Initial Environmental Examination

Project Number:
November 2012

THA: THEPPANA WIND FARM (WATABAK 2) PROJECT
Chaiyaphum Province

Prepared by Electricity Generating Public Company Limited (EGCO)

ABBREVIATIONS

ADB	-	Asian Development Bank
BOD	-	Biochemical Oxygen Demand
CDM	-	Clean Development Mechanism
COD	-	Chemical Oxygen Demand
DO	-	Dissolved Oxygen
EGCO	-	Electricity Generating Public Company Limited
IEE	-	Initial Environmental Examination
PEA	-	Provincial Electricity Authority
TDS	-	Total Dissolved Solids
TGO	-	Thailand Greenhouse Gas Management Organization
T/L	-	Transmission Line
TPW	-	Theppana Wind Farm Company, Ltd.
TSP	-	Total Suspended Particle

WEIGHTS AND MEASURES

MW	-	Megawatt
kV	-	kilovolt
km	-	kilometer
kVA	-	kilovolt ampere
m	-	meter
v	-	volt
m2	-	square meter
mm	-	millimeter
hr	-	hour
µg	-	microgram
m3	-	cubic meter
kg	-	kilogram
dB(A)	-	average A-weighted decibels

CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

1. Theppana Wind Power Project, a project of the Electricity Generating Public Co., Ltd. (EGCO) will entail the construction of a 3 x 2.5 MW wind farm in Watabaek sub-district, Thepsathit district, Chaiyaphum province, 250 km north-east of Bangkok (the "Project"). The Project will be developed and implemented under a 5-year power purchase agreements (PPAs) with the Provincial Electricity Authority of Thailand ("PEA") with automatically renewal every 5 years for a total contracted capacity of 6.9 MW. The Project will be connected via 22 kV distribution line to PEA's Bumnejnarong substation, which is located approximately 40 km away to the east of the project site.

A. Project Proponent

2. The Project is being developed by Electricity Generating Company Limited ("EGCO") and Pro-Ventum Co., Ltd. ("Pro-Ventum") using a project company, Theppana Wind Farm Company Limited[1] (TPW or Project Company), a special purpose vehicle established in Thailand.

3. EGCO is Thailand's first independent power producer and is currently the second largest private power producer in the country. EGCO was privatized by EGAT in 1992 and the company was later listed on Stock Exchange of Thailand in 1995.

B. Project Overview

4. The Project comprises of 3 WTGs x 2.5 MW of GoldWind GW109/2500 at 90 m hub height turbine. The inter-turbine distance between turbines is approximately 3.3 wind turbine diameters. The total installed capacity will be 7.5 MW for the whole wind farm. The Project sites could be accessed via Highway 2354. The wind farm access/internal road with approximately 5 m width will be constructed by EPC contractor. The wind farm access/internal road will be used for the transportation of WTG's components, and future access to each WTG and substation. Wind farm substation will be connected with the existing PEA's 22kV overhead lines.

5. During the construction period, the project area covers 1.3 hectares (about 8.4 rais) which includes wind turbine generators, substations, equipment, machineries with area of 0.5 hectares (about 3 rais) and right of way with area of 0.8 hectares (about 5.4 rais). During the operation period, the projects area covers 0.9 hectares (about 5.7 rais) which is divided into 0.5 hectares (about 3 rais) for location of wind turbine generators and 0.4 hectares (about 2.7 rais) for right of way (shown in Figure 1).

6. The Project shall be financed by group of Lenders including Asian Development Bank (ADB) and Thai Financial Institutions. EPC Contractors are consortium of Italian Engineering Co. Ltd. (Italthai) and Goldwind. The Project will be constructed under a fixed-price,date-certain, turnkey EPC arrangement covering all design, engineering, supply, construction, testing and

[1] Theppana Wind Farm Company Ltd. (TPW), is a special purpose project company that is owned 90% by EGCO, a major power supply holding company in Thailand and 10% by the founder of Pro Ventum, an international wind power developer based in Germany.

commissioning. Construction will be for a period of 12-months. And operation and maintenance (O&M) for this Project will be undertaken by Goldwind for the first five years after Commercial Operations Date (COD) with an option to extend. TPW will take over O&M services after 5 years.

C. IEE Study

7. The Ministry of Natural Resources and Environment (MONRE) does not require an environmental impact assessment for wind power plant project. Nevertheless, the Project Company has assigned Greener Consultant Co., Ltd. to undertake an initial environmental examination (IEE) which includes environmental and social assessment of the project to ensure that the project will be environmentally sound and acceptable to the local communities. This IEE document presents the findings and conclusions to fully comply with ADB's Safeguard Policy Statement (2009) for category B1 projects and internationally recognized standards such as USEPA. Furthermore, the IEE report will be submitted to Thailand Greenhouse Gas Management Organization (TGO) for the project to be registered under the Clean Development Mechanism (CDM) program.

8. The objectives of the IEE are to:

(i) Assess the existing environmental and socioeconomic conditions of the project area
(ii) Identify likely impacts of the proposed project on the natural and human environment of the area, to predict and evaluate these impacts, and determine significance of these impacts, in the context of the technical and regulatory concerns
(iii) Proposed appropriate mitigation measures that should be incorporated in the design of the project to minimize, if not eliminate, the adverse impacts.
(iv) Assess the compliance status of the proposed activities with respect to the environmental legislation and ADB's environmental and social standards.
(v) Formulate an environmental and social management plan (ESMP) to provide an implementation mechanism for the mitigation measures identified during the study.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

9. This chapter discusses the policy, legal and administrative framework as well as institutional set-up relevant to the environmental and social assessment of the proposed project.

A. Compliance with Thai Regulations

10. Currently, developers of wind power projects in Thailand are not required to undertake the EIA process. However, an IEE report study has been prepared and public consultation meeting was held on 16 March 2012 as required by the Thai Constitution. For a wind power project, several environmental issues have been identified that need to be taken into consideration during construction and operation these issues include: (i) noise, (ii) shadow flicker, (iii) visual impacts, (iv) species mortality, (v) habitat alteration; and (vi) water quality.

11. For the proposed wind power project it is anticipated that noise emission and shadow flicker issues will be the significant environmental impacts that will be addressed and mitigated during project implementation.

1. Thai Noise Regulations

12. Noise quality shall comply with the following Thai noise standard Notification of Environmental Board No. 15 B.E. 2540 (1997) under the Conservation and Enhancement of National Environmental Quality Act B.E. 2535 (1992) and Notification of Pollution Control Department, Subject: Calculation of Noise Level Dated August 11, B.E. 2540 (1997).

Table 1: Thai Noise Standards

Ambient Noise Standard	
Standard	**Noise Calculation**
Maximum Sound Level (Lmax) should not exceed 115 dB(A)	Equivalent Sound Level (Leq) from Fluctuating Noise
A-weighted Equivalent Continuous Sound Level (Leq) 24 hours should not exceed 70 dB(A)	Equivalent Sound Level (Leq) from Steady Noise

13. In addition, the wind farm will need to comply with the Thai noise standard Notification of Environmental Board NO. 17 B.E. 2543 (2000) under the Conservation and Enhancement of National Environmental Quality Act 2535 (1992), which states that an Annoyance Noise means the noise of which noise level is 10 dB(A) or greater than the background noise (L90). Therefore, the maximum increase in noise level from the plant should in any case be lower than 10dB(A).

14. Maximum noise level at site boundary of 70 dB(A) is the Thai standard applicable to the project. However, it should be noted that the US EPA states that 70 dB(A) is the level of environmental noise which will prevent any measurable hearing loss over a lifetime, with a levels of 55 dB(A) and 45 dB(A) indoors are identified as preventing activity interference and annoyance. These levels of noise are considered those which will permit spoken conversation and other activities such as sleeping, working and recreation, which are part of the daily human condition.

B. Applicable International Guidelines

15. The international guidelines are applied in this study. For noise impact study, The Noise Control Act 1972 (US.EPA) is considered in the noise impact study with Thailand regulation. For shadow flicker impact study, the standards of German guidelines (Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windenergianlagen (WEA-Shattenwurf-Hinweise), 2002) are applied in this study.

C. Asian Development Bank (ADB) Policies and Guidelines

16. ADB policies and standards to manage social and environmental risks and impacts are considered:

(i) ADB Safeguard Policy Statement (2009);
(ii) Social Protection Strategy;

(iii) Public Communication Policy; and
(iv) Labor Standards.

1. The ADB's Safeguard Policy Statement 2009 sets out the policy objectives scope and trigger, and principles for following three key safeguard areas:

(i) Environmental safeguard;
(ii) Involuntary resettlement safeguard; and
(iii) Indigenous people safeguards.

17. The objective and scope of above three key areas are briefly described as under.

18. **Environment Policy.** This policy element ensures the environmental soundness and sustainability of projects and supports the integration of environmental considerations into the project decision-making process. Environmental safeguards are triggered if a project is likely to have potential environmental risks and impacts.

19. During the design, construction, and operation of a project the borrower/client will apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines.

20. **Involuntary Resettlement Policy.** This policy guideline encourages avoiding involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced person in real terms relative to pre-project levels; and to improve the standards of living of the displaced poor and other vulnerable groups

21. The involuntary resettlement safeguards covers physical displacement (relocation loss of residential land or loss of shelter) and economic displacement (loss f land assets, access to assets, income sources, or means of livelihoods) as a result of (i) involuntary restrictions on land use or on access to legally designated parks and protected areas. It covers them whether such losses and involuntary restrictions are full or partial, permanent or temporary.

22. **Indigenous People Policy.** This guides the project proponent to design and implement projects in a way that fosters full respect for indigenous peoples' identity, dignity, human rights, livelihood systems, and cultural uniqueness as defined by the indigenous peoples themselves so that they (i) receive culturally appropriate social and economic benefits, (ii) do not suffer adverse impacts as a result of projects, and (iii) can participate actively in projects that affect them.

23. The indigenous people's safeguards are triggered if a project directly or indirectly affects the dignity, human rights, livelihood systems or culture of indigenous peoples or affects the territories or natural or cultural resources that indigenous peoples own, use, occupy, or claim as an ancestral domain or asset. The term indigenous peoples are used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees: (i) self-identification as members of a distinct indigenous cultural group and recognition of the identity by others; (ii) collective attachment to geographically distinct habits or ancestral territories in the project area and to the natural resources in these habits and territories; (iii) customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture; and (iv) a distinct language, often different form

of the official language of the country or region. In considering these characteristics, national legislation, customary law, and any international conventions to which the country is a party will be taken into account. A group that has lost collective attachment to geographically distinct habits or ancestral territories in the project area because of forced severance remains eligible for coverage under this policy.

24. **Policy on Gender and Development (1998).** The Asian Development Bank (ADB) first adopted a Policy on the Role of Women in Development (WID) in 1985 and over the passage of time has progressed from a WID to a gender and development (GAD) approach that allows gender to be seen as a crosscutting issue influencing all social and economic processes. ADB"s policy on GAD will adopt mainstreaming as a key strategy in promoting gender equity. The key elements of ADB"s policy will include the following.

25. Gender sensitivity: to observe how ADB operations affect women and men, and to take into account women's needs and perspectives in planning its operations

26. Gender analysis: to assess systematically the impact of a project on men and women, and on the economic and social relationship between them

27. Gender planning: to formulate specific strategies that aim to bring about equal opportunities for men and women Mainstreaming: to consider gender issues in all aspects of ADB operations, accompanied by efforts to encourage women"s participation in the decision-making process in development activities

28. Agenda setting: to assist developing member country (DMC) governments in formulating strategies to reduce gender disparities and in developing plans and targets for women"s and girls" education, health, legal rights, employment, and income-earning opportunities

29. ADB will aim to operationalize its policy on GAD primarily by mainstreaming gender considerations in its macroeconomic and sector work, including policy dialogue, lending, and technical assistance (TA) operations. Increased attention will be given to addressing directly gender disparities, by designing a larger number of projects with GAD either as a primary or secondary objective in health, education, agriculture, natural resource management, and financial services, especially microcredit, while also ensuring that gender concerns are addressed in other ADB projects, including those in the infrastructure sector.

2. 2001 Social Protection Strategy

30. It is the set of policies and programs designed to reduce poverty and vulnerability by promoting efficient labor markets, diminishing people's exposure to risks and enhancing their capacity to protect themselves against hazards and interruption/loss of income. Social Protection consists of five major elements:

(i) **Labor markets policies and programs** designed to facilitate employment and promote and efficient operation of labor markets;
(ii) **Social insurance** programs to cushion the risks associated with the unemployment, health, disability, work injury, and old age;
(iii) **Social assistance and welfare service programs** for the most vulnerable groups with no other means of adequate support;

(iv) **Micro and area-based schemes** to address vulnerability at the community level; and
(v) **Child protection** to ensure the healthy and productive development of the future Asian workforce.

3. 2011 Public Communications Policy

31. The Public Communications Policy of ADB guides the institutional efforts to be transparent and accountable to the people it serves. The Policy recognizes that transparency and accountability are essential to development effectiveness. The objective of the policy is to enhance stakeholders' trust in and ability to engage with ADB. The policy recognizes the right of people to seek, receives, and imparts information about ADB operations. It supports knowledge sharing and enables participatory development or two-way communications with affected people. The policy is based on a presumption in favor of disclosure unless there is a compelling reason for nondisclosure. It commits ADB to disclose institutional, financial, and project-related information proactively on its website, following strictly time limits, and provides mechanisms to handle responses and complaints.

4. Core Labor Standards

32. ADB adopted a commitment to core labor standards (CLS) as part of its Social Protection Strategy in 2001. Since then, ADB ensures that CLS are duly considered in the design and implementation of its investment projects. In this regards a handbook for CLS has been developed by ADB with cooperation of International Labor Organization (ILO). The objective is to convince decision makers that the introduction of CLS and labor standards in general will not impede development. The labor standards are simple the rules that govern how people are treated in a working environment. Labor standards cover a very wide variety of subjects, mainly concerning basic human rights at work, respect for safety and health and ensuring that people are paid for their work. CLS are a set of four internationally recognized basic rights and principles at work:

(i) Freedom of association and the effective recognition of the right to collective bargaining;
(ii) Elimination of all forms of forced or compulsory labor;
(iii) Effective abolition of child labor; and
(iv) Elimination of discrimination in respect of employment and occupation.

III. DESCRIPTION OF THE PROJECT

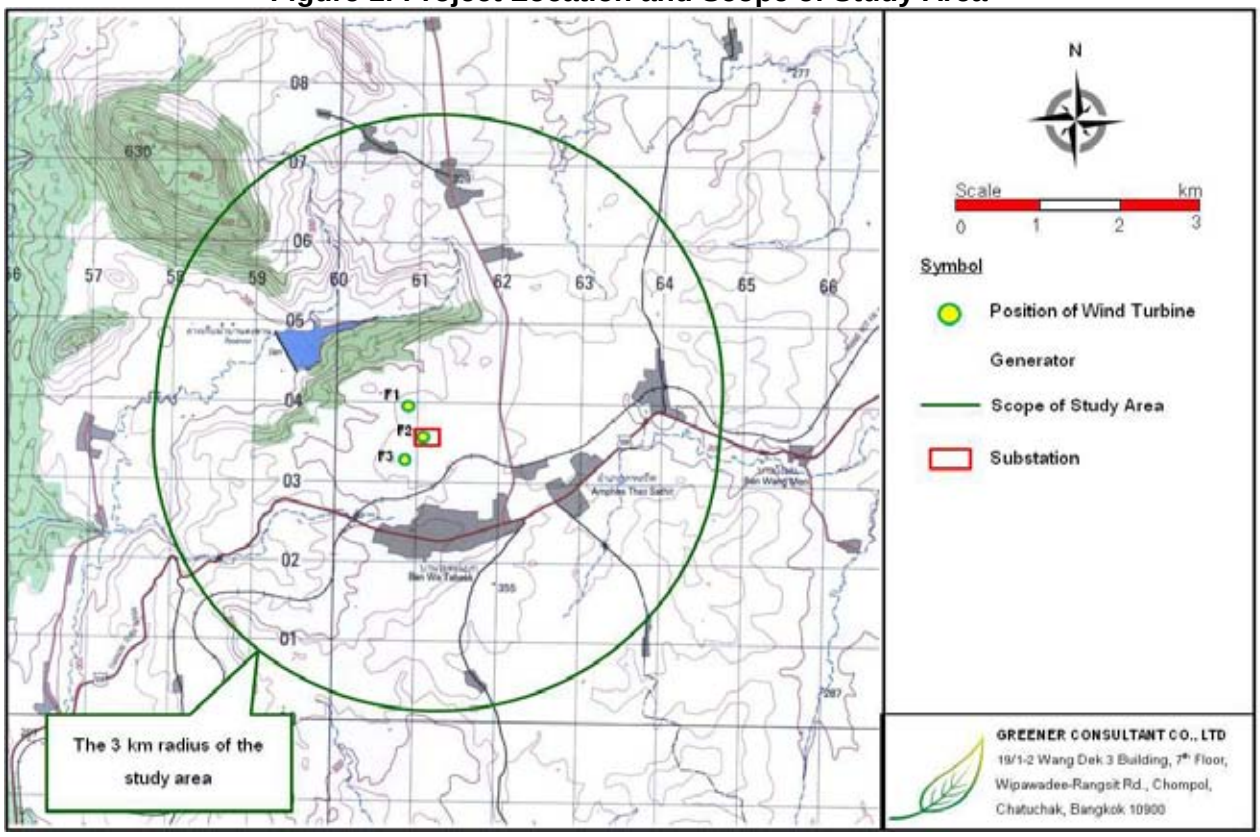
33. This chapter provides a simplified description of various components of the proposed project and their salient features, location, and phases with particular emphasis on aspects related to environmental and social.

A. Project Location

34. The project is located in Watabak Subdistrict, Thep Sathit District, Chaiyaphum Province (refer to Figure 1), about 255 kilometers (km) northeast of Bangkok. Highway no. 205 and no. 2354 will be used for transportation. For wind potential area, According to the study report from

the Joint Graduate School of Energy and Environment of King Mongkut's University of Technology Thonburi, it illustrated that the average annual wind speed of the project area (Watabak Subdistrict, Thep Sathit District, Chaiyaphum Province) is about 6-7 m/s. Therefore, the location of Theppana Wind Farm (Watabak 2) Project has enough potential of wind energy to produce electricity.

Figure 1: Project Location and Scope of Study Area



B. Project Scope and Layout

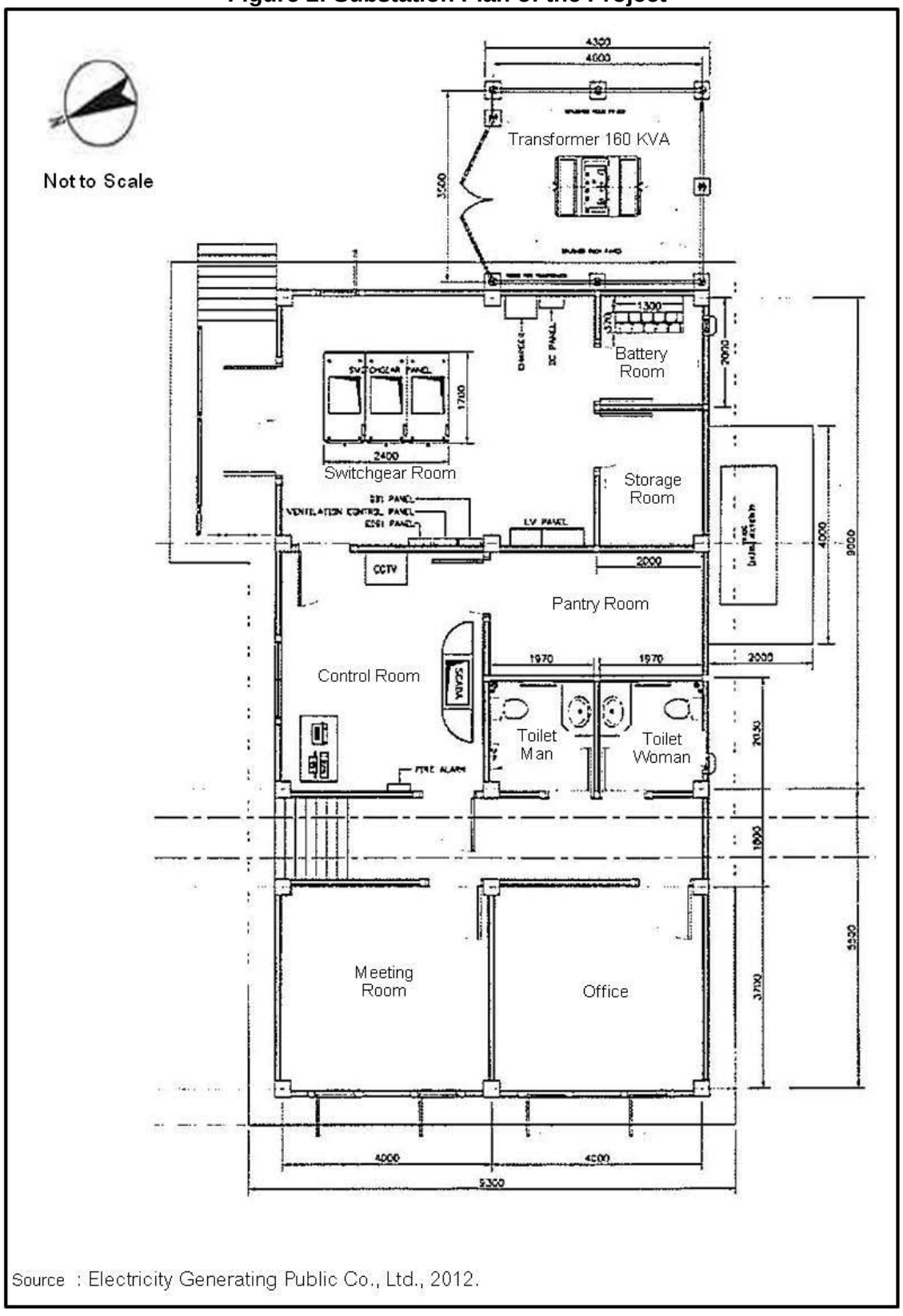
35. The project has surveyed existing environmental conditions in the study area within 3 km radius around the project sites (refer to Figure 1). The land utilization will be allocated for three (3) wind turbine generators, 1 substation (shown as Figure 2), right of way, control room, and green area. The Project chose a wind turbine specification that is Goldwind 2.5 MW of Gold Wind Science and Technology Co., Ltd. The technical specifications of Goldwind 2.5 MW are present in Table 2 and Figure 3.

Table 2: Specifications of Wind Turbine

Item	Description
Power	
Rated Power	2,500 kW
Cut-in Wind Speed	3 m/s
Rated Wind Speed	10.3 m/s
Cut-out Wind Speed	25 m/s (10 Minute Averge)
Rotor	
Type	Simoma 52.5
Position	Upwind
Diameter	109 m
Swept Area	9,059 m^2
Speed Range	7.0-14.5 rmp
Material of Rotor Hub	Casted Iron
Blades	
Type	3-bladed and horizontal axis
Blade Length	52.5 m
Meterial	Fiberglass
Power Control	Collective Pitch Control / Rotor Speed Control
Safety System	Independent Blade Pitch Control Hydraulic Disk Brake Hydraulic Bolt Lock
Yaw System	4 Induction Motors
Tower	
Type	Tubular Steel Tower (Q345C)
Hub Height	90 m
Foundation	Flat Foundation
Material	Reinforced Concrete with Foundation Steel Section
Converter	Full Power Converter (IGBT Modular System)
Transformer	
Input Voltages	690 v
Output Voltages	22 kv
Control System	Microprocessor Controlled, DFÜ (SCADA)
Design Standard	IEC IIIa TÜV Nord (Design Assessment)

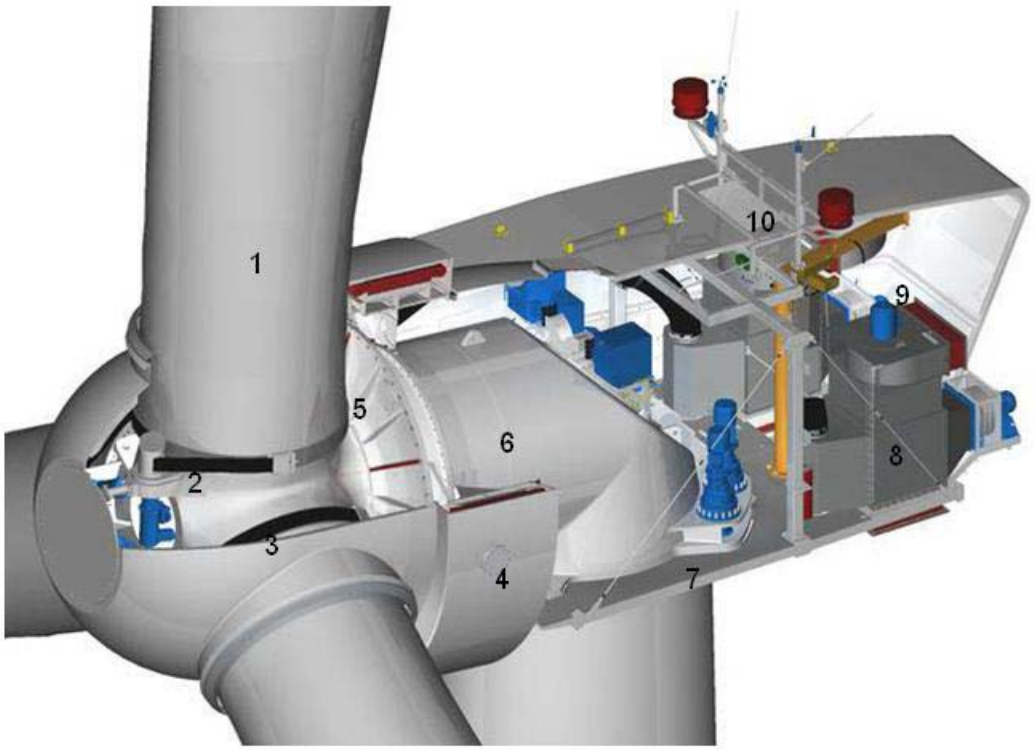
Source : Goldwind Science and Technology Co., Ltd., 2011.

Figure 2: Substation Plan of the Project



Source : Electricity Generating Public Co., Ltd., 2012.

Figure 3: Goldwind 2.5 MW Turbine



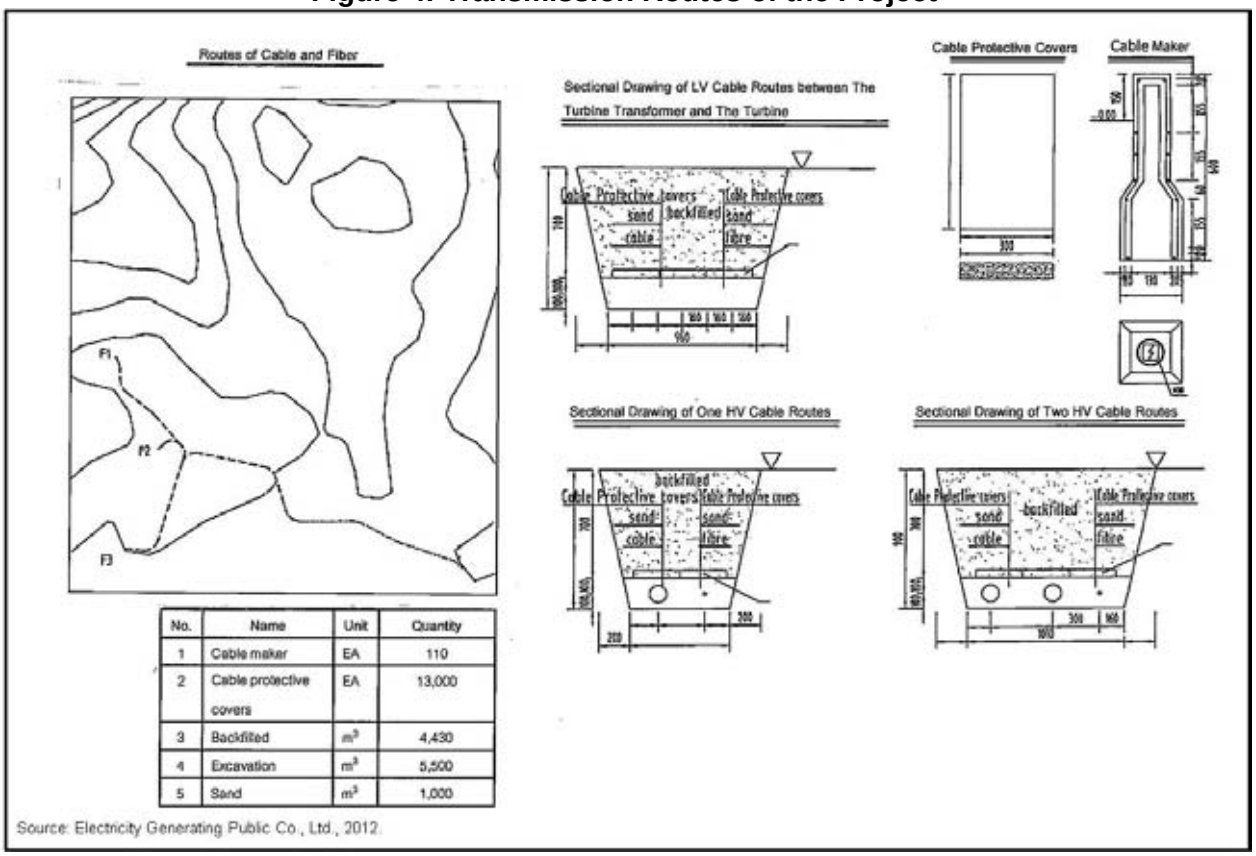
Goldwind 2.5 MW Components

1. Rotor Blade
2. Pitch System
3. Casted Hub
4. PMDD Generator
5. Rotor / Generator Bearing
6. Base Frame
7. Yaw System
8. Heat Exchanger
9. Auxiliary Crane
10. Metrological Equipment

Source : Goldwind Science and Technology Co., Ltd., 2011.

