4010	4136	5081	5797
27	4326	3666	3659	3822	6071	3615	3619	4857	6194
28	4439	4130	4104	4292	7279	3981	3732	5243	7456
29	4668	3973	3971	4122	6125	3943	3989	5137	6245
30	4775	4114	4107	4269	6447	4064	4068	5302	6569
31	4905	4576	4550	4739	7695	4431	4192	5702	7867
32	4872	4272	4261	4435	6869	4195	4133	5479	6993
33	4939	4308	4298	4467	6769	4244	4213	5508	6892
34	4949	4397	4382	4562	7133	4304	4202	5604	7262
35	4991	4470	4453	4636	7282	4367	4241	5672	7417
36	5208	4820	4796	4985	7865	4685	4475	5976	8024
37	2546	2334	2367	2227	1090	2517	2889	1988	1224
38	5647	5060	5048	5223	7635	4979	4905	6267	7758

Annex 7 Main result of construction noise (2 pages)

Project:
121219_Tafila_Agu_ESIA

Description:
Layout 9f_v2

Printed/Page
20.12.2012 00:24 / 1

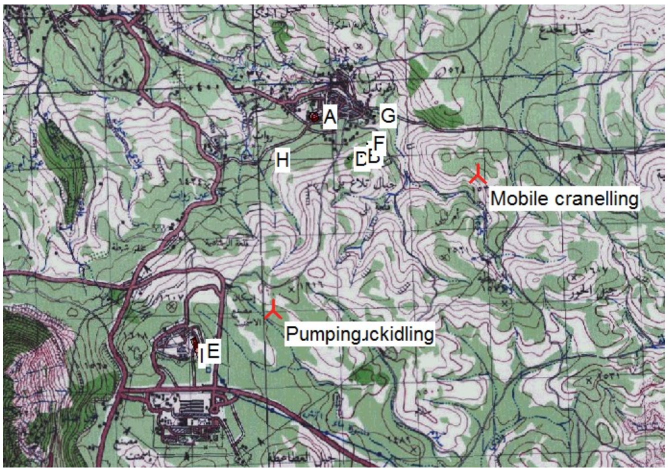
Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 21:05/2.8.563

DECIBEL - Main Result

Calculation: Construction Works

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
Alternative
Meteorological coefficient, C0:
0,0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are mean values (Lwa) (Normal)
Pure tones:
Pure and Impulse tone penalty are added to WTG source noise
Height above ground level, when no value in NSA object:
5,0 m Allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0,0 dB(A)



Scale 1:100.000
New WTG Noise sensitive area

WTGs

	UTM WGS84 Zone: 36				WTG type						Noise data					
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Wind speed	Status	LwA,ref	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]		[dB(A)]	
Breaker	756.011	3.400.294	1.519,8	Breaker	Yes	Various	-1	1	1,0	2,5	USER	Breaker (mounted on wheeled backhoe)	10,0	From slope	120,0	0 dB g
Breaker	753.310	3.398.507	1.589,0	Breaker	Yes	Various	-1	1	1,0	2,5	USER	Breaker (mounted on wheeled backhoe)	10,0	From slope	120,0	0 dB g
Dozer	753.310	3.398.507	1.589,0	Dozer	Yes	Various	-1	1	1,0	2,5	USER	Dozer	10,0	From slope	109,0	0 dB g
Dozer	756.011	3.400.294	1.519,8	Dozer	Yes	Various	-1	1	1,0	2,5	USER	Dozer	10,0	From slope	109,0	0 dB g
Dump TRuck	756.011	3.400.294	1.519,8	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	756.011	3.400.294	1.519,8	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	753.310	3.398.507	1.589,0	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	753.310	3.398.507	1.589,0	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	753.310	3.398.507	1.589,0	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump Truck	756.011	3.400.294	1.519,8	Dump Truck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump Truck	756.011	3.400.294	1.519,8	Dump Truck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	756.011	3.400.294	1.519,8	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	753.310	3.398.507	1.589,0	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	753.310	3.398.507	1.589,0	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Excavator	756.011	3.400.294	1.519,8	Excavator	Yes	Various	-1	1	1,0	2,5	USER	Excavator	10,0	From slope	107,0	0 dB g
Excavator	756.011	3.400.294	1.519,8	Excavator	Yes	Various	-1	1	1,0	2,5	USER	Excavator	10,0	From slope	107,0	0 dB g
Excavator	753.310	3.398.507	1.589,0	Excavator	Yes	Various	-1	1	1,0	2,5	USER	Excavator	10,0	From slope	107,0	0 dB g
Excavator	753.310	3.398.507	1.589,0	Excavator	Yes	Various	-1	1	1,0	2,5	USER	Excavator	10,0	From slope	107,0	0 dB g
Flatbed trucks	756.011	3.400.294	1.519,8	Flatbed trucks	Yes	Various	-1	1	1,0	2,5	USER	flatbed trucks	10,0	From slope	108,0	0 dB g
Flatbed trucks	753.310	3.398.507	1.589,0	Flatbed trucks	Yes	Various	-1	1	1,0	2,5	USER	flatbed trucks	10,0	From slope	108,0	0 dB g
Flatbed trucks	756.011	3.400.294	1.519,8	Flatbed trucks	Yes	Various	-1	1	1,0	2,5	USER	flatbed trucks	10,0	From slope	108,0	0 dB g
Flatbed trucks	753.310	3.398.507	1.589,0	Flatbed trucks	Yes	Various	-1	1	1,0	2,5	USER	flatbed trucks	10,0	From slope	108,0	0 dB g
Mixer Truck	753.310	3.398.507	1.589,0	Mixer Truck	Yes	Various	-1	1	1,0	2,5	USER	Concrete Mixer truck	10,0	From slope	108,0	0 dB g
Mixer Truck	756.011	3.400.294	1.519,8	Mixer Truck	Yes	Various	-1	1	1,0	2,5	USER	Concrete Mixer truck	10,0	From slope	108,0	0 dB g
Mixer Truck	756.011	3.400.294	1.519,8	Mixer Truck	Yes	Various	-1	1	1,0	2,5	USER	Concrete Mixer truck	10,0	From slope	108,0	0 dB g
Mixer Truck	753.310	3.398.507	1.589,0	Mixer Truck	Yes	Various	-1	1	1,0	2,5	USER	Concrete Mixer truck	10,0	From slope	108,0	0 dB g
Mixer truck idling	756.011	3.400.294	1.519,8	Mixer truck idling	Yes	Various	-1	1	1,0	2,5	USER	mixer truck idling	10,0	From slope	99,0	0 dB g
Mixer truck idling	753.310	3.398.507	1.589,0	Mixer truck idling	Yes	Various	-1	1	1,0	2,5	USER	mixer truck idling	10,0	From slope	99,0	0 dB g
Mobile crane	753.310	3.398.507	1.589,0	Mobile crane	Yes	Various	-1	1	1,0	2,5	USER	mobile crane	10,0	From slope	106,0	0 dB g
Mobile crane	753.310	3.398.507	1.589,0	Mobile crane	Yes	Various	-1	1	1,0	2,5	USER	mobile crane	10,0	From slope	106,0	0 dB g
Mobile crane	756.011	3.400.294	1.519,8	Mobile crane	Yes	Various	-1	1	1,0	2,5	USER	mobile crane	10,0	From slope	106,0	0 dB g
Mobile crane	756.011	3.400.294	1.519,8	Mobile crane	Yes	Various	-1	1	1,0	2,5	USER	mobile crane	10,0	From slope	106,0	0 dB g
Pumping	753.310	3.398.507	1.589,0	Pumping	Yes	Various	-1	1	1,0	2,5	USER	pumping	10,0	From slope	106,0	0 dB g
Pumping	756.011	3.400.294	1.519,8	Pumping	Yes	Various	-1	1	1,0	2,5	USER	pumping	10,0	From slope	106,0	0 dB g
Roller	756.011	3.400.294	1.519,8	Roller	Yes	Various	-1	1	1,0	2,5	USER	Roller	10,0	From slope	107,0	0 dB g
Roller	753.310	3.398.507	1.589,0	Roller	Yes	Various	-1	1	1,0	2,5	USER	Roller	10,0	From slope	107,0	0 dB g

g) Data calculated from data for other wind speed (uncertain)

Calculation Results

Sound Level

Noise sensitive area		UTM WGS84 Zone: 36				Demands	Sound Level	Demands fulfilled ?
No.	Name	East	North	Z	Imission height	Noise	From WTGs	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	
House in Ghurandil 1	House in Ghurandil 1	754.485	3.400.569	1.419,2	1,5	65,0	46,6	Yes
House in Ghurandil 2	House in Ghurandil 2	754.310	3.400.507	1.420,1	1,5	65,0	46,0	Yes
House in Ghurandil 3	House in Ghurandil 3	754.473	3.400.538	1.424,9	1,5	65,0	46,6	Yes
House in Ghurandil 4	House in Ghurandil 4	754.556	3.400.701	1.424,9	1,5	65,0	46,7	Yes
House in Ghurandil 5	House in Ghurandil 5	754.649	3.401.071	1.424,9	1,5	65,0	46,0	Yes
Lafarge cement factory and houses	Lafarge cement factory and houses	752.327	3.398.034	1.600,0	1,5	65,0	49,9	Yes

To be continued on next page...

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 21:05/2.8.563

DECIBEL - Main Result

Calculation: Construction Works

...continued from previous page

Noise sensitive area		UTM WGS84 Zone: 36				Demands	Sound Level	Demands fulfilled ?
No.	Name	East	North	Z	Imission height	Noise	From WTGs	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	
Mosque / School	Mosque / School	753.904	3.401.036	1.350,2	1,5	65,0	43,1	Yes
Mosque Gharandil Suburb	Mosque Gharandil Suburb	753.266	3.400.495	1.393,7	1,5	65,0	43,8	Yes
Mosque Lafarge	Mosque Lafarge	752.248	3.397.898	1.594,7	1,5	65,0	48,2	Yes

Distances (m)

WTG	Mosque / School	House in Ghurandil 3	House in Ghurandil 1	House in Ghurandil 2	Lafarge cement factory and houses	House in Ghurandil 4	House in Ghurandil 5	Mosque Gharandil Suburb	Mosque Lafarge
Breaker	2233	1557	1550	1714	4306	1511	1568	2752	4461
Breaker	2546	2334	2367	2227	1090	2517	2889	1988	1224
Dozer	2546	2334	2367	2227	1090	2517	2889	1988	1224
Dozer	2233	1557	1550	1714	4306	1511	1568	2752	4461
Dump TRuck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Dump TRuck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Dump TRuck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Dump TRuck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Dump TRuck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Dump Truck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Dump Truck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Dump TRuck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Dump TRuck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Dump TRuck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Excavator	2233	1557	1550	1714	4306	1511	1568	2752	4461
Excavator	2233	1557	1550	1714	4306	1511	1568	2752	4461
Excavator	2546	2334	2367	2227	1090	2517	2889	1988	1224
Excavator	2546	2334	2367	2227	1090	2517	2889	1988	1224
Flatbed trucks	2233	1557	1550	1714	4306	1511	1568	2752	4461
Flatbed trucks	2546	2334	2367	2227	1090	2517	2889	1988	1224
Flatbed trucks	2233	1557	1550	1714	4306	1511	1568	2752	4461
Flatbed trucks	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mixer Truck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mixer Truck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Mixer Truck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Mixer Truck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mixer truck idling	2233	1557	1550	1714	4306	1511	1568	2752	4461
Mixer truck idling	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mobile crane	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mobile crane	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mobile crane	2233	1557	1550	1714	4306	1511	1568	2752	4461
Mobile crane	2233	1557	1550	1714	4306	1511	1568	2752	4461
Pumping	2546	2334	2367	2227	1090	2517	2889	1988	1224
Pumping	2233	1557	1550	1714	4306	1511	1568	2752	4461
Roller	2233	1557	1550	1714	4306	1511	1568	2752	4461
Roller	2546	2334	2367	2227	1090	2517	2889	1988	1224

Annex 8 Main result of decommissioning noise (2 pages)

Project:
121219_Tafila_Agu_ESIA

Description:
Layout 9f_v2

Printed/Page
20.12.2012 00:24 / 1

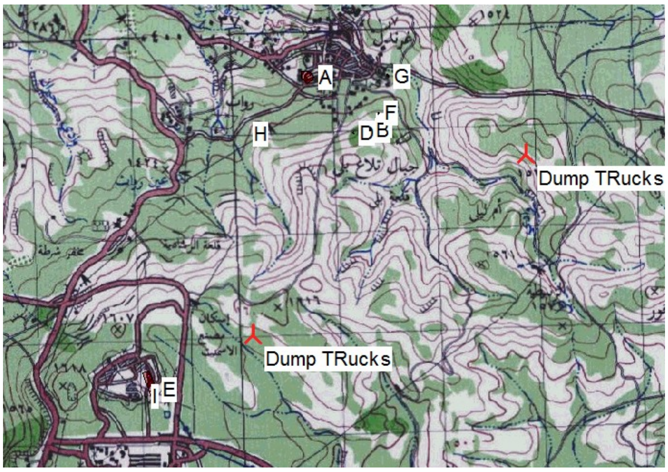
Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 21:07/2.8.563

DECIBEL - Main Result

Calculation: Decommissioning Works

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
Alternative
Meteorological coefficient, C0:
0,0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are mean values (Lwa) (Normal)
Pure tones:
Pure and Impulse tone penalty are added to WTG source noise
Height above ground level, when no value in NSA object:
5,0 m Allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0,0 dB(A)



Scale 1:75.000
New WTG Noise sensitive area

WTGs

	UTM WGS84 Zone: 36				WTG type						Noise data					
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Creator	Name	Wind speed [m/s]	Status	LwA,ref [dB(A)]	Pure tones
Dump TRuck	756.011	3.400.294	1.519,8	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	756.011	3.400.294	1.519,8	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	753.310	3.398.507	1.589,0	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	756.011	3.400.294	1.519,8	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	753.310	3.398.507	1.589,0	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Dump TRuck	753.310	3.398.507	1.589,0	Dump TRuck	Yes	Various	-1	1	1,0	2,5	USER	Dump truck	10,0	From slope	115,0	0 dB g
Excavator	753.310	3.398.507	1.589,0	Excavator	Yes	Various	-1	1	1,0	2,5	USER	Excavator	10,0	From slope	107,0	0 dB g
Excavator	756.011	3.400.294	1.519,8	Excavator	Yes	Various	-1	1	1,0	2,5	USER	Excavator	10,0	From slope	107,0	0 dB g
Flatbed trucks	756.011	3.400.294	1.519,8	Flatbed trucks	Yes	Various	-1	1	1,0	2,5	USER	flatbed trucks	10,0	From slope	108,0	0 dB g
Flatbed trucks	756.011	3.400.294	1.519,8	Flatbed trucks	Yes	Various	-1	1	1,0	2,5	USER	flatbed trucks	10,0	From slope	108,0	0 dB g
Flatbed trucks	753.310	3.398.507	1.589,0	Flatbed trucks	Yes	Various	-1	1	1,0	2,5	USER	flatbed trucks	10,0	From slope	108,0	0 dB g
Flatbed trucks	753.310	3.398.507	1.589,0	Flatbed trucks	Yes	Various	-1	1	1,0	2,5	USER	flatbed trucks	10,0	From slope	108,0	0 dB g
Mobile crane	756.011	3.400.294	1.519,8	Mobile crane	Yes	Various	-1	1	1,0	2,5	USER	mobile crane	10,0	From slope	106,0	0 dB g
Mobile crane	753.310	3.398.507	1.589,0	Mobile crane	Yes	Various	-1	1	1,0	2,5	USER	mobile crane	10,0	From slope	106,0	0 dB g
Mobile crane	753.310	3.398.507	1.589,0	Mobile crane	Yes	Various	-1	1	1,0	2,5	USER	mobile crane	10,0	From slope	106,0	0 dB g
Mobile crane	756.011	3.400.294	1.519,8	Mobile crane	Yes	Various	-1	1	1,0	2,5	USER	mobile crane	10,0	From slope	106,0	0 dB g

g) Data calculated from data for other wind speed (uncertain)

Calculation Results

Sound Level

Noise sensitive area		UTM WGS84 Zone: 36				Demands	Sound Level	Demands fulfilled ?
No.	Name	East	North	Z [m]	Imission height [m]	Noise [dB(A)]	From WTGs [dB(A)]	Noise
House in Ghurandil 1	House in Ghurandil 1	754.485	3.400.569	1.419,2	1,5	65,0	42,4	Yes
House in Ghurandil 2	House in Ghurandil 2	754.310	3.400.507	1.420,1	1,5	65,0	41,7	Yes
House in Ghurandil 3	House in Ghurandil 3	754.473	3.400.538	1.424,9	1,5	65,0	42,4	Yes
House in Ghurandil 4	House in Ghurandil 4	754.556	3.400.701	1.424,9	1,5	65,0	42,4	Yes
House in Ghurandil 5	House in Ghurandil 5	754.649	3.401.071	1.424,9	1,5	65,0	41,7	Yes
Lafarge cement factory and houses	Lafarge cement factory and houses	752.327	3.398.034	1.600,0	1,5	65,0	45,7	Yes
Mosque / School	Mosque / School	753.904	3.401.036	1.350,2	1,5	65,0	38,9	Yes
Mosque Gharandil Suburb	Mosque Gharandil Suburb	753.266	3.400.495	1.393,7	1,5	65,0	39,6	Yes
Mosque Lafarge	Mosque Lafarge	752.248	3.397.898	1.594,7	1,5	65,0	44,0	Yes

Distances (m)

WTG	Mosque / School	House in Ghurandil 3	House in Ghurandil 1	House in Ghurandil 2	Lafarge cement factory and houses	House in Ghurandil 4	House in Ghurandil 5	Mosque Gharandil Suburb	Mosque Lafarge
Dump TRuck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Dump TRuck	2233	1557	1550	1714	4306	1511	1568	2752	4461

To be continued on next page...

