New Mechanism Feasibility Study for Renewable Energy Development by Wind Power Generation in Low Wind Speed Conditions in Thailand

By Yonden Engineering Co., Inc.

1. Organizational Set-up for Study Implementation

Yonden Engineering Company is principally responsible for the implementation of this Study, with the following companies participating with their respective areas of responsibility:
1. Shikoku Electric Power Co., Inc.: Study assistance in areas of institutions & policies and electric power
2. Mitsubishi UFJ Morgan Stanley Securities Co. Ltd: Assistance in the quantification of GHG reductions and in the formulation of MRV
3. ITOCHU Techno-Solutions Corporation: Assistance in wind state analysis and simulation
4. Thai Local Company (Counterpart Company): Supply of wind state data and assistance in In Situ investigation
5. ENSOL (local consultant company): Assistance in the collection of information

2. Outline of project activities

(1) Outline of project activities

The bilateral offset credit Mechanism project for which this Study is meant covers the entire wind power generation activities in Thailand. CO2 emission reductions shall be attained by way of wind power generation companies selling electricity power to grid companies and thus replacing fossil-fuel-generated power. As one example, there is the project promoted by the Thai Counterpart Company of this Study in Samut Prakan Province of Thailand. This is a wind power generation project implemented by the local Counterpart Company at a project site owned by it (hereafter referred to as the Project Concerned).

Then, economic viability will be also assessed as regards model projects in low wind velocity regions & areas throughout Thailand and agendas for wind power generation business in Thailand will be analyzed. Based on the knowledge and experiences acquired in the 2010 JICA project “Information Collection and Verification Study on Thai Electric Power Sector” undertaken by Shikoku Electric Power Company, Inc, etc., a possible effective framework of
the new mechanism will be explored for wind power generation in Thailand (there has been no CDM projects ever implemented in the wind power generation sector) through introduction of Japan’s wind power generation technology which can be operated with a high degree of efficiency even in a low wind velocity situation and thus wind power generation projects will be promoted and diffused through the effective use of a mechanism of financing.

In the Alternative Energy Development Plan (AEDP) (2008-2022) formulated by the Thai Government in an effort to promote the use of renewable energy sources, a target for increased wind power generation has been set. Through the implementation of the Project Concerned and model projects, contribution is expected to be made towards attainment of such target and is expected to have positive impacts in terms of reducing emissions of air pollution substances such as Sox and particulate matter from the existing thermal power generation plants.

(2) Circumstances in the host country

On a visit to Thailand Greenhouse Gas Management Organization (TGO), which is the designated national authority which controls CDM projects, it was stated that the Thai Government is aware that the existing CDM system has problems required to be addressed and that in this context the Thai Government entertains certain expectations of the new mechanism. At the same time it was also pointed out that it would be difficult to proceed with studies based only on the existing conditions because neither information has been made available on how the Japanese Government is going to deal with the new system and nor the concrete details of the new system etc. have been indicated. A number of questions have been posed; how the outcome of this Study can contribute to the promotion of projects, what will be the next step of action; who is going to become the beneficiary of the bilateral offset credit mechanism, the Thai Government or private businesses; the sale of credits in the private sector is going to be possible as in the case of CER; how are its procedures going to be in that case, etc. However, we noticed that there was a high degree of interest in the new mechanism.

As regards Thai policies on wind power generation, which is the subject of this Study, a variety of support measures including Adder have been taken with a view to install 800MW by 2022 as planned in the Power Development Plan (PDP) and the AEDP and active measures have been also taken to introduce renewable energy including wind power. However, support measures for initial investment seem to be insufficient and there are also procedural problems, which must be addressed. Progress seems not to have been achieved as planned.

As regards climate change policies, a package of comprehensive policy measures covering all the related sectors entitled National Economic and Social Development Plan (NESDP) are being prepared. Preparatory work is being done on the basis of various policies measures
proposed from each Ministry and Agency concerned. NESDP will prove to be extremely important in terms of foreseeing and verifying future trends in Thailand in this connection.

The contents of PDP and AEDP (2008-2022) will be reflected in NESDP. Matters such as implementation periods seem to be being revised on the basis of the latest data. We have been informed that PDP and AEDP would be announced soon. However, no exact date of announcement of the NESDP was given, as it is subject to Cabinet approval.

At COP17 held towards the end of 2011, the Thai Representative announced that Thailand would reduce its energy intensity by 25% below the current level within 20 years, and that 25% of the energy generated by fossil fuels would be replaced by green energy within 10 years. It was also announced that the National Energy Policy Board had approved a 20-Year Energy Conservation Plan (2011-2030) and the Alternative Energy Development Plan (2012-2021) with a view to achieving those targets. The concrete contents of these Plans, though not yet announced, are in line with NESDP and will be important in terms of following trends in energy policies and policies for promoting renewable energy in Thailand.