36. The transmission lines (T/L) consists of 22 kV cable laying to transmit electricity from each wind turbine to substation. The transmission route connects the 3 wind turbines and transmits electricity to substation. The total length of T/L for this route is about 1 km (shown as Figure 4) which will be installed underground. The 2,750 kVA transformer is installed on each wind turbine to adjust the voltage from 690 V to 22 kV and transmits electricity to substation. Then, substation will transmit electricity to Bumnejnarong Substation, Chaiyaphum Province of Provincial Electricity Authority (PEA). PEA has responsibility to maintain and operate transmission line of Bumnejnarong Substation.

Figure 4: Transmission Routes of the Project



No.	Name	Unit	Quantity
1	Cable maker	EA	110
2	Cable protective covers	EA	13,000
3	Backfilled	m^3	4,430
4	Excavation	m^3	5,500
5	Sand	m^3	1,000

Source: Electricity Generating Public Co., Ltd., 2012.

1. Land Acquisition

37. Land Requirement. The project will be requiring 1.3 hectares (about 8.125 rais) during construction and 0.9 hectares (about 5.625 rais) during operation. The project will be located in an agricultural area planted to cassava and no individual or households will be displaced by the project. Breakdown of the land requirement is shown in Table 3 below:

Table 3: Land Requirement

Structure	Area	Remarks
Land Requirement During Project Construction		
Wind turbine generators	0.5 hectares (3.125 rais)	Area required covers location of storage area for supplies, materials, turbine, and other equipments/ machineries.
Substations		
Right of Way	0.8 hectares (5 rais)	
Sub-total	1.3 hectares (8.125 rais)	
Land Requirement During Project Operation		
Wind turbine generators	0.5 hectares (3.125 rais)	Area required covers location of storage area for supplies,
Substations		

Structure	Area	Remarks
		materials, turbine, and other equipments/machineries.
Right of Way	0.4 hectares (2.5 rais)	
Sub-total	0.9 hectares (5.625 rais)	

38. **Land Acquisition.** Theppana Wind Farm Company Limited (TPW) entered into a long-term lease agreement with the ALRO for the location of turbines, access road, substation and green area. The ALRO lease agreement also includes consent from 18 farmer beneficiaries who are using the area for agricultural production. Consents of these individuals were obtained by the project sponsor after consulting and negotiating with them. The agreed rental rate for ALRO land is 199,850 baht per annum[2] for a 27 year term. A fixed rate per plot or per rai was agreed to be paid by TPW to the affected farmer beneficiaries and the consent given was good for the duration of the project. The Agreement has been signed and registered with the land office. A project fund will be established for implementation of small development projects that will benefit the community. (Refer to Appendix III- Social Due Diligence Report)

39. **Status of Land Acquisition.** The affected lands in the proposed project site are ALRO land. Details are shown in Table 4 as follows:

Table 4: Status of Land Acquisition

Land Type	Number of Owners/ Leaseholders	Area Leased	Arrangements	Remarks
ALRO Land	1 (ALRO is the owner)	0.9 hectares (5.7 rais)	199,850 baht per annum	Term – 27 years (Agreement has been signed and registered with the land office.)

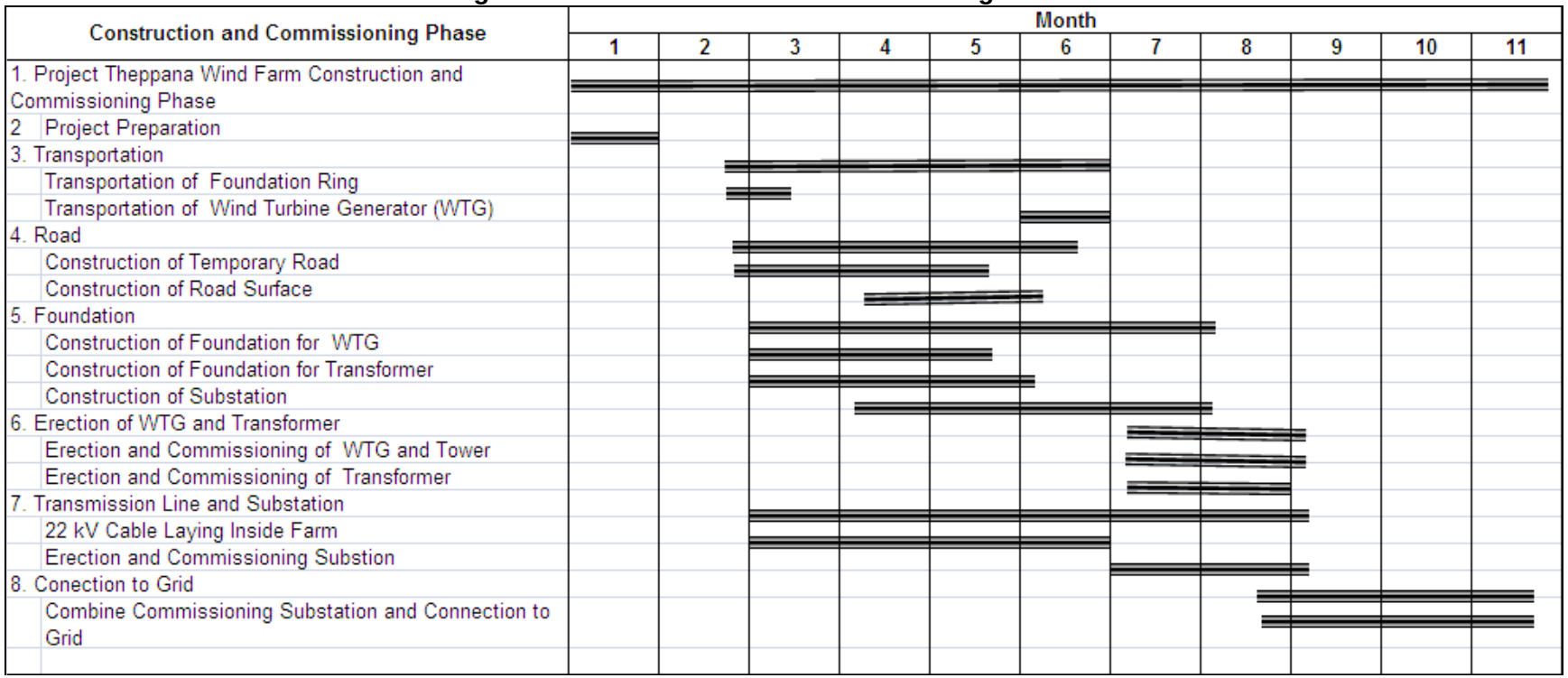
40. There is no required land acquisition for the T/L since the existing T/L of PEA will be used by the project.

C. Construction Activities

41. The design, construction, and commissioning will be undertaken by the contract between TPW and contractor. The project construction plan will take about 11 months (as shown in Figure 5) with approximately maximum of 250 civil workers (only for the short-peak period). All construction workers will stay outside the project area and thus there will be no need for construction camp.

[2] The rental rate is subject to change in accordance with the relevant regulation of Land Reform Committee (LRC).

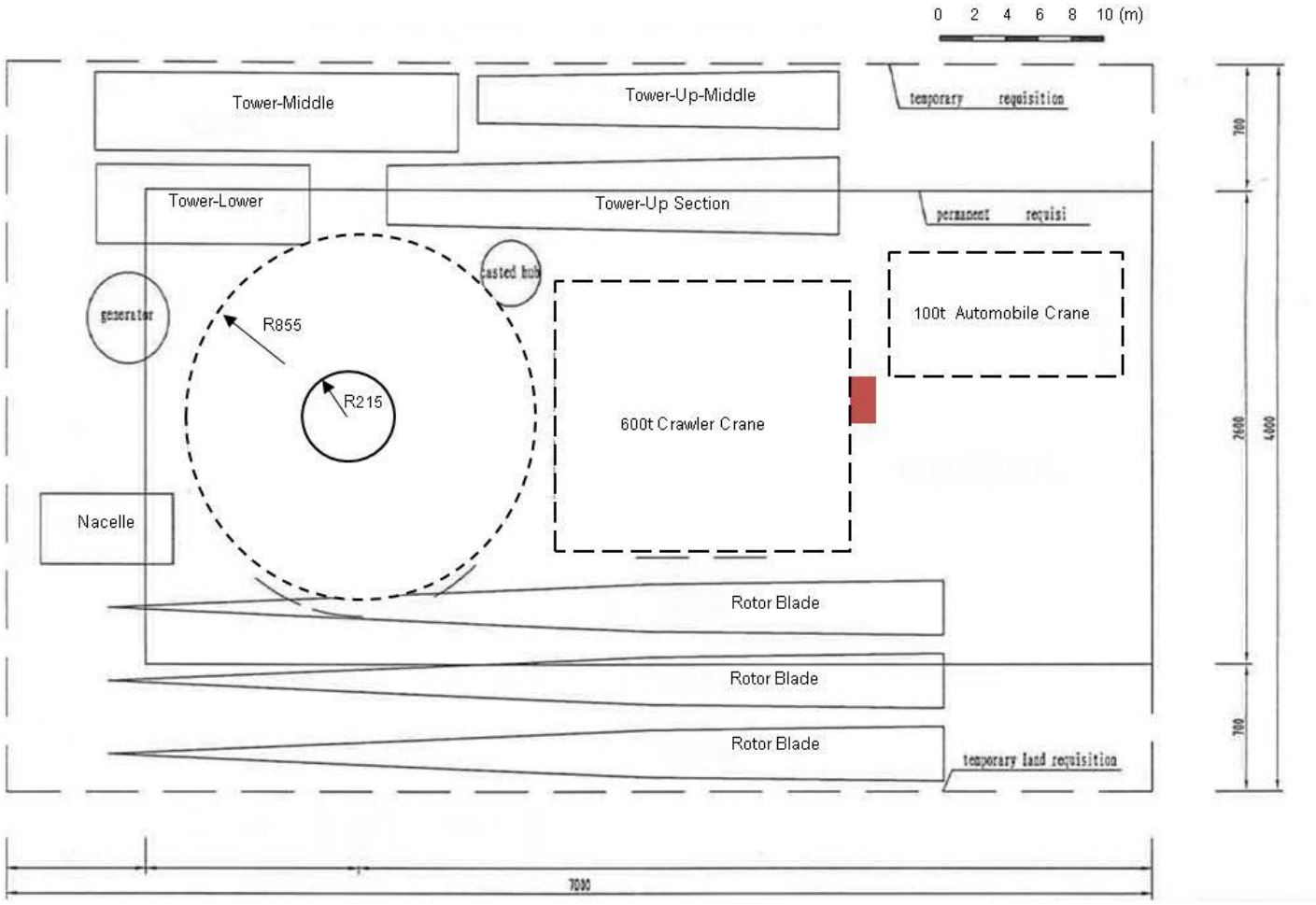
Figure 5: Construction and Commissioning Schedule



Source: Electricity Generating Public Co., Ltd., 2012.

42. During the construction period, the project area will be prepared for the construction of wind turbine with area of 1.75 rais (about 0.28 hectares) per 1 wind turbine which covers location of storage area for supplies, materials, turbine, and other equipment. Figure 6 presents the typical land utilization for 1 wind turbine during the construction period.

Figure 6: Land Utilization for 1 Wind Turbine during the Construction Period

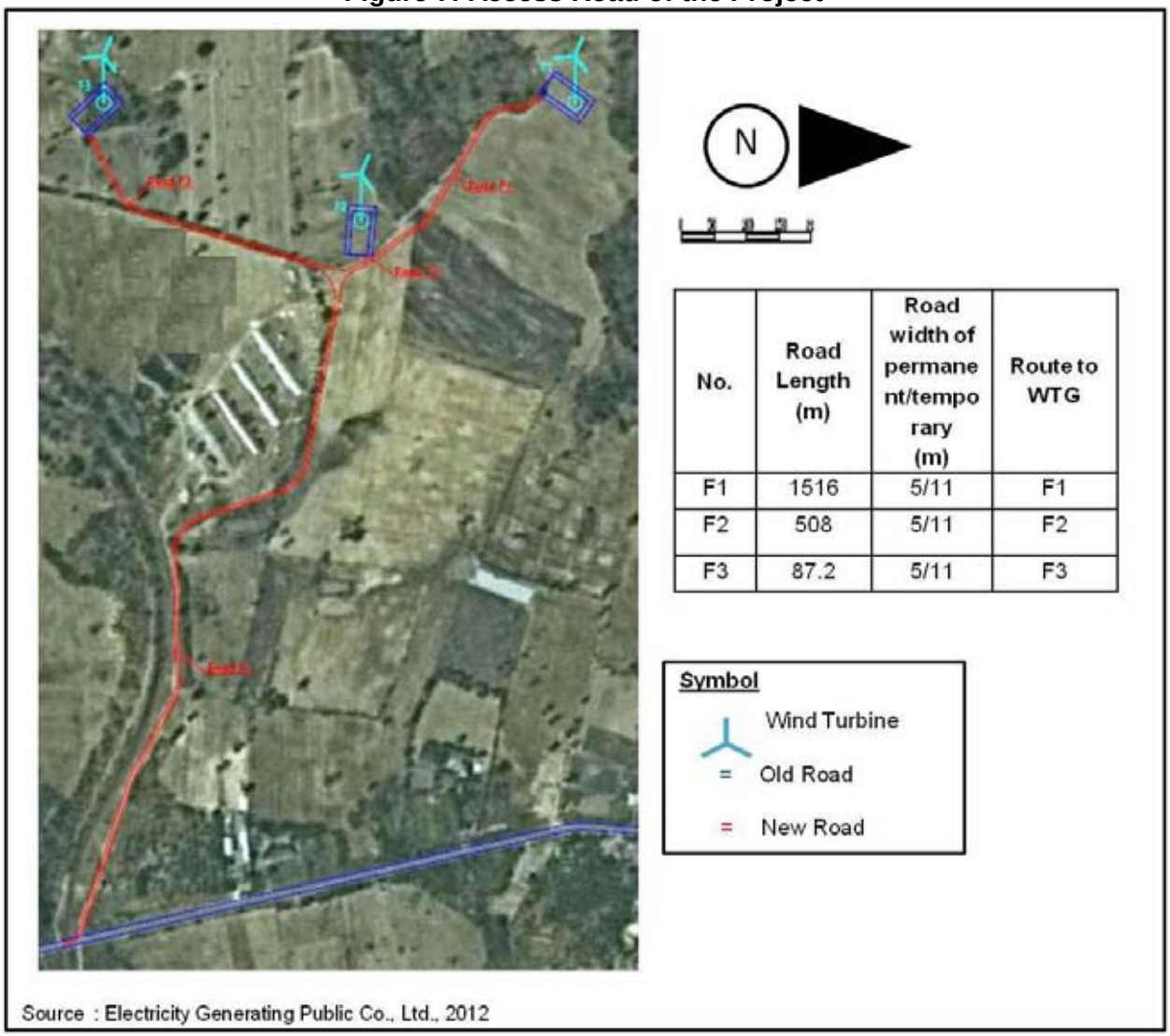


Note : All the dimensions are in centimeter.

Source: Electricity Generating Public Co., Ltd., 2012.

43. Highway no. 205 and no. 2354 will be used for transportation of construction materials and labourers. Moreover, the project needs to adjust and construct road to access to each wind turbine location. The new access roads will be constructed to allow the passage of large trucks for delivery of materials. During the operation period, the road will be reduced from width of 11 m to 5 m. Water drainage system will be prepared along the road. TPW has already contacted and made a temporary agreement to rent area for making right of way (0.8 hectares or about 5.4 rais) with the landowners. The access road of the project is shown in Figure 7.

Figure 7: Access Road of the Project



No.	Road Length (m)	Road width of permanent/temporary (m)	Route to WTG
F1	1516	5/11	F1
F2	508	5/11	F2
F3	87.2	5/11	F3

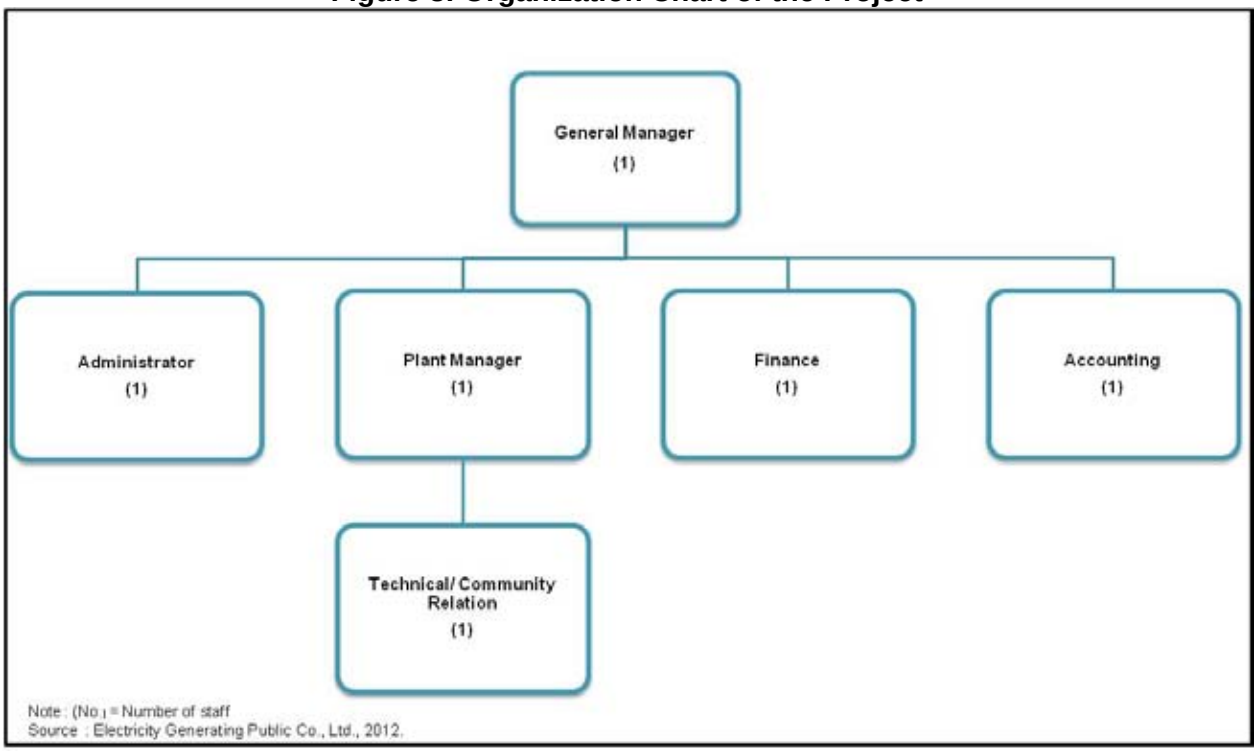
Source : Electricity Generating Public Co., Ltd., 2012

D. Operational Activities

44. O&M activities for wind power are relatively simple, consisting of remote monitoring, regular inspections, minor repairs, part replacement, measurements and data verification.

45. For the operation period, there are 7 staffs which they have a responsibility to control and check the efficiency of wind turbine system and all equipment. Moreover, they have a responsibility to cooperate with the local communities around the project area. Figure 8 presents the organization chart of the project. For hiring of women-employee, the project has women employees to work in accounting and financial which the project has prepared policies to take care them such as annual health check for women program.

Figure 8: Organization Chart of the Project



46. Green area will be provided with area of 0.3 Rai or 5% of total area. The lawn and culture shrubs will be planted around wind turbine generators to be buffer between the project area and nearest communities. Moreover, the noise impact assessment is not over standard.

E. Decommissioning Activities

47. The design plant life is 25 years. Decommissioning will involve the dismantling of the turbines, supporting towers and the Administration building/substation, and transporting it out of the project area. It is expected that this activity will take approximately 6 months and will require heavy haul trucks (60-feet size) for the turbine components. The turbine components will be sold as scrap, and all the concrete will be broken up and removed and disposed of to designated landfill site. The stored fuel and oil, together with the containers will be transported out of the site for sale/disposal at suitable landfill sites. The remaining non-hazardous waste will be sent to a licensed disposal services company. The site will be restored as far as possible to its original condition. The access roads may be left intact, if local people desire to use them. If not, road structures will be dismantled and the land returned to its original condition.

IV. DESCRIPTION OF EXISTING ENVIRONMENT AND SOCIOECONOMIC CONDITIONS

A. Physical Environment

48. The topography of around project area is rolling plain with is the agricultural areas including cassava plantation, teak plantation, mango orchard, rubber plantation, etc. Soil series are Lat Ya, Tha Yang, Khao Yai and Slope Complex Series.For geographical characteristics, rock characteristics around the projects area are sedimentary and metamorphic rocks. Moreover, the earthquake occurring around the project area is Zone 0 according to Thailand seismic hazard map (Department of Mineral Resources, 2005) which is considered lowest risk (< 3 Mercalli). There is no tectonic plate lies close to the project site.

B. Meteorology and Climate

49. The climate of the Project area in Chaiyaphum province is considered as tropical monsoon, with three distinct seasons:

(i) Winter from November to February;
(ii) Summer from March to May; and
(iii) Rainy Season from June to October

50. According to historical weather statistics recorded during 2002-2011 at Chaiyaphum meteorological station which is the closest meteorological station to the Project site in Chaiyaphum Province, the meteorological data can be summarised:

(i) The annual mean temperature averages 27.4^{o}C with monthly maximum temperature of 38oC and monthly minimum temperatures of 17^{o}C;
(ii) The maximum wind speed during 2002-2011 has been 25 m/s in May 2010, measured at 182 cm height above mean sea level;
(iii) The highest average monthly precipitation is 457 mm in August 2010. The annual mean rainfall during 2002-2011 is approximately 1,999 mm.

C. Ambient Air Quality

51. No sources of anthropogenic sources of air pollution exist in the immediate vicinity of the site; therefore the ambient air of the area is likely to be free from the key pollutants such as carbon monoxide (CO), oxides of nitrogen (NO_2), and sulphur dioxide (SO_2). However total Suspended Particulates (TSP) was measured in 3 sampling locations from 05 to 08 March 2012 (shown in Figure 10). These sampling locations are: (1) Ban Watabak, (2) Khum Mor Din Sai Community, and (3). Tessaban 2 Community. The high volume air sampler was applied to collect to air pollutants. Gravimetric method is certified by Department of Pollution that was used to analyze TSP. The results illustrated that TSP were not over the standard value (shown as Table 5).

Figure 9: Sampling Locations for Air Quality, Noise Level and Surface Water Quality

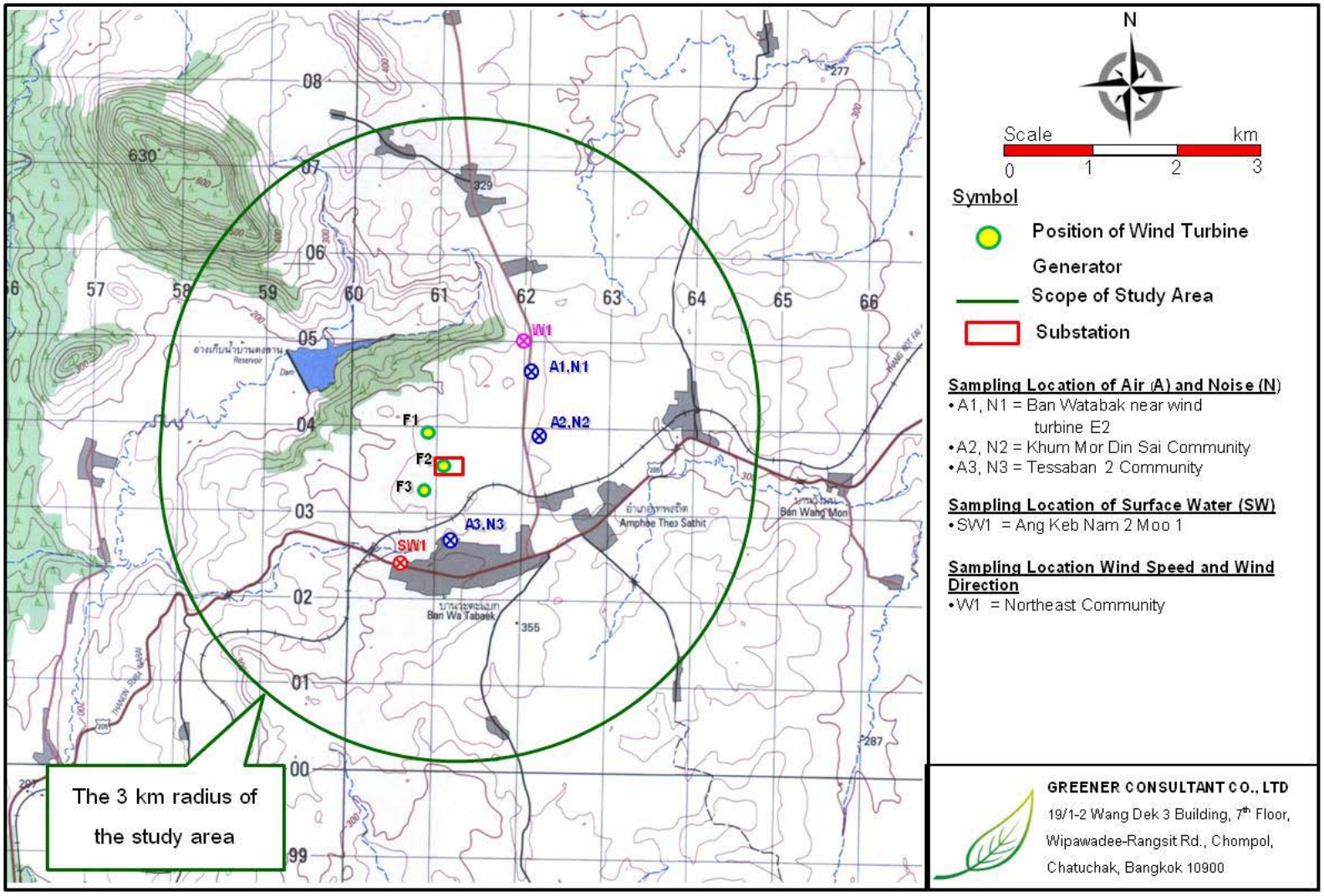


Table 5: The Result of 24-Hour Average of Total Suspended Particulates (TSP) in the Atmosphere

Station	Measurement Date	24-Hour Average Total Suspended Particle (mg/m^3)
Ban Watabak (A1)	5-6/03/12	0.092
	6-7/03/12	0.088
	7-8/03/12	0.114
Khum Mor Din Sai Community (A2)	5-6/03/12	0.118
	6-7/03/12	0.115
	7-8/03/12	0.137
Tessaban 2 Community (A3)	5-6/03/12	0.131
	6-7/03/12	0.115
	7-8/03/12	0.119
Standard		0.33

Sources: Greener Consultant Co., Ltd., 2012.
The National Ambient Air Quality Standards, as specified in Notification of National Environmental Board NO. 24, B.E. 2547 (2004)

D. Ambient Noise Level Monitoring

52. Wind turbines do make some noise. The carefully designed rotor blades with low rotational speed along with good noise insulation generator help limit noise emission. Typically, at 200 m the sound from a modern, medium-sized wind turbine would be about 45 dB, quieter than a typical living room. At 400 m, the sound would be no louder than leaves rustling in a gentle breeze. By keeping enough distance from built-up or other noise sensitive areas, noise pollution is avoided. Existing ambient noise levels are typical for a rural area with a small population. Noise sources may include wind, birds, tractors, motor bike and vehicle.

53. Ambient noise level measurement covering 3 sampling locations (refer to Figure 10) has been conducted during 5-8 March 2012. The sampling and methodology is certified by Notification of Environmental Board B.E. 2540 (1997) regarding Noise and Vibration Standard. The parameters comprise equivalent continuous sound level during a 24 hour period (Leq- 24 hr), and maximum sound level (Lmax) (3 consecutive days measurement). The results revealed that Leq-24 hr and Lmax were not over the standard value as shown in Table 6 below.

Table 6: The Result of Ambient Noise Level around the Project Area

Stations	Distance for the Project Site (meter)	Measurement Date	Measurement Result (dB (A))	
			Leq-24 hr	Lmax
1. Ban Watabak (N1)	1,288	5-6/03/12	56.2	90.2
		6-7/03/12	54.8	90.2
		7-8/03/12	54.3	82.2
2. Khum Mor Din Sai Community (N2)	1,057	5-6/03/12	51.0	86.4
		6-7/03/12	49.8	77.8
		7-8/03/12	49.6	81.4
3.Tessaban 2 Community (N3)	520	5-6/03/12	52.0	81.6
		6-7/03/12	52.5	94.1
		7-8/03/12	53.0	86.1
Standard			70[1/]	115[1/]
			70[2/]	-

Source: Greener Consultant Co., Ltd., 2012.
[1]The National Noice and Vibration Standards, as specified in Notification of National Environmental Board No.24, B.E. 2547 (2004)
[2]The Noise Control Act 1972 (US.EPA)

E. Wind Speed and Wind Direction

54. Wind speed and wind direction monitoring have been conducted during 5-8 March 2012. There was 1 sampling station (refer to Figure 10) located in the northeast of the project area. Cup Anemometer and Wind Vane were applied to measure wind speed and wind direction. The results illustrated that major wind direction comes from west with a wind speed ranging from 6 to 11 km/hr. It is the light air which equals to 19.44% of wind speed during the conducting period. From the result, the wind speed around the project area is suitable for wind power plant project as shown in Table 7 below.