Project:
121219_Tafila_Agu_ESIA

Description:
Layout 9f_v2

Printed/Page
20.12.2012 00:24 / 2

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Andrea Gütschow / a.guetschow@cube-engineering.com

Calculated:
19.12.2012 21:07/2.8.563

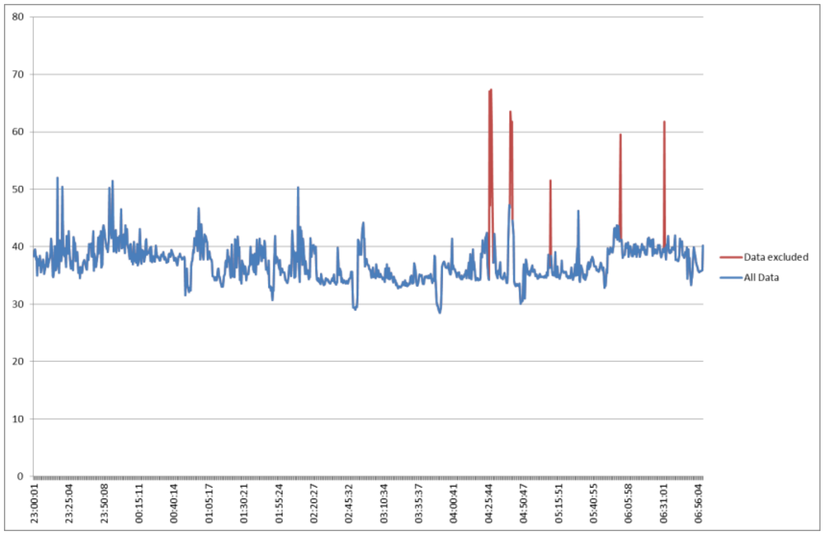
DECIBEL - Main Result

Calculation: Decommissioning Works

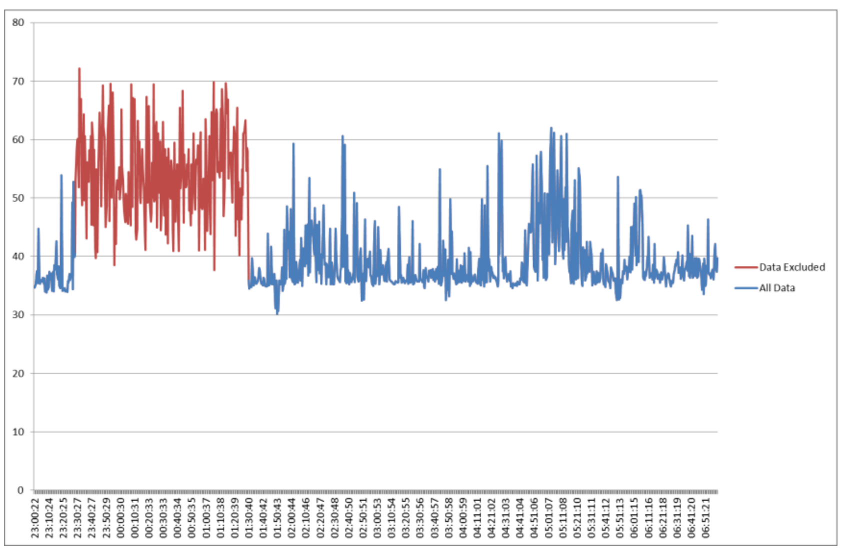
...continued from previous page

WTG	Mosque / School	House in Ghurandil 3	House in Ghurandil 1	House in Ghurandil 2	Lafarge cement factory and houses	House in Ghurandil 4	House in Ghurandil 5	Mosque Gharandil Suburb	Mosque Lafarge
Dump TRuck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Dump TRuck	2233	1557	1550	1714	4306	1511	1568	2752	4461
Dump TRuck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Dump TRuck	2546	2334	2367	2227	1090	2517	2889	1988	1224
Excavator	2546	2334	2367	2227	1090	2517	2889	1988	1224
Excavator	2233	1557	1550	1714	4306	1511	1568	2752	4461
Flatbed trucks	2233	1557	1550	1714	4306	1511	1568	2752	4461
Flatbed trucks	2233	1557	1550	1714	4306	1511	1568	2752	4461
Flatbed trucks	2546	2334	2367	2227	1090	2517	2889	1988	1224
Flatbed trucks	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mobile crane	2233	1557	1550	1714	4306	1511	1568	2752	4461
Mobile crane	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mobile crane	2546	2334	2367	2227	1090	2517	2889	1988	1224
Mobile crane	2233	1557	1550	1714	4306	1511	1568	2752	4461

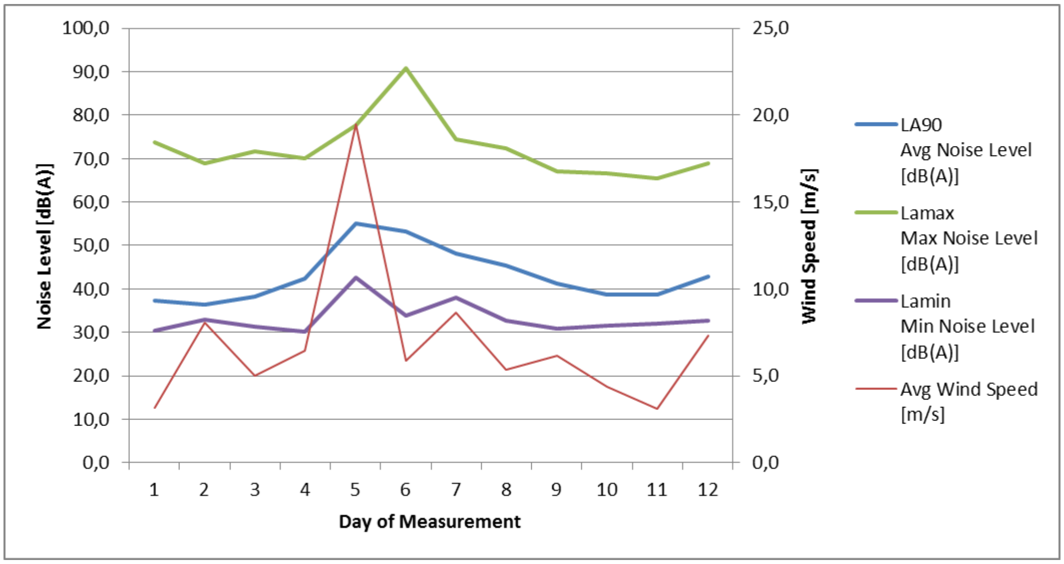
Annex 9 Measured noise data (3 pages)



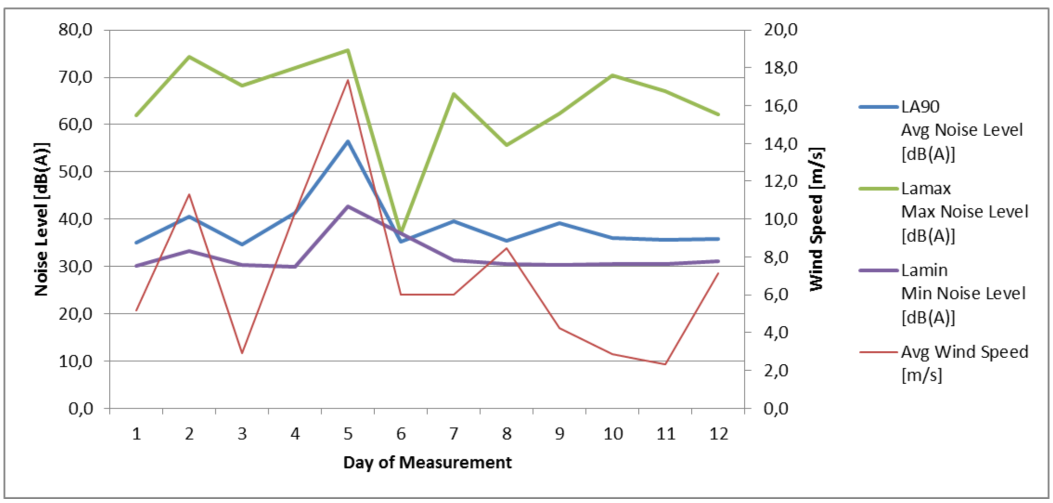
Example of extraordinary nocturnal noise data – 19th to 20th of April



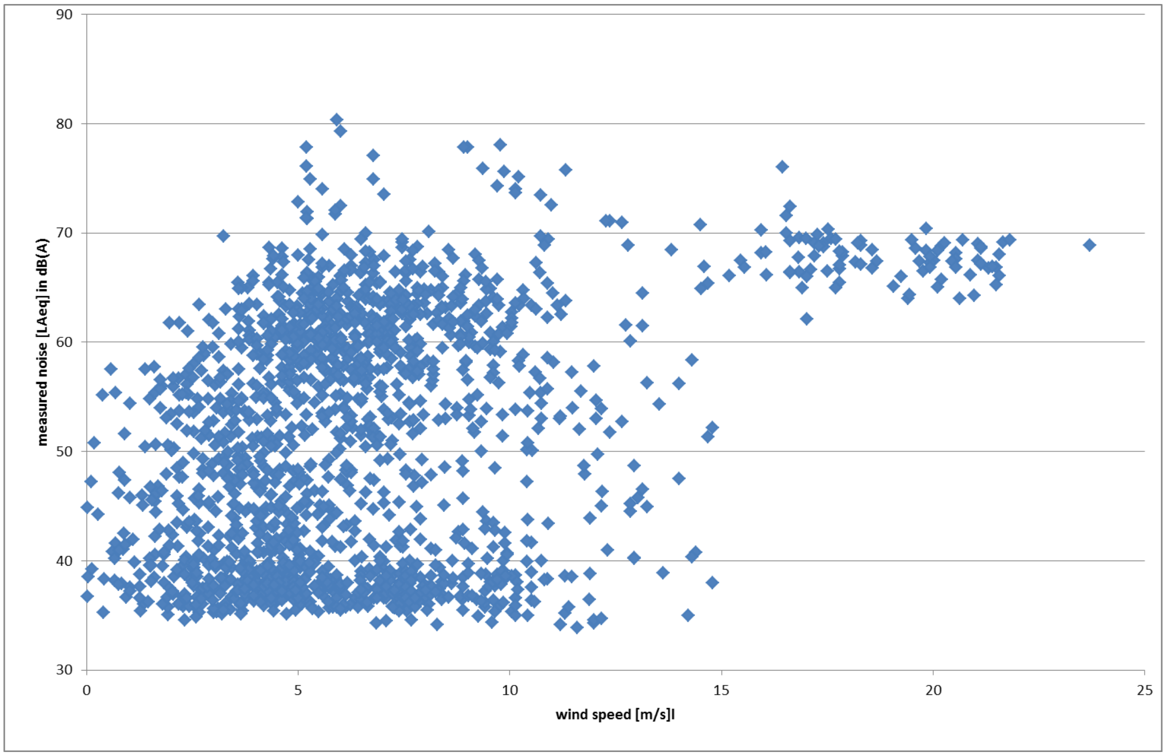
Example of extraordinary noise data – 14th to 15th of April (probably a celebration)



Gharandil NSA 5: measured ambient noise level during quiet day-time (6 p.m. until 11 p.m.)



Gharandil NSA 5: measured ambient noise level during night hours



Measured noise versus wind speed based on $LA90_{10\text{-min}}$ during the second measurement period

Annex 10 Result of the shadow flickering calculations

Project:
20120913_Tafila_Agu2

Description:
preliminary layout Vestas V90 3.0 MW

Printed/Page
12.11.2012 17:11 / 1

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Hauptergebnis

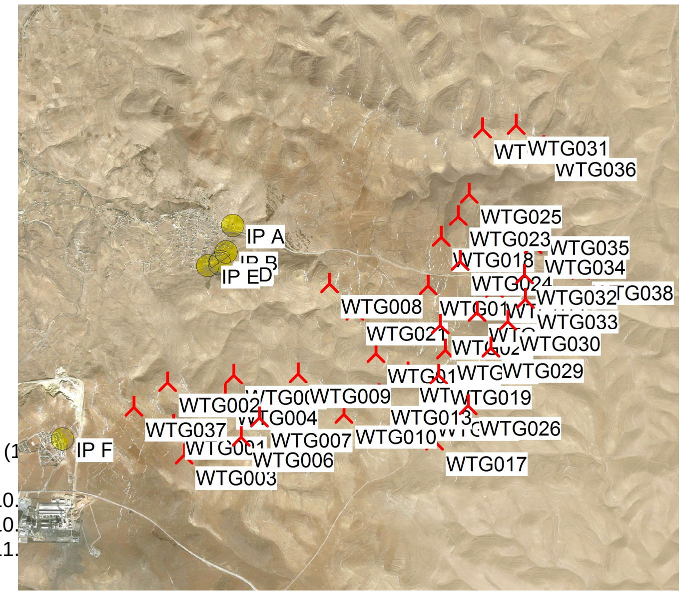
Calculation: Astronomically possible

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence 3 °
Day step for calculation 1 days
Time step for calculation 1 minutes
The calculated times are "worst case" given by the following assumptions:
The sun is shining all the day, from sunrise to sunset
The rotor plane is always perpendicular to the line from the WTG to the sun
The WTG is always operating

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Höhenlinien: CONTOURLINE_ONLINEDATA_0.wpo (1
Area object(s) used in calculation:
Areal-Objekt (ZVI): REGIONS_20120913_Tafila_Agu2_RECOVER002 30.10.
Areal-Objekt (ZVI): REGIONS_20120913_Tafila_Agu2_RECOVER002 30.10.
Areal-Objekt (ZVI): REGIONS_20120913_Tafila_Agu2_RECOVER003 06.11.
Obstacles not used in calculation
Eye height: 1,5 m
Grid resolution: 10,0 m



Scale 1:100.000
New WTG Shadow receptor

WTGs

	UTM WGS84 Zone: 36				WTG type						Shadow data	
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
WTG001	753.874	3.398.269	1.589,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG002	753.776	3.398.861	1.596,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG003	754.032	3.397.860	1.573,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG004	754.586	3.398.705	1.585,8	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG005	754.700	3.398.990	1.550,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG006	754.826	3.398.125	1.542,4	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG007	755.074	3.398.402	1.584,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG008	756.011	3.400.294	1.518,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG009	755.601	3.399.032	1.552,8	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG010	756.260	3.398.479	1.563,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG011	758.328	3.400.289	1.518,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG012	756.686	3.399.337	1.564,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG013	756.744	3.398.762	1.571,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG014	757.143	3.399.081	1.545,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	1.712	12,0
WTG015	757.404	3.398.613	1.558,7	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	1.712	12,0
WTG016	757.396	3.400.302	1.519,4	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG017	757.538	3.398.132	1.510,3	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG018	757.562	3.400.984	1.455,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG019	757.575	3.399.060	1.571,4	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	1.712	12,0
WTG020	757.581	3.399.756	1.526,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG021	756.378	3.399.926	1.514,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG022	757.658	3.399.410	1.545,8	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG023	757.794	3.401.282	1.450,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG024	757.835	3.400.659	1.478,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG025	757.941	3.401.596	1.441,8	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG026	757.997	3.398.642	1.498,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG027	758.092	3.399.950	1.532,1	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG028	758.106	3.402.511	1.501,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG029	758.296	3.399.454	1.526,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG030	758.526	3.399.833	1.580,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	1.712	12,0
WTG031	758.577	3.402.570	1.477,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG032	758.745	3.400.485	1.476,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG033	758.763	3.400.147	1.504,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0

To be continued on next page...