(3) Eligibility as a new mechanism

The problems to be addressed to promote wind power generation business in Thailand will be summarized as follows;

- Problems on additionality of CDM projects
  - Because of incentive measures such as the Adder, the superficial profitability of wind projects are improved, making them difficult to prove additionality, and thus becoming CDM, even though the actual profitability is unstable.

- Problems on the future prospect of CDM
  - The EU which had lead the carbon market is closing its door for CDM projects from emerging countries such as Thailand.

- Problems on wind state conditions in Thailand
  - Relaxing EIA requirements and providing up-front financial support as part of unilateral NAMA has to be considered.

- Technical problems
  - The transfer of advanced technology and know-how from Japan, etc. is needed

In order to overcome these problems, effective promotion through a new framework such as a bilateral offset credit mechanism, etc. is essential.
(4) Ways and means to diffuse business and activities

In terms of the amount of production of wind power generators (hereafter referred to as wind turbine) internationally compared, European products come first, Chinese & Indian products are rapidly emerging, followed by Japanese products.

Many of recent large wind turbines are those with cut-in wind velocity (wind velocity required for starting electricity generation) of less than 35/s, which makes possible high efficiency power generation in low wind velocity regions & areas. Among these types of wind turbines Japanese and European wind turbine technology is regarded as of top level in terms of performance.

When wind state in Thailand considered, in Thailand regions & areas valid for wind power generation with a wind blow of more than 6m/s at a 65 m above ground constitutes only 7% of the total national land territory area, with practically all of them concentrated in Southern Malay Peninsula as well as in the mountain areas in the West and in the East. Regions & areas other than those are considered not to have wind state suitable for wind power generation.

Therefore, the transfer to Thailand of the large-scale and high efficiency wind power generation technology owned by Japanese wind turbine makers under a new mechanisms expected to contribute to further promotion and diffusion of wind power generation in Thailand.

Furthermore, it is proposed that assistance measures to be provided under the new system should cover both “hardware” and “software” assistance such as funding of initial cost and technical support including the dispatch of experts.

3. Contents of Study

(1) Items of Study

The following are the items, which must be clarified in this Study and in the Project Concerned;

- Policy measures for promotion and diffusion of renewable energy sources
  - Outline of AEDP
  - Target figures for introduction of wind power generation and past performance records
  - Outlines of funding support measures, etc.
- Grid interconnection for wind power generation projects
  - Interconnection capacity limits for suburban power grid connection
  - Necessary and sufficient conditions for grid interconnection

<4>
Wind power potential
- Verification of potential calculation method in Thailand
- Calculation of potential of low wind velocity oriented wind power generation, etc.

Environmental impact assessment (EIA) relating to wind power generation
- Assessment items of EIA
- Whether or not EIA is necessary in wind power generation projects
- Problems in obtaining EIA approval, etc.

Assessment of economic viability relating to wind power generation projects
- Understanding of wind state for Thailand
- Cost required for wind power generation projects in Thailand
- Assessment of economic viability of wind power generation projects in Thailand, etc.

(2) Contents of Study

① In situ studies

A total of 3 in situ study tours have been organized. Major organizations visited and contents of studies are as follows;

(Thai Government related organizations)
By visiting TGO, DEDE, ONEP, and EPPO, studies have been conducted concerning the actual status of wind power generation introduced, wind power potential, institutional & policy aspects of measures for promotion & diffusion of renewable energy projects and environmental impact assessment, etc.

(Public Power Corporations)
By visiting EGAT, MEA and PEA, studies have been conducted on the actual status of operation of the wind turbines owned, their construction cost as well as on the conditions and procedures of grid interconnection, etc.

(Others)
The local Counterpart Company and the Project Site have been visited and investigation at the proposed Site was conducted in accordance with the basic plan for the introduction of wind power generation. Discussions have been held with the local Consultant Company on the cost of wind power generation constructions and O&M in Thailand, etc.

② Other investigation work

(Assessment on the economic viability of wind power generation projects)
This Study covers wind power generation projects in general in Thailand. At As examples, economic viability of regarding the Project Concerned promoted by the Counterpart
Company of this Project in Samut Prakan Province and general wind power generation model projects in low wind velocity regions & areas, economic viability has been assessed to study economic viability trends in wind power generation business in Thailand. In Thailand, Chinese-made wind turbines have been already introduced. However, these wind turbines have given rise to a lot of mechanical troubles. In view of these troubles, assessment and examination have been also carried out at sites where Japanese and European wind turbines (2 wind turbines each of 2-3 mw class have been chosen) have been installed, with a view to activating wind power generation projects through the introduction of high quality wind turbines.