Table 7: Measurement of Wind Speed and Direction around North-East of the Project During 5-8 March 2012

Direction	Wind Speed (Percentage)	
	Light Air (1-5 km/hr)	Light Breeze (6-11 km/hr)
N	1.389	1.389
NNE	-	-
NE	-	-
ENE	-	-
E	-	-
ESE	-	-
SE	-	-
SSE	-	-
S	6.944	2.778
SSW	-	-
SW	11.111	13.889
WSW	-	-
W	18.056	19.444
WNW	-	1.389
NW	4.167	9.772
NNW	-	-
Total	**41.667**	**48.611**
Calm (<1 Km/Hr)	**0.000**	**0.000**

Source: Greener Consultant Co., Ltd, 2012.

F. Surface Water Quality

55. The sampling and testing of surface water was conducted during 8 March 2012. The sampling and methodology followed Standard Methods for the Examination of Water and Wastewater, AWWA, APHA Ed. st, . Ang Keb Nam 2 Moo 1 has been identified as the sampling location (refer to Figure 10). The parameters comprised of pH, conductivity, temperature, turbidity, TDS, BOD, COD, grease and oil. The results showed that all values were less than the standard value as shown in Table 8).

Table 8: The Measurement Result of Surface Water Quality around the Study Area

Parameter	Unit	Ang Keb Nam 2 Moo 1	Standard[1/]
pH	-	7.5	5.0-9.0
Temperature	0C	29.0	T[2/]
Turbidity	NTU	1.4	-
Conductivity	us/cm	291.0	-
TSS	mg/l	3.0	-
TDS	mg/l	136.0	-
BOD5	mg/l	1.0	< 2.0
COD	mg/l	37.0	-
Grease & Oil	mg/l	<2	-

Source: Greener Consultant Co., Ltd., 2012.
[1/]Surface Water within Type III Standard, as specified in Notification of the National Environment Board No.8, B.E.2537 (1994)
[2/]T = Water temperature is not over 3 degree celsius

G. Biological Environment

56. Land utilization of the project area is agricultural areas including cassava plantation, teak plantation, mango orchard, and rubber plantation. The project area is not located in or near a sensitive ecosystem. An ecological survey of the project area confirmed that there are not significant flora and fauna. Methodology of the biological resources survey was conducted from 27 February – 2 March 2012. The consultant company applied quadrant plot to survey horizontal and vertical characteristics by purpose sampling. Survey results showed that there are 102 tree species (shown in Appendix I) that are commonly found in the project area and are not endangered. If these tree species will be removed or cut during the construction,TPW will ask for permission from the landowners. Moreover, wildlife animals including birds, mammals, reptiles, and amphibian were found in the project area and no endangered or vulnerable animals were found.

57. The project area is not an officially declared protected, watershed, forest area. The site does not provide habitat to any terrestrial or avian faunal species, not it is located along the route of migratory birds. The nearest national park, Pa Hin Ngam, is about 20 km away from the project site.

H. Socioeconomic Environment

58. Watabak Subdistrict is within a 3 km radius of the project site. Watabak Subdistrict has 22 villages with a total population of 12,881 living in 3.688 households (District Office, 2011). There is no household within the 500 m radius from the nearest turbine. The predominant land utilization of the project site is agriculture. Most of households rely on agriculture as their main source of income. And the project is far from airport, television and telecom network. Therefore, it is expected that the project will not have electromagnetic interference.

59. For local people health, there is a public health station of Watabak Subdistrict which they can get the medicines and remedy without payment. Moreover, there are highways no. 205 and no. 2354 which is route for local transportation. For local utility supply, there are local government sectors such as PEA (supply electricity) and Provincial Waterworks Authority (supply water utility) and etc.

60. There are no important historical and cultural sites within the project area. There are no records of archaeological findings.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

61. This chapter assesses the potential impacts of the proposed project on the physical and biological environment of the project area. Also provided in the Chapter is the significance of potential impacts, the recommended mitigation measures to minimize, if not eliminate, the potentially adverse impacts and the residual impacts.

A. Construction Phase Impacts

62. Impacts during the construction are likely to be limited within the project site and short term such as the following:

63. **Air Emission.** The most significant change to air emissions resulting from the activity is likely to be an increase in air pollution from construction phase vehicle movements and disturbance of soil during road and foundation construction. In the dust volume assessment (Box Model), the result revealed that dust volume in the air is maximum 11.19 µg/m^3 which is less than the standard value (330 µ/m^3). The project has prepared mitigation measures and the expected impact should be low.

64. **Noise Emission.** During the construction period, the Project prohibits loud noise generating construction activities to be operated during the period of 19.00-07.00. The noise impact assessment is then carried out only during the daytime period (07.00-19.00) by identifying loud noise generating activities during the construction period to be machinery operation. Projected calculation of the noise level measurement covering the 3 sensitive areas has indicated that noise level will be between 52.7 and 56.2 dB(A) values are still within the standard limit of not exceeding 70 dB(A) which follows Ambient Noise Standard according to Notification of Environmental Board No. 15 (B.E. 2540, 1997) which is shown in Table 9.

Table 9: General Noise Level during Construction Period

Stations	Distance for the Project Site (meter)	Noise Level Around the Project Area During Construction	Existing Noise Level[1/]	General Noise Level After the Project Development[2/]
Ban Watabak (N1)	1288	46.1	56.2	56.6
Khum Mor Din Sai Community (N2)	1057	47.8	51.0	52.7
Tessaban 2 Community (3)	520	54.0	52.5	56.3
Standard[3/]				70.0

Remarks: [1/]Noise Measurement done from 5-8 March 2012; [2/]Noise Level from Construction activities and Existing Noise Level of Sensitive Receptors; [3/]Notification of National Environment Board No. 15 (B.E. 2540).
Source: Greener Consultant Co., Ltd., 2012

65. Moreover, results of nuisance noise level measurement met the noise and vibration standards of Notification of Environmental Board No.15 B.E. 2540 (1997) as shown in Table 10. Moreover, the project has determined to stop nuisance activities from 7.00 p.m. to 7.00 a.m., to have good public relations and at the same time require labourers to wear proper personal noise equipment (e.g. ear plug, ear muff) to reduce the impact. Therefore, the impacts could be accepted.

Table 10: Result of Nuisance Noise Level During Construction Period

Sensitive Receptors	Specific Noise Level during Construction Period	
	Day TIme (6:00-22:00)[1/]	Night Time (22:00-6:00)
1. Ban Watabak (N1)	2.1-8.8	No Activities
2. Khum Mor Din Sai Community (N2)	0.2-9.7	No Activities
3. Tessaban 2 Community (N3)	5.0-9.4	No Activities
Standard[2/]	**10**	

Remarks: [1/]Construction activities during 07:00-09:00; [2/]Notification of Pollution Control Committee regarding measurement method for background noise level (B.E. 2550).
Source: Greener Consultant Co., Ltd., 2012.

66. **Wastewater Management.** The project has methods to manage wastewater through construction of temporary water drainage system along the same line with permanent water drainage system for rainfall drainage. Moreover, the project will provide portable toilets for labourers to avoid the release of sewage within the study area. Therefore, the impacts on surface water and groundwater are considered unlikely to cause environmental nuisance.

67. **Land Utilization.** The project uses small area only and the area is not in the city planning specified by Department of Public Works and Town & Country Planning. Therefore, impact on land utilization should be low.

68. **Traffic Management.** For traffic assessment of Highways no. 205 and no. 2354, the results illustrated that the traffic conditions low vehicle and pedestrian movement. TPW required the contractor to train all drivers to limit velocity/speed and weight of vehicles during delivery of equipment at site. Therefore, the impact should be low.

69. **Water Supply.** During the construction period, water will be bought and stored in the project area for drinking water consumption. The Contractor will prepare sufficient bottled waters for labourers. Therefore, the impact on ground water utilization should be low.

70. **Power Supply.** The project will purchase electricity from PEA. Therefore, the impact on electricity use of communities should be low.

71. **Solid Waste Management.** Solid waste generated by laborers is estimated to be 200 kg/day. Rubbish bags or containers are prepared for collecting solid waste. Then, company licensed by government sector will take it to eliminate. Therefore, the impact should be low.

72. **Occupational Health and Safety.** During the construction period, the occupational health and safety plan will be prepared by the project owner to prevent accident by eliminating or reducing conditions that may cause accidents from employees, machine or work environment. Moreover, the project will monitor and control the contractor to strictly follow the

safety plan. The tender and bid document and contractor's contract documents will include clear provision to achieve this. If implemented and monitored properly, the, impact on occupational health and safety is expected to be low.

73. Below are the highlights of the Occupational health and safety of civil workers and local people. The occupational health and safety plan is established to include 3 categories such as: (i) General Occupational Health and Safety, (ii) Fire Prevention and (iii) Emergency Plan.

1. General Occupational Health and Safety

74. The Project has established its occupational health and safety measures for a contractor to follow as operating procedures that are described below.

a. Safety in Workplace

(i) Clearly identify boundary of construction area and indicate with signs showing boundary, dangers, and all prohibitions. All prohibitions will be strictly followed throughout the construction period.

(ii) Post symbol sign and warning sign in potentially danger area such as "machine substitution is in process", "danger", and hang "do not turn on switch" at switch position. Signs used must be of standard size and post in a noticeable area.

(iii) A contractor must adequately provide appropriate fire suppression system. Fire alert, fire fighting water, and extinguisher must be routinely inspected to ensure it's in good condition at all times.

(iv) A contractor must assign a safety officer as a person who is responsible for conducting safety inspection of construction activity and implementation of safety rules.

(v) A contractor must report information on occurrence of accidents within the project area and adjacent area. Information should be accompanied with evidence and documentation. Specifically, the information must be reported to the Project immediately when there is severe injury or death.

b. Personal Safety

(i) Indicate in a service contract that a contractor must clearly establish operating procedures for equipment to ensure safety during the construction period with at least must cover the law on labor such as Notification of Ministry of Interior, etc.

(ii) Post symbol sign for the laborers or workers to wear the proper personal protection equipment (PPE) within the designated construction areas.

(iii) Strictly supervise all workers of a contractor to wear personal protective equipment that is suitable for job condition such as ear muffs, ear plugs, safety helmet, safety shoes, gloves, welding mask, etc.

(iv) Organize safety training for all workers of a contractor to ensure safety during construction. The Project will specify topic and detail of the training.

(v) Arrange first-aid and primary care such as preparation of first-aid kit, first-aid personnel, and arrangement of a standby vehicle for transferring injured person to nearby hospital.

c. Safety regarding Equipment and Machinery

(i) Organize safety training for all workers of a contractor to ensure safety. The project will specify topic and detail of the training.

(ii) Check all equipment and machineries before using.

d. Safety Checking

Safety officer is responsible to check and control the construction to ensure safety. Moreover, safety officer must report information on occurrence of accidents within the project area and adjacent area and suggest the resolutions to contractor.

2. Fire Prevention

75. Portable Fire Extinguishers are installed in several appropriate areas such as control room and substation. Type and size to be installed will be in accordance with NFPA standard and check the efficiency every 3 months.

3. Emergency Plan

76. The Project has established its emergency plan to ensure that all employees realize their roles when an emergency occurs to prevent chaotic events. The plan is also promoted about safety measures for employees while being in an emergency. The emergency plan consists of the following.

(i) **Operating Procedure.** Practically, all employees must follow the plan strictly, are not allowed to take any risk, if not necessary, and try to save their lives as much as possible. In addition, all employees must participate in an emergency rehearsal by imitating several potential incidents that may occur within the Project area. Employees of maintenance and operation division must be trained on basic fire fighting procedure and put on practice regularly.

(ii) Levels of emergency can be divided into 2 following levels.

- Emergency Level 1: it is an emergency that occurs within the project and has no impact on surroundings. The designated emergency coordinator can control the situations and damages within specified area by only employing the Project's personnel and emergency tools prepared within the project.

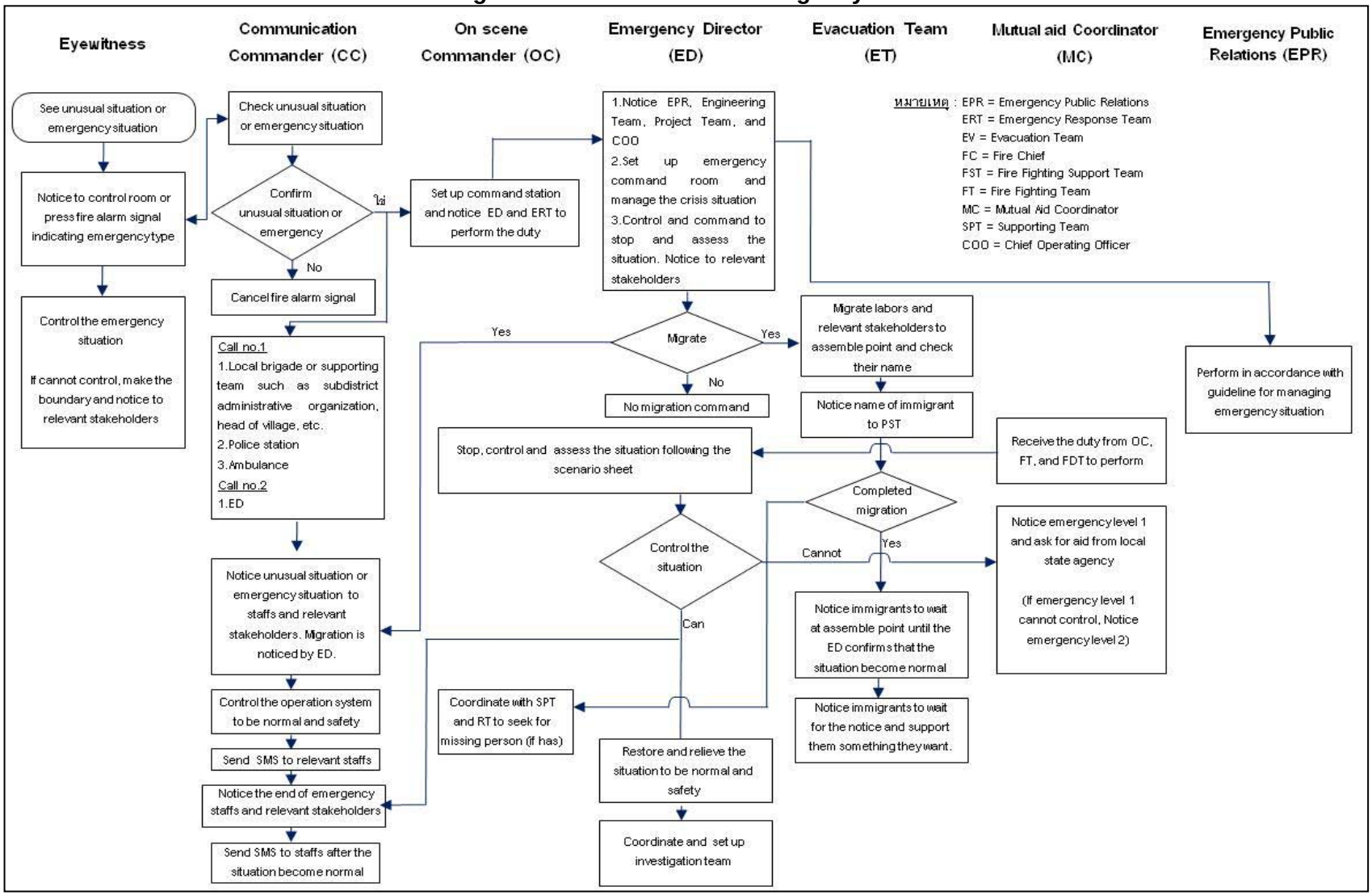
- Emergency Level 2: it is an emergency that may occur both within the project area and surroundings. The designated emergency coordinator assesses the situation and decides that emergency plan prepared for Emergency Level 1 cannot keep the situation under control and it is necessary to request for assistance from outside agencies such as Subdistrict Administrative Organization etc.

(iii) Duty and Responsibility

77. Scope of employee's duty and responsibility and procedure of in the emergency plan is shown in Figure 10.

78. As the project's adverse environmental and social impacts can be mitigated, the local communities and community leader did not oppose to the project. However, they recommended that the project should support community development and cultural activities.

Figure 10: Procedures of Emergency Plan



B. During Operation

79. Production process of the project does not have air pollution sources because there is no fuel burning. Moreover, the project will be registered under the CDM (reduce carbon dioxide in the atmosphere) program; therefore, the project has a positive impact.

80. Noise Emission. SPM9613 Model of Power Acoustics, Inc.PMB302, 12472 Lake Underhill Rd Orlando, FL was applied to predict the equivalent continuous sound level during a 24 hour period (Leq 24 hr). The model predicted four (4) case studies according to wind speed: Case 1 (5-6 m/s), Case 2 (7 m/s), Case 3 (8 m/s), and Case 4 (9 m/s). The results illustrated that all values were not over 70 dB(A) which met the Ambient Noise Standards according to Notification of Environmental Board B.E. 2540 (1997). Refer to Table 11 and Figure 11 to Figure 14.

Table 11: General Noise Level (Leq 24 hr.) during Operation Period

Sensitive Receptors	General Noise Level dB(A)								
	Existing Noise Level	The Noise Assessment Result from SPM9613				Total Noise Level			
		Case1[2/]	Case2[2/]	Case 3[2/]	Case 4[2/]	Case 1[2/]	Case 2[2/]	Case 3[2/]	Case 4[2/]
1. Ban Watabak (N1)	56.2	15.8	18.8	22.8	25.8	56.2	56.2	56.2	56.2
2. Khum Mor Din Sai Community (N2)	51.0	23.3	26.3	30.0	33.3	51.0	51.0	51.0	51.1
3. Tessaban 2 Community (N3)	52.5	31	34.0	38.0	41.0	52.5	52.6	52.7	52.8
Standard[1/]	**70**								

Remark: 1/ Notification of National Environment Board No.15 (B.E.2540)
2/ Case 1: Noise level at wind speed 5-6 m/s
Case 2: Noise level at wind speed 7 m/s
Case 3: Noise level at wind speed 8 m/s
Case 4: Noise level at wind speed 9 m/s
Source : Greener Consultant Co.,Ltd, 2012.