Project:
20120913_Tafila_Agu2

Description:
preliminary layout Vestas V90 3.0 MW

Printed/Page
12.11.2012 17:11 / 2

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Hauptergebnis

Calculation: Astronomically possible

...continued from previous page

	UTM WGS84 Zone: 36				WTG type						Shadow data	
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
WTG034	758.854	3.400.914	1.473,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG035	758.896	3.401.187	1.469,1	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG036	758.969	3.402.282	1.450,4	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG037	753.310	3.398.507	1.589,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG038	759.533	3.400.567	1.463,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0

Shadow receptor-Input

		UTM WGS84 Zone: 36								
No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
IP A	IP A	754.636	3.401.083	1.353,8	0,1	2,0	0,1	-35,0	90,0	"Green house mode"
IP B	IP B	754.552	3.400.710	1.403,1	0,1	2,0	0,1	-45,0	90,0	"Green house mode"
IP C	IP C	754.479	3.400.573	1.419,8	0,1	2,0	0,1	-35,0	90,0	Fixed direction
IP D	IP D	754.466	3.400.544	1.426,1	0,1	2,0	0,1	-15,0	90,0	"Green house mode"
IP E	IP E	754.303	3.400.508	1.420,2	0,1	2,0	0,1	-35,0	90,0	"Green house mode"
IP F	IP F	752.320	3.398.041	1.601,2	0,1	2,0	0,1	-105,0	90,0	"Green house mode"

Calculation Results

Shadow receptor

		Shadow, worst case		
No.	Name	Shadow hours per year	Shadow days per year	Max shadow hours per day
		[h/year]	[days/year]	[h/day]
IP A	IP A	10:14	48	0:17
IP B	IP B	5:14	23	0:18
IP C	IP C	4:42	22	0:17
IP D	IP D	4:36	21	0:17
IP E	IP E	0:00	0	0:00
IP F	IP F	21:00	87	0:21

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
WTG001	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4392)	2:22	
WTG002	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4393)	0:00	
WTG003	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4394)	0:00	
WTG004	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4395)	0:00	
WTG005	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4396)	0:00	
WTG006	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4397)	0:00	
WTG007	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4398)	0:00	
WTG008	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4399)	21:45	
WTG009	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4400)	0:00	
WTG010	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4401)	0:00	
WTG011	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4402)	0:00	
WTG012	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4403)	0:00	
WTG013	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4404)	0:00	
WTG014	VESTAS V112 3000 112.0 !O! NH: 84,0 m (Ges:140,0 m) (4405)	0:00	
WTG015	VESTAS V112 3000 112.0 !O! NH: 84,0 m (Ges:140,0 m) (4406)	0:00	
WTG016	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4407)	0:00	
WTG017	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4408)	0:00	
WTG018	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4409)	0:00	
WTG019	VESTAS V112 3000 112.0 !O! NH: 84,0 m (Ges:140,0 m) (4410)	0:00	
WTG020	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4411)	0:00	
WTG021	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4412)	0:00	
WTG022	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4413)	0:00	

To be continued on next page...

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Hauptergebnis

Calculation: Astronomically possible

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
WTG023	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4414)	0:00	
WTG024	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4415)	0:00	
WTG025	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4416)	0:00	
WTG026	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4417)	0:00	
WTG027	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4418)	0:00	
WTG028	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4419)	0:00	
WTG029	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4420)	0:00	
WTG030	VESTAS V112 3000 112.0 !O! NH: 84,0 m (Ges:140,0 m) (4421)	0:00	
WTG031	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4422)	0:00	
WTG032	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4423)	0:00	
WTG033	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4424)	0:00	
WTG034	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4425)	0:00	
WTG035	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4426)	0:00	
WTG036	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4427)	0:00	
WTG037	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4428)	18:38	
WTG038	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4429)	0:00	

Project:
20120913_Tafila_Agu2

Description:
preliminary layout Vestas V90 3.0 MW

Printed/Page
12.11.2012 17:11 / 4

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Kalender

Calculation: Astronomically possible **Shadow receptor:** IP A - IP A

Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:
The sun is shining all the day, from sunrise to sunset
The rotor plane is always perpendicular to the line from the WTG to the sun
The WTG is always operating

Day	January			February	March	April	May	June	July	August	September	October	November			December		
1	06:35			06:30	06:06	06:28	05:55	05:36	05:38	05:55	06:14	06:31	05:52			06:17		07:00 (WTG008)
	16:47			17:13	17:36	18:56	19:16	19:35	19:45	19:33	19:02	18:24	16:51			16:36	15	07:15 (WTG008)
2	06:36		07:19 (WTG008)	06:29	06:04	06:27	05:54	05:36	05:39	05:56	06:14	06:31	05:53			06:18		07:00 (WTG008)
	16:48	4	07:23 (WTG008)	17:14	17:37	18:57	19:16	19:36	19:45	19:32	19:01	18:23	16:50			16:36	15	07:15 (WTG008)
3	06:36		07:18 (WTG008)	06:29	06:03	06:26	05:53	05:35	05:39	05:56	06:15	06:32	05:54			06:18		07:01 (WTG008)
	16:49	7	07:25 (WTG008)	17:15	17:37	18:58	19:17	19:37	19:45	19:32	19:00	18:22	16:49			16:36	14	07:15 (WTG008)
4	06:36		07:18 (WTG008)	06:28	06:02	06:25	05:52	05:35	05:39	05:57	06:15	06:33	05:54			06:19		07:02 (WTG008)
	16:49	8	07:26 (WTG008)	17:16	17:38	18:58	19:18	19:37	19:45	19:31	18:59	18:21	16:48			16:36	13	07:15 (WTG008)
5	06:36		07:18 (WTG008)	06:27	06:01	06:23	05:51	05:35	05:40	05:57	06:16	06:33	05:55			06:20		07:03 (WTG008)
	16:50	10	07:28 (WTG008)	17:17	17:39	18:59	19:18	19:38	19:45	19:30	18:57	18:19	16:48			16:36	12	07:15 (WTG008)
6	06:36		07:18 (WTG008)	06:27	06:00	06:22	05:51	05:35	05:40	05:58	06:17	06:34	05:56			06:21		07:04 (WTG008)
	16:51	11	07:29 (WTG008)	17:18	17:39	19:00	19:19	19:38	19:45	19:29	18:56	18:18	16:47			16:36	11	07:15 (WTG008)
7	06:36		07:18 (WTG008)	06:26	05:59	06:21	05:50	05:35	05:41	05:59	06:17	06:34	05:57			06:22		07:04 (WTG008)
	16:52	12	07:30 (WTG008)	17:18	17:40	19:00	19:20	19:39	19:44	19:28	18:55	18:17	16:46			16:36	10	07:14 (WTG008)
8	06:36		07:18 (WTG008)	06:25	05:58	06:20	05:49	05:35	05:41	05:59	06:18	06:35	05:58			06:22		07:06 (WTG008)
	16:52	13	07:31 (WTG008)	17:19	17:41	19:01	19:20	19:39	19:44	19:28	18:54	18:16	16:45			16:36	8	07:14 (WTG008)
9	06:37		07:18 (WTG008)	06:25	05:56	06:19	05:48	05:35	05:42	06:00	06:18	06:36	05:58			06:23		07:07 (WTG008)
	16:53	14	07:32 (WTG008)	17:20	17:41	19:01	19:21	19:40	19:44	19:27	18:52	18:15	16:45			16:37	7	07:14 (WTG008)
10	06:37		07:18 (WTG008)	06:24	05:55	06:17	05:47	05:34	05:42	06:01	06:19	06:36	05:59			06:24		07:09 (WTG008)
	16:54	15	07:33 (WTG008)	17:21	17:42	19:02	19:22	19:40	19:44	19:26	18:51	18:13	16:44			16:37	4	07:13 (WTG008)
11	06:37		07:18 (WTG008)	06:23	05:54	06:16	05:47	05:34	05:43	06:01	06:19	06:37	06:00			06:25		
	16:55	15	07:33 (WTG008)	17:22	17:43	19:03	19:22	19:40	19:44	19:25	18:50	18:12	16:43			16:37		
12	06:37		07:18 (WTG008)	06:22	05:53	06:15	05:46	05:34	05:43	06:02	06:20	06:38	06:01			06:25		
	16:56	16	07:34 (WTG008)	17:23	17:44	19:03	19:23	19:41	19:43	19:24	18:49	18:11	16:43			16:37		
13	06:36		07:17 (WTG008)	06:21	05:52	06:14	05:45	05:34	05:44	06:02	06:20	06:38	06:02			06:26		
	16:56	17	07:34 (WTG008)	17:23	17:44	19:04	19:24	19:41	19:43	19:23	18:47	18:10	16:42			16:37		
14	06:36		07:18 (WTG008)	06:20	05:50	06:13	05:44	05:34	05:44	06:03	06:21	06:39	06:03			06:27		
	16:57	17	07:35 (WTG008)	17:24	17:45	19:05	19:24	19:42	19:43	19:22	18:46	18:09	16:42			16:38		
15	06:36		07:18 (WTG008)	06:20	05:49	06:12	05:44	05:35	05:45	06:04	06:22	06:40	06:03			06:27		
	16:58	17	07:35 (WTG008)	17:25	17:46	19:05	19:25	19:42	19:42	19:21	18:45	18:08	16:41			16:38		
16	06:36		07:19 (WTG008)	06:19	05:48	06:10	05:43	05:35	05:45	06:04	06:22	06:40	06:04			06:28		
	16:59	17	07:36 (WTG008)	17:26	17:46	19:06	19:26	19:42	19:42	19:20	18:43	18:07	16:41			16:38		
17	06:36		07:19 (WTG008)	06:18	05:47	06:09	05:43	05:35	05:46	06:05	06:23	06:41	06:05		07:01 (WTG008)	06:28		
	17:00	17	07:36 (WTG008)	17:27	17:47	19:07	19:26	19:43	19:42	19:19	18:42	18:05	16:40	3	07:04 (WTG008)	16:39		
18	06:36		07:19 (WTG008)	06:17	05:46	06:08	05:42	05:35	05:46	06:05	06:23	06:42	06:06		06:59 (WTG008)	06:29		
	17:01	17	07:36 (WTG008)	17:27	17:47	19:07	19:27	19:43	19:41	19:18	18:41	18:04	16:40	8	07:07 (WTG008)	16:39		
19	06:36		07:20 (WTG008)	06:16	05:44	06:07	05:41	05:35	05:47	06:06	06:24	06:42	06:07		06:58 (WTG008)	06:30		
	17:02	16	07:36 (WTG008)	17:28	17:48	19:08	19:28	19:43	19:41	19:17	18:40	18:03	16:39	11	07:09 (WTG008)	16:39		
20	06:35		07:21 (WTG008)	06:15	05:43	06:06	05:41	05:35	05:48	06:07	06:24	06:43	06:08		06:57 (WTG008)	06:30		
	17:03	15	07:36 (WTG008)	17:29	17:49	19:08	19:28	19:43	19:40	19:16	18:38	18:02	16:39	13	07:10 (WTG008)	16:40		
21	06:35		07:21 (WTG008)	06:14	05:42	06:05	05:40	05:35	05:48	06:07	06:25	06:44	06:08		06:57 (WTG008)	06:31		
	17:03	14	07:35 (WTG008)	17:30	17:49	19:09	19:29	19:44	19:40	19:15	18:37	18:01	16:38	14	07:11 (WTG008)	16:40		
22	06:35		07:22 (WTG008)	06:13	05:41	06:04	05:40	05:35	05:49	06:08	06:26	06:44	06:09		06:57 (WTG008)	06:31		
	17:04	13	07:35 (WTG008)	17:31	17:50	19:10	19:30	19:44	19:39	19:14	18:36	18:00	16:38	15	07:12 (WTG008)	16:41		
23	06:34		07:24 (WTG008)	06:12	05:39	06:03	05:39	05:36	05:49	06:08	06:26	06:45	06:10		06:57 (WTG008)	06:32		
	17:05	11	07:35 (WTG008)	17:31	17:51	19:10	19:30	19:44	19:39	19:13	18:35	17:59	16:38	16	07:13 (WTG008)	16:41		
24	06:34		07:25 (WTG008)	06:11	05:38	06:02	05:39	05:36	05:50	06:09	06:27	06:46	06:11		06:57 (WTG008)	06:32		
	17:06	8	07:33 (WTG008)	17:32	17:51	19:11	19:31	19:44	19:38	19:11	18:33	17:58	16:37	17	07:14 (WTG008)	16:42		
25	06:34		07:28 (WTG008)	06:10	05:37	06:01	05:38	05:36	05:51	06:10	06:27	06:47	06:12		06:57 (WTG008)	06:33		
	17:07	3	07:31 (WTG008)	17:33	17:52	19:12	19:31	19:44	19:38	19:10	18:32	17:57	16:37	17	07:14 (WTG008)	16:42		
26	06:33			06:09	05:36	06:00	05:38	05:37	05:51	06:10	06:28	06:47	06:13		06:57 (WTG008)	06:33		
	17:08			17:34	17:53	19:12	19:32	19:44	19:37	19:09	18:31	17:56	16:37	17	07:14 (WTG008)	16:43		
27	06:33			06:08	05:34	05:59	05:37	05:37	05:52	06:11	06:28	06:48	06:14		06:57 (WTG008)	06:34		
	17:09			17:34	17:53	19:13	19:33	19:45	19:37	19:08	18:29	17:55	16:37	17	07:14 (WTG008)	16:44		
28	06:32			06:07	05:33	05:58	05:37	05:37	05:52	06:11	06:29	06:49	06:14		06:58 (WTG008)	06:34		
	17:10			17:35	17:54	19:14	19:33	19:45	19:36	19:07	18:28	17:54	16:37	17	07:15 (WTG008)	16:44		
29	06:32				06:32	05:57	05:37	05:37	05:53	06:12	06:30	06:50	06:15		06:58 (WTG008)	06:34		
	17:11				18:54	19:14	19:34	19:45	19:35	19:06	18:27	17:53	16:36	17	07:15 (WTG008)	16:45		
30	06:31				06:31	05:56	05:36	05:38	05:54	06:12	06:30	06:50	06:16		06:59 (WTG008)	06:35		
	17:11				18:55	19:15	19:34	19:45	19:35	19:05	18:26	17:52	16:36	16	07:15 (WTG008)	16:45		
31	06:31				06:29		05:36		05:54	06:13		06:51				06:35		
	17:12				18:56		19:35		19:34	19:03		17:52				16:46		
Potential sun hours	323			310	371	387	424	423	432	411	371	355	319			316		
Total, worst case		307												198			109	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
20120913_Tafila_Agu2

