Study on Economic Partnership Projects in Developing Countries in FY2016

Study on Wind Power Energy Generation Project in Caraga Region of the island of Mindanao, Republic of the Philippines

Final Report

February 2017

Prepared for:

Ministry of Economy, Trade and Industry

Presented by :

Chodai Co.,Ltd.

Shizen Energy Inc.

Preface

This report is a collation of the results of a study concerning a wind power energy generation project in the Caraga region of the island of Mindanao, Republic of the Philippines, part of the Japanese Ministry of Economy, Trade and Industry's 2016 program for Projects to Promote Overseas Sales of Quality Energy Infrastructure Systems, contracted to Chodai Co., Ltd. and Shizen Energy Inc.

The study in question pertains to a proposed wind power project in the Caraga region of the island of Mindanao in the Republic of the Philippines which is planned to take advantage of the latent wind power resources of the area to produce electricity in order to ease the power deficiencies facing the region and contribute to its economic development. The project will also improve the attractiveness of the region for the establishment of factories for overseas corporations, particularly aiding the involvement of companies from Japan. This will assist in the economic development of the region and in job creation, and is also expected to contribute through this in a wider sense to the amelioration of the more fundamental problem facing the island: the establishment and maintenance of peace and a more stable way of life for its citizens.

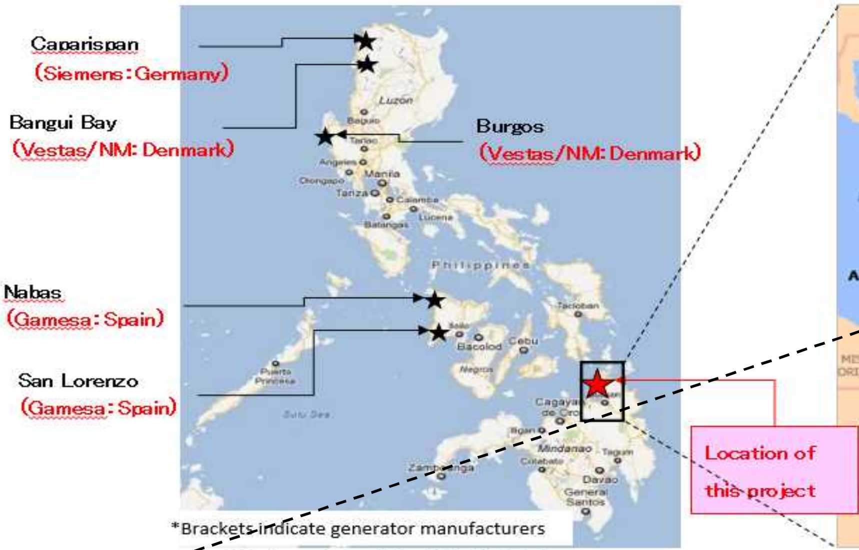
It is our fervent desire that this report aids in the realization of this project and proves useful for the reference of all those involved.

February 2017

Chodai Co., Ltd.

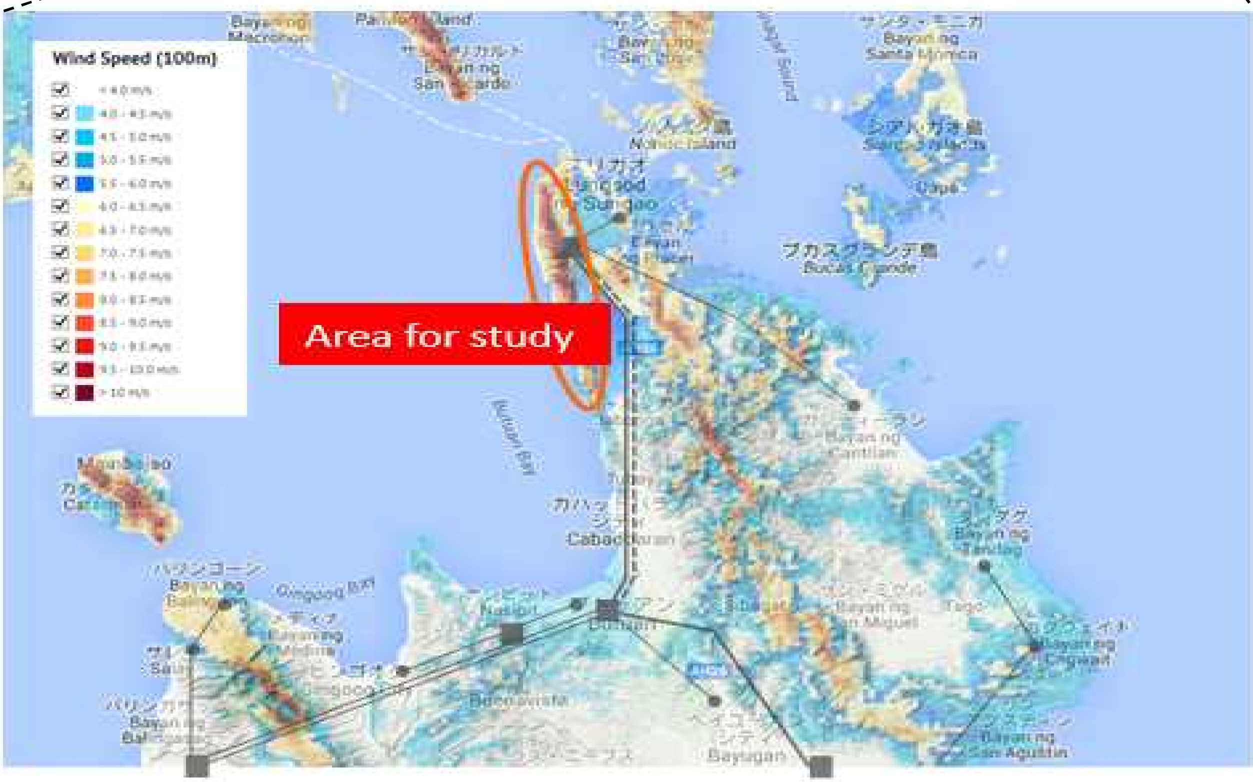
Shizen Energy Inc.

Project Location Maps



Mindanao, Republic of The Philippines

Caraga Administrative Region, Mindanao



Provinces of Agusan del Norte and Surigao del Norte, Caraga Administrative Region

Source: Created by the study team

Provinces of Agusan del Sur and Surigao del Sur, Caraga Region, Republic of the Philippines

Abbreviations Table

Abbreviation	Official name
ANECO	Agusan del Norte Electric Cooperative
ASEAN	Association of South East Asian Nations
BSP	Bangko Sentral ng Pilipinas (Central Bank of the Philippines)
B/C	Benefit / Cost
CNC	Certification of Non-Coverage
DENR	Department of Environment and Natural Resources
DOE	Department of Energy
ECA	Environmentally Critical Area
ECC	Environmental Compliance Certificates
ECP	Environmentally Critical Project
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
EMB	Environmental Management Bureau
EPCC	Equi-Parco Construction Company
EPIRA	Electric Power Industry Restructuring Act
ERC	Energy Regulatory Commission
FS	Feasibility Study
FIRR	Financial Internal Rate of Return
FIT	Feed-in Tariff
GDP	Gross Domestic Product
GOCC	Government Owned and Controlled Corporation
IEE	Initial Environmental Examination
IMF	International Monetary Fund
IPP	Independent Power Producer
IRR	Internal Rate of Return
JBIC	Japan Bank for International Cooperation
JCM	Joint Crediting Mechanism
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
MIFL	Moro Islamic Liberation Front
MinDa	Mindanao Development Authority
NAMRIA	National Mapping and Resource Information Authority
NEA	National Electrification Administration
NEDA	National Economic and Development Authority

Abbreviation	Official name
NEDO	New Energy and Industrial Technology Development Organization
NIPAS	National Integrated Protected Areas System
NGCP	National Grid Corporation of the Philippines
NPC	National Power Corporation
NREP	National Renewable Energy Program
NREL	The National Renewable Energy Laboratory
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
O&M	Operation & Maintenance
PD	Project Description
PEISS	Philippine Environmental Impact Statement System
PPA	Power Purchase Agreement
PSA	Philippine Statistics Authority
PSALM	Power Sector Assets and Liabilities Management Corporation
REMB	Renewable Energy Management Bureau
SCF	Standard Conversion Factor
SPUG	Small Power Utilities Group
SPC	Special Purpose Company
SURNECO	Surigao del Norte Electric Cooperative
THRC	Twinpeak Hydro Resources Corporation
TRANSCO	National Transmission Corporation

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Summary

(1) Project Background and Necessity

The island of Mindanao in the Philippines continues to suffer from issues of employment shortages and poverty originally brought about as a result of the military conflict which has plagued the area. The tireless and concerted efforts made by the Japanese government over the past few years have contributed to the signing of a peace agreement between the Philippine government and the Moro Islamic Liberation Front (MILF), and preparation is now underway for the establishment of autonomous local body government in the area. In the near future, it is anticipated that infrastructural investment and regional development, including Japanese ODA, will undergo rapid growth, and that investment from the private sector will also expand significantly. Relations between Japan and the Philippines continue to be positive; following the election in June 2016 of the former mayor of Davao City, Rodrigo Duterte, as President of the Philippines, he paid a visit to Japan and met with Prime Minister Abe, a visit which was reciprocated by Prime Minister Abe in January of 2017, accompanied by a pledge for Japan to provide 1 trillion yen in economic aid to the Philippines. Additionally, Japan and the Philippines signed a JCM agreement on January 12th, 2017, making the Philippines Japan's 17th JCM partner, and leading to the anticipation of further economic growth as the relationship between the two nations deepens further. Hopes are extremely high for the future peace and economic development of the island.

The Caraga region, in the northeast of the island of Mindanao, has thriving timber and agricultural and fisheries industries, but problems in terms of basic infrastructure in such areas as electricity supply have restricted its economic development. Severe shortages in employment opportunities have also led to a continuous loss of talented human resources to other regions. The region features no permanently operational electricity-generating facilities, with power provided from Iligan City, approximately 300 kilometers away. This has led to problems related to long-distance power distribution, such as increased costs, power loss, and instability of supply, all of which have served to hamper regional development. In an initial wind power generation potential study carried out by Shizen Energy Inc., it was established that the average wind speed of the planned location for this project is 9.3 to 13.0 m/s (the standard level required for commercialization in Japan is considered to be 6.0 m/s), with a stable wind direction. With the area also largely protected from the effects of typhoons, the study established that the planned area has extremely high potential for the development of a wind power generation plant. Starting from this point, this study is intended as an examination of the feasibility of the implementation of a wind power generation project in the Caraga region of the island of Mindanao in the Philippines.

The population of the Philippines stands at 100.98 million (as of the 2015 national census) and is growing at a rate of just over 1% per annum. Well placed to receive the so-called "demographic bonus" over the next 40 years, it has one of the highest market potentials in Southeast Asia over the long term. In addition to this, its economy has maintained high levels of growth in recent years, recording 7.1% growth in 2013 and 6.1% in 2014, figures which outstrip most of its Southeast Asian neighbors. Increasing consumption levels as a result of stable living costs and increased spending on infrastructure provide powerful evidence for the projection of relatively high growth for the Philippines in the foreseeable future.

As a result of this economic growth, electricity demand in the Philippines continues to grow every year, with peak demand for the entire country in 2014 reaching 11,822 MW. This can be broken down into figures of 8,717 MW for Luzon, 1,636 MW for the Visayas, and 1,469 MW for Mindanao. Projections for electricity demand from 2015 to 2030 place the per annum increase for the entire nation at 4.6%. Broken down by island group, however, we can see that in comparison to 4.1% for Luzon and 5.7% for the Visayas, Mindanao's anticipated yearly increase in demand is the largest at 6.1%. The island of Mindanao is also widely recognized as an area that suffered from severe electricity shortages up until just a few years ago, with chronic power outages adversely affecting economic growth. Up until around 2014, electricity shortage was a serious problem, but the immediate needs of the area were addressed by the establishment and operation of new large-scale coal-powered thermal power plants in 2015 and 2016. As a result, it is now believed that the island of Mindanao should enjoy an electrical power supply surplus from 2017 to 2025. While it is certainly true that the frequency of power stoppages has declined since the operation of new large-scale coal-powered thermal power plants in 2015, daily power outages were experienced once again when one experienced a temporary operational failure in May 2016. This proves that the current power supply situation is heavily dependent on these new coal-powered thermal power plants. So fragile, in fact, is the situation, that the operational failure of a single such plant is enough to immediately create a situation in which supply is insufficient to meet demand. With the economy projected to develop rapidly in the future and the yearly electricity demand set to grow by 100 to 200 MW each year, unless something is done soon, the area will once again suffer from chronic power shortages within a few short years. Furthermore, while it is true that on paper the generational capacity of the power plants on the island of Mindanao is more than enough to cover current needs, many of these facilities are in need of maintenance and upgrading, meaning that there is a significant gap between the rated capacity of all of the power plants in the region and their practical generating capacity. It is clear that the development of further power sources remains a priority for the area in order to handle increasing supply demands in the future. At the present time, there are very few such projects in development, a fact regarding which the local government has noted its concern.

Considering the supply and demand balance of its electricity stocks for the next decade or two, it is essential that the Philippine government implements both energy saving schemes and secures new energy sources. It is believed that under these specific circumstances, the development of new, environmentally-friendly power generation facilities on the island of Mindanao, isolated as it is in terms of electrical networks from both Luzon and the Visayas, will serve to contribute significantly to the alleviation of these issues facing the Philippines.

（2） Basic Policies Concerning Project Details

1) Business Potential of a Wind Power Generation Project

Several areas with potential as locations for a wind power generation project in the provinces of Agusan del Norte and Surigao del Norte in the Caraga region were selected based on NREL data, and evaluated via data analysis in the four categories of wind conditions, topography, transport and logistics infrastructure (ports and roads), and electricity networks. With the addition of turbulence evaluation simulations, an overall evaluation of each location was reached. As a result of this process, an area on the ridge on the western edge of the provinces of Agusan del Norte and Surigao del Norte, outside of the environmentally protected zones in the area, was identified as having the highest potential, and worthy of a focused study (Potential Area 1).

The next step in the process would fundamentally be the erection of a wind-measuring pole in the location of the area for further study, followed by the gathering and analysis of data obtained therefrom. However, as an SPC for the project has not yet been registered and an RE contract has not yet been signed with the DOE, the erection of a measuring pole in the area proved impractical. As a compromise measure, therefore, it was decided to use the Cabadbaran area for this, on land owned by one of our local partner corporations, which allowed us freedom of choice for location and incurred no costs for land usage.

As this location lies some 34 kilometers from the area identified for further study, the data obtained here (from a 34-meter high pole) was adjusted for height using the wind profile power law and compared to the NREL's data (from a 30 meter-high model) for evaluation. The results revealed that the actually-recorded data matched the NREL data within an acceptable margin of error, underscoring the reliability of the NREL data. Additionally, the NREL data was able to be used in the creation of a high-resolution wind profile map. This map enabled a projection to be made regarding the area for further study; specifically, that the wind power obtained in the area had sufficient potential for a project based there to be profitable.

2) Current Status and Future Plans for Wind Condition-Measuring Poles

Two further poles for measuring wind conditions are planned for erection in the north and south of the area for focused study. (Financing for these poles has already been obtained, and they will not be considered as part of the costs of the project itself.) These poles will be used to continue to gather wind condition data.

3) Phase Distribution in the Area for Additional Study

Considering the issues involved in the installation of wind turbines and the connection of the turbines to the electricity distribution network, it will be difficult to carry out the entire process at once. Therefore, it has been decided to divide the project into three geographical phases. In terms of the order in which the phases will be implemented, they have been analyzed in the below manner based on the key factor of transportation distance.

i) Phase 1 has been given the highest priority as a result of possessing three specific points of merit: existing roads run all the way to the ridgeline for phase 1, the topography of the area is relatively gentle and well-suited for a wind power generation project, and phase 2 has the ability to be expanded more 50MW.

ii) Although phase 3 has the lowest degree of difficulty, new roads will need to be constructed to reach the ridgeline. Additionally, the existence of a protected area near the area makes phase 3 an unlikely candidate for further expansion. For these reasons, it has been given the lowest priority.

iii) Based on the factors outlined in i) and ii) above, it has been decided that the order of priority will be phase 1, phase 2, then phase 3. A final decision on the order of construction will be made after obtaining final wind condition data and following coordination meetings with the NGCP.

(3) Project Overview

This will be a renewable energy project involving the erection of a series of wind turbines (2.0 MW per turbine, manufactured by Hitachi, Ltd.) on the ridge line (other than the area covered by the environmentally protected zone) in the west of the provinces of Surigao del Norte and Agusan del Norte, in the Caraga region in the northeast of the island of Mindanao. The scale of the generating capability of the project will be approximately 150 MW in total, with construction divided into three phases.

1) Total Business Costs

Costs are estimated at 10.6 billion yen per 50 MW phase. There are three phases, yielding a total cost of 31.8 billion yen.

2) Overview of the Results of the Preliminary Financing and Economic Analysis of the Project

The project IRR, Equity IRR, NPV, average DSCR, minimum DSCR, and investment payback period are as outlined in the below table.

Items	Units	Figures
Project IRR	%	9.73%
Equity IRR	%	9.98%
NPV	Peso	883,853,832
Average DSCR	N/A	1.51
Minimum DSCR	N/A	1.34
Payback period	Years	15 years

The project IRR exceeds the long-term interest rates of the Philippines, while the NPV is positive and the minimum DSCR exceeds 1.3. All of these data points suggest that the project is worthy of investment. However, the investment payback period is relatively long at 15 years, which means that should the abovementioned economic conditions worsen in the future, there may be a need to re-examine the viability of the enterprise.

Risk factors identified in the cash flow analysis include increased costs related to deterioration over time and schedule delays.

With respect to deterioration of the facilities over time, plans have been put in place to conduct regular maintenance checks from the perspectives of both remote monitoring stations and practical daily on-site work, allowing for the swift replacement of parts and other consumables when identified as necessary by either maintenance checks or operational faults. This should ensure that any age-related deterioration of the facilities is kept to an absolute minimum. As a result, this factor has not been considered significant when analyzing the viability of the project.

Further, should the project site be designated as a NIPAS area, it will become necessary to consult with local indigenous peoples and form an agreement regarding land usage rights and compensation. Decisions regarding the designation of the area as a NIPAS area or otherwise will be carried out by both local government bodies and the National Commission on Indigenous People (NCIP). This issue will be confirmed with both parties immediately following the explanation of the proposed business model to local government authorities. Even in the instance that the project site is designated as a NIPAS area, it will still be possible to carry out consultations with the indigenous peoples and reach an agreement with them after a decision regarding project implementation is made and before an EIS application is made. Therefore, it is not believed that this will be a factor restricting the overall project schedule.

In order to evaluate the project's economic effects in terms of efficiency of resource distribution to the national economy, EIRR has been calculated in the following manner. EIRR allows for the calculation of overall return by defining costs as "that which will lower the national income (= economic costs)", and benefits as "that which will increase the national income (= economic benefits)."

To calculate economic costs, we must first determine the Standard Conversion Factor (SCF) which will allow for the conversion of the costs of non-tradable commodities to international standards. It should be noted that as data relating to total export customs value have not been released by either the Philippine government or the World Bank, it was not considered when calculating the SCF. The final calculations revealed an SCF of 0.95.

As a basic overview of the cost benefit analysis of the project, it has been calculated that over the 20-year span of the project, total costs are expected to amount to PHP 5,595 million, while total benefits are expected to be PHP 9,067 million, for a B/C ratio of 1.62, and a net benefit of PHP 3,472 million. The EIRR of 6.55% also far outstrips the Philippines' policy interest rate of 3%, further reinforcing the societal value of the project.

3) Analysis of Environmental and Social Factors

With respect to land acquisition, the National Integrated Protected Areas System (NIPAS) Act was enacted by the government of the Republic of the Philippines in order to protect regional natural resources, biodiversity and locations of historic and cultural value. Additionally, the Rules and Regulations Implementing Republic Act No. 8371 were signed and ratified by the Office of the President, National Commission on Indigenous Peoples (NCIP), before the Indigenous Peoples' Rights Act was enacted in 1997. Should the planned project site be designated as a NIPAS area, then all development activity in the area will be prohibited. For this reason, the establishment of whether or not the planned project site will fall into a NIPAS area will be of the utmost importance.

At the present time, it is unclear whether the planned project site will be designated as a NIPAs area under the IPRA Law. In the instance that it is designated as such, the proponent of the project will be required to hold consultation meetings with ethnic minorities and indigenous peoples in the affected area regarding land usage permission and compensation, with representatives of the NCIP present as a third party. Before the project can be carried out, a certificate of free, prior and informed consent (FPIC) must also be obtained. It is therefore highly preferable that investigations into this matter are carried out immediately following the explanations of the business venture to local government bodies, and that all appropriate considerations are made to those affected.

In terms of the tasks which need to be undertaken by the implementing entities in the Philippines for the realization of the project, we remain in the preliminary investigative phase. In terms of the environmental impact of the project, the environmental impact assessment (EIA), needed for the ECC application, which is in turn necessary for the project's implementation, has not yet been carried out. In order to proceed with the project, from an environmental impact standpoint the following will need to be carried out.

- The swift implementation of an EIA and the creation of an EIS for the project in accordance with the PEISS Law of the Republic of the Philippines and all other relevant rules and regulations.
- Approval of the EIS by the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR), and the acquisition of an ECC.

(4) Technical Advantages of Japanese Companies

1) Advantages in Business Management

The advantages of the participation of a Japanese company on the operational side of this project are as follows.

Table 1: Management Advantages of a Japanese Company for the Project

Management ability	・ The ability to comprehensively organize and analyze the project from a wide range of perspectives centered on its viability as a business model. ・ Highly-developed project management capability allowing for the strict management of scheduling, quality and costs through until the completion of the project.
Problem-solving ability	・ The ability to use new ideas and ingenuity to improve upon areas of concern and solve major problems. ・ The ability to view the project over the long term to predict and avoid future problems as well as immediate ones.
Engineering ability	・ Plant design to allow for increased capacity and yearly power output. ・ Facility layout with high workability and no wasteful inefficiencies.
Technical competitiveness	・ High levels of technical expertise in design, manufacturing, maintenance and repair. A wide range of choices for materials. ・ Highly reliable O&M ability and the ability to create plants with a long lifespan. ・ Knowhow based on extensive experience concerning the reliable operation of the plant and the minimization of any stoppages. ・ Superior performance when evaluated in terms of life-cycle costs. ・ Superior ability of Japanese companies to manage schedules and ensure timely delivery.
Financing	・ Information gathering, coordination and negotiation in order to expand the financing options of the project via the use of aid and financing facilities offered by the Ministry of Economy, Trade and Industry (METI) and the Ministry of the

	Environment under the terms of the JCM, and by the New Energy and Industrial Technology Development Organization (NEDO). ・ Aid for private enterprise-run high-efficiency renewable energy businesses which will contribute to the meeting of JCM targets. ・ Investment from Japanese corporations.

2) Technical Advantages Enjoyed by Japanese-Manufactured Wind Power Technology

The technical advantages enjoyed by Japanese companies in this field are as outlined below.

a) Wind profile analysis software

• Analysis specifically suited to wind power generation on the island of Mindanao will be undertaken, by using the appropriate wind profile analysis software for each wind condition, identifying and analyzing topographically-caused turbulence, and evaluating the standard amount of energy produced.

• As RIAM COMPACT is extremely adept at recreating topographically-caused turbulence (a primary cause of increased malfunction frequency when strong), it will be the primarily-used software for turbulence analysis.

• As MASCOT is known to provide accurate figures for power generation estimates, it will be used in this area.

b) Technical advantages of Hitachi generators

• Hitachi wind turbine generators use downwind rotors (the only company in the world to do so), in which the nacelle is positioned upwind of the rotor, as opposed to standard upwind rotors, where the nacelle is located downwind of the rotor. The benefits of this system are as outlined below.

• The downward-tilted rotor is able to more efficiently catch winds surging upwards over mountainous terrain, thereby increasing efficiency.

• Efficiency is further increased by the presence of the nacelle, located upwind of the rotor, which serves to distribute wind more efficiently towards the rotor blades.

• As the wind sensors, measuring wind direction and velocity, are housed in the nacelle upwind of the rotors, this makes it possible to obtain data on wind direction and velocity free of disturbance, allowing for more precise yaw control.

• Loads imposed on the rotor shaft can be reduced, leading to improved mechanical reliability.

• When set at standstill for storm winds, the system can be set to free yaw, thereby allowing the downwind rotor to let the winds blow by naturally. As a result, even in cases of power failure, the system can maintain a high degree of stability.

- The total electrical charge transfer, a key indicator of the generator's anti-lightning strength, is set at 600 C, an extremely high level twice the IEC I standard of 300 C.
- Turbines can be easily transported, with significantly lower weight constraints than foreign-manufactured wind power generators. For example, the nacelle can be broken into its constituent parts for transportation.

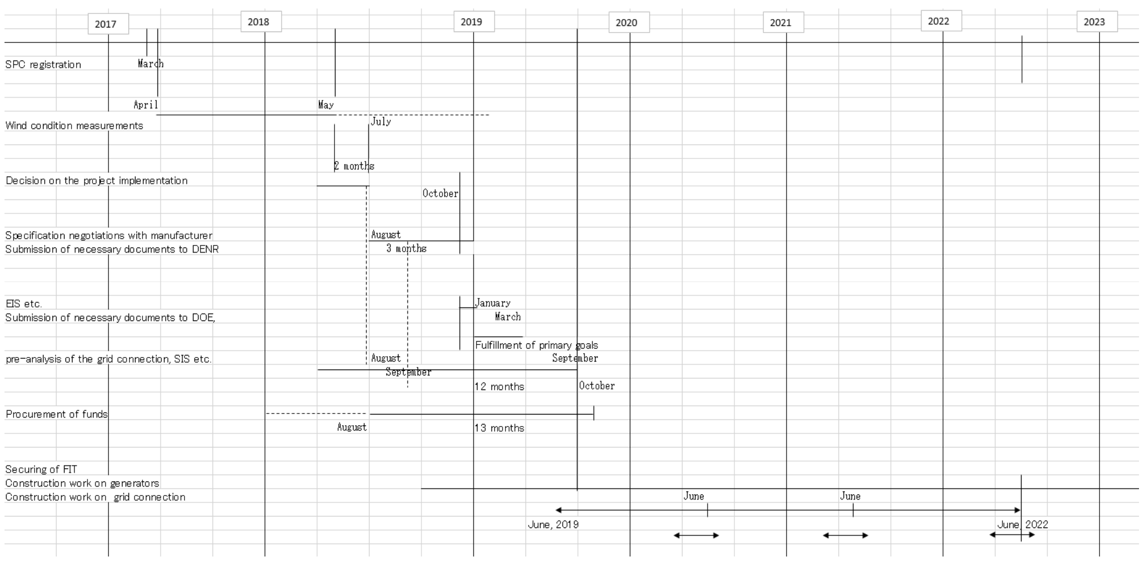
c) Hitachi's remote controlled O&M

- All Hitachi wind power generators feature as standard the "supervisory control and data acquisition" (SCADA) system, allowing for remote monitoring of the generator. Data collected by the SCADA system includes rotor velocity, azimuth angle, nacelle angle and approximately 100 other points of analog data, along with wind velocity and power generation levels, and can be monitored from any location the world over via internet cables.
- Remote monitoring is also carried out from the Remote Monitoring Center in Hitachi City, Ibaraki Prefecture.

（5） Detailed Schedule and Risks Facing the Project

1) Detailed Schedule

Fig. 1: Detailed Schedule for the Implementation of the Project



2) Risks Facing the Project's Implementation

The following risks exist.

a) Should the wind velocity of the area for additional study drop by more than 20% of the projected values, the utilization factor will decrease.

b) Should the planned construction area prove to have unstable ground or an active fault line running beneath it, construction costs may increase and technical issues may arise which cannot be dealt with.

c) Should the EIS or SIS take much longer than anticipated to be carried out, it could lead to unexpected delays to the construction period, which would in turn lead to delays in the project's completion.

d) Depending on the SIS results, various restrictions or receipt constraints unforeseen by the project could be enforced.

e) There is a small possibility that the maximum wind velocity engendered by a typhoon in the area could exceed the wind turbines' maximum capacity. (In the data from the last 10 years from 2007 to 2016, a maximum wind velocity of over 50 m/s has only been recorded in one instance out of 235 recorded typhoons.)

f) If the project is to be joined to the major extant electricity distribution networks, it is possible that the timing may not fit with the NGCP's schedule for the expansion of its distribution lines.

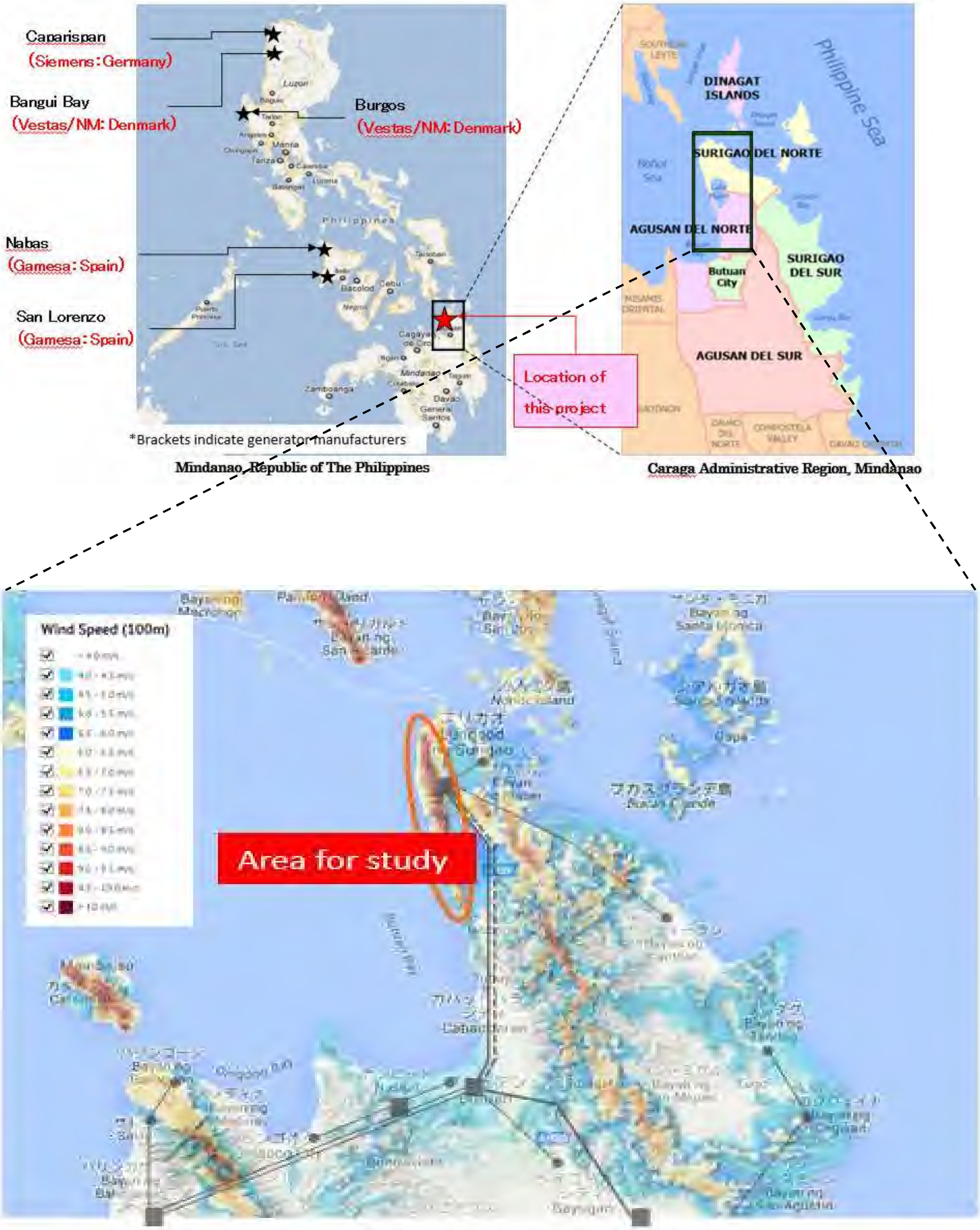
g) Should construction costs increase by 20% or more, the equity IRR would be approximately 6%, which would make the expected yield for investors quite low when considering exchange rate risks of the Philippine peso, country risks, and business risks.

h) Should the FIT unit rate (currently 7.40 PHP/kWh) drop by 20% or more, the equity IRR will drop below 5%, significantly lowering the expected yield for investors.

i) Financing risks also exist, in the fields of loan amounts, return periods and methods, interest rates, up-front fees, due diligence costs, covenants, and collateral.

(6) Maps of Project Location in the Host Country

Fig. 2: Project Location Maps



Mindanao, Republic of The Philippines

Caraga Administrative Region, Mindanao

Provinces of Agusan del Norte and Surigao del Norte, Caraga Administrative Region

（7） Effects of Project Implementation on Stable Energy Supply in Japan

A JCM agreement between Japan and the Republic of the Philippines was signed in January 2017 which is expected to contribute to Japan reaching its goals for the reduction of greenhouse gas emissions. It is also anticipated that the JCM will allow for the expansion of energy saving schemes and renewable energy generation projects, leading to a reduction in energy consumption based on fossil fuels in the Philippines.

It is estimated that this project (at a 150 MW scale) will produce a yearly energy output of 328,500 MWh (calculated using a yearly utilization factor of approximately 25% of the rated capacity of 2 MW x 75 units = 150 MW). When converted to diesel generation, this would result in a reduction of 185,246 metric tons of diesel (417,276 kℓ at a specific gravity of 0.86 at 15°C) consumed in the vicinity of Japan. This would indirectly allow Japan to procure diesel, one of Japan's primary energy sources, in a simpler and more stable manner.

As this would be the first wind power generation project on the island of Mindanao, it could become an example of a pioneering project which could set the trend for future projects elsewhere on the island, thereby serving to lower the energy consumption of the entire island.

（8） Other Issues Requiring Examination

1) Updated Wind Profile Models Based on Actually Observed Data

- In order to procure funding for the project, it will be necessary to confirm the project's viability based on at least one full year's worth of actually observed wind condition data. Therefore, it will be necessary to reconfirm the project's viability after examining the wind condition data obtained over the next year, and then conducting on-location surveys of the planned project site.

2) Phase Division Based on the Above Surveys

- In addition to an examination of the project's profitability as outlined above, this data will then be used to reconsider the phase division and overall construction schedule of the project. Furthermore, as this project is planned to be a low-carbon enterprise making use of high-efficiency generating facilities, the business scheme is planned to make use of the JCM. As such, plans for meetings with relevant agencies and financing procurement will need to be updated.

3) Financing Methods after Improving the Accuracy of the Project's Cost Projections

- This is related to the phase division and construction scheduling outlined above, but once more accurate data has been obtained and the business plans updated, details of financing plans will need to be updated and re-examined with an eye toward the use of both the financing program for JCM model projects and two-step loans from JICA or JBIC.

Chapter 1: Overview of Host Country and Business Sector

(1) Issues Pertaining to the Host Country's Economy and Finances

1) Economic overview

Having endured decades of stagnation from the 1960s to the 1990s, the Philippine economy has enjoyed stable growth ever since the appointment of President Ramos in 1992. President Benigno Aquino Ⅲ, who took office in May 2010, made prompt moves to put into practice his campaign promises to eradicate corruption and improve the fiscal health of the nation, earning him strong public support. Under his leadership, the economy maintained its positive growth. Economic growth as measured by Gross Domestic Product (GDP) stood at 6.8% in 2012, 7.1% in 2013, and 6.1% in 2014, indicating that the nation has maintained strong growth levels in comparison to its Southeast Asian neighbors. Inflation rates have largely fallen within the 3 to 5% range established as the objective of the national government: 4.7% in 2011, 3.2% in 2012 and 2.9% in 2013. This economic expansion is largely owed to increased consumer spending as a result of stable costs of living and increased expenditure on infrastructural improvements. All of the principal economic indicators suggest that the country is in a positive economic state (Table 1-1-1); prudent fiscal management and abundant foreign currency reserves have ensured that the Philippines has become one of the most stable nations in Southeast Asia at the macro-economic level.

Table 1-1-1 Principal Economic Indicators

	Unit	2010	2011	2012	2013	2014	2015*
Total GDP	Million USD	199,591	224,143	250,092	271,928	284,618	292,000
GDP growth	%	7.63	3.66	6.84	7.06	6.13	5.80
GDP per capita	USD	2,155.4	2,379.4	2,610.6	2,789.5	2,862.4	285,800.0
Inflation rate	%	3.78	4.72	3.17	2.93	4.17	1.40
Unemployment rate (urban areas)	%	7.3	7	7	7.1	6.8	6.3
Exchange rate (average; PHP/USD)		45.11	43.31	42.23	42.45	44.40	-
Remaining foreign debt	Million USD	73,594	75,569	79,949	78,489	77,674	-
Foreign debt as percentage of GDP	%	36.9	33.7	32	28.9	27.3	-

Source: International Monetary Fund (IMF)
World Economic Outlook Database, October 2015
(Remaining foreign debt figures courtesy of the Central Bank of the Philippines, or Bangko Sentral ng Pilipinas (BSP))
*2015 data from the homepage of the Japanese Ministry of Foreign Affairs

The establishment of the Association of South East Asian Nations (ASEAN) Economic Community (AEC) on December 31st, 2015, has served to strengthen moves to unify the economies of the region, further improving the outlook for economic growth for nations involved. It is also anticipated that the ASEAN nations will begin to compete even more vigorously among themselves to improve conditions for investment in their countries. The major credit rating agencies give Philippine government bonds a “BBB minus” rating, placing them in the “investment” grade, while the future outlook for the economy has been raised to “positive.” The investment policies of the previous Aquino government have been carried on by the new Duterte regime beginning in 2016.

Following the election in June 2016 of Rodrigo Duterte as President of the Philippines, he paid a visit to Japan and met with Prime Minister Abe, a visit which was reciprocated by Prime Minister Abe in January of 2017, accompanied by a pledge for Japan to provide 1 trillion yen in economic aid to the Philippines. Relations between the two nations continue to be healthy, and further economic development can be expected as they strengthen further still.

2) Trade

The total value of trade carried out by the Republic of the Philippines exceeds USD 100 billion over the past five years. Both exports and imports are on the increase, and the nation has maintained a trade deficit over that time (Table 1-1-2). The primary exports of the Philippines are electrical appliances and parts, and specialist items, with electrical appliances and parts accounting for approximately 35% of the total export value in 2013. Electrical appliances and parts are followed in terms of export value by completed products produced on consignment, and machinery and machinery parts. Together, these items account for approximately 51% of all exports from the Philippines.

In terms of the Philippines’ primary trading partners, as of 2015, exports with the highest total value were made to Japan (21.1%), the United States (15.0%), China (10.9%), Hong Kong (10.6%), and Singapore (6.2%), while the highest total value of imports came from China (16.2%), the United States (10.8%), Japan (9.6%), Taiwan (7.9%), and Singapore (7.0%). The recent dramatic increase in the figures for trade with China is particularly noteworthy.

Table 1-1-2: Trade Balance (unit: million USD)

	2010	2011	2012	2013	2014	2015*
Total exports	51,541	48,316	52,072	53,928	61,932	58,648
Total imports	54,932	60,495	62,128	61,832	64,530	70,153
Trade balance	-11,096	-13,866	-12,745	-10,648	-12,753	-
Foreign currency reserves	62,373	75,302	83,831	83,187	79,541	80,640

Source: BSP (trade balance)

*From *Sekai Keizai no Neta Cho* (“World Economics Notebook”): “Philippine Trade”

3) Foreign Investment

Foreign investment in the Philippines stood at PHP 186.9 billion in the year 2014, marking the second successive year in which this figure had fallen since the record high was set in 2012. It is true that at the current time, the Philippines is seen as a less attractive target for foreign investment than its neighbors, but the Philippine government is focusing heavily on encouraging foreign direct investment through the establishment and management of special economic zones, tax incentives, and improvements in investment criteria, leading to high expectations for lively development in the near future. Broken down by country, Japan (responsible for 19.1% of all foreign investment) is the largest investor in the Philippines, followed by the Netherlands (17.5%), and the United States (9.3%). When divided by industry, the manufacturing industry received over half (58.6%) of all foreign direct investment, followed by management and support services (15.9%), and real estate (8.3%). See Table 1-1-3 for details.

With the signing of a bilateral Joint Crediting Mechanism (JCM) agreement on January 12th, 2017, making the Philippines Japan's 17th JCM partner, further economic growth is anticipated as the relationship between the two nations deepens further. Cooperation between the two nations on issues of the environment and energy are expected to be strengthened, and expectations for significant Japanese contribution in this area are high.

Table 1-1-3: Foreign Direct Investment

(unit: million PHP)

Sector	2013	2014	Proportion (%)	Growth (%)
Manufacturing	77,557.6	109,495.3	58.6	41.2
Real estate	6,434.7	15,584.5	8.3	142.2
Electricity and gas	74,497.3	6,179.9	3.3	△91.7
Management and support services	24,567.6	29,755.3	15.9	21.1
Information and communications	3,560.8	4,937.4	2.6	38.7
Construction	8.7	7,735.3	4.1	88,641.4
Hospitality	25,380.8	5,520.8	3.0	△78.2
Forestry and fisheries	2,678.8	536.7	0.3	△80.0
Transportation	55,468.1	6,103.4	3.3	△89.0
Wholesale / Retail / Car repair	155.0	551.8	0.3	255.9
Total (including other categories)	274,013.5	186,943.1	100.0	△31.8

Source: National Statistical Coordination Board (NSCB)

4) Major Industries

Division of the Philippine economy by sector reveals that the commercial and service industries account for over 50% of the nation's GDP, indicating that tertiary industries dominate. The next largest share is held by the manufacturing sector at approximately 23%, then the livestock and fisheries industries at 12%. No major shifts have been observed in terms of the shares of each sector in the past five years (Table 1-1-4).

Table 1-1-4: GDP by Sector

(unit: million PHP)

Sector	2010	2011	2012	2013	2014
Livestock and fisheries	344,347	364,944	378,350	406,010	444,058
Mining	34,583	27,307	25,866	25,521	26,294
Manufacturing	603,467	628,013	661,876	750,634	836,065
Electricity and water	70,883	75,098	84,867	88,626	91,500
Construction	122,876	138,840	168,849	182,537	223,390
Commerce and service	1,353,449	1,489,056	1,642,343	1,803,214	1,953,543
Total	2,529,605	2,723,257	2,962,195	3,256,542	3,574,849

Source: BSP (GDP by sector)

5) Fiscal Balance

The fiscal balance of the Philippine government has made significant strides towards stability since the turn of the millennium. The budget deficit was gradually reduced between 2010 and 2012, before budget surpluses of PHP 23.06 billion (0.2% of GDP) and PHP 111.29 billion (0.9% of GDP) were recorded in 2013 and 2014 respectively (Table 1-1-5).

Due to increased spending on public works projects to improve infrastructure, a budget deficit is anticipated once again for the year 2015, but under President Aquino the government's fiscal balance has certainly been improved and stabilized. This has in turn contributed significantly to the improved credit ratings of the Philippine government by the major credit rating agencies.

Table 1-1-5: Fiscal Balance

(unit: billion PHP)

	2010	2011	2012	2013	2014	2015*
Revenue	1,512.80	1,708.44	1,965.70	2,175.28	2,440.55	2,567.72
Expenditure	1,724.63	1,747.29	1,997.78	2,152.22	2,329.26	2,538.11
Fiscal balance	-211.83	-38.85	-32.08	23.06	111.29	29.61

Source： Philippine Department of Finance (fiscal balance)

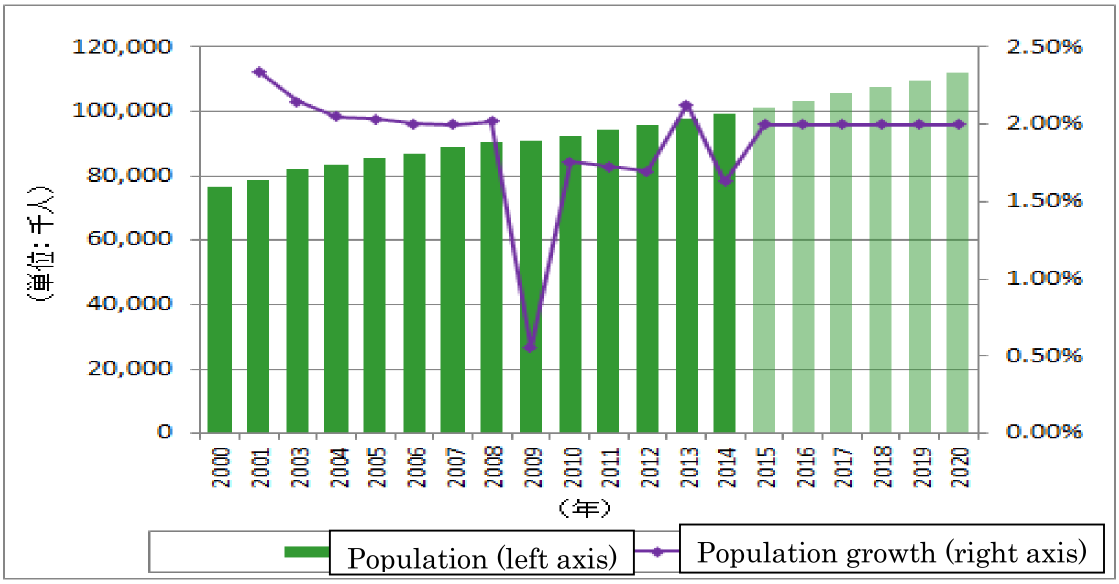
*From *Sekai Keizai no Neta Cho* ("World Economics Notebook")

6) Population

The population of the Philippines stands at 100.98 million (as of the 2015 national census) and is growing at a steady rate of just over 1% per annum. As of 2014, the Philippines ranks in 12th place, just behind Mexico, among the world's most populous nations, while calculations by the United Nations suggest that the population of the Philippines will grow by over 50% to reach 157 million in 2050, moving into 10th place and overtaking Japan, projected to be 16th at that time (Fig. 1-1-1).

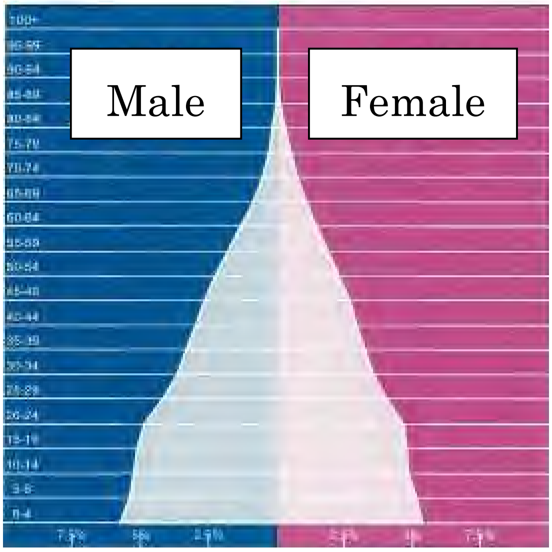
The population distribution forms an almost perfect pyramid, with the population increasing continuously with younger demographics, placing the Philippines in a position to receive the so-called "demographic bonus" for the next 40 years as its working-age population continues to grow (Fig. 1-1-2).

Fig. 1-1-1: Population Trends in the Philippines (2000-2020)



Source: Created based on the IMF's "World Economic Outlook Database, October 2015"
NB: Figures up until 2014 are confirmed; figures from 2016 onwards are estimates.

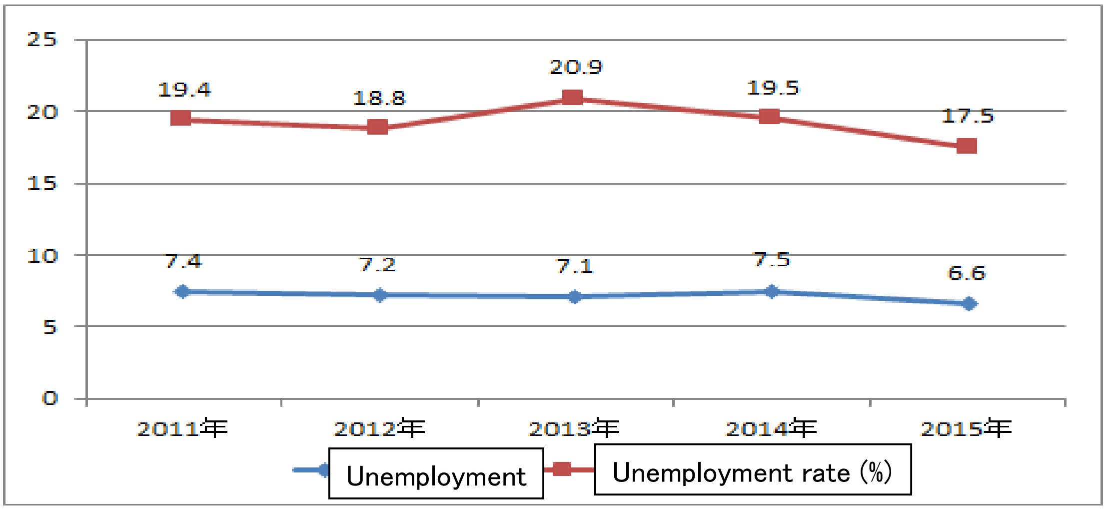
Fig. 1-1-2: Population Pyramid of the Philippines (2016)



Source：http://www.populationpyramid.net/ja/ﾌｨﾘﾋﾟﾝ/2016/
NB: 2016 estimate data used

Almost half of this population (49%) resides in cities, and a still high ratio (23%) lives below the poverty line on less than USD 2.50 a day ("State of World Population," 2011). While the working population has exceeded 40 million, unemployment is currently hovering around the 7% mark. While unemployment has been gradually declining in recent years as a result of consistent economic growth, the proportion of inadequately employed workers (desiring a change in jobs or additional work) remains high, at just under 20%. The creation of employment opportunities and the evening out of income gaps remains a key issue facing the nation as a whole (Fig. 1-1-3).

Fig. 1-1-3: Unemployment rate and underemployment rate



Source: Created by the study team based on data from the National Statistics Office (NSO)
Note 1: Data from January of each year is used.
Note 2: Underemployment rate indicates the proportion of people who are unsatisfied with their hours and/or pay, and therefore desire a change in employment or additional work.

(2) Overview of the Planned Project Sector

1) Energy Supply and Demand for the Mindanao Area

Electricity demand in the Philippines is increasing every year, with the peak figure for the nation as a whole in 2014 reaching 11,822 MW (8,717 MW in Luzon, 1,636 MW in the Visayas, and 1,469 MW in Mindanao) (Fig. 1-2-1). Going forward, estimates for the period from 2015 to 2030 suggest an average yearly increase in electricity demand of 4.6% for the nation as a whole, broken down into 4.1% for Luzon, 5.7% for the Visayas and the largest figure of 6.1% for Mindanao. Additionally, while the actions of the Moro Islamic Liberation Front (MILF), a militant separatist group based in the south of the island of Mindanao, have long hindered growth in the region, a peace accord was signed between MILF and the Philippine government on March 27, 2014, thanks in no small part to the long and tireless support provided by the Japanese government. This agreement has led to the establishment of a new government for the Bangsamoro Autonomous Region in June 2016, and the constructive dissolution of the government of the Autonomous Region of Muslim Mindanao (ARMM). In this way, concrete progress is being made to ending the civil war which has plagued the region. Following Prime Minister Abe's visit to the Philippines in 2017 and his pledge of increased economic aid, it is anticipated that investment from private corporations will increase rapidly. There is also expected to be a corresponding increase in electricity consumption in response to the increased stability of everyday lives in the region.