Figure 11: Noise Level Contour Leq 24 hr.) Case1

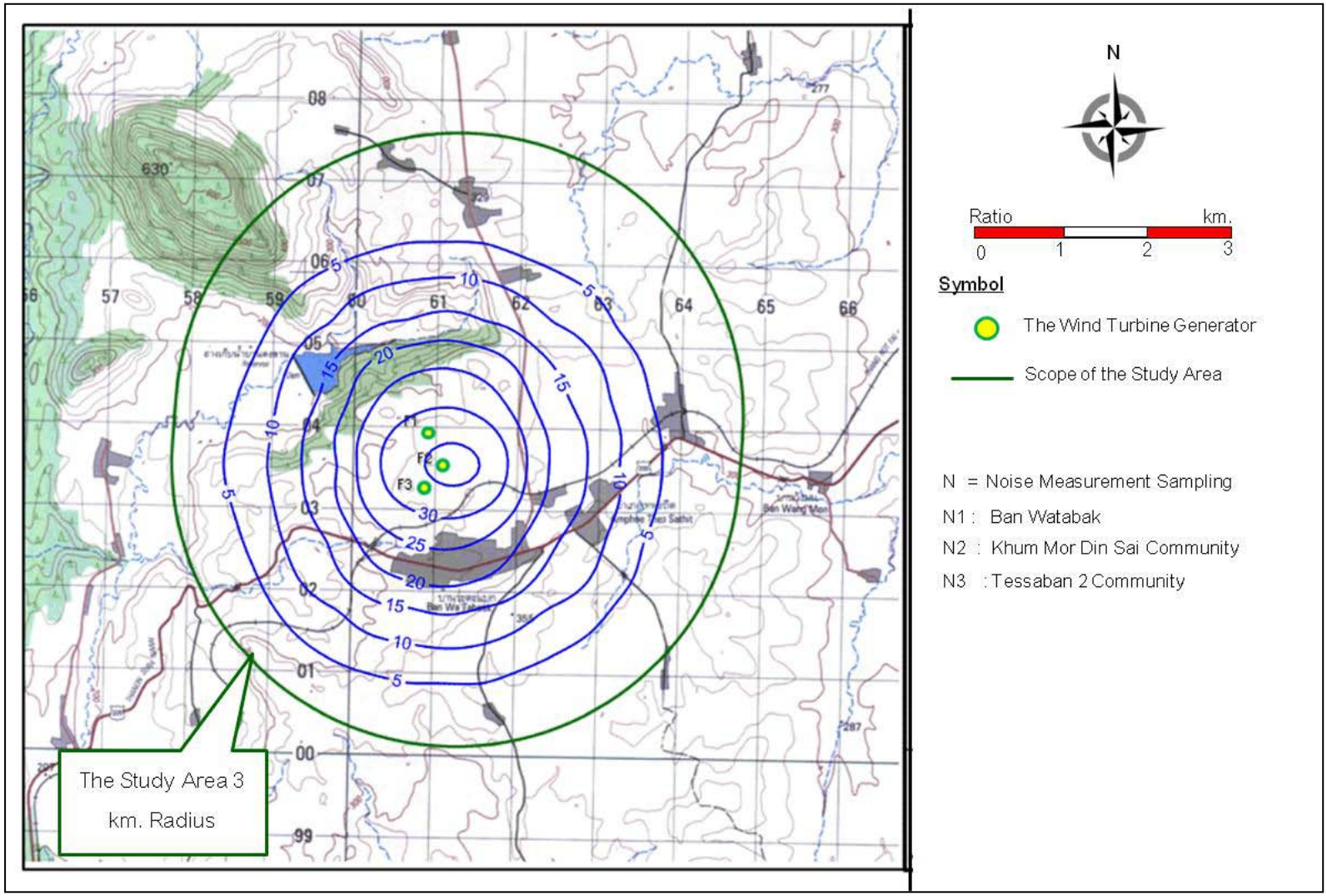


Figure 12: Noise Level Contour Leq 24 hr.) Case2

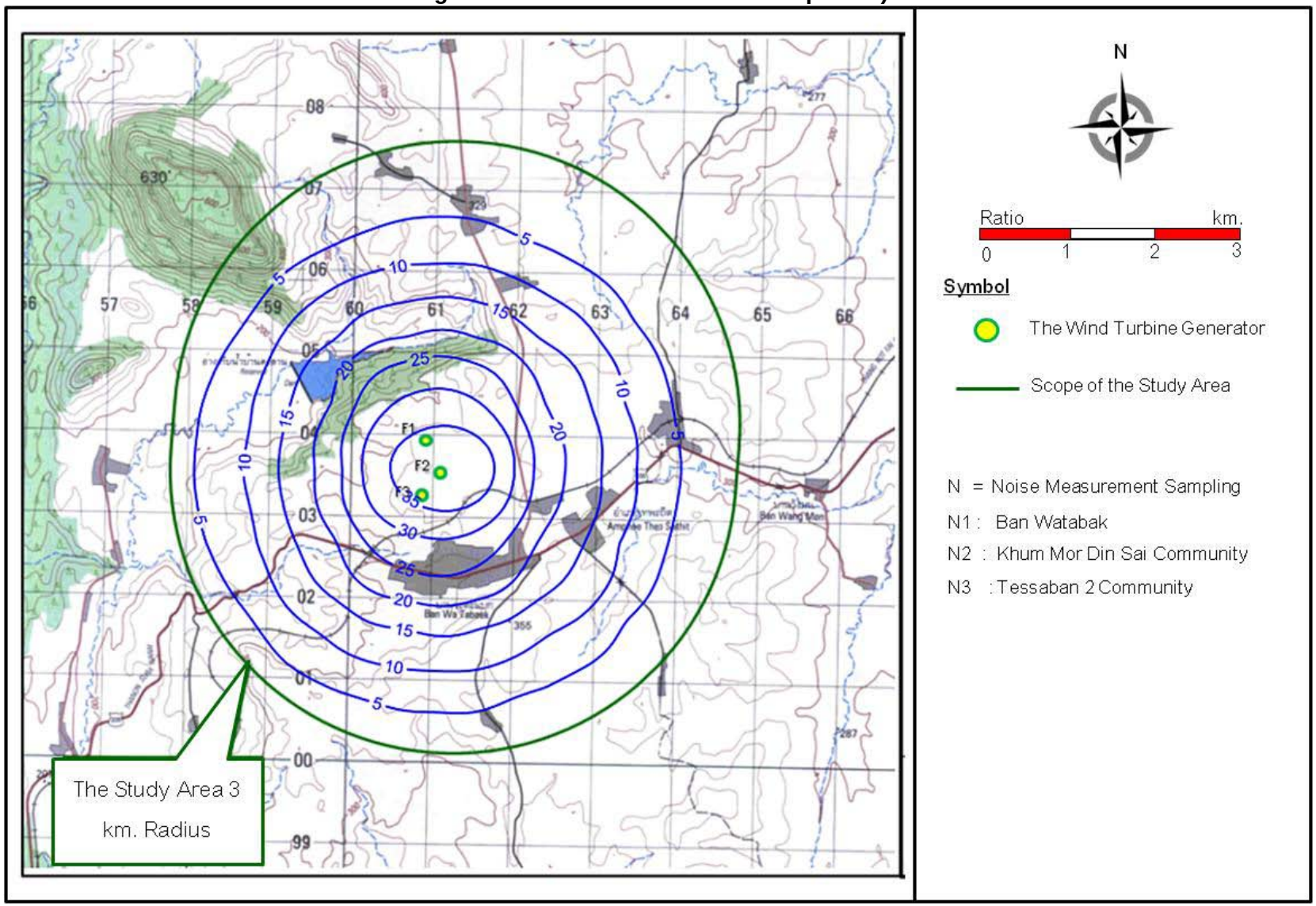


Figure 13: Noise Level Contour Leq 24 hr.) Case 3

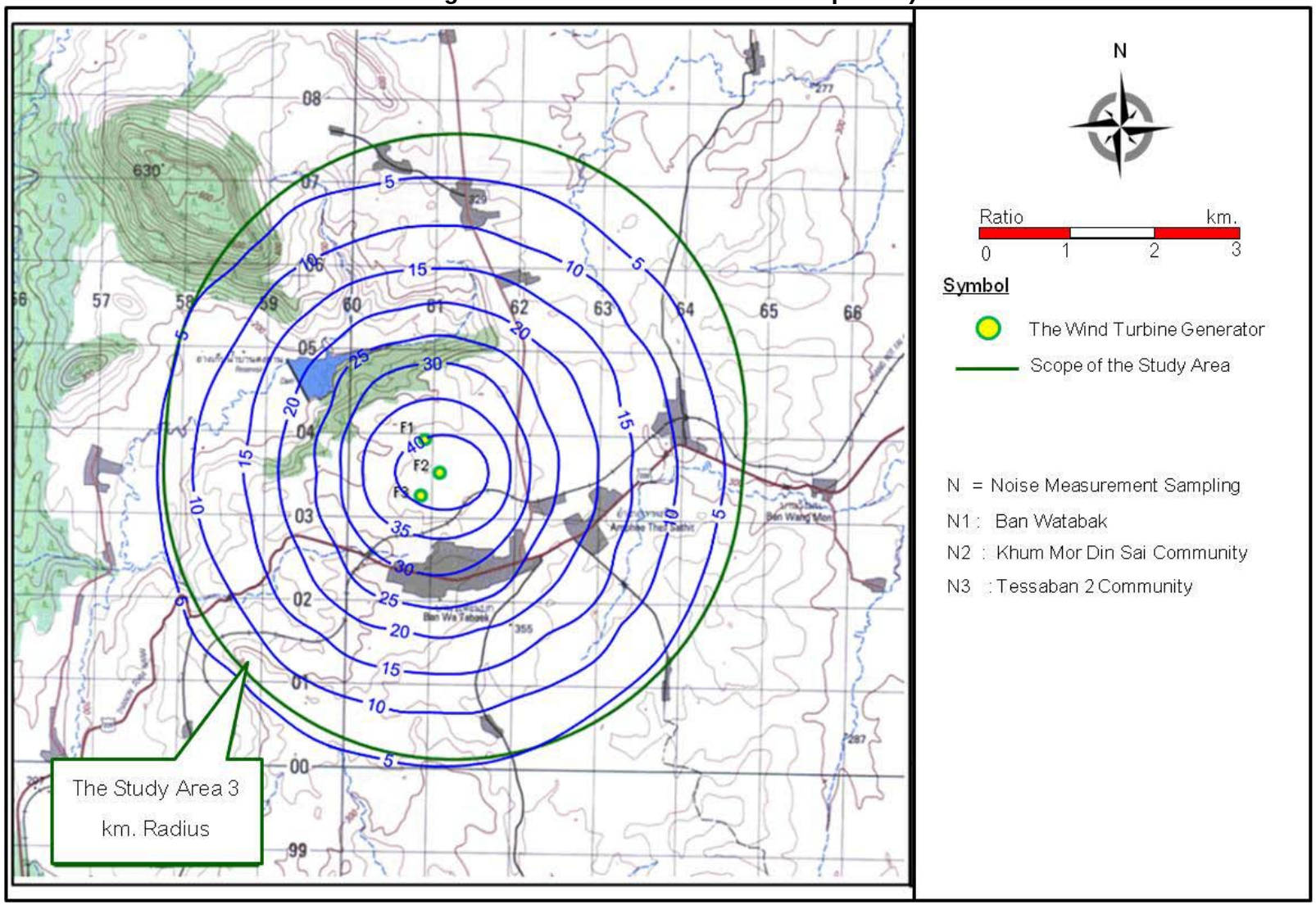
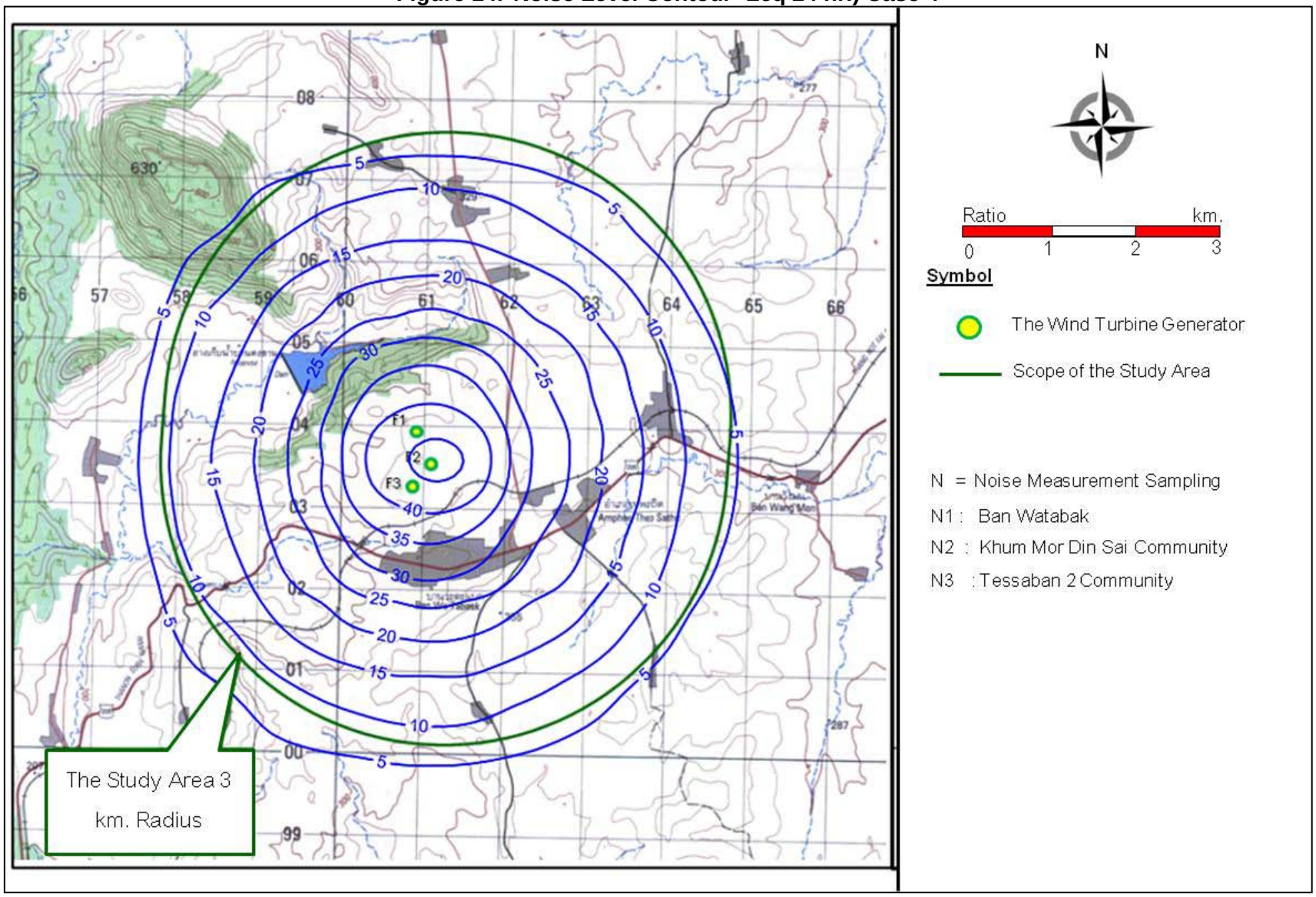


Figure 14: Noise Level Contour Leq 24 hr.) Case 4



64. For nuisance noise level measurement, the results met noise level standards of Notification of Environmental Board No.15 B.E. 2540 (1997) (refer to Table 12 and Appendix II). The project has determined to have good public relations, to prepare staffs to wear the personal noise equipments (e.g. ear plug, ear muff) and to make noise monitoring contour map to further assess possible noise impact during operation.

Table 12: Specific Noise Level During Operation Period

Sensitive Receptors	Maximum Specific Noise Level dB(A)							
	Day Time (6:00-22:00)				Night Time (22:00-6:00)			
	Case1[2/]	Case2[2/]	Case3[2/]	Case4[2/]	Case1[2/]	Case2[2/]	Case3[2/]	Case4[2/]
1. Ban Watabak (N1)	8.6	8.6	8.6	8.6	3.6	3.6	3.6	3.6
2. Khum Mor Din Sai Community (N2)	9.4	9.4	9.4	9.4	5.1	5.1	5.2	5.2
3. Tessaban 2 Community (N3)	4.6	4.6	4.7	4.7	3.2	3.3	3.6	6.2
Standard[1/]	10							

Remark: 1/ Notification of Pollution control Committee regarding measurement method for background noise level B.E.2550
2/ Case 1: Noise level at wind speed 5-6 m/s
Case 2: Noise level at wind speed 7 m/s
Case 3: Noise level at wind speed 8 m/s
Case 4: Noise level at wind speed 9 m/s
Source : Greener Consultant Co.,Ltd, 2012

81. **Waste water Management.** The project has suitable methods to manage wastewater by providing septic tanks. Moreover, TPW will buy and store raw water in the project area for consumption only. As a result, the impact on surface and groundwater should be low.

82. **Biological Resources.** The project area is an agricultural area that can still support many kinds of domestic animals that can move outside the immediate project area. Therefore, the impact on biological resources should be low.

83. **Employment Generation.** During the operation period, TPW plans to hire local people who have are experienced and qualified to fill up required positions.

84. **Landscape and Visibility.** As the project area does not have important tourist places. Moreover, the project will change the landscape from agricultural areas and vacant area to wind power plant area which can be a potential eco-tourism destination. A green area will be set up to maintain surrounding environment and build a good landscape.

85. **Shadow Flicker.** Shadow flicker means alternating changes in light intensity due to the rotating wind turbine blades case on the ground that will disturb local people living around the project area. The Planning Guidelines of Department of Environment, Heritage and Local Government of Germany recommended that shadow flicker at neighboring offices and dwellings within 500 m should not exceed 30 hours per years or 30 minutes per day.

86. WindPro Model has been applied to predict shadow flicker impact of the project. There were total 6 observation areas: 1. Community locating in the southwest of the project, 2. Tessaban 2 Community, 3. Community locating in the southeast of the project, 4. Khum Mor Din Sai Community, 5. Ban Watabak, and 6. Community locating in the northeast of the project (refer to Figure 15). The results revealed that 6 observation areas receive shadow flicker less

than 30 hours per years as shown in Table 13 and Figure 16. The shadow flicker model results are shown in Appendix III. The proposed wind farm will only have 3 turbines and is situated far from any population so this issue does not require any special attention as there is no population setting directed directly towards the wind turbine tower.

Table 13: Shadow Flicker Result from WindPRO Model

Community	Distance from the Project site (meter)	Predicted Shadow Flicker (hours/year)	The Highest Shadow Flicker per Day (Minute)	Predicted Shadow Flicker per year (day)
1. Community locating in the southwest of the project	1,333	12:16	20	44
2. Tessaban 2 Community	533	0 (No Shadow)	0 (No Shadow)	0 (No Shadow)
3. Community locating in the southeast of the project	1,200	23:55	20	87
4. Khum Mor Din Sai Community	1,000	12:24	21	52
5. Ban Watabak	1,350	0 (No Shadow)	0 (No Shado)	0 (No Shadow)
6. Community locating in the northeast of the project	1,667	0 (No Shadow)	0 (No Shadow)	0 (No Shadow)
Standard[1/]		30	30	-

[1/]German guidelines (Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windenergianlagen (WEA-Shattenwurf-Hinweise), 2002)

Figure 15: Observation Area for Shadow Flicker Impact Assessment

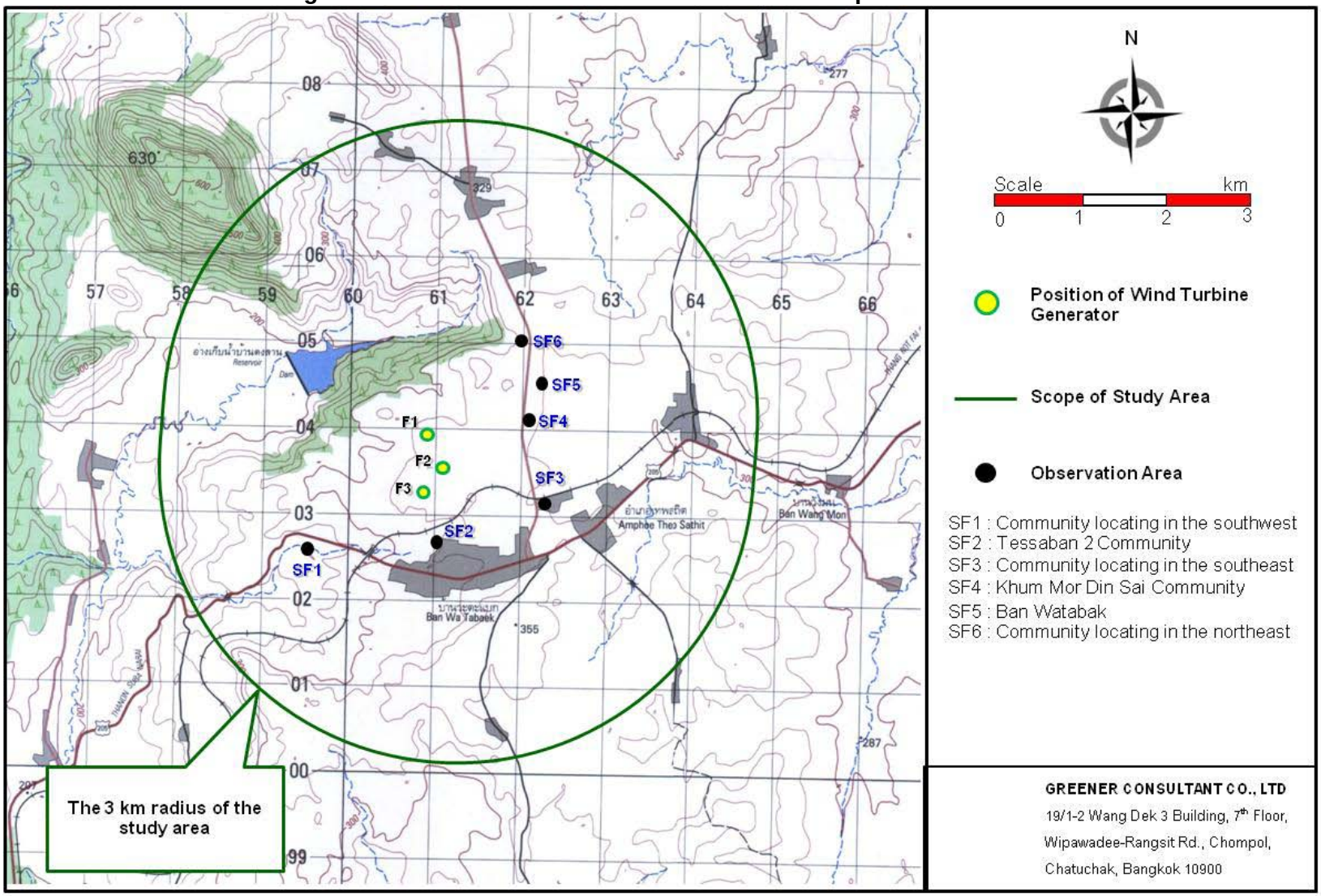
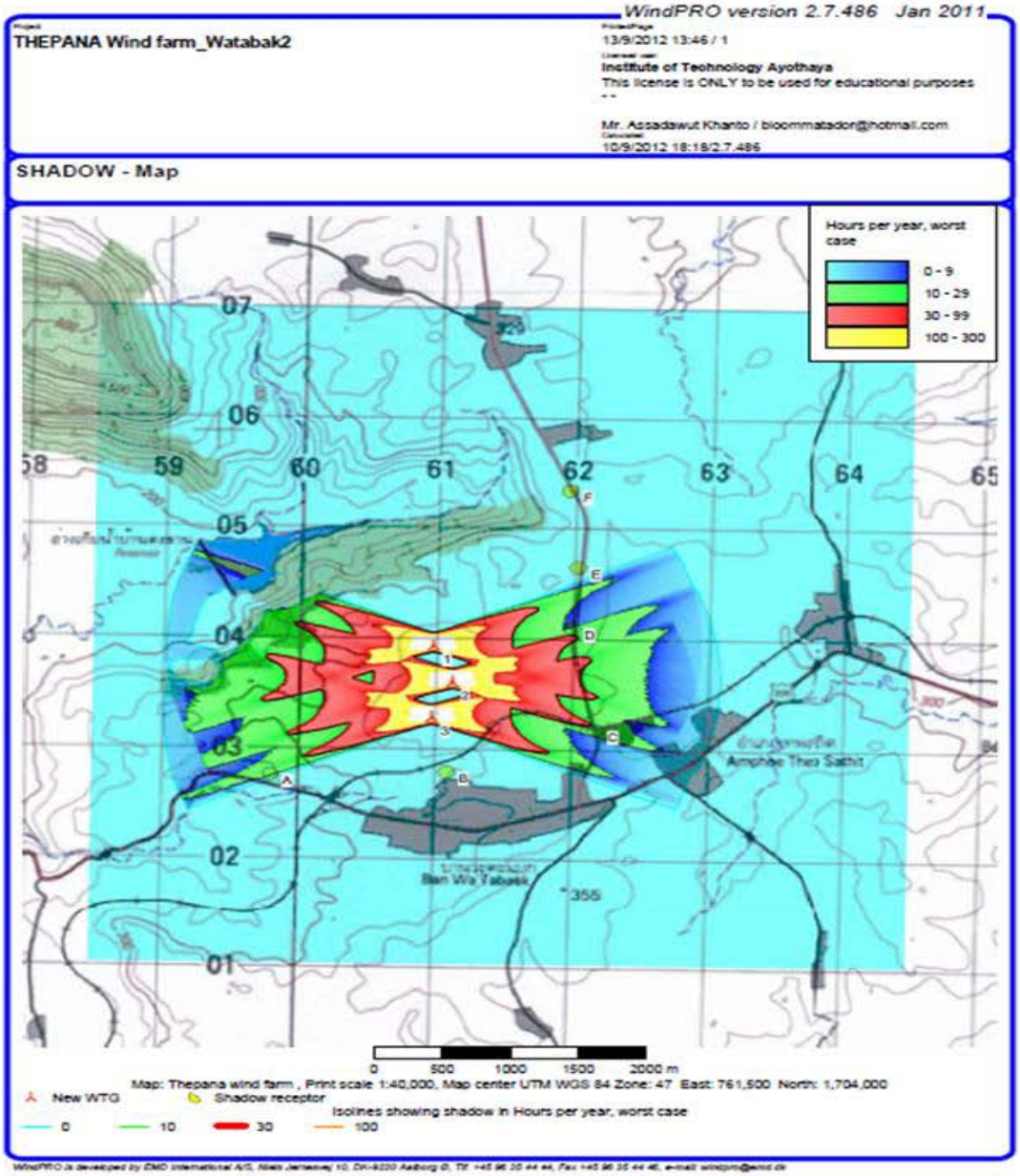


Figure 16: Shadow Flicker Simulation Map



Symbol

Wind Turbine Position

Observation Point

A : Community locating in the southwest (SF1)
B : Tessaban 2 Community (SF2)
C : Community locating in the southeast(SF3)
D : Khum Mor Din Sai Community(SF4)
E : Ban Watabak (SF5)
F : Community locating in the northeast (SF6)

VI. ANALYSIS OF ALTERNATIVES

87. The project's feasibility study reviews the technical aspects and conceptual design between Goldwind 1.5 MW and Goldwind 2.5 MW of Goldwind Science and Technology Co. Ltd. The Goldwind 2.5 MW was chosen based on the specification, wind potential of the project site, the cost and benefits.

VII. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

88. The success of any project will depend largely on the social acceptance of the community within its area of operation. In securing the support and acceptance of the community, they should be informed and involved in decision making process by seeking their views, concerns and suggestions on different project aspects that may directly or indirectly affect them.

89. A consultation meeting was organized by TPW at the Thepsathit District Office last 16 March 2012 (9:00am to 12:00 noon) to: (a) present information about the project and the result of initial environmental assessment to the community residing near the project area to ensure understanding and awareness, (b) to seek the view and comments of the community about the project and its potential impact, (c) to build a good relationship between the sponsor and the community by providing a venue where project and issues related to it can be discussed, and (d) to gather comments and suggestions from the public which can serve as basis in formulating mitigation Gas Management measures. The proceedings will also serve as basis in preparing a report for submission to Thailand Greenhouse Organization (Public Organization) (TGO).

A. Information Disclosure

90. The project sponsor prepared presentation materials to inform the community and stakeholders of the following: (a) project description, (b) results of initial environmental assessment including sampling points for determination of environmental quality regarding air, water, and noise level, (c) global warning effect and carbon credits, (d) details of project's implementation, (e) wind power production process, (f) project's implementation schedule, (g) environmental management and mitigation measures, and (h) project's benefit. Contact information of TPW staff was also provided to the participants in case there are questions and complaints from the public.

91. The public consultation was attended by 101 people[3] (refer to Figure 17) and the information provided led to the following opinions towards the project, including concerns/suggestions:

[3] The following attended the public consultation: community leaders and members, government officials and representatives – Thepsathit District, Watabaek Sub-district, Local Environment Office, local energy group representative, representative from local agriculture group, school teachers,and monks.

Table 14: Highlights of Public Consultation

Issues Raised/Comments	Response from the Project Sponsor
How the project will affect the people in terms of land acquisition? If rental fee will be paid by Project Company to ALRO and affected farmer beneficiaries	It was confirmed by the project sponsor that the project will need to occupy an ALRO land and 18 farmer beneficiaries utilizing the area for cassava production will be affected. The participants were informed of the lease agreement entered into by Project Company and ALRO, as well as consent given by the affected farmer beneficiaries. Based on Lease Agreement, an annual fee will be paid by Project Company to ALRO and affected farmer beneficiaries
Benefits that the community can gain from the project	Aside from having a clean energy source, the participants were informed of potential employment opportunities for local community members during project construction. Small development activities/projects will also be implemented by the project sponsor
Impact of the project in terms of land utilization near the project site. Is it true that planting of timber around the project site will be prohibited	It was confirmed with the community that there is no restriction on utilization of land near the project area for as long as crops/trees that will be planted will not exceed 5 meter height The project site and the area near it are utilized for cassava production and there are no timbers grown in the area. The farmers can still plant cassava but as mentioned before, planting of trees above 5 meters near the site will not be allowed.
If shadow flicker impact study was done for the project	The project sponsor confirmed the conduct of study and informed the participants that there is no anticipated negative impact on the nearby residences
Impact of project to traditional life and animals and mitigation measures	The participants were informed that there is no anticipated negative impact on traditional life and animals
Project sponsor's preparation for equipments that will be used for the project	The Construction Plan was presented to the participants which include preparatory activities
Impact to the residents near the turbine and proposed management of impact	The nearest community to the turbine is more than 500 meters away and impact in terms of noise is not expected
If the project can lead to drying within	The project sponsor that those impacts are

Issues Raised/Comments	Response from the Project Sponsor
impact area, incidence of dust dispersion, damage to agricultural products	not anticipated to be caused by the project
The project should facilitate site visit for local people Project Company to convert a portion of project site as public park for local people	After construction, the community members and visitors may visit the project site. They just need to coordinate with the Community Relations officer or responsible Project Company staff in the site This is not possible but people can visit the project site
The project sponsor should update the local people about the project	An information board will be made available in the project office so that people can be updated on project status

Figure 17: Public Consultation Meeting on 16 March 2012 at Thepsathit District, Chaiyaphum

B. Conduct of Survey and Results

92. A perception survey was conducted by the project sponsor to be able to know what people think about the project and gauge project acceptability. Fifty four (54) local residents were interviewed and results are as follows:

93. **Perceived Impact of the Project.** Majority of the respondents think that noise will not be an issue and that the project will not negatively affect soil quality in the area. Majority of the respondents are not expecting the following negative impacts to be caused by the project: negative impact on biodiversity, wastewater, poor public health and bad odor within the project area.

94. **Anticipated Benefits from the Project.** When asked what the expected benefits are, majority of the respondents gave the following answers: alleviation of global warming (97%), stable and clean energy source (68%), and assistance to poor children (64%), employment opportunity during construction (61%).

95. Ninety three percent (93%) of the respondents find the project acceptable and appreciated the public consultation that was conducted in the Thepsathit Office. 54% of the respondents prefer project updates/information be sent through community leaders while 44% prefer that a community relations officer be hired and be responsible in information dissemination on project matters. 76% of the respondents expect the project sponsor to support local environment activities.

VIII. GRIEVANCE REDRESS MECHANISM

96. A Grievance Redress Mechanism (GRM) has been devised to provide a venue to discuss issues through conflict resolution and address issues adequately. During project construction and operation, a community relations (CR) officer who will be posted at the site office will be responsible in receiving and handling complaints or query regarding the project.

97. **Management of Complaints or Query.** A community member can approach the CR officer anytime for complaints or query. A formal complaint (letter) can also be sent (a complaints box will also be provided in the CR office) to the CR officer or the Plant Manager for timely appropriate action. Any complaint filed will be immediately handled and targeted to be settled by the CR officer within 5 working days. The CR officer will be reporting regularly to the Plant Manager to ensure that all issues are handled adequately and matters requiring management decision can reach TPW the soonest possible time.

98. The CR officer will be maintaining a Record Book to keep track of the following: (a) date of the complaint, (b) details about the complainant (name and contact information), (c) description of grievance, (d) actions taken, (e) follow up requirements, and (f) the target date for the implementation of the mitigation measures, if there are any. The record book will include a narrative on the actual measures/process undertaken to handle or mitigate these concerns.

99. An Information Board visible to the community will also be made available to update the community of the ongoing project activities.

IX. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

100. This chapter outlines the environmental and social management plan (ESMP) and defines the institutional arrangements required for the implementation of the plan. This ESMP also presents the environmental monitoring requirements for different phases of the project. ESMP during the construction and operation period is shown from Table 14 to Table 17 and also refer to **Figure 10**.

101. **Objectives of ESMP.** This ESMP provides the delivery mechanism to address the adverse environmental and social impacts of the proposed project during its implementation, to enhance project benefits, and to introduce standards of good practices to be adopted during all project stages.

102. The primary objectives of the ESMP are to:

(i) Facilitate the implementation of the mitigation measures identified in this report;
(ii) Define the responsibilities of the project proponents, contractors, and environmental issues among them;
(iii) Define a monitoring mechanism and identify monitoring parameters in order to:
- Ensure the complete implementation of all mitigation measures;
- Ensure the effectiveness of the mitigation measures; and
- Provide a mechanism for taking timely action in the face of unanticipated environmental or social situations

103. This ESMP provides the delivery mechanism to address the adverse environmental and social impacts of the proposed project during its implementation, to enhance project benefits, and to introduce standards of good practices to be adopted during all project stages.

104. TPW will designate the Plant Manager as the Environment, Health and Safety (EHS) Officer. He will ensure that all personnel adhere to general environmental protection measures and specific mitigation measures as reflected in the ESMP are properly implemented. The Field Technical Officer will support the EHS Officer during construction and operation of the project. The Contractor will be subject to certain liabilities under the environmental laws of the country and under its contract with TPW.

105. During the operation phase of the proposed project, environmental management will become a routine function, as an integral part of the O&M activities. Goldwind will provide support to TPW within 5 years in terms of operation and maintenance of the project and its facilities.

Table 15: Environmental Impact Prevention and Mitigation Measures for Construction Period

Table 15 (Continued

Environmental Impact	Prevention and Mitigation Measures	Location	Duration
Air Quality	- Cover material with cloth or plastic to prevent the spreading of, for example, soil, dust or sand during the transportation into the project area.	- Transportation route and in the project area	- Throughout construction
	- Spray water on the construction area to reduce spreading of dust during construction.	- Within the project area	- Throughout construction
	- Limit vehicle velocity at the site of construction (less than 40 km/hr).	- Within the project area	- Throughout construction
	- Check or maintain conditions of engines/machines used for the construction by the specified time (as specified in the manual of machines).	- Engines/machines in the site of construction	- Throughout construction
	- Provide wash bays to clean wheels of vehicles before exiting the construction area.	- Vehicles in the construction area	- Throughout construction
	- Do not burn objects or rubbishes in the construction area.	- Within the project area	- Throughout construction
Noise	- Stop the construction activities causing loud noise during 7.00 p.m. -7.00 a.m.	- Within the project area	- Throughout construction
	- Provide personal noise protective equipments such as ear plug or ear muff for workers that work in the areas with high noise level.	- Within the project area	- Throughout construction
	- Check or maintain conditions of engines/machines used for	- Within the project area	- Throughout construction

Table 15 (Continued

Environmental Impact	Prevention and Mitigation Measures	Location	Duration
	the construction by the specified time (as specified in the manual of machines). - If necessary instruct contractor to install temporary noise barrier at the project area that is close to the communities before starting the construction.	- Within the project area	- Throughout construction
3. Water Quality	- Provide adequate number of sanitary toilet with bury septic tanks to match number of workers. - Instruct the contractor to construct the temporary water drainage system along the same permanent route. - Do not throw any rubbish in public canal.	- Within the project area - Within the project area - Within the project area	- Throughout construction - Throughout construction - Throughout construction
4. Transportation	- Cooperate with Department of Highways or related officer for facilitating of equipment and machines transportation. - Avoid transportation of heavy equipments and machines of wind turbine during rush hour (7.00-8.00 a.m. and 5.00-6.00 p.m.). - instruct all drivers to be strictly comply with the traffic rules and regulations. - Limit vehicle velocity at the site of construction (less than 40 km/hr). - Control overloading-weight of truck in accordance with the	- Transportation route and in the project area - Transportation route and in the project area - Within the project area - Transportation route - Within the project area	- Throughout construction - Throughout construction - Throughout construction - Throughout construction - Throughout construction

Table 15 (Continued

Environmental Impact	Prevention and Mitigation Measures	Location	Duration
	specified law to prevent damage on road surface.	- Within the project area	
	- Provide officers to facilitate and control traffic of trucks in and out of the project area.		- Throughout construction
	- Inform related government sector in the case of closing the road for transporting the heavy equipments or machines which declare local people to change and avoid the route.	- Communities around project area	- Throughout construction
	- Check or maintain conditions of engines/machines or vehicle before using for ensuring the safety of transportation.	- Engines/machines in the site of construction	
	- All drivers must have driver license.	- Transportation route and in the project area	- Throughout construction
	- Survey and adjust the transportation route by transportation engineer for ensuring the safety of transportation.	- Transportation route and in the project area	- Throughout construction
	- Create coordinating team for resolving problems in the case of accident occurred during transportation.	- Transportation route and in the project area	- Throughout construction
			- Throughout construction

Table 15 (Continued

Environmental Impact	Prevention and Mitigation Measures	Location	Duration
5. Solid Waste Management	- Provide rubbish bags or containers for solid waste from worker before organizations that are allowed by government sector take it to eliminate.	- Within the project area	- Throughout construction
	- Do not throw any rubbish in drainage pipe.	- Within the project area	- Throughout construction
	- Appoint person in charge to gather all wastes to be eliminate at the project area.	- Within the project area	- Throughout construction
		- Within the project area	- Throughout construction
	- Sort type of waste that can reuse for selling.	- Within the project area	- Throughout construction
	- Cooperate with the organizations that are allowed by government sector to take waste to eliminate.		
6. Socio-economic Condition	- Cooperate with head of communities to provide the project plan and inform local communities by letter/paper.	- Within the project area and communities around project area	- Throughout construction
	- Strictly comply with environmental policies of the project for advantages of communities around the project area.	- Within the project area and communities around project area	- Throughout construction
		- Within the project area and Communities around project area	
	- Monitor all workers of contractor to avoid problem of theft, drug, gambling by setting of regulation and penalty.	- Within the project area and communities around project area	- Throughout construction
		- Within the project area and communities around project area	
	- Promote a good relationship with related local communities	- Within the project area and	

Table 15 (Continued

Environmental Impact	Prevention and Mitigation Measures	Location	Duration
	by visiting communities and creating public relation media such as brochure of project details, newsletter, etc. for informing project progress. - Inform local communities regarding the construction plan especially the transportation through the communities for avoiding any obstacles of daily life. - Create public relation team to look after and receive petitions and troubles throughout the project construction.	communities around project area	- Throughout construction - Throughout construction - Throughout construction
Public Health	- Protect the outbreak of diseases. There are methods as follow; Provide clean water for workers consumption. Manage rubbish following sanitation. Provide adequate number of sanitary toilet to match with number of workers. - Strictly comply with the air quality, noise, rubbish management and occupational health and safety standards and/or guidelines. - Provide adequate number of first-aid-kit sectors and medical supplies including vehicles that can send patients to	- Within the project area - Within the project area - Within the project area	- Throughout construction - Throughout construction - Throughout construction

Table 15 (Continued

Environmental Impact	Prevention and Mitigation Measures	Location	Duration
	hospitals in emergency or accident case.		
Occupational Health and Safety	- Provide provisions on health and safety management in employment contract including safety protection and sanitation of workers in the project area.	- Within the project area	- Before construction
	- Comply with the regulations on the standard and administer and manage safety, occupational health and working environment such as Labor Protection Act B.E. 2541 (A.D. 1998)	- Within the project area	- Throughout construction
	- Put warning signs for safety operation particularly in restricted areas such as “Construction Area”, “Slow down”, “Helmet Area”.	- Within the project area	- Throughout construction
	- Provide security guards to patrol the area within 24 hours and to control and manage traffic of vehicles in and out of the project area.	- Within the project area	- Throughout construction
	- Train the workers regarding the correct use of equipment and machines.	- Within the project area	- Throughout construction
	- Instruct the workers to use the personal protective equipments which match to the type of work.	- Within the project area	- Throughout construction
	- Appoint person in charge to examine the safety operating procedure, condition of machines/equipments including safety working environment.	- Within the project area	- Throughout construction

Table 15 (Continued

Environmental Impact	Prevention and Mitigation Measures	Location	Duration
	- Provide adequate and suitable fire protection system and have a monitoring plan. - Train the workers regarding the safety details to ensure the safety during the construction. - Instruct the contractor to record the statistic and detail of accident that occur in the project area.	- Within the project area - Within the project area - Within the project area	- Throughout construction - Throughout construction - Throughout construction

Note The project owner is responsible to control the contractor company.