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➢ Economic viability assessment of the Project Concerned

The annual average wind velocity at a height of 80m above ground is estimated to be as low as 4.65m/s and the Site Concerned needs additional development such as the construction of an access road, etc. It must be said that sufficient its economic viability is low when considered in the light of wind state simulation, and initial cost and O&M cost calculated.

➢ Economic viability assessment of model projects

Assuming the general VSPP project, assessment was conducted on the performance and economic viability of Japanese and European wind turbines in areas with a wind velocity of 6.0m/s considered to be as the standard for economic viability in Thailand and in low wind velocity regions & areas with a wind velocity of 5.5m/s. In terms of facility utilization rates in areas with a wind velocity of 6m/s, Japanese products have somewhat surpassed European products. However, in terms of performance, both are nearly equal and in terms of cash flows both have proved to be at a level where economic viability is considered to exist. In areas with a wind velocity of 5.5m/s as well, both have proved to be nearly equal in terms of performance but have failed to reach a level where economic viability is considered to exist.

In both cases, in terms of economic viability, European products have proved to have *prime facie* superiority reflecting the difference in initial cost. However, in simulation using the average exchange rate over the past 5 years, the result has reversed with Japanese products having superiority over European products. However, it has proved to be that relative merits in economic viability largely reflect exchange rate impacts. Therefore, for the reason that it still fails to reach a level where economic viability is considered to exist, it is an effective measure to provide gap-filling assistance that will make projects economically viable. Viewed in the light of these results, there are no substantial difference between Japanese wind turbines and European turbines in terms of performance and cost. Through
assistance provided under the bilateral off-set credit mechanism, the promotion of introduction of Japanese wind turbines and the diffusion of wind power generation projects can be expected.

4. Outcome of research on the feasibility of projects & activities under the new mechanism

(1) Emission reduction effects from implementation of projects & activities

If the reference scenario is assumed to be the continuation of the status quo, the amount of emissions reduction will be calculated by multiplying the amount of electricity from wind power projects sold to the grid, by the grid emission factor in accordance with the CDM methodology for grid-connected electricity generation from renewable energy sources. Of the two factors, namely the electricity sales amount and the grid emission factor, the determination of the emission factor is particularly important for identifying the reference scenario.

The methodologies to be applied to projects for replacing grid-connected power by renewable energy sources are Consolidated Baseline Methodology ACM0002 and Small-Scale Methodology AMS.I.-D. In calculating the grid emission factor, the calculation tool for electricity system is utilized. In the said tool, the combined margin (CM) which is the weighed average of the operating margin (OM) for the operation of the existing power station and the build margin (BM) is adopted as the grid emission factor.

As regards the methodologies for calculating OM, there are 4 methodologies, namely (a) Simple OM, (b) Simple adjusted OM, (c) Dispatch data analysis OM and (d) Average OM. In Thailand (a) Simple OM is adopted in many cases. As regards (a), there are 2 options of either fixing it *ex ante* or renewing it *ex post* annually during the project implementation period. As regards BM, there is only one method for calculation, but, there is the option of either fixing *ex ante* or renewing annually *ex post*.

Thailand Greenhouse Gas Management Organization (TGO) publishes CM default values to facilitate the work of CDM business entities. In so doing, TGO uses Simple OM for OM and calculates BM in accordance with the established tool because of constraint in data development.

As of January 2012, 66 Thai projects are registered with the United Nations as CDM projects and 160 projects are listed as Thai Government approved CDM projects. The majority of CDM projects in Thailand are related to biogas generation or biomass generation. More

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1."Consolidated baseline methodology for grid–connected electricity generation from renewable sources" (Version 12.2.0)

2."Grid connected renewable electricity generation" (Version 17)
than 80% of such projects are related renewable energy sources. The average annual emission reduction of the 66 projects amounts to about 53,000 t/CO2. At present CER is issued from 10 projects and their total amount of emission reduction is 1,045 thousand t/CO2.

Table 1: Types of emission factor utilized in Thai registered CDM projects

<table>
<thead>
<tr>
<th>Number of registered projects</th>
<th>Grid-connected power projects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of projects</td>
<td>Those using Ex ante method</td>
<td>Those using Ex post method</td>
</tr>
<tr>
<td>66</td>
<td>61</td>
<td>51</td>
</tr>
</tbody>
</table>

Of these, 61 are grid-connected projects, of which 51 projects calculate \textit{ex ante} emission factors. The choice made between the \textit{ex ante} option and the \textit{ex post} option relates to and depends upon the availability of data on power development plans & other related data of the country concerned. For example, in the case of countries where increased coal-fired power generation is emphasized in power development plans, the \textit{ex post} calculation method is more advantageous in obtaining bigger emission reductions. In the case of countries such as Thailand where increased renewable energy sources, increased hydroelectric power import from overseas and increased nuclear power generation are emphasized, the \textit{ex ante} method of calculation tends to be preferred as is clear from Table 1

(2) Determination of reference scenario and project boundary

1. Determination of reference scenario

The baseline scenario under the CDM is identified as the most realistic scenario available to project entities that provide outputs or services comparable with the proposed project activity, when realistic and credible alternative scenarios are compared.