Description:
preliminary layout Vestas V90 3.0 MW

Printed/Page
12.11.2012 17:11 / 5

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Kalender

Calculation: Astronomically possible **Shadow receptor:** IP B - IP B

Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February			March	April	May	June	July	August	September	October			November	December
1	06:35	06:30			06:06	06:28	05:55	05:36	05:38	05:55	06:14	06:31			05:52	06:17
	16:47	17:13			17:36	18:56	19:16	19:35	19:45	19:33	19:02	18:24			16:51	16:36
2	06:36	06:29			06:04	06:27	05:54	05:36	05:39	05:56	06:14	06:31			05:53	06:18
	16:48	17:14			17:37	18:57	19:16	19:36	19:45	19:32	19:01	18:23			16:50	16:36
3	06:36	06:29			06:03	06:26	05:53	05:35	05:39	05:56	06:15	06:32			05:54	06:18
	16:49	17:15			17:37	18:58	19:17	19:37	19:45	19:32	19:00	18:22			16:49	16:36
4	06:36	06:28			06:02	06:25	05:52	05:35	05:39	05:57	06:15	06:33			05:54	06:19
	16:49	17:16			17:38	18:58	19:18	19:37	19:45	19:31	18:59	18:21			16:48	16:36
5	06:36	06:27			06:01	06:23	05:51	05:35	05:40	05:57	06:16	06:33			05:55	06:20
	16:50	17:17			17:39	18:59	19:18	19:38	19:45	19:30	18:57	18:20			16:48	16:36
6	06:36	06:27			06:00	06:22	05:51	05:35	05:40	05:58	06:17	06:34			05:56	06:21
	16:51	17:18			17:39	19:00	19:19	19:38	19:45	19:29	18:56	18:18			16:47	16:36
7	06:36	06:26			05:59	06:21	05:50	05:35	05:41	05:59	06:17	06:34			05:57	06:22
	16:52	17:18			17:40	19:00	19:20	19:39	19:44	19:28	18:55	18:17			16:46	16:36
8	06:36	06:25			05:58	06:20	05:49	05:35	05:41	05:59	06:18	06:35			05:58	06:22
	16:52	17:19			17:41	19:01	19:20	19:39	19:44	19:28	18:54	18:16			16:45	16:36
9	06:37	06:25			05:56	06:19	05:48	05:35	05:42	06:00	06:18	06:36			05:58	06:23
	16:53	17:20			17:41	19:01	19:21	19:40	19:44	19:27	18:52	18:15			16:45	16:37
10	06:37	06:24			05:55	06:17	05:47	05:34	05:42	06:01	06:19	06:36			05:59	06:24
	16:54	17:21			17:42	19:02	19:22	19:40	19:44	19:26	18:51	18:13			16:44	16:37
11	06:37	06:23			05:54	06:16	05:47	05:34	05:43	06:01	06:19	06:37			06:00	06:25
	16:55	17:22			17:43	19:03	19:22	19:40	19:44	19:25	18:50	18:12			16:43	16:37
12	06:37	06:22			05:53	06:15	05:46	05:34	05:43	06:02	06:20	06:38			06:01	06:25
	16:56	17:23			17:44	19:03	19:23	19:41	19:43	19:24	18:49	18:11			16:43	16:37
13	06:36	06:21			05:52	06:14	05:45	05:34	05:44	06:02	06:20	06:38			06:02	06:26
	16:56	17:23			17:44	19:04	19:24	19:41	19:43	19:23	18:47	18:10			16:42	16:37
14	06:36	06:20			05:50	06:13	05:44	05:34	05:44	06:03	06:21	06:39			06:03	06:27
	16:57	17:24			17:45	19:05	19:24	19:42	19:43	19:22	18:46	18:09			16:42	16:38
15	06:36	06:20			05:49	06:12	05:44	05:35	05:45	06:04	06:22	06:40		07:24 (WTG008)	06:03	06:27
	16:58	17:25			17:46	19:05	19:25	19:42	19:42	19:21	18:45	18:08	4	07:28 (WTG008)	16:41	16:38
16	06:36	06:19		06:49 (WTG008)	05:48	06:10	05:43	05:35	05:45	06:04	06:22	06:40		07:20 (WTG008)	06:04	06:28
	16:59	17:26	9	06:58 (WTG008)	17:46	19:06	19:26	19:42	19:42	19:20	18:43	18:07	11	07:31 (WTG008)	16:41	16:38
17	06:36	06:18		06:48 (WTG008)	05:47	06:09	05:43	05:35	05:46	06:05	06:23	06:41		07:19 (WTG008)	06:05	06:28
	17:00	17:27	13	07:01 (WTG008)	17:47	19:07	19:26	19:43	19:42	19:19	18:42	18:05	13	07:32 (WTG008)	16:40	16:39
18	06:36	06:17		06:47 (WTG008)	05:46	06:08	05:42	05:35	05:46	06:05	06:23	06:42		07:17 (WTG008)	06:06	06:29
	17:01	17:27	15	07:02 (WTG008)	17:47	19:07	19:27	19:43	19:41	19:18	18:41	18:04	15	07:32 (WTG008)	16:40	16:39
19	06:36	06:16		06:46 (WTG008)	05:44	06:07	05:41	05:35	05:47	06:06	06:24	06:42		07:17 (WTG008)	06:07	06:30
	17:02	17:28	17	07:03 (WTG008)	17:48	19:08	19:28	19:43	19:41	19:17	18:40	18:03	16	07:33 (WTG008)	16:39	16:39
20	06:35	06:15		06:46 (WTG008)	05:43	06:06	05:41	05:35	05:48	06:07	06:24	06:43		07:16 (WTG008)	06:08	06:30
	17:03	17:29	17	07:03 (WTG008)	17:49	19:08	19:28	19:43	19:40	19:16	18:38	18:02	17	07:33 (WTG008)	16:39	16:40
21	06:35	06:14		06:46 (WTG008)	05:42	06:05	05:40	05:35	05:48	06:07	06:25	06:44		07:15 (WTG008)	06:08	06:31
	17:03	17:30	17	07:03 (WTG008)	17:49	19:09	19:29	19:44	19:40	19:15	18:37	18:01	18	07:33 (WTG008)	16:38	16:40
22	06:35	06:13		06:46 (WTG008)	05:41	06:04	05:40	05:36	05:49	06:08	06:26	06:44		07:16 (WTG008)	06:09	06:31
	17:04	17:31	17	07:03 (WTG008)	17:50	19:10	19:30	19:44	19:39	19:14	18:36	18:00	16	07:32 (WTG008)	16:38	16:41
23	06:34	06:12		06:46 (WTG008)	05:39	06:03	05:39	05:36	05:49	06:08	06:26	06:45		07:16 (WTG008)	06:10	06:32
	17:05	17:31	16	07:02 (WTG008)	17:51	19:10	19:30	19:44	19:39	19:13	18:35	17:59	16	07:32 (WTG008)	16:38	16:41
24	06:34	06:11		06:47 (WTG008)	05:38	06:02	05:39	05:36	05:50	06:09	06:27	06:46		07:17 (WTG008)	06:11	06:32
	17:06	17:32	14	07:01 (WTG008)	17:51	19:11	19:31	19:44	19:38	19:11	18:33	17:58	14	07:31 (WTG008)	16:37	16:42
25	06:34	06:10		06:47 (WTG008)	05:37	06:01	05:38	05:36	05:51	06:10	06:27	06:47		07:18 (WTG008)	06:12	06:33
	17:07	17:33	12	06:59 (WTG008)	17:52	19:12	19:31	19:44	19:38	19:10	18:32	17:57	12	07:30 (WTG008)	16:37	16:42
26	06:33	06:09		06:49 (WTG008)	05:36	06:00	05:38	05:37	05:51	06:10	06:28	06:47		07:20 (WTG008)	06:13	06:33
	17:08	17:34	8	06:57 (WTG008)	17:53	19:12	19:32	19:44	19:37	19:09	18:31	17:56	7	07:27 (WTG008)	16:37	16:43
27	06:33	06:08			05:34	05:59	05:37	05:37	05:52	06:11	06:28	06:48			06:14	06:34
	17:09	17:34			17:53	19:13	19:33	19:45	19:37	19:08	18:29	17:55			16:37	16:44
28	06:32	06:07			05:33	05:58	05:37	05:37	05:52	06:11	06:29	06:49			06:14	06:34
	17:10	17:35			17:54	19:14	19:33	19:45	19:36	19:07	18:28	17:54			16:37	16:44
29	06:32				06:32	05:57	05:37	05:37	05:53	06:12	06:30	06:50			06:15	06:34
	17:11				18:54	19:14	19:34	19:45	19:35	19:06	18:27	17:53			16:36	16:45
30	06:31				06:31	05:56	05:36	05:38	05:54	06:13	06:30	06:50			06:16	06:35
	17:11				18:55	19:15	19:34	19:45	19:35	19:05	18:26	17:52			16:36	16:45
31	06:31				06:29		05:36		05:54	06:13		06:51				06:35
	17:12				18:56		19:35		19:34	19:03		17:52				16:46
Potential sun hours	323	310			371	387	424	423	432	411	371	355			319	316
Total, worst case			155										159			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:	Description:	Printed/Page
20120913_Tafila_Agu2	preliminary layout Vestas V90 3.0 MW	12.11.2012 17:11 / 6

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Kalender

Calculation: Astronomically possible **Shadow receptor:** IP C - IP C

Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset
The rotor plane is always perpendicular to the line from the WTG to the sun
The WTG is always operating

Day	January	February			March			April	May	June	July	August	September	October			November	December
1	06:35	06:30			06:06		06:31 (WTG008)	06:28	05:55	05:36	05:38	05:55	06:14	06:31			05:52	06:17
	16:47	17:13			17:36	13	06:44 (WTG008)	18:56	19:16	19:35	19:45	19:33	19:02	18:24			16:51	16:36
2	06:36	06:29			06:04		06:30 (WTG008)	06:27	05:54	05:36	05:39	05:56	06:14	06:31			05:53	06:18
	16:48	17:14			17:37	15	06:45 (WTG008)	18:57	19:16	19:36	19:45	19:32	19:01	18:23			16:50	16:36
3	06:36	06:29			06:03		06:30 (WTG008)	06:26	05:53	05:35	05:39	05:56	06:15	06:32			05:54	06:18
	16:49	17:15			17:37	16	06:46 (WTG008)	18:58	19:17	19:37	19:45	19:32	19:00	18:22			16:49	16:36
4	06:36	06:28			06:02		06:29 (WTG008)	06:25	05:52	05:35	05:39	05:57	06:15	06:33		07:12 (WTG008)	05:54	06:19
	16:49	17:16			17:38	17	06:46 (WTG008)	18:58	19:18	19:37	19:45	19:31	18:59	18:21	4	07:16 (WTG008)	16:48	16:36
5	06:36	06:27			06:01		06:29 (WTG008)	06:23	05:51	05:35	05:40	05:57	06:16	06:33		07:08 (WTG008)	05:55	06:20
	16:50	17:17			17:39	17	06:46 (WTG008)	18:59	19:18	19:38	19:45	19:30	18:57	18:20	10	07:18 (WTG008)	16:48	16:36
6	06:36	06:27			06:00		06:29 (WTG008)	06:22	05:51	05:35	05:40	05:58	06:17	06:34		07:06 (WTG008)	05:56	06:21
	16:51	17:18			17:39	15	06:44 (WTG008)	19:00	19:19	19:38	19:45	19:29	18:56	18:18	14	07:20 (WTG008)	16:47	16:36
7	06:36	06:26			05:59		06:29 (WTG008)	06:21	05:50	05:35	05:41	05:59	06:17	06:34		07:05 (WTG008)	05:57	06:22
	16:52	17:18			17:40	15	06:44 (WTG008)	19:00	19:20	19:39	19:44	19:28	18:55	18:17	16	07:21 (WTG008)	16:46	16:36
8	06:36	06:25			05:58		06:31 (WTG008)	06:20	05:49	05:35	05:41	05:59	06:18	06:35		07:04 (WTG008)	05:58	06:22
	16:52	17:19			17:41	12	06:43 (WTG008)	19:01	19:20	19:39	19:44	19:28	18:54	18:16	16	07:20 (WTG008)	16:45	16:36
9	06:37	06:25			05:56		06:33 (WTG008)	06:19	05:48	05:35	05:42	06:00	06:18	06:36		07:04 (WTG008)	05:58	06:23
	16:53	17:20			17:41	7	06:40 (WTG008)	19:01	19:21	19:40	19:44	19:27	18:52	18:15	17	07:21 (WTG008)	16:45	16:37
10	06:37	06:24			05:55			06:17	05:47	05:34	05:42	06:01	06:19	06:36		07:04 (WTG008)	05:59	06:24
	16:54	17:21			17:42			19:02	19:22	19:40	19:44	19:26	18:51	18:13	16	07:20 (WTG008)	16:44	16:37
11	06:37	06:23			05:54			06:16	05:47	05:34	05:43	06:01	06:19	06:37		07:03 (WTG008)	06:00	06:25
	16:55	17:22			17:43			19:03	19:22	19:40	19:44	19:25	18:50	18:12	16	07:19 (WTG008)	16:43	16:37
12	06:37	06:22			05:53			06:15	05:46	05:34	05:43	06:02	06:20	06:38		07:04 (WTG008)	06:01	06:25
	16:56	17:23			17:44			19:03	19:23	19:41	19:43	19:24	18:49	18:11	15	07:19 (WTG008)	16:43	16:37
13	06:36	06:21			05:52			06:14	05:45	05:34	05:44	06:02	06:20	06:38		07:05 (WTG008)	06:02	06:26
	16:56	17:23			17:44			19:04	19:24	19:41	19:43	19:23	18:47	18:10	12	07:17 (WTG008)	16:42	16:37
14	06:36	06:20			05:50			06:13	05:44	05:34	05:44	06:03	06:21	06:39		07:07 (WTG008)	06:03	06:27
	16:57	17:24			17:45			19:05	19:24	19:42	19:43	19:22	18:46	18:09	7	07:14 (WTG008)	16:42	16:38
15	06:36	06:20			05:49			06:12	05:44	05:35	05:45	06:04	06:22	06:40			06:03	06:27
	16:58	17:25			17:46			19:05	19:25	19:42	19:42	19:21	18:45	18:08			16:41	16:38
16	06:36	06:19			05:48			06:10	05:43	05:35	05:45	06:04	06:22	06:40			06:04	06:28
	16:59	17:26			17:46			19:06	19:26	19:42	19:42	19:20	18:43	18:07			16:41	16:38
17	06:36	06:18			05:47			06:09	05:43	05:35	05:46	06:05	06:23	06:41			06:05	06:28
	17:00	17:27			17:47			19:07	19:26	19:43	19:42	19:19	18:42	18:05			16:40	16:39
18	06:36	06:17			05:46			06:08	05:42	05:35	05:46	06:05	06:23	06:42			06:06	06:29
	17:01	17:28			17:47			19:07	19:27	19:43	19:41	19:18	18:41	18:04			16:40	16:39
19	06:36	06:16			05:44			06:07	05:41	05:35	05:47	06:06	06:24	06:42			06:07	06:30
	17:02	17:28			17:48			19:08	19:28	19:43	19:41	19:17	18:40	18:03			16:39	16:39
20	06:35	06:15			05:43			06:06	05:41	05:35	05:48	06:07	06:24	06:43			06:08	06:30
	17:03	17:29			17:49			19:08	19:28	19:43	19:40	19:16	18:38	18:02			16:39	16:40
21	06:35	06:14			05:42			06:05	05:40	05:35	05:48	06:07	06:25	06:44			06:08	06:31
	17:03	17:30			17:49			19:09	19:29	19:44	19:40	19:15	18:37	18:01			16:38	16:40
22	06:35	06:13			05:41			06:04	05:40	05:36	05:49	06:08	06:26	06:44			06:09	06:31
	17:04	17:31			17:50			19:10	19:30	19:44	19:39	19:14	18:36	18:00			16:38	16:41
23	06:34	06:12			05:39			06:03	05:39	05:36	05:49	06:08	06:26	06:45			06:10	06:32
	17:05	17:31			17:51			19:10	19:30	19:44	19:39	19:13	18:35	17:59			16:38	16:41
24	06:34	06:11			05:38			06:02	05:39	05:36	05:50	06:09	06:27	06:46			06:11	06:32
	17:06	17:32			17:51			19:11	19:31	19:44	19:38	19:11	18:33	17:58			16:37	16:42
25	06:34	06:10			05:37			06:01	05:38	05:36	05:51	06:10	06:27	06:47			06:12	06:33
	17:07	17:33			17:52			19:12	19:31	19:44	19:38	19:10	18:32	17:57			16:37	16:42
26	06:33	06:09			05:36			06:00	05:38	05:37	05:51	06:10	06:28	06:47			06:13	06:33
	17:08	17:34			17:53			19:12	19:32	19:44	19:37	19:09	18:31	17:56			16:37	16:43
27	06:33	06:08		06:37 (WTG008)	05:34			05:59	05:37	05:37	05:52	06:11	06:28	06:48			06:14	06:34
	17:09	17:34	2	06:39 (WTG008)	17:53			19:13	19:33	19:45	19:37	19:08	18:29	17:55			16:37	16:44
28	06:32	06:07		06:33 (WTG008)	05:33			05:58	05:37	05:37	05:52	06:11	06:29	06:49			06:14	06:34
	17:10	17:35	10	06:43 (WTG008)	17:54			19:14	19:33	19:45	19:36	19:07	18:28	17:54			16:37	16:44
29	06:32				06:32			05:57	05:37	05:37	05:53	06:12	06:30	06:50			06:15	06:34
	17:11				18:54			19:14	19:34	19:45	19:35	19:06	18:27	17:53			16:36	16:45
30	06:31				06:31			05:56	05:36	05:38	05:54	06:13	06:30	06:50			06:16	06:35
	17:11				18:55			19:15	19:34	19:45	19:35	19:05	18:26	17:52			16:36	16:45
31	06:31				06:29				05:36		05:54	06:13		06:51				06:35
	17:12				18:56				19:35		19:34	19:03		17:52				16:46
Potential sun hours	323	310			371			387	424	423	432	411	371	355			319	316
Total, worst case			12			127									143			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
20120913_Tafila_Agu2