Table 16: Environmental Impact Prevention and Mitigation Measures for Operation Period[1/]

Environmental Impact	Prevention and Mitigation Measures	Location	Duration	Responsible By
1. Noise Level	- Check or maintain conditions of engines/machines by the specified time (as specified in the manual of machines) for preventing loud noise from them.	- Within the project area	- Throughout operation	- The project owner
	- Make noise contour map and use the results for creating environmental management regarding noise plan.	- Communities around project area and in the project area - Within the project area	- within 6 months (after the project start[1/] - Throughout operation	- The project owner - The project owner
	- Control vehicle velocity at the project area by putting the velocity limit sign.	- Within the project area		
	- Provide personnel noise protective equipments such as ear plug or ear muff for worker that work in the project area.		- Throughout operation	- The project owner
2. Transportation	- Instruct drivers to drive carefully and follow traffic rules strictly.	- Transportation route and in the project area	- Throughout operation - Throughout operation	- The project owner
	- Limit vehicle velocity when passing through the communities (less than 60 km/hr or less than the traffic rules).	- Transportation route and in the project area	- Throughout operation	- The project owner
	- Check or maintain internal road within the project area to ensure the safety for all seasons.	- Within the project area	- Throughout operation	
	- Install light signal on wind tower in accordance with safety regulation of building in the airway.	- Within the project area		- The project owner

Environmental Impact	Prevention and Mitigation Measures	Location	Duration	Responsible By
				- The project owner
3 Water Drainage System and Flood Protection	- Collect domestic wastewater from labors in the septic tank before discharging into public water drainage system. - Prepare permanent water drainage system to collect rainfall/runoff before discharging into public water drainage system. - Conduct regular maintenance of water drainage system.	- Within the project area - Within the project area - Within the project area	- Throughout operation. - Throughout operation - Throughout operation	- The project owner - The project owner - The project owner
4 Solid Waste Management	- Provide 3 different bins for general waste, recycle waste, and hazardous waste. - Provide suitable garbage bins with covers and easy to move before send off to disposal by a licensed disposal services company. - Collect recycle waste to reuse or contacting the buyer companies to buy it.	- Within the project area - Within the project area - Within the project area	- Throughout operation. - Throughout operation. - Throughout operation.	- The project owner - The project owner - The project owner

Environmental Impact	Prevention and Mitigation Measures	Location	Duration	Responsible By
5 Socio-economic Condition	- Participate in local activities for a good relationship.	- Communities around project area and in the project area - Communities around the project area	- Throughout operation.	- The project owner
	- Inform the project detail and preventive measures to local people.	- Communities around and in the project area	- Throughout operation.	- The project owner
	- Prepare the complaint process to receive petitions from local communities.		- Throughout operation.	- The project owner
6 Aesthetic	- Provide a green zone in the project area at least 5% of total area.	- Within the project area	- Throughout operation.	- The project owner
7. Shadow Flicker	- Establish a grievance redress mechanism to receive and facilitate resolution of complaints (if any) from the local people about shadow flicker impacts of the project (if any).	- Communities near the project area	- throughout operation	- The project owner

Remark: [1/] For the first year of operation noise contour monitoring will be done every six months. The following years of operation, noise contour monitoring will be done once a year. However, in case there will be noise level exceeding the Thai standards. TPW will implement the necessary corrective action plan to address any compliants from local residents.

Table 17: Environmental Quality Monitoring Program for Construction Period

Measured Index	Sampling Location	Frequency	Responsibility
Air Quality - TSP (24 hr) - Wind Speed and Wind Direction (1 Sampling Location	- 3 sampling locations (shown in figure 18) o Ban Watabak A1) o Khum Mor Din Sai Community A2 o Tessaban 2 Community A3)	- Measuring every 6 months throughout construction period (to measure 3 days/time)	- The project owner
2 Noise Level - Leq-24 hr, Leq-1 hr, L_{max}, and L_{90}-5 min	- 3 sampling locations (refer to figure 18) o Ban Watabak N1) o Khum Mor Din Sai Community N2 o Tessaban 2 Community N3)	- Measuring every 6 months throughout construction period (to measure 3 days/time)	- The project owner

Table 18. Environmental Quality Monitoring Program for Operation Period

Measured Index	Sampling Location	Frequency	Responsibility
1 Noise Level - Leq-24 hr, Leq-1 hr, L_{max}, and L_{90}-5 min	- 3 sampling locations (refer to figure 18) o Ban Watabak N1) o Khum Mor Din Sai Community N2 o Tessaban 2 Community N3)	- Measuring every 6 months (to measure 3 days/time)	- The project owner
2. Shadow Flicker - Receive and facilitate resolution of complaints from communities near the project (if any) - If complaint is found valid project owner will provide necessary corrective measures.		- Throughout operation	- The project owner

X. CONCLUSION AND RECOMMENDATIONS

106. The attitude of the stakeholders is generally very positive towards the project development. From the social survey and during the public consultation most of the participants agree with the project development. During the IEE preparation detailed assessment of the physical resources, biological resources, human use value and quality of life have been given careful attention. During operation, the project has proposed mitigation measures and monitoring procedures to ensure that the project will have minimal environmental and social impacts. To promote and build strong partnership with the local community TPW will establish a Grievance Redress Mechanism that will allow local people to raise their issues, concerns or complaints during project implementation.

Appendix 1

List of Flora in the Study Area

No.	Thai Name	Scientific Name
		Albizia lebbeck
		Syzygium sp.
3.		Schleichera oleosa
4.		Careya arborea
5.		Azadirachta indica
6.		Cananga latifolia
7.		Diospyros mollis
8.		Terminalia catappa
9.		Mitragyna brononis
10		Cassia fistula
11		Ficus sp.
12		Millingtonia hortensis
13		Cassia siamea
14		Alstonia scholaris
15		Lagerstroemia speciosa
16		Lagerstroemia macrocarpa
17		Bombax anceps
18		Cratoxylum formosum
19		Markhamia stipulata
20		Spondias pinnata
21		Morinda elliptica
22		Butea monosperma
23		Ervingia malayana
24		Millettia brandisiana
25		Tamarindus indica
26		Morinda coreia
27		Orxylum indicum
28		Diospyros sp.
29		Peltophorum pterocarpum
30		Ficus religiosa
31		Delonix regia
2		Mangifera indica
3		Ceiba pentandra
34		Pithecellobium dulce
35		Acacia auriculaeformis
36		Tabebuia rosea
37		Pterocarpus indica
38		Albizia saman
39		Eucalyptus sp.
40		Sesbania grandiflora
41		Leucaena leucocephala
42		Flacourtia indica

No.	Thai Name	Scientific Name
43		Zizyphus mauritiana
44		Phyllanthus acidus
45		Bauhinia purpurea
46		Citrus aurantifolia
47		*Moringa oleifera*
48		*Annona squamosa*
49		*Bougainvillea spectabilis*
50		*Ixora sp.*
51		*Sida acuta*
52		*Calotropis gigantea*
53		*Borassus flabellifer*
54		*Cocos nucifera*
55		*Passiflora foetida*
56		Zizyphus oenoplia
57		*Paederia pilifera*
58		*Coccinia grandis*
59		Mimosa pigra
60		*Heliotropium indicum*
61		*Vernonia cinerea*
62		*Eupatorium odoratum*
63		Ageratum conyzoides
64		Gomphrena celosioides
65		Musa sapientum
66		Carica papaya
67		Crotaloria mucronata
68		Psilotrichum ferrugineum
69		Penisetum polystachyon
70		Eleusine indica
71		Chloris barbata
72		Phychelytrum repens
73		Imperata cylindrica
74		Dactyloctenium aegyptium
75		Oryza sativa
76		Capsicum frutescens
77		Zea mays
78		Sida acuta
79		Careya arborea
80		Hevea brasiliensis
81		Tectona glandis
82		Carex stramentita
83		Dalbergia cultrata

No.	Thai Name	Scientific Name
84		Bauhinia saccocalyx
85		Suregada multiflorum
86		Dalbergia oliveri
87		Xylia xylocarpa
88		Spondias pinnata
89		*Stereospermum cylindricum*
90		Lantana camara
91		*Croton oblongifolius*
92		*Ficus hispida*
93		*Hydnocarpus ilicifolius*
94		*Lepisanthes rubiginosa*
95		*Urena sinuata*
96		*Abrus precatorius*
97		*Cratoxylum cochinchinensis*
98		*Horrisonia perforata*
99		*Melinis repens*
100		Millingtonia hortensis
101		Millettia leucantha
102		Ixora coccinea

Noise Modelling Results

Table A2.1 Specific Noise Assessment Result Case 1 in Day Time (Wind Speed 5-6 m/s)

Time	Noise Level before Project Implementation(dBA)		Noise Level during Construction Period (dBA)						Noise Level during Operation Period (dBA)					
	Background Noise	Leq 1 hr[1/]	Noise Level during Construction Period (dBA)	Leq 1 hr[2/]	Differnce	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]	Noise Level during Operation Period (dBA)	Leq 1 hr[2/]	Difference	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]
06:00-07:00	42.1	55.1	46.1	55.6	0.5	7.0	48.6	6.5	15.8	55.1	0.0	7.0	48.1	6.0
07:00-08:00	45.5	57.2	46.1	57.5	0.3	7.0	50.5	5.0	15.8	57.2	0.0	7.0	50.2	4.7
08:00-09:00	45.8	56.8	46.1	57.2	0.4	7.0	50.2	4.4	15.8	56.8	0.0	7.0	49.8	4.0
09:00-10:00	45.1	57.1	46.1	57.4	0.3	7.0	50.4	5.3	15.8	57.1	0.0	7.0	50.1	5.0
10:00-11:00	44.7	60.3	46.1	60.5	0.2	7.0	53.5	8.8	15.8	60.3	0.0	7.0	53.3	8.6
11:00-12:00	45.3	53.7	46.1	54.4	0.7	7.0	47.4	2.1	15.8	53.7	0.0	7.0	46.7	1.4
12:00-13:00	43.0	53.2	46.1	54.0	0.8	7.0	47.0	4.0	15.8	53.2	0.0	7.0	46.2	3.2
13:00-14:00	42.1	53.7	46.1	54.4	0.7	7.0	47.4	5.3	15.8	53.7	0.0	7.0	46.7	4.6
14:00-15:00	41.4	51.6	46.1	52.7	1.1	7.0	45.7	4.3	15.8	51.6	0.0	7.0	44.6	3.2
15:00-16:00	42.9	55.9	46.1	56.3	0.4	7.0	49.3	6.4	15.8	55.9	0.0	7.0	48.9	6.0
16:00-17:00	43.8	53.0	46.1	53.8	0.8	7.0	46.8	3.0	15.8	53.0	0.0	7.0	46.0	2.2
17:00-18:00	42.3	53.2	46.1	54.0	0.8	7.0	47.0	4.7	15.8	53.2	0.0	7.0	46.2	3.9
18:00-19:00	48.1	56.8	46.1	57.2	0.4	7.0	50.2	2.1	15.8	56.8	0.0	7.0	49.8	1.7
19:00-20:00	57.2	58.6	No Construction Activity						15.8	58.6	0.0	7.0	51.6	-5.6
20:00-21:00	57.3	58.9	No Construction Activity						15.8	58.9	0.0	7.0	51.9	-5.4
21:00-22:00	56.7	58.1	No Construction Activity						15.8	58.1	0.0	7.0	51.1	-5.6

1/ Noise Measurement during 5-6 March 2012.
2/Calculate from Background Noise and Noise from The Project activities.
3/Noise Level after Adjustment - Background Noise.

Table A2.2 Specific Noise Assessment Result Case 1 in Night Time (Wind Speed 5-6 m/s)

Time	Noise Level before Project Implementation(dBA)		Noise Level during Construction Period (dBA)						Noise Level during Operation Period (dBA)					
	Background Noise	Leq 1 hr[1/]	Noise Level during Construction Period (dBA)	Leq 1 hr[2/]	Differnce	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]	Noise Level during Operation Period (dBA)	Leq 1 hr[2/]	Difference	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]
22:00-22:05	57.2	58.2	No Construction Activities						15.8	58.2	0.0	7.0	51.2	-6.0
22:05-22:10	57.0	58.0	No Construction Activities						15.8	58.0	0.0	7.0	51.0	-6.0
22:10-22:15	56.9	58.0	No Construction Activities						15.8	58.0	0.0	7.0	51.0	-5.9
22:15-22:20	56.5	58.0	No Construction Activities						15.8	58.0	0.0	7.0	51.0	-5.5
22:20-22:25	57.2	58.4	No Construction Activities						15.8	58.4	0.0	7.0	51.4	-5.8
22:25-22:30	56.5	57.8	No Construction Activities						15.8	57.8	0.0	7.0	50.8	-5.7
22:30-22:35	56.3	57.7	No Construction Activities						15.8	57.7	0.0	7.0	50.7	-5.6
22:35-22:40	57.3	58.4	No Construction Activities						15.8	58.4	0.0	7.0	51.4	-5.9
22:40-22:45	56.8	58.0	No Construction Activities						15.8	58.0	0.0	7.0	51.0	-5.8
22:45-22:50	56.6	57.7	No Construction Activities						15.8	57.7	0.0	7.0	50.7	-5.9
22:50-22:55	56.4	57.5	No Construction Activities						15.8	57.5	0.0	7.0	50.5	-5.9
22:55-23:00	56.2	57.6	No Construction Activities						15.8	57.6	0.0	7.0	50.6	-5.6
23:00-23:05	55.5	57.4	No Construction Activities						15.8	57.4	0.0	7.0	50.4	-5.1
23:05-23:10	55.5	56.9	No Construction Activities						15.8	56.9	0.0	7.0	49.9	-5.6
23:10-23:15	55.9	57.2	No Construction Activities						15.8	57.2	0.0	7.0	50.2	-5.7
23:15-23:20	56.0	57.6	No Construction Activities						15.8	57.6	0.0	7.0	50.6	-5.4
23:20-23:25	56.2	57.5	No Construction Activities						15.8	57.5	0.0	7.0	50.5	-5.7
23:25-23:30	55.8	57.0	No Construction Activities						15.8	57.0	0.0	7.0	50.0	-5.8
23:30-23:35	56.0	57.5	No Construction Activities						15.8	57.5	0.0	7.0	50.5	-5.5
23:35-23:40	56.2	57.7	No Construction Activities						15.8	57.7	0.0	7.0	50.7	-5.5
23:40-23:45	56.6	57.8	No Construction Activities						15.8	57.8	0.0	7.0	50.8	-5.8
23:45-23:50	56.8	57.8	No Construction Activities						15.8	57.8	0.0	7.0	50.8	-6.0
23:50-23:55	56.4	57.6	No Construction Activities						15.8	57.6	0.0	7.0	50.6	-5.8

Table A2.2 (continuation)

Time	Noise Level before Project Implementation(dBA)		Noise Level during Construction Period (dBA)						Noise Level during Operation Period (dBA)					
	Background Noise	Leq 1 hr[1/]	Noise Level during Construction Period (dBA)	Leq 1 hr[2/]	Differnce	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]	Noise Level during Operation Period (dBA)	Leq 1 hr[2/]	Difference	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]
23:55-00:00	55.8	57.1	No Construction Activities						15.8	57.1	0.0	7.0	50.1	-5.7
00:00-00:05	55.2	56.9	No Construction Activities						15.8	56.9	0.0	7.0	49.9	-5.3
00:05-00:10	56.1	57.5	No Construction Activities						15.8	57.5	0.0	7.0	50.5	-5.6
00:10-00:15	56.2	57.5	No Construction Activities						15.8	57.5	0.0	7.0	50.5	-5.7
00:15-00:20	56.0	57.2	No Construction Activities						15.8	57.2	0.0	7.0	50.2	-5.8
00:20-00:25	54.5	56.6	No Construction Activities						15.8	56.6	0.0	7.0	49.6	-4.9
00:25-00:30	55.2	57.0	No Construction Activities						15.8	57.0	0.0	7.0	50.0	-5.2
00:30-00:35	55.4	58.3	No Construction Activities						15.8	58.3	0.0	7.0	51.3	-4.1
00:35-00:40	54.9	56.2	No Construction Activities						15.8	56.2	0.0	7.0	49.2	-5.7
00:40-00:45	53.3	55.9	No Construction Activities						15.8	55.9	0.0	7.0	48.9	-4.4
00:45-00:50	53.7	55.7	No Construction Activities						15.8	55.7	0.0	7.0	48.7	-5.0
00:50-00:55	53.2	55.2	No Construction Activities						15.8	55.2	0.0	7.0	48.2	-5.0
00:55-01:00	54.3	55.7	No Construction Activities						15.8	55.7	0.0	7.0	48.7	-5.6
01:00-01:05	53.4	55.0	No Construction Activities						15.8	55.0	0.0	7.0	48.0	-5.4
01:05-01:10	54.1	55.5	No Construction Activities						15.8	55.5	0.0	7.0	48.5	-5.6
01:10-01:15	53.8	55.3	No Construction Activities						15.8	55.3	0.0	7.0	48.3	-5.5
01:15-01:20	53.8	55.2	No Construction Activities						15.8	55.2	0.0	7.0	48.2	-5.6
01:20-01:25	53.3	55.0	No Construction Activities						15.8	55.0	0.0	7.0	48.0	-5.3
01:25-01:30	53.1	54.5	No Construction Activities						15.8	54.5	0.0	7.0	47.5	-5.6
01:30-01:35	53.6	55.2	No Construction Activities						15.8	55.2	0.0	7.0	48.2	-5.4
01:35-01:40	52.8	54.3	No Construction Activities						15.8	54.3	0.0	7.0	47.3	-5.5
01:40-01:45	53.1	54.8	No Construction Activities						15.8	54.8	0.0	7.0	47.8	-5.3
01:45-01:50	54.1	55.3	No Construction Activities						15.8	55.3	0.0	7.0	48.3	-5.8
01:50-01:55	53.1	54.9	No Construction Activities						15.8	54.9	0.0	7.0	47.9	-5.2
01:55-02:00	51.7	53.9	No Construction Activities						15.8	53.9	0.0	7.0	46.9	-4.8

Table A2.2 (continuation)

Time	Noise Level before Project Implementation(dBA)		Noise Level during Construction Period (dBA)						Noise Level during Operation Period (dBA)					
	Background Noise	Leq 1 hr[1/]	Noise Level during Construction Period (dBA)	Leq 1 hr[2/]	Differnce	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]	Noise Level during Operation Period (dBA)	Leq 1 hr[2/]	Difference	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]
04:05-04:10	49.2	52.1	No Construction Activities						15.8	52.1	0.0	7.0	45.1	-4.1
04:10-04:15	49.1	53.8	No Construction Activities						15.8	53.8	0.0	7.0	46.8	-2.3
04:15-04:20	48.9	52.0	No Construction Activities						15.8	52.0	0.0	7.0	45.0	-3.9
04:20-04:25	48.6	51.8	No Construction Activities						15.8	51.8	0.0	7.0	44.8	-3.8
04:25-04:30	49.8	52.6	No Construction Activities						15.8	52.6	0.0	7.0	45.6	-4.2
04:30-04:35	48.8	52.6	No Construction Activities						15.8	52.6	0.0	7.0	45.6	-3.2
04:35-04:40	46.7	52.2	No Construction Activities						15.8	52.2	0.0	7.0	45.2	-1.5
04:40-04:45	45.9	49.7	No Construction Activities						15.8	49.7	0.0	7.0	42.7	-3.2
04:45-04:50	44.7	49.7	No Construction Activities						15.8	49.7	0.0	7.0	42.7	-2.0
04:50-04:55	44.6	51.2	No Construction Activities						15.8	51.2	0.0	7.0	44.2	-0.4
04:55-05:00	45.5	50.0	No Construction Activities						15.8	50.0	0.0	7.0	43.0	-2.5
05:00-05:05	44.1	49.6	No Construction Activities						15.8	49.6	0.0	7.0	42.6	-1.5
05:05-05:10	40.1	49.2	No Construction Activities						15.8	49.2	0.0	7.0	42.2	2.1
05:10-05:15	39.1	44.2	No Construction Activities						15.8	44.2	0.0	7.0	37.2	-1.9
05:15-05:20	39.7	49.1	No Construction Activities						15.8	49.1	0.0	7.0	42.1	2.4
05:20-05:25	39.6	50.2	No Construction Activities						15.8	50.2	0.0	7.0	43.2	3.6
05:25-05:30	40.2	47.1	No Construction Activities						15.8	47.1	0.0	7.0	40.1	-0.1

Table A2.2 (continuation)

Time	Noise Level before Project Implementation(dBA)		Noise Level during Construction Period (dBA)						Noise Level during Operation Period (dBA)					
	Background Noise	Leq 1 hr[1/]	Noise Level during Construction Period (dBA)	Leq 1 hr[2/]	Differnce	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]	Noise Level during Operation Period (dBA)	Leq 1 hr[2/]	Difference	Adjustment Value	Noise Level after Adjustment	Specific Noise Level[3/]
05:30-05:35	40.0	48.0	No Construction Activities						15.8	48.0	0.0	7.0	41.0	1.0
05:35-05:40	39.2	44.2	No Construction Activities						15.8	44.2	0.0	7.0	37.2	-2.0
05:40-05:45	40.1	50.3	No Construction Activities						15.8	50.3	0.0	7.0	43.3	3.2
05:45-05:50	40.8	51.2	No Construction Activities						15.8	51.2	0.0	7.0	44.2	3.4
05:50-05:55	41.8	51.4	No Construction Activities						15.8	51.4	0.0	7.0	44.4	2.6
05:55-06:00	41.5	51.7	No Construction Activities						15.8	51.7	0.0	7.0	44.7	3.2

1/Noise Measurement during 5-6 March 2012
2/ /Calculate from Background Noise and Noise from The Project activities.
3/ Noise Level after Adjustment - Background Noise

“Shadow Flicker” Model

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:43 / 1

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com

Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Main Result

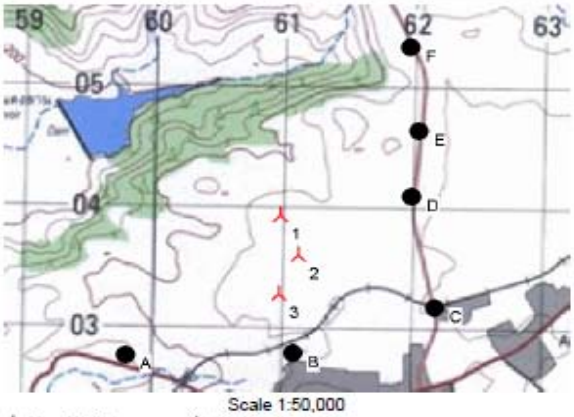
Assumptions for shadow calculations

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: Height Contours: Theppana.wpo (1)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10 m



Scale 1:50,000
New WTG
Shadow receptor

WTGs

	UTM WGS84 Zone: 47 East	North	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
	UTM WGS84 Zone: 47		[m]					[kW]	[m]	[m]	[m]	[RPM]
1	760,996	1,703,915	330.0	Goldwind GW 2.5/10...	Yes	Goldwind	GW 2.5/109-2,500	2,500	109.0	90.0	1,974	14.5
2	761,138	1,703,588	330.0	Goldwind GW 2.5/10...	Yes	Goldwind	GW 2.5/109-2,500	2,500	109.0	90.0	1,974	14.5
3	760,991	1,703,261	329.8	Goldwind GW 2.5/10...	Yes	Goldwind	GW 2.5/109-2,500	2,500	109.0	90.0	1,974	14.5

Shadow receptor-Input

No.	Name	UTM WGS84 Zone: 47 East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	Community on SW of Project	759,810	1,702,732	281.2	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
B	THESABAN 2 Community	761,108	1,702,765	320.0	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
C	Community on SE of project	762,201	1,703,156	320.0	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
D	Kum Mo Din Sai Community	762,010	1,704,083	330.0	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
E	Ban Watabak near E2	762,055	1,704,631	333.8	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
F	Community on NE of Project	761,985	1,705,326	327.0	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	Community on SW of Project	12:16	44	0:20
B	THESABAN 2 Community	0:00	0	0:00
C	Community on SE of project	23:55	87	0:20
D	Kum Mo Din Sai Community	12:24	52	0:21
E	Ban Watabak near E2	0:00	0	0:00
F	Community on NE of Project	0:00	0	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)	8:52	
2	Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)	20:56	

To be continued on next page...