Based upon this, the following three scenarios can be conceived as reference scenarios for wind power generation project entities interconnecting with system power supply.

(a) In the case where the wind power generation project concerned is to be implemented without emission reductions credits

In Thailand there is at present no law (RPS Act) that makes it mandatory to source more than a certain ratio of power generation from renewable energy sources. There is no plan either to enact such law in the near future. Therefore, it is unlikely that projects from renewable energy sources such as wind power will be implemented as BAU conditions. Actually the target figure for wind power generation development is mentioned in the 2010
Power Development Plan (PDP). However, it is essential that such plan targets should be supported by positive financial assistance measures in order to become a reality.

(b) Possibility of replacing the power supply project activity concerned by other realistic and highly reliable projects

The siting of wind power stations is decided on the basis of factors such as wind state, topographical conditions, area and distance from the grid interconnection, etc. As projects will be examined and analyzed in the light of economic viability, etc. it is difficult to compare uniformly with alternative scenarios of generation from other energy sources.

(c) Continuation of the status quo

In Thailand, no sufficient financial, technological and educational & promotional support measures have been in place in spite of the fact that funding subsidy policies such as the Adder system have been formulated. Therefore, it is difficult to see wind power generation projects implemented unless creation of a value added system for granting additional emission reduction credits, etc. is considered. Therefore, the most realistic scenario will be to encourage the implementation of projects through providing economic incentives in the form of emission right credits. Thus, the reference scenario in this Study is identified as the continuation of the status quo.

2. Determination of project boundary

Unlike CDM projects, the boundary under the bilateral offset credit mechanism should comprehensively cover projects that are implemented in line with certain principles such as NAMA. The determination of boundary is essential also for grasping precisely and verifying the effects of GHG emissions reductions. Furthermore, a framework for each project should also be considered. The following summary is a set of principles considered as the boundary for this Project;

Geographical boundary

- The boundary shall cover the wind power generation plant facilities throughout Thailand which are eligible for assistance under the bilateral offset credit mechanism and the electric power systems supplying electricity from wind power plants.
- The boundary shall be defined per project and the collectivity of such projects shall become the boundary of the bilateral offset credit mechanism.

Technologies and capacity of facilities

- Projects introducing low wind velocity/high efficiency technology: It shall be a project
introducing low wind velocity/high efficiency technology that may function even at a wind power generation site with a level ground wind velocity of less than 6m/s in Thailand. The standard shall be a cut-in wind velocity of less than 3.5m/s

- Projects introducing large size equipment units: In Thailand small sized wind power generation equipment of 250 kW class are already domestically produced. And small-scale wind power generation projects that can be implemented with relatively little financial and technical difficulties have marked some successful results. Therefore, the projects covered by the bilateral offset credit mechanism shall be those that will introduce large sized wind turbines of 2-3MW and accordingly require advance technological transfers from overseas such as Japan and financial assistance.

(3) Monitoring methodology & plan

What is going to be monitored in this Project are 2 items, namely the quantity of electricity to be sold by the wind power generation project entity to the State power corporation and the system power supply grid emission factor. As indicated in the following Table, the methodology for monitoring these parameters shall correspond to ACM0002 of CDM (consolidated baseline methodology for grid-connected electricity generation from renewable sources).
Table 2: Methodology for monitoring the quantity of electricity sold

<table>
<thead>
<tr>
<th>Contents</th>
<th>The net quantity of electricity generation supplied to the grid by the wind power generation project implemented under the new mechanism concerned during a particular year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>MWh/year</td>
</tr>
<tr>
<td>Measuring methodology</td>
<td>Using a calibrated watt-hour meter, the net electricity sold shall be measured by subtracting the amount of electricity purchased from the amount of electricity sold. The amount of electricity sold shall be compared and checked against the generation certificate co-signed by both the wind power generation entity and the grid. The amount of electricity purchased shall be compared and checked against the amount of electricity consumption entered in the invoice issued to the wind power generation entity by the grid.</td>
</tr>
<tr>
<td>Frequency of measuring</td>
<td>As a rule more than once a month</td>
</tr>
</tbody>
</table>