Description:
preliminary layout Vestas V90 3.0 MW

Printed/Page
12.11.2012 17:11 / 7

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Kalender

Calculation: Astronomically possible **Shadow receptor:** IP D - IP D

Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March			April	May	June	July	August	September	October			November	December
1	06:35	06:30	06:06			06:28	05:55	05:36	05:38	05:55	06:14	06:31			05:52	06:17
	16:47	17:13	17:36			18:56	19:16	19:35	19:45	19:33	19:02	18:24			16:51	16:36
2	06:36	06:29	06:04		06:30 (WTG008)	06:27	05:54	05:36	05:39	05:56	06:14	06:31		07:09 (WTG008)	05:53	06:18
	16:48	17:14	17:37	9	06:39 (WTG008)	18:57	19:16	19:36	19:45	19:32	19:01	18:23	5	07:14 (WTG008)	16:50	16:36
3	06:36	06:29	06:03		06:28 (WTG008)	06:26	05:53	05:35	05:39	05:56	06:15	06:32		07:05 (WTG008)	05:54	06:18
	16:49	17:15	17:37	13	06:41 (WTG008)	18:58	19:17	19:37	19:45	19:32	19:00	18:22	11	07:16 (WTG008)	16:49	16:36
4	06:36	06:28	06:02		06:27 (WTG008)	06:25	05:52	05:35	05:39	05:57	06:15	06:33		07:04 (WTG008)	05:54	06:19
	16:49	17:16	17:38	15	06:42 (WTG008)	18:58	19:18	19:37	19:45	19:31	18:59	18:21	13	07:17 (WTG008)	16:48	16:36
5	06:36	06:27	06:01		06:26 (WTG008)	06:23	05:51	05:35	05:40	05:57	06:16	06:33		07:02 (WTG008)	05:55	06:20
	16:50	17:17	17:39	16	06:42 (WTG008)	18:59	19:18	19:38	19:45	19:30	18:57	18:20	15	07:17 (WTG008)	16:48	16:36
6	06:36	06:27	06:00		06:25 (WTG008)	06:22	05:51	05:35	05:40	05:58	06:17	06:34		07:02 (WTG008)	05:56	06:21
	16:51	17:18	17:39	17	06:42 (WTG008)	19:00	19:19	19:38	19:45	19:29	18:56	18:18	16	07:18 (WTG008)	16:47	16:36
7	06:36	06:26	05:59		06:25 (WTG008)	06:21	05:50	05:35	05:41	05:59	06:17	06:34		07:02 (WTG008)	05:57	06:22
	16:52	17:18	17:40	16	06:41 (WTG008)	19:00	19:20	19:39	19:44	19:28	18:55	18:17	16	07:18 (WTG008)	16:46	16:36
8	06:36	06:25	05:58		06:25 (WTG008)	06:20	05:49	05:35	05:41	05:59	06:18	06:35		07:01 (WTG008)	05:58	06:22
	16:52	17:19	17:41	16	06:41 (WTG008)	19:01	19:20	19:39	19:44	19:28	18:54	18:16	16	07:17 (WTG008)	16:45	16:36
9	06:37	06:25	05:56		06:26 (WTG008)	06:19	05:48	05:35	05:42	06:00	06:18	06:36		07:01 (WTG008)	05:58	06:23
	16:53	17:20	17:41	14	06:40 (WTG008)	19:01	19:21	19:40	19:44	19:27	18:52	18:15	16	07:17 (WTG008)	16:45	16:37
10	06:37	06:24	05:55		06:27 (WTG008)	06:17	05:47	05:34	05:42	06:01	06:19	06:36		07:02 (WTG008)	05:59	06:24
	16:54	17:21	17:42	12	06:39 (WTG008)	19:02	19:22	19:40	19:44	19:26	18:51	18:13	14	07:16 (WTG008)	16:44	16:37
11	06:37	06:23	05:54		06:28 (WTG008)	06:16	05:47	05:34	05:43	06:01	06:19	06:37		07:02 (WTG008)	06:00	06:25
	16:55	17:22	17:43	8	06:36 (WTG008)	19:03	19:22	19:40	19:44	19:25	18:50	18:12	12	07:14 (WTG008)	16:43	16:37
12	06:37	06:22	05:53			06:15	05:46	05:34	05:43	06:02	06:20	06:38		07:05 (WTG008)	06:01	06:25
	16:56	17:23	17:44			19:03	19:23	19:41	19:43	19:24	18:49	18:11	6	07:11 (WTG008)	16:43	16:37
13	06:36	06:21	05:52			06:14	05:45	05:34	05:44	06:02	06:20	06:38			06:02	06:26
	16:56	17:23	17:44			19:04	19:24	19:41	19:43	19:23	18:47	18:10			16:42	16:37
14	06:36	06:20	05:50			06:13	05:44	05:34	05:44	06:03	06:21	06:39			06:03	06:27
	16:57	17:24	17:45			19:05	19:24	19:42	19:43	19:22	18:46	18:09			16:42	16:38
15	06:36	06:20	05:49			06:12	05:44	05:35	05:45	06:04	06:22	06:40			06:03	06:27
	16:58	17:25	17:46			19:05	19:25	19:42	19:42	19:21	18:45	18:08			16:41	16:38
16	06:36	06:19	05:48			06:10	05:43	05:35	05:45	06:04	06:22	06:40			06:04	06:28
	16:59	17:26	17:46			19:06	19:26	19:42	19:42	19:20	18:43	18:07			16:41	16:38
17	06:36	06:18	05:47			06:09	05:43	05:35	05:46	06:05	06:23	06:41			06:05	06:28
	17:00	17:27	17:47			19:07	19:26	19:43	19:42	19:19	18:42	18:05			16:40	16:39
18	06:36	06:17	05:46			06:08	05:42	05:35	05:46	06:05	06:23	06:42			06:06	06:29
	17:01	17:28	17:47			19:07	19:27	19:43	19:41	19:18	18:41	18:04			16:40	16:39
19	06:36	06:16	05:44			06:07	05:41	05:35	05:47	06:06	06:24	06:42			06:07	06:30
	17:02	17:28	17:48			19:08	19:28	19:43	19:41	19:17	18:40	18:03			16:39	16:39
20	06:35	06:15	05:43			06:06	05:41	05:35	05:48	06:07	06:24	06:43			06:08	06:30
	17:03	17:29	17:49			19:08	19:28	19:43	19:40	19:16	18:38	18:02			16:39	16:40
21	06:35	06:14	05:42			06:05	05:40	05:35	05:48	06:07	06:25	06:44			06:08	06:31
	17:03	17:30	17:49			19:09	19:29	19:44	19:40	19:15	18:37	18:01			16:38	16:40
22	06:35	06:13	05:41			06:04	05:40	05:36	05:49	06:08	06:26	06:44			06:09	06:31
	17:04	17:31	17:50			19:10	19:30	19:44	19:39	19:14	18:36	18:00			16:38	16:41
23	06:34	06:12	05:39			06:03	05:39	05:36	05:49	06:08	06:26	06:45			06:10	06:32
	17:05	17:31	17:51			19:10	19:30	19:44	19:39	19:13	18:35	17:59			16:38	16:41
24	06:34	06:11	05:38			06:02	05:39	05:36	05:50	06:09	06:27	06:46			06:11	06:32
	17:06	17:32	17:51			19:11	19:31	19:44	19:38	19:11	18:33	17:58			16:37	16:42
25	06:34	06:10	05:37			06:01	05:38	05:36	05:51	06:10	06:27	06:47			06:12	06:33
	17:07	17:33	17:52			19:12	19:31	19:44	19:38	19:10	18:32	17:57			16:37	16:42
26	06:33	06:09	05:36			06:00	05:38	05:37	05:51	06:10	06:28	06:47			06:13	06:33
	17:08	17:34	17:53			19:12	19:32	19:44	19:37	19:09	18:31	17:56			16:37	16:43
27	06:33	06:08	05:34			05:59	05:37	05:37	05:52	06:11	06:28	06:48			06:14	06:34
	17:09	17:34	17:53			19:13	19:33	19:45	19:37	19:08	18:29	17:55			16:37	16:44
28	06:32	06:07	05:33			05:58	05:37	05:37	05:52	06:11	06:29	06:49			06:14	06:34
	17:10	17:35	17:54			19:14	19:33	19:45	19:36	19:07	18:28	17:54			16:37	16:44
29	06:32		06:32			05:57	05:37	05:37	05:53	06:12	06:30	06:50			06:15	06:34
	17:11		18:54			19:14	19:34	19:45	19:35	19:06	18:27	17:53			16:36	16:45
30	06:31		06:31			05:56	05:36	05:38	05:54	06:13	06:30	06:50			06:16	06:35
	17:11		18:55			19:15	19:34	19:45	19:35	19:05	18:26	17:52			16:36	16:45
31	06:31		06:29				05:36		05:54	06:13		06:51				06:35
	17:12		18:56				19:35		19:34	19:03		17:52				16:46
Potential sun hours	323	310	371			387	424	423	432	411	371	355			319	316
Total, worst case				136									140			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Kalender

Calculation: Astronomically possible **Shadow receptor:** IP E - IP E

Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:
The sun is shining all the day, from sunrise to sunset
The rotor plane is always perpendicular to the line from the WTG to the sun
The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	06:35	06:30	06:06	06:28	05:55	05:36	05:38	05:55	06:14	06:31	05:52	06:17
	16:47	17:13	17:36	18:56	19:16	19:36	19:45	19:33	19:02	18:24	16:51	16:36
2	06:36	06:29	06:04	06:27	05:54	05:36	05:39	05:56	06:14	06:31	05:53	06:18
	16:48	17:14	17:37	18:57	19:16	19:36	19:45	19:32	19:01	18:23	16:50	16:36
3	06:36	06:29	06:03	06:26	05:53	05:35	05:39	05:56	06:15	06:32	05:54	06:18
	16:49	17:15	17:37	18:58	19:17	19:37	19:45	19:32	19:00	18:22	16:49	16:36
4	06:36	06:28	06:02	06:25	05:52	05:35	05:39	05:57	06:15	06:33	05:54	06:19
	16:49	17:16	17:38	18:58	19:18	19:37	19:45	19:31	18:59	18:21	16:48	16:36
5	06:36	06:27	06:01	06:23	05:51	05:35	05:40	05:57	06:16	06:33	05:55	06:20
	16:50	17:17	17:39	18:59	19:18	19:38	19:45	19:30	18:57	18:20	16:48	16:36
6	06:36	06:27	06:00	06:22	05:51	05:35	05:40	05:58	06:17	06:34	05:56	06:21
	16:51	17:18	17:39	19:00	19:19	19:38	19:45	19:29	18:56	18:18	16:47	16:36
7	06:36	06:26	05:59	06:21	05:50	05:35	05:41	05:59	06:17	06:34	05:57	06:22
	16:52	17:18	17:40	19:00	19:20	19:39	19:44	19:28	18:55	18:17	16:46	16:36
8	06:36	06:25	05:58	06:20	05:49	05:35	05:41	05:59	06:18	06:35	05:58	06:22
	16:52	17:19	17:41	19:01	19:20	19:39	19:44	19:28	18:54	18:16	16:45	16:36
9	06:37	06:25	05:56	06:19	05:48	05:35	05:42	06:00	06:18	06:36	05:58	06:23
	16:53	17:20	17:41	19:01	19:21	19:40	19:44	19:27	18:52	18:15	16:45	16:37
10	06:37	06:24	05:55	06:17	05:47	05:34	05:42	06:01	06:19	06:36	05:59	06:24
	16:54	17:21	17:42	19:02	19:22	19:40	19:44	19:26	18:51	18:14	16:44	16:37
11	06:37	06:23	05:54	06:16	05:47	05:34	05:43	06:01	06:19	06:37	06:00	06:25
	16:55	17:22	17:43	19:03	19:22	19:40	19:44	19:25	18:50	18:12	16:43	16:37
12	06:37	06:22	05:53	06:15	05:46	05:34	05:43	06:02	06:20	06:38	06:01	06:25
	16:56	17:23	17:44	19:03	19:23	19:41	19:43	19:24	18:49	18:11	16:43	16:37
13	06:36	06:21	05:52	06:14	05:45	05:34	05:44	06:02	06:20	06:38	06:02	06:26
	16:56	17:23	17:44	19:04	19:24	19:41	19:43	19:23	18:47	18:10	16:42	16:37
14	06:36	06:20	05:50	06:13	05:44	05:34	05:44	06:03	06:21	06:39	06:03	06:27
	16:57	17:24	17:45	19:05	19:24	19:42	19:43	19:22	18:46	18:09	16:42	16:38
15	06:36	06:20	05:49	06:12	05:44	05:35	05:45	06:04	06:22	06:40	06:03	06:27
	16:58	17:25	17:46	19:05	19:25	19:42	19:42	19:21	18:45	18:08	16:41	16:38
16	06:36	06:19	05:48	06:10	05:43	05:35	05:45	06:04	06:22	06:40	06:04	06:28
	16:59	17:26	17:46	19:06	19:26	19:42	19:42	19:20	18:43	18:07	16:41	16:38
17	06:36	06:18	05:47	06:09	05:43	05:35	05:46	06:05	06:23	06:41	06:05	06:28
	17:00	17:27	17:47	19:07	19:26	19:43	19:42	19:19	18:42	18:06	16:40	16:39
18	06:36	06:17	05:46	06:08	05:42	05:35	05:46	06:05	06:23	06:42	06:06	06:29
	17:01	17:28	17:47	19:07	19:27	19:43	19:41	19:18	18:41	18:04	16:40	16:39
19	06:36	06:16	05:44	06:07	05:41	05:35	05:47	06:06	06:24	06:42	06:07	06:30
	17:02	17:28	17:48	19:08	19:28	19:43	19:41	19:17	18:40	18:03	16:39	16:39
20	06:35	06:15	05:43	06:06	05:41	05:35	05:48	06:07	06:24	06:43	06:08	06:30
	17:03	17:29	17:49	19:08	19:28	19:43	19:40	19:16	18:38	18:02	16:39	16:40
21	06:35	06:14	05:42	06:05	05:40	05:35	05:48	06:07	06:25	06:44	06:08	06:31
	17:03	17:30	17:49	19:09	19:29	19:44	19:40	19:15	18:37	18:01	16:38	16:40
22	06:35	06:13	05:41	06:04	05:40	05:36	05:49	06:08	06:26	06:44	06:09	06:31
	17:04	17:31	17:50	19:10	19:30	19:44	19:39	19:14	18:36	18:00	16:38	16:41
23	06:34	06:12	05:39	06:03	05:39	05:36	05:49	06:08	06:26	06:45	06:10	06:32
	17:05	17:31	17:51	19:10	19:30	19:44	19:39	19:13	18:35	17:59	16:38	16:41
24	06:34	06:11	05:38	06:02	05:39	05:36	05:50	06:09	06:27	06:46	06:11	06:32
	17:06	17:32	17:51	19:11	19:31	19:44	19:38	19:11	18:33	17:58	16:37	16:42
25	06:34	06:10	05:37	06:01	05:38	05:36	05:51	06:10	06:27	06:47	06:12	06:33
	17:07	17:33	17:52	19:12	19:31	19:44	19:38	19:10	18:32	17:57	16:37	16:42
26	06:33	06:09	05:36	06:00	05:38	05:37	05:51	06:10	06:28	06:47	06:13	06:33
	17:08	17:34	17:53	19:12	19:32	19:44	19:37	19:09	18:31	17:56	16:37	16:43
27	06:33	06:08	05:34	05:59	05:38	05:37	05:52	06:11	06:28	06:48	06:14	06:34
	17:09	17:34	17:53	19:13	19:33	19:45	19:37	19:08	18:29	17:55	16:37	16:44
28	06:32	06:07	05:33	05:58	05:37	05:37	05:52	06:11	06:29	06:49	06:14	06:34
	17:10	17:35	17:54	19:14	19:33	19:45	19:36	19:07	18:28	17:54	16:37	16:44
29	06:32		06:32	05:57	05:37	05:37	05:53	06:12	06:30	06:50	06:15	06:34
	17:11		18:54	19:14	19:34	19:45	19:35	19:06	18:27	17:53	16:36	16:45
30	06:31		06:31	05:56	05:36	05:38	05:54	06:13	06:30	06:50	06:16	06:35
	17:11		18:55	19:15	19:34	19:45	19:35	19:05	18:26	17:52	16:36	16:46
31	06:31		06:29		05:36		05:54	06:13		06:51		06:35
	17:12		18:56		19:35		19:34	19:03		17:52		16:46
Potential sun hours	323	310	371	387	424	423	432	411	371	355	319	316
Total, worst case												

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Kalender

Calculation: Astronomically possible **Shadow receptor:** IP F - IP F

Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:
- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