SHADOW - Main Result

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
3	Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)	18:47	

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 1

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar

Shadow receptor: A - Community on SW of Project

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	January	February	Maroh	April	May	June	July	August	September	October	November	Decemher
1	06:41	06:44	06:32	06:10	05:51	05:43	06:05 (3)	05:48	06:07 (3)	05:57	06:02	06:05	06:11	06:25
	17:55	18:12	18:22	18:27	18:32	18:42	10 06:15 (3)	18:49	19 06:26 (3)	18:46	18:28	18:05	17:46	17:42
2	06:42	06:44	06:32	06:10	05:51	05:43	06:05 (3)	05:48	06:07 (3)	05:57	06:02	06:05	06:11	06:26
	17:56	18:13	18:22	18:27	18:33	18:42	11 06:16 (3)	18:49	19 06:26 (3)	18:45	18:27	18:04	17:46	17:42
3	06:42	06:44	06:31	06:09	05:50	05:43	06:04 (3)	05:48	06:07 (3)	05:57	06:02	06:05	06:12	06:26
	17:56	18:13	18:23	18:27	18:33	18:42	13 06:17 (3)	18:50	18 06:25 (3)	18:45	18:27	18:03	17:45	17:43
4	06:42	06:44	06:30	06:08	05:50	05:43	06:04 (3)	05:49	06:08 (3)	05:58	06:02	06:05	06:12	06:27
	17:57	18:14	18:23	18:28	18:33	18:43	14 06:18 (3)	18:50	18 06:26 (3)	18:44	18:26	18:03	17:45	17:43
5	06:43	06:43	06:30	06:08	05:50	05:43	06:03 (3)	05:49	06:09 (3)	05:58	06:03	06:05	06:13	06:28
	17:57	18:14	18:23	18:28	18:33	18:43	15 06:18 (3)	18:50	17 06:26 (3)	18:44	18:25	18:02	17:45	17:43
6	06:43	06:43	06:29	06:07	05:49	05:43	06:03 (3)	05:49	06:09 (3)	05:58	06:03	06:05	06:13	06:28
	17:58	18:15	18:23	18:28	18:34	18:43	16 06:19 (3)	18:50	16 06:25 (3)	18:44	18:24	18:01	17:44	17:43
7	06:43	06:43	06:28	06:06	05:49	05:43	06:03 (3)	05:50	06:10 (3)	05:58	06:03	06:05	06:13	06:29
	17:59	18:15	18:24	18:28	18:34	18:44	16 06:19 (3)	18:50	16 06:26 (3)	18:43	18:24	18:01	17:44	17:44
8	06:44	06:42	06:28	06:05	05:48	05:43	06:02 (3)	05:50	06:10 (3)	05:59	06:03	06:05	06:14	06:29
	17:59	18:16	18:24	18:28	18:34	18:44	18 06:20 (3)	18:50	15 06:25 (3)	18:43	18:23	18:00	17:44	17:44
9	06:44	06:42	06:27	06:05	05:48	05:43	06:02 (3)	05:50	06:11 (3)	05:59	06:03	06:06	06:14	06:30
	18:00	18:16	18:24	18:28	18:35	18:44	18 06:20 (3)	18:50	13 06:24 (3)	18:42	18:22	17:59	17:43	17:44
10	06:44	06:42	06:26	06:04	05:48	05:44	06:03 (3)	05:51	06:12 (3)	05:59	06:03	06:06	06:15	06:30
	18:00	18:16	18:24	18:28	18:35	18:45	19 06:22 (3)	18:50	13 06:25 (3)	18:42	18:21	17:58	17:43	17:44
11	06:44	06:41	06:26	06:03	05:47	05:44	06:03 (3)	05:51	06:13 (3)	05:59	06:03	06:06	06:15	06:31
	18:01	18:17	18:24	18:29	18:35	18:45	19 06:22 (3)	18:50	11 06:24 (3)	18:41	18:20	17:58	17:43	17:45
12	06:45	06:41	06:25	06:03	05:47	05:44	06:03 (3)	05:51	06:14 (3)	05:59	06:03	06:06	06:15	06:32
	18:02	18:17	18:24	18:29	18:35	18:45	19 06:22 (3)	18:50	8 06:22 (3)	18:41	18:20	17:57	17:43	17:45
13	06:45	06:41	06:24	06:02	05:47	05:44	06:03 (3)	05:51	06:16 (3)	06:00	06:03	06:06	06:16	06:32
	18:02	18:18	18:25	18:29	18:36	18:45	19 06:22 (3)	18:50	4 06:20 (3)	18:40	18:19	17:56	17:42	17:45
14	06:45	06:40	06:24	06:01	05:46	05:44	06:03 (3)	05:52		06:00	06:03	06:06	06:16	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	19 06:22 (3)	18:50		18:40	18:18	17:56	17:42	17:46
15	06:45	06:40	06:23	06:01	05:46	05:44	06:03 (3)	05:52		06:00	06:03	06:07	06:17	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	20 06:23 (3)	18:49		18:39	18:17	17:55	17:42	17:46
16	06:45	06:39	06:22	06:00	05:46	05:44	06:03 (3)	05:52		06:00	06:03	06:07	06:17	06:34
	18:04	18:19	18:25	18:29	18:37	18:46	20 06:23 (3)	18:49		18:38	18:17	17:54	17:42	17:47
17	06:45	06:39	06:21	05:59	05:45	05:45	06:04 (3)	05:53		06:00	06:03	06:07	06:18	06:34
	18:04	18:19	18:25	18:30	18:37	18:47	20 06:24 (3)	18:49		18:38	18:16	17:54	17:42	17:47
18	06:45	06:38	06:21	05:59	05:45	05:45	06:04 (3)	05:53		06:00	06:04	06:07	06:18	06:35
	18:05	18:19	18:25	18:30	18:37	18:47	20 06:24 (3)	18:49		18:37	18:15	17:53	17:42	17:48
19	06:45	06:38	06:20	05:58	05:45	05:45	06:04 (3)	05:53		06:01	06:04	06:07	06:19	06:35
	18:06	18:20	18:26	18:30	18:38	18:47	20 06:24 (3)	18:49		18:37	18:14	17:53	17:42	17:48
20	06:45	06:37	06:19	05:57	05:45	05:45	06:04 (3)	05:54		06:01	06:04	06:08	06:19	06:36
	18:06	18:20	18:26	18:30	18:38	18:47	20 06:24 (3)	18:49		18:36	18:13	17:52	17:42	17:48
21	06:45	06:37	06:18	05:57	05:44	05:45	06:04 (3)	05:54		06:01	06:04	06:08	06:20	06:36
	18:07	18:20	18:26	18:30	18:38	18:48	20 06:24 (3)	18:49		18:35	18:13	17:51	17:41	17:49
22	06:45	06:36	06:18	05:56	05:44	05:46	06:05 (3)	05:54		06:01	06:04	06:08	06:20	06:37
	18:07	18:20	18:26	18:30	18:38	18:48	20 06:25 (3)	18:48		18:35	18:12	17:51	17:41	17:49
23	06:45	06:36	06:17	05:56	05:44	05:46	06:05 (3)	05:54		06:01	06:04	06:08	06:21	06:37
	18:08	18:21	18:26	18:31	18:39	18:48	20 06:25 (3)	18:48		18:34	18:11	17:50	17:41	17:50
24	06:45	06:35	06:16	05:55	05:44	05:46	06:05 (3)	05:55		06:01	06:04	06:09	06:21	06:38
	18:08	18:21	18:26	18:31	18:39	18:48	20 06:25 (3)	18:48		18:34	18:10	17:50	17:41	17:50
25	06:45	06:35	06:16	05:55	05:44	05:46	06:05 (3)	05:55		06:01	06:04	06:09	06:22	06:38
	18:09	18:21	18:26	18:31	18:39	18:48	20 06:25 (3)	18:48		18:33	18:10	17:49	17:42	17:51
26	06:45	06:34	06:15	05:54	05:44	05:46	06:06 (3)	05:55		06:02	06:04	06:09	06:23	06:39
	18:09	18:22	18:26	18:31	18:40	18:49	20 06:26 (3)	18:47		18:32	18:09	17:49	17:42	17:51
27	06:45	06:33	06:14	05:53	05:44	05:47	06:06 (3)	05:56		06:02	06:04	06:10	06:23	06:39
	18:10	18:22	18:27	18:32	18:40	18:49	20 06:26 (3)	18:47		18:32	18:08	17:48	17:42	17:52
28	06:45	06:33	06:13	05:53	05:43	05:47	06:06 (3)	05:56		06:02	06:04	06:10	06:24	06:40
	18:10	18:22	18:27	18:32	18:40	18:49	19 06:25 (3)	18:47		18:31	18:07	17:48	17:42	17:53
29	06:45		06:13	05:52	05:43	05:47	06:06 (3)	05:56		06:02	06:04	06:10	06:24	06:40
	18:11		18:27	18:32	18:41	18:49	19 06:25 (3)	18:47		18:30	18:06	17:47	17:42	17:53
30	06:45		06:12	05:52	05:43	05:48	06:07 (3)	05:56		06:02	06:05	06:10	06:25	06:41
	18:11		18:27	18:32	18:41	18:49	19 06:26 (3)	18:46		18:29	18:06	17:47	17:42	17:54
31	06:44		06:11		05:43	06:07 (3)		05:57		06:02		06:11		06:41
	18:12		18:27		18:41	6 06:13 (3)		18:46		18:29		17:46		17:54
Potential sun hours	351	326	374	374	398	391		401		392	367	366	343	348
Total, worst case					6	543		187						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

WindPRO version 2.7.486 Jan 2011

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 2

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar

Shadow receptor: B - THESABAN 2 Community

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	January	February	March	April	May	June	July	August	September	October	November	December
1	06:41	06:44	06:32	06:10	05:51	05:43	05:48	05:57	06:02	06:05	06:11	06:25
	17:55	18:12	18:22	18:27	18:32	18:42	18:49	18:46	18:28	18:05	17:46	17:42
2	06:42	06:44	06:32	06:10	05:51	05:43	05:48	05:57	06:02	06:05	06:11	06:26
	17:56	18:13	18:22	18:27	18:33	18:42	18:49	18:45	18:27	18:04	17:46	17:42
3	06:42	06:44	06:31	06:09	05:50	05:43	05:48	05:57	06:02	06:05	06:12	06:26
	17:56	18:13	18:23	18:27	18:33	18:42	18:49	18:45	18:26	18:03	17:45	17:42
4	06:42	06:44	06:30	06:08	05:50	05:43	05:49	05:58	06:02	06:05	06:12	06:27
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:26	18:03	17:45	17:43
5	06:43	06:43	06:30	06:07	05:50	05:43	05:49	05:58	06:03	06:05	06:13	06:28
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:25	18:02	17:44	17:43
6	06:43	06:43	06:29	06:07	05:49	05:43	05:49	05:58	06:03	06:05	06:13	06:28
	17:58	18:15	18:23	18:28	18:34	18:43	18:50	18:44	18:24	18:01	17:44	17:43
7	06:43	06:43	06:28	06:06	05:49	05:43	05:50	05:58	06:03	06:05	06:13	06:29
	17:58	18:15	18:23	18:28	18:34	18:44	18:50	18:43	18:24	18:01	17:44	17:43
8	06:44	06:42	06:28	06:05	05:48	05:43	05:50	05:59	06:03	06:05	06:14	06:29
	17:59	18:15	18:24	18:28	18:34	18:44	18:50	18:43	18:23	18:00	17:44	17:44
9	06:44	06:42	06:27	06:05	05:48	05:43	05:50	05:59	06:03	06:06	06:14	06:30
	18:00	18:16	18:24	18:28	18:34	18:44	18:50	18:42	18:22	17:59	17:43	17:44
10	06:44	06:42	06:26	06:04	05:48	05:44	05:50	05:59	06:03	06:06	06:15	06:30
	18:00	18:16	18:24	18:28	18:35	18:45	18:50	18:42	18:21	17:58	17:43	17:44
11	06:44	06:41	06:26	06:03	05:47	05:44	05:51	05:59	06:03	06:06	06:15	06:31
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:58	17:43	17:45
12	06:44	06:41	06:25	06:03	05:47	05:44	05:51	05:59	06:03	06:06	06:15	06:32
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:57	17:43	17:45
13	06:45	06:41	06:24	06:02	05:47	05:44	05:51	06:00	06:03	06:06	06:16	06:32
	18:02	18:17	18:25	18:29	18:36	18:46	18:50	18:40	18:19	17:56	17:42	17:45
14	06:45	06:40	06:24	06:01	05:46	05:44	05:52	06:00	06:03	06:06	06:16	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	18:50	18:40	18:18	17:56	17:42	17:46
15	06:45	06:40	06:23	06:01	05:46	05:44	05:52	06:00	06:03	06:07	06:17	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	18:49	18:39	18:17	17:55	17:42	17:46
16	06:45	06:39	06:22	06:00	05:46	05:44	05:52	06:00	06:03	06:07	06:17	06:34
	18:04	18:19	18:25	18:29	18:37	18:46	18:49	18:38	18:17	17:54	17:42	17:47
17	06:45	06:39	06:21	05:59	05:45	05:44	05:53	06:00	06:03	06:07	06:18	06:34
	18:04	18:19	18:25	18:30	18:37	18:47	18:49	18:38	18:16	17:54	17:42	17:47
18	06:45	06:38	06:21	05:59	05:45	05:45	05:53	06:00	06:03	06:07	06:18	06:35
	18:05	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:15	17:53	17:42	17:47
19	06:45	06:38	06:20	05:58	05:45	05:45	05:53	06:01	06:04	06:07	06:19	06:35
	18:06	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:14	17:53	17:42	17:48
20	06:45	06:37	06:19	05:57	05:45	05:45	05:54	06:01	06:04	06:08	06:19	06:36
	18:06	18:20	18:26	18:30	18:38	18:47	18:49	18:36	18:13	17:52	17:41	17:48
21	06:45	06:37	06:18	05:57	05:44	05:45	05:54	06:01	06:04	06:08	06:20	06:36
	18:07	18:20	18:26	18:30	18:38	18:48	18:49	18:35	18:13	17:51	17:41	17:49
22	06:45	06:36	06:18	05:56	05:44	05:45	05:54	06:01	06:04	06:08	06:20	06:37
	18:07	18:20	18:26	18:30	18:38	18:48	18:48	18:35	18:12	17:51	17:41	17:49
23	06:45	06:36	06:17	05:56	05:44	05:46	05:54	06:01	06:04	06:08	06:21	06:37
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:34	18:11	17:50	17:41	17:50
24	06:45	06:35	06:16	05:55	05:44	05:46	05:55	06:01	06:04	06:09	06:21	06:38
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:10	17:50	17:41	17:50
25	06:45	06:35	06:15	05:55	05:44	05:46	05:55	06:01	06:04	06:09	06:22	06:38
	18:09	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:10	17:49	17:41	17:51
26	06:45	06:34	06:15	05:54	05:44	05:46	05:55	06:02	06:04	06:09	06:22	06:39
	18:09	18:21	18:26	18:31	18:40	18:49	18:47	18:32	18:09	17:49	17:42	17:51
27	06:45	06:33	06:14	05:53	05:44	05:47	05:56	06:02	06:04	06:09	06:23	06:39
	18:10	18:22	18:27	18:31	18:40	18:49	18:47	18:31	18:08	17:48	17:42	17:52
28	06:45	06:33	06:13	05:53	05:43	05:47	05:56	06:02	06:04	06:10	06:24	06:40
	18:10	18:22	18:27	18:32	18:40	18:49	18:47	18:31	18:07	17:48	17:42	17:53
29	06:45		06:13	05:52	05:43	05:47	05:56	06:02	06:04	06:10	06:24	06:40
	18:11		18:27	18:32	18:41	18:49	18:47	18:30	18:06	17:47	17:42	17:53
30	06:45		06:12	05:52	05:43	05:47	05:56	06:02	06:04	06:10	06:25	06:40
	18:11		18:27	18:32	18:41	18:49	18:46	18:29	18:06	17:47	17:42	17:54
31	06:44		06:11		05:43		05:57	06:02		06:11		06:41
	18:12		18:27		18:41		18:46	18:29		17:46		17:54
Potential sun hours	351	326	374	374	398	391	401	392	367	366	343	348
Total, worst case												

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 3

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com

Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar

Shadow receptor: C - Community on SE of project

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	January	February	Maroh	April	May	June
1	06:41 17:55	06:44 18:12	06:32 18:22	06:10 18:27 11 18:00 (3) 18:11 (3)	05:51 18:32	05:43 18:42 18 18:05 (2) 18:23 (2)
2	06:42 17:55	06:44 18:13	06:32 18:22	06:10 18:27 12 17:58 (3) 18:10 (3)	05:51 18:33	05:43 18:42 18 18:05 (2) 18:23 (2)
3	06:42 17:56	06:44 18:13	06:31 18:23	06:09 18:27 14 17:56 (3) 18:10 (3)	05:50 18:33	05:43 18:42 18 18:05 (2) 18:23 (2)
4	06:42 17:57	06:44 18:14	06:30 18:23	06:08 18:28 15 17:55 (3) 18:10 (3)	05:50 18:33	05:43 18:43 19 18:05 (2) 18:24 (2)
5	06:43 17:57	06:43 18:14	06:30 18:23	06:07 18:28 16 17:55 (3) 18:11 (3)	05:49 18:33	05:43 18:43 19 18:05 (2) 18:24 (2)
6	06:43 17:58	06:43 18:15	06:29 18:23	06:07 18:28 17 17:54 (3) 18:11 (3)	05:49 18:34	05:43 18:43 19 18:05 (2) 18:24 (2)
7	06:43 17:58	06:43 18:15	06:28 18:23	06:06 18:28 17 17:54 (3) 18:11 (3)	05:49 18:34	05:43 18:44 19 18:05 (2) 18:24 (2)
8	06:44 17:59	06:42 18:15	06:28 18:24	06:05 18:28 17 17:54 (3) 18:11 (3)	05:48 18:34	05:43 18:44 20 18:05 (2) 18:25 (2)
9	06:44 18:00	06:42 18:16	06:27 18:24	06:05 18:28 17 17:54 (3) 18:11 (3)	05:48 18:34	05:43 18:44 20 18:05 (2) 18:25 (2)
10	06:44 18:00	06:42 18:16	06:26 18:24	06:04 18:28 17 17:54 (3) 18:11 (3)	05:47 18:35	05:43 18:45 20 18:05 (2) 18:25 (2)
11	06:44 18:01	06:41 18:17	06:26 18:24	06:03 18:29 16 17:55 (3) 18:11 (3)	05:47 18:35	05:44 18:45 19 18:07 (2) 18:26 (2)
12	06:44 18:01	06:41 18:17	06:25 18:24	06:03 18:29 12 17:57 (3) 18:09 (3)	05:47 18:35	05:44 18:45 19 18:07 (2) 18:26 (2)
13	06:45 18:02	06:40 18:17	06:24 18:25	06:02 18:29 7 17:59 (3) 18:06 (3)	05:46 18:36	05:44 18:45 20 18:07 (2) 18:27 (2)
14	06:45 18:03	06:40 18:18	06:23 18:25	06:01 18:29	05:46 18:36	05:44 18:46 20 18:07 (2) 18:27 (2)
15	06:45 18:03	06:40 18:18	06:23 18:25	06:01 18:29	05:46 18:36	05:44 18:46 20 18:07 (2) 18:27 (2)
16	06:45 18:04	06:39 18:18	06:22 18:25	06:00 18:29	05:46 18:36	05:44 18:46 20 18:07 (2) 18:27 (2)
17	06:45 18:04	06:39 18:19	06:21 18:25	05:59 18:30	05:45 18:37	05:44 18:47 20 18:07 (2) 18:27 (2)
18	06:45 18:05	06:38 18:19	06:21 18:25	05:59 18:30	05:45 18:37	05:45 18:47 20 18:08 (2) 18:28 (2)
19	06:45 18:05	06:38 18:19	06:20 18:25	05:58 18:30	05:45 18:37	05:45 18:47 20 18:08 (2) 18:28 (2)
20	06:45 18:06	06:37 18:20	06:19 18:26	05:57 18:30	05:45 18:38	05:45 18:47 20 18:08 (2) 18:28 (2)
21	06:45 18:07	06:37 18:20	06:18 18:26	05:57 18:30	05:44 18:38	05:45 18:48 20 18:08 (2) 18:28 (2)
22	06:45 18:07	06:36 18:20	06:18 18:26	05:56 18:30	05:44 18:38	05:45 18:48 20 18:08 (2) 18:28 (2)
23	06:45 18:08	06:36 18:21	06:17 18:26	05:56 18:31	05:44 18:12 (2) 18:39 6 18:18 (2)	05:46 18:48 20 18:09 (2) 18:29 (2)
24	06:45 18:08	06:35 18:21	06:16 18:26	05:55 18:31	05:44 18:10 (2) 18:39 11 18:21 (2)	05:46 18:48 20 18:09 (2) 18:29 (2)
25	06:45 18:09	06:35 18:21	06:15 18:26	05:54 18:31	05:44 18:08 (2) 18:39 12 18:20 (2)	05:46 18:48 20 18:09 (2) 18:29 (2)
26	06:45 18:09	06:34 18:21	06:15 18:26	05:54 18:31	05:44 18:07 (2) 18:40 14 18:21 (2)	05:46 18:49 20 18:09 (2) 18:29 (2)
27	06:45 18:10	06:33 18:22	06:14 18:26	05:53 18:31	05:43 18:07 (2) 18:40 14 18:21 (2)	05:47 18:49 20 18:10 (2) 18:30 (2)
28	06:45 18:10	06:33 18:22	06:13 18:27	05:53 18:32	05:43 18:06 (2) 18:40 15 18:21 (2)	05:47 18:49 20 18:10 (2) 18:30 (2)
29	06:45 18:11		06:12 18:27	05:52 18:32	05:43 18:06 (2) 18:41 16 18:22 (2)	05:47 18:49 20 18:10 (2) 18:30 (2)
30	06:45 18:11		06:12 18:27	05:52 18:32	05:43 18:06 (2) 18:41 16 18:22 (2)	05:47 18:49 19 18:10 (2) 18:29 (2)
31	06:44 18:12		06:11 18:03 (3) 18:27 6 18:09 (3)		05:43 18:06 (2) 18:41 16 18:22 (2)	
Potential sun hours	351	326	374	374	398	391
Total, worst case			6	188	120	587

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Shadow receptor: C - Community on SE of project

Assumptions for shadow calculations

Maximum distance for influence	2,000	m
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

	July			August			September			October	November	December
1	05:48		18:11 (2)	05:57			06:02		17:55 (3)	06:05	06:11	06:25
	18:49	19	18:30 (2)	18:45			18:28	16	18:11 (3)	18:05	17:46	17:42
2	05:48		18:10 (2)	05:57			06:02		17:53 (3)	06:05	06:11	06:26
	18:49	20	18:30 (2)	18:45			18:27	17	18:10 (3)	18:04	17:46	17:42
3	05:48		18:10 (2)	05:57			06:02		17:52 (3)	06:05	06:12	06:26
	18:49	20	18:30 (2)	18:45			18:26	17	18:09 (3)	18:03	17:45	17:42
4	05:49		18:11 (2)	05:58			06:02		17:51 (3)	06:05	06:12	06:27
	18:50	20	18:31 (2)	18:44			18:26	17	18:08 (3)	18:03	17:45	17:43
5	05:49		18:11 (2)	05:58			06:02		17:51 (3)	06:05	06:12	06:28
	18:50	20	18:31 (2)	18:44			18:25	17	18:08 (3)	18:02	17:44	17:43
6	05:49		18:11 (2)	05:58			06:03		17:50 (3)	06:05	06:13	06:28
	18:50	19	18:30 (2)	18:43			18:24	17	18:07 (3)	18:01	17:44	17:43
7	05:50		18:12 (2)	05:58			06:03		17:50 (3)	06:05	06:13	06:29
	18:50	19	18:31 (2)	18:43			18:23	16	18:06 (3)	18:00	17:44	17:43
8	05:50		18:12 (2)	05:58			06:03		17:50 (3)	06:05	06:14	06:29
	18:50	19	18:31 (2)	18:43			18:23	15	18:05 (3)	18:00	17:44	17:44
9	05:50		18:12 (2)	05:59			06:03		17:50 (3)	06:06	06:14	06:30
	18:50	19	18:31 (2)	18:42			18:22	14	18:04 (3)	17:59	17:43	17:44
10	05:50		18:12 (2)	05:59			06:03		17:51 (3)	06:06	06:15	06:30
	18:50	18	18:30 (2)	18:42			18:21	12	18:03 (3)	17:58	17:43	17:44
11	05:51		18:13 (2)	05:59			06:03		17:52 (3)	06:06	06:15	06:31
	18:50	18	18:31 (2)	18:41			18:20	11	18:03 (3)	17:58	17:43	17:45
12	05:51		18:13 (2)	05:59			06:03		17:55 (3)	06:06	06:15	06:32
	18:50	18	18:31 (2)	18:41			18:20	7	18:02 (3)	17:57	17:43	17:45
13	05:51		18:14 (2)	06:00			06:03			06:06	06:16	06:32
	18:50	16	18:30 (2)	18:40			18:19			17:56	17:42	17:45
14	05:52		18:15 (2)	06:00			06:03			06:06	06:16	06:33
	18:49	16	18:31 (2)	18:40			18:18			17:56	17:42	17:46
15	05:52		18:15 (2)	06:00			06:03			06:07	06:17	06:33
	18:49	16	18:31 (2)	18:39			18:17			17:55	17:42	17:46
16	05:52		18:16 (2)	06:00			06:03			06:07	06:17	06:34
	18:49	14	18:30 (2)	18:38			18:17			17:54	17:42	17:47
17	05:53		18:17 (2)	06:00			06:03			06:07	06:18	06:34
	18:49	14	18:31 (2)	18:38			18:16			17:54	17:42	17:47
18	05:53		18:18 (2)	06:00			06:03			06:07	06:18	06:35
	18:49	12	18:30 (2)	18:37			18:15			17:53	17:42	17:47
19	05:53		18:19 (2)	06:01			06:04			06:07	06:19	06:35
	18:49	11	18:30 (2)	18:37			18:14			17:53	17:42	17:48
20	05:53		18:20 (2)	06:01			06:04			06:08	06:19	06:36
	18:49	9	18:29 (2)	18:36			18:13			17:52	17:41	17:48
21	05:54			06:01			06:04			06:08	06:20	06:36
	18:49			18:35			18:13			17:51	17:41	17:49
22	05:54			06:01			06:04			06:08	06:20	06:37
	18:48			18:35			18:12			17:51	17:41	17:49
23	05:54			06:01			06:04			06:08	06:21	06:37
	18:48			18:34			18:11			17:50	17:41	17:50
24	05:55			06:01			06:04			06:09	06:21	06:38
	18:48			18:33			18:10			17:50	17:41	17:50
25	05:55			06:01			06:04			06:09	06:22	06:38
	18:48			18:33			18:09			17:49	17:41	17:51
26	05:55			06:01			06:04			06:09	06:22	06:39
	18:47			18:32			18:09			17:49	17:41	17:51
27	05:56			06:02			06:04			06:09	06:23	06:39
	18:47			18:31			18:08			17:48	17:42	17:52
28	05:56			06:02			06:04			06:10	06:24	06:40
	18:47			18:31			18:07			17:48	17:42	17:52
29	05:56			06:02			06:04			06:10	06:24	06:40
	18:46			18:30			18:06			17:47	17:42	17:53
30	05:56			06:02		17:58 (3)	06:04			06:10	06:25	06:40
	18:46			18:29	8	18:06 (3)	18:06			17:47	17:42	17:54
31	05:57			06:02		17:56 (3)				06:11		06:41
	18:46			18:29	13	18:09 (3)				17:46		17:54
Potential sun hours	401			392			367			366	343	348
Total, worst case		337			21			176				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 5