Table 3: Methodology for monitoring the grid emission factor

<table>
<thead>
<tr>
<th>Contents</th>
<th>The combined margin grid emission factor for the year concerned calculated using the latest CDM tool for electric power system emission factor calculation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>tCO₂ /MWh</td>
</tr>
<tr>
<td>Measuring methodology</td>
<td>Thai Government organizations such as TGO shall calculate them by using the above tool</td>
</tr>
<tr>
<td>Frequency of measuring</td>
<td>As a rule once a year</td>
</tr>
</tbody>
</table>

(4) GHG emissions and reductions:

GHG emissions and reductions shall be calculated by way of applying CDM methodology ACM0002 (consolidated baseline methodology for grid-connected electricity generation from renewable sources).

$$ER_y = BE_y - PE_y \quad \ldots(1)$$

ER<sub>y</sub> : Emission reduction during y year (t CO₂e/yr)

BE<sub>y</sub> : Reference emission during y year (t CO₂/yr)

PE<sub>y</sub> : Project emission during y year (t CO₂/yr)
The reference emission shall be calculated by way of using the following equation (2).

\[ \text{BE}_y = \text{EGPJ},y \times \text{EFgrid,CM},y \quad \ldots(2) \]

- \( \text{BE}_y \): Reference emission during \( y \) year (t CO2/yr)
- \( \text{EGPJ},y \): The net amount of power generation supplied to the grid through the CDM project implemented during \( y \) year (MWh/yr)
- \( \text{EFgrid,CM},y \): The combined margin grid emission factor for \( y \) year calculated by way of using the latest power system emission factor calculation tool (tCO2/MWh)

According to Consolidated Baseline Methodology ACM0002 and Small-Scale Methodology AMS.I.-D., the project emission amount is defined as nil in electricity generation from renewable sources. As this is a wind power electricity generation project, no fossil fuel is supposed to be consumed in the implementation of a wind power generation project. Therefore, the project emission shall be nil.

Thus, the emission reduction shall be calculated according to the following equation (3)

\[ \text{ER}_y = \text{EGPJ},y \times \text{EFgrid,CM},y \quad \ldots(3) \]

Emissions leakages shall be ignored, although such leakages actually may potentially arise from fossil fuel use in the project construction and upper-stream process according to ACM0002. In the Small Scale Methodology AMS.I.-D., leakages are required to be considered if electricity facilities are to be transferred from other projects. Therefore, no emissions leakages shall be considered in this Project coming under the new mechanism, which covers only new wind power electricity generation.

The following are the trial calculation done on the basis of wind power generation project potential in Thailand and by making use of the emission factor default value published by TGO.

<table>
<thead>
<tr>
<th>Compared with target value (Capacity to be introduced by 2022)</th>
<th>Electricity generation (GWh) by 2022</th>
<th>Reduction potential (thousand tCO2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% (80MW) : Case A</td>
<td>704</td>
<td>391</td>
</tr>
<tr>
<td>30% (240MW) : Case B</td>
<td>2,416</td>
<td>1,342</td>
</tr>
<tr>
<td>50% (400MW) : Case C</td>
<td>4,127</td>
<td>2,292</td>
</tr>
<tr>
<td>100% (800MW) : Case D</td>
<td>8,405</td>
<td>4,668</td>
</tr>
</tbody>
</table>

Table 4 : Emissions reduction potential based on ex ante CM emission factor published by TGO

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The actual emissions reduction will be calculated per project. However, for the purpose of trial calculation of the nationwide emissions reduction potential of the host country, the following conditions have been assumed:

Table 5: Prerequisites for trial calculation of the nationwide emissions reduction potential of the host country as a whole

<table>
<thead>
<tr>
<th>1. EGPJ,y (MWh)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity supply amount (MWh) from the wind power generation project under the new mechanism to the grid</td>
<td></td>
</tr>
<tr>
<td>= Capacity of wind power generation facilities introduced under the new mechanism (MW) × 8,760 hours × load factor</td>
<td></td>
</tr>
<tr>
<td>✓ Capacity of wind power generation facilities introduced under the new system (MW)</td>
<td></td>
</tr>
<tr>
<td>= Capacity of wind power generation facilities introduced under AEDP (Alternative Energy Development Plan) – 7.78MW which is the amount introduced in 2011</td>
<td></td>
</tr>
<tr>
<td>As the load factor, 22.2% of the Japanese manufacturer A’s wind turbine at a wind velocity of 5.5m/s has been adopted, following the results of this Study.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. EFgrid,CM,y (tCO2/MWh)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The CM emission factor default value of 0.5554, published by TGO and applied to wind power generation, has been utilized.</td>
<td></td>
</tr>
</tbody>
</table>

(5) Methodology for the measurement, reporting and verification (MRV) of emissions reduction effects

Of measurement, reporting and verification (MRV), the methodology of measurement for this Project has been already discussed in (3) above. Therefore, here reporting and verification will be discussed. As far as monitoring items in this Project is concerned, these are very simple. Since reporting is going to be made on the basis of the receipts, etc. issued by power companies, here mainly the methodology and organizational set-up for verification will be discussed.