Day	January	February	March	April			May			June		
1	06:35	06:30	06:06	06:28			05:55			05:36		05:54 (WTG037)
	16:47	17:13	17:36	18:56			19:16			19:36	17	06:11 (WTG037)
2	06:36	06:29	06:04	06:27			05:54			05:36		05:54 (WTG037)
	16:48	17:14	17:37	18:57			19:16			19:36	18	06:12 (WTG037)
3	06:36	06:29	06:03	06:26			05:53			05:36		05:54 (WTG037)
	16:49	17:15	17:37	18:58			19:17			19:37	18	06:12 (WTG037)
4	06:36	06:28	06:02	06:25			05:52			05:35		05:54 (WTG037)
	16:49	17:16	17:38	18:58			19:18			19:37	19	06:13 (WTG037)
5	06:36	06:28	06:01	06:23		06:40 (WTG001)	05:52			05:35		05:53 (WTG037)
	16:50	17:17	17:39	18:59	2	06:42 (WTG001)	19:18			19:38	19	06:12 (WTG037)
6	06:36	06:27	06:00	06:22		06:38 (WTG001)	05:51			05:35		05:53 (WTG037)
	16:51	17:18	17:40	19:00	4	06:42 (WTG001)	19:19			19:38	19	06:12 (WTG037)
7	06:36	06:26	05:59	06:21		06:37 (WTG001)	05:50			05:35		05:53 (WTG037)
	16:52	17:19	17:40	19:00	6	06:43 (WTG001)	19:20			19:39	19	06:12 (WTG037)
8	06:37	06:25	05:58	06:20		06:36 (WTG001)	05:49			05:35		05:53 (WTG037)
	16:53	17:19	17:41	19:01	7	06:43 (WTG001)	19:20			19:39	20	06:13 (WTG037)
9	06:37	06:25	05:56	06:19		06:35 (WTG001)	05:48			05:35		05:53 (WTG037)
	16:53	17:20	17:42	19:01	8	06:43 (WTG001)	19:21			19:40	20	06:13 (WTG037)
10	06:37	06:24	05:55	06:18		06:34 (WTG001)	05:47			05:35		05:53 (WTG037)
	16:54	17:21	17:42	19:02	9	06:43 (WTG001)	19:22			19:40	20	06:13 (WTG037)
11	06:37	06:23	05:54	06:16		06:33 (WTG001)	05:47			05:35		05:53 (WTG037)
	16:55	17:22	17:43	19:03	9	06:42 (WTG001)	19:22			19:40	20	06:13 (WTG037)
12	06:37	06:22	05:53	06:15		06:31 (WTG001)	05:46			05:35		05:53 (WTG037)
	16:56	17:23	17:44	19:03	10	06:41 (WTG001)	19:23			19:41	20	06:13 (WTG037)
13	06:37	06:21	05:52	06:14		06:30 (WTG001)	05:45			05:35		05:53 (WTG037)
	16:57	17:24	17:44	19:04	9	06:39 (WTG001)	19:24			19:41	21	06:14 (WTG037)
14	06:36	06:21	05:51	06:13		06:30 (WTG001)	05:45			05:35		05:53 (WTG037)
	16:57	17:24	17:45	19:05	7	06:37 (WTG001)	19:24			19:42	21	06:14 (WTG037)
15	06:36	06:20	05:49	06:12			05:44			05:35		05:53 (WTG037)
	16:58	17:25	17:46	19:05			19:25			19:42	21	06:14 (WTG037)
16	06:36	06:19	05:48	06:11			05:43			05:35		05:53 (WTG037)
	16:59	17:26	17:46	19:06			19:26			19:42	21	06:14 (WTG037)
17	06:36	06:18	05:47	06:09			05:43			05:35		05:54 (WTG037)
	17:00	17:27	17:47	19:07			19:26			19:43	21	06:15 (WTG037)
18	06:36	06:17	05:46	06:08			05:42			05:35		05:54 (WTG037)
	17:01	17:28	17:48	19:07			19:27			19:43	21	06:15 (WTG037)
19	06:36	06:16	05:44	06:07			05:41		05:59 (WTG037)	05:35		05:54 (WTG037)
	17:02	17:28	17:48	19:08			19:28	2	06:01 (WTG037)	19:43	21	06:15 (WTG037)
20	06:35	06:15	05:43	06:06			05:41		05:58 (WTG037)	05:35		05:54 (WTG037)
	17:03	17:29	17:49	19:09			19:28	5	06:03 (WTG037)	19:43	21	06:15 (WTG037)
21	06:35	06:14	05:42	06:05			05:40		05:58 (WTG037)	05:35		05:54 (WTG037)
	17:04	17:30	17:49	19:09			19:29	7	06:05 (WTG037)	19:44	21	06:15 (WTG037)
22	06:35	06:13	05:41	06:04			05:40		05:57 (WTG037)	05:36		05:54 (WTG037)
	17:04	17:31	17:50	19:10			19:30	8	06:05 (WTG037)	19:44	21	06:15 (WTG037)
23	06:34	06:12	05:39	06:03			05:39		05:57 (WTG037)	05:36		05:55 (WTG037)
	17:05	17:31	17:51	19:10			19:30	10	06:07 (WTG037)	19:44	21	06:16 (WTG037)
24	06:34	06:11	05:38	06:02			05:39		05:57 (WTG037)	05:36		05:55 (WTG037)
	17:06	17:32	17:51	19:11			19:31	11	06:08 (WTG037)	19:44	21	06:16 (WTG037)
25	06:34	06:10	05:37	06:01			05:38		05:56 (WTG037)	05:36		05:55 (WTG037)
	17:07	17:33	17:52	19:12			19:31	12	06:08 (WTG037)	19:44	21	06:16 (WTG037)
26	06:33	06:09	05:36	06:00			05:38		05:56 (WTG037)	05:37		05:56 (WTG037)
	17:08	17:34	17:53	19:12			19:32	13	06:09 (WTG037)	19:45	21	06:17 (WTG037)
27	06:33	06:08	05:35	05:59			05:38		05:56 (WTG037)	05:37		05:56 (WTG037)
	17:09	17:34	17:53	19:13			19:33	14	06:10 (WTG037)	19:45	21	06:17 (WTG037)
28	06:32	06:07	05:33	05:58			05:37		05:55 (WTG037)	05:37		05:56 (WTG037)
	17:10	17:35	17:54	19:14			19:33	15	06:10 (WTG037)	19:45	21	06:17 (WTG037)
29	06:32		06:32	05:57			05:37		05:55 (WTG037)	05:38		05:57 (WTG037)
	17:11		18:55	19:14			19:34	16	06:11 (WTG037)	19:45	21	06:18 (WTG037)
30	06:31		06:31	05:56			05:37		05:55 (WTG037)	05:38		05:57 (WTG037)
	17:12		18:55	19:15			19:34	16	06:11 (WTG037)	19:45	20	06:17 (WTG037)
31	06:31		06:30				05:36		05:54 (WTG037)			
	17:12		18:56				19:35	17	06:11 (WTG037)			
Potential sun hours	323	310	371	387			424			423		
Total, worst case					71			146			606	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
20120913_Tafila_Agu2

Description:
preliminary layout Vestas V90 3.0 MW

Printed/Page
12.11.2012 17:11 / 10

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

SHADOW - Kalender

Calculation: Astronomically possible **Shadow receptor:** IP F - IP F

Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:
- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

Day	July			August			September			October	November	December
1	05:38		05:57 (WTG037)	05:55			06:14		06:32 (WTG001)	06:31	05:52	06:17
	19:45	20	06:17 (WTG037)	19:33			19:02	9	06:41 (WTG001)	18:25	16:51	16:36
2	05:39		05:58 (WTG037)	05:56			06:14		06:32 (WTG001)	06:31	05:53	06:18
	19:45	20	06:18 (WTG037)	19:33			19:01	9	06:41 (WTG001)	18:23	16:50	16:36
3	05:39		05:58 (WTG037)	05:56			06:15		06:33 (WTG001)	06:32	05:54	06:19
	19:45	20	06:18 (WTG037)	19:32			19:00	8	06:41 (WTG001)	18:22	16:49	16:36
4	05:40		05:58 (WTG037)	05:57			06:15		06:33 (WTG001)	06:33	05:54	06:19
	19:45	20	06:18 (WTG037)	19:31			18:59	7	06:40 (WTG001)	18:21	16:48	16:36
5	05:40		05:59 (WTG037)	05:58			06:16		06:34 (WTG001)	06:33	05:55	06:20
	19:45	20	06:19 (WTG037)	19:30			18:57	6	06:40 (WTG001)	18:20	16:48	16:36
6	05:40		05:59 (WTG037)	05:58			06:17		06:34 (WTG001)	06:34	05:56	06:21
	19:45	19	06:18 (WTG037)	19:29			18:56	4	06:38 (WTG001)	18:18	16:47	16:36
7	05:41		06:00 (WTG037)	05:59			06:17		06:35 (WTG001)	06:35	05:57	06:22
	19:44	19	06:19 (WTG037)	19:28			18:55	2	06:37 (WTG001)	18:17	16:46	16:36
8	05:41		06:00 (WTG037)	05:59			06:18			06:35	05:58	06:22
	19:44	19	06:19 (WTG037)	19:28			18:54			18:16	16:45	16:37
9	05:42		06:01 (WTG037)	06:00			06:18			06:36	05:58	06:23
	19:44	18	06:19 (WTG037)	19:27			18:52			18:15	16:45	16:37
10	05:42		06:01 (WTG037)	06:01			06:19			06:36	05:59	06:24
	19:44	18	06:19 (WTG037)	19:26			18:51			18:14	16:44	16:37
11	05:43		06:02 (WTG037)	06:01			06:19			06:37	06:00	06:25
	19:44	18	06:20 (WTG037)	19:25			18:50			18:12	16:43	16:37
12	05:43		06:02 (WTG037)	06:02			06:20			06:38	06:01	06:25
	19:43	17	06:19 (WTG037)	19:24			18:49			18:11	16:43	16:37
13	05:44		06:03 (WTG037)	06:02			06:21			06:38	06:02	06:26
	19:43	17	06:20 (WTG037)	19:23			18:47			18:10	16:42	16:38
14	05:44		06:03 (WTG037)	06:03			06:21			06:39	06:03	06:27
	19:43	16	06:19 (WTG037)	19:22			18:46			18:09	16:42	16:38
15	05:45		06:04 (WTG037)	06:04			06:22			06:40	06:03	06:27
	19:42	15	06:19 (WTG037)	19:21			18:45			18:08	16:41	16:38
16	05:46		06:04 (WTG037)	06:04			06:22			06:40	06:04	06:28
	19:42	14	06:18 (WTG037)	19:20			18:44			18:07	16:41	16:38
17	05:46		06:05 (WTG037)	06:05			06:23			06:41	06:05	06:29
	19:42	14	06:19 (WTG037)	19:19			18:42			18:06	16:40	16:39
18	05:47		06:06 (WTG037)	06:06			06:23			06:42	06:06	06:29
	19:41	13	06:19 (WTG037)	19:18			18:41			18:05	16:40	16:39
19	05:47		06:06 (WTG037)	06:06			06:24			06:42	06:07	06:30
	19:41	12	06:18 (WTG037)	19:17			18:40			18:03	16:39	16:40
20	05:48		06:07 (WTG037)	06:07			06:24			06:43	06:08	06:30
	19:40	11	06:18 (WTG037)	19:16			18:38			18:02	16:39	16:40
21	05:48		06:07 (WTG037)	06:07			06:25			06:44	06:09	06:31
	19:40	9	06:16 (WTG037)	19:15			18:37			18:01	16:39	16:40
22	05:49		06:08 (WTG037)	06:08			06:26			06:45	06:09	06:31
	19:39	8	06:16 (WTG037)	19:14			18:36			18:00	16:38	16:41
23	05:50		06:08 (WTG037)	06:09			06:26			06:45	06:10	06:32
	19:39	6	06:14 (WTG037)	19:13			18:35			17:59	16:38	16:41
24	05:50		06:09 (WTG037)	06:09			06:27			06:46	06:11	06:32
	19:38	3	06:12 (WTG037)	19:12			18:33			17:58	16:38	16:42
25	05:51			06:10			06:27			06:47	06:12	06:33
	19:38			19:10			18:32			17:57	16:37	16:43
26	05:51			06:10			06:28			06:47	06:13	06:33
	19:37			19:09			18:31			17:56	16:37	16:43
27	05:52			06:11			06:29			06:48	06:14	06:34
	19:37			19:08			18:30			17:55	16:37	16:44
28	05:53			06:11			06:29			06:49	06:14	06:34
	19:36			19:07			18:28			17:54	16:37	16:44
29	05:53			06:12		06:31 (WTG001)	06:30			06:50	06:15	06:34
	19:35			19:06	7	06:38 (WTG001)	18:27			17:54	16:37	16:45
30	05:54			06:13		06:31 (WTG001)	06:30			06:50	06:16	06:35
	19:35			19:05	9	06:40 (WTG001)	18:26			17:53	16:36	16:46
31	05:54			06:13		06:31 (WTG001)				06:51		06:35
	19:34			19:03	10	06:41 (WTG001)				17:52		16:46
Potential sun hours	432			411			371			355	319	316
Total, worst case		366			26			45				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
20120913_Tafila_Agu2

Description:
preliminary layout Vestas V90 3.0 MW

Printed/Page
12.11.2012 17:11 / 11

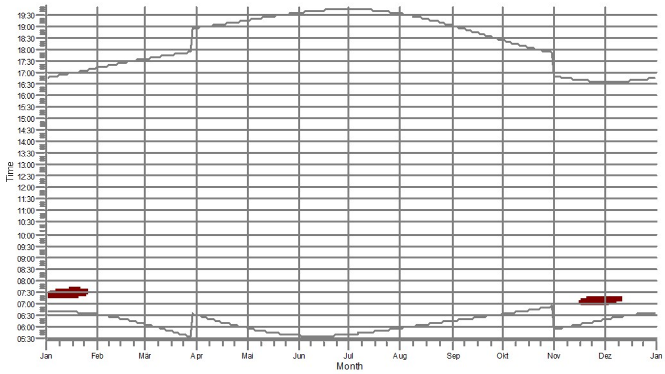
Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:03/2.8.563

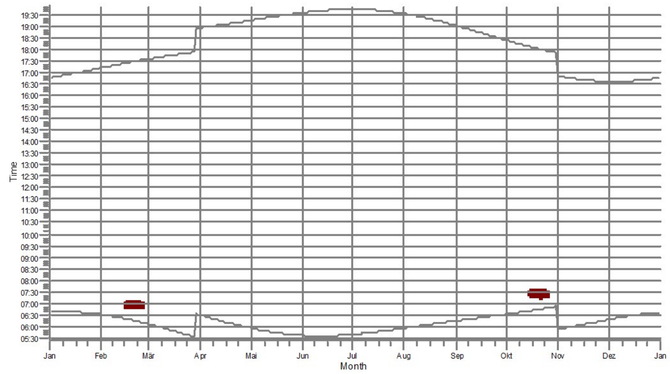
SHADOW - Grafischer Kalender

Calculation: Astronomically possible

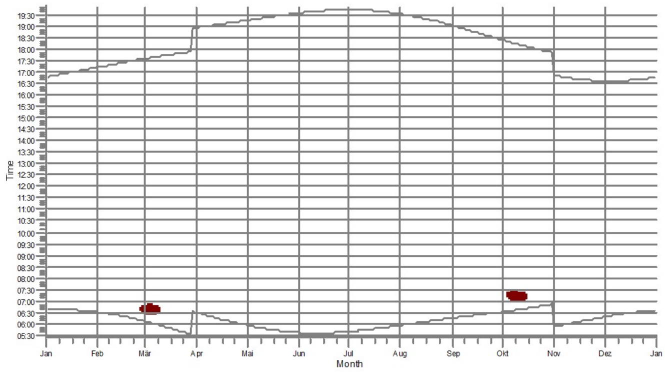
IP A: IP A



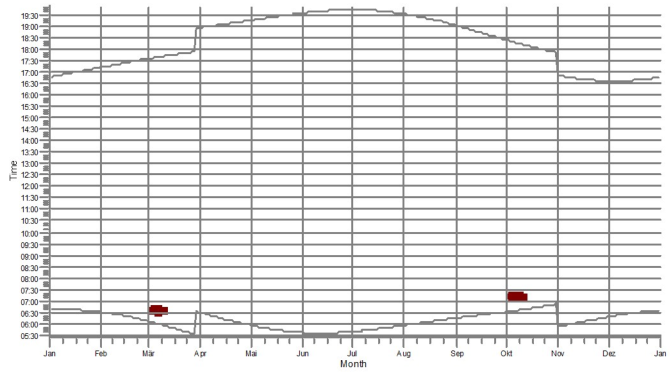
IP B: IP B



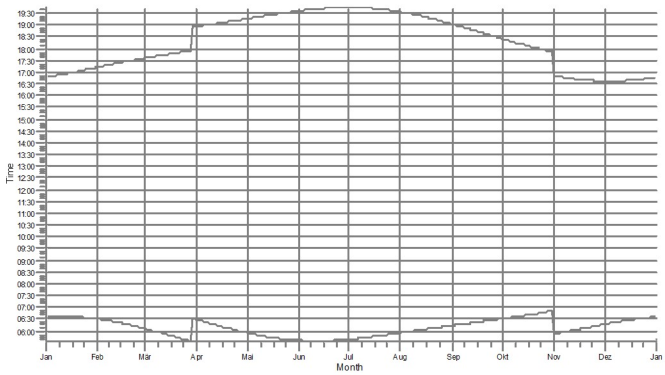
IP C: IP C



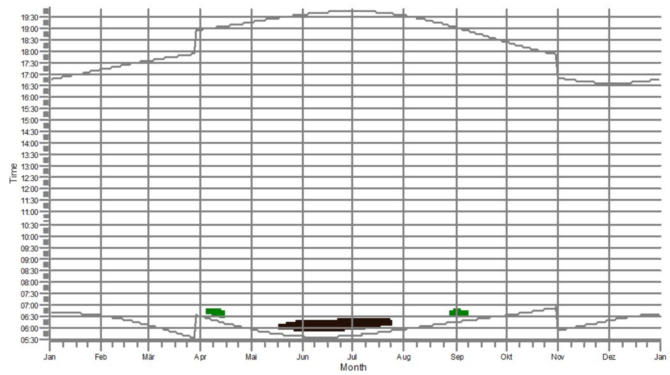
IP D: IP D



IP E: IP E



IP F: IP F



WTGs

WTG001: VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4392)