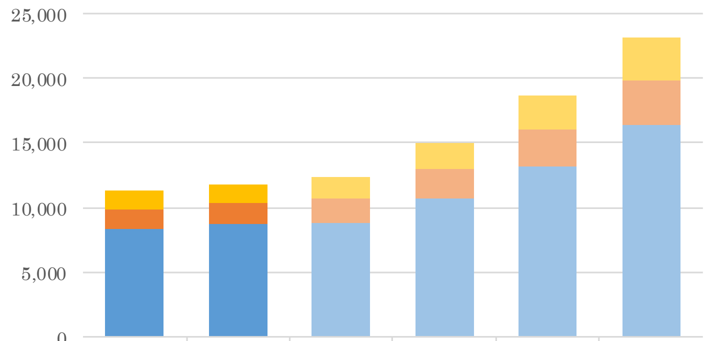
In terms of the energy sector alone, the DOE's National Renewable Energy Program (NREP, 2011-2030) has estimated that peak electricity demand on the island of Mindanao will expand from 1,321 MW in 2012 to a level 2.6 times that of 3,494 MW by the year 2030, for a year-on-year average growth rate of 4.86%.

As of December 2014, facilities in Mindanao for generating electricity had a total rated capacity of 2,210 MW, while according to the NGCP's power transmission development plan of December 2014 the island's facilities have a practical maximum generating capacity of 1,851 MW. Divided by energy source, it can be seen that hydropower makes up 45% of the whole. The NGCP's power transmission development plan for 2014-2015 indicates that capacity has expanded only very marginally to 1,860 MW, with 45% generated by hydropower and 0% by wind power (Fig. 1-2-2).

Looked at in terms of times of day, serious electricity shortages are felt during the primary active hours of 9 a.m. to 10 p.m. (Fig. 1-2-3). Around 6 p.m., in particular, electricity supply shortages of up to 600 MW have been recorded on some days, leading to chronic blackouts. It is clear that the heaviest loads on the system are caused by electrical lighting. According to the results of a study carried out by the Mindanao Development Authority (MinDA), the economic effects of blackouts on the area led to losses of PHP 2.3 billion in the first quarter of 2014 alone.

Since this time, new large-scale coal-powered thermal power plants have begun operation in 2015 and 2016, solving the energy deficiency issues of Mindanao in the short term. It is now believed that the island of Mindanao should enjoy an electrical power supply surplus from 2017 to 2025. While it is certainly true that the frequency of power stoppages has declined since the operation of new large-scale coal-powered thermal power plants in 2015, daily power outages were experienced once again when one experienced a temporary operational failure in May 2016. This proves that the current power supply situation is heavily dependent on these new coal-powered thermal power plants. So fragile, in fact, is the situation, that the operational failure of a single such plant is enough to immediately create a situation in which supply is insufficient to meet demand. Furthermore, while it is true that on paper the generational capacity of the power plants on the island of Mindanao is more than enough to cover current needs, many of these facilities are in need of maintenance and upgrading, meaning that there is a significant gap between the rated capacity of all of the power plants in the region and their practical generating capacity.

Fig. 1-2-1: Peak Energy Demand Estimates by Area (unit: MW)



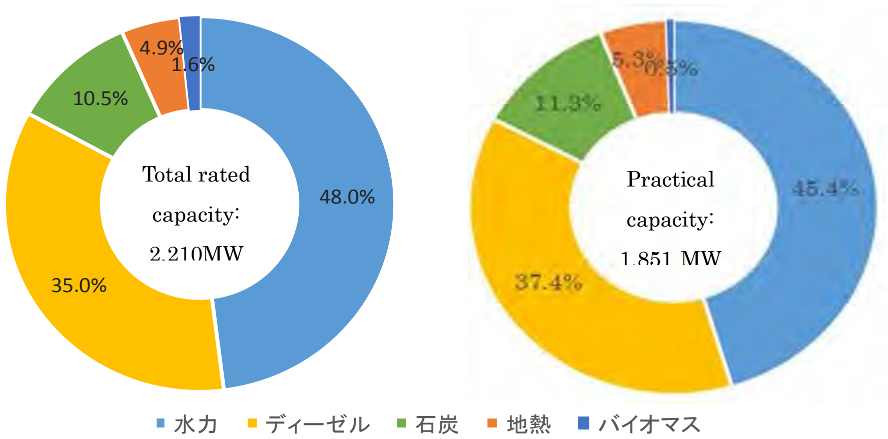
	2013年	2014年	2015年	2020年	2025年	2030年
Mindanao ミンダナオ	1,428	1,469	1,657	2,068	2,592	3,250
Visayas ビサヤ	1,572	1,636	1,799	2,237	2,759	3,431
Luzon ルソン	8,305	8,717	8,892	10,693	13,274	16,477

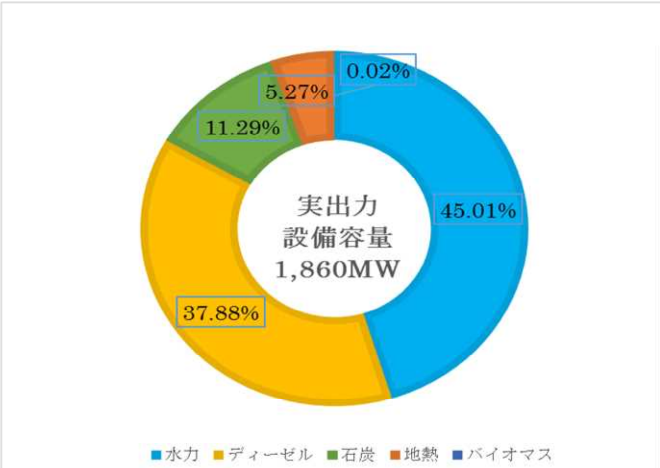
Source: Created by the study team based on data from the DOE 2013 Supply-Demand Outlook
*Data up until 2014 is confirmed; 2015 onwards are DOE estimates.

Fig. 1-2-2: Power-Generating Facilities in the Mindanao Area by Energy Source

Hydropower / Diesel / Coal / Geothermal / Biomass

Source: Created by the study team based on DOE documentation (December 2014)

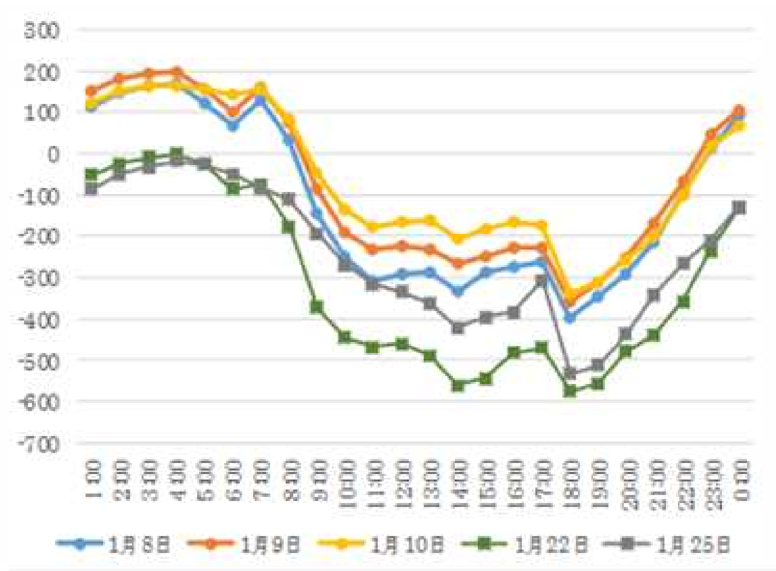




Hydropower / Diesel / Coal / Geothermal / Biomass

Source: Created by the study team based on DOE documentation (December 2015)

Fig. 1-2-3: Electricity Supply-Demand Balance by Time of Day for the Mindanao Area (unit: MW)



Source: Created by the study team based on data published by the Philippine National Statistical Coordination Board (NSCB)
*Positive figures indicate an energy surplus; negative figures an energy deficit

2) Power Grids of the Mindanao Area and the Provinces of Agusan del Norte and Surigao del Norte

As the power grid of the Mindanao area is separate and independent from the national grid serving Luzon and the Visayas, all power demands on the island must be met by energy sources generated on the island. This fact has made the energy shortage facing the island particularly urgent, and one which can only be addressed by increasing the generating capacity of facilities on Mindanao. Furthermore, as hydropower is Mindanao's major energy source, most of its power plants are concentrated in the north of the island, where water resources are abundant. At the same time, however, almost half of the island's entire demand is centered on the southeastern province of Davao, meaning that energy generated in the north has to be transported south. As of 2013, the electricity supply network of Mindanao (Table 1-2-1, Fig. 1-2-4) featured a total of 5,145.64 cct-km (circuit kilometers) of transmission and sub-transmission power lines, making this the second largest network in the country, behind that covering north

Luzon. Total substation capacity of the system was 3,317 MVA. The Transmission Development Plan 2015 reveals that by 2015, the combined length of the 138 kV and 69 kV transmission and sub-transmission power lines was 5,832 cct-km, indicating an increase over the 2013 figures of 690 cct-km (13%). While the networks of Luzon and the Visayas are contracting slightly, the Mindanao network is expanding rapidly. In order to help alleviate this problem, new coal-powered thermal power plants were constructed in the southern regions of Mindanao and have begun operation in 2015 and 2016.

Total substation capacity of the Mindanao area for both 138 kV and 69 kV lines has increased only marginally from 3,317.5 MVA in 2013 to 3,327 MVA in 2015, while compensative capacity has dropped over the same period from 330.5 MVA to 300 MVA. Of the 15,878 MW of total generating capacity of the entire Republic of the Philippines as of the year 2015, coal-powered thermal power accounted for 5,354 MW (33.72%), hydropower 2,993 MW (18.85%), natural gas 2,760 MW (17.38%), oil 2,790 MW (17.57%), geothermal 1,607 MW (10.12%), and renewable energy 374 MW (biomass 0.69%, wind power 1.19%, solar power 0.47%).

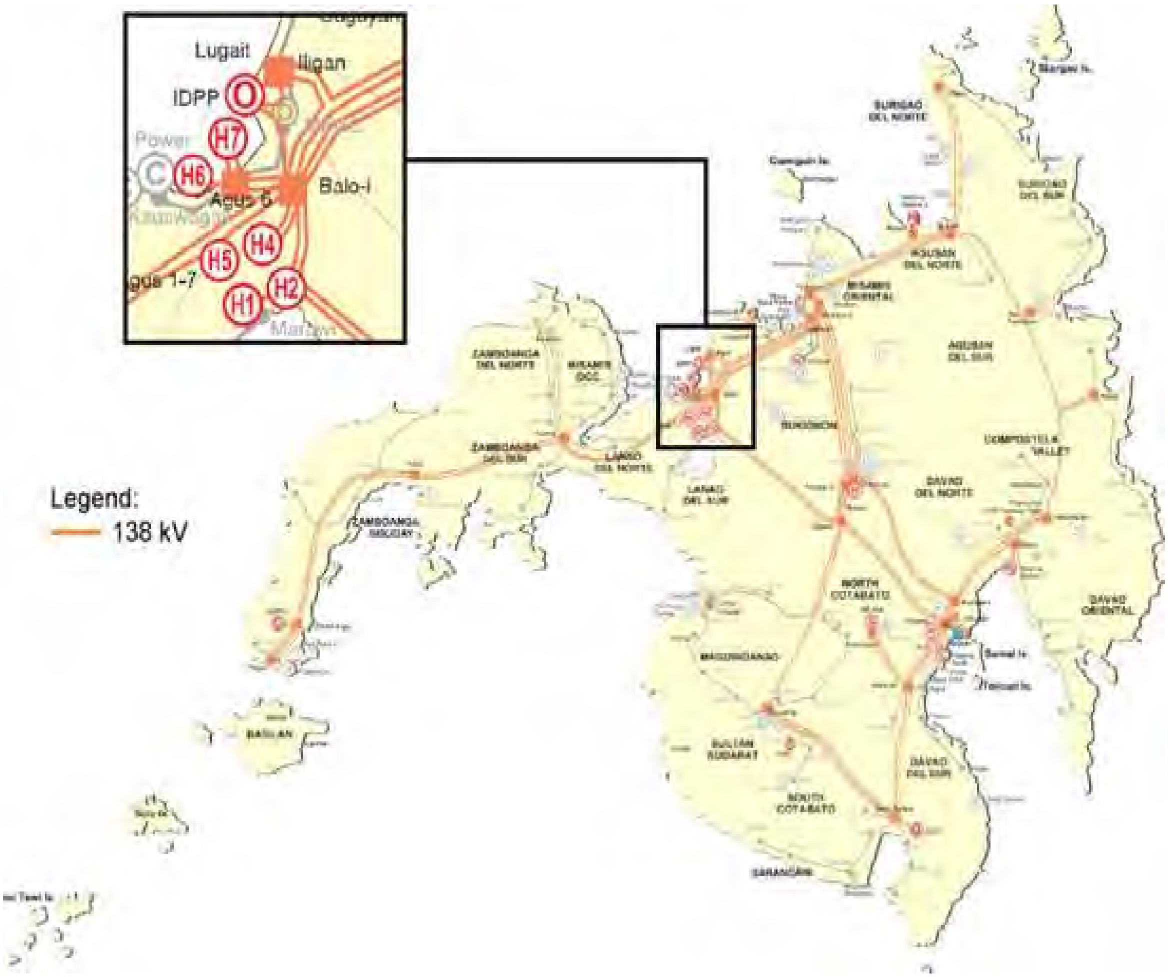
For the island of Mindanao, the total generating capacity of 1,860 MW as of 2015 was divided into 915 MW from conventional energy sources such as coal and oil, and 945 MW from renewable energy sources. The detailed breakdown sees coal providing 210 MW (11.29%), oil 705 MW (37.88%), and LNG 0 MW (0%) for the conventional energy sources, with wind power 0 MW (0%), solar power 0.3 MW (0.02%), biomass 10 MW (0.54%), geothermal 98 MW (5.27%), and hydropower 837 MW (45.01%) making up the renewable sources. As can be seen, the region is heavily reliant on hydropower first and thermal power using fossil fuels second. The average year-on-year increase in electricity demand for the island of Mindanao over the decade from 2005 to 2014 was 2.24%.

Table 1-2-1: Electricity Distribution Networks in the Mindanao Area

Voltage	Transmission lines (cct-km)	Sub-transmission lines (cct-km)	Substation capacity (MVA)	Compensative capacity (MVAR)
138-kV	3,268.09	33.84	3,240	67.5
69-kV or below	4	1,839.71	77.50	263
Total	3,272.09	1,873.55	3,317.5	330.5

Source: NGCP Transmission Development Plan 2013

Fig. 1-2-4: Mindanao Area Power Grid



Source: NGCP Transmission Development Plan 2015

Fig. 1-2-5: Electricity System Map of the Province of Agusan del Norte (including Butuan City)

Source: ANECO Annual Report 2014

Photographs 1-2-1: Power Lines and Substations

138 kV and 69 kV power lines running along a highway by fields

Looc Substation (69kV), Surigao City

138 kV transmission lines running from the mountains towards Surigao City

69 kV power lines (within Looc Substation, Surigao City)

69 kV power lines leading to Looc Substation, Surigao City

Placer Substation (138kV)

138kV transmission lines (under construction)

Figure 1-2-5 shows the power grid of the province of Agusan del Norte, including Butuan City. According to the 2014 annual report of the Agusan del Norte Electric Cooperative (ANECO), responsible for the management and maintenance of this power grid, the area covered by the grid is some 2,730.24 square kilometers, it provides electricity to 120,336 households, peak demand on the grid is 57,240 kW, and the total amount of electricity sold in a year is 271,003,754.13 kWh. Production to the grid is contracted to the National Power Corporation (NPC) for 27,950 kW and to Independent Power Producers (IPP) for 30,000 kW, meaning that the total production capacity of the system is 57,950 kW. As can be appreciated, the gap between supply capacity and peak demand is extremely slender at just 710 kW, meaning that the system has very little margin for failure. Recent improvements to supply capacity have ensured that supply continues to outstrip demand, but when the longer term (any period including 2022 or beyond) is considered, the development of new energy sources is an absolute necessity.

3) Issues Facing the Mindanao Area and Future Development Plans

Since the passing of the Electric Power Industry Reform Act (EPIRA) of 2001, the Philippines has seen the privatization of several power plants which were formerly the property of the NPC, which used to enjoy a monopoly on the production and distribution of electricity throughout the nation. This law passed the rights to purchase electrical power from IPPs and to then sell it to consumers into the hands of private enterprise through the signing of Power Purchase Agreements (PPAs). In the Mindanao area, however, as of January 2015, approximately 65% of the power-generating infrastructure remains under the management of the NPC. The primary reason for this state of affairs is that local stakeholders have opposed privatization on the grounds that it could lead to a monopoly on power supply in the area, and that this would, in turn, lead to an increase in power costs. Most significant of all such power-generating infrastructure is the Agus-Pulangui hydropower complex, which is made up of six distinct plants, and is owned by the NPC. With a total generating capacity of 776 MW (as of June 2015), it makes up roughly 40% of the power generating capacity of the island as a whole. The complex cannot be divided up and sold off without compromising its generating efficiency, but if it is privatized and sold to a single company, that company would wield excessive influence over power pricing in the entire Mindanao area. At the current time, the MinDA (Mindanao Development Authority; an organization established under the former Arroyo government via RA 9996 of February 17th, 2010, for the purposes of the social and economic development of Mindanao) is in the process of establishing a government-owned and controlled corporation (GOCC) to which to transfer the ownership rights of the Agus-Pulangui hydropower complex. The possibility of operating and managing the complex through the use of a public-private partnership (PPP) is also currently being explored.

With the opening of the electric power sector, the importance of the role of private firms in the establishment of stable and reliable power production cannot be underestimated. In order to ease the very serious electricity shortages currently faced, it will be crucial to decide on investments in the short term that will be based on a firm analysis of uncertain medium-to-long term demand. Until now, in the privatization of the electric power sector, major local financial groups such as San Miguel, Aboitiz, Lopez, MERALCO and Metro Group have played a significant role. At the same time, however, the major players in the industry remain restricted to these few names, resulting in the power production and distribution industry becoming something of an oligopoly. Moving forward, rather than large-scale development, for which there are high barriers to entry and long lead times for construction, decentralized, small-to-medium-scale energy development will assume a role of greater importance.

As for the Caraga region, peak energy demand in the central province of Agusan del Norte is 57 MW, with equivalent figures of 25 MW for Agusan del Sur, 26 MW for Surigao del Norte, and 10 MW for Surigao del Sur, and a total for the region of approximately 120 MW. The region has no permanent power plants within its borders, and can only call on extremely expensive fossil fuel plants in emergencies when certain conditions are met to satisfy extraordinary levels of demand. Fundamentally, the region relies upon long-distance power transmission from the Iligan region 300 kilometers away, and is forced to purchase this electricity at expensive rates inflated by the costs of this transmission and power losses. Energy produced in the Iligan region is also distributed to other provinces, and as Cagayan de Oro, the second largest city on the island of Mindanao, lies between Iligan and Caraga, power transmission to the relatively distant Caraga region necessarily assumes a lower priority. Not only does the distance mean that transmission losses contribute to higher unit costs, but supply is also unstable and unreliable.

The forecast electricity demand data for regional electrification plans included in the JICA report, "Study on Institutional Capacity Building for the DOE under a Restructured Philippine Electric Power Industry" (2004) indicate that the system loss proportion for public facilities selling electric power directly to consumers is approximately 12.1%, which is significantly larger than the power loss figure of under 5% for Japan. A variety of preventative measures have been put in place in Japan, including the optimization of the switching between power systems, voltage step-up transformation, and the tamper-proofing of electricity meters.

Table 1-2-2: Electricity Demand Data Forecasts

Forecast/Planning Results	Units	Forecast						
		2003	2004	2005	2006	2007	2008	2009
10. ENERGY REQUIREMENT								
10a. Electricity Consumption								
Direct Sales To Customers	(1)							
Residential	MWH	8,116,844	8,360,349	8,611,160	8,869,495	9,135,579	9,409,647	9,691,936
Commercial	MWH	7,732,441	7,964,414	8,203,346	8,449,447	8,702,930	8,964,018	9,232,939
Industrial	MWH	6,550,689	6,747,209	6,949,626	7,158,114	7,372,858	7,594,044	7,821,865
Contractual Exports	MWH	274,380	282,611	291,089	299,822	308,817	318,081	327,624
Others	MWH	137189.82	141305.5146	145544.68	149911.0204	154408.3511	159040.6016	163811.8196
Public Bldgs	MWH	116,974	120,483	124,098	127,821	131,655	135,605	139,673
Street Lights	MWH	10,049	10,350	10,661	10,980	11,310	11,649	11,999
Others (Pls. specify, i.e., irrigation, etc.) Direct sale to XXX Corp	MWH	10,167	10,472	10,786	11,110	11,443	11,786	12,140
Total: Direct Sales to Customers	MWH	22,811,543	23,495,889	24,200,766	24,926,789	25,674,592	26,444,830	27,238,175
Utility's Energy Consumption	(2)							
Company/Office/Housing	MWH	1,420	1,463	1,507	1,552	1,599	1,647	1,696
Pumped Storage Requirement	MWH							
Utility's Station use: Distribution	MWH	843,781	869,095	895,167	922,022	949,683	978,174	1,007,519
Utility's System Losses	MWH	2,769,318	2,852,397	2,937,969	3,026,108	3,116,892	3,210,398	3,306,710
Subtotal: Utility's Energy Consumption	MWH	3,614,519	3,722,955	3,834,643	3,949,683	4,068,173	4,190,218	4,315,925

Source: JICA report, "Study on Institutional Capacity Building for the DOE under a Restructured Philippine Electric Power Industry"

Photographs 1-2-2: Electric Power Systems

As a result of the abovementioned issues pertaining to energy provision to the region, Caraga remains singularly lacking in attractiveness as an investment target for private enterprise. While the region's largest city, Butuan, has a population of 350,000 and abundant human resources, the lack of any industrial parks in the area with the facility to augment the region's produce with added value has meant that there remains a serious shortage of employment opportunities. This, in turn, has led to an exodus from the region of quality human resources with higher education.

Its geographical location in the northeast of the island of Mindanao makes it an ideal gateway to Mindanao for the major Philippine cities of Manila and Cebu, as well as for Japan, South Korea and Taiwan. In order to maintain a balance to the development of the island, it is an area that, along with Cagayan de Oro, also a gateway city in the north, and Davao, the gateway to the south, should be the target of future economic development.

In terms of potential for economic development, the region has abundant stocks of timber, agricultural products such as rice, coconut, banana and mango, and seafood such as prawn and eel. The major problem for the region, however, is that while these primary industry products are harvested or caught in the region, they are not processed there, and end up leaving the region without providing any added value to their places of origin. The region's greatest competitive advantage is not being fully utilized to aid its own economic development.

(3) Status of the Planned Project Area

1) Geography and Administrative Divisions

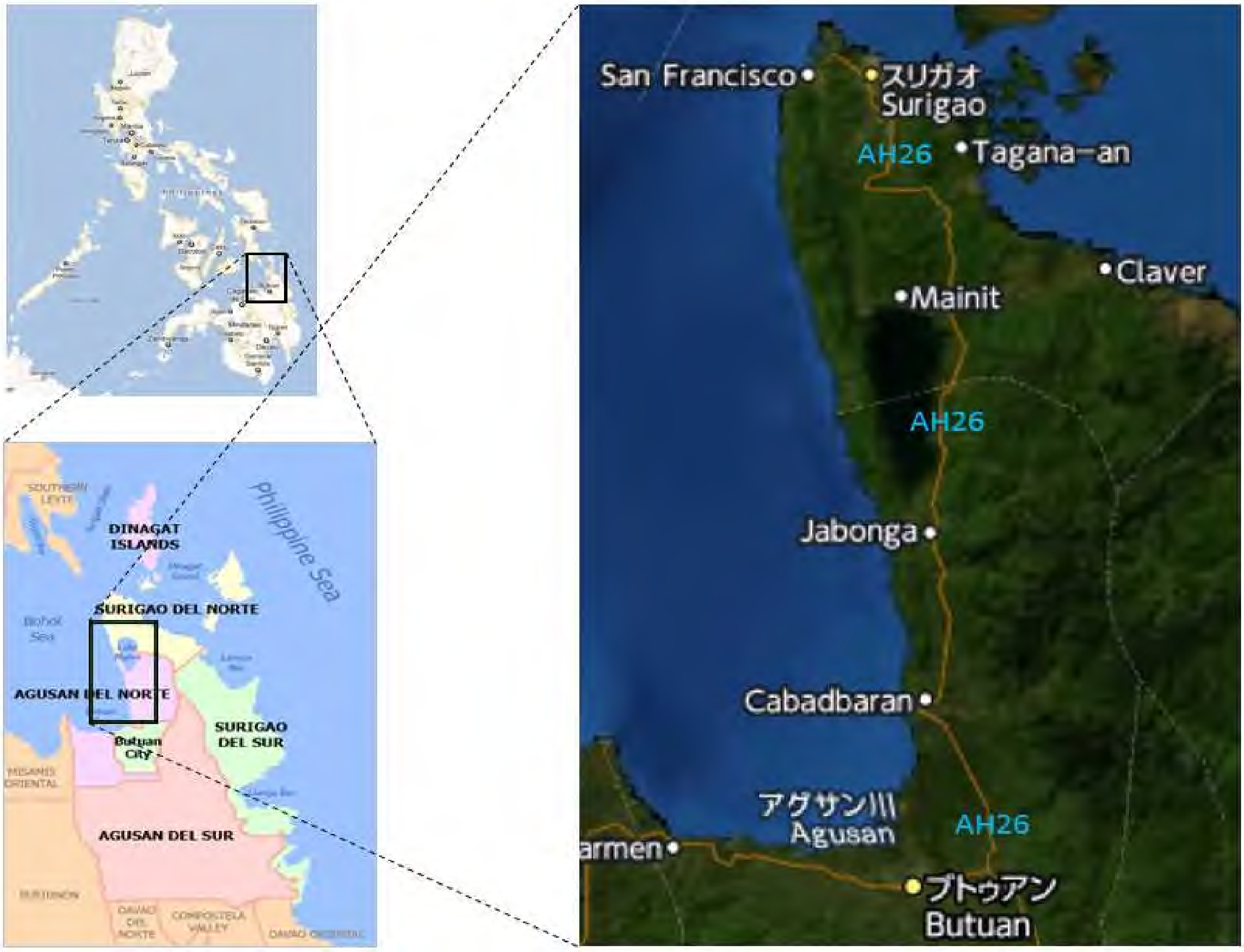
As an island nation, the Republic of the Philippines can be conveniently divided into three main island groups: Luzon, containing the capital, Manila; the Visayas, with its main city of Cebu; and Mindanao, with Davao City at its center. Administratively, the nation is divided into 18 regions, which are further subdivided into 81 provinces (the equivalent of Japanese prefectures). Below this, and making up each province, are cities and municipalities, and these are further divided into the smallest administrative unit, barangays.

The area for examination as the potential site of the wind power generation project that is the subject of this study lies in the provinces of Agusan del Norte and Surigao del Norte (see Fig. 1-3-1 for a map of the potential project site).

The province of Agusan del Norte lies in the Caraga region (Region XIII), in the northeastern part of the island of Mindanao, in the south of the Republic of the Philippines. The capital of the province is the city of Cabadbaran, but the provincial government still operates out of Butuan City.

The province of Surigao del Norte lies in the Caraga region (Region XIII), in the northeastern part of the island of Mindanao, in the south of the Republic of the Philippines. The capital of the province is the city of Surigao. Surigao del Norte borders Agusan del Norte and Surigao del Sur to the south, and faces the Surigao Strait to the north.

Fig. 1-3-1: Map of the Area for Further Investigation (Overview)



Source: Study team and Yahoo Maps (http://map.yahoo.co.jp/maps)

2) Climate and Land Use

The climate of Agusan del Norte falls into Type IV of the four climate types of the Philippines, with no dry season and rainfall distributed fairly evenly throughout the year, although January typically experiences the most rainfall. While it is located in the south of the typhoon belt centered on the island of Leyte, it is rare for typhoons to actually pass directly through the province. Data from the Japan Meteorological Agency pertaining to typhoons affecting the island of Mindanao in the Philippines (9°48′59” to 5°36′27″ north, 126°35′35″ to 121°27′35″ east) indicate that of the 235 typhoons recorded over the decade from 2007 to 2016, only four saw their center make landfall on the island of Mindanao (one in 2011, two in 2012, one in 2014), for a ratio of 1.7%. Of these, two inflicted major damage. The first of these was typhoon #1121, Washi (known as Severe Tropical Storm Sendong in the Philippines), which formed on December 15th, 2011. Its lowest central pressure measured 992 hPa, producing maximum wind speeds of 25 m/s, and with the area featuring winds averaging 15 m/s or more extending north in a radius of 220 kilometers and south in a radius of 170 kilometers. According to a press release by the National Disaster Risk Reduction & Management Council of December 18th, 2011, the death toll from the storm had reached 332 (the Philippine Red Cross put the death toll at 497), but later this number was amended to over 1200. The same press conference gave figures of 281 missing (162 according to the Philippine Red Cross), 108,130 affected by the typhoon, and 34,911 evacuees. The second storm to inflict major damage was typhoon #1224, Bopha (known as Typhoon Pablo in the Philippines), which formed on November 27th, 2012. With a central pressure of as low as 930 hPa, maximum wind speeds of 50 m/s, an area with a radius of 150 kilometers featuring winds averaging above 25 m/s and an area with a radius of 390 kilometers featuring winds averaging above 15 m/s, it resulted in the deaths of 1020 people, with a further 844 missing, according to the National Disaster Risk Reduction & Management Council. The same source put the total number of people affected at 120,000, including 87,000 evacuees. CNN News reported that the wind speed at landfall was 49 m/s, but it reached 67 m/s as the maximum momentary wind velocity on December 3rd, pushing the storm into the super typhoon category. The other two typhoons which made landfall on Mindanao were typhoon #1223, Son-Tinh, which formed on October 23rd, 2012, with a central barometric pressure of 998 hPa, maximum wind speeds of 18 m/s, and an area with a radius of 280 km/h featuring winds averaging above 15 m/s; and typhoon #1423, Jangmi, which formed on December 28th, 2014, and had a central barometric pressure of 996 hPa, maximum wind speeds of 20 m/s, and an area extending 280 kilometers north and 170 kilometers south featuring winds averaging above 15 m/s. All typhoons other than Bopha in 2012 featured winds of below 25 m/s, but Washi in 2011 had winds of 50 m/s. The wind turbines planned for the project at this point are manufactured by Hitachi, Ltd., built to withstand typhoons with a wind velocity class of IIA+, allowing them to cope with extreme wind gusts of up to 70 m/s (for three seconds) and consistent winds of 50 m/s (for 10 minutes). It will be necessary from a risk-hedging perspective to analyze the potential necessity of upgrading this functionality to withstand super typhoons.

In terms of topography, the province features a vast alluvial plain created by the Agusan River, with a basin area of 10,921 square kilometers, the third-largest in the Philippines, and a mountain range extending from the north of the province to the east. The other important body of surface water besides the Agusan River is Lake Mainit, the fourth-largest lake in the Philippines, situated in the northeast of the province of Agusan del Norte.

The total area of the city of Butuan is 82,000 hectares, of which 32.8% is made up of forests, while 48.6% is farmland (Table 1-3-1).

Table 1-3-1: Land Use in Butuan City

	Area (km^2)	Percentage
Farmland	397.23	48.6
Forests	268	32.8
Grassland and pastures	61.14	7.5
Other	90.24	11.1
Total	816.61	100.0

Source: Created by the study team

The province of Agusan del Norte has a total land area of 273,000 hectares. According to data released by the provincial government, approximately 73% of this area is covered in forestland, 25% farmland (including fish farms and public water bodies), and the remaining 2% is urban (Table 1-3-2).

Table 1-3-2: Land Use in Agusan del Norte

	Area (ha)	Percentage
Urban	4,416.61	1.62
Farmland	69,422.35	25.43
Forests	199,185.04	72.96
Total	273,024.0	100.0

Source: Created by the study team

The province of Surigao del Norte has a total land area of 292,000 hectares, of which Surigao City covers 24,000 hectares, or 8.4%.

Table 1-3-3: Land Use in Surigao del Norte

	Area (ha)	Percentage
Urban	24,534 (Surigao City)	8.4
Farmland	No data available	No data available
Forests	No data available	No data available
Total	292,030	100.0

Source: Created by the study team

3) Population

As of August 2015, the population of the province of Agusan del Norte, excluding Butuan City, stood at 354,503, while the population of Butuan City, geographically within but administratively dependent from the province, was of a comparable scale at 337,063. Population is on the rise, with an average yearly population increase for the period from 2000 to 2015 of 1.42% for the province of Agusan del Norte and 1.43% for Butuan City. The Philippine Statistics Authority (PSA) projects the population of the Caraga region to continue to grow at a yearly average rate of 1.72% for the 45 year period from 2010, suggesting that both Agusan del Norte and Butuan are expected to grow at a rate exceeding the national average.

As of August 2015, the population of the province of Surigao del Norte was 485,088, with an average yearly increase for the period from 2000 to 2015 of 1.71%. The province’s total area is 292,000 hectares, of which Surigao City (population 118,543 as of the 2000 national census) covers 24,000 hectares.

4) Barangays

The province of Agusan del Norte is made up of 166 barangays, a number which increases to 252 when Butuan City is included. The province of Surigao del Norte is made up of 435 barangays.

5) Infrastructure Status

The province of Agusan del Norte and Butuan City respectively feature 127 kilometers and 98 kilometers of National Roads, and 252 kilometers and 97 kilometers of provincial or municipal roads. According to data provided by the provincial government, 51% of these National Roads are sealed with concrete and 29% with asphalt, while the remaining 20% are dirt roads. For provincial roads, only 17% are concrete and 3% asphalt, leaving 80% as unpaved or dirt roads. Villages and schools are dotted along these roads, and speed humps to forcibly slow traffic are often installed near schools in particular.

The province features three ports, of which Nasipit is the largest. The other two, Butuan and Masao, both lie within the confines of Butuan City. In terms of airports, the region features Bancasi Airport in Butuan City and Surigao Airport in Surigao City. Surigao Airport is a minor domestic airport, with regular commercial flights to Manila and Cebu, but Bancasi Airport is far more developed and serves as the major aerial hub for the Caraga region.

With respect to the infrastructure of Surigao del Norte, the province features a total of 100 kilometers of roads, of which 50 kilometers are part of National Road AH26, which runs north from Butuan as far as Surigao City, and the remaining 50 kilometers are provincial roads. AH 26 is well-maintained, and although there are still some sites where concrete is being poured, work continues to be done on the highway, and it is expected to be fully sealed within the next few years. The western coastal road from Surigao City is a provincial road which is partially paved with concrete. In locations where houses line the road, pipes have been imbedded beneath the road for self-styled “infrastructural” purposes, necessitating speed restrictions for passing automobiles.

There are two ports near Surigao City: the port of Surigao and the port of Lipata. Lipata is considered the more advantageous of the two because of the fact that there are fewer issues with transporting large-scale cargo along the roads leading to the port there.

Photographs 1-3-5: Infrastructure Status

National Road

Port of Lipata

Port of Lipata

Transportation route

Road being paved with concrete

Transportation route

Bridge on transportation route

Provincial road (transportation route)

Private mountain road

Bancasi Airport, Butuan City

6) Industry

The major industries of the province of Agusan del Norte, including Butuan City, are agriculture, forestry and mining. Agriculture is particularly important to the province, which is known throughout the nation as a major rice production area. Other major crops produced in the province include coconut, banana, mango, corn, and abaca (natural fibers). Approximately 430,000 cubic meters of timber products are produced in the province yearly (2009 statistics), making it the largest producer of timber in northern Mindanao (Table 1-3-4). The province boasts 120,000 hectares of potential mining areas, dominated by 95,000 hectares for gold and 10,000 hectares for nickel.

It is believed that the major industries of the province of Surigao del Norte are also agriculture, forestry and mining. However, the trip made to the region for the purposes of this study did not include interviews with local authorities in Surigao del Norte as the SPC had not yet been established at the time and land development permits had not yet been received. The wide plains alongside the National Roads in the area are widely used for rice farming. The planned project site lies in the mountainous area in the west of the province of Surigao del Norte, which is dominated by forests and only sparsely populated in small settlements dotted along the National Road, with very little development having been undertaken. On-site investigations and use of Google Earth reveal that there is only a single settlement within one kilometer of the planned power plant construction site: a small settlement lying to the south of the area for further study on the western edge of Lake Mainit. The area can reasonably expect strong winds to blow upward from the sea in the west across the mountains. Major agricultural products include rice and bananas. General trends are expected to follow those for Agusan del Norte outlined in Table 1-3-4.

A can be seen in the below photographs (Photographs 1-3-6), the area alongside the major roads is generally used for rice farming. The soil surface appears to contain several small stones and relatively soft rocks. Refer to Chapter 4, Section (3) for more details.

Photographs 1-3-6: Industry

Town alongside a National Road

Drying rice

138 kV transmission line and surrounding houses alongside a National Road

Rice paddy alongside a National Road

Table 1-3-4: Agricultural Production of the Province of Agusan del Norte

Crop	Yield (metric tons)			
	2010	2012	2013	2014
Rice	70,835.0	73,595.0	95,434.0	99,786.0
Corn	9,750.0	9,840.0	13,018.0	15,153.0
Abaca	508.3	529.1	521.2	547.0
Cacao	6.5	5.6	7.1	7.5
Coffee	111.2	88.4	65.8	71.3
Rubber	106.4	421.1	505.6	644.6
Banana	80,954.7	73,975.2	64,260.9	58,698.5
Durian	93.8	128.4	182.7	328.9
Mango	11,186.6	11,687.0	14,497.8	14,740.4
Mangosteen	0.5	0.2	7.5	4
Papaya	657.6	672.5	535.9	487.8
Pineapple	2,724.5	3,269.7	1,987.5	1,421.6
Cassava	5,708.2	5,147.7	4,323.7	3,637.2

Source: Created by the study team based on data from the Philippine Statistics Authority (PSA)

Chapter 2: Study Methodology

(1) Study Contents

In order to assess the viability of the implementation of this project, the following areas have been examined as part of this study, and results compiled in accordance with the stipulated “report creation guidelines.”

1) Overview of the Host Country and Sector

a) The economic and financial situation of the host country

A study was conducted of relevant documentation and data regarding the economic and financial situation in the Philippines, as well as its primary industries and population trends.

b) Overview of the planned project sector

A study was conducted of relevant documentation and data regarding the current supply/demand balance for electric power in Mindanao and the Philippines, and projections for the future.

c) Status of the host area

A study was conducted of relevant documentation and data, together with on-site surveys, to establish the current social and environmental situation of northeast Mindanao, the planned project site.

2) Relevant Laws and Regulations

a) Examination of energy laws, political policy pertaining to wind power generation, foreign investment restriction, and available incentives in the Republic of the Philippines

b) Examination of the application and approval process for permits, relevant environmental laws, and laws pertaining to land acquisition

3) Project Content and Technical Appraisal

a) Wind power generation potential of the island of Mindanao

The creation of an accurate wind power generation potential map for the Caraga region of Mindanao using a simulation derived from variables based on topography, climate and sunlight, with the technical cooperation of Associate Professor Takanori Uchida of the Research Institute for Applied Mechanics at Kyushu University

b) Wind power generation project potential for the provinces of Agusan del Norte and Surigao del Norte in the Caraga region

Summary of the situation regarding land rights holders and local residents, material transportation routes, and connectivity with existing power grids

c) Wind condition measurement preparation and data acquisition

d) Examination of the viability of a wind power generation project in the Caraga region

Analysis of wind condition simulation and turbine placement calculations, overview of generating equipment, the construction plan outline, and the maintenance and management plan outline

e) Project background and necessity

Summary of the project’s background and necessity

f) Analysis of the environmental and social situation, beneficial environmental effects of the project’s implementation, identification of environmental and social impacts of the project’s implementation, JCM credit preliminary calculations

4) Environmental and Social Considerations

In addition to summarizing the present environmental and social situation of the target area, analyses were carried out of the beneficial environmental effects of the project's implementation, the environmental and social impacts of the project's implementation, and the JCM credit preliminary calculations. Host country laws and regulations pertaining to environmental and social considerations that could impact upon the project's implementation were identified, and necessary measures summarized for adherence to these rules.

5) Economic and Financial Viability

A study of the project's feasibility was carried out through such measures as a calculation of the total project costs, a cash flow analysis, sensitivity analysis, preliminary financing and economic analysis, and an examination of plans for procuring funding. An examination of the cash flow following the project's implementation was also conducted, together with a sensitivity analysis.

6) Project Execution Schedule

An analysis of the schedule for the implementation of the project was carried out.

7) Practical Executive Ability of Host Country Operators

An overview was compiled of the implementing bodies of the project in the host country, together with their areas of jurisdiction and rights, and an analysis of their capabilities to operate the project.

8) Competitive and Technical Advantages of Japanese Corporations

The form of participation and advantages of the involvement of Japanese corporations in the project were analyzed. Necessary policies to encourage the involvement of Japanese corporations and the use of Japanese products in the project were also identified.

9) Projections for Project Financing

Plans for procuring funding for the project were analyzed, and their feasibility determined.

10) Action Plan and Issues Facing Project Implementation

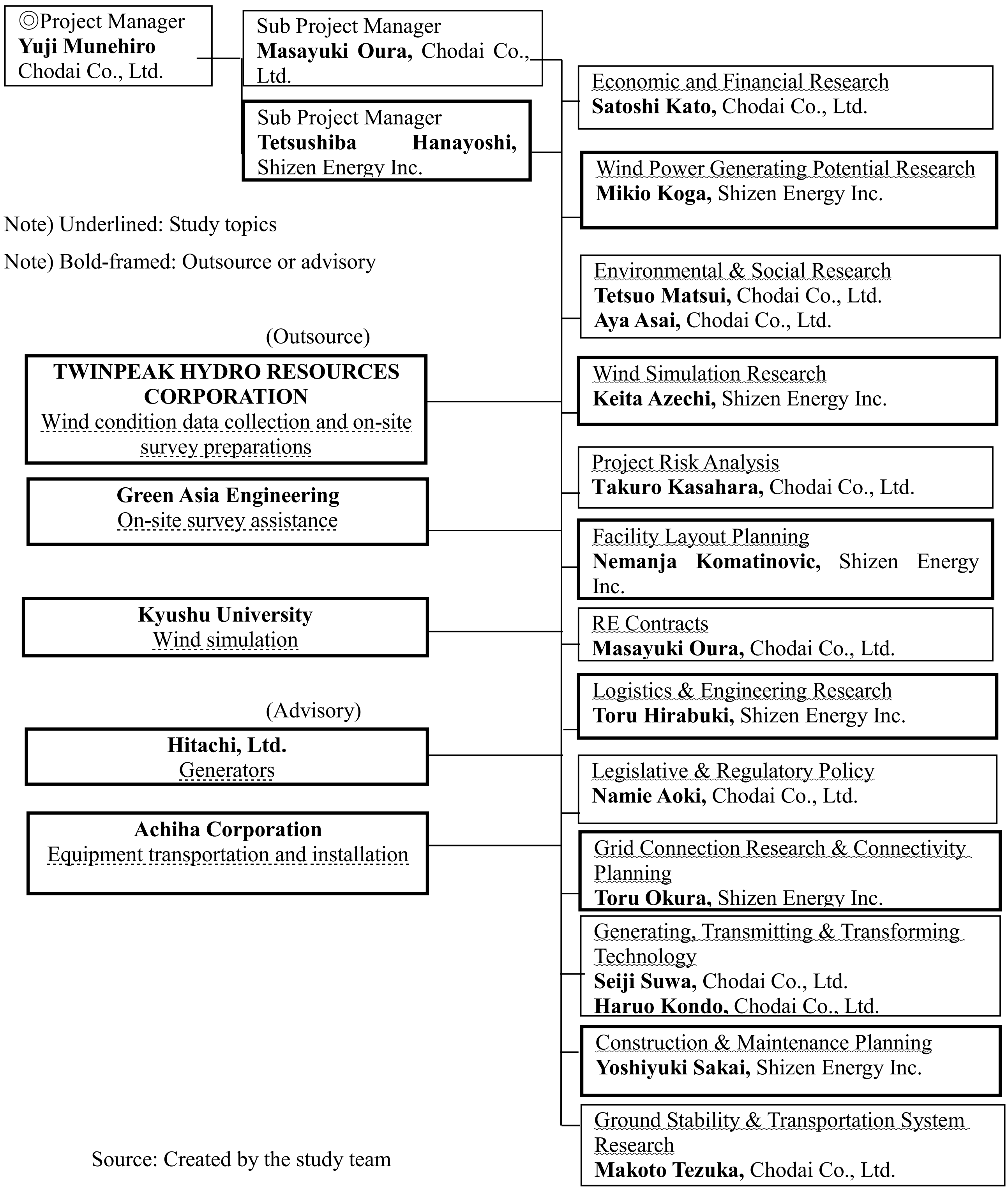
An action plan for the realization of the project was developed, and potentially problematic issues identified.

(2) Study method and study team organization

This study was carried out in Japan via the gathering and organization of materials and data, followed by calculations and analysis, followed by the creation of this report. Additionally, on-site surveys, and visits and interviews with relevant parties were carried out in the Republic of the Philippines.

The organizational structure of the parties involved in the study is shown below (Fig. 2-2-1), and involved a collaboration between Chodai Co., Ltd. and Shizen Energy Inc.

Fig. 2-2-1: Study Team Organization



Source: Created by the study team

(3) Study Schedule

Data collection and organization, calculation and analysis were carried out in Japan between August 19th and December 24th, 2016, while reports were drafted and written between September 2nd, 2016 and February 28th, 2017. On-site surveys in the Philippines were conducted in accordance with the data in Table 2-3-1 below.

Table 2-3-1: Study Schedule

Agenda	2016 AUG	SEPT	OCT	NOV	DEC	2017 JAN	FEB
[On-site surveys]							
1) 1st on-site survey (9/19-9/24)							
2) 2nd on-site survey (11/1-11/6)							
3) 3rd on-site survey (12/18-12/24)							
4) Debriefing (2/13-2/16, 2017)							
[Domestic projects]							
Preparation & planning							
1) Overview of host country and sector							
2) Examination of the content and technical aspects of the project							
3) Environmental and social analysis							
4) Economic and financial analysis							
5) Creation of written report (draft)							
6) Creation of written report (final version)							

Source: Created by the study team

Table 2-3-2: Overview of the On-Site Survey Findings

On-site survey	Date	Organization name	Meetings held with	Main points
[1st round] 9/19（Mon）～9/24 (Sat) Munehiro Oura Matsui Kondo Hirabuki Nemanja Azechi	9/20（Tue）～9/22 (Thu)	Equi-Parco Philippine Department of Energy（DOE） Twinpeak Hydro Resources Corporation (THRC) Green Asia Engineering (GAE)	Equi-Parco CEO Ruben A. Javier Peta Navana (DOE) THRC President Takano GAE President Maeda +Approx. 10 staff from Equi-Parco	- Preliminary meeting with involved parties - Discussion of study details
		Butuan City Council	Ronnie Vicente C. Lagnada (Mayor of Butuan City) Peta Navana (DOE) THRC President Takano GAE President Maeda +Approx. 10 staff from Equi-Parco	- Meeting with Mayor of Butuan City - Outlining details to the Mayor - Discussions concerning the acquisition of a Renewable Energy Contract in the Philippines
		On-site observation	Peta Navana (DOE) THRC President Takano GAE President Maeda	- On-site survey of installation site - Confirmation of transportation route Other issues: - Condition of surrounding roads

	9/23 (Fri)	Embassy of Japan JICA JETRO	Trade & Commerce Attaché Suzuki Dep. Manager Yamada Mr. Baba Director Sasaki	- Explanation of study details - Explanation of study policies and details of outsourcing - Explanation of study details - Explanation of study policies and details of outsourcing - Explanation of study details - Explanation of study policies and details of outsourcing
[2nd round] 11/1 (Tue)～11/6 (Sun) Munehiro Oura	11/2 (Wed)	DOE JETRO NAMRIA (National Mapping and Resource Information Authority)	Andresito F. (Andy) Ulgado, REMB (Renewable Energy Management Bureau) Director Sasaki Ms. Mary Jane Montemor	- Confirmation of protocol for registering wind power generating business and information collection - Explanation of study details - Acquisition of a (soft copy) topographical map of the study area from NAMRIA

	11/3(Thu) ～11/5 (Sat)	Equi-Parco THRC GAE On-site survey Caraga Region	CEO Ruben A. Javier Pres. Takano Pres. Maeda +Approx. 10 staff from Equi-Parco Pres. Takano Pres. Maeda	- Discussion regarding establishment of the SPC - Discussion regarding procuring wind condition study apparatus - On-site survey of installation site - Examining installation location and confirmation of installation process - Confirmation of transportation route

[3rd round] 12/15 (Thu) ～12/24 (Sat) Munehiro Kato Oura Matsui Asai Kondo Hirabuki Azechi	12/19 (Mon) ～12/21 (Wed)	Equi-Parco THRC GAE Achiha Corporation (Achiha)	CEO Ruben A. Javier Pres. Takano Pres. Maeda Pres. Achiha +Approx. 10 staff from Equi-Parco	- Discussion of study details - Reaching of agreement to establish the SPC - Discussion concerning procuring wind condition study apparatus - Discussion of details of transportation route
		On-site survey Caraga Region	THRC President Takano GAE President Maeda Achiha Pres. Achiha	- Examining installation location and confirmation of installation process; confirmation of transportation route
		NGCP Office ANECO (Butuan City) SURNECO (Surigao City)	Darwin T. Daymiel (ANECO) Heads of each office	- Discussions with ANECO (Agusan del Norte Electric Cooperative) and SURNECO (Surigao del Norte Electric Cooperative) - Discussions with NGCP (National Grid Corporation of the Philippines) - Confirmation of NGCP grid - Detailed simulation of wind conditions of the study area using wind condition analysis software, “RIAM COMPACT”

[4th round] 2/4 (Sat) ～2/9 (Thu) Munehiro	2/4 (Sat)～ 2/9 (Thu)	THRC Equi-Parco	Pres. Takano CEO Ruben A. Javier	- Discussions on how to proceed with the establishment of the SPC - Confirmation on required registration protocol - Preparation for RE contract application following SPC establishment
[5th round] 2/12 (Sun)～ 2/18 (Sat) Kato Oura Hirabuki Nemanja Hanayoshi	2/13 (Mon) ～2/17 (Fri) 2/16 (Thu)	Embassy of Japan JICA JETRO ADB JBIC Equi-Parco THRC GAE DOE Ministry of Economy, Trade and Industry MinDA	Trade & Commerce Attaché Suzuki Dep. Manager Yamada Mr. Baba Director Sasaki CEO Ruben A. Javier Pres. Takano Pres. Maeda +Approx. 10 staff from Equi-Parco Peta Navana Financial Cooperation Division Director Hirai Mr. Morimoto	- Summary of study findings - Discussion regarding installation location - Wind condition analysis - Simulation results - Assessing business feasibility - Discussion regarding financing - Mindanao Energy Seminar (Davao)

Source: Created by the study team

Chapter 3: Examination of Applicable Laws and Regulations

(1) Energy Laws and Political Policies in the Philippines

1) Energy Laws and Political Policies in the Philippines

The “Philippine Energy Plan 2009-2030,” drawn up by the DOE, places particular focus on “ensuring energy security” and “efficient implementation of energy sector reforms.”

As part of the drive to ensure energy security, the document outlines policy thrusts to accelerate the exploration and development of oil, gas and coal resources, to intensify development and utilization of renewable energy resources, to attain nationwide electrification, and to improve transmission and distribution systems. Regarding renewable energy in particular, the plan is to triple capacity from its 2010 figure of 5,438 MW by the year 2030. The introduction of the FIT system in July 2012 allowed operators of renewable energy power plants registered with the system to sell their power at a higher rate than the market would usually dictate.

Regarding the efficient implementation of energy sector reforms, the department’s policy is to pursue reforms to energy laws that will allow for increased efficiency, competition, transparency and reliability in the energy sector.

With respect to electric power, the ratifying of the Electric Power Industry Restructuring Act of 2001 led to the breakup and privatization of the National Power Corporation (NPC) and the establishment of the Wholesale Electricity Spot Market.