As regards authorities empowered to conduct verification, under CDM system the Designated Operational Entity (DOE) is authorized to verify monitoring data and project implementation progress reports. Under the new system as well, it will be more practical to let such third parties conduct verification. Apart from DOE authorized under the CDM system, there are other third parties such as organizations certified under ISO 14065 (the international standard that specifies principles and requirements for bodies that undertake validation or verification of greenhouse gas (GHG) assertions). While emphasizing the importance of
transparency and reliability, the idea of opening the door more widely to other organizations might be considered.

The parameters to be verified are only two items, namely the amount of electricity sold and the grid emission factor, each of which shall be verified in the following manner;

1. **Verification of the amount of electricity sold**

   In verifying the amount of electricity sold, the verification organization shall receive from wind power generation entities 1. the amount of electricity sold to power companies, 2. certificates indicating the amount of electricity generated, 3. the amount of electricity purchased from power companies, and 4. invoices issued by power companies. Then, the verification organization shall compare 1 with 2, shall compare 3 with 4 to verify the amount of electricity consumed, shall verify whether the difference between the amount of electricity sold and the amount of electricity purchased has been correctly calculated, and thus shall verify the net amount of electricity sold.

   Both electricity generation certificates and invoices are basic documents for payment between IPP entities and power companies. Therefore, their objectivity is ensured. Generally speaking, both business entities are expected to keep in custody these documents for a certain period of time. Such series of procedures are not considered to add up to the burden of IPP entities and therefore should be acceptable to them.

2. **Verification of emission factor**

   The emission factor verification process will somewhat differ in reference scenario calculation, depending upon whether *ex ante* data has been chosen or *ex post* data has been chosen.

   This Study proposes that in the Project Concerned the grid emission factor should be fixed to *ex ante*. In this case, the monitoring of the emission factor becomes unnecessary and the verification organization shall check on whether or not the emission factor has been correctly applied in calculating the emissions reduction and on whether or not there has been any mistake in such calculation. It is advisable that the *ex ante* emission factor applied should be the one at the time when the project became fully operational, not the one at the time when the Project Concerned was approved under the new system. Namely, what is adopted is not the emission factor as of the time of validation under the CDM system but the emission factor as of the time when operation has started. In this way, it is ensured that the credit creating mechanism will reflect more closely with reality.

   On the other hand, when the grid emission factor renewed *ex post* is to be applied every year,
the verification organization shall verify whether IPP entities have applied the emission factor based on the latest official information then available and whether there has been no mistake made in the calculation process.

(6) Ensuring environmental integrity

It is well known that the spread of wind power generation projects have positive impacts such as zero of GHG and air pollution substances during the operation and slowing-down consumption of limited fossil fuel resources.

However, while having positive impacts, the spread of wind power generation projects have also negative impacts as well including power output instability, low energy intensity, noise pollution problems, spoiling natural landscapes and bird strike problems. In order to avoid or minimize such negative impacts, grid interconnection capacity, residential conditions surrounding the construction, spots of scenic beauty, flight routes of migratory birds at and around construction sites must be fully investigated and after that, the construction site of wind power generation stations must be identified and thoroughly examined.

In constructing wind power generation stations in Thailand, environmental impact assessment (EIA) must be implemented when such construction works take place along or near Class I Watersheds, river coasts & sea coastlines, and within or near Natural Parks or Historical Parks.

According to ONEP, there are no assessment items peculiar to wind power generation projects. When wind power generation stations are to be constructed, matters relating to the safety of civil engineering works and construction works, noise pollution and low frequency sound, risks of spoiling landscapes and risks of bird strikes, etc. which are general and common EIA items, have to be examined and assessed.

(7) Other indirect impacts

The following are some of negative impacts that are likely to arise in the future as wind power generation is promoted and diffused in Thailand, together with counter-measures that have been taken in Japan

- Noise pollution & low frequency sound: to ensure to keep a distance of approximately 1,000 m between wind power generation stations and residential areas; to control the operation of wind turbines appropriately, to organize advance briefing meetings for local residents
- Destruction of landscapes: to examine the layout of major panoramic view
points and landscape resources by resorting to visual methodologies such as conceptual drawings and photomontage methodology

- Bird strikes: to do mowing around the construction site, to install stroboscopes, to install explosion scarecrows

(8) Comments from stakeholders

Because of their peculiarity, wind power generation projects may cause various problems after their construction works have been completed. In view of this, chiefs of villages & regions of the project sites deemed to represent local residents have been interviewed mainly on issues relating to their environmental awareness. Their favorable comments were as follows:

- The wind turbine, if constructed, will become the symbol of their villages. Therefore, we are for the construction.
- We naturally expect that electricity charges for local residents will be lowered because of such wind turbine power generation.
- As the construction site is more than 1km away from the residential area, we should think that there would be no noise problem for us.