WTG008: VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4399)

WTG037: VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4428)

Project:	Description:	Printed/Page
20120913_Tafila_Agu2	preliminary layout Vestas V90 3.0 MW	12.11.2012 17:18 / 1

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:17/2.8.563

SHADOW - Hauptergebnis

Calculation: Meteorologically likely

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BET DAGAN]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6,13	7,37	7,49	8,82	10,88	11,49	12,04	11,94	10,17	8,94	7,78	6,19

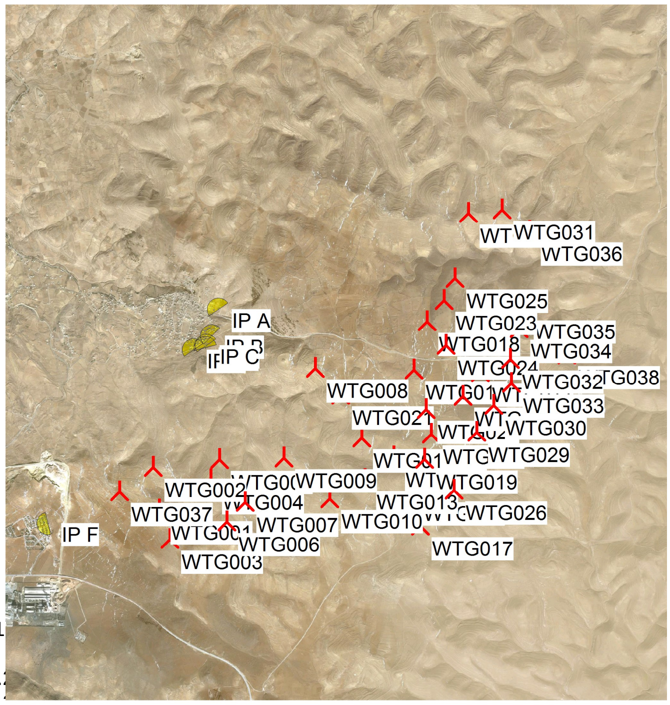
Operational hours are calculated from WTGs in calculation and wind distribution:
Terraindaten 12 Sektoren; Radius: 20.000 m (13)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
320	192	212	203	256	471	505	280	623	2.104	2.174	1.020	8.359

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Höhenlinien: CONTOURLINE_ONLINEDATA_0.wpo (1
Area object(s) used in calculation:
Areal-Objekt (ZVI): REGIONS_20120913_Tafila_Agu2_RECOVER002 30.10.
Areal-Objekt (ZVI): REGIONS_20120913_Tafila_Agu2_RECOVER002 30.10.
Areal-Objekt (ZVI): REGIONS_20120913_Tafila_Agu2_RECOVER003 06.11.
Obstacles not used in calculation
Eye height: 1,5 m
Grid resolution: 10,0 m



Scale 1:100.000
New WTG   Shadow receptor

WTGs

	UTM WGS84 Zone: 36				WTG type						Shadow data	
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
WTG001	753.874	3.398.269	1.589,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG002	753.776	3.398.861	1.596,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG003	754.032	3.397.860	1.573,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG004	754.586	3.398.705	1.585,8	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG005	754.700	3.398.990	1.550,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG006	754.826	3.398.125	1.542,4	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG007	755.074	3.398.402	1.584,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG008	756.011	3.400.294	1.518,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG009	755.601	3.399.032	1.552,8	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG010	756.260	3.398.479	1.563,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG011	758.328	3.400.289	1.518,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG012	756.686	3.399.337	1.564,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG013	756.744	3.398.762	1.571,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG014	757.143	3.399.081	1.545,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	1.712	12,0
WTG015	757.404	3.398.613	1.558,7	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	1.712	12,0
WTG016	757.396	3.400.302	1.519,4	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG017	757.538	3.398.132	1.510,3	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG018	757.562	3.400.984	1.455,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG019	757.575	3.399.060	1.571,4	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	1.712	12,0
WTG020	757.581	3.399.756	1.526,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG021	756.378	3.399.926	1.514,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG022	757.658	3.399.410	1.545,8	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG023	757.794	3.401.282	1.450,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG024	757.835	3.400.659	1.478,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG025	757.941	3.401.596	1.441,8	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG026	757.997	3.398.642	1.498,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0

To be continued on next page...

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

Calculated:
12.11.2012 17:17/2.8.563

SHADOW - Hauptergebnis

Calculation: Meteorologically likely

...continued from previous page

	UTM WGS84 Zone: 36				WTG type						Shadow data	
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
WTG027	758.092	3.399.950	1.532,1	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG028	758.106	3.402.511	1.501,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG029	758.296	3.399.454	1.526,2	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG030	758.526	3.399.833	1.580,0	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	84,0	1.712	12,0
WTG031	758.577	3.402.570	1.477,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG032	758.745	3.400.485	1.476,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG033	758.763	3.400.147	1.504,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG034	758.854	3.400.914	1.473,5	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG035	758.896	3.401.187	1.469,1	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG036	758.969	3.402.282	1.450,4	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG037	753.310	3.398.507	1.589,6	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0
WTG038	759.533	3.400.567	1.463,9	VESTAS V112 3000 112....	Yes	VESTAS	V112-3.000	3.000	112,0	94,0	1.711	12,0

Shadow receptor-Input

No.	Name	UTM WGS84 Zone: 36 East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
IP A	IP A Met	754.636	3.401.083	1.353,8	1,0	1,5	1,0	-35,0	90,0	Fixed direction
IP B	IP B Met	754.552	3.400.710	1.403,1	1,0	1,5	1,0	-45,0	90,0	Fixed direction
IP C	IP C Met	754.479	3.400.573	1.419,8	1,0	1,5	1,0	-35,0	90,0	Fixed direction
IP D	IP D Met	754.466	3.400.544	1.426,1	1,0	1,5	1,0	-15,0	90,0	Fixed direction
IP E	IP E Met	754.303	3.400.508	1.420,2	1,0	1,5	1,0	-35,0	90,0	Fixed direction
IP F	IP F Met	752.320	3.398.041	1.601,2	1,0	1,5	1,0	-105,0	90,0	Fixed direction

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year
		[h/year]
IP A	IP A Met	4:44
IP B	IP B Met	2:49
IP C	IP C Met	2:30
IP D	IP D Met	2:26
IP E	IP E Met	0:00
IP F	IP F Met	11:39

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case	Expected
		[h/year]	[h/year]
WTG001	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4392)	2:20	1:18
WTG002	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4393)	0:00	0:00
WTG003	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4394)	0:00	0:00
WTG004	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4395)	0:00	0:00
WTG005	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4396)	0:00	0:00
WTG006	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4397)	0:00	0:00
WTG007	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4398)	0:00	0:00
WTG008	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4399)	21:46	10:54
WTG009	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4400)	0:00	0:00
WTG010	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4401)	0:00	0:00
WTG011	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4402)	0:00	0:00
WTG012	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4403)	0:00	0:00
WTG013	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4404)	0:00	0:00
WTG014	VESTAS V112 3000 112.0 !O! NH: 84,0 m (Ges:140,0 m) (4405)	0:00	0:00
WTG015	VESTAS V112 3000 112.0 !O! NH: 84,0 m (Ges:140,0 m) (4406)	0:00	0:00

To be continued on next page...

Licensed user:
CUBE Engineering
Breitscheidstraße 6
DE-34119 Kassel
+49 (0) 561 28 85 73 0
Mertens / t.mertens@cube-engineering.com

SHADOW - Hauptergebnis

Calculation: Meteorologically likely

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
WTG016	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4407)	0:00	0:00
WTG017	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4408)	0:00	0:00
WTG018	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4409)	0:00	0:00
WTG019	VESTAS V112 3000 112.0 !O! NH: 84,0 m (Ges:140,0 m) (4410)	0:00	0:00
WTG020	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4411)	0:00	0:00
WTG021	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4412)	0:00	0:00
WTG022	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4413)	0:00	0:00
WTG023	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4414)	0:00	0:00
WTG024	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4415)	0:00	0:00
WTG025	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4416)	0:00	0:00
WTG026	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4417)	0:00	0:00
WTG027	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4418)	0:00	0:00
WTG028	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4419)	0:00	0:00
WTG029	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4420)	0:00	0:00
WTG030	VESTAS V112 3000 112.0 !O! NH: 84,0 m (Ges:140,0 m) (4421)	0:00	0:00
WTG031	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4422)	0:00	0:00
WTG032	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4423)	0:00	0:00
WTG033	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4424)	0:00	0:00
WTG034	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4425)	0:00	0:00
WTG035	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4426)	0:00	0:00
WTG036	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4427)	0:00	0:00
WTG037	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4428)	18:39	10:21
WTG038	VESTAS V112 3000 112.0 !O! NH: 94,0 m (Ges:150,0 m) (4429)	0:00	0:00

Annex 11 Public Consultation Meeting

Public Consultation
Minutes of Meeting
November 12, 2012 [10:30 – 12:55]

Q: The masts were installed 1 year ago, and there has been no other progress?
A: Wind Measurement takes at least a year. The masts have been up for a little over a year.

Discussion: Projection Description (Turbine count, approximate location, Turbine size)

Q: What is a MW? How big is the project relative to Jordan?
A: The project would be about 2% of the country's installed generation.

Q: Do owners still have access to land?
A: Overall, yes. The project just needs a dunum or so for each turbine foundation. Area outside of this is free for use by the owner.

Clarification: The purpose of the consultation session is to present the project, not debate the land lease.

Discussion: Background on the Company. The company is Jordanian, with funding from the IFC, EIB, and other international financial institutions. Consulting is provided from Germany and the UK.

Discussion on the components of a turbine: +50m blades (3), 100m tower height, generator, control equipment, manufactured in Europe, subterranean cabling, substation, turbine foundations, road network for access to turbines.

Discussion: Each tower base needs 20m diameter, approximately 2m depth. +400 cubic meters of cement

Q: Who is conducting the ESIA?
A: The ESIA is being conducted by a team comprised of Al Rawabi for Energy and Environment Consulting (REEC), and Cube Engineering of Germany.

Discussion on different stages of the ESIA were explained, including the Public Consultation stage, which is currently
Discussion on Renewable Energy, and on how it brings positive and negative impacts. In order to minimize the negative, steps are taken during the development of the project, including public input.

The construction stage was explained,, including the impacts of dust, noise, accidents, etc., and these are all studied in the ESIA, along with the local impact of the project, including Job creation, and local economic benefits.

Shadow of the turbines… blade flickering was discussed along with the map of shadow impact.

Q: Does the EMF from buried cables cause cancer?
A: Buried medium voltage electrical cables are a common method of electricity transmission, and do not represent a threat to public health.

What will the company offer for the local community? ***Discussion on local employment resulting from the construction / operations, collateral benefit to local businesses, schools improvement program, environmental programs. It was discussed that this is a major project for the south part of the country, which is generally seen as an underserved area.***

Discussion on where the power is sent to. It was explained that the energy is injected into the NEPCO grid, and cannot be used to power people's local houses.

Suggestion: Company should look into providing scholarships for local students as part of its benefit program. It was confirmed that the Company was in fact considering this option.

Discussion on Tafila Solar program implemented by Petra Solar was discussed, and the fact that those roof mounted systems directly benefitted the people whose houses had the panels, in the form of lower electrical bills. This program was actually grant funded, and developed under

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟ انه مشروع يوجد نفع على المنطقه

حيث انها من جيوب الفقر ولا يوجد بها سكان

ما هو رأيك في طاقة الرياح؟

نعتبرها بنك بترول لطاقه غرندل

ما هو رأيك في مزرعة الرياح في الطفيلة؟

جيده جدا لعدم ضرر الأغنام والسكان

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

تفيد المنطقه عالميا وزراعيا وجذب السكان التي هجروا المواطنين

نتمنى لهذه الشركه التوفيق

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

هذا المشروع يبشر للطلاب معرفه الطاقه

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

شكرا جزيلا لتعاونكم

المختار
احمد سالم عوده عيال سلمان

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

الحل الوحيد لحماية البيئة وتوفير عملة صعبة لكل الدولة نظراً
للوضع الاقتصادي الحالي

ما هو رأيك في طاقة الرياح؟

اعتمادها على حركة الرياح ~~[illegible]~~ حركتها يسبب توليد
طاقة أكثر والتشجيع انشاءات الهوائية

ما هو رأيك في مزرعة الرياح في الطفيلة؟

توفير فرص عمل لابناء المحافظة والتوعية بالطاقة المتجددة
لانشاء [illegible] عن العمل العام في المستقبل

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

زيادة الوعي بأهمية الرياح وفائدتها للمجتمع المحلي وأهمية المحافظة
على ~~[illegible]~~ خاصية طاقة الرياح

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

توفير طاقة رياح من دون تلوث + تخفيف العبء على محطات
الطاقة ~~[illegible]~~ الحركية الرئيسية في الدولة

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

تعبيد الطرق القريبة من المزرعة (1) عمالة من المجتمع المحلي
(2) تحريك حركة الأسواق المجاورة من مرافق ضيافة
ومواد تموينية للعمال

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

قيام بعض الطيور باتخاذها أعشاش للتفريخ

شكرا جزيلا لتعاونكم

3

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

Very good concept, hard to ~~ben~~capture though

ما هو رأيك في طاقة الرياح؟

A very effective way to generate energy.

ما هو رأيك في مزرعة الرياح في الطفيلة؟

Good Ideas if it was done properly -

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

the public awareness should be elevated.
to generate positive feedback.

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

lower the energy bill

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

1- provide a source of income for the locals.
2. reduce the dependancy on fossil fuel.
3. help the environmental

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

~~1~~ ~~The~~ * if the project failed to materialize.
~~The community will become more se~~

شكرا جزيلا لتعاونكم

4

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

هي البديل الاسلم والآمن للطاقة غير المتجددة.

ما هو رأيك في طاقة الرياح؟

مصدر آمن للطاقة ويعد من اقل انواع الطاقة
ضرراً على البيئة.

ما هو رأيك في مزرعة الرياح في الطفيلة؟

انا من مؤيدي طاقة الرياح في منطقتي ولكن نطالب
بعمل اي نشاط بيئي بعدي محاذير من اثرها على الطيور لاسيما المهاجرة.

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

دراسة الاثر البيئي بشكل ادق وخصوصاً على الطيور
المهاجرة بسبب قرب منطقة المشروع من ناحية اهم
مسار هجرة للطيور عالمياً من جهة الاهمية (٢).
من اجل ابعاد المراوح عن مسار الطيور.

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

اغلبها ايجابية وانها توفر ثروة الطاقة
في الاردن

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

١. انخفاض فاتورة الطاقة الوطنية.
٢. استفادة ابناء المنطقة.

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

قد تكون اثار سلبية على التنوع الحيوي لاسيما الطيور
خاصة الجوارح.

شكرا جزيلا لتعاونكم

5

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟
نحن نؤيد هذه الطاقة ولذلك [illegible] لابد من شيء في هذه الطاقة
فائدة [illegible] المتوقع والنتائج والتي [illegible]
[illegible] التعليق [illegible]

ما هو رأيك في طاقة الرياح؟
امنه واقل تكلفة من الغاز والاخرى

ما هو رأيك في مزرعة الرياح في الطفيلة؟
تجربة رائدة [illegible] المشروع حيث ان المنطقة التي
اختيرت بعيدة عن المناطق السكنية [illegible]
السكان

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.
نعم رائدة ومن خلال معرفتي بالمنطقة لا يمكن أن
تكون [illegible] الى تلك المنطقة

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟
توفير الطاقة بشكل مستمر واقل تكلفة

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.
1- سهولة ايصال التيار الكهربائي
2- اقل تكلفة
3- استمرارية التيار الكهربائي دون انقطاع

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.
لا يوجد

شكرا جزيلا لتعاونكم

6

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

طاقة نظيفة
طاقة دائمة يمكن الاعتماد عليها
هي الطاقة التي يتم توليدها بشكل [illegible] من مصادر لا تنضب.

ما هو رأيك في طاقة الرياح؟

طاقة نظيفة ومتوفرة ورخيصة
غير مكلفة.

ما هو رأيك في مزرعة الرياح في الطفيلة؟

المزرعة تتعرض للرياح على مدار السنة
ومعظم الأيام والرياح مستمرة وغير قوية

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

توفير فرص العمل للشباب العاطل
المساهمة في تنمية المجتمع المحلي.