According to the December 28th, 2016, release of the *Daily NNA, Philippines Edition*, the NGCP has announced plans to become a public company by January 2019. *The Philippine Star* newspaper reports that the NGCP is allotting PHP 89.55 billion (approximately 211.0 billion yen) from 2017 to 2020 in capital expenditures, with plans for a further PHP 23.88 billion beyond 2020 for the expansion and upgrading of its grid networks.

Source:“FY 2013 Infrastructure and System Expansion Projects (Renewable Energy and Energy Conservation Technology System Feasibility Studies) for the Relaxation of Energy Supply and Demand”; “Feasibility Study of a Large-Scale Sugar Mill Biomass and Energy Conservation Project in the Philippines,” March 2014

2) Organizational Structure of the Energy Industry

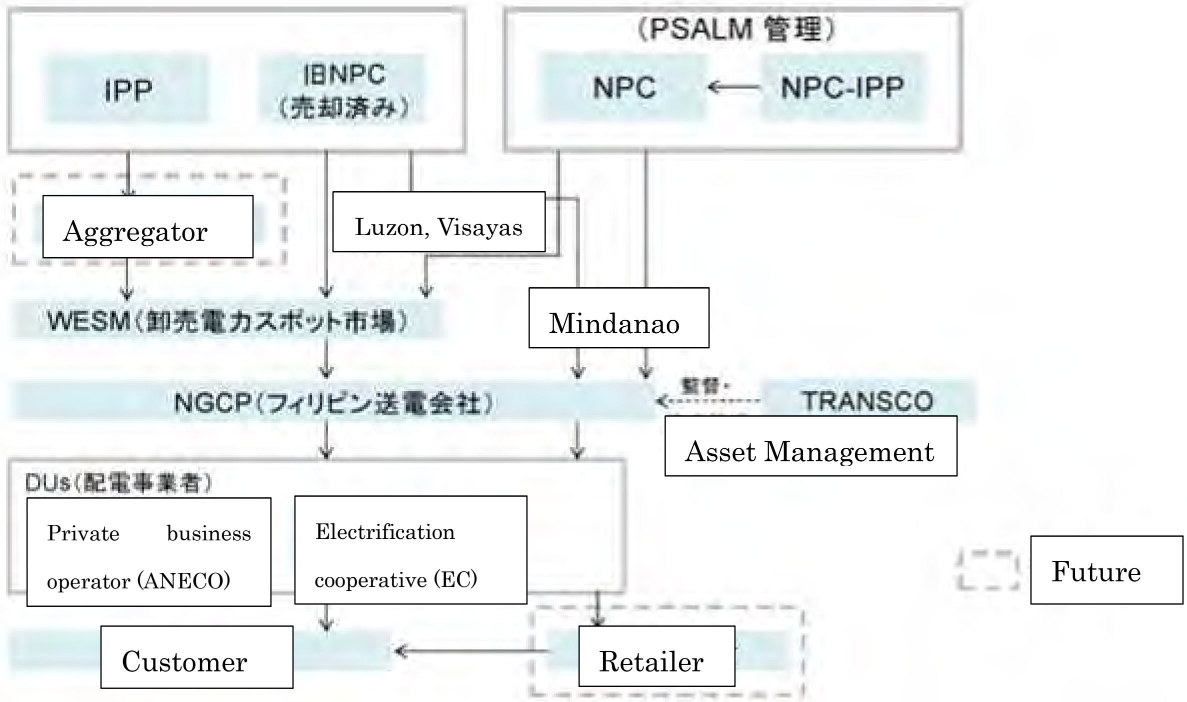
a) Governmental Authority on Energy Policy Creation

The Department of Energy (DOE) is responsible for policy design and the establishment of targets for the energy industry. As well as devising, executing and monitoring all plans in the energy field, it also oversees the development of energy resources and energy conservation projects.

b) Electric Power Industry Structure

The overall structure of the electric power industry is laid out in the chart below (Fig. 3-1-1), with details of the function filled by each organization.

Fig. 3-1-1: Electric Power Industry Structure



Source: Kaigai Shokoku no Denki Jigyou ("The Electricity Sector in Various Foreign Countries"), Japan Electric Power Information Center, Inc., 2011

① Department of Energy (DOE)

The administrative organization with the authority to manage and oversee all aspects of energy development and usage. Creates both "energy plans" and "energy resource development plans."

② Energy Regulatory Commission (ERC)

An independent regulatory authority created by the EPIRA with the power to grant approvals on issues such as electricity costs. Its role includes the "promotion of competition," "encouragement of market growth," "protection of consumer choice," "maintenance of rational pricing schemes," and the "prevention and punishment of abuse of market control." It oversees the appropriate execution of the EPIRA law.

③ National Electrification Administration (NEA)

Established in 1969 for the purpose of promoting "regional electrification programs." Under the purview of the DOE, the NEA provides funding (often in the form of low-interest loans) for regional electrification, and is involved in the construction of regional power-generating infrastructure. As well as providing funding and handing over control of constructed power-generating facilities to the EC, it is also involved in the organization, overview and guidance, and personnel training of the EC.

④ Power Sector Assets and Liabilities Management Corporation (PSALM)

Established by the EPIRA, PSALM is a company which manages and operates electric power assets. Its primary objective is the clearance of the NPC's debts and irrecoverable stranded costs. To this end, it is authorized to sell off the power-generating assets, real estate, and other liquefiable assets of the NPC, as well as the electricity-purchasing contracts signed between the NPC and IPPs. The clearance of debts is also intended to promote the privatization of the industry. PSALM is designed by law to exist for 25 years following the implementation of the EPIRA, and is to sell off all assets during that time. All sellable assets of the NPC legally become the property of PSALM, and all money raised is set against the NPC's debt. Any assets which PSALM fails to sell during the period of its existence will be returned to the property of the state.

⑤ The National Power Corporation (NPC)

A government-owned organization established in 1936. For many decades following its establishment, the NPC held a monopoly over the country's power generation and transmission industries, but with the implementation of the EPIRA, its assets were to be privatized. The passing of the EPIRA gave the NPC rights to manage power plants, but it also gave birth to TRANSCO, designed to manage power transmission facilities, and PSALM, which manages power-generation and transmission assets. Therefore, the NPC is now only responsible for the management of existing power stations from the pre-privatization days, and the electrification of so-called "missionary areas," separated from electricity transmission networks, via the Small Power Utilities Group (SPUG). It is now unable to develop new energy resources in any other regions.

It should be noted that the power-generating facilities in the SPUG areas are also planned to eventually be sold to private enterprise.

⑥ The National Transmission Corporation (Transco)

Established by the EPIRA to take over the power distribution side of the NPC's business, Transco became an independent entity in 2003 and operated as the Philippines' only power transmission company. In 2009, however, it ceded the rights to power transmission in the country to the NGCP, a company established by a Chinese-Philippine consortium. Currently, Transco oversees the NGCP's business management, and manages power transmission assets.

⑦ The National Grid Corporation of the Philippines (NGCP)

Bids were solicited for 25 years of Transco's power transmission business rights in December 2007, and these rights were won by a consortium from China and the Philippines. The NGCP is the company this consortium formed to operate the business. Philippine interests led by the Monte Oro Group provided 60% of the company's capital, while the State Grid Corporation of China provided the remaining 40%. The company officially acquired the rights to the business and began operation in January 2009. NGCP is currently responsible for Transco's former tasks of construction plans, construction, and maintenance and management of power transmission facilities, as well as power grid operation.

(2) Laws, Policies, Foreign Investment Restrictions, and Incentives Relating to Wind Power Generation in the Republic of the Philippines

1) Laws and Political Policies Relating to Wind Power Generation in the Philippines

Development of renewable energy sources in the Philippines is promoted by the Department of Energy (DOE). As well as establishing the National Renewable Energy Program (NREP) in 2008 as a means of encouraging the development of renewable energy sources, the DOE also drew up the Renewable Energy Act of the same year, which lays out the framework and technical standards required for such projects.

The NREP includes plans to multiply by 2.8 the total rated output of all renewable energy facilities in the country from 5,438 MW as of 2010 to 15304.3 MW by the year 2030. Wind energy has been designated as a particular target of this expansion; from its rated output of 33.0 MW as of 2010, it is slated for additional facilities to be added with a total output of 1048.0 MW by 2015, an additional 855.0 MW by 2020, and an additional 442.0 MW by 2025, leading to a total rated capacity of all facilities of 2378.0 MW by the year 2030 (Table 3-2-1).

Table 3-2-1: NREP Expansion Targets

Classification	Installed capacity in 2010	Target additional capacity				Total additional capacity	Installing capacity by 2030
		2015	2020	2025	2030		
Geothermal	1,966.0	220.0	1,100.0	95.0	80.0	1,495.0	3,461.0
Hydraulic power	3,400.0	341.3	3,161.0	1,891.8	0.0	5,394.1	8,724.1
Biomass power	39.0	276.7	0.0	0.0	0.0	276.7	315.7
Wind power	33.0	1,048.0	855.0	442.0	0.0	2,345.0	2,378.0
Solar power	1.0	269.0	5.0	5.0	5.0	284.0	285.0
Ocean	0.0	0.0	35.5	35.0	0.0	70.5	70.5
Total	5,438.0	2,155.0	5,156.5	2,468.8	85.0	9,865.3	15,304.3

Source: NREP Executive Summary, DOE

2) Foreign Investment Restrictions on Wind Power Generation Projects in the Republic of the Philippines

Trends in foreign investment restrictions

The major laws governing foreign investment policy in the Philippines are the Omnibus Investments Code of 1987, the Foreign Investments Act of 1991, the Bases Conversion and Development Act of 1992, and the Special Economic Zone Act of 1995. In fundamental terms, the Philippine government actively welcomes direct investments from foreign companies in the Philippines, and is prepared to provide a variety of incentives such as the relaxation of regulations.

Ever since the inception of the Corazon Aquino government in 1986, the Philippine government has persisted with a policy of pursing economic development of the state through the encouragement of private investment, both from within the Philippines and from overseas. This policy has remained unchanged through the governments of Benigno Aquino and now Rodrigo Duterte.

The only industries for which foreign investment is restricted in the Philippines are those listed on the Foreign Investment Negative List (Ninth Regular Foreign Investment Negative List, established by Executive Order No. 98 of October 29th, 2012). In theory, it should be possible to establish a company in the Philippines with 100% foreign capital, provided that it is in an industry not included in the Negative List. However, the Energy Investor's Guidebook, published by the DOE for energy developers, stipulates that one of the conditions for an application as a renewable energy project is that the proponent of the project needs to be "either a company with Philippine capital, or a company with at least 60% Philippine capital." This means that in order for Japanese companies to develop a renewable energy generation business in the Philippines, an SPC must be established for the purpose, with 60% of its investment base coming from Philippine investors, and 40% coming from Japanese corporations.

3) Incentives Available for Wind Power Generation Projects in the Republic of the Philippines

a) Taxation incentives

This project will be eligible for a variety of economic incentives to encourage renewable energy development under the Renewable Energy Act. They include a seven year exemption on corporate income tax, a ten year exemption from duties on imported materials, and lowered tax rates on real estate.

b) Feed-In Tariff (FIT) incentives

The Energy Regulatory Commission (ERC) released regulations for the adoption of FITs in July of 2010, while the first resolution approving the rates themselves was passed by the ERC in July 2012. FIT rates are proposed by the NREB, set up as part of the Renewable Energy Act, then approved by the ERC. The tariff rates as at 2012 for wind power generation were 8.53 PHP (app. 19 yen)/kWh. Revisited every three years, the rates were lowered to 7.40 PHP/kWh in 2015. The entitlement period is guaranteed at 20 years.

Table 3-2-2: Feed-In Tariff Rates (per kWh) in the Philippines (July 2012; *December 2015)

Category	Rate proposed by the NREB	Rate approved by the ERC	Adoption target (MW)
Hydropower	6.15 PHP 0.123USD 14.02JPY	5.90 PHP 0.118 USD 13.45 JPY	250
Biomass	7.00 PHP 0.140 USD 15.96 JPY	6.63 PHP 0.133 USD 15.12 JPY	250
Wind power	- - -	* 7.40 PHP 0.148 USD 16.87 JPY	200
Solar power	- - -	* 8.69 PHP 0.174 USD 19.81 JPY	50

Note: Exchange rates are from January 2016 (1 PHP = 0.02 USD = 2.28 JPY)

(3) Approval Processes

1) Environmental Impact Assessment Procedures

The central role in environmental management in the Republic of the Philippines is held by the Department of Environment and Natural Resources (DENR), a governmental department established in 1987. In particular, the Environmental Management Bureau (EMB), a subordinate department of the DENR, is responsible for the formulation of environmental management policy, the implementation of management laws and regulation frameworks, and the creation of technical guidelines pertaining to environmental issues. Its regional offices throughout the country are responsible for the enforcing of environmental laws. Environmental impact assessments are the domain of the EMB’s Environmental Impact Assessment and Management Division, and each regional office functions as the liaison between the division and relevant project proponents.

The Philippine Environmental Impact Statement System (PEISS) was established in 1997 by Presidential Decree No. 1586 to serve as the standard for environmental impact assessments in the Philippines. The Environmental Impact Assessment (EIA) system was formally established in 1978, and the key terms of "Environmentally Critical Projects" (ECP) and "Environmentally Critical Areas" (ECA) were officially defined in 1981, dividing applicable projects into broad categories. The EIA system stipulates that environmental impact assessments must be carried out with specific reference to the type, scale and location of the planned project. Proponents are required to submit either an Environmental Impact Statement (EIS) or an Initial Environmental Examination (IEE) report for examination by the DENR. Should the paperwork meet the relevant standards, the DENR will issue an Environmental Compliance Certificate (ECC), thereby approving the project's implementation.

As this wind power generation project will feature generating facilities with an output of 150 MW, an ECC will be necessary. However, it does not constitute an ECP, and as the project site does not lie within a protected area, it is not in an ECA either. According to the "Revised Guidelines for Coverage Screening and Standardized Requirements" (EMB MC 2004-05), if this project were altered to become a smaller-scale project, an ECC would no longer be necessary, but a Project Description (PD) would need to be submitted and a Certificate of Non-Coverage (CNC) would also need to be acquired. The EIA procedures for a wind power project are outlined in Table 3-3-1 below.

Table 3-3-1: IEE Checklist

Project	ECC necessary			ECC unnecessary
	ECP projects	Non-ECP projects		
		EIS	IEE Checklist	PD (a CNC may be required)
Renewable energy (including wind power)	None	≧100 MW	Between 5 and 100 MW	≦5 MW

Source: Revised Guidelines for Coverage Screening and Standardized Requirements (EMB MC No. 005)

2) Procedures Concerning Renewable Energy

The DOE has produced a circular covering the necessary procedures for application to the department for approval as a renewable energy project under the Renewable Energy Act of 2008 (RA 9513) and the Biofuels Act of 2006 (RA 9367). This circular contains detailed flow charts (see Attached Reference Material 1) for necessary procedures for the following cases:

a) Direct negotiation with the DOE
b) Competitive bidding
c) Changing of RE contract type under the Renewable Energy Act (RA 9513) from the pre-development stage to the development/commercial operation stage
d) Changing of existing service contracts or terms of agreement for renewable energy resources in the RE contract pursuant to RA 9513

Further, in addition to following the prescribed flow for the application and approval process, it will be absolutely necessary to ensure that the application forms and affidavits for renewable energy services and commercial operations contracts are fully understood and completed without omission, and that the requirements for renewable energy projects as laid out in the provided checklists are all met (see Attached Reference Material 1 for details).

Once the details of each category in the prescribed list have been analyzed and summarized, and the relevant application forms and checklists have been completed, they must be submitted to the Renewable Energy Management Bureau (REMB) of the DOE.

It should be noted that in order to ultimately establish a commercial operations contract for renewable energy development, there are two stages into which projects are divided: the pre-development stage and the development/commercial stage. The pre-development stage is defined as the period of time involving the preliminary assessment and feasibility study up until the financial closing of the RE project. The development/commercial stage is defined as the period of time involving the development of RE resources including the construction and installation of relevant facilities up to the operation phase of those facilities.

3) Processes for Licensing and Approvals

(Based on "FY 2013 Infrastructure and System Expansion Projects (Renewable Energy and Energy Conservation Technology System Feasibility Studies) for the Relaxation of Energy Supply and Demand"; "Feasibility Study of a Large-Scale Sugar Mill Biomass and Energy Conservation Project in the Philippines," METI, March 2014, pp.34, 35, 51-55.)

An overview of each step of the process before the project can be begun is as follows:

a) Project feasibility study and declaration of intent

Measurements and analysis of wind resources will continue from March onwards, as will consultations and negotiations between the participating companies in the SPC. In this instance, the power generation method will involve the use of wind power facilities, while the scale of the project in terms of power generated has been largely determined at this point (late February, 2017). Going forward, analysis will continue, and once the feasibility of the project has been determined through each company's internal processes, evaluations will be made regarding investment.

b) Registration of the SPC

The SPC which will be the proponent of the power generation business will be registered as a company. A contract with the local participating companies for the establishment of the SPC has already been signed in January 2017. Remaining steps include the registration and certification of the company, and the signing of an RE contract.

c) EIA submission and approval

An EIA must be submitted, and an Environmental Compliance Certificate (ECC) received.

d) Carry out examinations of the possibility of connecting with the local grid and examine issues of capacity and connection points. Apply to the NGCP and ANECO for permission to carry out System Impact Studies or Distribution Impact Studies, and implement them.

e) Receive a Confirmation of Commerciality from the DOE.

f) Procure funding and sign project financing contracts before construction begins.

g) Begin construction. The installation of all 75 wind turbines is expected to take one and a half to two years.

h) Once construction is completed and ERC recognition has been obtained, FIT approval can be secured. FIT rates and the energy capacity to which those rates apply will be confirmed.

i) Begin operation and the selling of electricity.

*Projects which are considered to exert a major impact upon the environment are defined as Environmentally Critical Projects (ECP). Among renewable energy projects, wind farms and wind power generation facilities are not considered to fall within this ECP category. Depending on the project scale, however, either an Environmental Impact Statement (EIS) or an Initial Environmental Examination (IEE) checklist must be submitted to the regional office of the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR). (The categories in the IEE checklist are as follows: Ⅰ Project overview; Ⅱ Environmental impact and management plans (checklist format); Ⅲ Plans for disposal or repair (if applicable); Ⅳ Details of environmental management systems and overview of wastewater treatment facilities, air pollution mitigation measures, etc.)

With regard to environmental impact assessment, the Philippine Environmental Impact Statement System (PEISS) was established in 1997 by Presidential Decree No. 1586. This system requires an environmental impact assessment to be conducted and submitted for approval. Only after an Environmental Compliance Certificate (ECC) is acquired can development begin on the project.

However, not all projects require an ECC; those that do not will simply require a Project Description (PD) to be drawn up and submitted in order to obtain a Certificate of Non-Coverage (CNC) to allow the project to proceed. For this reason, close consultation must be continued with the relevant authorities as the project proceeds.

Time periods required for the issuance of an ECC are a maximum of 60 working days for projects requiring an EIS (which need a prior examination from a specialist consultant), and a maximum of 30 working days for projects requiring an IEE checklist (for which all materials can be provided by the proponent itself).

(4) Overview of Laws Pertaining to Environmental and Social Concerns in the Host Country

1) Environmental Laws and Regulations

In terms of laws pertaining to environmental issues in general in the Philippines, Presidential Decree No. 1151 (the Philippine Environmental Policy) and Presidential Decree No. 1152 (the Philippine Environmental Code) were enacted in 1977, and are equivalent to Japan’s Basic Environment Law. Presidential Decree No. 1151 defines the state’s environmental policies and goals, asserts the right of every citizen to a healthy environment, and outlines the guidelines for evaluating environmental impact and the agencies which will carry out such evaluations. Presidential Decree No. 1152, which follows the same guiding principles as Presidential Decree No. 1151, defines the standards for the control of air quality, water quality, land use, natural resources and waste.

Table 3-4-1: Environmental Laws and Regulations in the Philippines

Field	Year of enactment	Law	Registered number
Basic environmental laws	1977	Philippine Environmental Policy	Presidential Decree No. 1151
		Philippine Environmental Code	Presidential Decree No. 1152
Air quality	1999	Philippine Clean Air Act of 1999	Republic Act No. 8749
	2000	Implementing Rules and Regulations For RA 8749	DENR Administrative Order No. 81
	1993	Air Quality Standard	DENR Administrative Order No. 14
Water quality	2004	Clean Water Act	Republic Act No. 9275
	2005	Implementing Rules and Regulations for RA 9275	DENR Administrative Order No. 10
	1990	Water Usage and Classification / Water Quality Criteria	DENR Administrative Order No. 34
		Effluent Regulations	DENR Administrative Order No. 35
Noise pollution	1980	Noise Control Regulations	NPCC Memorandum Circular No. 002, Series of 1980
Waste management	1975	Sanitation Code	Presidential Decree No. 856
	1990	Toxic Substances and Hazardous and Nuclear Wastes Control Act	Republic Act No. 6969
	2000	Ecological Solid Waste Management Act	Republic Act No. 9003
Environmental impact assessment	1977	Philippine Environmental Impact Statement System (PEISS)	Presidential Decree No. 1586
	2003	Implementing Rules and Regulations (IRR) for the Philippine Environmental Impact Statement (EIS) System	DENR Administrative Order No. 30
	2014	Revised Guidelines for Coverage Screening and Standardized Requirements under the Philippine Environmental Impact Statement System (PEISS)	EMB Memorandum Circular No. 005

Source: Created by the study team

(5) Laws Pertaining to Land Acquisition

The National Integrated Protected Areas System (NIPAS) Act was enacted in the Republic of the Philippines in 1992 in order to protect regional natural resources, biodiversity and locations of historic and cultural value. Development activity in any area designated as a NIPAS area under this law is prohibited. For this reason, for the smooth implementation of the project, the establishment of whether or not the project site will fall into a NIPAS area and the subsequent acquisition of that land will be of the utmost importance.

In the instance that the planned project site is designated as a NIPAS area, studies will be carried out immediately following the explanations of the business venture to local government bodies, and all appropriate considerations will be made. If it is not designated as a NIPAS area, then no permission or agreements need to be obtained from relevant organizations. This issue is explored in detail in Section (3) Subsection 3) of Chapter 6.

Table 3-5-1: Laws Pertaining to Land Acquisition and Indigenous Peoples in the Philippines

Field	Year of enactment	Law	Registered number
Indigenous peoples	1992	National Integrated Protected Areas System Act	Republic Act No. 7586
	1993	Rules and Regulations for the Identification, Delineation and Recognition of Ancestral Land and Domain Claims	DENR Administrative Order No. 2
	1997	Indigenous Peoples' Rights Act	Republic Act No. 8371

Source: Created by the study team

Land use approval from the Philippine Department of Environment and Natural Resources will be required for the signing of an RE contract.

Chapter 4: Project Details and Technology Aspect Evaluation

（１） Project Background, Necessity, etc.

1) The State of Mindanao Island's Electricity Supply and Demand

The population of the Philippines is currently estimated at around 100,981,000 people according to a national census conducted in 2015, and is increasing by more than 1% every year. In addition, thanks to a population "bonus" period expected to occur over the next 40 years, it has one of the greatest long-term potential markets of any country in southeast Asia. In addition, the economy has continued to perform strongly, with 7.1% growth in 2013 and 6.1% growth in 2014, significantly higher growth rates than other Southeast Asian countries. And thanks to an increase in consumer activity due to stable prices and an increase in infrastructure, we can expect the Philippine economy to continue to show relatively high growth for the foreseeable future.

In accordance with this economic growth, the Philippines' electricity demand is increasing year over year. Peak electricity demand in 2014 reached 11,822MW nationwide, with Luzon reaching 8,717MW, Visayas reaching 1,636MW, and Mindanao reaching 1,469MW (see figure 4-1-1). Looking at the demand estimate from 2015 to 2030, Mindanao is the largest at 6.1%, while the annual average growth rate for the whole country is 4.6%, with Luzon at 4.1% and Visayas at 5.7%. In addition, as of several years ago, Mindanao Island was known as a region where electricity was in tight supply, with frequent blackouts that had major recurring economic impacts. It did not help matters that the activities of the Moro Islamic Liberation Front (MILF) in the southern part of Mindanao Island have been a bottleneck for Mindanao for many years. However, on March 27, 2014, a comprehensive peace agreement was signed with the Japanese government, and in January 2017, Prime Minister Shinzo Abe visited the area and proposed an economic collaboration worth 1 trillion yen. On January 12, 2017, the Philippines and Japan officially signed the JCM, making the Philippines the 17th country to do so. As the Philippines continues to develop resources and local regions, the demand for electricity will continue to increase as the populace's lives continue to improve and stabilize. A stable electricity supply will be essential as the Philippines continues to make up for delayed economic development.

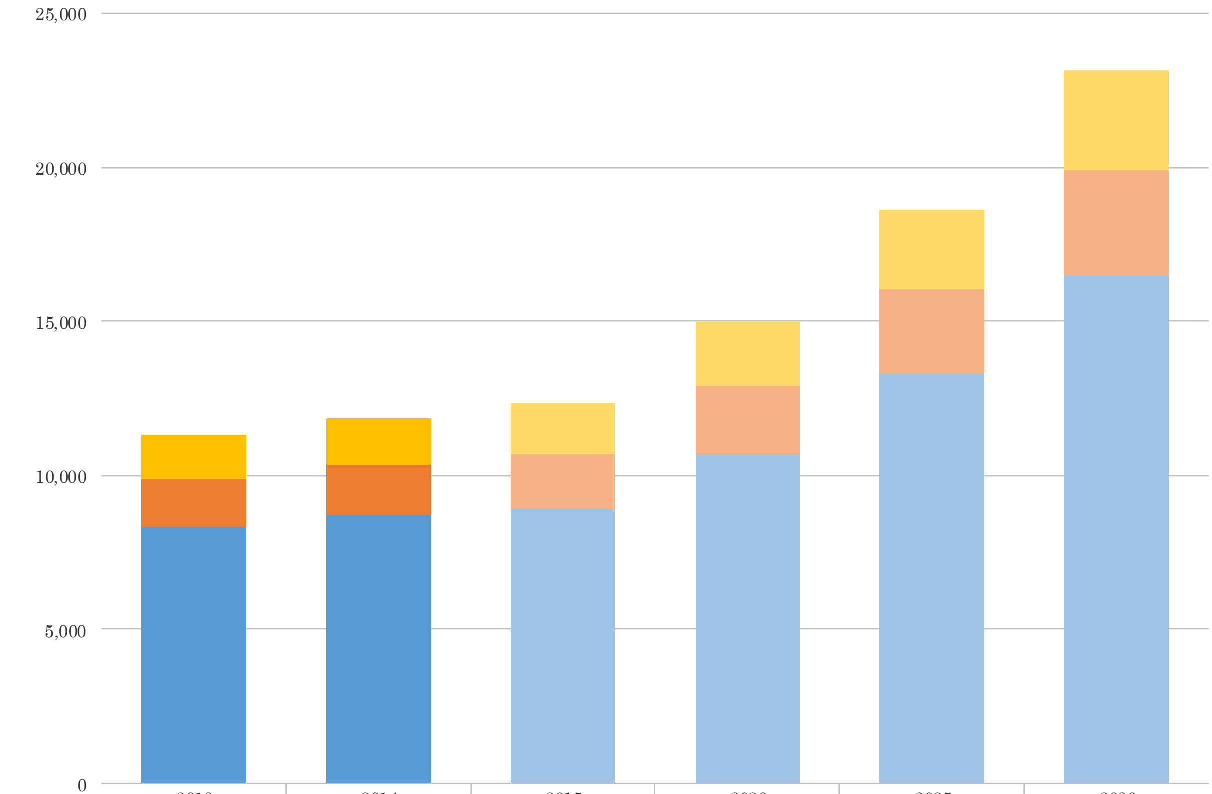
Even though the Caraga region does not have a power plant that operates consistently at all hours, it still has a population of about 2.5 million people, and their peak electricity demands are believed to be about 120MW, which is currently being supplied from the Iligan region approximately 300km away. As such, Caraga's economic development has stalled due primarily to their infrastructural instability, of which electricity is a major component.

Electricity shortages were a serious problem in Caraga up until two to three years ago (around 2014), but after that, in the current period leading from 2015 to 2016, the electricity supply and demand balance of Mindanao Island, most recently due to the launch of a new large-scale coal power plant, is now expected to be have excess supply from 2017 on to 2025. Since the large-scale thermal power plant was launched in 2015, the frequency of power outages has decreased compared to conditions in 2014 and earlier. However, when the large thermal power plant shut down in May 2016, power outages occurred every day. This shows that the current situation, where the power supply depends on this single large-scale coal plant, is fragile, since it is liable to shut-downs and leaves the region without sufficient power when inactive. Furthermore, since Mindanao Island has no major industry, even though their electrical demands may not be all that constrained at this point in time, as major industry does become established (such as Robinson, a large-scale shopping mall located in General Santos City) and expands to the region, the current fluctuating power supply state is far too fragile to meet the increased demand. With the region foreseen to undergo rapid economic development soon, measures will need to be taken in order to meet the increased annual 100MW–200MW electricity demand, or the days of insufficient power supply will reappear in a few short years. In addition, even though Mindanao Island's current power facilities may be enjoying a surplus at this moment in time, those facilities are also currently lacking repairs and improvements, and as a result they are unable to generate power at their theoretical maximum capacity.

Although all of Mindanao Island's electrical supply and demand balance may be in surplus at this particular point in time, it is important that more developments in power supply are enacted in order to meet future rapid economic development.

Currently, the Philippine government is attempting to advance efficient energy and new secure new sources of energy in order to meet the electricity demands of the near and 10-odd year distant future. In this kind of situation, the electrical grids in Mindanao's Luzon and Visayas areas are both isolated instead of interconnected, and we believe that providing new, environmentally-friendly power plants and connecting them to the two grids will help to solve this problem.

Figure 4-1-1: Forecasted Peak Power Demand by Area (unit: MW)



	2013	2014	2015	2020	2025	2030
Mindanao	1,428	1,469	1,657	2,068	2,592	3,250
Visayas	1,572	1,636	1,799	2,237	2,759	3,431
Luzon	8,305	8,717	8,892	10,693	13,274	16,477

Source: Created by Survey Team based on DOE development plans for 2009–2030

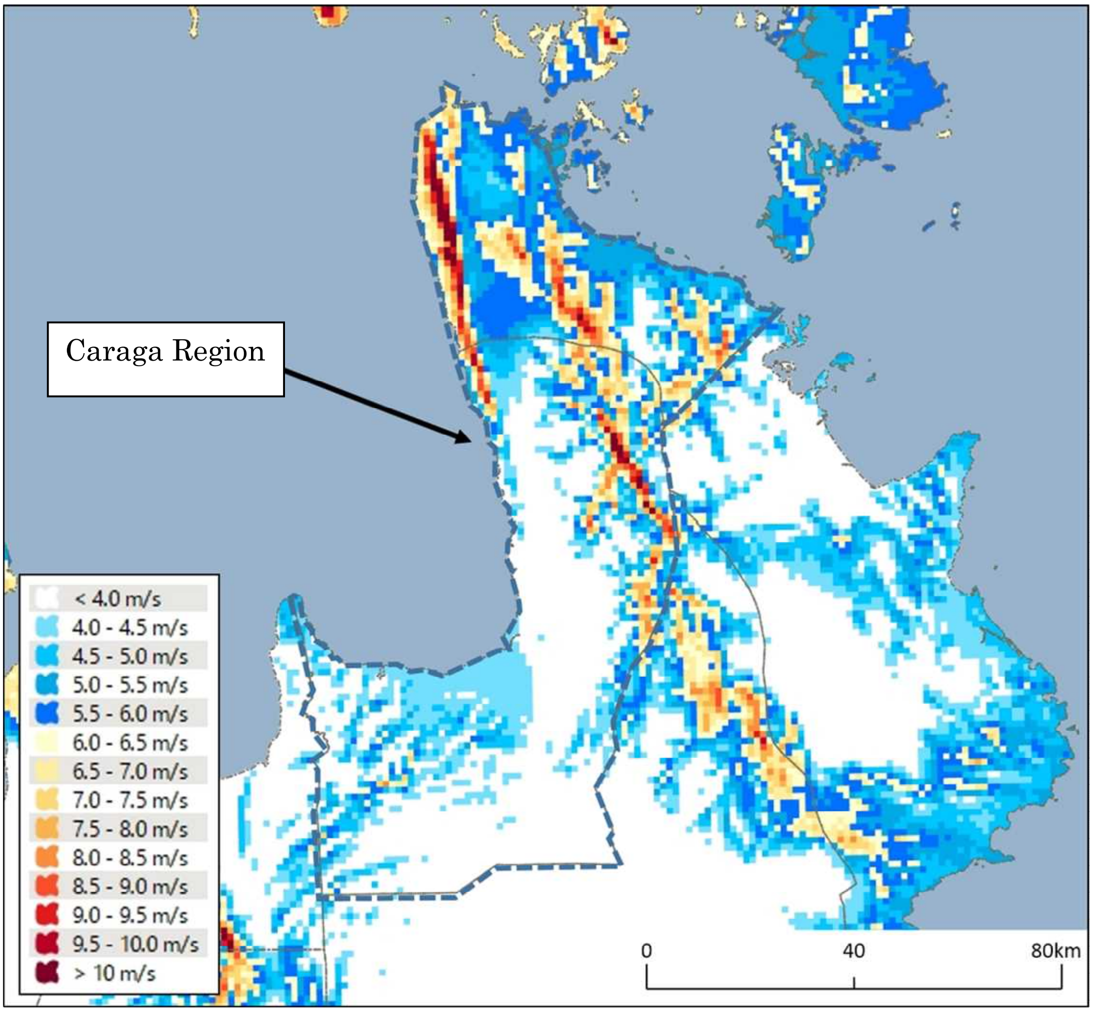
(2) The Caraga Region's Wind Power Potential and Area Selection

In this section, we will select a number of areas in the Caraga region's Agusan del Norte and Surigao del Sur provinces that could serve as sites for wind power plants, then examine each area from a theoretical perspective to determine their suitability based on 4 factors: wind conditions, topography, transport infrastructure (bays and roads), and power supply. We will then give each area an overall grade and select the areas with especially high potential.

1) General Wind Conditions Map

Thanks to USAID support, in 2014, the United States' NREL (National Renewable Energy Laboratory) produced a general map of wind conditions across the entire Philippines. You can see figure 4-2-1 for a general map of wind conditions focused on Agusan del Norte and Surigao del Norte. As the figure shows, the entire south part of Agusan del Norte has weak winds (less than 6m/s) whereas the north part of Agusan del Norte and Surigao del Norte have areas with strong winds (7m/s and faster).

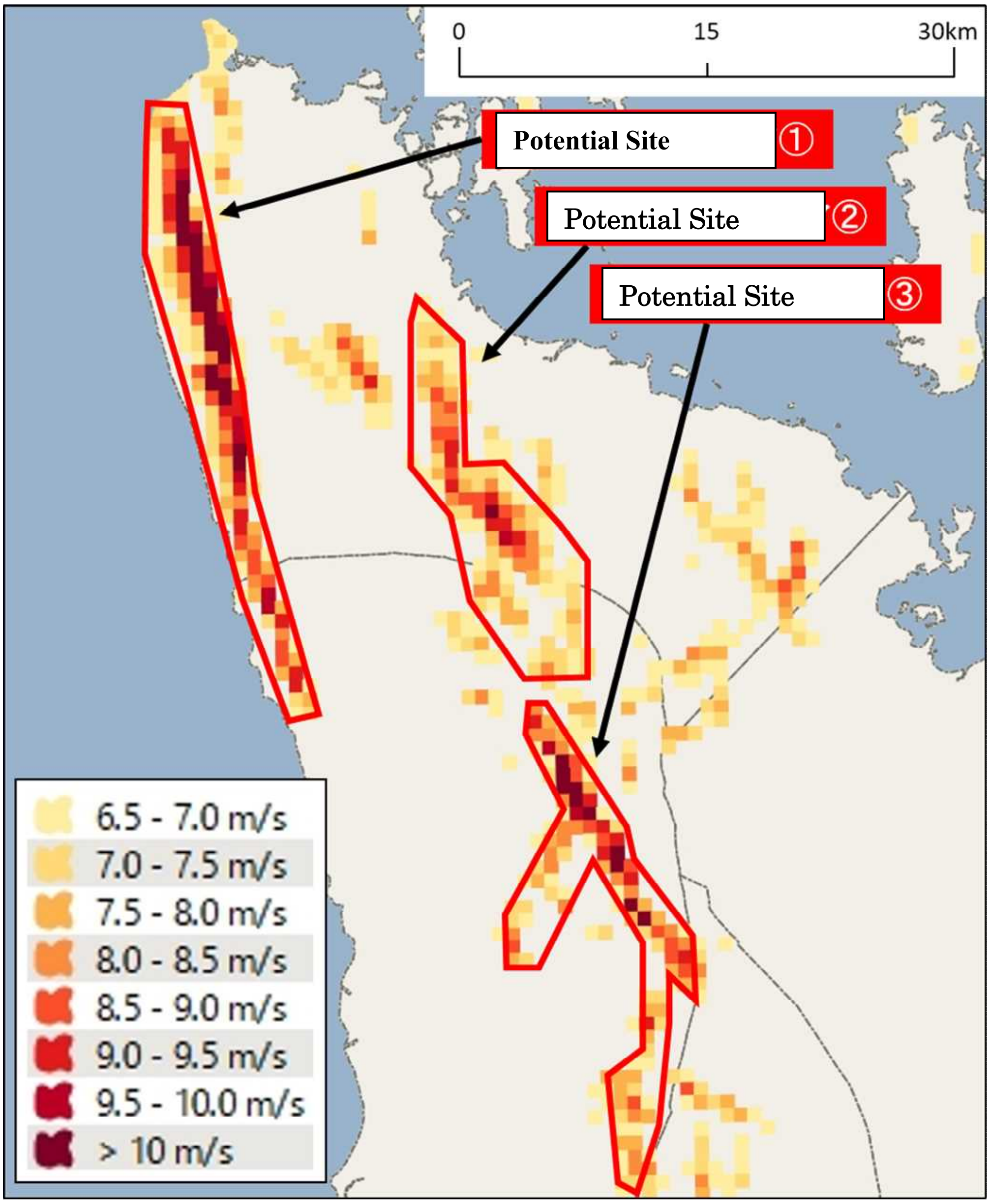
Figure 4-2-1: General Wind Conditions Map (average annual wind speeds at 80m above ground level)



Source: Created by Survey Team based on NREL Wind Prospector

Generally, an area's potential to serve as a good site for wind power is determined by whether it has annual wind speeds of 6–6.5m/s at an altitude of 80m. In this report, we have determined which areas meet that standard and pointed them out in figure 4-2-1. Furthermore, since we will need project sites with a certain level of wind strength in order to execute this wind power plant project, we have selected 3 such areas (all of them in hills or mountainous areas) and indicated them in figure 4-2-2. In particular, you can see that potential site ① has better, wider areas with more suitable wind conditions than areas ② or ③.

Figure 4-2-2: Potential Sites in Agusan del Norte and Surigao del Norte



Source: Survey Team

2) Topography/Altitude

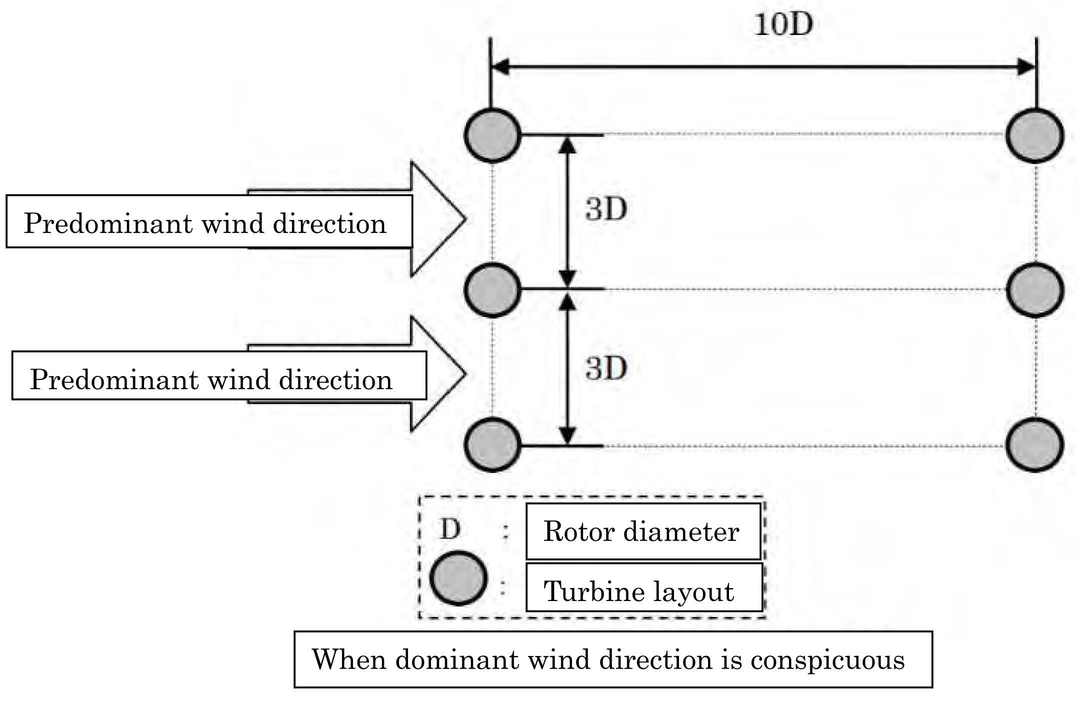
a) The Relationship Between Predominant Wind Directions and Topography

When evaluating turbine placement, for hilly and mountainous areas, the ideal topography is land where the ridge is perpendicular to predominant wind directions.

When considering predominant wind directions and turbine placement, as you can see in figure 4-2-3, in general, the space between turbines needs to be spacious for the predominant wind direction (10x the rotor's diameter is a good rule of thumb) and narrow for the predominant wind direction's perpendicular direction (3x the rotor's diameter is a good rule of thumb here). The reason is because if you place another turbine in a zone with irregular wind conditions caused by an existing turbine, the amount of energy that can be collected from the existing turbine greatly decreases. For hilly and mountainous areas, turbines are basically placed along the ridge, so in order to place turbines efficiently (i.e. to place more turbines along a single ridge) the ideal placement is on a ridge that is perpendicular to predominant wind directions, as mentioned above.

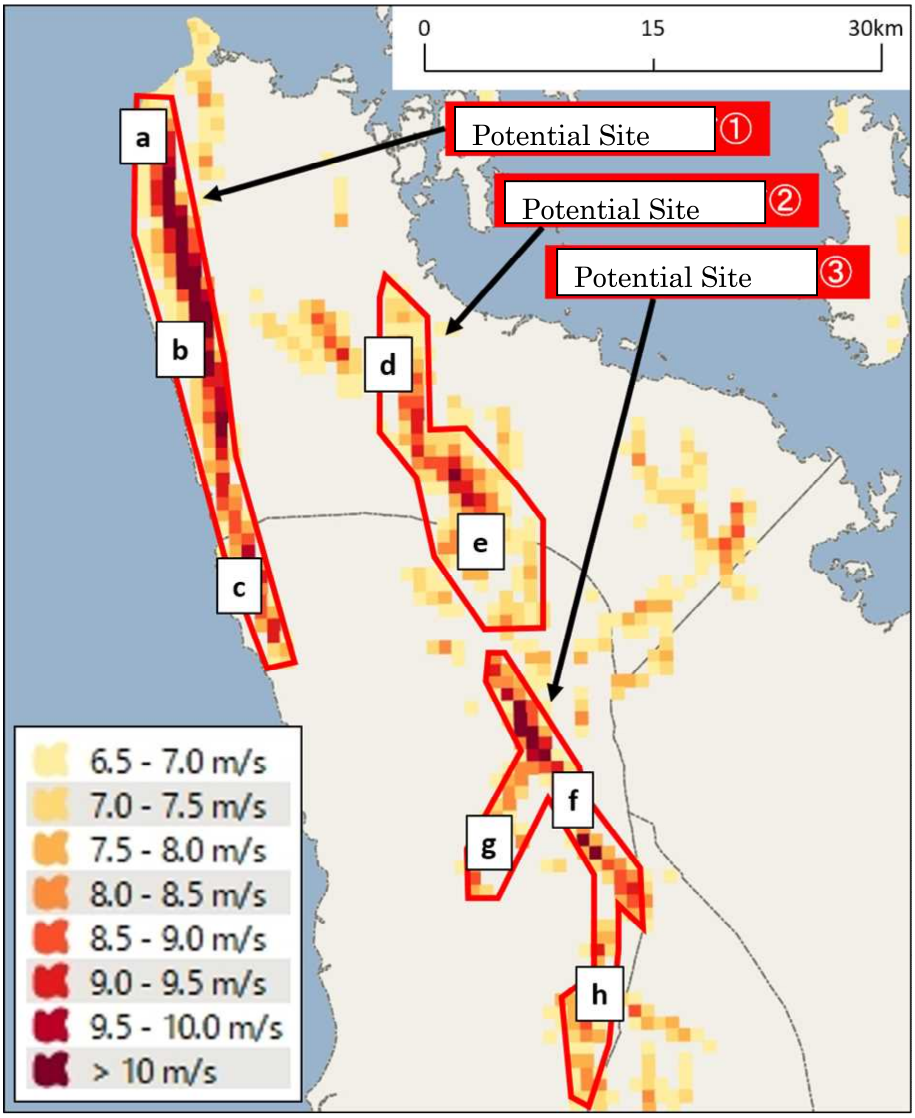
Given all the above, we have evaluated the relationship between each of these three potential sites' ridge and predominant wind conditions (figure 4-2-4). As the figure shows, potential site ① in particular has a long ridge stretching north and south across predominant northeast and southwest wind conditions, making it an excellent candidate. As for potential sites ② and ③, parts of their ridge are flat in areas where predominant wind directions track in from the east-northeast, which unfortunately keeps them solidly in the "potential" realm.

Figure 4-2-3: Placing Windmills in Areas With Predominant Wind Directions



Source: NEDO (2008) Wind Power Introductory Guidebook

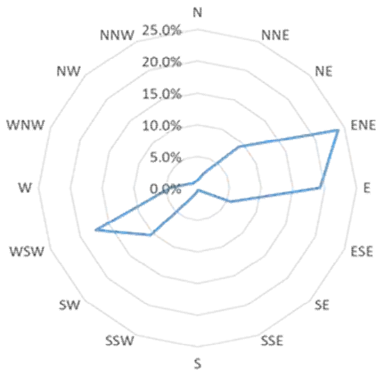
Figure 4-2-4: Relationship Between Predominant Wind Directions and Topography in Potential Sites



Source: Survey Team

Wind Rose: Potential Site ①

a



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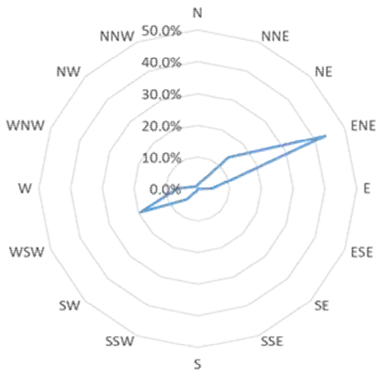

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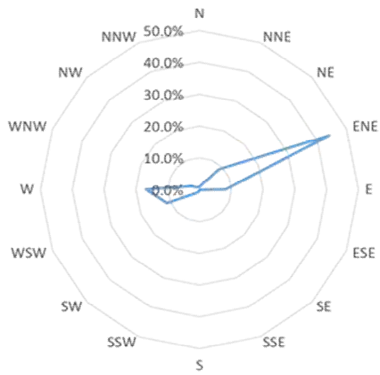

Wind Rose: Potential Site ②

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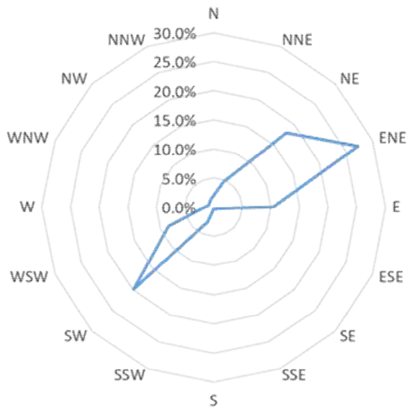

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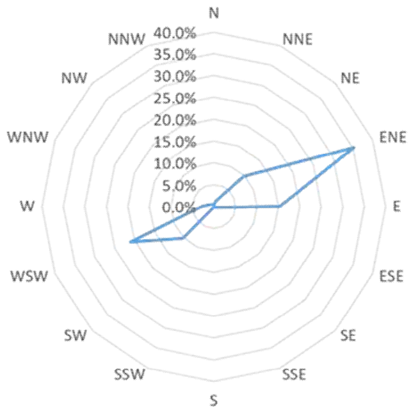

Wind Rose: Potential Site ③

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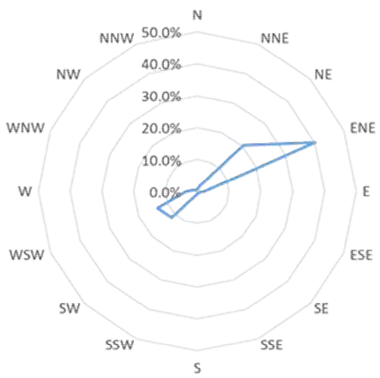

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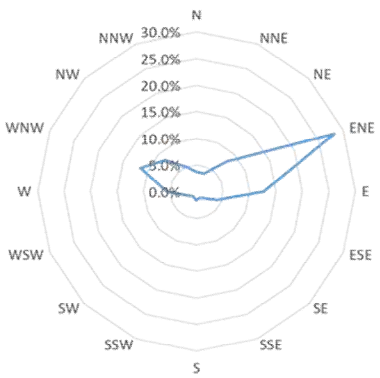

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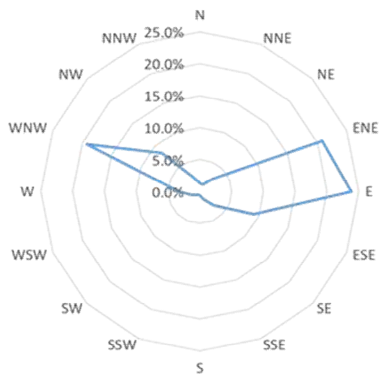


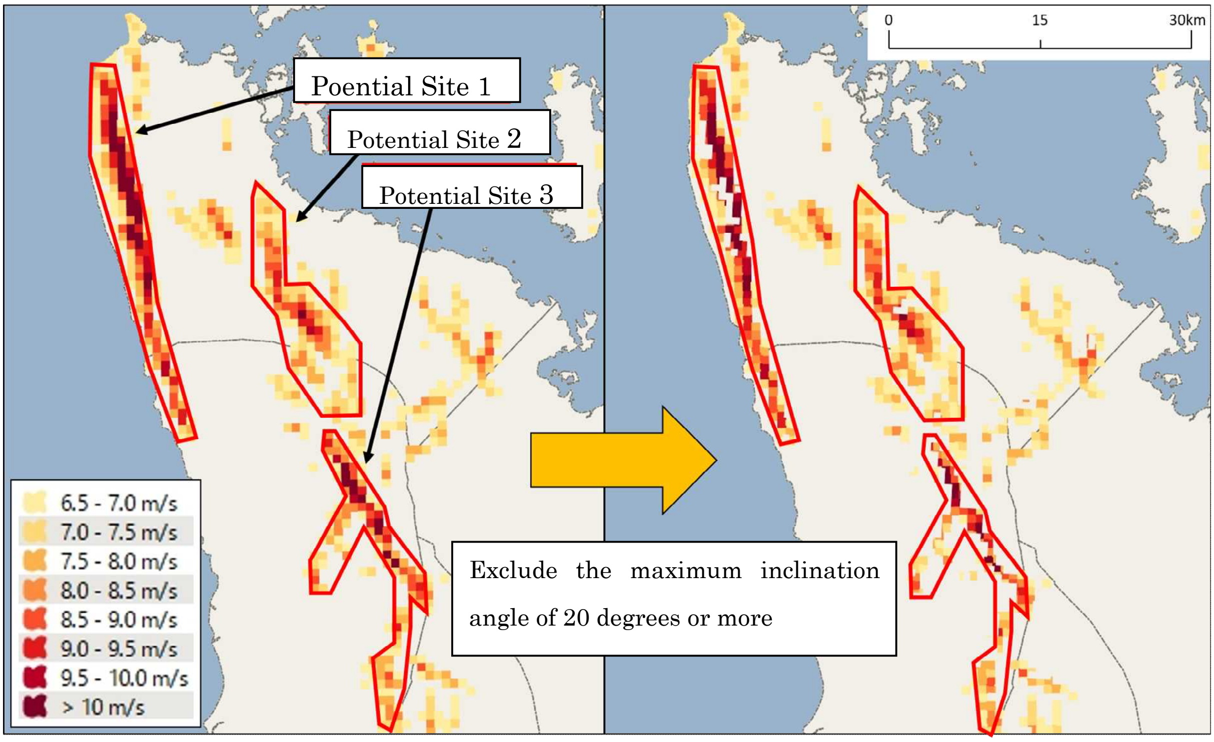
Source: Created by Survey Team based on NREL Wind Prospector

b) Maximum Incline Angle

When considering the constructability of access roads and other aspects relevant to wind power plant construction, it's a good idea to evaluate the topography's maximum incline angle. For example, when Japan's Ministry of Environment evaluates a potential wind power plant project, it deems areas with a maximum incline angle of 20 degrees or more as a standard that is difficult to use as a project site. For this report, we are using the same standard of 20 degrees or more to grade the maximum incline angle permissible.