On the other hand, opinions expressing concern over possible negative impacts on the local environment have been also voiced:

- It is the prerequisite that there shall be no negative impacts upon the surrounding environment. Once the concrete construction plan has been prepared, the village headman representing local residents will have to report to the City and Prefecture. Therefore, the village headman has to verify such plan with special reference to issues of environmental impacts.

As it is likely that practically all the local residents have never seen actually wind turbines, it is highly important that before the project is actually started, briefing meetings be organized for local residents and their full understanding and consent is ensured in the consensus-making process.

(9) Organizational set-up for project & activities implementation

The following is the organizational set-up for the implementation of wind power generation projects recommended by the Study Mission.
Diagram1: The organizational set-up for project & activities implementation recommended by the Study Mission

In the organizational set-up for the implementation of the Project Concerned, the power receive contract is meant by MEA and the wind power generation entity is meant by the local company who is the company implementing the Project Concerned.

(10) Funding plan

When financial institutions are looked for that may provide funds for wind power generation projects, the Revolving Fund or ESCO Fund may be thought of. These Funds have been established by the Thai Government to promote & expand the development of renewable energy sources. However, the ceiling of funding per project is 50 million Baht and the payout period is normally 7 years. Therefore, it would be difficult for wind power generation projects to apply for funding from these Funds. The reason is that the ceiling of funding is too low for wind power generation projects which involve huge initial cost and that they have to depend largely on wind state and accordingly have more difficulty in getting a clearer future perspective of revenue & profitability. Moreover, there has been practically no record of such wind turbine projects having received funding from these Funds. Funding from private banks may be conceivable. However, here again terms & conditions for funding are far more severe than those of these Funds including higher interest rates.
BOI provides tax incentives such as corporate income (normal rate of 30%) tax exemption for a period of 8 years (for a period of 5 years following the initial 8 years, an exemption of 50% applies) and exemption of import duties of 7% for the import of machinery & equipment. These measures also apply to wind power generation projects. However, the realities are that even these incentives have not widely applied for by wind power generation entities because of high initial cost in projects, which makes these incentives hardly attractive.

It is difficult for wind power generation entities even through these incentives to take care of their initial cost. This difficulty is considered to be one of the major factors that hamper the spread and development of wind power generation in Thailand. Therefore, financial assistance for initial project cost will become an effective leverage item in the incentive package under the new mechanism.

(11) Measures designed to promote the introduction of Japanese technologies

The promotion of wind turbine projects in Thailand will contribute towards to sustainable economic development in Thailand including the creation of new jobs through the transfer of operation & maintenance know-how in conjunction with project implementation. As regards financial assistance, which is an element as important as technological transfers, more realistic assistance is required under the new mechanism in view of the above-mentioned constraints of the existing Thai Renewable Energy Sources Promotion System (Revolving Fund and ESCO Fund) that pose difficulties for wind power generation projects. In designing the new mechanism, what is important is a comprehensive package type of content comprising incentives both in funding and in transfer of technology & know-how.

1. Funds

It is recommended that funds shall be transferred to DESD (management organ of the ENCON Fund) for the existing ENCON Fund. The funds thus transferred shall expand the capital of Revolving Fund and ESCO Fund, shall facilitate project entities in procuring their initial cost (that will allow the provided funds to be most effectively used) together with the proposed prolongation of the payout period. In this way assistance shall be strengthened for wind power generation business handicapped by unclear revenue & profitability perspectives.

2. Technology

In Thailand wind state that prevails is generally unfavorable for wind power generation. In the future more wind power generation projects will have to be implemented in the so-called low wind velocity (wind velocity of less than 6m/s) areas & regions. The most suitable solution for such projects to be implemented successfully and with economic viability will be
to take advantage of Low Wind Velocity Oriented Wind Power Generation proposed by this Study.

3. Know-how

Generally speaking, a wind power generation project consists of 3 phases, namely Planning, Construction, and Operation & Management. And at the final stage of Planning, the selection of a wind turbine type is made. Because of this, it will be difficult to provide direct assistance under the new mechanism at the Planning phase.

However, measures to provide know-how assistance & support such as dispatching supervisors and giving local training & education right from the Planning phase, will contribute to the development of the wind power generation business market in Thailand. These measures will prove to be a vital element of support & assistance that enables the subsequent Construction Works and Operation & Management (O&M) phases to be smooth. For this very reason, know-how assistance & support should cover the Planning phase. And it is proposed that once Japanese wind turbines have been selected, the cost incurred in the process leading up to such selection be also funded under the new mechanism.