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com

Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar

Shadow receptor: D - Kum Mo Din Sai Community

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	January	February		March		April	May	June	July	August	September	October		November	December		
1	06:41	06:44		06:32		17:48 (1)	06:10	05:51	05:43	05:48	05:57	06:02	06:05		06:11	06:25		
	17:55	18:12		18:22	19	18:05 (1)	18:27	18:32	18:42	18:49	18:45	18:28	18:05		17:46	17:42		
2	06:42	06:44		06:32		17:48 (1)	06:10	05:51	05:43	05:48	05:57	06:02	06:05		06:11	06:26		
	17:55	18:13		18:22	19	18:05 (1)	18:27	18:33	18:42	18:49	18:45	18:27	18:04		17:46	17:42		
3	06:42	06:44		06:31		17:45 (1)	06:09	05:50	05:43	05:48	05:57	06:02	06:05		06:12	06:26		
	17:56	18:13		18:23	20	18:05 (1)	18:27	18:33	18:42	18:49	18:45	18:26	18:03		17:45	17:42		
4	06:42	06:44		06:30		17:46 (1)	06:08	05:50	05:43	05:49	05:58	06:02	06:05	17:29 (1)	06:12	06:27		
	17:57	18:14		18:23	20	18:06 (1)	18:28	18:33	18:43	18:50	18:44	18:26	18:03	11 17:40 (1)	17:45	17:43		
5	06:43	06:43		06:30		17:46 (1)	06:07	05:49	05:43	05:49	05:58	06:02	06:05	17:28 (1)	06:12	06:28		
	17:57	18:14		18:23	20	18:06 (1)	18:28	18:33	18:43	18:50	18:44	18:25	18:02	16 17:42 (1)	17:44	17:43		
6	06:43	06:43		06:29		17:46 (1)	06:07	05:49	05:43	05:49	05:58	06:03	06:05	17:24 (1)	06:13	06:28		
	17:58	18:15		18:23	20	18:06 (1)	18:28	18:34	18:43	18:50	18:43	18:24	18:01	19 17:43 (1)	17:44	17:43		
7	06:43	06:43		06:28		17:47 (1)	06:06	05:49	05:43	05:49	05:58	06:03	06:05	17:23 (1)	06:13	06:29		
	17:58	18:15		18:23	20	18:07 (1)	18:28	18:34	18:44	18:50	18:43	18:23	18:00	19 17:42 (1)	17:44	17:43		
8	06:44	06:42		06:28		17:48 (1)	06:05	05:48	05:43	05:50	05:58	06:03	06:05	17:21 (1)	06:14	06:29		
	17:59	18:15		18:24	17	18:05 (1)	18:28	18:34	18:44	18:50	18:43	18:23	18:00	20 17:41 (1)	17:43	17:44		
9	06:44	06:42		06:27		17:50 (1)	06:05	05:48	05:43	05:50	05:59	06:03	06:06	17:20 (1)	06:14	06:30		
	18:00	18:16		18:24	13	18:03 (1)	18:28	18:34	18:44	18:50	18:42	18:22	17:59	21 17:41 (1)	17:43	17:44		
10	06:44	06:42		06:26		17:54 (1)	06:04	05:47	05:43	05:50	05:59	06:03	06:06	17:20 (1)	06:15	06:30		
	18:00	18:16		18:24	5	17:59 (1)	18:28	18:35	18:45	18:50	18:42	18:21	17:58	20 17:40 (1)	17:43	17:44		
11	06:44	06:41		06:26			06:03	05:47	05:44	05:51	05:59	06:03	06:06	17:20 (1)	06:15	06:31		
	18:01	18:17		18:24			18:29	18:35	18:45	18:50	18:41	18:20	17:58	20 17:40 (1)	17:43	17:45		
12	06:44	06:41		06:25			06:03	05:47	05:44	05:51	05:59	06:03	06:06	17:20 (1)	06:15	06:32		17:11 (2)
	18:01	18:17		18:24			18:29	18:35	18:45	18:50	18:41	18:20	17:57	19 17:39 (1)	17:42	17:45	3	17:14 (2)
13	06:45	06:41		06:24			06:02	05:46	05:44	05:51	06:00	06:03	06:06	17:19 (1)	06:16	06:32		17:10 (2)
	18:02	18:17		18:25			18:29	18:36	18:46	18:50	18:40	18:19	17:56	19 17:38 (1)	17:42	17:45	7	17:17 (2)
14	06:45	06:40		06:23			06:01	05:46	05:44	05:52	06:00	06:03	06:06	17:19 (1)	06:16	06:33		17:09 (2)
	18:03	18:18		18:25			18:29	18:36	18:46	18:50	18:40	18:18	17:56	18 17:37 (1)	17:42	17:46	9	17:18 (2)
15	06:45	06:40		06:23			06:01	05:46	05:44	05:52	06:00	06:03	06:07	17:20 (1)	06:17	06:33		17:09 (2)
	18:03	18:18		18:25			18:29	18:36	18:46	18:49	18:39	18:17	17:55	16 17:36 (1)	17:42	17:46	10	17:19 (2)
16	06:45	06:39		06:22			06:00	05:46	05:44	05:52	06:00	06:03	06:07	17:21 (1)	06:17	06:34		17:09 (2)
	18:04	18:18		18:25			18:29	18:37	18:46	18:49	18:38	18:17	17:54	16 17:37 (1)	17:42	17:47	11	17:20 (2)
17	06:45	06:39		06:21			05:59	05:45	05:44	05:53	06:00	06:03	06:07	17:22 (1)	06:18	06:34		17:09 (2)
	18:04	18:19		18:25			18:30	18:37	18:47	18:49	18:38	18:16	17:54	14 17:38 (1)	17:42	17:47	12	17:21 (2)
18	06:45	06:38		06:21			05:59	05:45	05:45	05:53	06:00	06:03	06:07	17:23 (1)	06:18	06:35		17:09 (2)
	18:05	18:19		18:25			18:30	18:37	18:47	18:49	18:37	18:15	17:53	12 17:35 (1)	17:42	17:47	12	17:21 (2)
19	06:45	06:38		06:20			05:58	05:45	05:45	05:53	06:01	06:04	06:07	17:25 (1)	06:19	06:35		17:10 (2)
	18:05	18:19		18:25			18:30	18:37	18:47	18:49	18:37	18:14	17:53	9 17:34 (1)	17:41	17:48	12	17:22 (2)
20	06:45	06:37		06:19			05:57	05:45	05:45	05:53	06:01	06:04	06:08		06:19	06:36		17:09 (2)
	18:06	18:20		18:26			18:30	18:38	18:47	18:49	18:36	18:13	17:52		17:41	17:48	14	17:23 (2)
21	06:45	06:37		06:18			05:57	05:44	05:45	05:54	06:01	06:04	06:08		06:20	06:36		17:10 (2)
	18:07	18:20		18:26			18:30	18:38	18:48	18:49	18:35	18:13	17:51		17:41	17:49	14	17:24 (2)
22	06:45	06:36		06:18			05:56	05:44	05:45	05:54	06:01	06:04	06:08		06:20	06:37		17:10 (2)
	18:07	18:20		18:26			18:30	18:38	18:48	18:48	18:35	18:12	17:51		17:41	17:49	14	17:24 (2)
23	06:45	06:36	17:53 (1)	06:17			05:56	05:44	05:46	05:54	06:01	06:04	06:08		06:21	06:37		17:11 (2)
	18:08	18:21	10 18:03 (1)	18:26			18:31	18:39	18:48	18:48	18:34	18:11	17:50		17:41	17:50	14	17:25 (2)
24	06:45	06:35	17:52 (1)	06:16			05:55	05:44	05:46	05:55	06:01	06:04	06:09		06:21	06:38		17:12 (2)
	18:08	18:21	12 18:04 (1)	18:26			18:31	18:39	18:48	18:48	18:33	18:10	17:50		17:41	17:50	13	17:25 (2)
25	06:45	06:35	17:49 (1)	06:15			05:54	05:44	05:46	05:55	06:01	06:04	06:09		06:22	06:38		17:12 (2)
	18:09	18:21	15 18:04 (1)	18:26			18:31	18:39	18:48	18:48	18:33	18:09	17:49		17:41	17:51	12	17:24 (2)
26	06:45	06:34	17:48 (1)	06:15			05:54	05:44	05:46	05:55	06:01	06:04	06:09		06:22	06:39		17:13 (2)
	18:09	18:21	16 18:04 (1)	18:26			18:31	18:40	18:49	18:47	18:32	18:09	17:49		17:41	17:51	12	17:25 (2)
27	06:45	06:33	17:47 (1)	06:14			05:53	05:43	05:47	05:56	06:02	06:04	06:09		06:23	06:39		17:13 (2)
	18:10	18:22	18 18:05 (1)	18:27			18:31	18:40	18:49	18:47	18:31	18:08	17:48		17:42	17:52	12	17:25 (2)
28	06:45	06:33	17:46 (1)	06:13			05:53	05:43	05:47	05:56	06:02	06:04	06:10		06:24	06:40		17:15 (2)
	18:10	18:22	19 18:05 (1)	18:27			18:32	18:40	18:49	18:47	18:31	18:07	17:48		17:42	17:52	10	17:25 (2)
29	06:45			06:13			05:52	05:43	05:47	05:56	06:02	06:04	06:10		06:24	06:40		17:16 (2)
	18:11			18:27			18:32	18:41	18:49	18:47	18:30	18:06	17:47		17:42	17:53	9	17:25 (2)
30	06:45			06:12			05:52	05:43	05:47	05:56	06:02	06:04	06:10		06:25	06:40		17:17 (2)
	18:11			18:27			18:32	18:41	18:49	18:48	18:29	18:06	17:47		17:42	17:54	7	17:24 (2)
31	06:44			06:11				05:43		05:57	06:02		06:11			06:41		17:19 (2)
	18:12			18:27				18:41		18:48	18:29		17:48			17:54	5	17:24 (2)
Potential sun hours	351	328		374		374	398	391	401	392	387	388		343	348		
Total, worst case			90		173								269			212	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 6

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar

Shadow receptor: E - Ban Watabak near E2

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	January	February	March	April	May	June	July	August	September	October	November	December
1	06:41	06:44	06:32	06:10	05:51	05:43	05:48	05:57	06:02	06:05	06:11	06:25
	17:55	18:12	18:22	18:27	18:32	18:42	18:49	18:46	18:28	18:05	17:46	17:42
2	06:42	06:44	06:32	06:10	05:51	05:43	05:48	05:57	06:02	06:05	06:11	06:26
	17:55	18:13	18:22	18:27	18:33	18:42	18:49	18:45	18:27	18:04	17:46	17:42
3	06:42	06:44	06:31	06:09	05:50	05:43	05:48	05:57	06:02	06:05	06:12	06:26
	17:56	18:13	18:23	18:27	18:33	18:42	18:49	18:45	18:26	18:03	17:45	17:42
4	06:42	06:44	06:30	06:08	05:50	05:43	05:49	05:58	06:02	06:05	06:12	06:27
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:26	18:03	17:45	17:43
5	06:43	06:43	06:30	06:07	05:49	05:43	05:49	05:58	06:02	06:05	06:12	06:28
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:25	18:02	17:44	17:43
6	06:43	06:43	06:29	06:07	05:49	05:43	05:49	05:58	06:03	06:05	06:13	06:28
	17:58	18:15	18:23	18:28	18:34	18:43	18:50	18:43	18:24	18:01	17:44	17:43
7	06:43	06:43	06:28	06:06	05:49	05:43	05:49	05:58	06:03	06:05	06:13	06:29
	17:58	18:15	18:23	18:28	18:34	18:44	18:50	18:43	18:23	18:00	17:44	17:43
8	06:44	06:42	06:28	06:05	05:48	05:43	05:50	05:58	06:03	06:05	06:14	06:29
	17:59	18:15	18:24	18:28	18:34	18:44	18:50	18:43	18:23	18:00	17:43	17:44
9	06:44	06:42	06:27	06:05	05:48	05:43	05:50	05:59	06:03	06:06	06:14	06:30
	18:00	18:16	18:24	18:28	18:34	18:44	18:50	18:42	18:22	17:59	17:43	17:44
10	06:44	06:42	06:26	06:04	05:47	05:43	05:50	05:59	06:03	06:06	06:15	06:30
	18:00	18:16	18:24	18:28	18:35	18:45	18:50	18:42	18:21	17:58	17:43	17:44
11	06:44	06:41	06:26	06:03	05:47	05:44	05:51	05:59	06:03	06:06	06:15	06:31
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:58	17:43	17:45
12	06:44	06:41	06:25	06:03	05:47	05:44	05:51	05:59	06:03	06:06	06:15	06:32
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:57	17:42	17:45
13	06:45	06:41	06:24	06:02	05:46	05:44	05:51	05:59	06:03	06:06	06:16	06:32
	18:02	18:17	18:25	18:29	18:36	18:46	18:50	18:40	18:19	17:56	17:42	17:45
14	06:45	06:40	06:23	06:01	05:46	05:44	05:52	06:00	06:03	06:06	06:16	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	18:50	18:40	18:18	17:56	17:42	17:46
15	06:45	06:40	06:23	06:01	05:46	05:44	05:52	06:00	06:03	06:07	06:17	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	18:49	18:39	18:17	17:55	17:42	17:46
16	06:45	06:39	06:22	06:00	05:46	05:44	05:52	06:00	06:03	06:07	06:17	06:34
	18:04	18:18	18:25	18:29	18:37	18:46	18:49	18:38	18:17	17:54	17:42	17:47
17	06:45	06:39	06:21	05:59	05:45	05:44	05:53	06:00	06:03	06:07	06:18	06:34
	18:04	18:19	18:25	18:30	18:37	18:47	18:49	18:38	18:16	17:54	17:42	17:47
18	06:45	06:38	06:21	05:59	05:45	05:45	05:53	06:00	06:03	06:07	06:18	06:35
	18:05	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:15	17:53	17:42	17:47
19	06:45	06:38	06:20	05:58	05:45	05:45	05:53	06:01	06:04	06:07	06:19	06:35
	18:05	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:14	17:53	17:41	17:48
20	06:45	06:37	06:19	05:57	05:45	05:45	05:53	06:01	06:04	06:08	06:19	06:36
	18:06	18:20	18:26	18:30	18:38	18:47	18:49	18:36	18:13	17:52	17:41	17:48
21	06:45	06:37	06:18	05:57	05:44	05:45	05:54	06:01	06:04	06:08	06:20	06:36
	18:07	18:20	18:26	18:30	18:38	18:48	18:49	18:35	18:13	17:51	17:41	17:49
22	06:45	06:36	06:18	05:56	05:44	05:45	05:54	06:01	06:04	06:08	06:20	06:37
	18:07	18:20	18:26	18:30	18:38	18:48	18:48	18:35	18:12	17:51	17:41	17:49
23	06:45	06:36	06:17	05:56	05:44	05:46	05:54	06:01	06:04	06:08	06:21	06:37
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:34	18:11	17:50	17:41	17:50
24	06:45	06:35	06:16	05:55	05:44	05:46	05:55	06:01	06:04	06:09	06:21	06:38
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:10	17:50	17:41	17:50
25	06:45	06:35	06:15	05:54	05:44	05:46	05:55	06:01	06:04	06:09	06:22	06:38
	18:09	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:09	17:49	17:41	17:51
26	06:45	06:34	06:15	05:54	05:44	05:46	05:55	06:01	06:04	06:09	06:22	06:39
	18:09	18:21	18:26	18:31	18:40	18:49	18:47	18:32	18:09	17:49	17:41	17:51
27	06:45	06:33	06:14	05:53	05:43	05:47	05:55	06:02	06:04	06:09	06:23	06:39
	18:10	18:22	18:27	18:31	18:40	18:49	18:47	18:31	18:08	17:48	17:42	17:52
28	06:45	06:33	06:13	05:53	05:43	05:47	05:56	06:02	06:04	06:10	06:24	06:40
	18:10	18:22	18:27	18:32	18:40	18:49	18:47	18:31	18:07	17:48	17:42	17:52
29	06:45		06:12	05:52	05:43	05:47	05:56	06:02	06:04	06:10	06:24	06:40
	18:11		18:27	18:32	18:41	18:49	18:47	18:30	18:06	17:47	17:42	17:53
30	06:45		06:12	05:52	05:43	05:47	05:56	06:02	06:04	06:10	06:25	06:40
	18:11		18:27	18:32	18:41	18:49	18:46	18:29	18:06	17:47	17:42	17:54
31	06:44		06:11		05:43		05:57	06:02		06:11		06:41
	18:12		18:27		18:41		18:46	18:29		17:46		17:54
Potential sun hours	351	326	374	374	398	391	401	392	367	366	343	348
Total, worst case												

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 7

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar

Shadow receptor: F - Community on NE of Project

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	January	February	March	April	May	June	July	August	September	October	November	December
1	06:41	06:44	06:32	06:10	05:51	05:43	05:48	05:57	06:02	06:05	06:11	06:25
	17:55	18:12	18:22	18:27	18:32	18:42	18:49	18:48	18:28	18:05	17:46	17:42
2	06:42	06:44	06:32	06:10	05:51	05:43	05:48	05:57	06:02	06:05	06:11	06:26
	17:55	18:13	18:22	18:27	18:33	18:42	18:49	18:45	18:27	18:04	17:46	17:42
3	06:42	06:44	06:31	06:09	05:50	05:43	05:48	05:57	06:02	06:05	06:12	06:26
	17:56	18:13	18:23	18:27	18:33	18:42	18:49	18:45	18:26	18:03	17:45	17:42
4	06:42	06:44	06:30	06:08	05:50	05:43	05:49	05:58	06:02	06:05	06:12	06:27
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:26	18:03	17:45	17:43
5	06:43	06:43	06:30	06:07	05:49	05:43	05:49	05:58	06:02	06:05	06:13	06:28
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:25	18:02	17:44	17:43
6	06:43	06:43	06:29	06:07	05:49	05:43	05:49	05:58	06:03	06:05	06:13	06:28
	17:58	18:15	18:23	18:28	18:34	18:43	18:50	18:44	18:24	18:01	17:44	17:43
7	06:43	06:43	06:28	06:06	05:49	05:43	05:49	05:58	06:03	06:05	06:13	06:29
	17:58	18:15	18:23	18:28	18:34	18:44	18:50	18:43	18:23	18:00	17:44	17:43
8	06:44	06:42	06:28	06:05	05:48	05:43	05:50	05:58	06:03	06:05	06:14	06:29
	17:59	18:15	18:24	18:28	18:34	18:44	18:50	18:43	18:23	18:00	17:43	17:44
9	06:44	06:42	06:27	06:05	05:48	05:43	05:50	05:59	06:03	06:06	06:14	06:30
	18:00	18:16	18:24	18:28	18:34	18:44	18:50	18:42	18:22	17:59	17:43	17:44
10	06:44	06:42	06:26	06:04	05:47	05:43	05:50	05:59	06:03	06:06	06:15	06:30
	18:00	18:16	18:24	18:28	18:35	18:45	18:50	18:42	18:21	17:58	17:43	17:44
11	06:44	06:41	06:26	06:03	05:47	05:44	05:51	05:59	06:03	06:06	06:15	06:31
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:58	17:43	17:45
12	06:44	06:41	06:25	06:03	05:47	05:44	05:51	05:59	06:03	06:06	06:15	06:32
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:57	17:42	17:45
13	06:45	06:41	06:24	06:02	05:46	05:44	05:51	05:59	06:03	06:06	06:16	06:32
	18:02	18:17	18:25	18:29	18:36	18:46	18:50	18:40	18:19	17:56	17:42	17:45
14	06:45	06:40	06:23	06:01	05:46	05:44	05:52	06:00	06:03	06:06	06:16	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	18:50	18:40	18:18	17:56	17:42	17:46
15	06:45	06:40	06:23	06:01	05:46	05:44	05:52	06:00	06:03	06:07	06:17	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	18:49	18:39	18:17	17:55	17:42	17:46
16	06:45	06:39	06:22	06:00	05:46	05:44	05:52	06:00	06:03	06:07	06:17	06:34
	18:04	18:18	18:25	18:29	18:37	18:46	18:49	18:38	18:17	17:54	17:42	17:47
17	06:45	06:39	06:21	05:59	05:45	05:44	05:53	06:00	06:03	06:07	06:18	06:34
	18:04	18:19	18:25	18:30	18:37	18:47	18:49	18:38	18:16	17:54	17:42	17:47
18	06:45	06:38	06:21	05:59	05:45	05:45	05:53	06:00	06:03	06:07	06:18	06:35
	18:05	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:15	17:53	17:42	17:47
19	06:45	06:38	06:20	05:58	05:45	05:45	05:53	06:01	06:04	06:07	06:19	06:35
	18:05	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:14	17:53	17:41	17:48
20	06:45	06:37	06:19	05:57	05:45	05:45	05:53	06:01	06:04	06:08	06:19	06:36
	18:06	18:20	18:26	18:30	18:38	18:47	18:49	18:36	18:13	17:52	17:41	17:48
21	06:45	06:37	06:18	05:57	05:44	05:45	05:54	06:01	06:04	06:08	06:20	06:36
	18:07	18:20	18:26	18:30	18:38	18:48	18:49	18:35	18:13	17:51	17:41	17:49
22	06:45	06:36	06:18	05:56	05:44	05:45	05:54	06:01	06:04	06:08	06:20	06:37
	18:07	18:20	18:26	18:30	18:38	18:48	18:48	18:35	18:12	17:51	17:41	17:49
23	06:45	06:36	06:17	05:56	05:44	05:46	05:54	06:01	06:04	06:08	06:21	06:37
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:34	18:11	17:50	17:41	17:50
24	06:45	06:35	06:16	05:55	05:44	05:46	05:55	06:01	06:04	06:09	06:21	06:38
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:10	17:50	17:41	17:50
25	06:45	06:35	06:15	05:54	05:44	05:46	05:55	06:01	06:04	06:09	06:22	06:38
	18:09	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:09	17:49	17:41	17:51
26	06:45	06:34	06:15	05:54	05:44	05:46	05:55	06:01	06:04	06:09	06:22	06:39
	18:09	18:21	18:26	18:31	18:40	18:49	18:47	18:32	18:09	17:49	17:41	17:51
27	06:45	06:33	06:14	05:53	05:43	05:47	05:55	06:02	06:04	06:09	06:23	06:39
	18:10	18:22	18:27	18:31	18:40	18:49	18:47	18:31	18:08	17:48	17:42	17:52
28	06:45	06:33	06:13	05:53	05:43	05:47	05:56	06:02	06:04	06:10	06:24	06:40
	18:10	18:22	18:27	18:32	18:40	18:49	18:47	18:31	18:07	17:48	17:42	17:52
29	06:45		06:13	05:52	05:43	05:47	05:56	06:02	06:04	06:10	06:24	06:40
	18:11		18:27	18:32	18:41	18:49	18:47	18:30	18:06	17:47	17:42	17:53
30	06:45		06:12	05:52	05:43	05:47	05:56	06:02	06:04	06:10	06:25	06:40
	18:11		18:27	18:32	18:41	18:49	18:46	18:29	18:06	17:47	17:42	17:54
31	06:44		06:11		05:43		05:57	06:02		06:11		06:41
	18:12		18:27		18:41		18:46	18:29		17:46		17:54
Potential sun hours	351	328	374	374	398	391	401	392	387	366	343	348
Total, worst case												

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 1

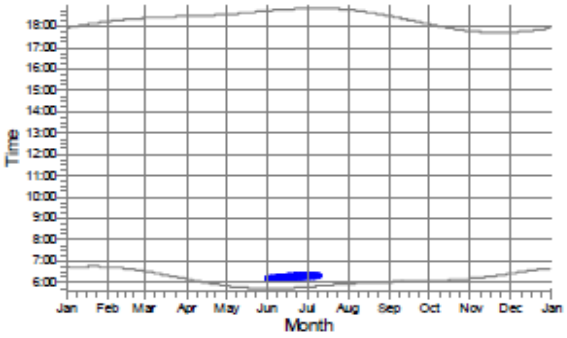
Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com

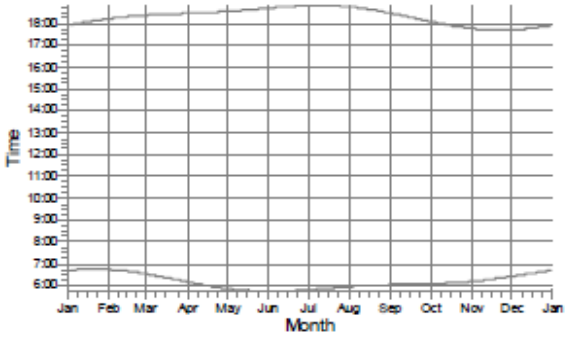
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar, graphical

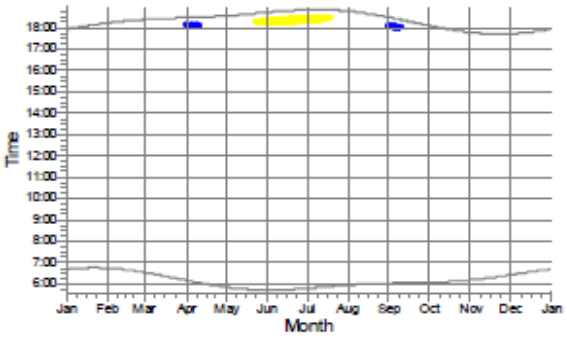
A: Community on SW of Project



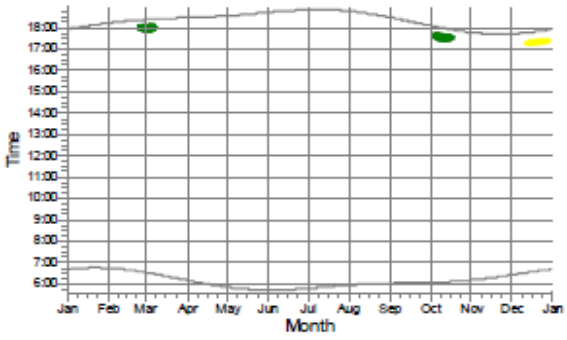
B: THESABAN 2 Community



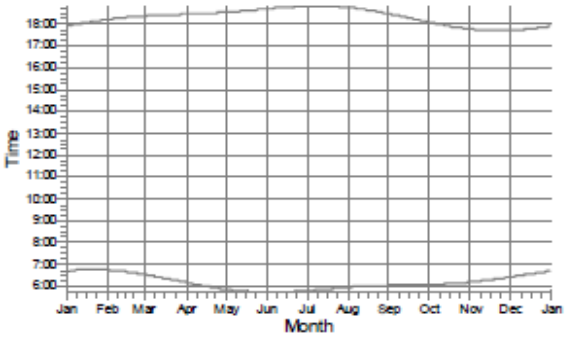
C: Community on SE of project



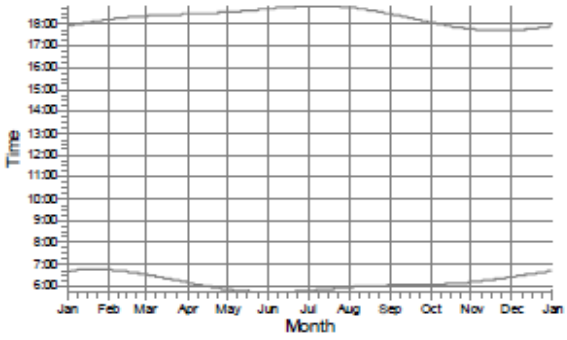
D: Kum Mo Din Sai Community



E: Ban Watabak near E2



F: Community on NE of Project



WTGs

1: Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)

2: Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)

3: Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 1

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar per WTG

WTG: 1 - Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	January	February	March	April	May	June	July	August	September	October	November	December
1	06:41	06:44	06:32 17:46-18:05/19	06:10	05:51	05:43	05:48	05:57	06:02	06:05	06:11	06:25
	17:55	18:12	18:22	18:27	18:32	18:42	18:49	18:46	18:28	18:05	17:46	17:42
2	06:42	06:44	06:32 17:46-18:05/19	06:10	05:51	05:43	05:48	05:57	06:02	06:05	06:11	06:26
	17:56	18:13	18:22	18:27	18:33	18:42	18:49	18:45	18:27	18:04	17:46	17:42
3	06:42	06:44	06:31 17:45-18:05/20	06:09	05:50	05:43	05:48	05:57	06:02	06:05	06:12	06:26
	17:56	18:13	18:23	18:27	18:33	18:42	18:50	18:45	18:27	18:03	17:45	17:42
4	06:42	06:44	06:30 17:46-18:06/20	06:08	05:50	05:43	05:49	05:58	06:02	06:05 17:29-17:40/11	06:12	06:27
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:26	18:03	17:45	17:43
5	06:43	06:43	06:30 17:46-18:06/20	06:07	05:50	05:43	05:49	05:58	06:03	06:05 17:26-17:42/16	06:13	06:28
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:25	18:02	17:44	17:43
6	06:43	06:43	06:29 17:46-18:06/20	06:07	05:49	05:43	05:49	05:58	06:03	06:05 17:24-17:43/19	06:13	06:28
	17:58	18:15	18:23	18:28	18:34	18:43	18:50	18:44	18:24	18:01	17:44	17:43
7	06:43	06:43	06:28 17:47-18:07/20	06:06	05:49	05:43	05:50	05:58	06:03	06:05 17:23-17:42/19	06:13	06:29
	17:58	18:15	18:23	18:28	18:34	18:44	18:50	18:43	18:24	18:01	17:44	17:43
8	06:44	06:42	06:28 17:48-18:05/17	06:05	05:48	05:43	05:50	05:59	06:03	06:05 17:21-17:41/20	06:14	06:29
	17:59	18:15	18:24	18:28	18:34	18:44	18:50	18:43	18:23	18:00	17:44	17:44
9	06:44	06:42	06:27 17:50-18:03/13	06:05	05:48	05:43	05:50	05:59	06:03	06:06 17:20-17:41/21	06:14	06:30
	18:00	18:16	18:24	18:28	18:34	18:44	18:50	18:42	18:22	17:59	17:43	17:44
10	06:44	06:42	06:26 17:54-17:59/5	06:04	05:48	05:44	05:50	05:59	06:03	06:06 17:20-17:40/20	06:15	06:30
	18:00	18:16	18:24	18:28	18:35	18:45	18:50	18:42	18:21	17:58	17:43	17:44
11	06:44	06:41	06:26	06:03	05:47	05:44	05:51	05:59	06:03	06:06 17:20-17:40/20	06:15	06:31
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:58	17:43	17:45
12	06:44	06:41	06:25	06:03	05:47	05:44	05:51	05:59	06:03	06:06 17:20-17:39/19	06:15	06:32
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:57	17:43	17:45
13	06:45	06:41	06:24	06:02	05:46	05:44	05:51	06:00	06:03	06:06 17:19-17:38/19	06:16	06:32
	18:02	18:17	18:25	18:29	18:36	18:46	18:50	18:40	18:19	17:56	17:42	17:45
14	06:45	06:40	06:24	06:01	05:46	05:44	05:52	06:00	06:03	06:06 17:19-17:37/18	06:16	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	18:50	18:40	18:18	17:56	17:42	17:46
15	06:45	06:40	06:23	06:01	05:46	05:44	05:52	06:00	06:03	06:07 17:20-17:36/16	06:17	06:33
	18:03	18:18	18:25	18:29	18:36	18:46	18:49	18:39	18:17	17:55	17:42	17:46
16	06:45	06:39	06:22	06:00	05:46	05:44	05:52	06:00	06:03	06:07 17:21-17:37/16	06:17	06:34
	18:04	18:19	18:25	18:29	18:37	18:46	18:49	18:38	18:17	17:54	17:42	17:47
17	06:45	06:39	06:21	05:59	05:45	05:44	05:53	06:00	06:03	06:07 17:22-17:36/14	06:18	06:34
	18:04	18:19	18:25	18:30	18:37	18:47	18:49	18:38	18:16	17:54	17:42	17:47
18	06:45	06:38	06:21	05:59	05:45	05:45	05:53	06:00	06:03	06:07 17:23-17:35/12	06:18	06:35
	18:05	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:15	17:53	17:42	17:47
19	06:45	06:38	06:20	05:58	05:45	05:45	05:53	06:01	06:04	06:07 17:25-17:34/9	06:19	06:35
	18:06	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:14	17:53	17:42	17:48
20	06:45	06:37	06:19	05:57	05:45	05:45	05:54	06:01	06:04	06:08	06:19	06:36
	18:06	18:20	18:26	18:30	18:38	18:47	18:49	18:36	18:13	17:52	17:41	17:48
21	06:45	06:37	06:18	05:57	05:44	05:45	05:54	06:01	06:04	06:08	06:20	06:36
	18:07	18:20	18:26	18:30	18:38	18:48	18:49	18:35	18:13	17:51	17:41	17:49
22	06:45	06:36	06:18	05:56	05:44	05:45	05:54	06:01	06:04	06:08	06:20	06:37
	18:07	18:20	18:26	18:30	18:38	18:48	18:48	18:35	18:12	17:51	17:41	17:49
23	06:45	06:36 17:53-18:03/10	06:17	05:56	05:44	05:46	05:54	06:01	06:04	06:08	06:21	06:37
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:34	18:11	17:50	17:41	17:50
24	06:45	06:35 17:52-18:04/12	06:16	05:55	05:44	05:46	05:55	06:01	06:04	06:09	06:21	06:38
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:10	17:50	17:41	17:50
25	06:45	06:35 17:49-18:04/15	06:15	05:54	05:44	05:46	05:55	06:01	06:04	06:09	06:22	06:38
	18:09	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:10	17:49	17:41	17:51
26	06:45	06:34 17:48-18:04/16	06:15	05:54	05:44	05:46	05:55	06:02	06:04	06:09	06:22	06:39
	18:09	18:21	18:26	18:31	18:40	18:49	18:47	18:32	18:09	17:49	17:42	17:51
27	06:45	06:33 17:47-18:05/18	06:14	05:53	05:44	05:47	05:56	06:02	06:04	06:09	06:23	06:39
	18:10	18:22	18:27	18:31	18:40	18:49	18:47	18:31	18:08	17:48	17:42	17:52
28	06:45	06:33 17:46-18:05/19	06:13	05:53	05:43	05:47	05:56	06:02	06:04	06:10	06:24	06:40
	18:10	18:22	18:27	18:32	18:40	18:49	18:47	18:31	18:07	17:48	17:42	17:53
29	06:45		06:13	05:52	05:43	05:47	05:56	06:02	06:04	06:10	06:24	06:40
	18:11		18:27	18:32	18:41	18:49	18:47	18:30	18:06	17:47	17:42	17:53
30	06:45		06:12	05:52	05:43	05:47	05:56	06:02	06:04	06:10	06:25	06:41
	18:11		18:27	18:32	18:41	18:49	18:46	18:29	18:06	17:47	17:42	17:54
31	06:44		06:11		05:43		05:57	06:02		06:11		06:41
	18:12		18:27		18:41		18:46	18:29		17:46		17:54
Potential sun hours	351	326	374	374	398	391	401	392	367	366	343	348
Sum of minutes with flicker	0	90	173	0	0	0	0	0	0	269	0	0