In figure 4-2-5, you can see the general wind resource map seen in figure 4-2-1, and a comparison map with areas exceeding incline angles of 20 degrees removed from the potential sites. For potential sites ① and ②, the area that has been removed is limited; in other words, areas with a maximum incline angle of 20 degrees or more do not exist in potential sites ① and ②, making them both comparatively favorable options in terms of incline. However, in potential site ③, the comparative area removed is large, meaning that the parts with a maximum incline angle of 20 degrees or more are also large, which in turn also means that potential site ③ is not a favorable option in terms of incline.

Figure 4-2-5: Potential Sites With Maximum Incline Angles Exceeding 20° Removed



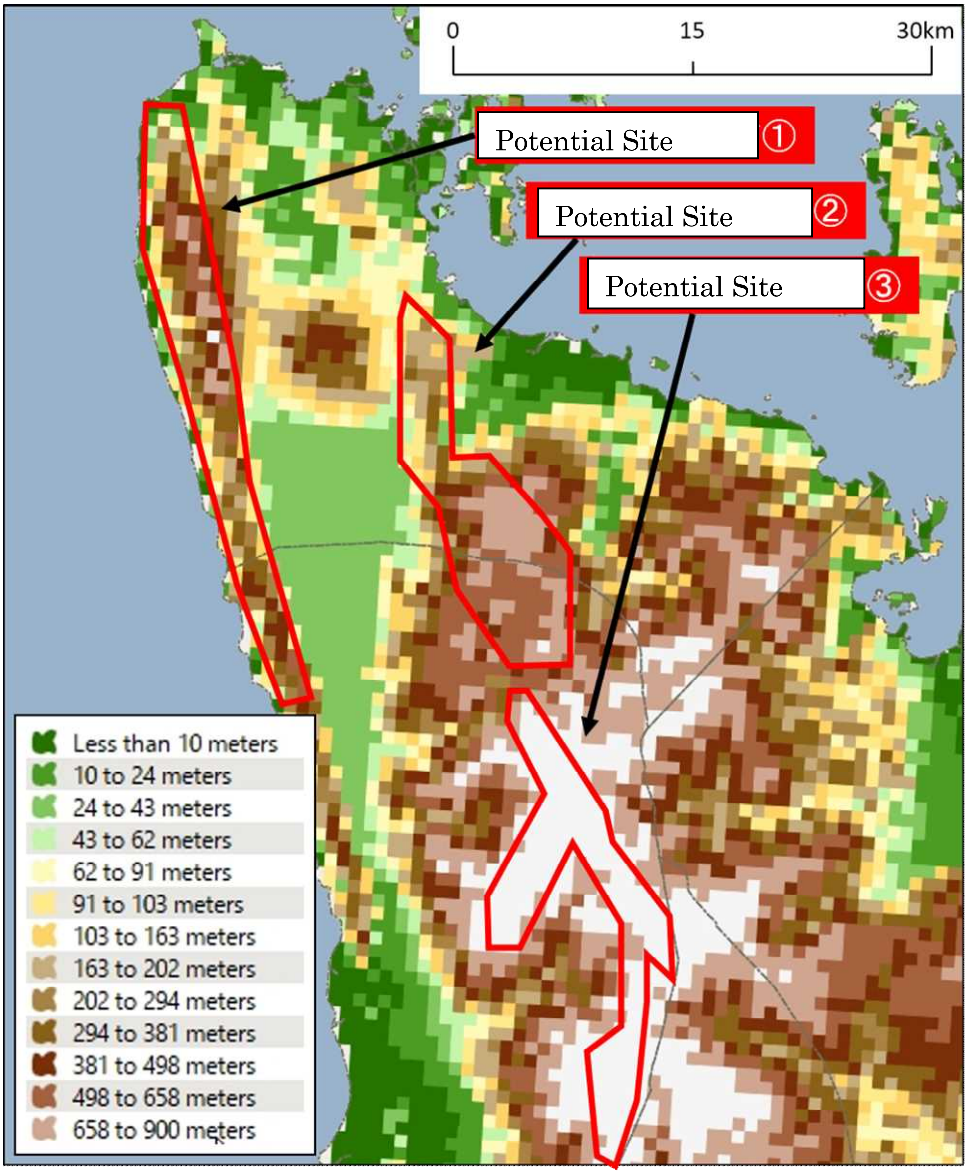
Source: Survey Team

c) Altitude

When considering the constructability of access roads and the amount of energy that will be realistically possible to acquire (because the higher the altitude, the lower density the air becomes, which in turn reduces energy acquisition efficiency) it's a good idea to evaluate the altitude. For example, when Japan's Ministry of Environment evaluates a potential wind power plant project, it deems areas with an altitude of 1000m or more as a standard that is difficult to use as a project site. For this report, we are using the same standard of 1000m or more in our evaluations.

Figure 4-2-6 shows the relationship between the potential sites and their altitude. As you can see, potential sites ① and ② are almost uniformly less than 1000m, but potential site ③ is the opposite, with nearly all of its area 1000m or higher. In other words, potential sites ① and ② are favorable options in terms of altitude, and potential site ③ is not.

Figure 4-2-6: Relationship Between Potential Sites and Altitude



Source: Survey Team

3) Transport Infrastructure (Bays and Roads)

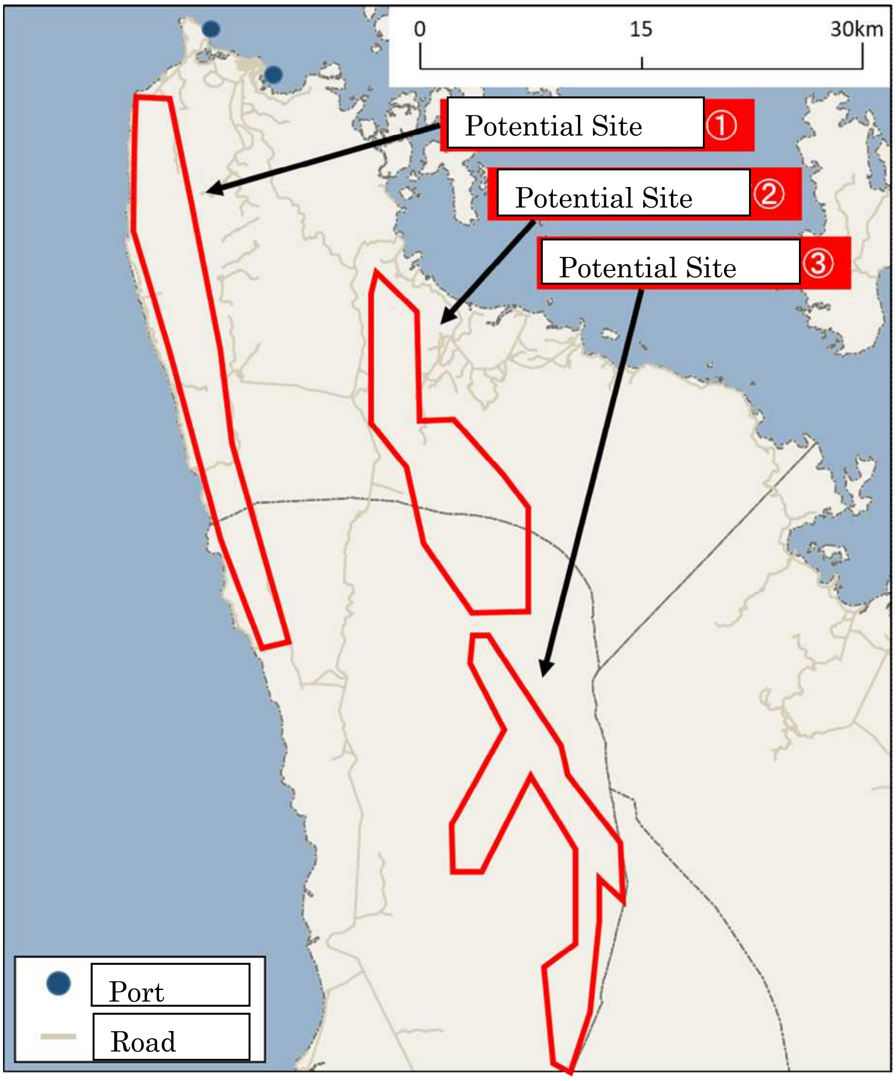
In regards to evaluating the feasibility of transporting the turbines to their potential sites, we have graded all three potential sites in table 4-2-1. The survey targets, as shown in figure 4-2-7, are the two bays located in Agusan del Norte and existing primary roads. The bays that we chose are ones we were able to confirm through satellite imagery as having a temporary storage yard to accommodate turbines.

Although the transport conditions for potential sites ① and ② both have points that will need special measures, we expect these measures to be within foreseeable bounds, and the conditions remain favorable overall. For potential site ③, the transport conditions are extremely poor. In particular, we were unable to confirm the existence of any roads near the ridge closer than 3km, which would mean that a large-scale construction would be needed just to create a road to the ridge.

Table 4-2-1: Each Potential Site's Windmill Transport Suitability

	Potential Site ①	Potential Site ②	Potential Site③
① Road Conditions (sufficient width, curvature, etc.)	Good	Good (although some curves may require extra measures)	Extremely Poor (roads are narrow, and it would be highly difficult to pass through the nearby villages)
② Access Roads Near Ridge	Yes	Yes	No
③ Estimated Distance From Bay	Approx. 10–15km	Approx. 50–55km	Approx. 70–75km
Overall Grade	Good	Good	Extremely Poor

Figure 4-2-7: Transport Infrastructure Near Potential Sites (Bays and Roads)



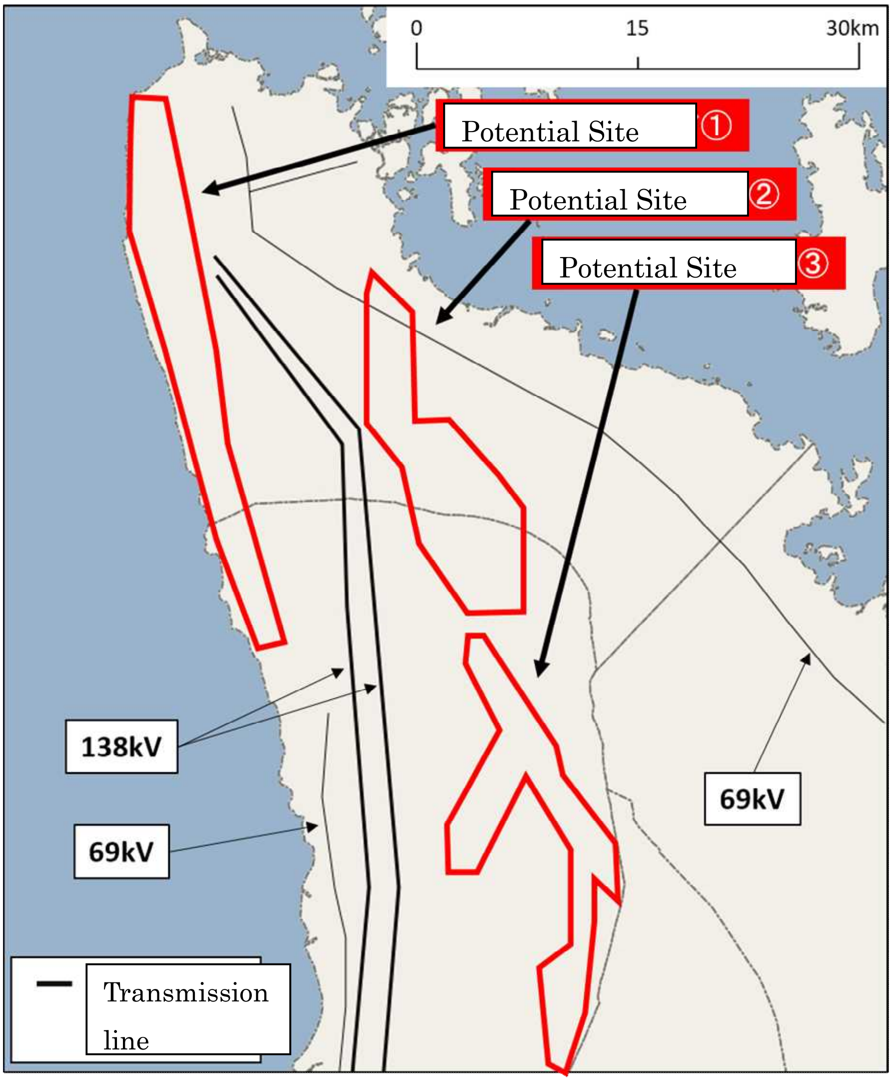
Source: Survey Team

4) Electric Power System

When considering the construction costs involved in connecting to the grid, reducing the distance to the electric power system (i.e. substations and transmission lines) as much as humanly possible is the quickest and most effective way to lower project costs. For example, when Japan's METI conducts a survey in regards to how large a wind power project could be feasible, they determine any project that would be located 40km or farther away from a transmission line as being difficult to use as a project site. In this report, we have evaluated potential sites on whether they are 20km or farther away from a transmission line, or half that of the Japanese METI's standard.

Figure 4-2-8 shows the transmission line routes. Possible sites ① through ③ are all within 20km of a transmission line, giving all three sites favorable conditions in terms of distance to the nearest transmission line.

Figure 4-2-8: Transmission Lines Near Potential Sites

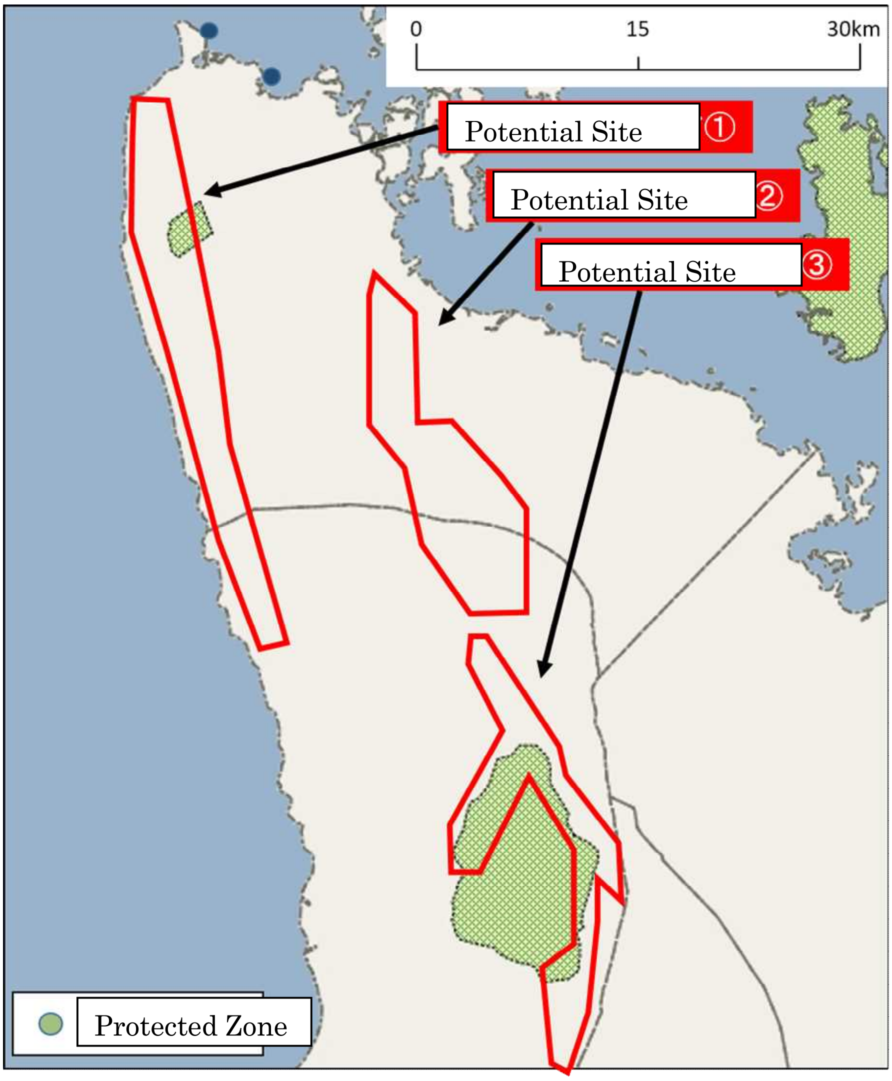


Source: Survey Team

5) Protected Zones

Figure 4-2-9 shows the location relationship between the potential sites and protected zones. Potential site ① will require extra attention, as part of its ridge overlaps with a protected zone; that said, this area is small and limited compared to the site overall. However, potential site ③ has a lot of overlap with a protected zone, making it a poor fit in terms of natural conservation. Finally, potential site ② does not overlap with any protected zone, making it the best fit in terms of natural conservation.

Figure 4-2-9: Protected Zones Near Potential Sites



Source: Survey Team

6) Overall Grade And Area Selection

The grades for each of the above five criteria have been listed in table 4-2-2. As you can see, potential site ③ has unfavorable altitude and transport infrastructure conditions, and has a lot of overlap with a protected zone, making it highly difficult to use as a project site. When comparing potential sites ① and ②, potential site ① is overall a better fit for the project's needs than potential site ②, with the exception of the area that overlaps with a protected zone. Based on these results, from the next section on, we will be examining site ① in detail as a possible venue for this project.

Table 4-2-2: Overall Grade of Potential Sites in the Caraga Region

		Potential Site ①	Potential Site ②	Potential Site ③
1) Wind Conditions		Great	Good	Good
2) Topography/ Altitude	① Predominant Wind Directions	Good	Good	Poor
	② Max Incline Angle	Good	Good	Good
	③Altitude	Good	Good	Bad
3) Transport Infrastructure		Good	Poor	Bad
4) Electric Power System		Good	Good	Good
5) Protected Zones		Further Study Required	Good	Bad
Overall Grade		Great	Further Study Required	Bad

Source: Survey Team

(３) Determining Wind Power Plant Viability In Potential Site

1) Site Topography (Overall Region Characteristics)

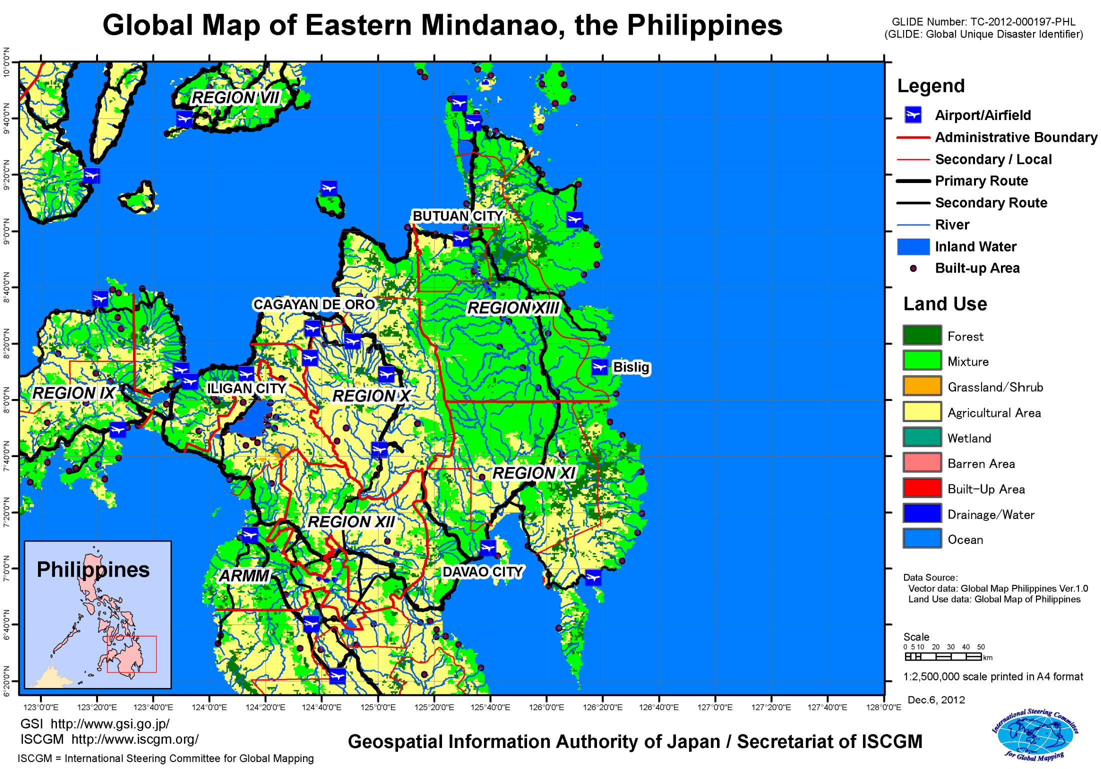
a) Potential Site Status

Using a wind power map created in 2014 by the NREL, we simulated general wind conditions in order to better determine the best place to install a wind conditions tower and the on-paper viability of the topography and distribution. Through this simulation, and the results of an on-site survey, we were able to confirm an area in the Caraga region with especially high potential as a project site: an approximately 50km mountain ridge that stretches north to south from Agusan del Norte to Surigao del Norte. We have determined this area worthy of in-depth consideration, and have gone over it to select possible wind condition tower sites in the area's north and south parts.

EPe western coastline on Mindanao Island's northeast area is a comparatively gentle mountainous area. The

NREL (National Renewable Energy Laboratory) report reveals that most of the winds here blow from east to west, and according to the NREL's north Mindanao Island wind conditions survey (conducted in January 2017), the region's average wind speed is 9.5–10m/s, and thus could indeed serve as a site for wind power.

Figure 4-3-1: Mindanao Earth Map



- North Side: The on-site survey conducted near the potential site has confirmed that it would be possible to both transport and install a meteorological tower at the site. We are currently asking one of our local partners to continue to investigate.
- South Side: The on-site survey has confirmed that it would be possible to both transport and install a meteorological tower at the site. There should also be minimal interference from the surrounding topography, further confirming the site's viability to host a meteorological tower.
- On the south section (where Phase 1 is) there is an especially gentle area on the ridge that is particularly suitable.
- Part of the central section (the area between phase 2 and the protected zone) is comparatively steep, so it will need further consideration.

Source: Earth Map – Geographical Survey Institute Map of The Philippines' Mindanao Island and Eastern Surroundings

The west area of Mindanao Island's Caraga region is a mountainous area facing Mindanao Sea, with the mountain range stretching north from the port town of Banbanon, down to the town of Jabonga on the west side of the region's south Meynit Lake.

The entire Philippines is covered with mountains, and its main island is also home to a large river. The main rivers in Mindanao Island are the Mindanao River and the Agusan River. When looking at Mindanao's eastern land usage (figure 4-1-2) we see forests, mixed woods, agricultural areas, and so on. The potential site area's population density is about 101–200 people per square kilometer, according to PSA 2015 data. The north area's population density is also not especially high. (Figure 4-3-4)

The climate is considered a tropical monsoon, with the annual average temperature being about 27° C. In the lowlands, the annual rainfall is about 2000mm. In most parts of the Philippines, the southwest monsoon period, ranging from May to November, is the rainy season, and the northeastern monsoon period from December to April is the dry season. From June to October, the northern half of the Philippine archipelago is often beset by typhoons, but Mindanao Island belongs to area with fewer incidents.

About 37% of the country is covered with forest. These forests are mainly composed of banyan trees, numerous palm tree species, rubber trees, and apiton and lauan from the lidaceae family, although fast-growing Falcata has also been undergoing afforestation in recent years. The swampy areas of the coastal regions are home to mangroves and nippa palms. Located in the southern part of the Philippines, Mindanao Island consists of the Zamboanga Peninsula, the Northern Mindanao region, the Davao region, the Soccsksargen region, the Caraga region, and the autonomous Muslim Mindanao region. The Caraga region is known as Region XIII in the northeastern part of Mindanao Island, consisting of the four provinces of Agusan del Norte and Agusan del Sur, and Surigao del Sur and Surigao del Norte. The central city is Butuan City, where mountains surround the lowlands that have formed around the mouth of the Agusan River.

b) Potential Site's Soil Quality (Rocks)

Figure 4-3-2 shows the soil quality surrounding the survey target.

As most of the land is mountainous, only about 27% of it is suitable for cultivation. The soil in the island's north part is mainly volcanic, whereas in the south it is made up of limestone, making the soil overall low in quality.

The northernmost part of Lake Meynit is made up of the New Tertiary stratum, which is home to Miocene quartz diorite. Batholith, sheet rock, intrusions, small rock complexes and distribution properties vary. This stratum spans the Mesozoic era to the Paleozoic and Paleogene era with granite, diorite, dacite, and so on.

Ultramafic and plutonic rocks are distributed in the Paleogene and Cretaceous era strata, near a protected zone. The rocks are predominantly peridotite, but are also accompanied by basalt, HANREI rock, and so on.

The stratum of the mountainous part between the west side of Meinit and the Mindanao Sea consists of Paleogene and Cretaceous-era formations (KP) and is mainly composed of fine grain basalt and pyroclastic material, gray wake (hard sandstone) and metamorphism. Granodiorite is distributed liberally throughout this area. It is essentially very hard bedrock, but it also displays masa-like properties when weathered. The nature of this masa earth varies greatly with the degree of weathering. This area is also home to rocks called peridotite.

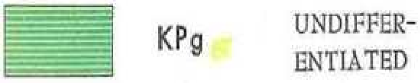
Serpentinite is also distributed liberally throughout this area, which means we will need to pay attention to rock quality when trying to cut out stable slopes, and be careful not to construct buildings in areas that could be eroded or collapse during a rainfall. Serpentinite is a swellable clay mineral (the main mineral constituting clay that is responsible for many of clay's peculiar properties, such as plasticity, stickiness, consolidation, etc.), meaning it swells with water and expands, leading to significant decreases in strength when wet. When constructing buildings, we will need to conduct a detailed on-site investigation, including boring holes) on the site's serpentinite.

Figure 4-3-2: Soil Quality In Area Surrounding Survey Target

N_1 OLIGOCENE - MIOCENE Mostly submarine andesite and/or basalt flows. Intercalated with pyroclastics and clastic sedimentary rocks and/or reef limestone lenses. Largely confined within the arial zones of Luzon, Visayas, and Mindanao.

NI NEOGENE Largely intra-Miocene quartz diorite. Mostly batholith, and stocks, some laccoliths; also sills, dikes, and other minox bodies. Include granodiorite and diorite porphyry facies and late Miocene dacite. Pervasive in Paleogene and Mesozoic, less widespread in early Miocene rock sequences.

UC CRETACEOUS - PALEOGENE Undifferentiated ultramafic and mafic plutonic rocks. Pre-dominantly peridotite associated with late gabbro and/or diabase dikes. Complex layered type in Zambales. Generally thrusted or upfaulted into Tertiary and older rock formations. Most bodies probably late Mosozoic to early Tertiary.



Largely graywacke and metamorphosed shale interbedded and/or intercelated with spilitic, basic and inermediate flows, and/or pyroclastics. Undifferentiated as to age. Probably Cretaceous and Paleogene.

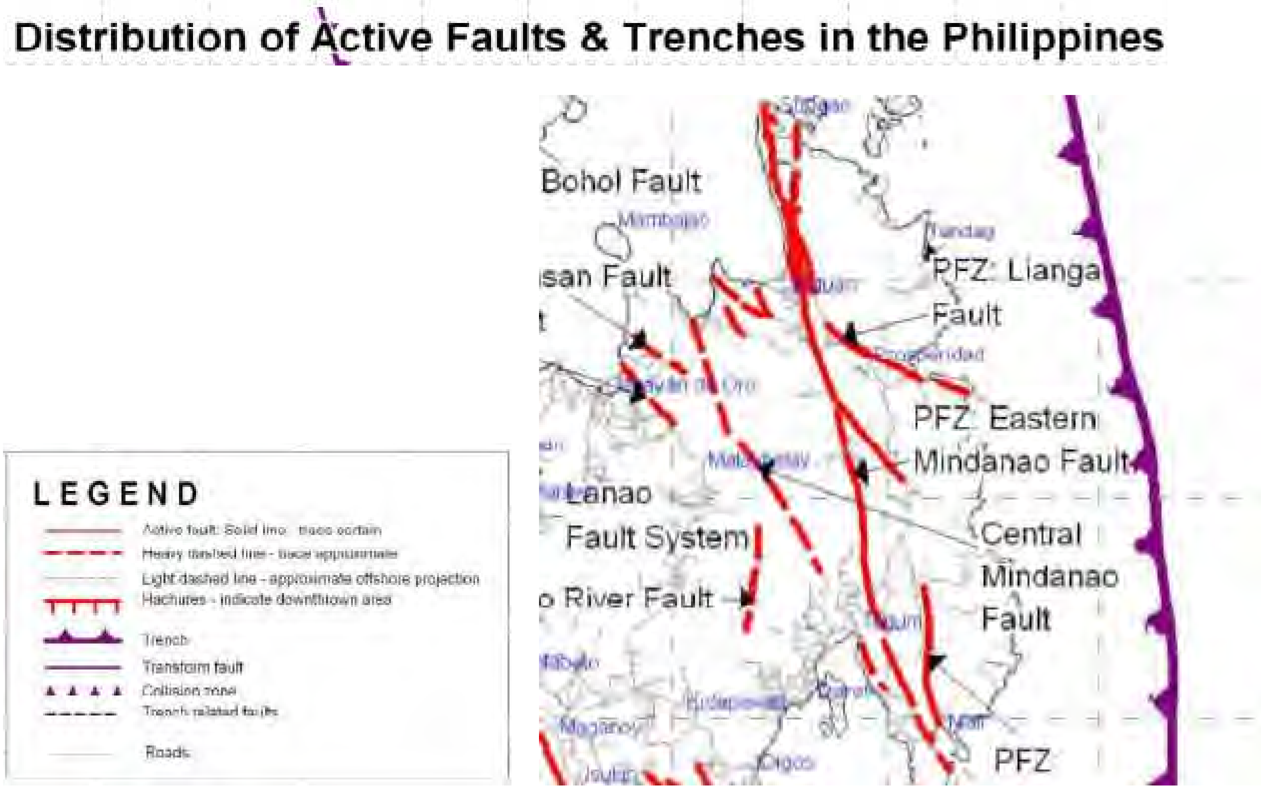
Source: Mines and Geosciences Bureau (1963)

c) Potential Site's Active Faults

Figure 4-3-3 shows active fault activity in the Philippines as of February 2000, based on research conducted by the Philippines Industrial Volcanology & Seismology Laboratory.

The definition of an active fault is "any fault that was active as of 10,000+ years ago, and could still show activity in the future." As the figure shows, the potential site is located directly on top of an active fault. There is a high possibility in this plan that a large building will be built directly on top of an active fault, so we will need to conduct a detailed investigation and ensure that any such building can, and is, made earthquake-resistant.

Figure 4-3-3: Active Faults in Mindanao Island



Source: Philippines Industrial Volcanology & Seismology, February 2000

Photo 4-3-1: Soil Quality

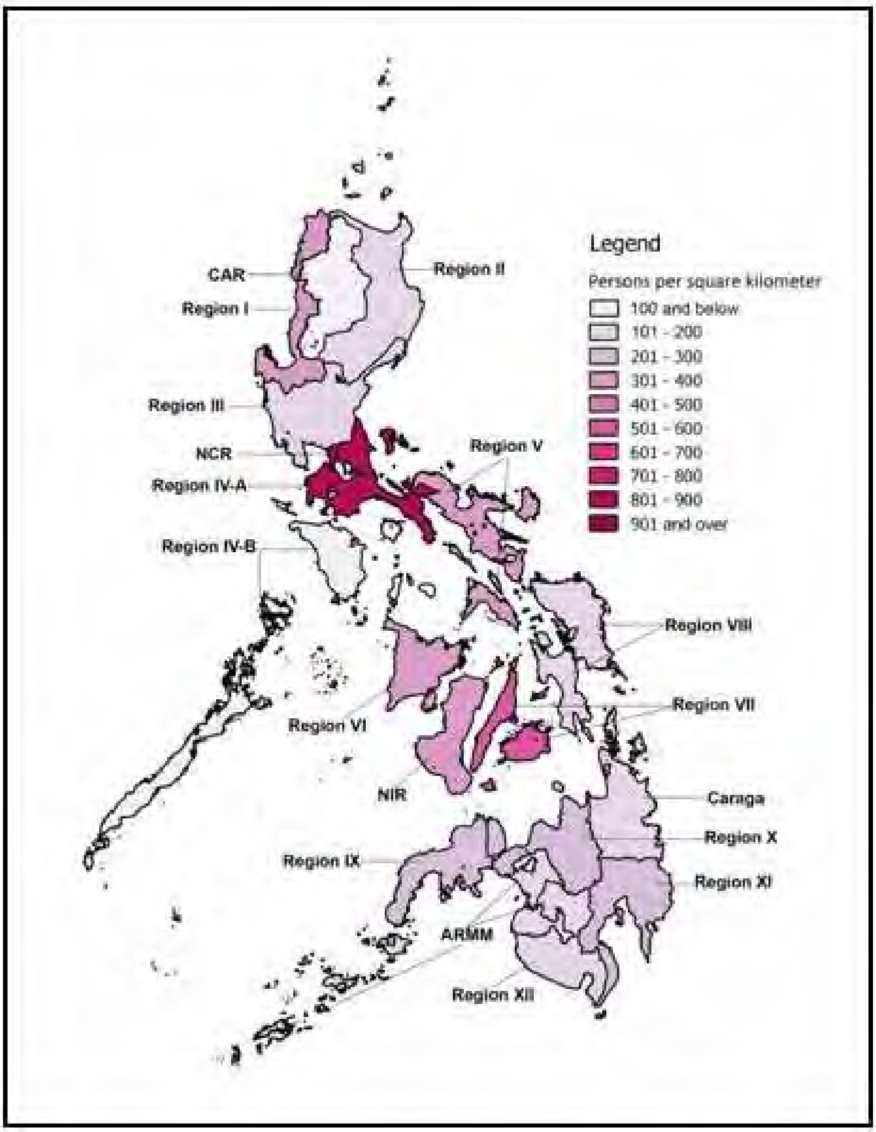
2) Land Owner(s) and Nearby Residents

There are some people living near parts of the access road, but in general, there is no local government here, and the land is officially owned by the government.

The north side of the potential site's mountains is a private land, with different landowners for each individual area, but the south side is a barangay area (autonomous region). Population density appears to be lower in the northern mountains (San Francisco - south). The population density of the potential site is very low, at less than 101 to 200 people per square kilometer according to the PSA 2015 data. With the exception of a scattering of villages along the coast and the primary road, there appear to be no villages in the mountains. In the mountain range's south side, there is a village near Santopay (93228.51 "N125 27 '08.88", with an altitude of 342m), around 600m from the mountain's summit.

There appear to be a scattering of fields around Lake Mainit's western area that we believe to be a barangay autonomous region. A protected zone lines between the northmost part and Mainit's north side, so that area cannot be used for a wind power plant.

Figure 4-3-4: Philippine Population Density



Source: PSA and LMB, DENR

Source: https://psa.gov.ph/content/philippine-population-density-based-2015-census-population

3) Land Usage

Figure 4-3-2 shows the potential site's land usage and protected zones.

a) Land Usage

Since the turbines, and the access roads accompanying them, will be built by following the ridge shown in figure 4-3-2 in accordance with wind resources. As such, the area occupied on the potential site will essentially correspond exactly to the ridge.

Given this, when we look at the land usage situation along the ridge, we see that it mainly consists of perennial plants, such as coconut trees, along with grasses and shrubbery. Houses and military sites that are not well-suited to development, as well as swamps and bogs, are nowhere to be found. Therefore, we believe that in terms of land usage, this potential site is well-suited for the project.

b) Protected Zones

There is only one protected zone that overlaps with the ridge on the potential site: Surigao Forest, a protected water source, in the north area. Although wind power is a relatively small-scale project, it does require some alteration to the land, so we will need to evaluate our options closely, including legal compatibility, in regards to situating the project near Surigao Forest. Furthermore, even though it hasn't been designated a protected zone at this point in time, figure 4-3-5 shows that the area surrounding the rafflesia habitat is currently in the process of applying to be designated a protected zone. If the application is approved, we will need to reevaluate our turbine placement, access road, and other options in order to accommodate this new restriction.

As you can see below, although there are two protected zones (one of them currently in the process of applying for protection) overlapping with the potential site, figure 4-3-5 shows that most of the site does not overlap with protected zones. Therefore, we have deemed this potential site to be suitable for the project in terms of not interfering with protected zones.

Figure 4-3-5: Potential Site Land Usage and Protected Zones

Source: Survey Team

4) Wind Power Transport

In order to evaluate the project's viability in terms of turbine transport, we have evaluated a total of 8 items, shown in table 4-3-1, regarding the routes (roads, bridges, overhead structures, etc.) to unloading ports and the site. The survey targets, as you can see in figure 4-3-6, include Surigao Port and Lipata Port for the unloading ports, as both are located relatively close to the potential site. For the routes to the site, we have evaluated a total of two: route 1, which connects Lipata Port to the ridge entrance on the north edge of the potential site; and route 2, national highway AH26, which connects Lipata Port to the ridge entrance on the potential site's central area.

Table 4-3-1: Potential Site's Land Usage and Protected Zones

Category	Transport Feasibility Survey Items	Survey Targets
Unloading Port	•On-Site Customs •Water Depth •Temporary Storage Yard •Transportability From Port	・Surigao Port ・Lipata Port
Route to the project site (roads, bridges, overhead structures, etc.)	•Height •Width •Weight •Length (road curvature)	・Route 1 (From Lipata Port to Site's North Ridge Entrance) ・Route 2 (From Lipata Port to Site's Central Ridge Entrance via National Highway AH26)

a) Unloading Ports

We have listed the results of our evaluation of whether Surigao Port and Lipata Port would be suitable as unloading ports in table 4-3-2. Surigao Port has a customs office on-site, and can accommodate large-scale cargo ships, which makes it suitable from that perspective, but is also a difficult place to carry things out of, so if we were to use it, we would also need to prepare a secondary ocean transport route to another port. Lipata Port can only accommodate barges, making it ill-suited from that perspective, but well-suited as a place from which to carry things out. Therefore, we believe that using both ports in the following manner would be the most effective means of transport.

1. Bring large cargo ships in through Surigao Port and have them go through customs
2. Use Surigao Port as temporary storage
3. Load cargo on to a barge at Surigao Port
4. Transport the cargo to Lipata Port over several trips
5. Use Lipata Port as temporary storage

Figure 4-3-6: Windmill Transportability Survey

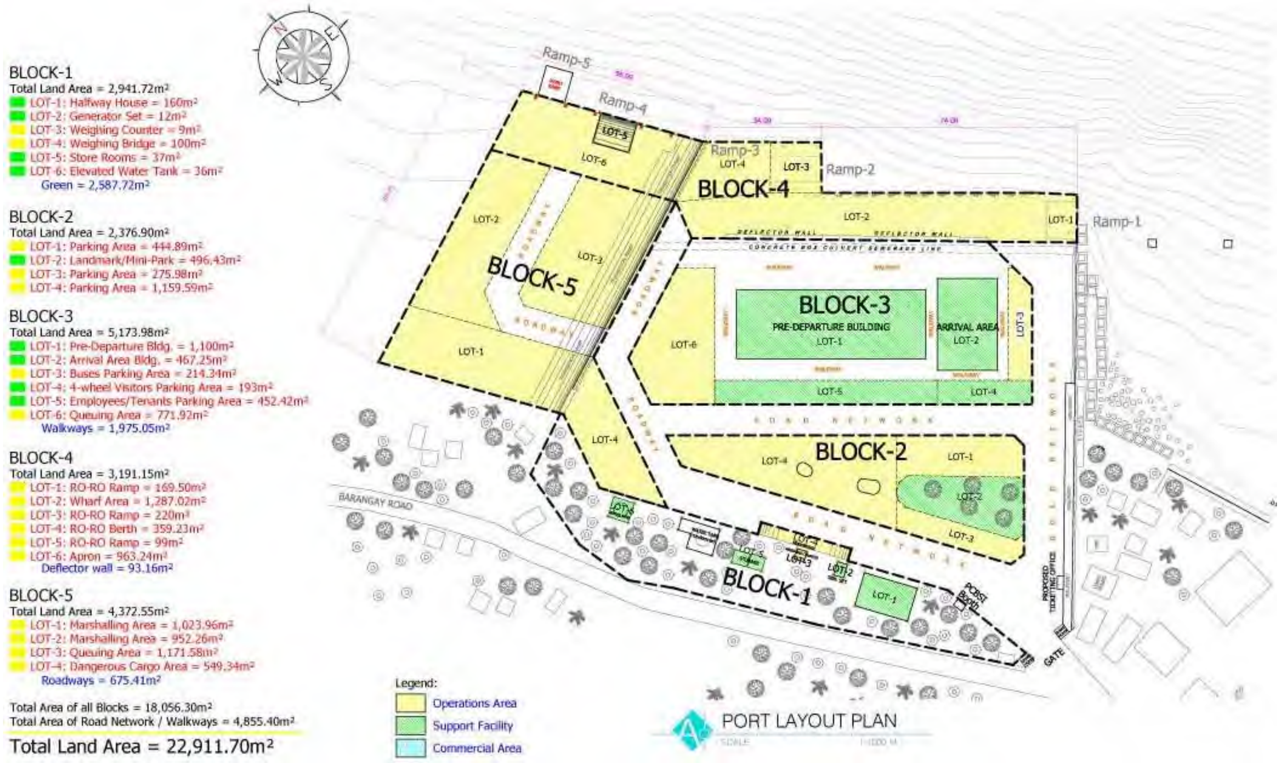
Source: Survey Team

Table 4-3-2: Surigao Port and Lipata Port Unloading Port Suitability Evaluation

Survey Item	Surigao Port	Lipata Port
On-Site Customs	Yes	No
Water Depth	We believe the water depth here reaches around 10m, since it can accommodate large cargo ships. (Photo: Large Cargo Ship at Surigao Port) 	About 4-5m: Cannot accommodate large cargo ships, only barges. Currently used for small ferry service. (Photo: Ferry at Lipata Port) 
Temp. Storage Yard	Estimated at 5000–6000m^2.	If we can use Block 5 (shown in figure 4-3) as a temporary storage yard, it should be about 4400m^2 (capable of storing about seven 2MW-class turbines, assuming each turbine measures 600m^2)
Ability To Carry Out From Port	The height and width of the security gate makes it difficult to carry out cargo. Furthermore, since the port is located within the city of Surigao, it would be difficult to transport the cargo to the national highway. (Photo: Surigao Port's Security Gate) 	The height and width of their security gate makes carrying out large cargo easy. (Photo: Lipata Port Security Gate) 

Suitability Grade	With its on-site customs office and ability to accommodate large cargo shops, it is well-suited as an unloading port for large cargo, but ill-suited to actually carry the cargo out, so a secondary sea route would be needed for that purpose.	Although it can only accommodate barges and other similarly-sized ships, it is well-suited for carrying out cargo, and should also be able to accommodate up to 7 units in temporary storage.

Figure 4-3-7: Lipata Port Land Usage Map



Source: Philippine Port Authority

b) Routes To Site (Roads, Bridges, Light Rail, etc)

Our evaluation standards and grades on route 1 and 2's viability as transport routes are shown in tables 4-3-3 and 4-3-4. Route 1 has a bridge that needs reinforcement so that it will be capable of handling loads of up to 2 tons, and route 2 has a narrow road near Payanasa Bridge that needs to be widened, but these issues aside, both routes have much fewer obstacles in transporting wind power plant cargo to mountainous areas than Japan, so they should both be perfectly viable options for transporting the necessary cargo.

Table 4-3-3: Route 1 and Route 2 Evaluation Standards

Survey Item	Evaluation Standard
Height	(Standard: approx. 5.4m) For this report, in regards to the target turbine, the Hitachi HTW2.0-86, the middle section of the tower has a diameter of approx. 4.3m, making its height when loaded onto a trailer the maximum permitted approx. 5.4m.  Source: Achiha Corporation
Width	(Standard: approx. 4.5m) The HTW2.0-86's anchor ring (width: approx. 4.5m) reaches the maximum permitted width when loaded onto a trailer truck. Since the truck's width is approx. 3m, the anchor ring ends up sticking out approx. 1.5m.  Source: Achiha Corporation
Weight	(Standard Weight Placed On Axle: approx. 11 tons) Placing the HTW2.0-86's tower section 2 (weight: approx. 50tons) onto the trailer truck reaches the maximum weight. Adding in the truck's own weight totals about 90 tons, equating to the maximum permissible weight placed on the axle of approximately 11 tons.  Source: Achiha Corporation

Length	(Standard: approx. 51m) The maximum length reached when placing an HTW2.0-86's blade (length: 43m) onto a trailer truck. Add in the truck's length, and you get approximately 51m.	 Source: Achiha Corporation

Table 4-3-4: Route 1 and Route 2's Transport Viability Evaluation

Survey Item	Route 1 (From Lipata Port to the potential site's north ridge entrance)	Route 2 (From Lipata Port to the potential site's central ridge entrance via national highway AH26)
Height	Applies To Both Route 1 and 2 •No overhead structures or tunnels that would get in the way. •However, there are countless electrical lines strewn above the roads in both routes, and there is a strong possibility that a trailer truck carrying a turbine (for a total height of approx. 5.4m) could come in contact with them. When transporting the cargo, we will need to discuss what options can be taken to avoid this situation with the electrical line owners, such as raising the lines' height or running them underground.	
Width	・No Issues	•Some measures required (specifically, the narrow road near Payanasa Bridge) •Since part of the bridge has concrete walls that are 5m wide, we should be able to improve the safety involved with transporting anchor rings on high-floor trailers
Weight	•Since there is a bridge with a load capacity of 2 tons, we will need to consider possible bridge reinforcement measures, including consulting with the road managers. (Point D in figure 4-3-6) •Since there are other bridges with unknown maximum loads, we will need to obtain the bridges' ledgers, etc. from the road administrator and evaluate their maximum load.	•Essentially No Issues •However, since there are bridges with unknown maximum loads, we will need to obtain the bridges' ledgers, etc. from the road administrator and evaluate their maximum load.
Length	・No Issues	•Some measures required (specifically, the narrow road near Payanasa Bridge)

		(Points I, J, K in figure 4-3-6)
Transport Viability Grade	•No major issues with height, width, or length. •The main issue with this route is the reinforcement needed on the bridge with a maximum load of 2 tons, as it will require consultation with the road and bridge administrators. We will also need to take measures regarding the electric lines above the road.	•With the exception of Payanasa Bridge, there are no major issues with height, width, weight, or length. •The main issue here is the road near Payanasa Bridge that needs to be widened and lengthened. We will also need to take measures regarding the electric lines above the road.

Table 4-3-5: Points Along Routes 1 and 2

	Point A: Routes 1 and 2 Lipata Port: No issues with the security gate's height or width
Confirmed Visually	Point B: Routes 1 and 2 This road is essentially quite wide. The bridge's maximum load (axle weight) is 20 tons, so there should be no issues.
	Point C: Routes 1 and 2 Route 1 turns right onto the left side, Route 2 turns left onto the right side. We can secure a 53-54m length on both routes, so there should be no issues.

<table>
<tr>
<td>
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<td>Point D: Route 1

The bridge with a maximum load of only 2 tons. We will need to consult with the bridge and road owners about the feasibility of reinforcing this bridge.</td>
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<tr>
<td>Confirmed Visually</td>
<td>Point E: Route 2

This bridge can handle a maximum load (axle weight) of 20 tons, so there should be no issues.</td>
</tr>
<tr>
<td></td>
<td>Point F: Route 2

Right turn on the right side. We can ensure a 54m length here, so there should be no issues.</td>
</tr>
<tr>
<td>Confirmed Visually</td>
<td>Point G: Route 2

Right turn on the right side. We can ensure a 51m or greater length here, so there should be no issues.</td>
</tr>
</table>

Confirmed Visually	Point H: Route 2 Right turn on the right side. We can ensure a 51m or greater length here, so there should be no issues.
	Point I: Route 2 Left turn on the left side. Only issue is the need to cut down some trees.
	Point J: Route 2 Left turn on the left side. Need to widen the inner road.

	Point K: Route 2 Right turn on the right side. Trailers will need to make a wide right turn from the left side in order to enter the bridge. Need to consult with land owners about widening the road (developing the land).
	Point L: Route 2 Cross swamp from left side to right side.

5) Connecting To The Grid

a) Survey Outline: Connecting Wind Power Stations in the Caraga Region's Agusan Del Norte and Surigao Del Norte to the Power Grid

- Grid Connection Status

The distribution and grid voltage classes in the Philippines, including Mindanao Island, are 200V, 13.2kV, a planned 22kV, 69kV, 138kV, and 230kV, respectively. The grid voltages in the Caraga region's Agusan del Norte and Surigao del Norte are the 69kV and 138kV systems, and the distribution co-op responsible for the 69kV system in this area is SRUNECO (Surigao del Norte (Surigao to Alegria) and ANECO (ANECO Butuan to Malacalaya (the Placer substation)). The 138kV transmission system, and part of the 69kV system, is run by the NGCP. Altogether, these three co-ops control all of these systems.

Across all of Mindanao, the transmission line used in the 69kV system is the ACSR 336.4mm2 (code name: LINNET, 529 A). The line used in the 138kV system is the ACSR 795mm2 (code name: CONDOR, 889 A) according to ANECO. This enables us to pinpoint the transmission line's transmission capacity.

In an answer given from the SRUNECO side at the hearing, the 69 kV system in SRUNECO's jurisdiction was said to be under the control of NGCP, but after double-checking with the NGCP, it was confirmed that SRUNECO was indeed the proper administrator. The SRUNECO substation was installed within the city Looc substation (transformer capacity: 20MVA).

The Placer (also known as Anislagan) substation is located next to Macalaya and is a primary substation, acting as the area's sole midpoint for both the 138kV and 69kV systems.

b) In regards to connecting the wind power facilities to the 138kV and 69kV systems' transmission lines, such as a system impact study (SIS) and other procedures that need to be carried out in order to determine the power generation scale, the distribution system, and the transmission system, we will need to pin down what level of power generation we want to introduce to the existing grid. Starting with the wind resources, and making a judgment from there, we will then need to pin down what level scale of wind power facilities it would be possible to install, even just a rough estimate.

We will need to sign service contracts in advance with the Philippine government's Department of Energy (DOE). In addition, in order to connect to the 138kV system (NGCP) and the 69kV system (ANECO, SRUNECO), we will need to conduct a system impact study (SIS) and a distribution impact study (DIS) ahead of time. We will then need to apply for a certificate of approval from DOE while proving that we are in compliance with all laws and regulations.

c) Evaluating Connections Between the Placer Substation and the Looc Substation in the SRUNECO (Surigao del Norte, spanning Surigao to Alegria) Area

Power is supplied from the Placer substation (transformer capacity: 50MVA) to the Looc substation (transformer capacity: 20MVA) in Surigao City over the 69kV transmission line, providing Surigao City with 16MW of electricity. The 69kV transmission line is suspended by poles, rather than being transmitted by a transmission tower like in Japan. This system also uses a single line for power transmission.