On the other hand, the Construction Works and Operation & Management (O&M) are matters that should arise after the selection of wind turbines have been made. Therefore, direct assistance & support under the new mechanism are applicable to them. Construction know-how and O&M know-how stocked in Japan are considered to be highly effective in promoting the introduction of wind power generation in Thailand.

According to the data collected in this Study, the efficiency and performance of both Japanese and European wind turbines have been almost equivalent in low wind velocity areas. As regards prices as well it has proved to be that there is no significant difference between Japanese and European products if the recent basic trends of the appreciated yen are to be corrected.

If Japanese products become more competitive in prices, they will be able to expand their market share in Thailand. Therefore, Japanese manufacturers are requested to make further efforts in reducing prices.

Moreover, for projects lacking sufficient economic viability such as the project the Site Concerned, it will be possible to improve their economic viability through financial and know-how assistance that will be provided under the new mechanism.

Assistance & support provided under the new mechanism will help spread the introduction of Japanese wind turbines even into low wind velocity regions and will contribute to further promotion and diffusion of wind power generation projects in Thailand.
(12) Future perspectives and agendas

Major agendas for further expansion of wind power generation business in Thailand under the new mechanism and measures proposed to address such agendas will be summarized as follows;

1. Agendas
   - What is required is providing direct financial assistance through the best use of BOCM as well as creating a suitable mechanism that can provide up-front financial assistance.
   - Policy measures must be introduced to provide direct assistance for wind power generation.
   - In the event that BOCM credits have market floatability as CDM-CER, the economic viability of projects become unclear due to price fluctuations

2. Proposed policy measures
   - A mechanism shall be created to enable direct financial assistance, especially up-front financial assistance to be provided.
   - It is proposed that a Fund should be created within ESCO Fund or within Revolving Fund to enable direct assistance for wind power generation projects.
   - Credits should be traded at a fixed price to ensure clear revenue & profitability perspectives.

5. Result of investigation on co-benefit

The subject of verification of co-benefit effects in this Study shall be Air Quality Improvement. And the target items of assessment shall be CO2, NOx, SOx and particulate matter. Wind power generation has large power variation. Therefore, among thermal power generation types that are able to complement and follow such variation and whose power adjustment is relatively easy, GTCC (Gas Turbine Combined Cycle) shall be selected as its alternative power source as it has a large total capacity in Thailand.

In considering the introduction of wind power generation under the new mechanism, 4 target figure cases were assumed as shown in Table 4. Table 6 shows the amounts of air pollution substances to be reduced in each studied case by 2022 as the result of wind power generation introduced.

Table 6 : Amounts of reduction of air pollution substances per studied case as the result of introduction of wind power generation under the new mechanism(unit=ton)
Against the target value of introduction of wind power generation (800 MW), Case A: 10% achieved, Case B: 30% achieved, Case C: 50% achieved and Case D: 100% achieved are assumed.

6. Result of investigation on contribution to sustainable development

This Study aim to help achieve the policy objectives of Thailand by way of promoting the introduction of Japanese wind turbines into the wind power generation sector in Thailand. As indicated in 4(11) Measures designed to promote the introduction of Japanese technologies, this Report has proposed the idea of creating a package mechanism combining both Hardware and Software elements as the policy measures under the new mechanism.

In the Hardware domain, financial assistance for initial cost funding is proposed in order to improve the economic viability of wind power projects. In the Software domain, know-how assistance such as dispatching Japanese experts as supervisors is proposed in order to cooperate in the collection & appraisal of wind state data and the selection of technologies to be applied, etc. in which Thai project entities tend to be less experienced. Especially it is difficult to provide, on a business basis, assistance in the Software domain. Therefore, it is more advisable that such assistance be provided as a government policy measure under the new mechanism.

Such package policy measures comprising both Hardware and Software elements will promote the introduction of Japanese wind turbines into the Thai wind power generation business market and thus will contribute to the stable growth of the wind power generation sector in Thailand. Moreover, as a second order effect new industrial sectors will be developed as exemplified in the creation of new employment opportunities created in the construction of wind power generation stations and the operation & management of such stations.

As a matter of the future, the domestic development and construction of their own wind turbines in Thailand will become possible through know-how transfers. The development and
promotion of their own sustainable wind power generation business can be expected.

The attractive points of this bilateral off-set project for Thailand will be that both Hardware and Software assistance can be expected. The major positive effects in the Software domain will be as follows:

- Efforts to achieve the target figure for the introduction of wind power generation set in AEDP (2008-2022) will be facilitated.
- Know-how assistance provided under this Project will contribute to Thai efforts to develop and produce domestically Thai own wind turbines
- New job opportunities will be created through the promotion of introduction of wind power generation.