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-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 2

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com

Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar per WTG

WTG: 2 - Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	January	February	March	April	May	June	July	August	September	October	November	December
1	06:41	06:44	06:32	06:10	05:51	05:43 18:05-18:23/18	05:48 18:11-18:30/19	05:57	06:02	06:05	06:11	06:25
	17:55	18:12	18:22	18:27	18:32	18:42	18:49	18:48	18:28	18:05	17:46	17:42
2	06:42	06:44	06:32	06:10	05:51	05:43 18:05-18:23/18	05:48 18:10-18:30/20	05:57	06:02	06:05	06:11	06:26
	17:56	18:13	18:22	18:27	18:33	18:42	18:49	18:45	18:27	18:04	17:46	17:42
3	06:42	06:44	06:31	06:09	05:50	05:43 18:05-18:23/18	05:48 18:10-18:30/20	05:57	06:02	06:05	06:12	06:26
	17:56	18:13	18:23	18:27	18:33	18:42	18:49	18:45	18:26	18:03	17:45	17:42
4	06:42	06:44	06:30	06:08	05:50	05:43 18:05-18:24/19	05:49 18:11-18:31/20	05:58	06:02	06:05	06:12	06:27
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:26	18:03	17:45	17:43
5	06:43	06:43	06:30	06:07	05:50	05:43 18:05-18:24/19	05:49 18:11-18:31/20	05:58	06:03	06:05	06:13	06:28
	17:57	18:14	18:23	18:28	18:33	18:43	18:50	18:44	18:25	18:02	17:44	17:43
6	06:43	06:43	06:29	06:07	05:49	05:43 18:05-18:24/19	05:49 18:11-18:30/19	05:58	06:03	06:05	06:13	06:28
	17:58	18:15	18:23	18:28	18:34	18:43	18:50	18:44	18:24	18:01	17:44	17:43
7	06:43	06:43	06:28	06:06	05:49	05:43 18:05-18:24/19	05:50 18:12-18:31/19	05:58	06:03	06:05	06:13	06:29
	17:58	18:15	18:23	18:28	18:34	18:44	18:50	18:43	18:24	18:01	17:44	17:43
8	06:44	06:42	06:28	06:05	05:48	05:43 18:05-18:25/20	05:50 18:12-18:31/19	05:59	06:03	06:05	06:14	06:29
	17:59	18:15	18:24	18:28	18:34	18:44	18:50	18:43	18:23	18:00	17:44	17:44
9	06:44	06:42	06:27	06:05	05:48	05:43 18:05-18:25/20	05:50 18:12-18:31/19	05:59	06:03	06:06	06:14	06:30
	18:00	18:16	18:24	18:28	18:34	18:44	18:50	18:42	18:22	17:59	17:43	17:44
10	06:44	06:42	06:26	06:04	05:48	05:44 18:05-18:25/20	05:50 18:12-18:30/18	05:59	06:03	06:06	06:15	06:30
	18:00	18:16	18:24	18:28	18:35	18:45	18:50	18:42	18:21	17:58	17:43	17:44
11	06:44	06:41	06:26	06:03	05:47	05:44 18:07-18:26/19	05:51 18:13-18:31/18	05:59	06:03	06:06	06:15	06:31
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:58	17:43	17:45
12	06:44	06:41	06:25	06:03	05:47	05:44 18:07-18:26/19	05:51 18:13-18:31/18	05:59	06:03	06:06	06:15	06:32 17:11-17:14/3
	18:01	18:17	18:24	18:29	18:35	18:45	18:50	18:41	18:20	17:57	17:43	17:45
13	06:45	06:41	06:24	06:02	05:46	05:44 18:07-18:27/20	05:51 18:14-18:30/18	06:00	06:03	06:06	06:16	06:32 17:10-17:17/7
	18:02	18:17	18:25	18:29	18:36	18:46	18:50	18:40	18:19	17:56	17:42	17:45
14	06:45	06:40	06:24	06:01	05:46	05:44 18:07-18:27/20	05:52 18:15-18:31/18	06:00	06:03	06:06	06:16	06:33 17:09-17:18/9
	18:03	18:18	18:25	18:29	18:36	18:46	18:50	18:40	18:18	17:56	17:42	17:46
15	06:45	06:40	06:23	06:01	05:46	05:44 18:07-18:27/20	05:52 18:15-18:31/18	06:00	06:03	06:07	06:17	06:33 17:09-17:19/10
	18:03	18:18	18:25	18:29	18:36	18:46	18:49	18:39	18:17	17:55	17:42	17:46
16	06:45	06:39	06:22	06:00	05:46	05:44 18:07-18:27/20	05:52 18:16-18:30/14	06:00	06:03	06:07	06:17	06:34 17:09-17:20/11
	18:04	18:19	18:25	18:29	18:37	18:46	18:49	18:38	18:17	17:54	17:42	17:47
17	06:45	06:39	06:21	05:59	05:45	05:44 18:07-18:27/20	05:53 18:17-18:31/14	06:00	06:03	06:07	06:18	06:34 17:09-17:21/12
	18:04	18:19	18:25	18:30	18:37	18:47	18:49	18:38	18:16	17:54	17:42	17:47
18	06:45	06:38	06:21	05:59	05:45	05:45 18:08-18:26/20	05:53 18:18-18:30/12	06:00	06:03	06:07	06:18	06:35 17:09-17:21/12
	18:05	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:15	17:53	17:42	17:47
19	06:45	06:38	06:20	05:58	05:45	05:45 18:08-18:26/20	05:53 18:19-18:30/11	06:01	06:04	06:07	06:19	06:35 17:10-17:22/12
	18:06	18:19	18:25	18:30	18:37	18:47	18:49	18:37	18:14	17:53	17:42	17:48
20	06:45	06:37	06:19	05:57	05:45	05:45 18:08-18:26/20	05:54 18:20-18:29/9	06:01	06:04	06:08	06:19	06:36 17:09-17:23/14
	18:06	18:20	18:26	18:30	18:38	18:47	18:49	18:36	18:13	17:52	17:41	17:48
21	06:45	06:37	06:18	05:57	05:44	05:45 18:08-18:26/20	05:54	06:01	06:04	06:08	06:20	06:36 17:10-17:24/14
	18:07	18:20	18:26	18:30	18:38	18:48	18:49	18:35	18:13	17:51	17:41	17:49
22	06:45	06:36	06:18	05:56	05:44	05:45 18:08-18:26/20	05:54	06:01	06:04	06:08	06:20	06:37 17:10-17:24/14
	18:07	18:20	18:26	18:30	18:38	18:48	18:48	18:35	18:12	17:51	17:41	17:49
23	06:45	06:36	06:17	05:56	05:44 18:12-18:18/6	05:46 18:09-18:29/20	05:54	06:01	06:04	06:08	06:21	06:37 17:11-17:25/14
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:34	18:11	17:50	17:41	17:50
24	06:45	06:35	06:16	05:55	05:44 18:10-18:21/11	05:46 18:09-18:29/20	05:55	06:01	06:04	06:09	06:21	06:38 17:12-17:25/13
	18:08	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:10	17:50	17:41	17:50
25	06:45	06:35	06:15	05:54	05:44 18:08-18:20/12	05:46 18:09-18:29/20	05:55	06:01	06:04	06:09	06:22	06:38 17:12-17:24/12
	18:09	18:21	18:26	18:31	18:39	18:48	18:48	18:33	18:10	17:49	17:41	17:51
26	06:45	06:34	06:15	05:54	05:44 18:07-18:21/14	05:46 18:09-18:29/20	05:55	06:02	06:04	06:09	06:22	06:39 17:13-17:25/12
	18:09	18:21	18:26	18:31	18:40	18:49	18:47	18:32	18:09	17:49	17:42	17:51
27	06:45	06:33	06:14	05:53	05:44 18:07-18:21/14	05:47 18:10-18:30/20	05:56	06:02	06:04	06:09	06:23	06:39 17:13-17:25/12
	18:10	18:22	18:27	18:31	18:40	18:49	18:47	18:31	18:08	17:48	17:42	17:52
28	06:45	06:33	06:13	05:53	05:43 18:08-18:21/15	05:47 18:10-18:30/20	05:56	06:02	06:04	06:10	06:24	06:40 17:15-17:25/10
	18:10	18:22	18:27	18:32	18:40	18:49	18:47	18:31	18:07	17:48	17:42	17:53
29	06:45		06:13	05:52	05:43 18:08-18:22/18	05:47 18:10-18:30/20	05:56	06:02	06:04	06:10	06:24	06:40 17:16-17:25/9
	18:11		18:27	18:32	18:41	18:49	18:47	18:30	18:06	17:47	17:42	17:53
30	06:45		06:12	05:52	05:43 18:08-18:22/18	05:47 18:10-18:29/19	05:56	06:02	06:04	06:10	06:25	06:41 17:17-17:24/7
	18:11		18:27	18:32	18:41	18:49	18:46	18:29	18:06	17:47	17:42	17:54
31	06:44		06:11		05:43 18:08-18:22/18		05:57	06:02		06:11		06:41 17:18-17:24/5
	18:12		18:27		18:41		18:46	18:29		17:46		17:54
Potential sun hours	351	326	374	374	398	391	401	392	367	366	343	348
Sum of minutes with flicker	0	0	0	0	120	587	337	0	0	0	0	212

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-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:45 / 4

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar per WTG

WTG: 3 - Goldwind GW 2.5/109 2500 109.0 !O! hub: 90.0 m (0)

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
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

	July		August		September		October	November	December
1	05:48	06:07-06:26/19	05:57		06:02	17:55-18:11/16	06:05	06:11	06:25
	18:49		18:46		18:28		18:05	17:46	17:42
2	05:48	06:07-06:26/19	05:57		06:02	17:53-18:10/17	06:05	06:11	06:26
	18:49		18:45		18:27		18:04	17:46	17:42
3	05:48	06:07-06:25/18	05:57		06:02	17:52-18:09/17	06:05	06:12	06:26
	18:49		18:45		18:26		18:03	17:45	17:42
4	05:49	06:08-06:26/18	05:58		06:02	17:51-18:08/17	06:05	06:12	06:27
	18:50		18:44		18:26		18:03	17:45	17:43
5	05:49	06:09-06:26/17	05:58		06:03	17:51-18:08/17	06:05	06:13	06:28
	18:50		18:44		18:25		18:02	17:44	17:43
6	05:49	06:09-06:25/16	05:58		06:03	17:50-18:07/17	06:05	06:13	06:28
	18:50		18:44		18:24		18:01	17:44	17:43
7	05:50	06:10-06:26/16	05:58		06:03	17:50-18:06/16	06:05	06:13	06:29
	18:50		18:43		18:24		18:01	17:44	17:43
8	05:50	06:10-06:25/15	05:59		06:03	17:50-18:05/15	06:05	06:14	06:29
	18:50		18:43		18:23		18:00	17:44	17:44
9	05:50	06:11-06:24/13	05:59		06:03	17:50-18:04/14	06:06	06:14	06:30
	18:50		18:42		18:22		17:59	17:43	17:44
10	05:50	06:12-06:25/13	05:59		06:03	17:51-18:03/12	06:06	06:15	06:30
	18:50		18:42		18:21		17:58	17:43	17:44
11	05:51	06:13-06:24/11	05:59		06:03	17:52-18:03/11	06:06	06:15	06:31
	18:50		18:41		18:20		17:58	17:43	17:45
12	05:51	06:14-06:22/8	05:59		06:03	17:55-18:02/7	06:06	06:15	06:32
	18:50		18:41		18:20		17:57	17:43	17:45
13	05:51	06:16-06:20/4	06:00		06:03		06:06	06:16	06:32
	18:50		18:40		18:19		17:56	17:42	17:45
14	05:52		06:00		06:03		06:06	06:16	06:33
	18:50		18:40		18:18		17:56	17:42	17:46
15	05:52		06:00		06:03		06:07	06:17	06:33
	18:49		18:39		18:17		17:55	17:42	17:46
16	05:52		06:00		06:03		06:07	06:17	06:34
	18:49		18:38		18:17		17:54	17:42	17:47
17	05:53		06:00		06:03		06:07	06:18	06:34
	18:49		18:38		18:16		17:54	17:42	17:47
18	05:53		06:00		06:03		06:07	06:18	06:35
	18:49		18:37		18:15		17:53	17:42	17:47
19	05:53		06:01		06:04		06:07	06:19	06:35
	18:49		18:37		18:14		17:53	17:42	17:48
20	05:54		06:01		06:04		06:08	06:19	06:36
	18:49		18:36		18:13		17:52	17:41	17:48
21	05:54		06:01		06:04		06:08	06:20	06:36
	18:49		18:35		18:13		17:51	17:41	17:49
22	05:54		06:01		06:04		06:08	06:20	06:37
	18:48		18:35		18:12		17:51	17:41	17:49
23	05:54		06:01		06:04		06:08	06:21	06:37
	18:48		18:34		18:11		17:50	17:41	17:50
24	05:55		06:01		06:04		06:09	06:21	06:38
	18:48		18:33		18:10		17:50	17:41	17:50
25	05:55		06:01		06:04		06:09	06:22	06:38
	18:48		18:33		18:10		17:49	17:41	17:51
26	05:55		06:02		06:04		06:09	06:22	06:39
	18:47		18:32		18:09		17:49	17:42	17:51
27	05:56		06:02		06:04		06:09	06:23	06:39
	18:47		18:31		18:08		17:48	17:42	17:52
28	05:56		06:02		06:04		06:10	06:24	06:40
	18:47		18:31		18:07		17:48	17:42	17:53
29	05:56		06:02		06:04		06:10	06:24	06:40
	18:47		18:30		18:06		17:47	17:42	17:53
30	05:56		06:02	17:58-18:06/8	06:04		06:10	06:25	06:41
	18:46		18:29		18:06		17:47	17:42	17:54
31	05:57		06:02	17:56-18:09/13			06:11		06:41
	18:46		18:29				17:46		17:54
Potential sun hours	401		392		367		366	343	348
Sum of minutes with flicker	187		21		176		0	0	0

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-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:46 / 1

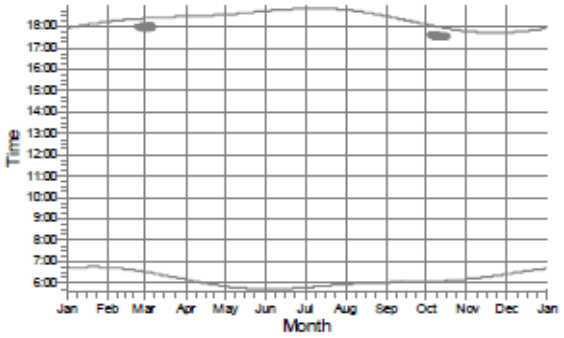
Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com

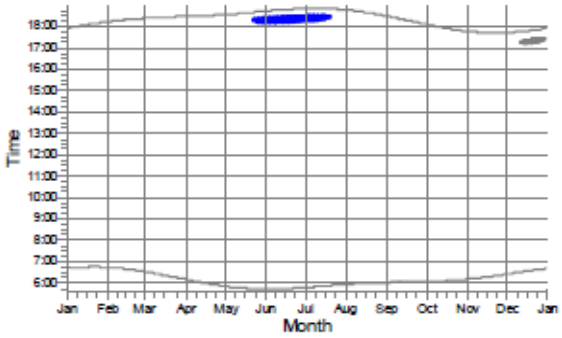
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Calendar per WTG, graphical

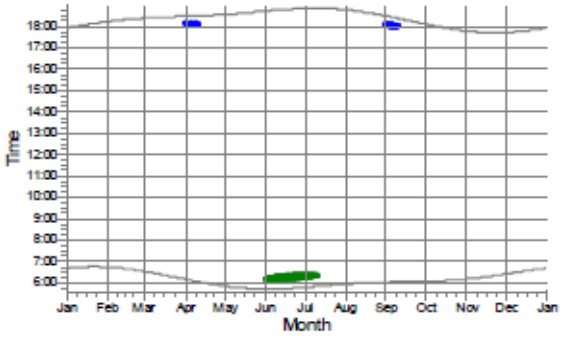
1: Goldwind GW 2.5/109 2500 109.0 IO! hub: 90.0 m (0)



2: Goldwind GW 2.5/109 2500 109.0 IO! hub: 90.0 m (0)



3: Goldwind GW 2.5/109 2500 109.0 IO! hub: 90.0 m (0)



Shadow receptor

A: Community on SW of Project

C: Community on SE of project

D: Kum Mo Din Sai Community

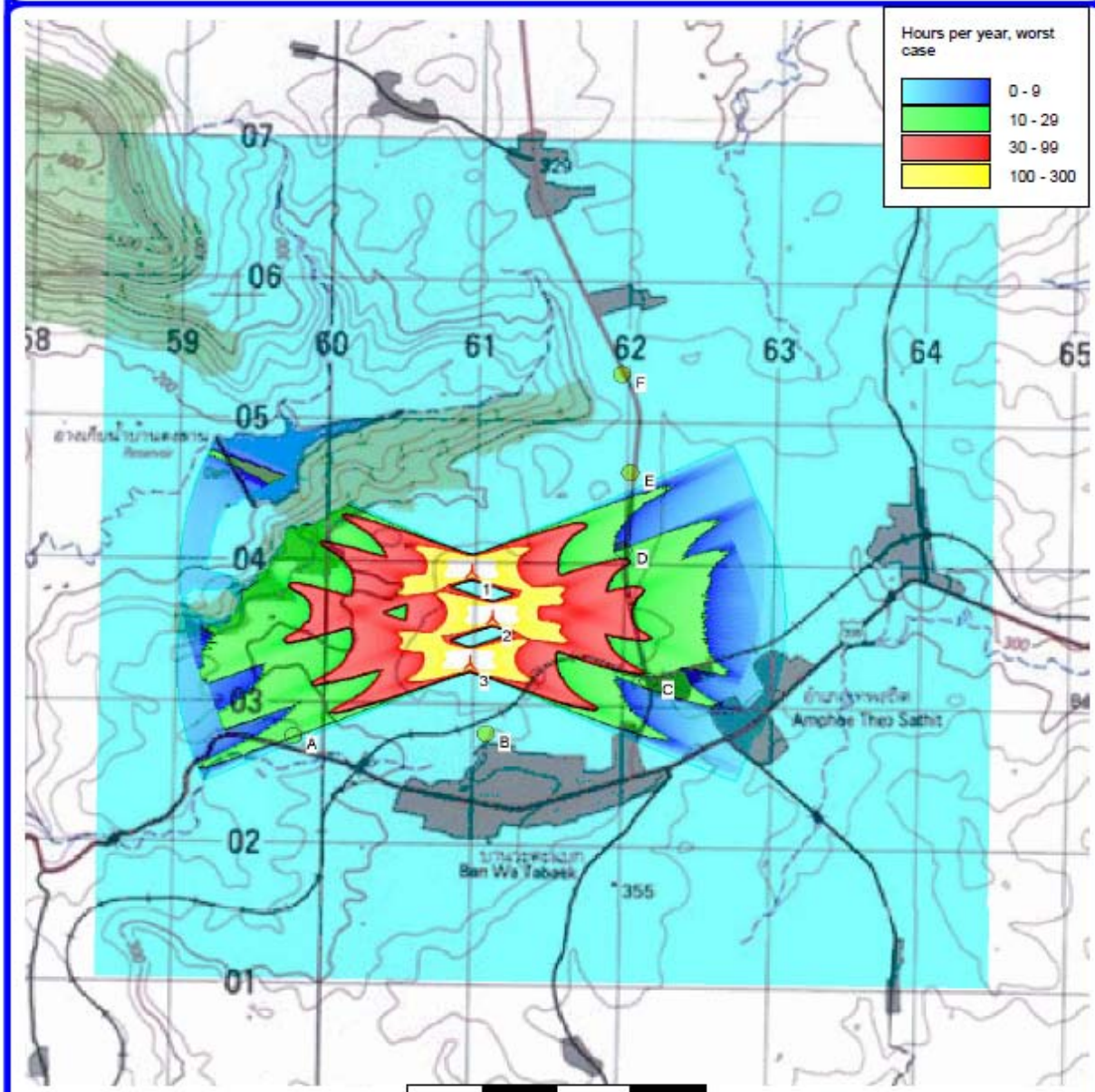
Project:
THEPANA Wind farm_Watabak2

Printed/Page
13/9/2012 13:46 / 1

Licensed user:
Institute of Technology Ayothaya
This license is ONLY to be used for educational purposes
- -

Mr. Assadawut Khanto / bloommatador@hotmail.com
Calculated:
10/9/2012 18:18/2.7.486

SHADOW - Map



Map: Thepana wind farm , Print scale 1:40,000, Map center UTM WGS 84 Zone: 47 East: 761,500 North: 1,704,000

New WTG Shadow receptor

Isolines showing shadow in Hours per year, worst case

0 10 30 100

Appendix 4

Social Due Diligence Report

I. INTRODUCTION

A. Project Description

1. The 7.5 megawatt (MW) Theppana Wind Power Project is part of Electricity Generating Public Company Limited's (EGCO) long-term growth strategy that places emphasis on expanding investments into renewable energy to strengthen its business in the independent power generation sector of Thailand. With its recent acquisitions and projects currently under development, EGCO plans to increase its installed renewable energy capacity to over 300 MW by 2015.[4] The project entails the construction and operation of a 7.5 MW wind power generation plant consisting of 3 wind turbines (2.5 MW each). The project will utilize Xinjiang *Goldwind* Science & Technology Company Limited (Goldwind) wind turbines, one of the leading and most established wind turbine manufacturers in the People's Republic of China (PRC). The project will be implemented under a PPA up to 6.9 MW with PEA under the VSPP program.

B. Methodology

2. This report was based on the following: project documents reviewed, on-site observation (during due diligence last July 4-6, 2012) and interview with a land owner/farmer, EGCO technical staff and consultant engaged by EGCO to prepare the IEE Report.

II. FINDINGS OF THE SOCIAL DUE DILIGENCE

A. Land Acquisition and Involuntary Resettlement

3. The Project will be located in Watabaek 2 sub-district, Thepsathit district, Chaiyaphum province where 3 wind turbine generators (WTGs) will be installed. The project has a total land requirement of 1.3 hectares (8.125 rais) during construction and 0.9 hectare (5.625 rais) during operation.[5] The proposed project site is owned by the Agricultural Land Reform Office (ALRO) and the project will not displace any individual or household.

4. Theppana Wind Farm Company Limited (TPW) entered into a long-term lease agreement with the ALRO for the location of turbines, access road, substation and green area. The ALRO lease agreement also includes consent from 21 farmer beneficiaries who are using the area for agricultural production. Consent of these individuals were obtained by the project sponsor after consulting and negotiating with them.[6] The agreed rental rate for ALRO land is 199,850 baht per annum[7] for a 27 year term. A fixed rate per plot or per rai was agreed to be paid by EGCO to the affected farmer beneficiaries and the consent given was good for the duration of the project.

---

[4] EGCO's current operating renewable energy installed capacity includes 9.9 MW biomass, and 104.5 MW solar.
[5] One rai = 1,600 square meters
[6] Consultation and negotiation with farmer beneficiaries started in 2009, consent was secured between 3 May 2010 and 5 July 2010.
[7] The rental rate is subject to change in accordance with the relevant regulation of Land Reform Committee (LRC).

5. Summary of farmer beneficiaries who gave their consent to TPW to use part of their land for the project area as follows:

Table: Summary of Farmer Beneficiaries Who Gave Consent

Project Structure	Number of Affected Farmer Beneficiaries		
	Male	Female	Total
Turbine, Sub-station and Access Road	1	1	2
Access Road and Green Area	3	1	4
Green Area only	7	5	12
Total	**11**	**7**	**18**

Sources: EGCO and LTA Report

6. To date, consent of all the affected farmer beneficiaries have been secured by the project sponsor. The lease agreement with ALRO, which include the consent of the farmer beneficiaries as attachment, have been registered with the land office.

7. **Willingness of Farmer Beneficiaries to Give Consent.** A landowner/farmer who was initially identified as project affected person[8] was interviewed during Due Diligence Mission. She has been around when the negotiation with land owners and farmer beneficiaries started. She expressed that the affected individuals, including her, willingly agreed to give their consent and allow the project sponsor to use portion of the land that they are utilizing for cassava production for the implementation of the project. The consent was given with the understanding that there will be an agreed fee depending on the area of land that will be affected. She also reported that negotiation was done openly and free from coercion or intimidation and that there are no outstanding issues related to land acquisition.

8. The willingness of the affected farmers, according to her, was due to the following reasons: (a) the percentage of the area that will be affected as against the total area utilized for cassava production is considered small, and (b) the rental fee is higher than the net income from the land.[9]

9. **Grievance Mechanism.** During interview with an EGCO staff, the ADB Safeguards Team was informed that a Grievance Redress Mechanism will be set up to address project-related issues during construction and operation. EGCO will be hiring a Community Relations (CR) officer that will be based in the project site and will be reporting directly to the Plant Manager. This CR officer has already been identified and reported to have been involved during consultation and negotiation with the project affected persons and is very familiar with the project.

[8] During Due Diligence, the project was designed to generate 15MW involving 6 wind turbines. It was later on reduced to 3 turbines.

[9] Cassava is planted once a year with an average income of 10,000 baht per rai.

B. Indigenous Peoples

10. Chaiyaphum Province is around 250 kilometers from Bangkok and although it was founded over 2 centuries ago during the early Rattanakosin period by a group of Vientiane people, majority of the people in the project site identify themselves as Thai. The project area and vicinity is not known to be settled, claimed or owned by any ethnic/Indigenous Peoples group.

C. Other Social Dimensions

11. Women were significantly represented during public consultation conducted and during the conduct of perception survey, they articulated their concerns about the project. The participants in the consultation requested to be clarified on the following matters: potential impact of the project to the community, how the community can benefit from the project, possible restrictions on land use, rental fee for affected land area and employment opportunities during construction, These issues were satisfactorily explained by the project sponsor representatives during the activity. Those present in the activity has no objection on the proposed project. It was just requested during the consultation that the community be regularly updated on the schedule of project activities.

12. During the construction phase, there will be employment opportunities among local community members. Although the project sponsor expressed its position that there will be no discrimination in hiring of workers/laborers during construction, direct employment of women may be limited because most of the work available will be physically demanding. They may be considered and/or prioritized for less physically demanding tasks.

III. CONCLUSIONS AND RECOMMENDATIONS

13. Based on information gathered, the following conclusions relevant to Safeguard Policy Statement (SPS) SR 2 principles and requirements are made:

(i) The project will temporarily affect areas used for farming during the construction phase and permanently during the operation phase. The compensation in the form of rental fee for permanent damage to crops in the affected area has already been agreed to the satisfaction of the affected farmers. The consent of the farmer beneficiaries forms part of the lease agreement with ALRO. No physical displacement will occur.

(ii) The amount of agreed rental fee is higher than the net income that can be derived from the affected agricultural land which is presently planted to cassava. The requirement of replacement cost compensation is sufficiently met.

(iii) The lease agreement concluded with ALRO which is the legal owner of the land is conducted according to the laws of Thailand. The compensation agreement with the affected farmers was reached openly and freely without the use of coercion, intimidation or deceit.

(iv) The project area and vicinity is not known to be settled, claimed or owned by any ethnic/Indigenous Peoples group.

(v) Significant number of women participated during public consultation. Due to the nature of work required by the project and national regulations, there will be limited opportunities for direct employment for women during construction.

(vi) Grievance Redress Mechanism will be set up to address project-related issues during construction and operation. EGCO will be hiring a Community Relations (CR) officer that will be based on the project site and will be reporting directly to the Plant Manager.

14. Except for the timely operationalization of grievance redress mechanism, the arrangements for land acquisition and compensation are found to be compliant with the SPS SR2 policies and principles. There are no outstanding issues nor any corrective actions required for the proposed project.

ANNEX

Names of People Met

Name	Position	Affiliation
Sumalee Boonlert	Project Afffected Person/Farmer	
Sorawit Na Nongkhai	Consultant	Greener
Sarocha Payungpongsanond	Vice President - Business Development	EGCO
Tanapong Noimonvite	Vice President – Operation and Maintenance	EGCO