We have learned that there are no plans to expand the power supply running from the Placer substation (transformer capacity: 50MVA) to the Looc substation (transformer capacity: 20MVA) in Surigao City.

The 69kV system managed by NGCP extends from Butuan to the Bayugan side (south side), excluding it from this project's range of consideration. The 69kV system (west side) running from Placer to Madrid is also out of this project's range of consideration. The 138kV system sends power from Butuan to Placer (transformer capacity: 50MVA), and there are two transmission lines on the transmission tower.

Plans to expand the power supply from Butuan to Placer are proceeding, and new transmission line facilities are currently under construction.

The transmission system related to this ANECO area is a 23MW route running along the north from Butuan to Santiago. In the near future, this route will gain an expansion in the form of another line, and there are plans to further enhance the transmission lines from Butuan to Santiago (within 5 years).

The Santiago substation is also planning to head north, up to Magsaysay (the area between Colorado and Bangonay) by the end of 2018 in order to keep voltage decreases in check.

It is possible to connect the potential wind power facilities from Placer (transformer capacity: 50MVA) to Looc (transformer capacity: 20MVA), but we believe this would leave us unable to deploy full capacity.

d) Connecting From the Placer (a.k.a. Anislagan) Substation to the Butuan Substation

We know from talking with SRUNECO that the capacity of the Butuan substation is 20MVA, of which they are already using 16MW. Specifically, 20 MVA is the capacity of the substation transformer, so the load capacity itself may not necessarily be 20MVA. If we divide 16 by 20 to get 0.8 for the power factor, then it becomes a question as to whether the substation is already handling its maximum load. The Philippine grid code demands a lagging power factor of 0.85 to a leading power factor of 0.90. Usually, with the lagging power factor, at least as it pertains to the Philippines, it is assumed that the electric lamp (resistance) load and electric motor load are part of the mainstream. Therefore, we can estimate that the power factor is on the lagging side, assuming a lagging power factor of 0.925 as an average value of the power factor of 1.0 to 0.85, and a load capacity of about 17.3MVA. From this, we can deduce that 86.5% or more of the transformer capacity is already being used as the load capacity, which in turn gives us a transmission line capacity of 58.5MW using the following formula:

$P = \sqrt{3} \times 529A \times 69kV \times 0.925 = 58.5MW$

Based strictly on our tour of the Looc substation in Surigao, we believe that there is no spare space to be found on the premises. We also know from our talks that there are no plans to add either an additional 69kV transmission line or to expand the substation facility in this area.

Connecting an additional load to the SRUNECO 69kV transmission system, if we were to swallow the above situation as-is, would be a difficult proposition from a substation transformer capacity perspective unless we were to build a new facility.

The transmission line's active current is supplied from the Placer substation (50 MVA) side to the Looc substation 20 MVA, 16 MW) in Surigao. Since the flow of electric power is assumed to be provided from the Placer substation and transmitted to the demand point in Surigao City, if it is possible to connect a new system to this system during this time by branching the system from the wind power plant side, an active current of 16 MW can be supplied to Surigao and 4 MW can be supplied to Butuan via the Placer substation, enabling the transformer itself to be powered without overloading. One problem with this is that, since the power would temporarily stop at Surigao during the connection, the current power flow would change (i.e. reversed from its present state) so we may need to re-evaluate the settings. As the voltage of this system rises, the voltage of the lower voltage system will be dragged up along with it, so we will need to take to prevent the voltage of the 13.2kV system and 200V distribution line from rising (such as changing pole transformers to taps, etc).

e) Connecting to the NGCP 138kV Transmission System Running From Butuan to Malacalaya via the Placer Substation

Based on the 138kV transmission line's specs, we know that the line's capacity is 212MVA. With a lagging power factor of, say, 0.925, it should be possible to transmit about 196MW of power.

Furthermore, given that there are plans to merge in a new 138kV system, we can expect the transmission system's capacity to double (2 × 196 = 392MW). This means that in the future, even if there is a demand for 60MW of power, the capacity should be well over 300MW, so if we can coordinate with the 138kV system, it should be very feasible to transmit a 100MW level of power.

If we can build a connection point to Placer to match the construction of the new 138kV transmission line, we should be able to connect to it relatively easily. However, since wind power brings major frequency fluctuations, we can foresee frequency fluctuations like what happened during the N-1 accident, as well as fluctuations (decreases) in voltage, so we will need to conduct a system impact study early on and to fully comprehend the power generation scale.

We also need to confirm exactly what kind of facilities these wind power facilities will be, whether or not they will work independently during blackouts, and other such questions.

For reference, we looked into how much active power could be transmitted from an active power perspective.

The distance from the Butuan substation to the Placer substation is about 82km. Looking at the current power transmission system's data, if the average impedance value of a ACSR 795mm2 per km is about 0.0162 + j 0.0956, and the impedance of 82km is 1.328 + j 7.835 Ω, when you compare the resistance component and the reactance component, the resulting power factor angle is almost a right angle, which means there would be no problem considering only reactance as impedance.

In which case, $|Z| = 7.95\ \Omega$ transmitted voltage and received voltage are almost equal $Es = Er = 138\ kV / \sqrt{3}$

$\therefore\ Ps = 2395 \times \sin 14° = 580$ MW

Since the existing data's phase angle is $\delta \approx 14°$, the active power would be $Ps = (Vs \cdot Vr)^2 \sin\delta / |Z| = (138 \times 10^3)^2 \sin\delta / 7.95 = 2395 \sin\delta$ MW So it seems that we should be able to transmit about 600 MW of electric power, and that it should be within the range of the above-mentioned transmission power currently under consideration.

f) Connecting to the ANECO 69kV Transmission System Running From Butuan to Santiago

The capacity of the Santiago substation is 5MVA, and the transmission capacity that can be sent over its single 69kV system is 63MVA. With a power factor of 0.925, this comes out to 58MW; if we suppose that another line will be added, it would then be 116MW. Since the current transformer capacity of Santiago is 5MVA ≈ 5MW, the Agusan power plant supplies 25MW and the Asiga power plant supplies 8MW, totaling 33MW altogether. Adding 5MW to this gets us 38MW ≈ 40MW. So even though this figure is only about 34% of the total capacity, it should be able to handle the transmission capacity just fine.

Simply adding a large electric power supply to the ANECO Santiago substation's 69kV transmission line would cause the system voltage to rise, so in order to avoid changing pole transformers to taps and causing temporary blackouts due to the rise in voltage in neighboring distribution lines, we may need to consider reversing the flow of power. In other words, having it flow from Santiago to Butuan instead of the other way around may help to alleviate such issues, but the decision still needs more deliberation.

Furthermore, if we are to connect part of the proposed wind power facilities to ANECO's new Magsayay substation, we will need to sign a contract with the DOE, and to apply for the DOE's approval, in which case, we will need to conduct a distribution impact study (DIS) ahead of time.

g) Connections between SRUNECO's Placer Substation and Surigao's Looc Substation (69kV system), NGCP's 138kV Transmission System (Butuan to Placer in Malacalava), and ANECO's 69kV System (Butuan to Santiago)

Of these three systems, the one we believe would have the fewest issues connecting to is the NGCP 138kV system. We believe that building a connection substation at Placer while the 138kV connection line is being expanded would be an eminently feasible way of connecting the wind power facilities and switchyard to the new transmission line.

In regards to the SRUNECO 69kV system spanning Placer and Looc, in theory it would be possible to connect to this as well, but it would require a temporary pause in power transmission. Furthermore, given that there are no plans to expand, there is a very low possibility of being able to connect to Surigao's 69kV transmission line, making it difficult to achieve in practice. However, this connection may still be able to accommodate a low MW capacity.

It would also be possible to connect to ANECO's 69kV system spanning Butuan and Santiago. However, in order to match the 69kV's new transmission line expansion and new substation, we would need to build a connecting substation ahead of time, and try to connect the wind power facilities' substation and switchyard to the new transmission line's connection.

In terms of capacity, even if we transmit so that a single line's load stays below 50%, we believe we should be able to send about 20MW to the transmission line.

However, since we don't want to invite misunderstandings, let me just add here that the transmittable level of active power is not solely determined by the transmission line's transmission capacity, so we would of course need to refer to the results of NGCP and ANECO's SIS and DIS.

6) Summary

The results of the above five criteria are all shown in table 4-3-6. Although each category has different tasks that will be required as part of this project, we believe they are all within the realm of feasibility at this point in time. As such, for perspectives 1–5, we believe that the potential site is more than capable of serving as the site for this wind power project.

Table 4-3-6: Summary of Project's Potential Site Evaluation Results

	Evaluation Result	Task
1) Site Topography	•Relatively gentle topography, less than 700-800m. •Mountain area soil in the north is primarily volcanic (rocks). •There is an active fault on the potential site.	•Buildings would need to be evaluated for weather proofing and earthquake proofing. Extra attention will need to be paid to the stability of the slope on Lake Mainit's west side, particularly to avoid erosion and/or collapsing during rainfall.
2) Land Owners and Nearby Residents	•Part of the access road is private property, but since this area is not its own municipality, the land is public and belongs to the government. •According to SPA data, this area's population density is less than 101–200 people per square meter, and there are almost no villages in the mountain area.	•Confirm whether it is an NIPAS area.
3) Land Usage	•The ridge for the proposed project site is currently only home to perennial plants, grasses, and shrubbery, with no houses, military sites, or swamps or bogs that would interfere with development. •There are two protected zones overlapping with the potential site (one of which is currently in the process of applying for protection).	•The protected zone currently applying for protection (a rafflesia habitat) still has many unverified factors, so we will work to continue acquiring new information.

	However, most of the ridge does not overlap with these zones.	
4) Turbine Transport	•In regards to unloading ports, we believe making use of both Surigao Port, which has a customs office and can accommodate large cargo ships, and Lipata Port, which is well-suited for carrying out large cargo, should be an effective means of transport. •There are two project site routes; one leading to the north ridge entrance, the other to the central ridge entrance. Both will need measures written on the right, but both can still be used for transport.	•In regards to weight, there is one bridge that can only bear up to 2 tons, so that will need to be reinforced. There are also other bridges whose maximum loads are currently unknown, and we will need to find out what those are. •In regards to width and length, there is a narrow road near Payanasa Bridge that needs to be widened. •In regards to height, some measures will need to be taken about the electric lines above the roads.
5) Connecting To The Grid	・We expect to connect to the 138kV system.	•We will need to conduct an SIS and/or DIS before applying to connect to this grid. (And before we do that, we will need to apply for an ECC to the METI, and conduct an EIA).

Source: Survey Team

（4） General Plan To Build A Wind Power Station On Potential Site

With the results of the previous sections, we have evaluated and formulated an overall project plan that will serve as the premise for chapter 5 (financial and economic feasibility) and chapter 6 (environmental and societal impact).

1) Wind Resource Simulation

For the next item, in order to formulate a turbine layout plan that will serve as the core for this project plan, and in order to evaluate how much power we can expect the project to product on a general level at this point in time, we will conduct a wind resource simulation. Generally, the goal of this simulation will be the following two points.

- Finalizing wind resources and optimal turbine placement from a topography perspective (as well as where to best put the meteorological tower)
- Estimate annual energy production in order to analyze finances and economics

a) Wind Resource Simulation Process

We have outlined the process for the wind resource simulation in figures 4-4-1 and 4-4-2. In general, wind resource simulations can be roughly classified into two categories: one conducted at an early level in the first stage of the process in order to get a general rating, and a more precise one at the second stage that goes into many more of the specifics that will be relevant to the project at hand. In this report, we will be conducting a first-stage wind resource simulation.

- <u>Stage 1: Overall Grade Based On Mesoscale Meteorological Model Wind Resource Predicted Results (Figure 4-4-1)</u>

➢ At the stage where there is no actual wind resource measurement data, we conducted wind resource simulations using an alternative method known as the mesoscale meteorological model. The mesoscale weather model is a calculation model used for weather forecasting, and enables us to predict weather (wind, temperature, rainfall, etc.) from several hours up to one day in the future. However, since this model is usually used to forecast weather for the entire world, the computational grid (resolution) it typically uses is about 1km to 10km, whereas for the purposes of this project, we need a much smaller scale of 10-odd meters to 100-odd meters, meaning that extra attention will need to be paid to the major points. The actual procedures used for the first stage described in this report is as follows.

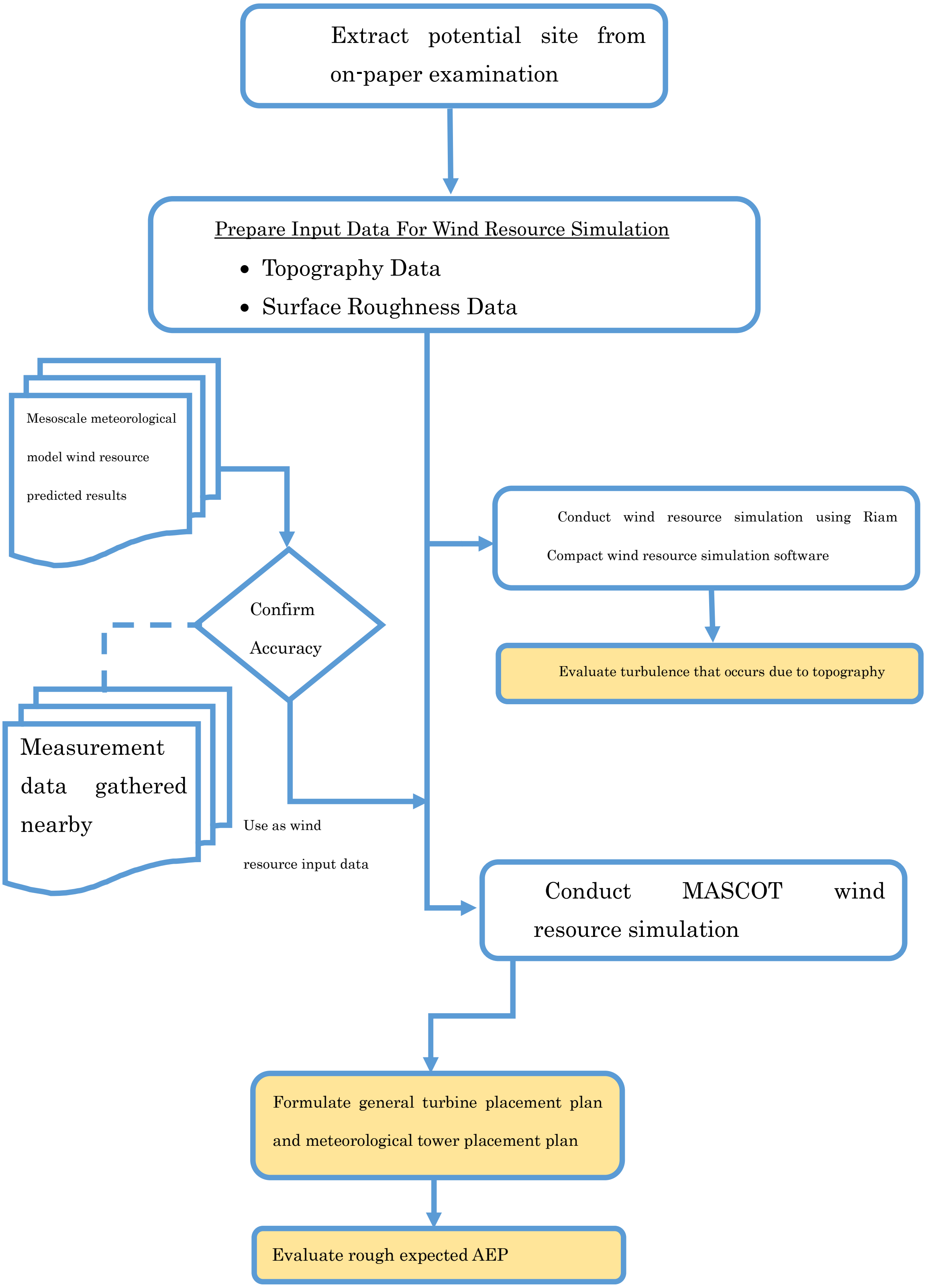
1. Extract potential site from on-paper examination
2. Create terrain data and surface roughness data
3. Create wind resource data using mesoscale meteorological model wind resource predicted results, and confirm data's accuracy
4. Conduct wind resource simulation using MASCOT wind resource simulation software: create high-resolution wind resource map
5. Conduct wind resource simulation using Riam Compact wind resource simulation software: evaluate turbulence that occurs due to topography
6. Formulate general turbine placement plan and meteorological tower placement plan
7. Evaluate rough expected annual energy production based on MASCOT wind resource simulation

- <u>Stage 2: Detailed Grade Based On Measured Wind Resource Data (Figure 4-4-2)</u>

Using the meteorological tower placement plan formulated in stage 1, we will build a meteorological tower and observe the actual wind resources for a minimum of one year. We will then use this data for a new wind resource simulation conducted in the same manner as that of stage 1, formulate a finalized wind turbine placement plan, and evaluate the expected annual energy production.

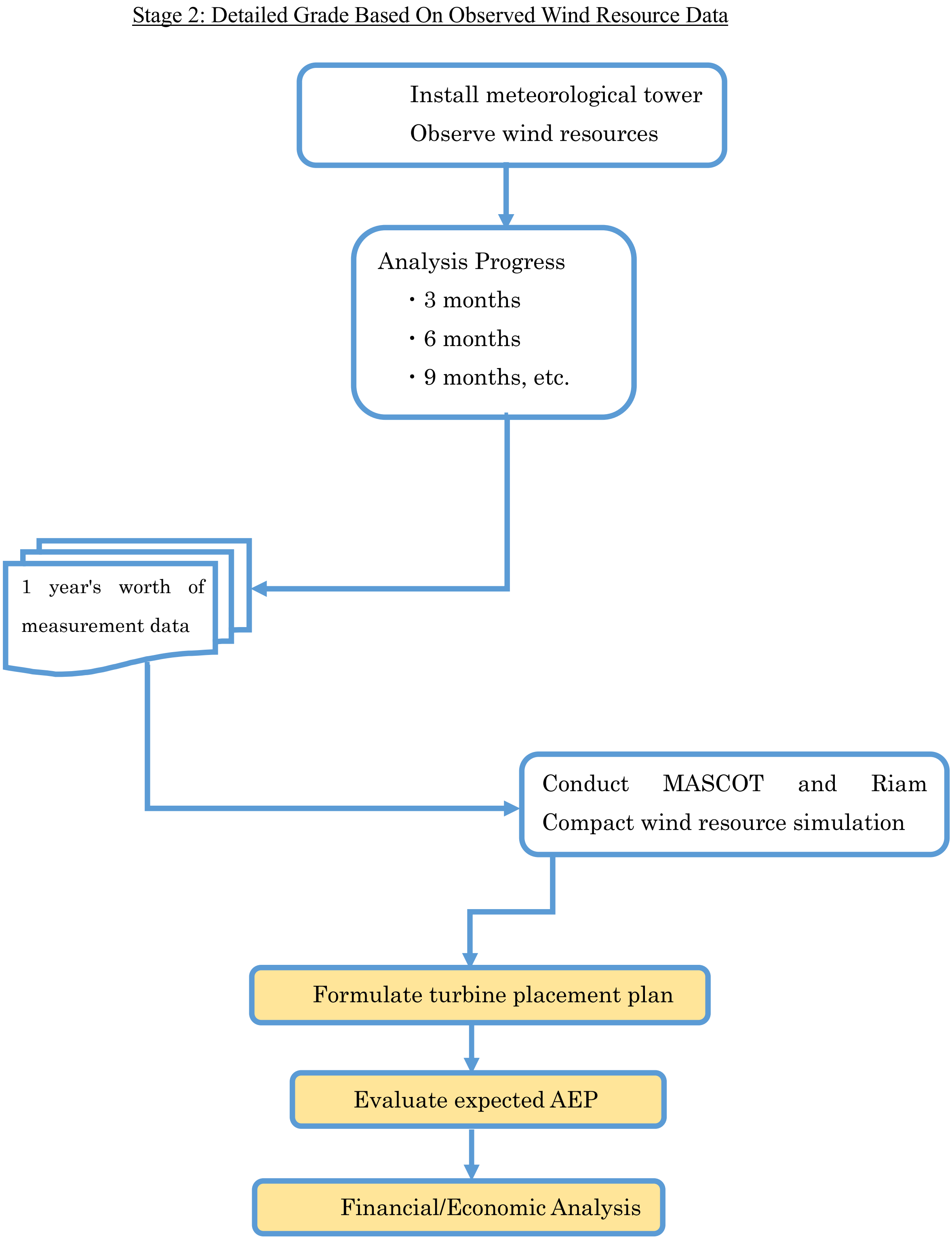
Figure 4-4-1: Wind Resource Simulation Process (Stage 1)

Stage 1: Overall Grade Based On Mesoscale Meteorological Modeling Wind Resource Predicted Results



Source: Survey Team

Figure 4-4-2: Wind Resource Simulation Process (Stage 2)



Source: Survey Team

b) Wind Resource Simulation Software

For this report, we have used two complementary wind resource simulation programs: MASCOT and Riam Compact. Both programs' features are listed in table 4-4-1, where you can see that MASCOT uses the RANS model, which excels at recreating static currents as a calculation model, and as such we have used that to evaluate the average wind speed and possible energy production using time-averaged static evaluation. On the other hand, Riam Compact uses the LES model, which excels at recreating constantly changing currents and dynamic evaluation, in order to evaluate turbulence, etc.

Table 4-4-1: Wind Resource Simulation Software Used

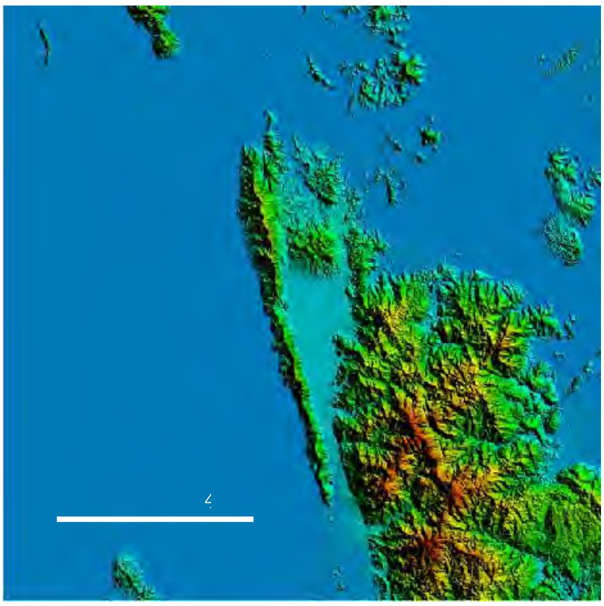
	MASCOT	Riam Compact
Turbulence Calculation Model	RANS Model (excels at recreating fields with static currents)	LES Model (excels at recreating fields with constantly changing currents)
Features	Highly accurate at evaluating average wind speeds and energy production using time-averaged static evaluation	High accurate at dynamic evaluation, such as turbulence
Usage In This Report	High-Resolution Wind Resource Map Creation Energy Production Evaluation	Turbulence Evaluation

c) MASCOT Wind Resource Simulation

Creating Topography Data and Surface Roughness Data

The topography data was created based on Shuttle Radar Topography Mission's publicly available 30m resolution altitude data (figure 4-4-3).

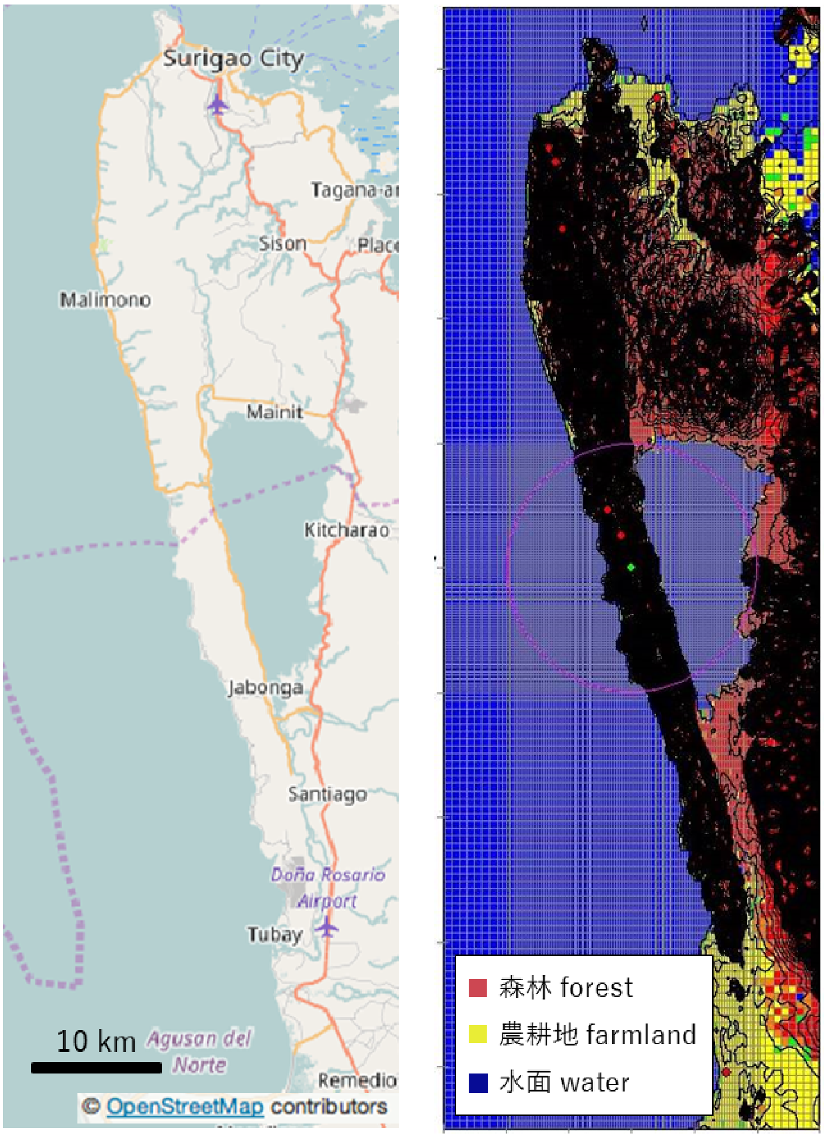
Figure 4-4-3: In-House Topography Data



Source: Made by survey team using publicly available SRTM data

The surface roughness data was created using the state of vegetation and the ground surface collected through Open Street Map images and on-site investigation (figure 4-4-4). Surface roughness refers to the value of the amount of resistance wind encounters when it comes in contact with the surface, and is determined by the state of the surface itself and any vegetation. For example, figure 4-4-4 shows that forest area is very rough, and water surfaces, shown in blue, are smooth.

Figure 4-4-4: In-House Surface Roughness Data



Source: Survey Team

<u>Confirming the Accuracy of Mesoscale Meteorological Model-Derived Wind Resource Predicted Results</u>

As mentioned above, at the stage where there is no actual wind resource measurement data, we created our own wind resource input data based on predicted wind resource results generated by our alternative mesoscale meteorological model. At this time, we were only able to acquire relevant results from an American meteorological data service company called 3TIER, thanks to the support of the above-mentioned NREL, and it was very simple to confirm the accuracy of this data. The resolution of the predicted results is 1 km, and we were able to acquire predicted results for the entire Philippines.

The accuracy confirmation for the 3TIER wind resource predicted results was conducted by comparing it to the only portion of genuine meteorological tower-provided measurement data available for the entire Caraga region. As you can see from tables 4-4-2 and 4-4-5, the measured wind resource data was measured at the 34m-tall Cabadbaran meteorological tower, located about 30km south from the potential site's southmost edge. This measured wind resource data was deemed ill-suited for direct wind resource simulation input data due to the following two points, so it was used only as comparison data for data accuracy verification purposes.

- The Site Where This Data Was Measured Was 30km South of This Project's Potential Site
  - According to the MEASNET international wind resource measurement guidelines, any measurement data that could be used for a mountainous area like the proposed site should ideally be collected no farther than 2km away, so a site that is 30km is out of the question.
- Measurement Resolution Is a Low 34m
  - MEASNET also specifies that measurement altitude should be 2/3 or greater than that of the expected turbine hub height. The type of turbine used in this report is the Hitachi-made HTW2.0-86, whose hub height is about 80m, so 34m is far too low.

Table 4-4-2: Acquired Measured Wind Resource Data Information

Category	Contents
Measurement Point	Cabadbaran (approx. 34km south of potential site)
Measurement Items	Wind Speed, Wind Direction (10min average intervals)
Measurement Altitude	34m

Ordinarily, we should evaluate the measurement data after setting up a wind resource pole near the potential site, but as this project moved forward, it became clear that installing such a pole near the potential site would be difficult before registering the SPC and signing an RE contract with the DOE, which is why we used the Cabadbaran area, which is owned by one of our partner companies and where we were free to install a pole freely with no land usage costs.

Since this area is 34km away from the potential site, we adjusted the data acquired from the 34m-tall pole with the NREL data (modeled at 30m) and compared the adjusted values in our evaluation.

Figure 4-4-5: Acquired Measurement Data's Measurement Points and Meteorological Tower Appearance

Source: Survey Team

We compared the mesoscale meteorological model wind resource predicted results conducted by 3TIER with the wind resource data measured at Cabadbaran in the following manner.

- We used the measured wind resource data as the comparison value for the annual average wind speed 34m above ground.
- For the wind resource predicted results comparison value, we selected a computational grid (one about 300m north of the measurement point) near the Cabadbaran measurement point used to collect the measured wind resource data, then used the value in that computational grid's predicted results. Also, the predicted results were collected 30m above ground, so we used the following formula to adjust them to the measured results we collected at 34m above ground.

$$U_{34m} = U_{30m} \times \left(\frac{34m}{30m}\right)^{1/7}$$

You can see the comparison results for both in table 4-4-3, which has a margin of error of 10%. We believe this margin is within acceptable bounds to use as a standard considering the unreliability of the wind resource predicted results derived from the mesoscale meteorological model. With only a single point of comparison, it was a simple process to compare the results, and we were also able to confirm a certain level of accuracy in the mesoscale meteorological model wind resource predicted results obtained from 3TIER. However, in general, mesoscale meteorological modeling tends to predict stronger wind speeds than are borne out by actual measurements, and we see that trend showing up in this comparison as well.

In regards to Cabadbaran's NREL data (30m altitude) and the measurement data we obtained there (34m tall pole), by adjusting the NREL data to 34m and measuring it against the measurement data, we got 3.3m/s for the former and 3.0m/s for the latter, which is well within the 10% permissible margin of error afforded to the mesoscale meteorological model, and as a result we were easily able to verify the accuracy of the NREL data.

In other words, even though Cabadbaran is over 30km away from the potential site, we determined that the data gathered there applies to Mindanao Island's north area, and that the NREL data is accurate.

Table 4-4-3: Comparison of Mesoscale Meteorological Model Wind Resource Predicted Results and Measured Wind Resource Data

Cabadbaran Measured Data Annual Wind Speed (m/s) at 34m	Mesoscale Meteorological Model Wind Resource Predicted Results Annual Wind Speed (m/s) Adjusted To 34m	Margin of Error (%)
3.0	3.3	10

Creating Wind Resource Input Data from Mesoscale Meteorological Model Wind Resource Predicted Results

Based on the above, we have created wind resource input data based on the mesoscale meteorological model wind resource predicted results provided by 3TIER using the following process.

1. Choosing a computational grid for the horizontal plane: Since our goal was to create a wind resource map of the entire potential site, we chose a point near the center of the potential site with a relatively high altitude compared to nearby topography for the wind resource predicted results. Specifically, we selected a computational grid located at the site planned for the meteorological tower (figure 4-4-12) which we will describe in more detail later.
2. Choosing the altitude for the computational grid: We thought that a meteorological model would be most accurate in a location where the surface was as smooth as possible, which is why we went with a computational grid at the highest altitude we could obtain (140m above ground level)
3. After choosing the above grids, we then used 1 year's worth of wind speed and wind direction predicted results (about 8,760 data points per hour on average) for the input data.

Creating a High-Resolution Wind Resource Map

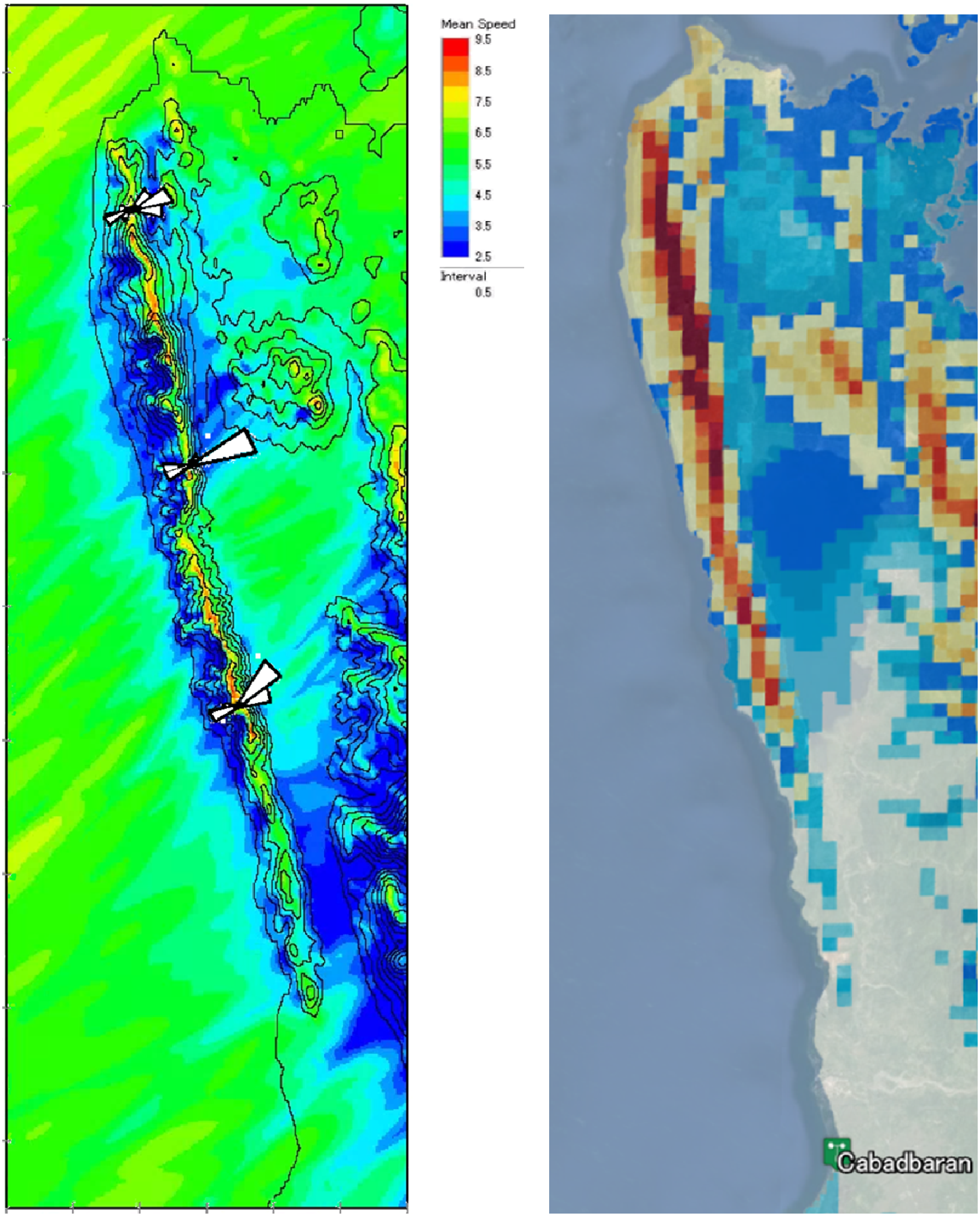
Using the above topographical data, ground surface roughness data, and wind resource data as input data, we simulated all 16 wind resource directions using MASCOT. The computational domain was 90km (x) in the north and south, 30km (y) in the east and west, and 10km (z) for altitude, with the computational grid ending up with 593 (x) × 404 (y) × 23 (z) points, or about 5.5 million points in total. The grid's x-axis and y-axis widths were expanded from the minimum 150m to the maximum 500m to an unreasonable interval heading out from the analysis's center.

Figure 4-4-6 shows the high resolution wind resource map created with MASCOT, as well as the wind resource map made with the mesoscale meteorological model based on the wind resource input data. In the high resolution wind resource map, we show not only the annual average wind speed distribution, but also wind roses of the potential site's north, central and south areas.

The annual average wind speed range shown in the high resolution wind condition map is very large. The low wind speed areas (indicated in figure 4-4-6 with dark blue) go as low as 2m/s, which the high wind speed areas (indicated with dark red) go as high as 9.3m/s. The high wind speed areas stretch north and south along the ridge of the potential site's hills and mountains, and in these areas the dominant wind directions are east-northeast (NEN) and west and southwest (WSW). Together, these average wind speeds and predominant wind directions make for a site very well suited to a wind power project.

As described above, the wind resource predicted results of the mesoscale meteorological model generally tends to overestimate (i.e. predict stronger wind speeds) than the measurement data. Since the high resolution wind condition map shown in figure 4-4-6 also shows the size of the average wind speed, even accounting for this trend, it still reconfirms that the wind resources of the potential site's ridge is generally well-suited to this project.

Figure 4-4-6: In-House High-Resolution Wind Resource Map (left) and Mesoscale Meteorological Model-Based Wind Resource Map (right)



Source: Left: Survey Team Right: Made by survey team based on NREL Wind Prospector

d) Riam Compact-Based Wind Resource Simulation

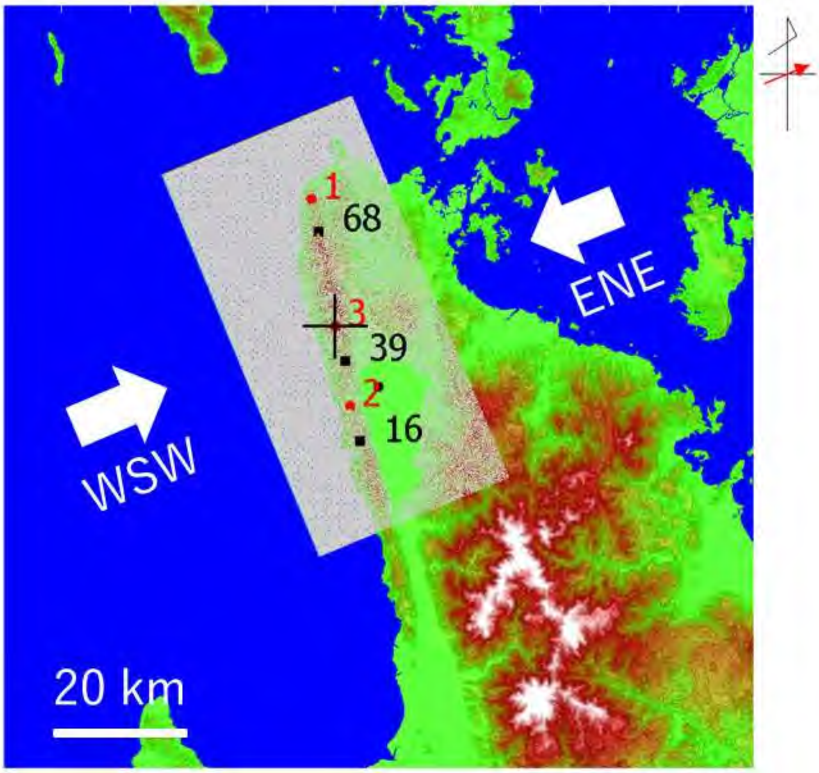
Settings for Topographical Data and Calculation Conditions

For the two predominant wind directions, east-northeast (ENE) and west-southwest (WSW), we conducted a wind resource simulation using Riam Compact in order to evaluate turbulence.

Just like with MASCOT, the terrain data was based on 30m resolution altitude data published by SRTM (Shuttle Radar Topography Mission) (figure 4-4-7). In addition, the computational domain was set to 30.0 (x) for the main current, × 60.0 (y) for perpendicular currents, × 5.0 (z) km for vertical movement. The number of computational grids totaled about 3.3 million points, or 201 (x) × 401 (y) × 41 (z) points in each direction, with the x and y axes distributed at equal intervals (150m). The z-axis width is spaced unevenly and drawn smoothly near the ground surface, with the vertical movement's minimum axis width set around 3.0m.

For the MASCOT wind resource simulation, we used the mesoscale meteorological model wind resource predicted results as input data for the purpose of creating a high-resolution wind resource map, but in order to evaluate the Riam Compact-based turbulence evaluation that focuses on the relative value of terrain-induced turbulence, we calculated wind with a specific hypothetical speed profile at the inflow boundary of the calculated zone. Specifically, for the inflow boundary, we used a speed profile that followed an index of 7 for the calculations.

Figure 4-4-7: Riam Compact Terrain Data and Calculation Conditions



Source: Left: Survey Team

※The white shading indicates the 30.0 (x) × 60.0 (y) × 5.0 (z)km calculated zone.

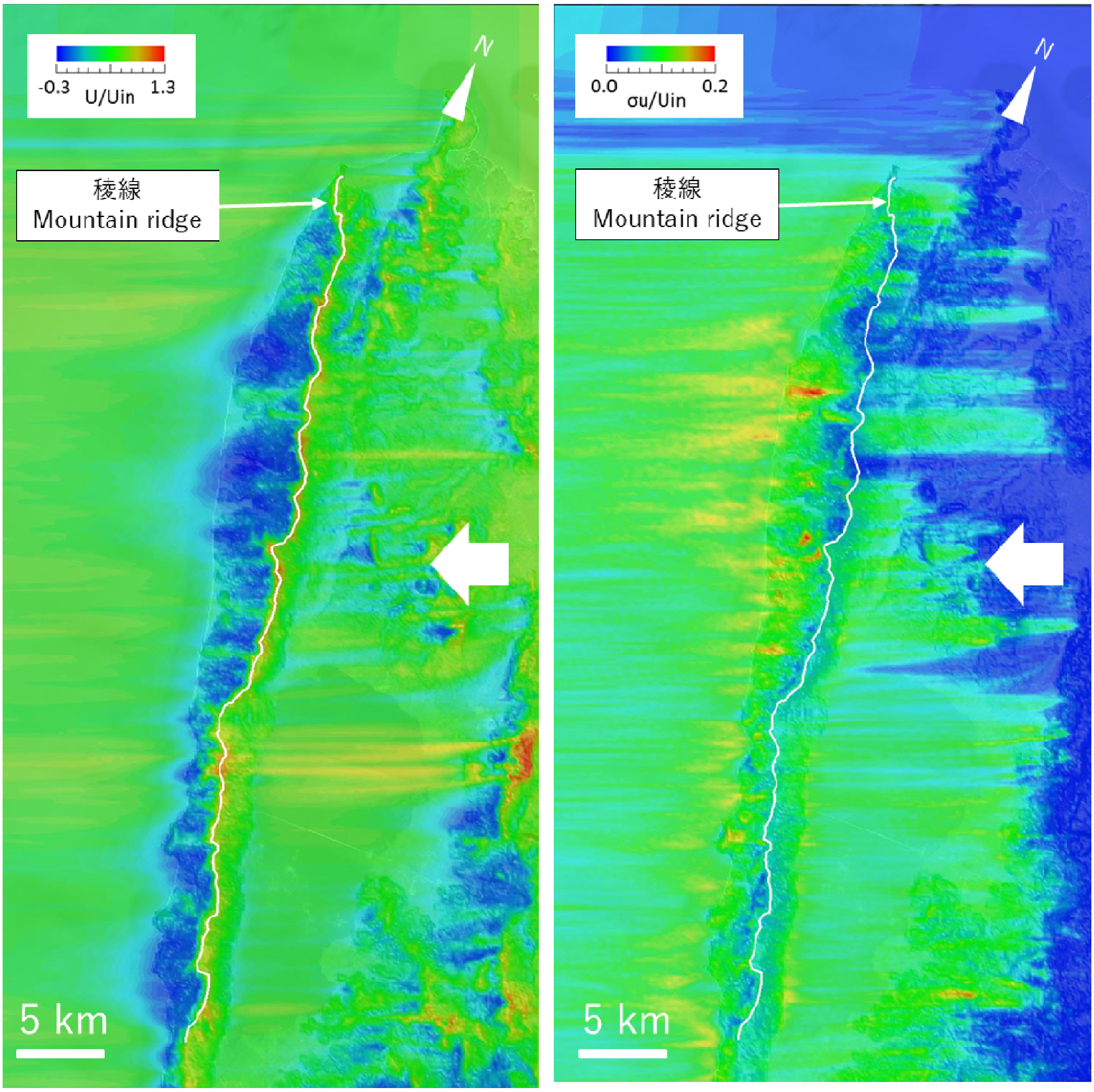
Turbulence Evaluation

The results of the Riam Compact wind resource simulation are shown in figures 4-4-8 (ENE results) and 4-4-9 (WSW results). As a result, we have been able to show not only the distribution of the standard deviation used for the turbulence evaluation, but also the distribution of the main current direction's average wind speed. As for the altitude shown in the results, we used 78m because that is the hub height of the Hitachi wind turbine (HTW2.0-86) we expect to use.

Figure 4-4-8: Riam Compact Calculation Results (ENE)

Left: Main Current Direction's Average Wind Speed Distribution at 78m AGL

Right: Standard Deviation Distribution at 78m AGL



Source: Survey Team

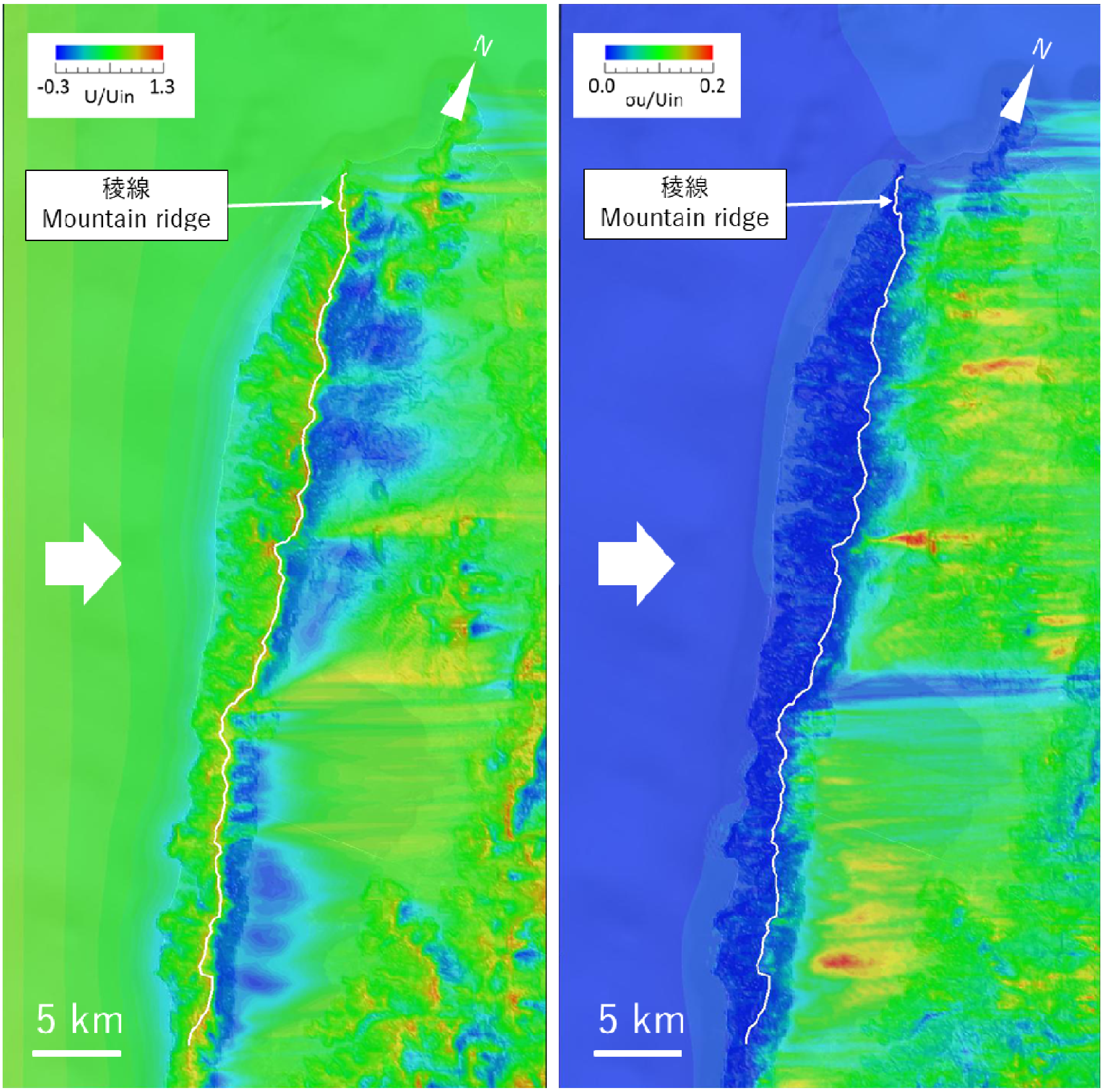
A) 78m is the hub height of the Hitachi wind turbine (HTW2.0-86) we expect to use.

B) The main current direction's wind speed and standard deviation are normalized from the maximum wind speed at the highest elevation at the inflow boundary

Figure 4-4-9: Riam Compact Calculation Results (WSW)

Left: Main Current Direction's Average Wind Speed Distribution at 78m AGL

Right: Standard Deviation Distribution at 78m AGL



Source: Survey Team

A) 78m is the hub height of the Hitachi wind turbine (HTW2.0-86) we expect to use.

B) The main current direction's wind speed and standard deviation are normalized from the maximum wind speed at the highest elevation at the inflow boundary

Looking at these results, we can see that, for the main current direction's average wind speed distribution, wind speed partially increases along the potential site's mountain ridge in both ENE and WSW directions. These results match the MASCOT calculation results shown in figure 4-4-6.

We also see that the standard deviation distribution that shows how strong the turbulence is entirely green across all of the mountain ridge areas (and that this is below the 0.20 threshold value established by Professor Jun Uchida at Kyushu University's Research Institute for Applied Mechanics), which confirms that it is not especially remarkable. The WSW ocean wind in particular is shown in blue along the mountain ridge, and shows us that the turbulence effect is extremely small.

Given all the above, it is clear that any turbulence effects caused by the predominant ENE and WSW winds passing over this topography are minimal. The wind speed increases in some mountain ridge areas, and we expect that it should be able to approach the turbines in a stable manner, making the potential site's mountain ridge a perfect place to build turbines.

2) General Turbine Layout Plan

Formulating the General Turbine Layout Plan

Based on the high-resolution wind resource map shown in

, we have listed our current general turbine layout plan in figure 4-4-10. For this general layout plan, we have separated the 150MW-total wind power station into three phases along the ridge's south, center, and north (with each phase assuming the installation of twenty-five 2MW turbines), with plans to develop in stages. For this report, we have used Hitachi-made HTW2.0-86 turbines in this proposed layout.

Our basic thinking behind this general turbine layout plan is as follows.