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

الآثار ستكون ~~إيجابية~~ آثار إيجابية
وذات مردود جيد على المنطقة

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

أن يكون للمواطنين رغبة في المشاركة في المشروع
أن توضح لهم الأمور الخاصة بذلك.

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

التأثير على الأرض وانتقال [illegible]
عدم مشاركة المواطنين في المشروع.

شكرا جزيلا لتعاونكم

(7)

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

هي مرحلة أولية وبدايات تقليدية في عصر التقنيات الحديثة ، ولكنها قديمة قدم البشرية منذ الحرب

ما هو رأيك في طاقة الرياح؟

هي بديل أمثل للطاقة وذات نتائج ايجابية .

ما هو رأيك في مزرعة الرياح في الطفيلة؟

ابناء منطقة الطفيلة بحاجة مثل هذا المشروع .

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

لا بأس من المزرعة مرحبا بذلك

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

كل عمل سوف يكون له ايجابيات والسلبيات . ولكني أرى ان الايجابيات هنا تطغى على السلبيات .

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

١- خدمة أبناء المنطقة من حيث العمل

٢- من حيث استيعاب الشباب العاملة .

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

مثلا ان السلبيات ستكون محدودة أو لا تذكر مقارنة بالايجابيات .

شكرا جزيلا لتعاونكم

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

المشروع جيد والأردن بحاجة لهذا المشروع

ما هو رأيك في طاقة الرياح؟

نأمل بالإسراع بهذا المشروع القيم

ما هو رأيك في مزرعة الرياح في الطفيلة؟

مشروع جيد

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

١- لا يوجد أي تعليق على هذا المشروع

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

بناء على المشروع الكبير لا يوجد أي سلبيات

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

جميع النقاط الايجابية جيدة

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة إنشاء مزرعة الرياح المزمعة في الطفيلة.

١- أشغال الأراضي من أهاليهم ويجب أن يكون المواطنين أهل المنطقة من أهم المستفيدين

شكرا جزيلا لتعاونكم المشروع

٩

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

مشروع جيد للمنطقه

ما هو رأيك في طاقة الرياح؟

فائده مستقبليه

ما هو رأيك في مزرعة الرياح في الطفيلة؟

مشروع جيد يشغل لواء الطفيله

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

شكرا جزيلا لتعاونكم

15

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

فكرة جيدة ومفيدة إذا طبقت في أرض الواقع ستعمل على خفض
فاتورة الطاقة في المملكة وتخفيض نسبة الطاقة النفطية في البيئة مما
يؤدي الى خفض العجز في ميزانية الدولة وتحسين الوضع المعيشي للمواطنين

ما هو رأيك في طاقة الرياح؟

عملية ناجحة وآمنة وسليمة في البيئة بجميع عناصرها.

ما هو رأيك في مزرعة الرياح في الطفيلة؟

مشروع ناجح ومفيد ويعود على المجتمع بالخير.

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

لا تعليق سوى سيروا والنجاح حليفكم.

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

1- خفض فاتورة الطاقة.
2- تقليل تأثير الطاقة النفطية في البيئة وعناصرها.
3- تقليل الاعتماد في الاستيراد على مصادر الطاقة المستوردة من الخارج

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

نا سبق ذكره.

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

لا اعتقد ان هنالك سلبيات إذا تم التركيز على موضوع
السلامة العامة وتطبيق كافة معاييرها

شكرا جزيلا لتعاونكم

١١

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

طاقة [illegible] ومفيدة

ما هو رأيك في طاقة الرياح؟

عملية ناجحة وآمنة وسليمة للبيئة

ما هو رأيك في مزرعة الرياح في الطفيلة؟

مشروع ناجح.

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

مشروع ناجح و[illegible] ومفيد.

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

[illegible] على المنطقة وخدمة المجتمع المحلي

تقليل فاتورة الطاقة.

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

عائد [illegible].

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

لا يوجد نقاط سلبية.

شكرا جزيلا لتعاونكم

(12)

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

الرأي هو ايجابي ونحن نؤيد هذا المشروع الحيوي

ما هو رأيك في طاقة الرياح؟

طاقة الرياح هي طاقة ممتازة وصديقة للبيئة [illegible] وتوفر الطاقة [illegible] للبيئة

ما هو رأيك في مزرعة الرياح في الطفيلة؟

مشروع طاقة الرياح مشروع ممتاز

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

المشروع ايجابي والطاقة النظيفة للبيئة
ومشروع جيد وذلك لوجود ارياح [illegible]

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

لا [illegible] سلبية [illegible] لانشاء مشروع الرياح

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

1- [illegible]
2- توفير الطاقة النظيفة
3- توفير فرص عمل لأهالي البلد

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

لا يوجد اي سلبية للمشروع

شكرا جزيلا لتعاونكم

13

مشروع طاقة الرياح في الطفيلة

استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

نرحب بالمشروع بكل قناعة

ونشكر القائمين ع هذه الانشائية

ما هو رأيك في طاقة الرياح؟

مقدمة الافكار الذكية لخدمة البشرية

ما هو رأيك في مزرعة الرياح في الطفيلة؟

مشروع ايجابي وممتاز

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

1) تشغيل ابناء المنطقة اولاً قبل غيرهم

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

منفعة الناس والوطن والبيئة

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

كل ما هو للمشروع مفيد وأجر القائمين ع المشروع ع الله

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

لا ضرر للمشروع وكل المشروع فائدة.

شكرا جزيلا لتعاونكم

سعود ابو حسن

١٤

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

لا بد من انتاج الطاقة المجددة وخاصة طاقة الرياح والمتوفرة في السلسلة الجبلية من لواء بصيرا الطفيلة

ما هو رأيك في طاقة الرياح؟

طاقة الرياح خدمة عافية للانسان وهي الاذهان لتوليد الافكار الذكية لخدمة الانسانية

ما هو رأيك في مزرعة الرياح في الطفيلة؟

مشروع تنموي مستدام لخدمة المجتمع المحلي والمساهمة في توليد الطاقة الوطنية

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

استمرار اقامة المشروع وتطويره لفتح فرص العمل والطاقة النظيفة

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

(1) التوعية الاجتماعية والمحافظة على سلامة البشرية وخاصة كونه مناطق لواء عامرة سياحيا

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

(1) استخدام تكنولوجيا الحضارة لخدمة الانسان تشغيل المجتمع المحلي والمحافظة على سلامة البيئة

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

كل ما تصبوا إليه المشروع ايجابي. والتمني تطوير المشروع اكثر من ذلك

شكرا جزيلا لتعاونكم ." وان تعدوا نعمة الله لا تحصوها. صدق الله العظيم

محمود المرفوع ١٧٢٤٤٣٢...

(15)

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

هي نوع من انواع الطاقة وتعتبر من افضل انواع الطاقة التي تحد من عدم استنزاف الطاقة الاحفورية وهي صديقة للبيئة فلا يوجد مشكلة منها ولا بد من التركيز على هذا النوع الكبير وعمل الدراسات اللازمة -

ما هو رأيك في طاقة الرياح؟

هي طاقة جديدة وهي استثمار جيد للطاقة لكل البلدان ونأمل ان يكون هناك مشاريع في الاستثمار في الرياح لتوليد الطاقة

ما هو رأيك في مزرعة الرياح في الطفيلة؟

هي جيدة وذلك لكثرة الرياح بالمنطقة ووجود مردود اقتصادي للناس وتوفير فرص عمل وبناء مجتمع اقتصادي للمنطقة

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

لا يوجد تعليقات ولكن نتمنى من الشركة ان تقوم بعمل دراسة اقتصادية اجتماعية للمنطقة وان يكون هناك برامج تنموية للمجتمع.

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

1) استثمار للمنطقة بانتاج الطاقة 2) ممكن ان تكون تهدد الطيور والطيور المهاجرة

2) توفير فرص عمل

3) برامج تنموية للناس والسكان المحليين

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

1) استثمار للمنطقة

2) توفير فرص عمل

3) برامج تنموية للاشخاص والسكان المحليين

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

1) الازعاج والضوضاء.

2) الخطر على الطيور

3) التأثير على الطيور المهاجرة والطيور المحلية في المنطقة.

شكرا جزيلا لتعاونكم

16

عمر ارشيد الدبس

مشروع طاقة الرياح في الطفيلة
استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

ممتازه

ما هو رأيك في طاقة الرياح؟

مصدر للطاقة

ما هو رأيك في مزرعة الرياح في الطفيلة؟

مفيد للمواطن

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

نرجو المحافظة على البيوت والشجر والمزارع

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

الاولويه في الوظائف لاصحاب الارض

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

توفير مصادر الطاقة

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

لا يوجد اضرار للحصول

شكرا جزيلا لتعاونكم

(17)

فالح ارشيد الدبيس

مشروع طاقة الرياح في الطفيلة

استبيان

الشركة الأردنية لمشروع طاقة الرياح تخطط لانشاء مزرعة لطاقة الرياح بقدرة 114 ميجا واط في محافظة الطفيلة .الشركة المالكة للمشروع تسعى لتخطيط المشروع بالتعاون مع السكان المحليين .ويجري هذا الاستبيان لتحديد الرأي واهتمامات السكان المحليين.

سنكون ممتنين إذا قمت بالمشاركة من خلال الإجابة على الأسئلة السبعة التالية:

ما هو رأيك في الطاقة المتجددة؟

طاقة نظيفة تساعد المجتمع

ما هو رأيك في طاقة الرياح؟

طاقة متجددة مستدامة

ما هو رأيك في مزرعة الرياح في الطفيلة؟

تساعد المجتمع على التطور

يرجى تقديم تعليقاتكم واقتراحاتكم على مزرعة الرياح المزمع اقامتها في منطقة غرندل.

اعطائنا من مصادر الكهرباء في منطقة

المشروع

الآثار التي تتوقعونها من انشاء مزرعة الرياح؟

توزيع مساعدات على [illegible]

قائمة النقاط الأساسية التي يعتبرها مفيده نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

توفر الطاقة والاستفادة من الكهرباء

في الجبال

قائمة النقاط الأساسية التي يعتبرها سلبية نتيجة انشاء مزرعة الرياح المزمعة في الطفيلة.

الاستفاده من الارض

شكرا جزيلا لتعاونكم


12.11.2012


12.11.2012


12.11.2012


JWPC
12.11.2012


12.11.2012


12.11.2012


12.11.2012


12.11.2012

Annex 12 Peronal Application Form

Ministry of Environment

Please note that I was a member of the CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Project Company PSC.

Project:	Environmental and Social Impact Assessment
Discipline:	Renewable Energy Project, Wind Farm Development
Period:	Study period (Sep. 2011 – Dec. 2012)
Name:	Stefan Chun
Specialty:	Electrical Engineer / Senior Consultant / Principal
Work Address:	Breitscheidstr. 6, 34119 Kassel, Germany
Phone:	+49 (0)561 28 85 73-30

Signature: Date: 18th December, 2012

Ministry of Environment

Please note that I was a member of CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Renewable Energy

Project: Wind Energy.

Discipline: Air quality and noise expert.

Period: Study period (Sep. 2011 – Dec. 2012)

Name : Hamed Al-Ajarmeh.

Specialty : Air quality and noise Impacts.

Work Address: Jordan-Amman.

Phone: 0777-425839

Signature ____________ Date: 18-12-2012

Ministry of Environment

Please note that I was a member of the CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Project Company PSC.

Project:	Environmental and Social Impact Assessment
Discipline:	Renewable Energy Project, Wind Energy
Period:	Study period (Sep. 2011 – Dec. 2012)
Name:	Timo Mertens
Specialty:	Dipl. Ing.
Work Address:	Breitscheidstr. 6, 34119 Kassel, Germany
Phone:	+49 (0)561 28 85 73-10

Signature: Date: 18th December, 2012

Ministry of Environment

Please note that I was a member of the CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Project Companny PSC.

Project: Tafila Wind Energy Project - Environmental and Social Impact Assessment

Discipline: Local Study Team Management

Period: Study period (Sep. 2011 – Dec. 2012)

Name: Bassam Hayek

Specialty: EIA and Environmental Resources Management

Work Address: Um Uthaina - Amman

Phone: 0776604104

Signature: Date: 18/12/2012

Ministry of Environment

Please note that I was a member of the CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Project Company PSC.

Project:	Environmental and Social Impact Assessment
Discipline:	Renewable Energy Project, Wind Energy
Period:	Study period (Sep. 2011 – Dec. 2012)
Name:	Andrea Gütschow
Specialty:	Dipl. – Geogr. - focus climatology and physical geography
Work Address:	Ehrenbergstr. 59, 22767 Hamburg, Germany
Phone:	+49 (0)40 60 00 94 67-0

Signature: Date: 18th December, 2012

Ministry of Environment

Please note that I was a member of the CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Project Company PSC.

Project:	Environmental and Social Impact Assessment
Discipline:	Renewable Energy Project, Wind Energy
Period:	Study period (Sep. 2011 – Dec. 2012)
Name:	Peter Ritter
Specialty:	
Work Address:	Breitscheidstr. 6, 34119 Kassel, Germany
Phone:	+49 (0)561 28 85 73-10

Signature: P. Ritter Date: 18th December, 2012

Ministry of Environment

Please note that I was a member of the CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Project Company PSC.

Project:	Environmental and Social Impact Assessment
Discipline:	Renewable Energy Project, Wind Energy
Period:	Study period (Sep. 2011 – Dec. 2012)
Name:	Jonas Feja
Specialty:	Master of Land Economy (MLE)
Work Address:	Ehrenbergstr. 59, 22767 Hamburg, Germany
Phone:	+49 (0)40 60 00 94 67-0

Signature: Date: 18th December, 2012

Jonas Feja

Ministry of Environment

Please note that I was a member of the CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Project Company PSC.

Project:	Environmental and Social Impact Assessment
Discipline:	Renewable Energy Project, Wind Energy
Period:	Study period (Sep. 2011 – Dec. 2012)
Name:	Marc Brüning
Specialty:	Project Engineer / Consultant
Work Address:	Breitscheidstr. 6, 34119 Kassel, Germany
Phone:	+49 (0)561 28 85 73-10

Signature: M. Brüning Date: 18th December, 2012

Ministry of Environment

Please note that I was a member of the CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Project Company PSC.

Project:	Environmental and Social Impact Assessment
Discipline:	Renewable Energy Project, Wind Energy
Period:	Study period (Sep. 2011 – Dec. 2012)
Name:	Lisa Keaton
Specialty:	
Work Address:	Ehrenbergstr. 59, 22767 Hamburg, Germany
Phone:	+49 (0)40 60 00 94 67-28

Signature: Date: 18th December, 2012

Lisa Keaton

Ministry of Environment

Please note that I was a member of CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Renewable Energy

Project: Wind Energy.

Discipline: Biodiversity.

Period: Study period (Sep. 2011 – Dec. 2012)

Name : Adnan Budire.

Specialty : Biodiversity Expert.

Work Address: Jordan-Amman.

Phone: 077918614

Signature: Date: 18-12-2012

Ministry of Environment

Please note that I was a member of CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Renewable Energy

Project: Tafila Wind Energy

Discipline: Socio-Economic & Archaeology

Period: Sep. 2011 – Dec. 2012

Name : Ramia Alajarmeh

Specialty : Environmental Engineer, Socio Economic Expert

Work Address: Al-Rawabi Environment and Energy Consultancies

Phone:0776178299

Signature: Date: 18/12/2012

Ministry of Environment

Please note that I was a member of CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Renewable Energy

Project: Al Tafila Wind Energy Project

Discipline: Socioeconomic Expert

Period: Study period (Sep. 2011 – Dec. 2012)

Name : Yanal Abeda

Specialty : Socioeconomic Impacts

Work Address: Al-Rawabi Consultancies.

Phone: 0795630738

Signature: Date: December 18, 2012.

Ministry of Environment

Please note that I was a member of CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Renewable Energy

Project: Jordan Wind Renewable Energy

Discipline:

Period: Study period (Sep. 2011 – Dec. 2012)

Name : Mustafa Al Kuisi

Specialty : Hydrogeologist

Work Address: University of Jordan

Phone:

Signature: Date: 18/12/2012.

Ministry of Environment

Please note that I was a member of CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Renewable Energy

Project: Wind Energy.

Discipline: Air quality and noise expert.

Period: Study period (Sep. 2011 – Dec. 2012)

Name : Anas Al-Ajarmeh.

Specialty : Air quality and noise Impacts.

Work Address: Jordan-Amman.

Phone: 0776478887

Signature: Date: 18-12-2012

Ministry of Environment

Please note that I was a member of CUBE / REEC Environmental Impact Assessment Study team for Al Tafila Wind Energy Project being developed by Jordan Wind Renewable Energy

Project: Wind Energy.

Discipline: Geology

Period: Study period (Sep. 2011 – Dec. 2012)

Name : Naser Hasweh

Specialty : Geology/Geophysics

Work Address: Jordan-Amman.

Phone: 0777-439549

Signature: Date: 18-12-2012