- As shown in figure
-

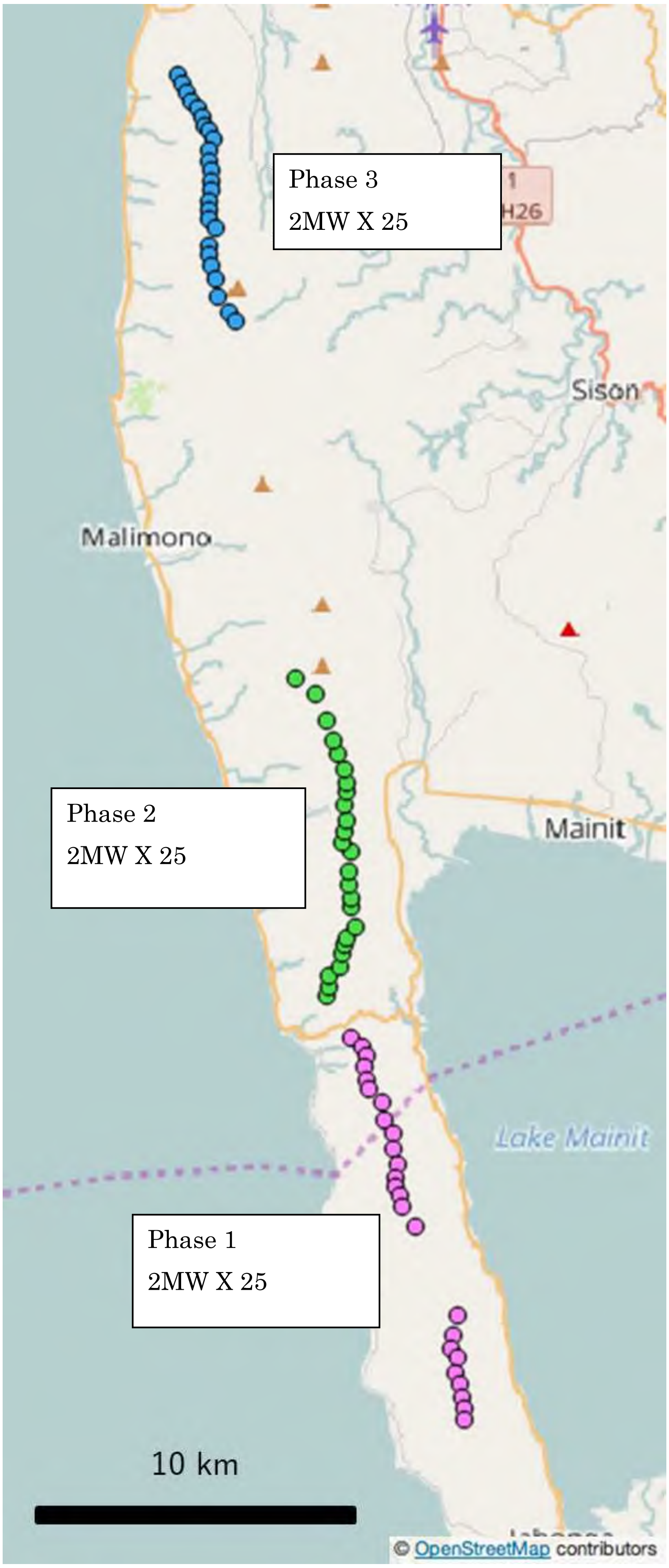
- , we would place the turbines along the ridge, where there are both fast winds and high-quality predominant wind directions
- The amount of space between turbines should be about 260m or more, or roughly 3x the rotor diameter, following the logic used in figure 4-2-3 assuming optimal predominant wind directions
- Phase 3 will not place any turbines in the protected Surigao Forest (figure 4-4-11)
- We have placed turbines in the rafflesia habitat, since at this point the habitat is currently only in the process of applying for protection, and it is too soon to determine whether or not it will actually be certified as a protected zone (figure 4-4-11)
  (However, we will work to quickly acquire new information as soon as it is available, and will take any measures necessary regarding turbine placement in the event that it is certified as a protected zone)
- We have placed turbines 500m or farther away from the residential area shown in figure 4-3-11 (figure 4-4-11)
  (In fact, we have tried to place the turbines 1000m or farther away from residential areas as much as possible. In regards to the turbines that are placed within 1000m of a residential area, we will take whatever measures are necessary regarding turbine placement following the results of the future environmental study)
- We have evaluated the transport distances for phases 1, 2, and 3, in that order, as per the following.

ⅰ) We believe phase 1 should be given first priority for the following 3 reasons: it already has a road leading to the site's mountain ridge; the terrain is relatively gentle, and well-suited for a wind power project; and it can be expanded to include phase 2 (+50MW).

ⅱ) Phase 3 is the easiest, but it also requires a road to be built to the ridge, and cannot be easily expanded thanks to the nearby protected zone, so we have designated it as third priority.

ⅲ) Taking i and ii above into account, we have come up with the following order of priorities (phase 1, 2, 3). In regards to the final order, we will need to decide that once we have the wind resource measurement results and have concluded negotiations with the NGCP about the grid.

Figure 4-4-10: General Turbine Layout Plan



Source: Survey Team

Figure 4-4-11: Location Relationship Between Currently Planned Turbine Layout and Protected Zones/Residential Areas

*Green indicates areas within 500m of a residential area, and blue indicates areas within 1000m of a residential area.

Source: Survey Team

General Estimated Annual Energy Production Evaluation

This evaluation of the general annual energy production with the turbine layout shown in figure 4-4-10 was conducted with MASCOT. The results are shown in table 4-4-4. As described above, the wind resource predicted results using the mesoscale meteorological model tend to be larger than those of measurement data, and we see that trend clearly in table 4-4-4 as well.

According to the NREL, annual energy production estimates in the Philippines based off the mesoscale meteorological model results in a margin of error by as much as 50%. Even if we are as conservative as possible with this margin of error (i.e. adjusting it down 50%) we can see that the average facility utilization rate in each phase still exceeds 20%, thus indicating that we should be able to expect overall good results.

However, as this is still just a rough general evaluation, in the future, we will need to conduct a stage 2 wind resource simulation (based on detailed measurement data) as shown in figure 4-4-2.

Table 4-4-4: MASCOT-Based General Expected Annual Energy Production Evaluation

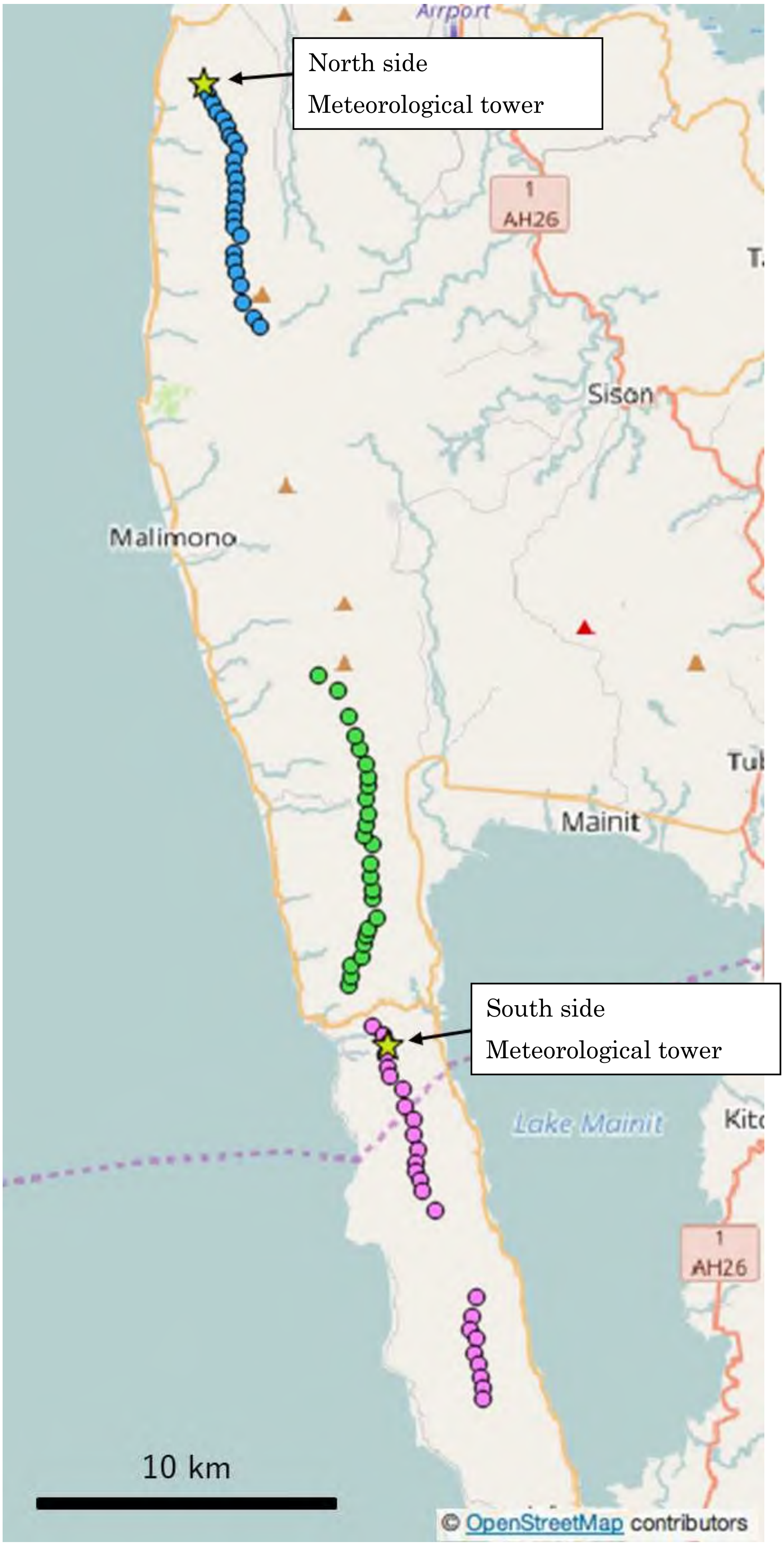
	Expected AEP (without considering wake effect) (GWh)	Expected AEP (considering wake effect) (GWh)	Average Facility Utilization Rate (%)
Phase 1	216	216	49.4
Phase 2	186	185	42.2
Phase 3	201	200	45.7

3) Planned Meteorological Tower Site

In order to conduct the wind resource simulation in stage 2, we will need to first build meteorological towers. As such, based on the below conditions, we have selected a planned site for these towers and listed them in figure 4-4-12. We also show the planned sites' current state in figures 4-4-13 and 4-4-14.

- As described above, according to the MEASNET international wind resource measuring guidelines, it is best to place the measuring point within 2km of the expected turbine site. AS such, we will need to build these towers to match the potential site. Therefore, we suggest the first such tower (south) be built in the mid-point between phase 1 and phase 2, and that the second one (north) be built during phase 3.
- From a constructability perspective, there are some locations that are already relatively easily accessible from existing roads and are relatively flat as well, so those are the points we have selected. An on-site investigation is currently taking place to verify these locations.
- As with the turbines, the meteorological towers also need to be built in locations with relatively little surface-induced turbulence. To that end, the calculation results of figures 4-4-8 and 4-4-9, together with the same conditions below, have been evaluated for turbulence near each potential meteorological tower using Riam Compact. You can see the results in table 4-4-5. In regards to the distribution of standard deviations in turbulence strength, we have confirmed that the turbulence effects at each of the proposed towers' heights (40m, 50m, 60m) fall well below the 0.20 threshold mentioned earlier.

Figure 4-4-12: Planned Meteorological Tower Sites



Source: Survey Team

Figure 4-4-13: Planned South-Side Meteorological Tower Site (the plain shown in the photo)

Source: Survey Team

Figure 4-4-14: Planned North-Side Meteorological Tower Site (the hill indicated by the arrow)

Source: Survey Team

Table 4-4-5: Meteorological Tower's Riam Compact Calculation Results

Standard Deviation Distribution in Measurement Instrument Height

Height	Unit 1 (South)		Unit 2 (North)	
	ENE	WSW	ENE	WSW
40m	0.11	0.03	0.12	0.03
50m	0.11	0.02	0.12	0.03
60m	0.11	0.02	0.11	0.02

※ The standard deviation's wind speed has been normalized at the inflow boundary's maximum elevation location

4) Streamline Evaluation Based on Turbine Selection and Japanese Technology Utilization

For this wind power project on this potential site, we expect to use Hitachi-made HTW2.0-86 turbines made with Japanese technology. Below, you can see a comparison between the HTW2.0-86 and models currently being used in other Philippine wind power stations, and the superiority of the Hitachi model should be clear.

As you can see in table 4-4-6 and figure 4-4-15, existing Philippine wind power stations are all land-based, and are located geographically in Luzon and Visayas, with none in our proposed site of Mindanao. Furthermore, the turbine models currently being used are all European: Vestas (Denmark), Siemens (Germany), and Gamesa (Spain). With the exception of Bangui Phase 1 and 2 in 2005, all of them began operating during 2014–2016.

Table 4-4-6: Existing Wind Power Stations in the Philippines

No.	Station	Output (MW) (Units × Per-Unit Output)	Model	Company	Year Begun
1	Bangui Phase 1 and 2	33 (20 x 1.65 MW)	Vestas V82	North Wind Power Development Corp	2005
2	Bangui Phase 3	18 (6 x 3 MW)	Siemens SWT108	North Wind Power Development Corp	2014
3	Burgos	150 (50 x 3 MW)	Vestas V90	EDC	2014
4	Caparispisan	81 (27 x 3 MW)	Siemens SWT101	North UPC	2014
5	Pililia Phase 1	54 (27 x 2 MW)	Gamesa G90	Alternegy Philippine Holdings Corp.	2015
6	San Lorenzo	54 (27 x 2 MW)	Gamesa G90	Trans-Asia Renewable Energy Corp.	2014
7	Nabas Phase 1	36 (18 x 2 MW)	Gamesa G90	Petro Wind Energy Incorporated	2015
8	Pililia Phase 2	72 (36 x 2 MW)	Gamesa G90	Alternegy Philippine Holdings Corp.	2016

Source: Survey Team

※The number displayed in the "No." column matches those shown in figure 4-4-15.

Figure 4-4-15: Location of Existing Philippine Wind Power Stations

Source: Survey Team

Table 4-4-6 compares the Hitachi turbine HTW2.0-86 to the models currently being used in existing Philippine wind power stations. Please note that the Vestas V82 and V90, and the Siemens SWT101 and 108 are all from the same series, so we only compared the latter models. Here are the results.

Table 4-4-7: A Comparison of the Hitachi HTW2.0-86 and Other Models

Model Name	Hitachi HWT2.0-86	Gamesa G90	Siemens SWT108	Vestas V90
Rated Output (MW)	2	2	3	3
Rotor Type	Downwind	Upwind	Upwind	Upwind
Cut-In Wind Speed (m/s)	4	3	3	3.5
Cut-Out Wind Speed (m/s)	24	21 (25)	25	25
Rated Output Wind Speed (m/s)	12	12	12.5	15
Extreme Wind Speed (m/s)	70 (3sec)	70 (3sec)	70 (3sec)	70 (3sec)
Turbulence Intensity (IEC-Class)	A	A	A	A
Blade Size (meters)	42	44	53	44
Nacelle Weight (tons)	Approx. 40	70	78	70

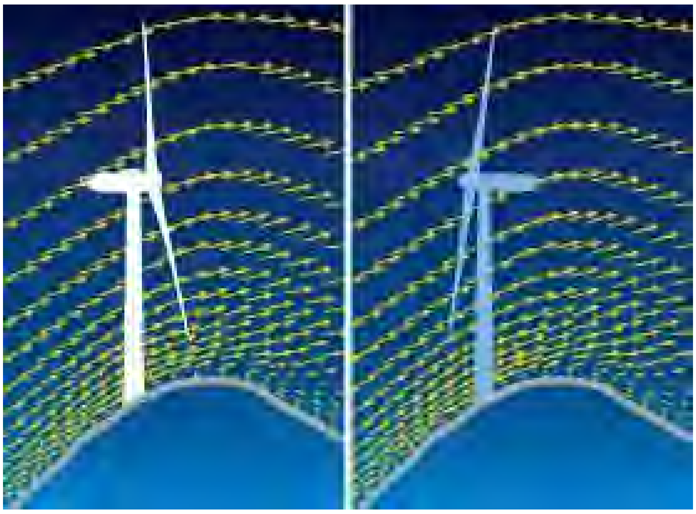
Source: Survey Team

a) Rotor Type

Hitachi turbines are the only ones that use downwind rotors, where the nacelle is hit with wind coming downward, rather than the opposite with upwind rotors (see figure 4-4-16 for an illustrative diagram). In the Philippines, especially in areas with topography and climate like our potential site (hills, mountains, and areas prone to hurricanes) downwind rotor turbines have the following advantages. Please also note that Hitachi turbines are the only ones in the world that use downwind rotors.

- Able to efficiently capture mountain-area upwinds, leading to increased efficiency. (Figure 4-4-16)
- The moment arm of the blade and the efficiency of the turbine is further increased by the presence of the nacelle, located upwind of the rotor, because it redirects the wind, increases the speed, and also the wind does not hit the root of the blade, it hits a point further away from the rotor axis.
- Since the wind direction speedometer that is central to controlling the turbine is on top of the wind, it is able to monitor the situation more precisely, leading to more efficient control possibilities.
- Reduces the load placed on the main body, leading to increased durability.
- During hurricanes or rough winds, the turbine takes advantage free yawing controls in order to let the wind pass through without resistance, enabling it to maintain greater stability during blackouts.
- The turbines that are currently part of the plan are made in Hitachi factories, and are designed to have the strongest turbulence intensity (resistance to powerful hurricanes), including resisting 70m/s winds for up to 3 seconds and 50m/s winds for up to 10 minutes. That said, more deliberations on how best to reduce risks, such as in handling super hurricanes and whether or not further measures are necessary, still need to be held.
- These turbines are easily transportable, and are lighter than comparable models made by other companies, which should open up more avenues for transport across some bridges (see d) below)
- The overall charge transfer capacity, which indicates resistance to lightning, is designed for 600C, twice the IECI international specification of 300C, making it very high in strength (see e) below)

Figure 4-4-16: Downwind Rotor (Left) and Upwind Rotor (Right)



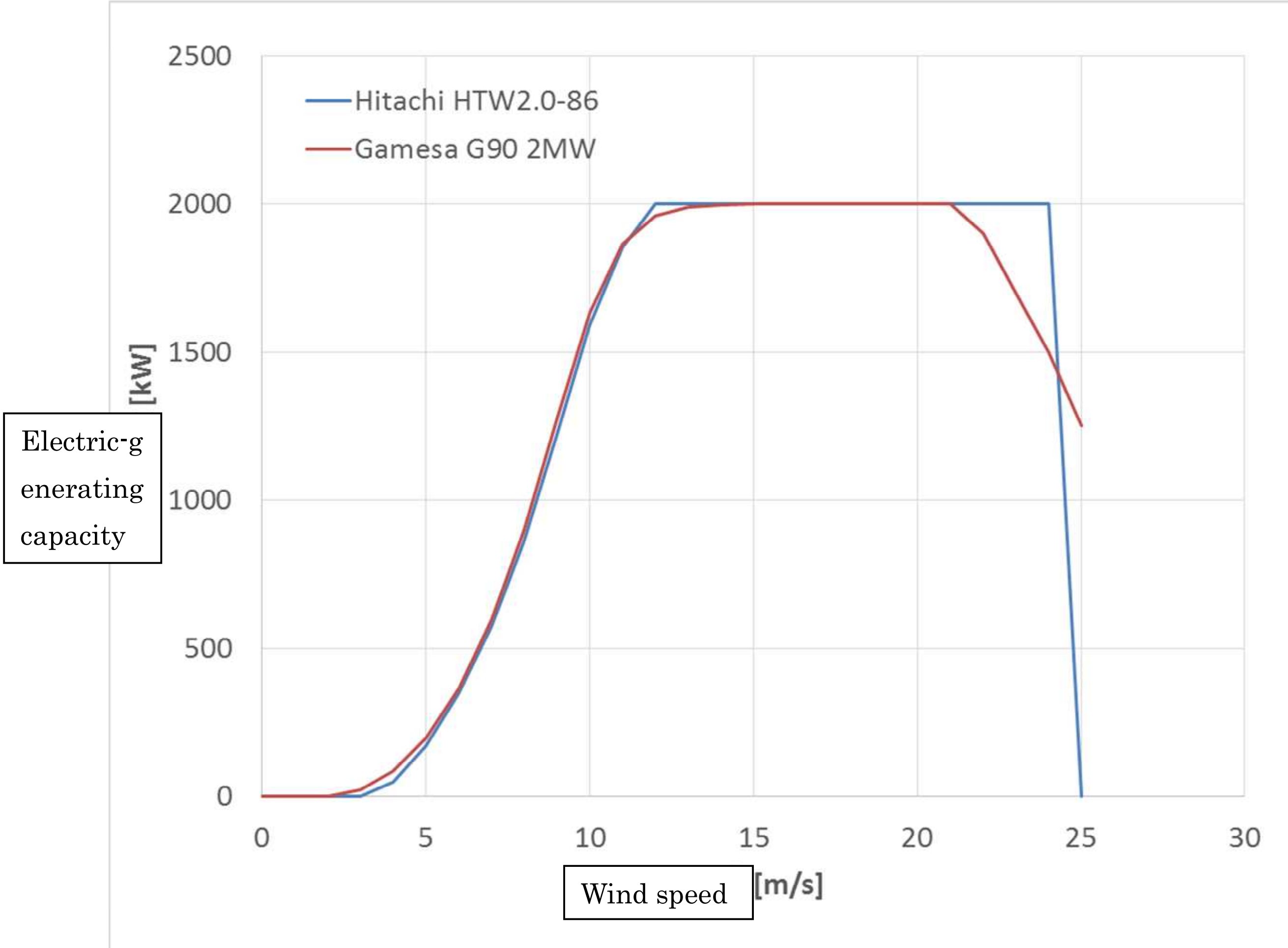
Source: Hitachi

b) Power Curve

Since it is difficult to make comparisons when rated output is different, we tried comparing the Hitachi HTW2.0-86 with the Gamesa G90, which has the same rated output.

As you can see in figure 4-4-17, in regards to the power curve showing the wind speed that initiates power generation (cut-in wind speed) and the wind speed that produces rated output, there isn't that much difference between the two. But during strong cut-out winds, where the blades stop producing energy and change their pitch angle to match the wind's direction in order to maintain durability, while both models perform similarly under 24–25m/s speeds, the Gamesa G90 starts to decrease output once wind speeds reach 21m/s, which is why we see a big difference in the power curve for 21–24m/s wind speeds. This shows how much more durable the HTW2.0-86 is constructed, and its superiority in providing a stable energy supply even during strong winds.

Figure 4-4-17: Power Curve Comparison of Hitachi HTW2.0-86 and Gamesa G90



Source: Survey Team

c) Extreme Wind Speeds and Turbulence Intensity

Extreme wind speeds refer to average wind speeds consisting of extreme values reproduced over 50 years with durations of 10 or 3 minutes, and are a value that serve as the foundation of a turbine foundation's durability. Turbulence intensity is a similar value for turbine design foundations, and refers to a given hub height's standard deviation wind speed. IEC standards are divided into A, B, and C classes, with A being the highest turbulence intensity.

As figure 4-4-17 shows, all turbines, including the Hitachi HTW2.0-86, possess high extreme wind speed values (3 seconds at 70m/s) and turbulence intensity values (IEC Class A). This stems from the fact that both the Philippines and Japan are countries that regularly have to deal with hurricanes. At any rate, we can see that from an extreme wind speed and turbulence intensity perspective, the HTW2.0-86 is just as durable and well-designed as any other model.

d) Transportability

As described above, in regards to transporting turbines to the potential site, the main obstacles are the maximum loads bridges can support, and narrow roads. The former needs to accommodate the heaviest turbine parts (normally, the nacelle) and the latter needs to be able to accommodate the longest parts, the blades.

In regards to the heaviest turbine parts, as the figure shows, the HTW2.0-86's nacelles are designed to be incredibly lightweight, and weigh in at only approx. 40 tons, roughly half those of other models. This means that, in the HTW2.0-86's case, the heaviest part is not the nacelle, but the tower's mid-section, which weighs approx. 50 tons; however, even that is only about 2/3 the weight of mid-sections from other models, which means that overall, the HTW2.0-86 has a significant advantage in transport across bridges. As for the blade length, as described above, not only does the HTW2.0-86 possess a superior power curve to the Gamesa G90, it does so with blades that are 2m shorter, at 42m long, making it that much easier to pass through narrow roads.

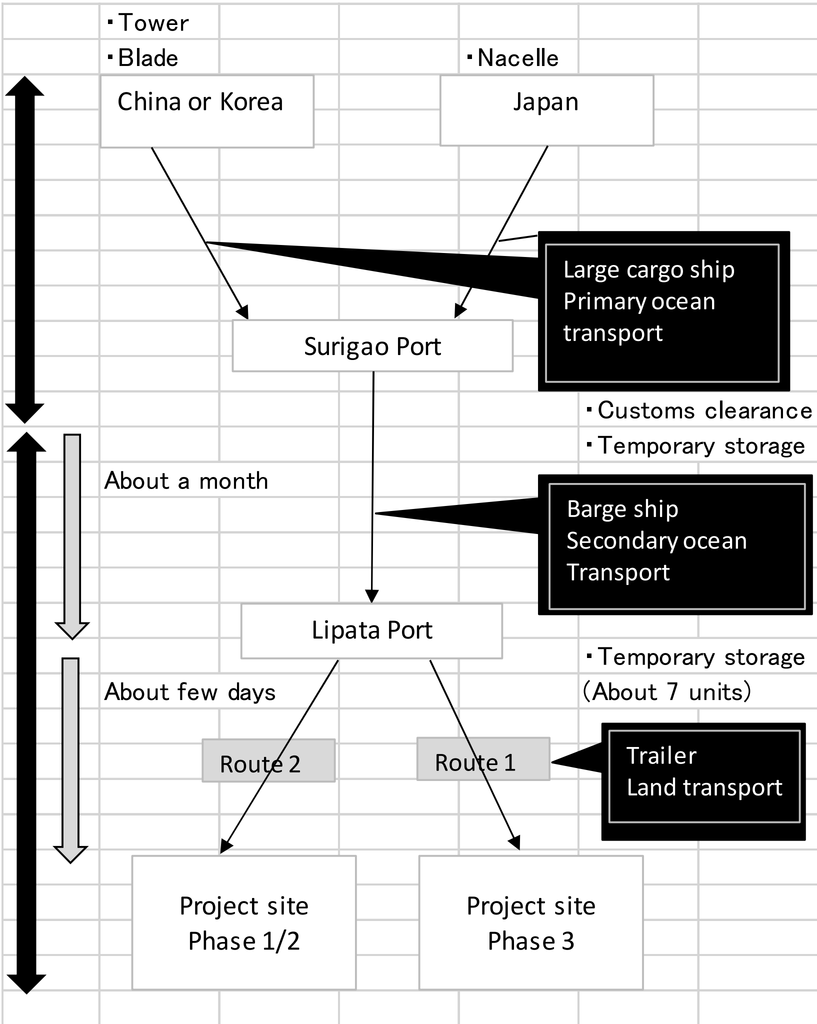
e) Lightning Resistance

As the HTW2.0-86 is designed to endure harsh Japanese climate, its overall charge transfer capacity is designed to be 600C, or twice the IEC standard of 300C. Like Japan, the Philippines is also prone to lightning strikes, so from a lightning resistance perspective, the HTW2.0-86 has another advantage.

5) General Turbine Transport Plan

Our current plan to transport the turbines is shown in figure 4-4-18 below.

Figure 4-4-18: General Transport Plan



a) Primary Ocean Transport

For the HTW2.0-86 that is the focus of this report, the tower and blades are manufactured in either China or Korea, and the nacelles (and other internal generators, etc) are manufactured in Japan, after which they are all transported by sea via large cargo ships. Although it depends on the contract, in general, this form of primary ocean transport is controlled by many automobile companies, and even this report has been written with the expectation that Hitachi will control this process.

Assuming that the importing port will have an on-site customs office and can accommodate large cargo ships, like Surigao Port, we would bring the turbine parts into Surigao Port to have them pass through customs there, and keep them in temporary storage. The temporary storage would be handled at Lipata Port, our secondary ocean transport, and should be capable of storing up to 7 turbine units, so we would bring 7 units in on large cargo ships. Therefore, for each phase (consisting of 25 units each) we expect to make four trips along our primary ocean transport: three 7 unit trips, and one 4 unit trip.

b) Secondary Ocean Transport

As carrying out large cargo like turbine parts from Surigao Part would be difficult, we will need to carry them out at Lipata Port using a secondary ocean transport line. However, as the water in Lipata Port is only 4–5m deep, it cannot accommodate large cargo ships, so the transport there must be done with barges. A single 2MW turbine unit requires a barge that can accommodate a minimum of 15m × 40m in size. Once a barge reaches Lipata Port, the turbine parts will be kept in temporary storage until they are ready to be transported to the power station site. Please note that we expect the process to take about 1 month between going through customs at Surigao Port and entering temporary storage at Lipata Port.

c) Land Transport

We expect land transport will be carried out by trailer trucks via the routes shown in figure 4-4-20. Phase 1 and Phase 2 would use route 2 (approx. 67km) and Phase 3 would use Route 1 (approx. 9km). Assuming that a single day's transport range is around 50km, we expect Route 2's transport to require two days, which means we will need to secure another temporary storage yard along it.

In regards to the access roads used for land transport to the project site, we will evaluate further when we formulate our detailed civil engineering plan based on the measurement results, but as shown in figure 4-4-19, we may end up needing to use special transport vehicles. This special standing transport vehicle was developed independently in Japan for the purposes of making it easier to install turbines in steep mountain areas. This vehicle helps to alleviate issues caused by blade length during transport, and the amount of land we would need to modify in order to transport the blades should be drastically reduced as a result.

Figure 4-4-19: An Example of a Special Standing Transport Vehicle

Source: Sankyu Inc.

Figure 4-4-20: Turbine Land Transport Route

Source: Survey Team

6) General Grid Connection Plan

Our expected plan for connecting to existing electrical systems is shown in figure 4-4-21, and the expected connection route is shown in figure 4-4-22.

Given the wind power station output in each phase (2MW × twenty-five units = 50MW) and the availability in the system's heat capacity mentioned in the previous section, the power transmission line that would be connected in all three phases is expected to be the 138kV one controlled by the NGCP. The NGCP's responsibility division point, thinking conservatively, would be between the connection substation and the 138kV transmission line that is scheduled to be installed near that line's connection point.

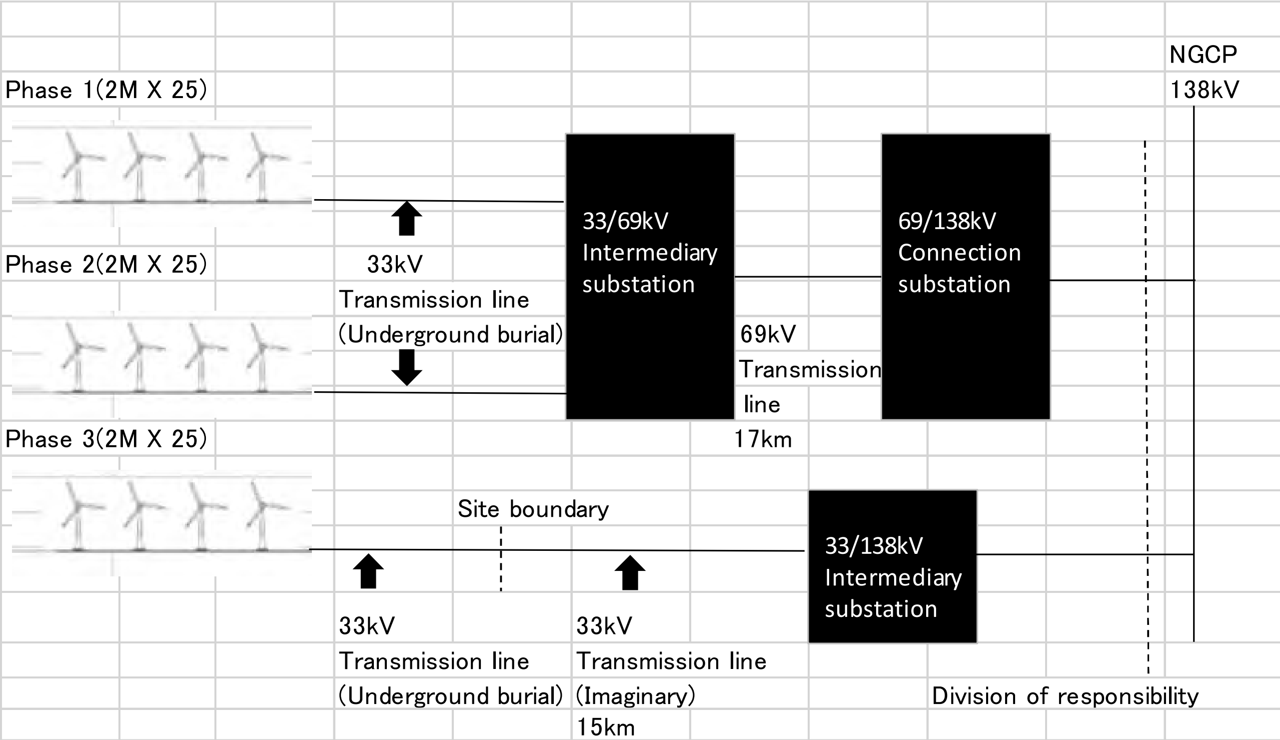
We have taken the following points into consideration when choosing the transmission line's route:

- The connection route should match the order of each phase
- In order to streamline costs, we would try to share existing transmission lines and substations as much as possible

In order to decrease risk, we would use power transmission lines that can be constructed independently as a base in each phase. At the same time, in Phase 1 and Phase 2, which would be conducted adjacent to each other, we would try to share the intermediary substation (33/69kV) and the connection substation (69/138kV) outside of the project site in order to streamline costs. For commonly owned transmission line parts, we would install a mid-way substation and boost the voltage on the turbine side from 33 kV to 69 kV in order to reduce power transmission loss. However, in Phase 3, we cannot lay power transmission lines in Surigao Forest located between the Phase 2 and Phase 3 project sites, so we expect to use a completely independent transmission line route. In each phase, we expect that the power transmission lines will be buried underground at the project site, and that suspended transmission lines will not be on the project site.

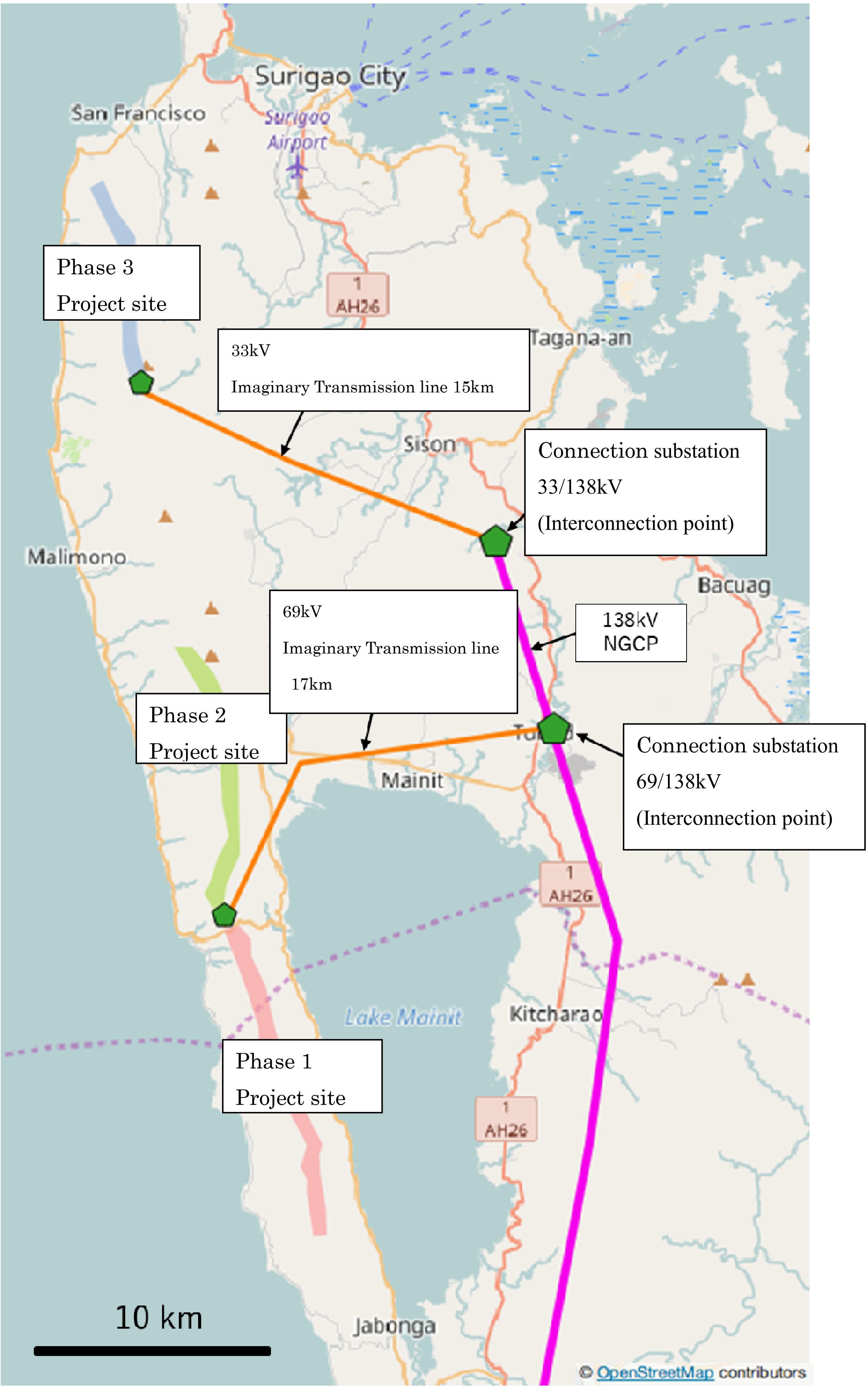
As for the construction period, we expect that Phase 1 and Phase 3, each including a substation installation, will take about 1.5 years. On the other hand, we expect Phase 2 to take about half a year, considering the parts it shares with Phase 1.

Figure 4-4-21: General Grid Connection Plan



Source: Survey Team

Figure 4-4-22: Grid Connection Routes



Source: Survey Team

7) General Civil Engineering Plan

This section describes the civil engineering construction that would be required as part of the wind power project, including laying down access roads (land development construction) and building the turbine foundations.

a) Access Road Construction (Land Development Construction)

Figure 4-4-23 shows the access roads we expect to build. For Phase 1, we are planning to use the end point of Route 2 (as shown in our land transport routes in figure 4-4-20) as our starting point and construct a 19km road along the southern ridge. For Phase 2, we are planning to construct a 12km road in the opposite direction, along the northern ridge. For Phase 3, we plan to use the end point of Route 1 as our starting point and construct an 11km access road (table 4-4-8) along the southern ridge. In regards to the ridge between Phases 2 and 3, we are not planning to build a through road because it that area is both relatively steep and overlaps with the Surigao Forest protected zone.

The access roads' standard specs will be designed so as to enable turbine transport. As such, in general they should be about 5.5m wide, and have an incline angle of no more than 10%. For locations with curves, we will need to adjust the specs to better accommodate the turbines' transportability. A detailed construction plan will be finalized once we have obtained measurement results and chosen a transport vehicle.

Figure 4-4-23: Routes of Future Access Roads

Source: Survey Team using Google Maps

Table 4-4-8: Access Road Route On-Site Survey

	Phase 1: New Access Road Route The southern ridge as seem from the end point of land transport Route 2, shown in figure 4-4-18. This gentle ridge continues for some distance.
	Phase 2: New Access Road Route The northern ridge as seem from the end point of land transport Route 2, shown in figure 4-4-18. Has more undulations than that in Phase 1.
	Phase 3: New Access Road Route The southern ridge as seem from the end point of land transport Route 1, shown in figure 4-4-18. Has a comparatively gentle, but slim, ridge.

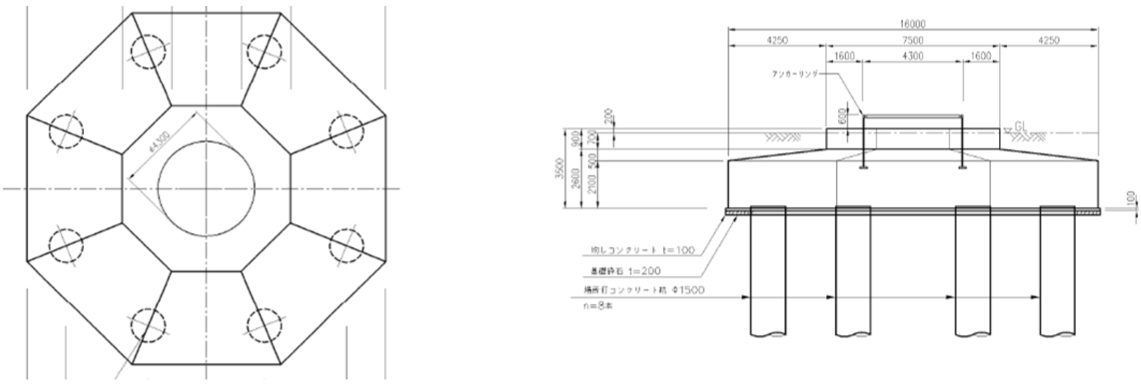
a) Turbine Foundation Construction

Turbines are both power generation facilities and high-rise buildings, so they require foundations that are up to the same level. As you can see in the 2MW class turbine foundation shown in figure 4-4-24, a single turbine requires concrete placement of about 600m^3, or 15,000m^3 in a single phase consisting of 25 units. It is very difficult to regularly supply this amount of concrete from a distance, so we plan to install two concrete batching plants with about a 1m^3 capacity on-site.

The exact foundation shape is determined from the results of a boring survey, but considering the local geological structure confirmed by the on-site survey, we assume we will need mat foundations that drive anchors into the bedrock. Since a mat foundation is relatively inexpensive compared to a pile foundation, we believe this is the preferred way to go for this project.

For each phase's construction period, although a single unit will take about 3 months to build, the land construction, anchor placement construction (figure 4-4-25), and main body construction will all be going on in parallel order, so we expect that building all 25 units in a single phase will only take about 10 months (or about two units per month).

Figure 4-4-24: Example 2MW Turbine Foundation Construction (Pile Foundation)



Source: Survey Team

Figure 4-4-25: Anchoring Construction (Pile Foundation)

Source: Achiha Corporation

8) General Turbine Assembly Construction Plan

Table 4-4-9 shows a rough plan for the 2MW-class turbine assembly construction. The assembly requires cranes capable of handling 600 tons, which do not currently exist on Mindanao Island. However, we did confirm at the hearing that equivalent-level cranes do exist on Luzon Island.

For the construction periods in each phase, although we expect a single unit's construction to take approximately 1.5 months, the internal electric parts installation, assembly, and turbine wiring will be going on in parallel, so we expect it to only take about 12 months to assemble all 25 units (or about 2 units per month).

Table 4-4-9: Turbine Assembly Construction Steps

Order	Construction Details
①	Turbine Wiring (Pre-Assembly) During the stage where we leave the turbines in temporary storage at the port, we will install the necessary wiring inside the towers as much as possible.
②	Internal Electric Parts: Install the transformers and control panels inside the turbine towers. This should take less than two weeks per unit.

③	Tower Assembly We will assemble the disassembled tower (for this report, we will assume these are HTW2.0-86s divided into three sections) using 600-ton class cranes. This construction should take about 10–14 days from the tower assembly to the blade assembly.	
④	Nacelle Assembly We will assemble the drivetrain (generator, gearboxes, etc.) used in the nacelles and the nacelle internals in mid-air using 600-ton class cranes.	
⑤	Blade Assembly Blades will be assembled one at a time in mid-air using 600-ton class cranes. Sometimes all 3 blades are assembled on the ground before being hoisted and installed, but in the HTW2.0-86's case, only one blade will be assembled.	
⑥	Turbine Wiring (Post-Assembly) Install final internal tower wiring. Should take less than two weeks per unit.	

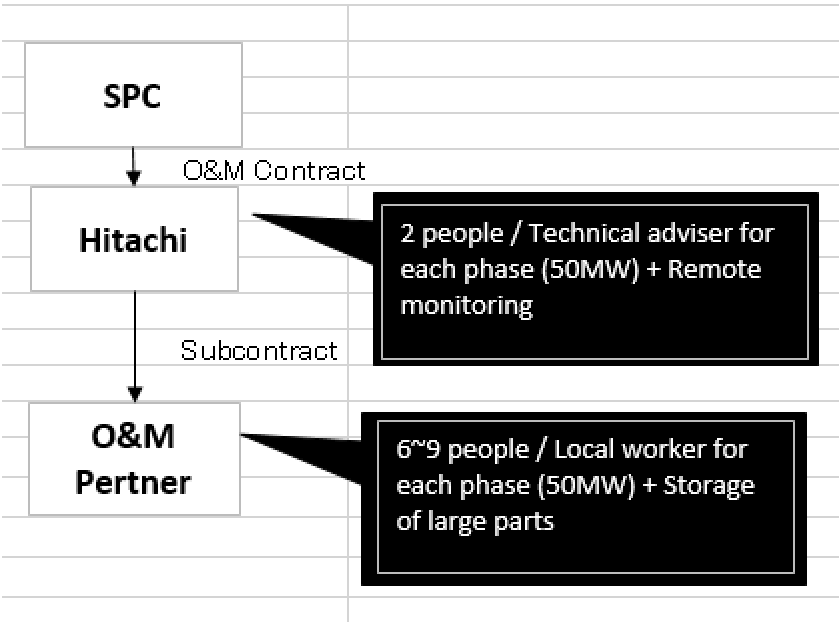
Photo Source: Achiha Corporation

9) General Operation and Management Plan

Our expected operation and management (O&M) system is shown in figure 4-4-26. In recent wind power projects, in order to stabilize earnings and expenses and to more reliably procure funding, there have been many cases where O&M contracts that include a certain rate of operations (i.e. the percentage of time where the turbine is operational) were signed with the turbine manufacturers. As such, for the wind power project proposed for this potential site, we expect to sign a similar O&M contract that includes a guaranteed operation rate with Hitachi. In our hearings with Hitachi, we have been told that they can indeed provide the same kind of O&M services that they offer in Japan (shown in table 4-4-10) on Mindanao Island in the Philippines as well, and they can train local workers at the Hitachi O&M training center in Japan.

O&M for wind power projects involves 24-hour remote supervision, regular inspections accompanying real-world operation, and support if repairs et al are needed.

Figure 4-4-26: Expected O&M System



Source: Survey Team

Table 4-4-10: O&M Services Provided By Hitachi

Service		Compliance
Guaranteed Operation Rate		90% for the first 6 months, 95% afterwards
Local Office		Possible
Inspections	Monthly	Yes
	6mo. / Annual	Yes
Supplying Parts		Yes
Large Part Storage		Prioritized from production line
Remote Supervision		24-Hour
Repairs		Yes

a) Remote Supervision

Hitachi turbines come standard with the SCADA remote supervision system, which enables those with proper access to check on rotor speeds, nacelle angles, roughly 100 other points of analog data, wind speeds, and energy production, from anywhere in the world through the Internet. Any errors that pop up, such as for a part in need of repair, can be sent automatically to an O&M supervisor, and can even be operated via remote control as well. In Hitachi's case, this remote supervision is carried out from their monitoring center in Japan's Ibaraki prefecture's Hitachi City.

Furthermore, in addition to the standard sensors, we are also considering installing a CMS (Condition Monitoring System) that includes special vibration sensors and networked cameras for central components such as the generator, gearboxes, etc. This CMS would enable us to foresee possible problems and avoid them ahead of time, and would help to improve the operations rate and the power station's capacity factor.

b) Regular Inspections / Repairs Accompanying Real-World Operation

During real-world operations, we will need to establish a local O&M base of operations in order to ensure quick and regular support. As you can see in figure 4-4-26, for this local O&M base, we expect to need about 2 technical advisors from Hitachi and maybe 6–9 local personnel for each phase (twenty-five 2MW turbines). Therefore, for all three phases, we expect to need about 25 people on-site, including the technical advisors.

On site, there will be regular inspections accompanying real-world operation, and the need for support in cases of unforeseen problems. For the former, we can start with roughly daily visual inspections performed by local personnel, move on to monthly, biannual, annual, and once-per-3-years inspections. We can then compare the inspection results to the quality control standards set by Hitachi, and determine if any parts need to be filled or replaced as necessary.

In order to make quick repairs for unforeseen problems a reality, the local O&M base will need a plan to store spare parts for the primary components (gearboxes, generators, etc.)

10) Summary

Table 4-4-11 sums up all of the above nine individual plans, and table 4-4-12 shows the rough general process we expect for each stage of these individual plans. We expect the construction period for each phase to last about 2 years from the day construction begins to the day the power station is operational.

Table 4-4-11: Summary of General Plans for Building Wind Power on This Potential Site

		Phase 1	Phase 2	Phase 3
Turbine Layout		South Ridge – Approx. 14km	Central Ridge – Approx. 11km	North Ridge – Approx. 9km
Generation Scale		50 MW 2MW Turbines × 25 Units	50 MW 2MW Turbines × 25 Units	50 MW 2MW Turbines × 25 Units
Expected Turbine Model		Hitachi HTW2.0-86 2MW Turbine		
Turbine Transport	Ocean	Customs at Surigao Port → Secondary Transport via Barge → Temp Storage and Carry-Out at Lipata Port		
	Land	Route 2 – Approximately 67km Land Transport (about 2 days per transport run)		Route 1 – Approximately 9km Land Transport (about 1 day per transport run)
Grid Connection	Site's Internal Transmission	33kV Underground Transmission Line	33kV Underground Transmission Line	33kV Underground Transmission Line
	Intermediary Substation	33/69kV Substation		N/A
	Site's External Transmission	69kV Suspended Transmission Line		33kV Suspended Transmission Line
	Transmission Line Connection	NGCP 138kV		NGCP 138kV
Civil Engineering	Access Roads	Pave Approx. 19km	Pave Approx. 12km	Pave Approx. 11km
	Turbine Foundation	Approx. 600m³ Concrete Foundation × 25 Units		
Total Construction Period		2 Years	2 Years	2 Years
O&M System		Hitachi would be the main O&M vendor, and would conduct O&M both from Japan and on-site with local O&M partners		

Source: Survey Team

Table 4-4-12: General Total Construction Period for Wind Power Project on Potential Site

	1st Year												2nd Year												3rd Year
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Manufacture Turbines (Anchoring)	■	■	■	■	■																				
Manufacture Turbines (Main Body)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
Transport Turbines (Anchoring)						■	■																		
Transport Turbines (Main Body)										■	■	■	■	■	■	■	■	■	■	■	■				
Prep Construction	■	■																							
Pave Access Roads			■	■	■	■	■																		
Build Turbine Foundations							■	■	■	■	■	■	■	■	■	■	■	■							
Install Turbines											■	■	■	■	■	■	■	■	■	■	■	■			
Connect To Grid					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Test Operation																							■	■	
Begin Operation																									■

※This estimated based on the construction starting date, and does not include the 3 months needed ahead of time to place the orders for the turbines.

※We expect turbine manufacturing for the main bodies would take place in four stages (7 units, 7 units, 7 units, 4 units), with each batch being transported shortly thereafter.

Source: Survey Team

Chapter 5 Financial and economic feasibility

(1) Cost estimate

The estimated construction costs for this project are shown in Table 5-1-1. These include the estimated costs the turbines, construction work, transportation and transmission lines. The estimates are based on the cost components of the project, using, as a reference point, the figure of USD 1.86m/MW reported by Bloomberg Energy Finance in October 2016 as the capex for an onshore wind farm project in the Philippines.

The potential output of this project as a whole is estimated to be 150MW, but we are have considered developing the business in three separate phases, with 50MW in each phase. These estimates therefore calculate the construction costs on the assumption that 50MW of output is added in each phase. The exchange rates used are P49/$ and P0.43/¥.

Table 5-1-1 Breakdown of construction costs

Item	Percentage	Cost (P m)	Cost (¥ m)
Construction costs (turbines, assembly etc.)	63.3%	2,885	6,710
Construction costs (foundations, structures)	15.9%	725	1,686
Construction costs (transportation)	9.2%	420	976
Construction costs (transmission)	11.6%	527	1,226
Total	100.0%	4,557	10,598

Source: Created by the Investigation Team

(2) Outline of findings from preliminary financial/economic analysis

1) Funding

This section identifies the total estimated cost of this project and the possibilities for funding it. Firstly, a special purpose company ('SPC') will be set up, to be the entity responsible for this project. The SPC will be responsible not just for the cost of construction (EPC), but for the total cost of the project, including interest costs during construction (IDC), land and development costs, which total around P5,662m. However, as many of the costs are still undefined, they are are based on discussions with relevant organizations and standard costs. 75% of funding for the project is expected to come from senior debt, with the remaining 25% coming from the capital invested by the sponsors/shareholders.

To find potential providers of senior debt, we will investigate whether there is any possibility of financial support through JICA's international investment and lending programs or from JBIC or the ADB. More specifically, as the project progresses, we will confirm the matters to be covered by due diligence when lending is under consideration, the terms of any loans (interest rates and repayment periods), and completion guarantees during construction. We will also examine the possibility of joint financing with local financial institutions or of using the JCM, which is a mechanism for bilateral credit.

Figure 5-2-1　Capital structure

Unit（単位）: Peso（ペソ）

Asset（資産）		Liability（負債）	
EPC（建設コスト）	4,557,000,000	Senior Debt（シニアローン借入）	
IDC（建中金利）	295,455,900	Principal（元本）	3,960,959,627
Land（土地）	245,000,000	IDC（建中金利）	285,189,093
DSRA（拘束口座）	202,085,226	Equity（純資産）	
Development（開発費用）	318,990,500	Equity（エクイティ）	1,415,382,907
Financing Costs（金融費用）	43,000,000	JCM Grant（JCM補助金）	0
Total Asset（総資産）	5,661,531,627	Total Liability & Equity（負債・純資産）	5,661,531,627

Unit（単位）: Peso（ペソ）

Financed by（資金調達）	amount（金額）	%
Senior Loan（シニアローン）	4,246,148,720	75.00%
Equity（エクイティ）	1,415,382,907	25.00%
JCM Grant（JCM補助金）	0	0.00%
Total（合計）	5,661,531,627	100.00%

2) Detailed conditions

The basic specifications of the project, and details of the financing terms and operating costs are shown below. However, as many of the details are still undefined, they are are based on discussions with relevant organizations and standard costs.

Table 5-2-1　Detailed terms of the business plan

Basic specifications	Rated output	kW	50.000
	Plant capacity factor	%	25%
	Power sold per year	kWh	109,500,000
	Unit Price	peso/kWh	7.40
Senior loan	Interest	%	6.00%
	Principal deferment	year	2
	Repayment period	year	15
	Collateral deposit	-	Six months' principal & interest
Operating costs	O&M	Peso	58,751,000
	Insurance	Peso	21,500,000
	Other	Peso	5,000,000
Other	Inflation	%	3.4%
	Corporation tax	%	30.00%

The Philippines has a feed-in tariff system for wind power. According to the Republic of the Philippines Energy Regulatory Commission (ERC), the unit price of wind-generated electricity had been set at P8.53/kWh in July 2012, but was cut to P7.4/kWh in October 2015. Attention will need to be paid to any future action by the ERC.

3) Business plan

Below are the forecast profit and loss statement, balance sheet and cash flow statement for the project. If the project can be operated as forecast, it will be feasible, based on stable revenues from the sale of electricity over its twenty-year lifetime.

Table 5-2-2 Business plan

ブトゥアン風力案件 事業計画（想定）

		2018 年	2019 年	2020 年	2021 年	2022 年	2023 年	2024 年	2025 年	2026 年	2027 年	2028 年	2029 年
通貨：フィリピン・ペソ		-2 年目	-1 年目	1 年目	2 年目	3 年目	4 年目	5 年目	6 年目	7 年目	8 年目	9 年目	10 年目
損益	売上	0	0	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000
	原価	0	0	430,880,727	433,711,261	436,638,033	439,664,315	442,793,491	446,029,059	449,374,637	452,833,964	456,410,908	460,109,468
	粗利	0	0	379,419,273	376,588,739	373,661,967	370,635,685	367,506,509	364,270,941	360,925,363	357,466,036	353,889,092	350,190,532
	販売管理費	0	0	2,000,000	2,068,000	2,138,312	2,211,015	2,286,189	2,363,920	2,444,293	2,527,399	2,613,330	2,702,184
	営業利益	0	0	377,419,273	374,520,739	371,523,655	368,424,670	365,220,320	361,907,021	358,481,071	354,938,638	351,275,762	347,488,349
	営業外費用	0	0	252,091,396	241,057,575	229,351,794	216,933,131	203,758,172	189,780,857	174,952,324	159,220,734	142,531,089	124,825,045
	経常利益	0	0	125,327,877	133,463,164	142,171,861	151,491,539	161,462,148	172,126,164	183,528,746	195,717,904	208,744,673	222,663,303
	税金	0	0	0	0	0	0	0	51,637,849	55,058,624	58,715,371	62,623,402	66,798,991
	税後利益	0	0	125,327,877	133,463,164	142,171,861	151,491,539	161,462,148	120,488,315	128,470,122	137,002,533	146,121,271	155,864,312

		2018 年	2019 年	2020 年	2021 年	2022 年	2023 年	2024 年	2025 年	2026 年	2027 年	2028 年	2029 年
通貨：フィリピン・ペソ		-2 年目	-1 年目	1 年目	2 年目	3 年目	4 年目	5 年目	6 年目	7 年目	8 年目	9 年目	10 年目
資産	流動資産	400,775,001	202,085,726	379,929,567	558,872,602	739,034,570	920,549,834	1,103,568,515	1,283,563,365	1,460,408,784	1,537,949,448	1,594,839,538	1,634,023,585
	固定資産	1,863,837,650	5,459,445,900	5,111,816,174	4,764,186,447	4,416,556,720	4,068,926,994	3,721,297,267	3,373,667,540	3,026,037,814	2,678,408,087	2,330,778,360	1,983,148,633
	資産合計	2,264,612,651	5,661,531,627	5,491,745,741	5,323,059,049	5,155,591,291	4,989,476,828	4,824,865,782	4,657,230,906	4,486,446,598	4,216,357,535	3,925,617,899	3,617,172,219
負債	固定負債	849,229,744	4,246,148,720	4,064,969,391	3,872,756,241	3,668,837,310	3,452,499,715	3,222,987,162	2,979,497,294	2,721,178,893	2,447,128,901	2,156,389,265	1,847,943,585
	シニアローン（元本）	792,191,925	3,960,959,627	3,791,949,059	3,612,645,747	3,422,422,863	3,220,615,406	3,006,517,875	2,779,381,804	2,538,413,146	2,282,769,497	2,011,557,150	1,723,827,971
	シニアローン（建中金利）	57,037,819	285,189,093	273,020,332	260,110,494	246,414,446	231,884,309	216,469,287	200,115,490	182,765,747	164,359,404	144,832,115	124,115,614
純資産	資本金	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907
	利益剰余金他	0	0	11,393,443	34,919,902	71,371,075	121,594,206	186,495,714	262,350,705	349,884,798	353,845,727	353,845,727	353,845,727
	JCM補助金	0	0	0	0	0	0	0	0	0	0	0	0
	負債＋純資産合計	2,264,612,651	5,661,531,627	5,491,745,741	5,323,059,049	5,155,591,291	4,989,476,828	4,824,865,782	4,657,230,906	4,486,446,598	4,216,357,535	3,925,617,899	3,617,172,219

	2018 年	2019 年	2020 年	2021 年	2022 年	2023 年	2024 年	2025 年	2026 年	2027 年	2028 年	2029 年
通貨：フィリピン・ペソ	-2 年目	-1 年目	1 年目	2 年目	3 年目	4 年目	5 年目	6 年目	7 年目	8 年目	9 年目	10 年目
営業CF	0	0	472,957,604	481,092,891	489,801,588	499,121,266	509,091,875	468,118,041	476,099,849	484,632,260	493,750,998	503,494,039
投資CF	-1,863,837,650	-3,595,608,250	0	0	0	0	0	0	0	0	0	0
財務CF	2,264,612,651	3,194,833,750	-181,179,329	-192,213,150	-203,918,931	-216,337,594	-229,512,554	-243,489,868	-258,318,401	-274,049,992	-230,392,922	-317,077,555
ネットCF	400,775,001	-400,774,501	291,778,275	288,879,741	285,882,657	282,783,671	279,579,321	224,628,173	217,781,448	210,582,268	263,358,076	186,416,484
配当金	0	0	113,934,434	109,936,706	105,720,688	101,268,408	96,560,640	44,633,323	40,936,029	133,041,604	146,121,271	155,864,312

		2030 年	2031 年	2032 年	2033 年	2034 年	2035 年	2036 年	2037 年	2038 年	2039 年
通貨：フィリピン・ペソ		11 年目	12 年目	13 年目	14 年目	15 年目	16 年目	17 年目	18 年目	19 年目	20 年目
損益	売上	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000	810,300,000
	原価	463,933,779	467,888,117	471,976,902	476,204,706	480,576,254	137,466,710	142,140,579	146,973,358	151,970,452	157,137,448
	粗利	346,366,221	342,411,883	338,323,098	334,095,294	329,723,746	672,833,290	668,159,421	663,326,642	658,329,548	653,162,552
	販売管理費	2,794,058	2,889,056	2,987,284	3,088,851	3,193,872	3,302,464	3,414,748	3,530,849	3,650,898	3,775,028
	営業利益	343,572,163	339,522,828	335,335,814	331,006,443	326,529,874	669,530,826	664,744,674	659,795,793	654,678,650	649,387,524
	営業外費用	106,040,703	86,112,395	64,970,453	42,540,966	18,745,524	0	0	0	0	0
	経常利益	237,531,460	253,410,432	270,365,362	288,465,477	307,784,350	669,530,826	664,744,674	659,795,793	654,678,650	649,387,524
	税金	71,259,438	76,023,130	81,109,608	86,539,643	92,335,305	200,859,248	199,423,402	197,938,738	196,403,595	194,816,257
	税後利益	166,272,022	177,387,303	189,255,753	201,925,834	215,449,045	468,671,578	465,321,272	461,857,055	458,275,055	454,571,267

		2030 年	2031 年	2032 年	2033 年	2034 年	2035 年	2036 年	2037 年	2038 年	2039 年
通貨：フィリピン・ペソ		11 年目	12 年目	13 年目	14 年目	15 年目	16 年目	17 年目	18 年目	19 年目	20 年目
資産	流動資産	1,654,423,290	1,654,894,686	1,634,224,141	1,591,124,108	1,524,228,632	1,524,228,632	1,524,228,632	1,524,228,632	1,524,228,632	1,524,228,632
	固定資産	1,635,518,907	1,287,889,180	940,259,453	592,629,727	245,000,001	245,000,001	245,000,001	245,000,001	245,000,001	245,000,001
	資産合計	3,289,942,197	2,942,783,866	2,574,483,594	2,183,753,835	1,769,228,633	1,769,228,633	1,769,228,633	1,769,228,633	1,769,228,633	1,769,228,633
負債	固定負債	1,520,713,563	1,173,555,233	805,254,961	414,525,201	0	0	0	0	0	0
	シニアローン（元本）	1,418,576,085	1,094,734,359	751,170,672	386,683,957	0	0	0	0	0	0
	シニアローン（建中金利）	102,137,478	78,820,874	54,084,288	27,841,245	0	0	0	0	0	0
純資産	資本金	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907	1,415,382,907
	利益剰余金他	353,845,727	353,845,727	353,845,727	353,845,727	353,845,727	353,845,727	353,845,727	353,845,727	353,845,727	353,845,727
	JCM補助金	0	0	0	0	0	0	0	0	0	0
	負債＋純資産合計	3,289,942,197	2,942,783,866	2,574,483,594	2,183,753,835	1,769,228,633	1,769,228,633	1,769,228,633	1,769,228,633	1,769,228,633	1,769,228,633

	2030 年	2031 年	2032 年	2033 年	2034 年	2035 年	2036 年	2037 年	2038 年	2039 年
通貨：フィリピン・ペソ	11 年目	12 年目	13 年目	14 年目	15 年目	16 年目	17 年目	18 年目	19 年目	20 年目
営業CF	513,901,749	525,017,029	536,885,480	549,555,560	563,078,770	468,671,578	465,321,272	461,857,055	458,275,055	454,571,267
投資CF	0	0	0	0	0	0	0	0	0	0
財務CF	-336,387,578	-356,873,582	-378,607,183	-401,664,361	-224,040,494	0	0	0	0	0
ネットCF	177,514,170	168,143,447	158,278,297	147,891,200	339,038,277	468,671,578	465,321,272	461,857,055	458,275,055	454,571,267
配当金	166,272,022	177,387,303	189,255,753	201,925,834	215,449,045	468,671,578	465,321,272	461,857,055	458,275,055	454,571,267

Source: Created by the Investigation Team

The business plan assumes that sales will be constant from year 1. The intention is that, most of the time, the project will be monitored remotely, along with daily physical inspections, and, when necessary, disposable parts and spare parts will be replaced during regular inspections or when dealing with faults. This is because, in basically the same way as for solar power, deterioration that occurs with the passage of time seems to be negligible.

If the area is designated as a NIPAS area, the impact on the schedule should not be particularly problematic. If the area is designated as a NIPAS area, there will need to be discussions with the indigenous inhabitants and agreement reached on issues such as land use and compensation. As it will be necessary to check with the local government and the National Commission on Indigenous Peoples (NCIP) on whether the area has been designated under NIPAS, these checks will be carried out as soon as the company has explained the project to the local government. Even if it was designated as a NIPAS area, it would be possible to go ahead promptly with discussions, and reach agreement, with indigenous inhabitants as soon as the decision is made to go ahead with the project, even before the EIS is submitted. This is therefore unlikely to be a constraint on the schedule.

4) Outline of findings from financial analysis

The table below shows the project IRR, equity IRR, NPV, average DSCR, minimum DSCR and payback time for the project.

Table 5-2-3 Findings from financial analysis

Item	Units	Figure
Project IRR	%	9.73%
Equity IRR	%	9.98%
NPV	Peso	883,853,832
Average DSCR	-	1.51
Minimum DSCR	-	1.34
Payback time	Year	15 years

The findings of our financial analysis of the project suggest that it is suitable for investment, as the project IRR is above the Philippines' long-term interest rate, the NPV is positive, and the minimum DSCR is more than 1.3. However, the payback time of fifteen years is comparatively long and, if the assumptions indicated above were subject to any deterioration, the feasibility of the project would need to be reexamined.

5) Outline of findings from economic analysis

In order to assess the economic benefits of the project in terms of its effectiveness in allocating resources in the national economy, an EIRR is calculated, as shown below. In an EIRR, the return is calculated assuming that costs are anything that reduces national income (i.e. economic costs) and benefits are anything that increases national income (i.e. economic benefits).

To calculate economic costs, firstly we calculate the standard conversion factor (SCF), which is the factor used to convert prices of non-tradable items to international prices. The SCF for this analysis was calculated without taking export duty into account, as data on this is not published by either the Philippine government or the World Bank.

$$SCF = (I+E) / [(I+Id) + (E+Ed)]$$

I : Total value of imports (CIF)

E : Total value of exports (FOB)

Id : Total import duties

Ed : Total export duties

Table 5-2-4　Calculation of SCF

Item　＊Units: billion pesos	2010	2011	2012	2013	2014	5-year average
Total exports	2,577	2,416	2,604	2,696	3,097	2,678
Total imports	2,747	3,025	3,106	3,092	3,226	3,039
Total import duties	259	265	290	305	369	298
Total export duties	–	–	–	–	–	–
SCF	0.95	0.95	0.95	0.95	0.94	0.95

Source: JETRO and World Bank, World Development Indicators

Total economic cost is calculated using local currency costs for construction and transmission works and foreign currency costs for turbines etc. Interest and taxes are excluded from economic costs, on the grounds that, from the point of view of society as a whole, they do not involve the consumption of resources.

Table 5-2-5　Calculation of economic costs

<Calculation of economic cost>

No.	Cost item	Foreign currency costs	Economic cost (1)	Local currency costs	SCF	Economic cost (2)	Total (1)＋(2)
1	Construction & transmission costs	-	-	1,252	0.95	1,189	1,189
2	Cost of turbines and transportation	3,305	3,305				3,305
3	Other (financing costs, etc.)	43	43				43
4:1+2+3	Total economic cost	3,348	3,348	1,252		1,189	4,537

The calculation of economic benefits assumes that the value of alternative costs saved by the project is also a fundamental benefit. In and around the area of the project, electricity is mostly generated by diesel engines. Therefore, as this project is subject to an FIT, the difference between this and the unit price of electricity over twenty years is taken to be the alternative cost saved in order to calculate the economic benefits. The unit price for diesel generation is taken to be P12/kWh. The cash flows in the table below allow for economic costs and economic benefits. The effect of inflation is not included, as these are costs that do not entail resource consumption.

Table 5-2-6 Cash flows for economic analysis

Units: million pesos

Period	Economic cost	Maintenance costs	Total costs	Alternative generation costs	Wind generation costs	Economic benefit	Net benefit
1	1,361		1,361				-1,361
2	3,176		3,176				-3,176
3		59	59	1,314	810	504	445
4		59	59	1,314	810	504	445
5		59	59	1,314	810	504	445
6		59	59	1,314	810	504	445
7		59	59	1,314	810	504	445
8		59	59	1,314	810	504	445
9		59	59	1,314	810	504	445
10		59	59	1,314	810	504	445
11		59	59	1,314	810	504	445
12		59	59	1,314	810	504	445
13		59	59	1,314	810	504	445
14		59	59	1,314	810	504	445
15		59	59	1,314	810	504	445
16		59	59	1,314	810	504	445
17		59	59	1,314	810	504	445
18		59	59	1,314	810	504	445
19		59	59	1,314	810	504	445
20		59	59	1,314	810	504	445
	4,537	1,058	5,595	23,652	14,585	9,067	3,472
							EIRR 6.55%

Source: Created by the Investigation Team

To summarize the findings of this assessment, the net economic benefit of the project over its twenty-year lifetime is around P3,472m. With an EIRR of 6.55%, it is socially beneficial to go ahead with the project, as this exceeds the Philippines' benchmark interest rate of 3%.

(3) Cash flow analysis

As stated above, the project was found to be feasible, based on stable revenues from the sale of electricity, assuming standard reference values. However, the project does entail a risk of rising construction costs as a result of, for example, inflation in raw material prices. The feed-in tariff for wind power producers in the Philippines was adjusted in 2015, and the unit price of electricity could cut again. Fluctuations in the volume of energy generated due to changes in wind speed are another factor affecting cash flows. Finally, the project also aims to secure a JCM subsidy, using bilateral credit provided by the Japanese government.

A sensitivity analysis was therefore carried out, based on these forecasts, examining four factors: changes in construction costs, changes in the feed-in-tariff, changes in the volume of energy generated, and whether or not a JCM subsidy is obtained. The makeup of funding was kept unchanged, with 75% from senior debt, irrespective of changes in the total cost of the project.

1) Sensitivity to changes in total cost

Construction costs can rise in the Philippines, for reasons including delays in construction work, changing exchange rates and inflation. This analysis looked at the project IRR and equity IRR in the event of a 10% decline, a 10% rise and a 20% rise in EPC costs (construction costs).

Table 5-3-1 Sensitivity to changes in construction costs

		Project IRR	Equity IRR
Construction costs	10% lower	11.11%	12.80%
	Base scenario	9.73%	9.98%
	10% higher	8.56%	7.79%
	20% higher	7.54%	6.07%

If construction costs rise by 20%, the equity IRR is around 6%, which is not attractive as an expected return for investors, given the exchange rate risk if the currency is the Philippine peso, as well as the country risk and project risk.

2) Sensitivity to changes in FIT

In the Philippines, wind power generators can sell electricity in a feed-in tariff framework - if the generator makes an application to the government and this is accepted, the government will guarantee the price. However, the feed-in-tariff was cut in 2015 from P8.53/kWh to P7.4/kWh, and further cuts are a possibility, depending on how much wind power generating capacity is installed. Nevertheless, in Mindanao, where there will be a shortage of electricity in future (starting in 2026), generators' prices are higher than in other islands in the Philippines, and it is possible that the local distribution cooperatives will buy electricity at prices above the FIT.

Table 5-3-2 Sensitivity to changes in FIT

		Project IRR	Equity IRR
Feed-in tariff	10% higher	11.26%	13.04%
	Base scenario	9.73%	9.98%
	10% lower	8.15%	7.10%
	20% lower	6.48%	4.49%

If the FIT is cut by 20%, the equity IRR is below 5%, which is very unattractive as an expected return for investors.

3) Sensitivity to changes in volume of electricity generated

Wind power generators are sometimes faced with wind conditions and wind speeds different to those initially forecast, and it is possible that the volume of power generated could fall, without achieving the forecast plant capacity factor. The base scenario is currently a plant capacity factor of 25%, and we analyzed sensitivity to a 10% rise, a 10% fall and a 20% fall in the plant capacity factor.

Table 5-3-3 Sensitivity to changes in plant capacity factor

		Project IRR	Equity IRR
Plant capacity factor	10% higher	11.26%	13.04%
	Base scenario	9.73%	9.98%
	10% lower	8.15%	7.10%
	20% lower	6.48%	4.49%

As with the feed-in tariff, a lower plant capacity factor was found to have a major impact on the project IRR and equity IRR.

4) Sensitivity to JCM subsidy

In January 2017, Japan and the Philippines officially approved the Joint Crediting Mechanism (JCM), a system for bilateral credit. As this project is eligible for the JCM, we intend to begin investigating this, in the hope that it will be selected. The returns shown below assume that the amount of JCM subsidy obtained is the maximum per project of ¥1bn.

Table 5-3-4 Sensitivity to JCM subsidy

		Project IRR	Equity IRR
JCM subsidy	With JCM subsidy	9.73%	13.59%
	Base scenario (no subsidy)	9.73%	9.98%

Securing a JCM subsidy would allow the sponsors to pursue the project with a smaller investment, as it would enable them to reduce their equity investment from 25% of the total cost of the project to 17.4%.

(4) Plans for funding

The feasibility of funding the project, whether from debt or equity, depends very much on its ability to produce cash flows/ In this respect, we conclude that the project is entirely feasible, given the financial and economic assessments, as verified in earlier sections of this report. The following section looks at the feasibility of funding the project from the perspective of debt.

1) Requirements for senior debt

To procure a senior loan, the conditions of the loan will need to be discussed, and the main items to be agreed are indicated below.

Table 5-4-1 Requirements for senior debt

Amount of the loan	● The amount of debt for this project is estimated to be 75% of the total cost of the project, and to raise that amount it will be necessary to agree not only the amount of the loan, but also the funding scheme and the terms thereof, such as whether it will be a syndicated loan or whether it will be a two-step loan from a local financial institution.
Repayment terms	● The construction of the project is estimated to take two years. The repayment of principal will therefore need to be deferred during construction and begin only after commercial operation commences. ● The repayment period is assumed to be 15 years, which is less than the lifetime of the project, plus a two year deferment for the principal. It will be necessary to find out whether such a long repayment period is possible. ● Repayment is by the straight-line method, set at a level at which the minimum DSCR (debt service coverage ratio) is always at least 1.3. It will be necessary to find out what the standard minimum DSCR is.
Interest	● The project assumes a fixed interest rate of 6% per annum, but it will be necessary to establish not only the level of interest rate, but also the interest rate structure, whether in fact it will be a variable interest rate to be revised annually based on the benchmark rate.
Up-front fees and due diligence costs	● It is assumed that there are no up-front fees for the project, but, as some financial institutions require a certain percentage of the loan value as an up-front fee, the level of any such fee would need to be established. ● The costs of the due diligence on legal, accounting and technological issues carried out by financial institutions in order to assess loans will need to be established. For this project they are assumed to be ¥100m.
Covenants	● The project is intended to be funded by project finance, based on the income stream from the project, in which case covenants will be imposed by the financial institutions after the loan has been granted, including "affirmative covenants" requiring the operator to perform certain obligations, and "negative covenants" requiring the operator to refrain from certain activities, in accordance with the loan agreement. ● Standard affirmative covenants include maintaining any necessary permits, approvals and licences, providing audited financial

	statements, maintaining DSCR and other financial covenants, and reporting in the event that the power station shuts down. These will need to be established. ● Standard negative covenants include restrictions on the transfer of assets, taking out new loans, and investing in anything other than the agreed business. These will also need to be established.
Collateral	● As the project is assumed to be funded by project finance, the senior lender(s) will acquire a first lien on all of the assets, including land and equipment, necessary to operate the project, but it will need to be established whether they will seek any other sponsor support. In particular, it will need to be established whether there are any guarantees from the sponsor during construction, and what they are.

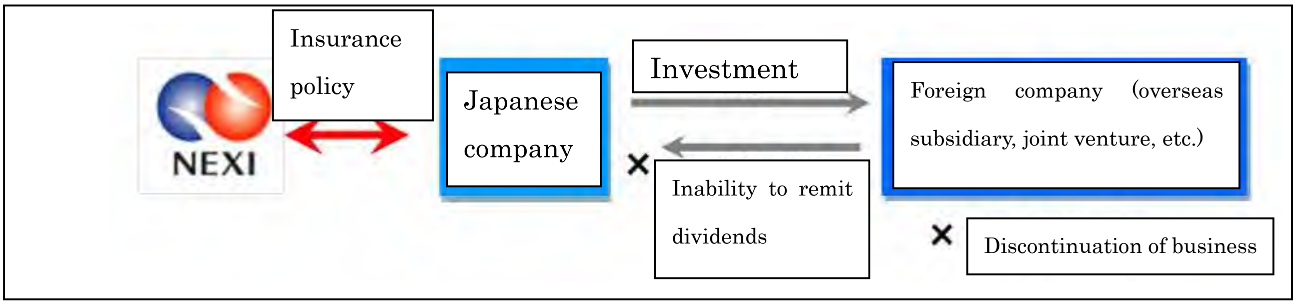
Source: Created by the Investigation Team

2) Possibility of using Nippon Export and Investment Insurance

We will establish which of the kinds of insurance provided by Nippon Export and Investment Insurance (NEXI) is likely to be used for this project.

The first is overseas investment insurance, which covers investments made overseas (by providing capital or buying shares, etc.) by Japanese companies. This covers country risks and political risks, such as expropriation, rights infringements, war, terrorism, revolution, or restrictions on foreign currency exchange, which are not covered by ordinary project insurance.

Figure 5-4-1: How overseas investment insurance works

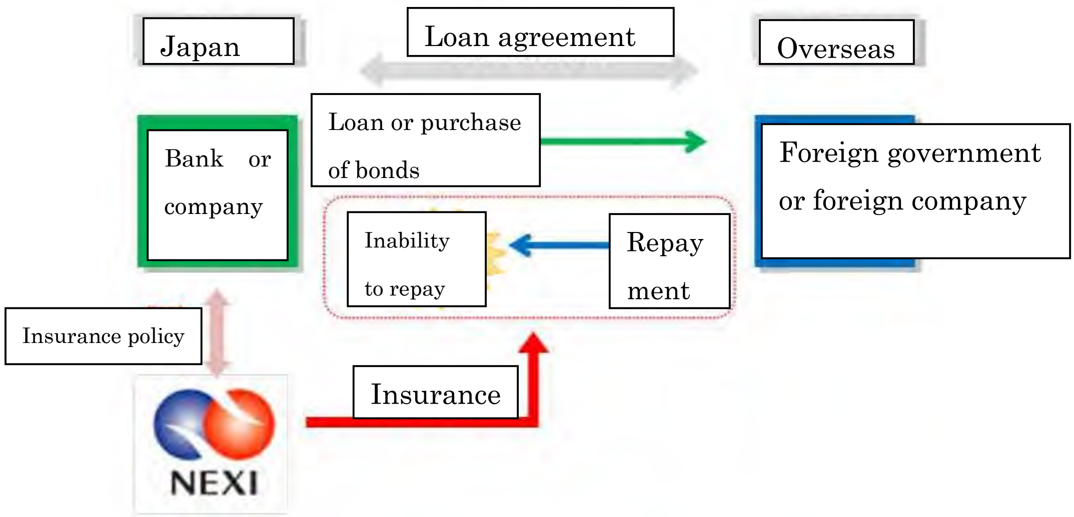


Source: NEXI website

Coverage is usually up to a maximum of 95% of the amount invested (or remitted) by the Japanese company. This insurance can be taken out before or after the investment is made, and it would be preferable to investigate overseas investment insurance in parallel with the establishment of the company.

The second type is overseas investment and loan insurance, which covers lending by Japanese companies or banks for infrastructure projects (including renewable energy) overseas. Specifically, this provides coverage for losses incurred when the lender is unable to redeem loans or bonds due to (1) force majeure such as war, revolution, prohibition of foreign currency exchange, suspension of remittance, or natural disaster, as in the case of overseas investment insurance, but also losses due to (2) the bankruptcy or default of a borrower.

Figure 5-4-2: How overseas investment and loan insurance works

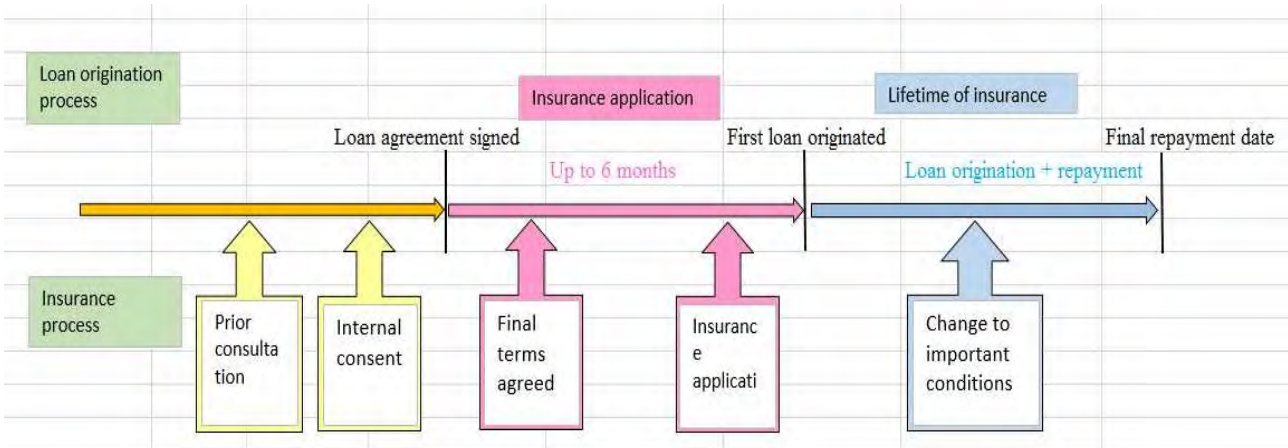


Source: NEXI website

Coverage varies according to the risks insured, but for credit risk of the sort described in (2) above, the standard coverage is 90-95%. For extraordinary risks of the sort described in (1), coverage can be 100%.

The process for taking out export and investment insurance involves firstly a prior consultation, explaining the project in outline, and then negotiating the extent of coverage, the premium and other terms. To consider insuring the project, NEXI will need to carry out due diligence, which will include not only technical and economic issues, but also an environmental assessment, the terms of which will need to be established.

Figure 5-4-3: Process for taking out export & investment insurance



Source: NEXI website

3) Hearing with JBIC

We conducted hearings with JBIC on financing possibility for the first phase of this project which will be approximately 10.6 billion yen for 50 MW, subject to the precondition that construction will be started within one and a half years. We have confirmed that there are possibilities to utilize JBIC's financing credit of environmental conservation activities, i.e. GREEN(* 1), as well as export financing and investment financing credits. However, from the viewpoint of business scale, application of investment financing is not realistic. In addition to these, we gained an understanding of their support program for small and medium-sized enterprises (SME) in Mindanao Island of the Philippines (hereinafter referred to as "EDP (Phase 2) " * 2), and loans specialized in the energy field in the program. On the basis of these results, three of (a) GREEN from 2016 (* 3), (b) EDP (Phase 2), and (c) new loan framework (* 4) are considered workable.

Furthermore, it was found that the combination of JCM equipment subsidiary and financing needs to be arranged in accordance with the purpose of each program.

Along with continuing to gather detailed information, it is necessary to update the funding plan once we have more reliable study results regarding the project scale, the construction schedule, the funding procurement schedule, the power sale contract strategy, and the timing of JCM equipment subsidiary, etc.

※1: GREEN (Global action for Reconciling Economic growth and Environmental preservation) is a project implemented by JBIC since April 1, 2010, to promote global environmental conservation through loans, guarantees and investment while seeking to mobilize private funds using advanced environmental technologies in developing countries.

※2: EDP (Environmental Development Program) is a two-step loan through Development Bank of Philippine (DBP).

※3: In the Philippines, application of GREEN started in August 2016, and it is a two-step loan with an approved loan amount of 25 million US dollar through BDO Unibank Inc. Two step loan is a loan method in which loans are financed collectively to a local bank and the local bank extends loans to the selected projects.

※4: JBIC is considering to make a new two-step loan that will be more specialized in the energy field than EDP, while they are extending new loans to EDP (for projects not limited to energy business) as well.

Chapter 6: Environmental and Social Considerations

(1) Analysis of Current Environmental and Social Factors

1) Analysis of the Current Situation

a) Overview of the project area

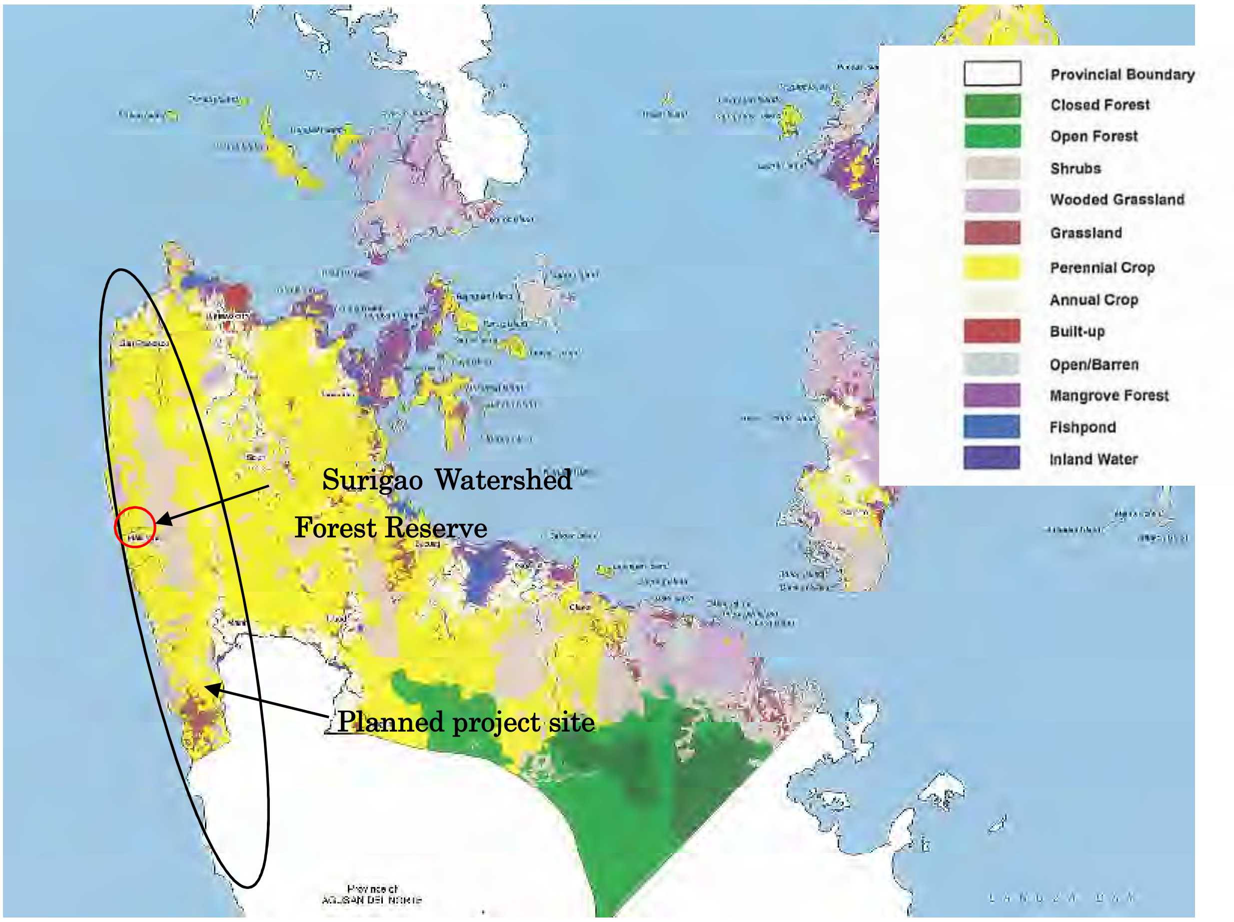
The area under consideration for the installation of wind power generating facilities as part of this project is a roughly 50 kilometer-long stretch of the ridge line running north to south on the western edge of the northeast of the island of Mindanao, in the provinces of Agusan del Norte and Surigao del Norte.

The planned project site is shown below (Fig. 6-1-1). The project site and the area around it primarily feature perennials and other shrubs and bushes, in the middle of which lies the Surigao Watershed Forest Reserve. The land use of the Surigao Watershed Forest Reserve is as outlined below (Table 6-1-1; Fig. 6-1-2). Over 50% of the reserve's total area of 967 hectares is covered in native forests. As shown in Figure 6-1-1, the area surrounding the planned project site tends to demonstrate the same general distribution of plant life as in the reserve, suggesting that the project site will also be dominated by native forests.

Further, as shown in Figure 6-1-3, Lake Mainit lies to the south of the planned project site. As well as acting as a known habitat for migratory birds, the fishing industry on the lake is also active.

It should also be noted that details regarding land ownership of the planned project site will be confirmed with local administrative authorities in the near future.

Fig. 6-1-1: Planned Project Site and Surrounds



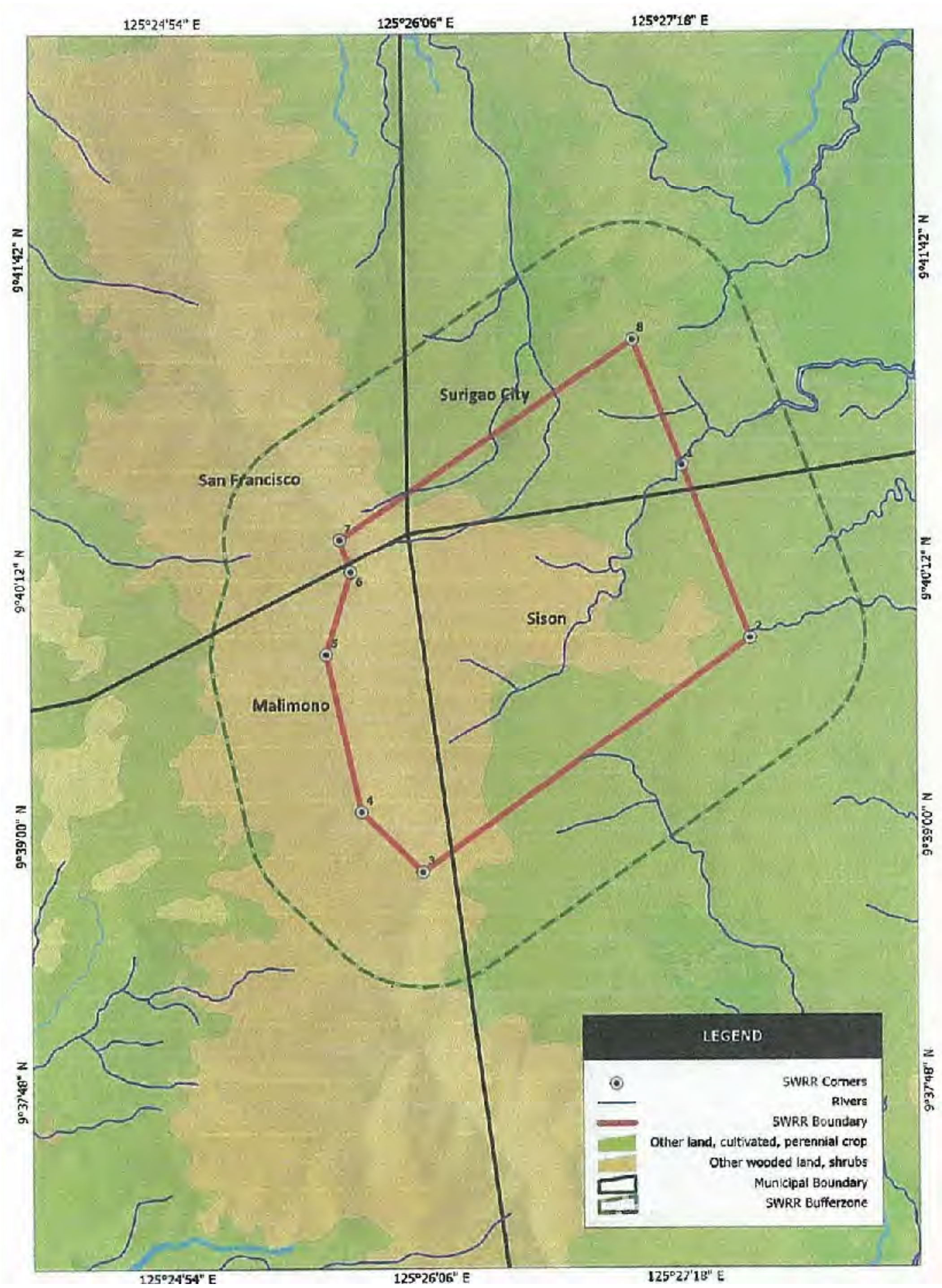
Source: Created by the study team based on materials provided by PENRO

Table 6-1-1: Land Use in the Surigao Watershed Forest Reserve

Category	Land use	Area (ha.)
Forest	Native forest	526.45
	Plantations	268.44
	Farmland	2.75
	Shrubs and grassland	169.36
Total		967.00

Source: Created by the study team

Fig. 6-1-2: Surigao Watershed Forest Reserve Overview



Source: Provided by CENRO

Fig. 6-1-3: Location of Planned Project Site and Lake Mainit

Source: Provided by CENRO

Photographs 6-1-1: Planned Project Site (top: north side; bottom: south side)

Source: Photographs taken by the study team

b) Status of the natural environment

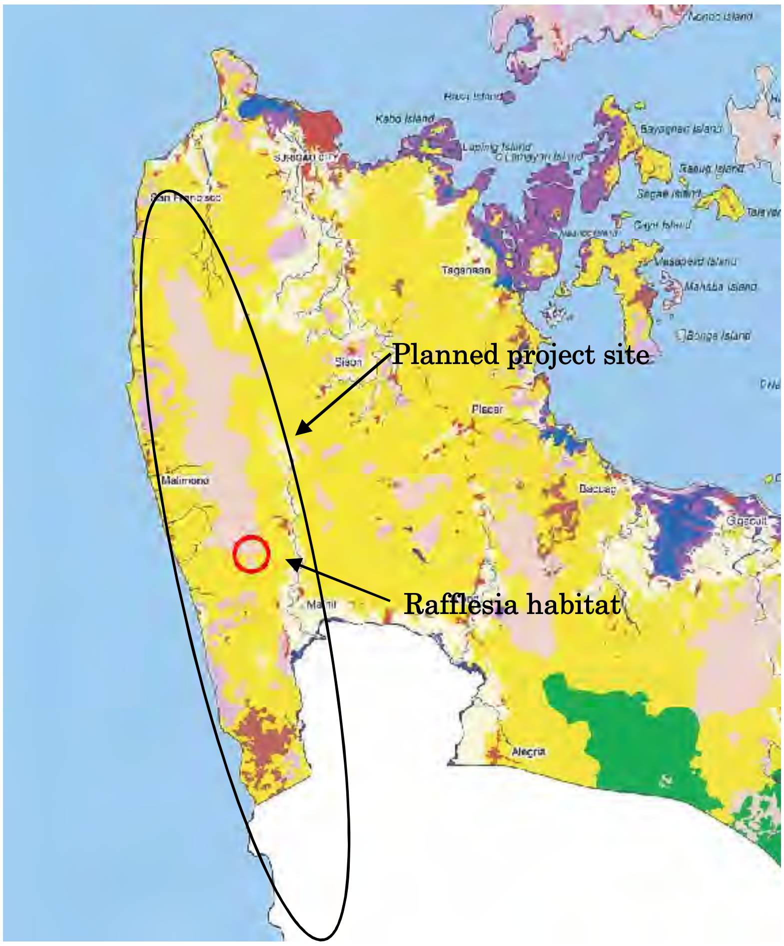
As stated above, the area around the planned project site is dominated by perennials and other shrubs and bushes, with large areas of native forest.

According to statements made during interviews with PENRO and CENRO, no comprehensive survey of the animal and plant life in the project area has yet been undertaken, but a simple survey of animal and plant life in the Surigao Watershed Forest Reserve, located in the center of the planned project site, has been carried out. The results of the survey revealed that the reserve is home to 260 different plant species, 29 bird species, 13 amphibian species, 11 reptile species, eight species of bat, and four species of terrestrial mammal. The most representative plants of the area include trees used for timber, including lauan, mahogany, acacia mangium, manggachapui (*Hopea acuminata*), mayapis, and kamagong (*Diospyros blancoi*). Animals identified living in the reserve include wild chickens and pigs, Philippine long-tailed macaques, woodpeckers, Philippine flying lemurs, and fruit bats. As the environment of the surrounding area (throughout the planned project site) is very similar, there is a high probability that the entire area of the planned project site will feature very similar wildlife to that identified within the Surigao Watershed Forest Reserve.

Lake Mainit, located to the south of the planned project site, is a habitat for migratory birds. The flight paths of these birds are unknown at the present time, but should future research reveal that their flight paths cut across the planned project area, then it will be necessary to investigate the possibility of putting in place environmental conservation measures, such as alterations in the specific installation locations of wind turbines. At least 41 different species of fish, including tank goby, tilapia, carp, and flathead mullet, have been identified in Lake Mainit, while the lake basin is home to animals such as fruit bats, kingfishers, and horny toads, and plants including manggachapui, agathis, and even Rafflesia, known as the world's largest flower and designated as an endangered species on the IUCN Red List (see Fig. 6-1-4). According to CENRO, the habitat of Rafflesia has not yet received any special designation, but the DENR is currently in the process of applying to have it declared a protected reserve.

After carrying out interviews with staff from the DENR, we were able to obtain a list of the migratory birds inhabiting the Lake Mainit area and a list of the animals living in the surrounding area which appear on the IUCN Red List. These lists are included below (Table 6-1-2; Table 6-1-3). While the Philippine hawk eagle appears on these lists, it has been ascertained through interviews with both PENRO and CENRO that the area around the planned project site is not a breeding ground for any birds of prey (including the Philippine hawk eagle). Furthermore, according to *The State of Philippine Birds*, the area around the planned project site is not an area of particular significance for any bird species (see Fig. 6-1-5).

Fig. 6-1-4: Rafflesia Habitats



Source: Barcelona, J., Manting, M., Arbolonio, R., Caballero, R., Pelser, P. “Phytotaxa” 174(5), 2014, 272-277.

Table 6-1-2: Migratory Birds Inhabiting the Lake Mainit Area

KITCHARAO, SURIGAO DEL NORTE (NORTHERN PART)	MAINIT, AGUSAN DEL NORTE (SOUTHERN PART)	
• Cattle Egret	• Asian Golden Plover	• Little-ringed Plover
• Intermediate Egret	• Australian Stilt	• Marsh Sandpiper
• Javan Pond Heron	• Barn Swallow	• Purple Heron
• Little Egret	• Barred rail	• Philippine Bulbul
• Moorhen	• Black-crowned Night Herc	• Pied Triller
• Tufted Duck	• Black Bittern	• Pied Fantail
• Tern	• Brahminy Kite	• Snipe
• Yellow Bittern	• Cinnamon Bittern	• Tufted Duck
• Brahminy Kite	• Common Bittern	• Tern
• Common Kingfisher	• Common Sandpiper	• Terek Sandpiper
• Swiftlets	• Crested Serpent Eagle	• Unidentified Godwit
	• Common Moorhen	• White-collared Kingfisher
	• Chestnut Monia	• Wood Sandpiper
	• Eurasian Curlew	• Whiskered Tern
	• Eurasian tree sparrow	• White-throated Kingfisher
	• Great Egret	• Wandering Whistling Duck
	• Great Bittern	• Yellow Bittern
	• Great Sand Plover	• Yellow-vented Bulbul
	• Greenshank	• Zebra Dove
	• Indigo-banded Kingfisher	• Philippine Duck
	• Intermediate Egret	• Rofous Night Heron
	• Javan Pond Heron	• Redshank
	• Kingfisher	• Short-billed brown dove
	• Kentish Plover	• Little Egret
	• Swiftlets	

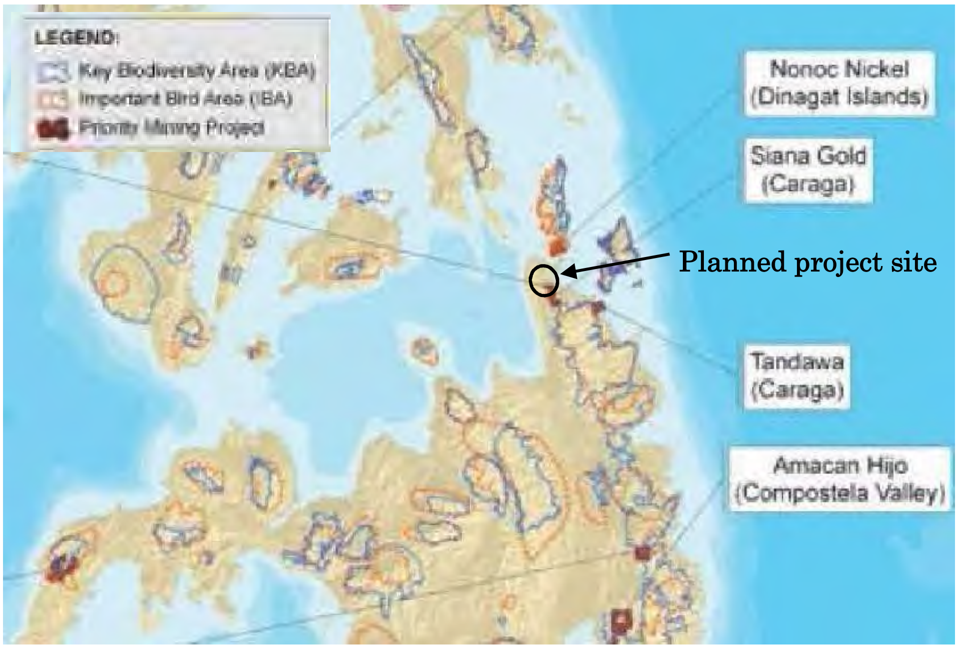
Source: Provided by the DENR

Table 6-1-3: Animal Species on the IUCN Red List Inhabiting the Lake Mainit Area

Binomial Name	English Name	Lacality	IUCN Status
Birds			
Nisaetus philippensis	Philippine Hawk Eagle	Alegria ; Mainit, SDN	En
Penelopides Panini	Visayan Tarictic Hornbill	Jabonga, ADN	En
Alcedo argentata	Silvery Kingfisher	All 4 sites of SDN	Vu
Buceros hydrocorax	Rofous Hornbill	Alegria ; Tubod, SDN	Vu
Gallicolumba criniger	Mindanao Bleeding Heart	Jabonga,ADN	Vu
Eurylaimus steerii	Mindanao Broadbill	Alegria ; Tubod, SDN	Vu
Ficedula basilanica	Little Slaty Flycatcher	Alegria;Mainit,SDN	Vu
Pitta steerii	Azure−breasted Pitta	Alegria;Mainit;Tubod,SDN	Vu
Mearnsia picina	Philippine Needletail	Alegria;Mainit,SDN	NT
Rhabdotorrhinos leucocephalus	Mindanao Wrinkled Hornbill	Alegria,SDN	NT
Dicaeum anthonyi	Flame−crowned Flowerpecker	Alegria;Mainit,SDN	NT
Flying Mammals			
Megaerops wetmorei	White−collared Fruit Bat	All 4 sites of SDN	Vu
Eonycteris robusta	Philippine Dawn Bat	Alegria;Tubod,SDN;Santiago ADN	NT
Amphibians			
Megophrys stejnegeri	Mindanao Horned Frog	Alegria;Mainit;Sison,SDN; Santiago;Jabonga,ADN	Vu
Limnonectes magnus	Giant Philippine Frog	All 4sites of SDN	NT
Reptile			
Hydrosaurus postulatus	Philippine Sailfin Lizard	Mainit,SDN;Jabonga,ADN	Vu

Source: Provided by the DENR

Fig. 6-1-5: Important Bird Areas in the Philippines



Source: The State of Philippine Birds（Haribon Foundation and BirdLife International, 2014）

Photograph 6-1-2: Forest at the Planned Project Site

Source: Photograph taken by the study team

Photograph 6-1-3: Lake Mainit Viewed from the Planned Project Site

Source: Photograph taken by the study team

c) Status of the social environment

Small pockets of farmland are scattered about within the planned project site, while the planned transportation route for the project equipment from the Port of Lipata also features residential housing and farmland along its route. Moving forward, it will be necessary to confirm details of land ownership with the relevant local administrative authorities.

2) Predictions for the Future (in the Case of Non-Implementation of the Project)

Should this project not be implemented, the following predictions for the future of the area can be made.

- While the area's timber, farming and fisheries industries are thriving, economic development has been delayed by a lack of basic infrastructure such as electrical power. Should this state of affairs continue, severe shortages in employment opportunities will lead to an acceleration of the loss of human resources to other regions.
- The region has no permanently operational power generating facilities, and electricity is currently provided via Iligan City, 300 kilometers away. Increased costs and energy loss as a result of long-distance power transmission have led to an instability of supply, which will continue if nothing is done to remedy the situation.
- If thermal power plants using fossil fuels are constructed and operated as an alternative to this project, impacts on the surrounding environment and greenhouse gas emissions will increase.

(2) Environmentally Beneficial Effects of the Project's Implementation

As wind power generation is a potentially carbon-neutral system, it has the ability to contribute to global warming mitigation efforts. As such, a study of the project was carried out to analyze its environmentally beneficial effects from the perspective of a reduction of carbon dioxide (CO_2) emissions.

No carbon dioxide emissions will be created by the implementation of this project. Therefore, the carbon dioxide reductions achieved by this project would be equivalent to the carbon dioxide emissions produced by a power plant using fossil fuels to produce the same amount of energy in the instance that this project was not implemented.

It should be noted that the use of automobiles to perform maintenance on the power generating facilities is expected to produce some level of CO_2 emissions. However, at this early, project-formation stage of the project, data concerning the type and number of vehicles required for maintenance and the distances these vehicles will be required to travel has not yet been obtained. For this reason, they have not been factored in to these calculations. Further, the amount of electricity consumed in the running of the wind power generators should also be considered. However, at this early, project-formation stage of the project, details are unclear, so this has also not been factored in to the calculations.

Once data concerning the type, number and distance traveled by maintenance vehicles comes to light as the project proceeds, it would be preferable to recalculate the environmentally beneficial effects of the project's implementation.

The anticipated scale of the project is as shown in Table 6-2-1 below.

Table 6-2-1: Project Scale

Component	Scale	
Wind power generation project	Yearly generated electricity	328,500 MWh

Note: Calculated with a total rated capacity of 2 MW × 75 units ＝ 150 MW; and a yearly utilization factor of 25%.

1) CO_2 Emissions Produced by the Project

As all energy required to run the wind farm can be produced on-site, the yearly CO_2 emissions generated by this project will be 0 t-CO_2/year.

2) Baseline CO_2 Reductions Achieved by the Project

a) Emissions reduced by replacing diesel generation

This project is planned to produce a total yearly energy output of 328,500 MWh. Below are the calculations of the amount of CO2 that would be emitted by a diesel-powered plant achieving the same production.

Yearly CO_2 emissions ＝ Volume of fuel used* x 38.2 GJ/metric ton (calorific value per fuel unit) x 0.0187 ton-C/GJ (carbon released per unit of calorific value) x 44 (molecular weight of CO_2) ÷ 12 (atomic weight of carbon)

[Reference: Order for Enforcement of the Act on Promotion of Global Warming Countermeasures, Article 6 Clause 1 Item 1, Ministry Ordinance for the Calculation of Greenhouse Gas Emissions, Article 2, Appendices

1 and 2]

*Fuel used was calculated with crude petroleum as the fuel, following the below premises:

Yearly petroleum used (metric tons) = Yearly electricity production (MWh) x calorific value conversion factor (9.0 GJ/MWh) x inverse of petroleum calorific value (0.02193 metric tons/GJ) ÷ diesel generation efficiency (35%)
= 328,500 MWh x 0.19737 metric ton/MWh ÷ 35%
= 185,246 metric tons

Yearly CO_2 emissions = 185,246 metric tons x 38.2 GJ/t x 0.0187 ton-C/GJ x 44 ÷ 12
= 485,205 ton-CO_2

3) Greenhouse Gas Reductions

Expected reductions in greenhouse gas emissions are indicated in Table 6-2-2 below. The expected reduction in greenhouse gas emissions as a result of the implementation of this project is 485,205 t-CO_2 per annum.

Table 6-2-2: Greenhouse Gas (CO_2) Emission Reductions

Unit: t-CO_2 per annum

Component	CO_2 emissions from the project (A)		Project's baseline CO_2 emissions (B)		CO_2 reductions (B-A)
Wind power generation project	Wind power generation	0	Fossil fuels generation	485,205	485,205

Source: Created by the study team

(3) Environmental and Social Impacts of the Project's Implementation

1) Impacted Environmental Categories

This study has been carried out at an extremely early stage of the project's development. The major objective of the "environmental and social considerations" section of the project formulation study is to identify in a broad sense what environmental and social categories will require further examination in the future for the development of the project.

With respect to the project that is the subject of this study, on-site surveys, interviews with relevant organizations and data gathering have been undertaken, and environmental and social issues requiring further attention have been identified, with special consideration given to the content and scale of the planned project.

As this project is a wind power generation venture, we have followed the JICA checklist for "other electric generation" projects, and identified the major effects the project could have on the natural and social environment. Results are laid out in Table 6-3-1 below.

Table 6-3-1: JICA Environmental Checklist (5. Other Electric Generation)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1. Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N (c) N (d) N	(a), (b), (c), (d) EIA reports for the project are yet to be prepared.
	(2) Explanation to Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the local stakeholders? (b) Have the comments from the stakeholders (such as local residents) been reflected in the project design?	(a) N (b) N	(a), (b) EIA reports for the project are yet to be prepared, and explanations to stakeholders have yet to be carried out.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) N	(a) As the planned project site has been selected after a detailed examination of wind patterns, no alternative locations have been considered. Plans to prevent pollution and other problems will be managed as the project moves forward to implementation.
2 Pollution Control	(1) Air Quality	(a) In the case that electric power is generated by combustion, such as biomass energy projects, do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted by power plant operations comply with the country's emission standards and ambient air quality standards? Are any mitigating measures taken? (b) Do air pollutants emitted from other facilities comply with the country's emission standards?	(a) Y (b) Y	(a) No combustion will take place. (b) No air pollutants will be emitted.
	(2) Water Quality	(a) Do effluents (including thermal effluent) from various facilities, such as power generation facilities, comply with the country's effluent standards? Is there a possibility that the effluents from the project will cause areas that do not comply with the country's ambient water quality standards? (b) Do leachates from the waste	(a) Y (b) Y	(a) No effluents will be produced from the generating facilities. (b) No leachates will be produced from waste disposal sites.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		disposal sites comply with the country's effluent standards and ambient water quality standards? Are adequate measures taken to prevent contamination of soil, groundwater, and seawater by leachates?		
	(3) Wastes	(a) Are wastes generated by the plant operations properly treated and disposed of in accordance with the country's regulations (especially biomass energy projects)?	(a) Y	(a) No waste will be generated by plant operations.
	(4) Soil Contamination	(a) Has the soil in the project site been contaminated in the past? Are adequate measures taken to prevent soil contamination?	(a) N	(a) The planned project site is primarily forestland featuring shrubs and perennials. As no factories or other industrial facilities have ever been erected there in the past, it is believed that the soil has never been contaminated. As this project will not produce any contaminants, soil contamination will not be an issue.
	(5) Noise and Vibration	(a) Do noise and vibrations comply with the country's standards? (b) In case of Wind Power Stations, does low frequency noise comply with the environmental standard?	(a) Y (b) Y	(a), (b) As the wind turbines used will produce a minimum of noise and vibration, they will comply with the country's standards. Details of methods for the reduction of noise and vibration will be provided as part of the EIS when carrying out the EIA.
	(6) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) Large volumes of groundwater will not be extracted as part of this project.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) Y	(a) The planned project site encompasses the Surigao Watershed Forest Reserve. However, wind power generating equipment will not be placed within the reserve, and any potential effects on the reserve should be avoidable.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that localized micro-meteorological changes due to wind power generation will affect	(a) Y (b) N (c) Y (d) Y (e) Y	(a) The planned project site does encompass both primeval forests and tropical rain forests, in part of which grows the Rafflesia, said to be the world's largest flower (listed as critically endangered on the IUCN Red List). Additionally, Lake Mainit, a habitat for migratory birds, lies near the planned project site. Should it be found that the birds' flight paths run through the project area, this factor will be incorporated into the placement of the turbines. Details will be provided as part of the EIS when carrying out the EIA. (b) The planned project site does not

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		valuable vegetation in the surrounding areas? (Is there valuable vegetation in the vicinity of the wind power generation facilities?) If impacts on vegetation are anticipated, are adequate measures considered? (e) Are the wind power generation facilities (wind turbines) sited by considering the habitats and migration routes of sensitive or potentially affected bird species?		encompass the protected habitats of endangered species designated by law or international treaty. However, the DENR is in the process of applying to make the habitat of the Rafflesia into a protected area. (c) Should any significant ecological impacts be anticipated, measures to reduce impacts on the ecosystem will be detailed in the EIS when carrying out the EIA. (d) Should localized micro-meteorological changes due to wind power generation affect valuable vegetation in the surrounding areas, measures to reduce impacts will be detailed in the EIS when carrying out the EIA. (e) Should the wind power generation facilities (wind turbines) be found to affect the habitats of valuable bird species or the migration routes of migratory birds, methods for the alleviation of these issues will be outlined in the EIS when carrying out the EIA.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to installation of the structures, such as weirs will adversely affect the water flows, waves and tides?	(a) N	(a) No hydrologic changes will be brought about by this project.
4. Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? (c) Is the resettlement plan, including compensation at full replacement cost, restoration of livelihoods and living standards, developed based on socioeconomic studies on resettlement? (d) Will compensation be paid prior to resettlement? (e) Have compensation policies been codified in writing? (f) Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Will agreements with the affected persons be obtained prior to	(a) N (b) N (c) N (d) N (e) N (f) N (g) N (h) N (i) N (j) N/Y	(a), (b), (c), (d), (e), (f), (g), (h), (i), (j) Small pockets of farmland are scattered about in the planned project site, while the planned transportation route for the project equipment from the Port of Lipata also features residential housing and farmland alongside it. It is possible that part of the transportation route will affect local residents or farmland. If relocation is required, appropriate explanations will be provided beforehand covering issues of compensation and assistance for restoration of livelihoods.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Will a plan be developed to monitor the impacts of resettlement? (j) Has a framework been developed to redress any grievances?		
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water (e.g., surface water, groundwater) used and discharge of effluents by the project will adversely affect the existing water uses and water area uses?	(a) N (b) N	(a) The project will not adversely affect the living conditions of inhabitants. The implementation of the project will create employment opportunities in the area. (b) Water usage will be carefully monitored to ensure that it does not affect existing water uses and water area uses.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There are no archeological, historical, cultural, or religious heritage sites in the planned project area.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) As the generating facilities are planned to be erected in an area of the landscape with few man-made structures, it is possible that some may consider them as damaging to the visual landscape. However, almost all views in the area feature the sky as background, and the colors of the wind power generation facilities (white or gray) should blend unobtrusively with the sky and clouds. Furthermore, their slender shape will mean that they are unlikely to adversely affect the landscape to any significant extent.
4. Social Environment	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N	(a), (b) It is unclear at the present moment whether the planned project area is designated as a NIPAS area under the IPRA Law, but in the event that it is designated as such, the project's proponents will need to consult with affected ethnic minorities and indigenous peoples, with the NCIP present as a third party observer, and show due consideration regarding land usage rights and compensation. Furthermore, before the project can be carried out, agreement must be

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				received from the affected peoples so that a certificate of free, prior and informed consent (FPIC) can be issued. Before the project is begun, investigations into this matter will be carried out immediately following the explanations of the business venture to local government bodies, and all appropriate considerations will be made to those affected.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project do not violate the safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a), (b), (c), (d) Investigations will be carried out and proposals will be made concerning labor conditions, accident prevention, and safety education as part of the EIA. The other workplaces managed by the proponent of this project, including dams, roads, and rice processing plants, all have a strong focus on safety education for all workers, including security staff, and it is anticipated that the same will be true of this project.
5. Other	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) Will construction cause traffic congestion, and if so, are adequate measures considered to reduce impacts?	(a) Y (b) Y (c) Y (d) Y	(a) Types and extent of any environmental impacts will be investigated at the time the EIA is carried out. Plans for the alleviation of any impacts will be proposed in the EIS. (b) Should any significant impacts on the ecosystem be a concern, methods for the alleviation of these issues will be outlined in the EIS when carrying out the EIA. (c) It is anticipated that the passing of construction vehicles will create a certain level of noise and vibration. Plans for the alleviation of any impacts will be proposed in the EIS. (d) It is anticipated that the presence of construction vehicles could lead to traffic congestion. Plans for the alleviation of any impacts will be proposed in the EIS.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Monitoring	(a) Will the proponent develop and implement monitoring programs for the environmental items that are considered to have potential impacts? (b) How are the items, methods and frequencies included in the monitoring program judged to be appropriate? (c) Will the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a), (b), (c), (d) The EIA for this project is yet to be carried out. Based on investigation results, categories for monitoring will be identified and detailed monitoring plans will be put in place when the EIA is carried out. While there are no legal regulations pertaining to the reporting of monitoring results, the proponent will be required to publish results and regularly report to the appropriate government agencies.
6. Notes	Reference to Checklists of Other Sectors	(a) Where necessary, pertinent items described in the checklists relating to dams and rivers should also be checked.	(a) N	(a) No new construction relating to dams or rivers is planned for this project.
	Notes on Using Environmental Checklists	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) Not applicable.

Note 1) Regarding the term "country's standards" mentioned in the environmental checklists, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are made, if necessary. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japanese experiences).
Note 2) Environmental checklists provide general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

2) Environmental Impact Assessment

The central role in environmental management in the Republic of the Philippines is held by the Department of Environment and Natural Resources (DENR), a governmental department established in 1987. In particular, the Environmental Management Bureau (EMB), a subordinate department of the DENR, is responsible for the formulation of environmental management policy, the implementation of management laws and regulation frameworks, and the creation of technical guidelines pertaining to environmental issues. Its regional offices throughout the country are responsible for the enforcing of environmental laws. Environmental impact assessments are the domain of the EMB’s Environmental Impact Assessment and Management Division, and each regional office functions as the liaison between the division and relevant project proponents.

The Philippine Environmental Impact Statement System (PEISS) was established in 1997 by Presidential

Decree No. 1586 to serve as the standard for environmental impact assessments in the Philippines. The Environmental Impact Assessment (EIA) system was formally established in 1978, and the key terms of "Environmentally Critical Projects" (ECP) and "Environmentally Critical Areas" (ECA) were officially defined in 1981, dividing applicable projects into broad categories. The EIA system stipulates that environmental impact assessments must be carried out with specific reference to the type, scale and location of the planned project. Proponents are required to submit either an Environmental Impact Statement (EIS) or an Initial Environmental Examination (IEE) report for examination by the DENR. Should the paperwork meet the relevant standards, the DENR will issue an Environmental Compliance Certificate (ECC), thereby approving the project's implementation.

The installation of power generating facilities with a total output of 150 MW is planned in the project. As shown in Table 6-3-2 below, this scale places the project within Category B under the "Revised Guidelines for Coverage Screening and Standardized Requirements" (EMB MC 2004-05), meaning that in order for the project to be implemented, an EIS must be submitted and an ECC issued.

Table 6-3-2: Category Division Guidelines under the PEISS (Renewable Energy)

Project	ECC necessary			ECC unnecessary
	Category A: ECP	Category B: Non-ECP		Category D
	EIS	EIS	IEE Checklist	PD
Renewable energy projects (wave power, solar power, wind power, and tidal power generation, etc.)	None	≧100 MW	Between 5 and 100 MW	≦5 MW

Source: Revised Guidelines for Coverage Screening and Standardized Requirements (EMB MC No.005)

Fundamentally, an EIS is to contain the following basic items:

A) Project description
B) Scoping report
C) Baseline environmental conditions
D) Impact assessment of the project on the environment and public health
E) Environmental risk assessment
F) Environmental management plan
G) Proposals for environmental monitoring and guarantee funds
H) Supporting documents pertaining to process of public participation, social acceptability, and technical and socio-economic data used
I) Accountability statement of the proponent
J) For projects located in ancestral lands or domains, an assessment of potential socio-economic impacts on indigenous peoples
K) For projects with significant impact on women, a consideration of gender issues
L) For projects with significant impact on population, specific attention should be paid to socio-economic impacts

3) Land Acquisition

The National Integrated Protected Areas System (NIPAS) Act was enacted by the government of the Republic of the Philippines in 1992 in order to protect regional natural resources, biodiversity and locations of historic and cultural value. In the following year, the Rules and Regulations Implementing Republic Act No. 8371 were signed and ratified by the Office of the President, National Commission on Indigenous Peoples (NCIP). Further, in July of 1997, the Indigenous Peoples' Rights Act (IPRA) was enacted as Philippines Republic Act No. 8371, allowing for specific areas to be designated as "NIPAS areas" under the concept of "ancestral lands or domains," thereby prohibiting development in said areas. For this reason, the establishment of whether or not the planned project site will fall into a NIPAS area will be of the utmost importance.

At the present time, it is unclear whether the planned project site will be designated as a NIPAS area under the IPRA Law. In the instance that it is designated as such, the proponent of the project will be required to hold consultation meetings with ethnic minorities and indigenous peoples in the affected area regarding land usage permission and compensation, with representatives of the NCIP present as a third party. Before the project can be carried out, a certificate of free, prior and informed consent (FPIC) must also be obtained. It is therefore highly preferable that investigations into this matter are carried out immediately following the explanations of the business venture to local government bodies, and that all appropriate considerations are made to those affected.

No significant effects on the schedule are expected even if the planned project area is designated as a NIPAS area. Should the project site be designated as such, it will become necessary to consult with local indigenous peoples and form an agreement regarding land usage rights and compensation. Decisions regarding the designation of the area as a NIPAS area or otherwise will be carried out by both local government bodies and the National Commission on Indigenous People (NCIP). This issue will be confirmed with both parties immediately following the explanation of the proposed business model to local government authorities. Even in the instance that the project site is designated as a NIPAS area, it will still be possible to carry out consultations with the indigenous peoples and reach an agreement with them after a decision regarding project implementation is made and before an EIS application is made. Therefore, it is not believed that this will be a factor restricting the overall project schedule.

Table 6-3-3: Laws and Regulations Pertaining to Land Use and Indigenous Peoples in the Republic of the Philippines

Category	Year of Enactment	Law	Registered number
Indigenous peoples	1992	National Integrated Protected Areas System Act (NIPAS)	Republic Act No. 7586
	1993	Rules and Regulations for the Identification, Delineation and Recognition of Ancestral Land and Domain Claims	DENR Administrative Order No. 2
	1997	Indigenous Peoples Rights Act	Republic Act No. 8371

Source: Created by the study team

4) Tasks to be Carried Out by the Host Country (Implementing Entities and Other Organizations) for the Realization of the Project

This project remains in the preliminary investigative phase. In terms of the environmental impact of the project, the environmental impact assessment (EIA), needed for the ECC application, which is in turn necessary for the project's implementation, has not yet been carried out. In order to proceed with the project, from an environmental impact standpoint the following will need to be carried out.

- The swift implementation of an EIA and the creation of an EIS for the project in accordance with the PEISS Law of the Republic of the Philippines and all other relevant rules and regulations.
- Approval of the EIS by the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR), and the acquisition of an ECC.

(4) Effects of Project Implementation on Stable Energy Supply in Japan

A JCM agreement between Japan and the Republic of the Philippines was signed in January 2017 which is expected to contribute to Japan reaching its goals for the reduction of greenhouse gas emissions. It is also anticipated that the JCM will allow for the expansion of energy saving schemes and renewable energy generation projects, leading to a reduction in energy consumption based on fossil fuels in the Philippines.

It is estimated that this project (at a 150 MW scale) will produce a yearly energy output of 328,500 MWh (calculated using a yearly utilization factor of approximately 25% of the rated capacity of 2 MW x 75 units = 150 MW). When converted to diesel generation, this would result in a reduction of 185,246 metric tons of diesel (417,276 kℓ at a specific gravity of 0.86 at 15℃) consumed in the vicinity of Japan. This would indirectly allow Japan to procure diesel, one of Japan's primary energy sources, in a simpler and more stable manner.

As this would be the first wind power generation project on the island of Mindanao, it could become an example of a pioneering project which could set the trend for future projects elsewhere on the island, thereby serving to lower the energy consumption of the entire island.

Chapter 7: Project Execution Schedule

(1) Important Points and Phasing Concepts as Pertaining to the Project's Future Execution

1) Prerequisite Review

The area we are considering for the wind power facilities is the west side of Lake Mainit's mountain range, located in Surigao del Norte.

The central point of Surigao del Norte's Lake Mainit's western mountain range is a protected forest area, so this area will need to be excluded from consideration.

The north area of Mindanao Island tends to have stronger winds than the south side, and could thus be a site for many wind power generators.

There is one 69kV transmission line between Surigao City, the Looc substation, and the Placer substation. It will be difficult to connect this line to a large-scale generator, so we will need to connect it to the 138kV NGCP affiliated line. The Placer substation (138kV) is located near Macalaya, about 10.3km northeast of Lake Mainit. Therefore, the final connection point will be the Placer substation's 138kV line. At this point in time, in accordance with the plan to expand the 138kV transmission line between the Butuan substation and the Placer substation, we believe that modifying the connection point of the substation should serve to alleviate any problems caused by the connection, such as power failure, compared to T-branching the 138kV transmission line.

If there is a T branch to the 138kV extension line, the restraint making Placer the connection point may be removed.

Near the above-mentioned Lake Mainit west-side mountain range area, there is an ANECO-controlled 69kV transmission line (336.4 MCM ACSR, 529 A) installed between the Santiago substation and the Butuan substation. In the near future, another 69kV transmission line (336.4 MCM ACSR, 529A) will be added to the Santiago substation, with plans for power to be supplied from Colorado to Alegria at 13.2kV. We believe that this system should be able to handle the maximum foreseen electrical load of 20MW to 30MW. Accordingly, if this area can be connected to the 69kV line, it will then be connected to the Santiago substation, which means that planning in accordance with the new 69kV transmission line expansion should alleviate power failures stemming from connecting the system to the wind power plants.

In regards to the connection to the 138kV system, we plan to install substations (33kV, 69kV, and 33kV or 138kV transformers) at the generator side (which will have a voltage of 33kV) and draw them into the Placer substation with a 138kV transmission line or cable. There are other options available as well, such as bringing up a 33kV transmission line from the generator side to the vicinity of the Prasela substation, raising the voltage at the Placer substation (either nearby or inside) and connecting it to the 138kV line. However, since it would generally make sense to draw 60 33kV power cables or transmission lines to the Placer substation (68 33kV units × 2MW - 8 units = 120MW (60 units) and since there is a distance of about 12 kilometers from the equipment installation review area to the 138kV transmission line area, it would mean that many transmission lines would need to pass through that distance, which in turn means that we would need to persuade the landowners as to that necessity. Given that, and the complexity of actually building the Placer substation, we believe this would be fairly difficult in practice. Therefore, it would be more realistic to establish a new substation in the vicinity of the wind power plant side, boost the voltage from 69kV to 138kV, draw it into the Placer substation with a power cable or a transmission line, or connect it to a 138kV transmission line.

One more review of the above relationships before we move on to phasing:

ⅰ. In the 69kV AECO system, install 5 to 10 units (looking at the surplus) ≈ 8 units, installing 16MW on the south side. At this time, the new 69kV substation will be added to the grid in accordance with the expansion of the 69kV system. However, considering the procedures that would be involved with connecting a 69kV system and a 138kV system, having two voltages would, at the very least, result in a completely different procedure window, and would create complications with connecting to the grid.

ⅱ. For the 138kV system, we will connect it via the Placer substation to the above mentioned 60 units. At this time, we will either divide the number of units by half, or 30 each, and make these Phase 1 and Phase 2, or, divide them by thirds and conduct 3 phases of 20 units each. Whichever plan we go with will depend on wind conditions, how much electricity we want to generate at an early stage, and other cash flow-related factors. Another thing to consider is that, since the early phase is given the best preferential treatment on taxation, we may want to make that our first priority.

ⅲ. For the 138kV system, the final connecting point will either by the Placer substation or a 138kV transmission line. However, in order to determine whether it is more advantageous to transmit power to the Placer substation via the shortest possible 12km distance at a generator voltage of 33kV, or to install substation facilities near the wind power generators during each phase and connect them to the transmission system, we will need to obtain consent from the land owner(s) and to consider the difficulty of building on the Placer substation side. We will also need to wait for answers from the NGCP side in regards to the new substation's scale, securing the needed area, the difficulty of building, the official results of the system impact study, and how much capacity can be granted.

ⅳ. In regards to connecting the 69kV system and/or the 138kV system to the grid, we believe we will have to match the transmission system's pace of expansion, so we will need to confirm the results of the impact study at that time. If the NGCP handles the connection to the grid at their own discretion, thus relieving the supplier(s) of any responsibility, that would be a substantial relief.

2) Basic Phasing Concept

ⅰ. Connecting to a 138kV line is better.

ⅱ. Whether we go with 2 phases or 3 phases depends on wind conditions. We can choose to prioritize generating electricity early, increasing profits and achievements, or we can choose to prioritize the initial phase, since that gets preferential tax treatment, and could be useful with raising funds.

ⅲ. We need to consider the scale of the new substation(s) being installed on the power plant side, and to consider the practicalities of securing the land we need and the difficulty of construction.

ⅳ. Officially, we need to wait for NGCP-side answers in regards to the results of the system impact study, and to determine how much capacity can be granted.

ⅴ.In regards to connecting the 138kV system to the grid, we believe we will have to match the transmission system's pace of expansion, so we will confirm the results of the impact study at that time. For the grid connection, we will need to come to a mutually satisfying agreement with the NGCP side before we can decide on the construction plan/phasing.

（２） Project Execution Schedule

1) Schedule Until Construction Is Completed

The JCM pact was formed on January 12, 2017, and we can expect that the signing and registration of the SPC will be held at the end of March 2017. Assuming that the wind speed measurements begin in April 2017, we will need to continue the measurements for at least 1 to 2 years, giving us May 2018 as a baseline of when we can expect best case-scenario data.

Assuming that sufficient wind power does exist (138MW ≒ 150MW, or 50MW for each of 3 phases), after we decide on a company level to go ahead with this project (about two months after we receive the results), we can confirm specifications with suppliers (maybe three months or so?). As for procuring funds, we expect that we will be finished with specification considerations and negotiations and begin putting in orders to supplies around October 2018.

It will take some time to submit the necessary documents to the Ministry of the Environment and the DOE (EIS: 2 months + SIS: 8 months = 10 months) and to conduct the necessary negotiations, reviews, etc. During this time, we would like to continue measuring wind conditions during this time.

Once the DOE grants permission, and we know how much capacity can be connected to the grid, we can consider and confirm the equipment specifications, power generation scale, and funders. Although this is still just an assumption at this point, once meetings with the DOE are held over these 10 months and those matters are decided, it should take about 6 months to 8 months starting around November 2018 to determine how much generating energy we can practically connect to the grid (so ending sometime between April to June of 2019, probably?).

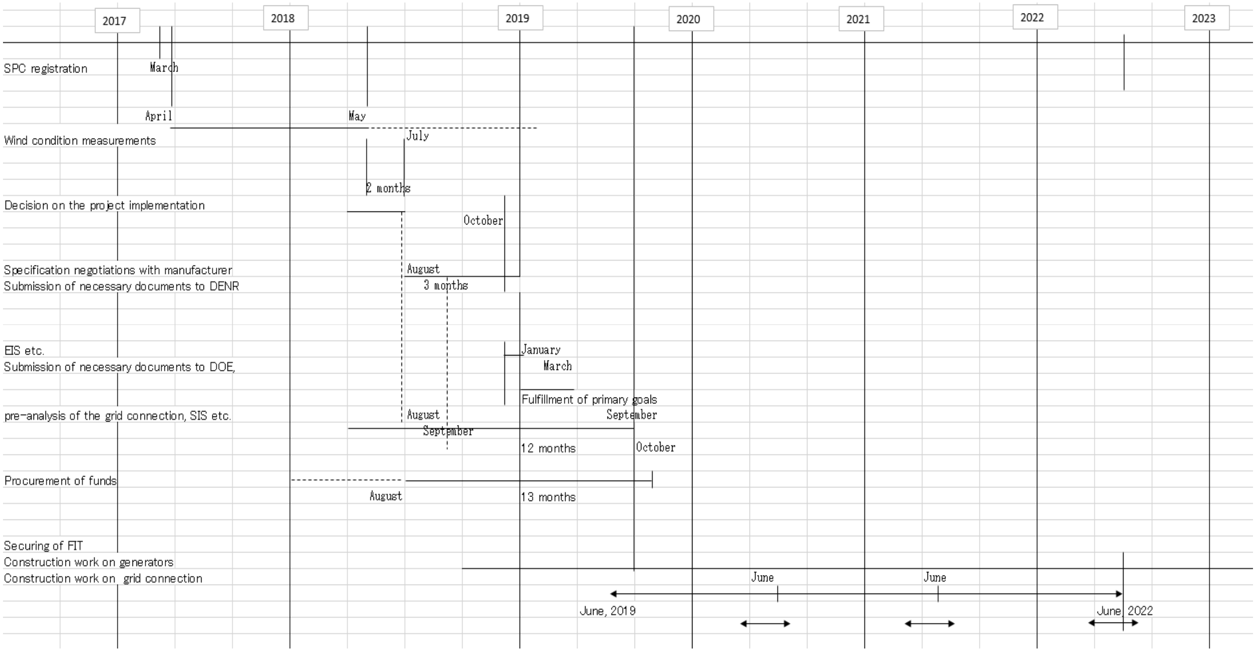
0.1% of the scale of the power plant design plan must be paid to the DOE. In addition, tax incentives will be lost if the project is not completed within three years from receipt of funds, so we will need to complete the construction within that time.

Over the course of 36 months, starting in July 2019 and ending in June 2022, with intervals in December 2020 and December 2021, we plan to build 68 units. 68 units over 36 months comes out to a construction pace of about 2 units per month. In more precise scheduling terms, in 2019 we plan to build 12 units; in 2020, 24; another 24 in 2021; and 8 units by June 2022.

However, this does not take connecting them to the ANECO side, which uses a 69kV system, into consideration, since this way it will be an easier procedure. We are currently considering how to handle connecting to a 138kV-only system (NGCP).

2) Proposed Project Execution Schedule

Figure 7-2-1: Proposed Execution Schedule Until Project Begins



Chapter 8: Implementing Agencies of Partner Country

（１）Implementation Capability of Partner Country Government / Local Government

Since this project will basically be a private investment operation, the implementation capability of the Philippine government will not be questioned in the process of permitting and licensing.

Following steps are necessary for the commencement of wind power operation.

1) To establish a Special Purpose Company (SPC) for the wind power project
2) To enter into a Renewable Energy Service Contact (RESC) with The Philippines' Department of Energy (DOE)

However, as it is required to complete the feasibility verification and commence the construction within 3 years from the contract day of RESC, timing of launch needs to be deliberated circumspectly.

The presiding ministry, DOE, has a subordinate agency called Renewable Energy Management Bureau (REMB) where has respective administrating departments for wind power, hydropower, and biomass etc. With relatively organized management, they have centralized control over information.

As for the local government, under the leadership of Butuan city, regional municipalities of Caraga Region have a generally cohesive administrative management with policies to proactively promote renewable energy business. There is no noteworthy issues to be found including their implementation capability.

Mr. Ronnie Lagnada of EPCC won the mayoral race on June 30, 2016 with a resounding election victory over other city councilors and local elected officials, and was formally inaugurated as the Mayor of Butuan city on July 1. Butuan is the regional center that plays a role in driving Caraga Region, and as a main pillar of his policy, Mr. Lagnada aims to attain low-carbon regional economic development by promoting renewable energy business. Owing to local government’s cooperation, officials of DOE, i.e. the counter partner for RESC were invited to the first field study of this project. The local government is more than cooperative, so its implementation capability should not be an issue.

（２） Implementation Capability of Partner Company

The implementation capability of each partner company in wind power operation are listed in table 8-1-1.

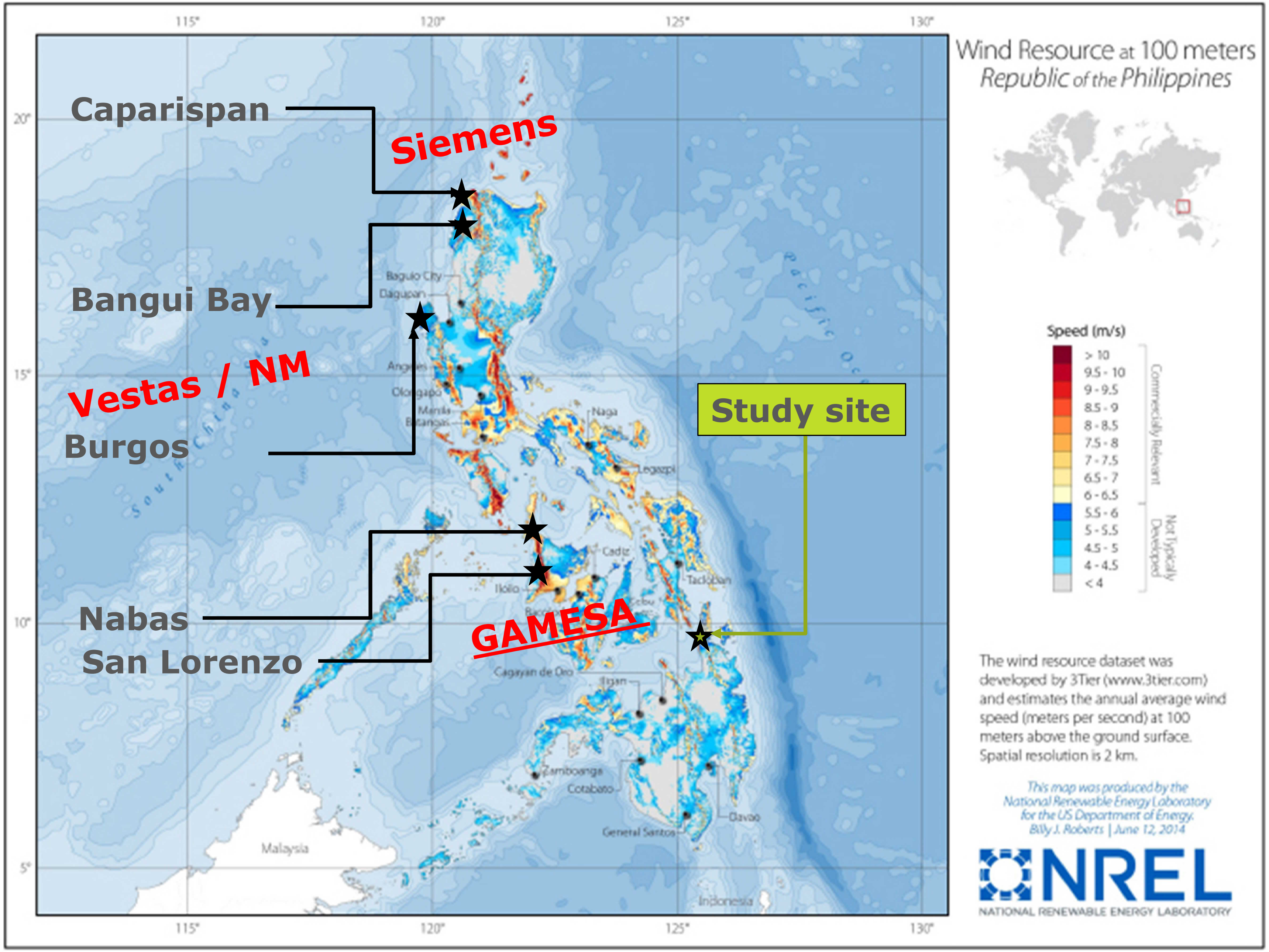
Our partner companies have experience in both construction of power plant and operation of electric power business, i.e. they have sufficient abilities as local implementing agencies. However, since they are short of experience and know-how on wind power, Japanese companies' involvement in power generation equipment supply, technology development and demonstration, construction management, and operation and maintenance (O&M) etc. are expected.

Although the Philippines only has a few completed wind power plants, there are other areas with potential for wind power projects. Therefore, considering that the know-how accumulated here can be utilized in other future wind power projects, the advantageous effect of technology transfer by this project is immeasurable.

Table 8-1-1　Implementation capability of partner companies

Partner company	Implementation capability
EPCC	・ EPCC is the largest general contractor in Mindanao, and owns many different heavy equipment necessary for the construction of wind turbines. By effectively utilizing these equipment, there will be no need for the purchase of new equipment which will result in reducing the construction cost. ・ Being the largest general contractor in Mindanao, EPCC has abundant experience in construction of infrastructure such as roads, bridges, and harbors. ・ EPCC also has know-how on construction of power plant and operation of electric power business. In addition to undertaking the construction of the power plant and investing in SPC for Asiga River small hydropower project, they are also involved in the development of Wawa River and Taguibo River small hydropower projects. ・ EPCC has signed a MOU with THRC and Chodai regarding the development of Special Economic Zone in Butuan City in which the biomass power plant of this project is planned to be constructed, and they will also have involvement in the construction and investment of this project.
THRC	・ THRC is a business planning and investment company. In addition to being involved in business planning and investment for an agricultural SPC, Agusan Green Field Resources Corporation (AGRAC), and other small hydropower SPCs, THRC is also a member of the mentioned MOU for the Special Economic Zone.

Source: Created by Investigation Team



Wind Resource at 100 meters
Republic of the Philippines
Speed (m/s)
> 10
9.5 - 10
9 - 9.5
8.5 - 9
8 - 8.5
7.5 - 8
7 - 7.5
6.5 - 7
6 - 6.5
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
< 4
Commercially Relevant
Not Typically Developed
The wind resource dataset was developed by 3Tier (www.3tier.com) and estimates the annual average wind speed (meters per second) at 100 meters above the ground surface. Spatial resolution is 2 km.
This map was produced by the National Renewable Energy Laboratory for the US Department of Energy. Billy J. Roberts | June 12, 2014
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
Caparispan
Siemens
Bangui Bay
Vestas / NM
Burgos
Study site
Nabas
San Lorenzo
GAMESA
Baguio City
Dagupan
Angeles
Olongapo
Manila
Batangas
Naga
Legazpi
Cadiz
Iloilo
Tacloban
Cagayan de Oro
Iligan
Zamboanga
Cotabato
Davao
General Santos
Malaysia
Indonesia
South China Sea
Pacific Ocean
115°
120°
125°
130°
20°
15°
10°
5°

Chapter 9: Advantages of the Involvement of Japanese Companies

(1) Projected Form of Involvement of Japanese Companies (Investment, Material Provision, Facility O&M)

1) Investment

The involvement of Japanese corporations in this enterprise follows the provisions established by contractual agreement between the stakeholders in the SPC set up to manage this project (Equi-Parco Construction Company (EPCC), Twinpeak Hydro Resources Corporation (THRC), Chodai Co., Ltd. and Shizen Energy Inc.) and adheres to the conditions outlined in the chart below. The Japanese corporations plan to make a 40% investment, the largest allowable under the foreign investment restriction laws.

Chodai	・Advice and guidance related to the entire project. ・Total consulting as an "owner's engineer" from the planning stages through to O&M. ・Consultancy regarding the procurement of Japanese equipment and low-interest financing from Japan. ・Equity participation in the SPC.
Shizen Energy	・Technical examination of the wind power generation project ・Wind profile measurements at the necessary locations for project development. ・Coordination for procurement of equipment for measuring wind conditions and wind power generation equipment. ・Transportation coordination for the wind power generation equipment (maximum length 51 meters, maximum height off ground 5.4 meters). ・Equity participation in the SPC.

2) Provision of Materials

The fundamental materials necessary for this project will be wind power generation equipment. For this project, it is planned to source this equipment from Hitachi, Ltd., one of Japan's foremost electronics manufacturers. Advantages of Hitachi products will be laid out below in section (2) of this chapter: "Competitive Advantages of the Involvement of Japanese Companies in the Implementation of the Project." Hitachi wind power generation products have not often been used overseas in the past, meaning that as this enterprise involves the overseas export of wind power generation technology, it will be positioned as a key project for the company.

3) Facility Operation and Management

The abovementioned wind power generation equipment planned for use in the project comes with a remote management system installed. As well as helping to maintain a high level of generating efficiency over the long term, this also makes it possible to execute maintenance plans which will lower the life-cycle costs of the equipment, and to place the facilities under constant supervision, allowing for a swift response to any unforeseen accidents. Not only will this supervisory system improve the profitability of the project as a whole, it will also allow for the acquisition of greenhouse gas emission reduction credits as part of the planned financing program for JCM model projects. This will have significant value for the contribution it will make to the Japanese government's stated target of the reduction of 50 to 100 million t-CO_2 of greenhouse gases by the year 2030.

(2) Competitive Advantages of the Involvement of Japanese Companies in the Implementation of the Project

1) Advantages in Business Management

The competitive advantages of the participation of Japanese companies on the operational side of this project are as follows.

Management ability	・The ability to comprehensively organize and analyze the project from a wide range of perspectives centered around its viability as a business model. ・Highly-developed project management capability allowing for the strict management of scheduling, quality and costs through until the completion of the project.
Problem-solving ability	・The ability to use new ideas and ingenuity to improve upon areas of concern and solve major problems. ・The ability to view the project over the long term to predict and avoid future problems as well as immediate ones.
Engineering ability	・Plant design to allow for increased capacity and yearly power output. ・Facility layout with high workability and no wasteful inefficiencies.
Technical competitiveness	・High levels of technical expertise in design, manufacturing, maintenance and repair. A wide range of choices for materials. ・Highly reliable O&M ability and the ability to create plants with a long lifespan. ・Knowhow based on extensive experience which will facilitate the reliable operation of the plant and the minimization of any stoppages. ・Superior performance when evaluated in terms of life-cycle costs. ・Superior ability of Japanese companies to manage schedules and ensure timely delivery.
Financing	・Information gathering, coordination and negotiation in order to expand the financing options of the project via the use of aid and financing facilities offered by the Ministry of Economy, Trade and Industry (METI) and the Ministry of the Environment under the terms of the JCM, and by the New Energy and Industrial Technology Development Organization (NEDO). ・Aid for private enterprise-run high-efficiency renewable energy businesses which will contribute to the meeting of JCM targets. ・Investment from Japanese corporations.

2) Technical Advantages Enjoyed by Japanese-Manufactured Wind Power Technology

The technical advantages enjoyed by Japanese companies in this field are as outlined below.

a) Wind profile analysis software

・Analysis specifically suited to wind power generation on the island of Mindanao will be undertaken, by using the appropriate wind profile analysis software for each wind condition, identifying and analyzing topographically-caused turbulence, and evaluating the standard amount of energy produced.

・As RIAM COMPACT is extremely adept at recreating topographically-caused turbulence (a primary cause of increased malfunction frequency when strong), it will be the primarily-used software for turbulence analysis.

・As MASCOT is known to provide accurate figures for energy production estimates, it will be used in this area.

b) Technical advantages of Hitachi generators

- Hitachi wind turbine generators use downwind rotors (the only company in the world to do so), in which the nacelle is positioned upwind of the rotor, as opposed to standard upwind rotors, where the nacelle is located downwind of the rotor. The benefits of this system are as outlined below.
- The downward-tilted rotor is able to more efficiently catch winds surging upwards over mountainous terrain, thereby increasing efficiency.
- The moment arm of the blade and the efficiency of the turbine is further increased by the presence of the nacelle, located upwind of the rotor, because it redirects the wind, increases the speed, and also the wind does not hit the root of the blade, it hits a point further away from the rotor axis.
- As the wind sensors, measuring wind direction and velocity, are housed in the nacelle upwind of the rotors, this makes it possible to obtain data on wind direction and velocity free of disturbance, allowing for more precise yaw control.
- Loads imposed on the rotor shaft can be reduced, leading to improved mechanical reliability.
- When set at standstill for storm winds, the system can be set to free yaw, thereby allowing the downwind rotor to let the winds blow by naturally. As a result, even in cases of power failure, the system can maintain a high degree of stability.
- The total electrical charge transfer, a key indicator of the generator's anti-lightning strength, is set at 600 C, an extremely high level twice the IEC I standard of 300 C.
- Turbines can be easily transported, with significantly lower weight constraints than foreign-manufactured wind power generators. For example, the nacelle can be broken into its constituent parts for transportation.

c) Hitachi's remote-controlled O&M

- All Hitachi wind power generators feature as standard the "supervisory control and data acquisition" (SCADA) system, allowing for remote monitoring of the generator. Data collected by the SCADA system includes rotor velocity, azimuth angle, nacelle angle and approximately 100 other points of analog data, along with wind velocity and power generation levels, and can be monitored from any location the world over via internet cables.
- Remote monitoring is also carried out from the Remote Monitoring Center in Hitachi City, Ibaraki Prefecture.

(3) Necessary Measures to Facilitate the Utilization of Japanese Company Products

The track record of Hitachi, Ltd.'s downwind rotors turbine is approx. 230 units (incl. contract base), some examples of projects are shown in Table 9-3-1. In order to accurately convey to our project partners in the Philippines the merits and demerits of these prior examples, technical demonstrations, training courses and on-site observation tours are planned in Japan, making use of aid provided by such agencies as the Overseas Human Resources and Industry Development Association.

Table 9-3-1: Examples of Projects Using Hitachi, Ltd.'s Downwind Rotors

Project name	Summary
Project in Saga Prefecture	In-development project commissioned by Shizen Energy Inc. in Saga Prefecture for which the use of Hitachi's downwind rotors is planned.
Akita Tenbinno Wind Farm	1 unit; 1.99 MW. Operation commenced in September 2015.
Nakajō Wind Farm	1 unit; 1.99 MW. Operation commenced in March 2014.
Wind Power Kamisu Daiichi Offshore Wind Farm	7 units; 2.0 MW per unit. Operation commenced in July 2010.

Chapter 10: Action Plan and Issues for Project Realization

（１） Status of initiatives for the project realization

Mindanao Island is facing the concern of a serious power shortage in the future, and this project is the first wind power renewable energy project to provide electricity in Mindanao Island. Therefore, considering the success of this project can be the model case for other areas, the local government is also placing their expectations on it.

It will be necessary to consult with partner companies and related organizations about a) building a cooperative framework for project implementation, b) building an alliance for raw material procurement, which are particularly important for promoting this project.

Regarding building cooperative framework for project implementation.

1) Establishment of SPC

In December 2016, equity investors of this project, EPCC, THRC, Shizen Energy Inc. and Chodai, together with respective group companies, have agreed to establish a SPC and have signed on a shareholder agreement. Registration of SPC has been completed in February 2017.

2) Application of RESC

From the completion of SPC registration in February 2017, we plan to complete RESC application procedure in the following March. Although the conclusion date of the RESC is undecided, from our experience, it should be less than 2 months to complete.

3) Local coordination

The territorial exclusivity of RESC will be applied from the time of application. In anticipation of applying in the following March, our local partner, EPCC, has started to hold orientation meetings to the municipalities where the tentative development site is located and is confirming the possibility of land utilization.

4) Installation of wind poles and measurement of continuous wind data

In the course of promoting this project, approaching local officials for the installation of wind poles in a situation without SPC registration and official RESC with DOE could expose Japanese side's intention of developing wind power plant in the targeted area. In order to avoid unwanted confliction over development concession and adverse effect to the project itself, it was decided not to install wind poles in the targeted area.

And so, we have decided to install wind poles in the Cabadbaran area owned by local partner company, in which there will be no cost concerning land use for the installation.

Since the Cabadbaran area is located approximately 34 km away from the targeted area, before the evaluation, the obtained measurement result (pole height 34 m) was corrected based on NREL data (model altitude 30 m) in accordance with power law of wind speed. As a result, the targeted area was extrapolated to be an area with sufficient wind power generation potential.

In the time ahead, we intend to measure and collect continuous wind data by installing two wind poles (already purchased) separately in the north and south point of the targeted area as an excluded expense from the budget of this project.

（２）Initiatives of related implementing agencies for the project realization

Although this project is a private investment operation, it is necessary to reach out to the local government in order to gain their cooperation for local coordination in the following issues.

Item	Content
Transporting road	The transporting road of the wind turbine can be utilized not only for the application in this wind power project but also for the living use of the surrounding residents. In particular, road construction can result in the development of tourism industry. As there already are future plans for tourism development, it is necessary to reach out to the local government and the Department of Public Works and Highways (DPWH) for role-sharing arrangement regarding the construction of transporting road.
Land use	It is desirable that the land use plan allows the targeted area for power plant development. But currently, there is no clearly stated land use plan by the state government or administrative district (Municipality) for the targeted area, so it is necessary to coordinate with the local government after entering into RESC with DOE.

Concerning the grid connection, consultation and collaboration with the power transmission operator and distribution cooperative are necessary for the contents shown in the following table.

Item	Content
National Grid Corporation of the Philippines （NCGP）	It is needed to request DOE for System Impact Study (SIS) before interconnecting to 138 kV power grid. Based on the result of SIS, it is necessary to coordinate with NGCP regarding the acceptable capacity of 138 kV power grid side and the timing of contact for the additional transmission line on the receiving side.
Surigao del Norte Electric Cooperative (SURNECO)	The distribution impact study (DIS) is needed in the case where there is no sufficient wind power to output 150 MW throughout the northern part of Mindanao Island, or it was decided to connect a part of 150 MW to the SURNECO side 69 kV power grid. Based on the result of DIS, it is necessary to coordinate with SURNECO and NGCP (69 kV side) regarding the acceptable capacity of 69 kV transmission grid side and the timing of contact for the additional transmission line on the receiving side, in particular in the case of power supply near the プラセーラ substation.
Agusan del Norte Electric Cooperative (ANECO)	The distribution impact study (DIS) is needed in the case where there is no sufficient wind power to output 150 MW throughout the northern part of Mindanao Island, or it was decided to connect a part of 150 MW to the ANECO side 69 kV power grid. Based on the result of DIS, it is necessary to coordinate regarding the acceptable capacity of ANECO (69 kV) transmission grid side and the timing and method of contact for the additional transmission line on the receiving side.

（３） Legal and financial constraints of the partner country

FIT has been established with legitimate legal framework. Power supply is outpacing demand till 2022. However, there is no project for power supply increase after 2022, and it is necessary to promote renewable energy from the viewpoint of national energy mix and GHG reduction plan. Under such circumstances, in Mindanao Island, the local government is taking cooperative measures for renewable energy project, so there will be few legal restrictions.

Also, on the financial side, there is no particular problem as the project is a private investment operation.

（４） Additional detailed analysis

For additional detailed analysis, the followings are needed.

Table 10-4-1 Necessary detailed analysis in the future

Item	Content
Update study result based on actual wind condition observation data	In terms of fund procurement, it is necessary to verify the feasibility based on actual wind condition observation data for at least one year. For this reason, it is necessary to reconfirm the feasibility based on the wind condition observation result of the next fiscal year and to update the plan of the entire project based on the field survey of the specific development site.
Review the phase division based on the above additional study result	Based on the above additional study result, it is necessary to review the phasing and construction schedule of the whole project as well as business profitability. Also, since this is a low carbon project using high-efficiency power generation facilities, its business scheme will be premised on the utilization of JCM, therefore, mutual consultation with related party are needed to update fund procurement plans and such.
Funding procurement after improving project expense calculation accuracy	Relating to the above mentioned phasing and construction schedule, along with the updated project plan based on actual observation data, it is also necessary to examine the details of the funding plan with a view to utilizing JICA and JBIC's two-step loan together with utilization of JCM equipment subsidies.