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Burgos Wind Farm Project

The Philippines

Technical Desk Review

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Abstract (max. 2000 char.):

This report presents the findings of the review, commissioned by the World Bank, of a 30MW wind farm in the northern Philippines being developed by PNOC-EDC. The review scope is limited to a desk review of some of the tender documents and the annual energy production estimate made by PNOC-EDC. In general, it is the reviewers' opinion that the documents provide the correct framework for a successful project and sufficient energy analysis for the financial investment. However, a major exception is the specification of the wind turbine itself, which appears to allow a wind turbine that may be inappropriate for the site conditions.

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Preface

This report presents the findings of a review carried out by Risø National Laboratory of a proposed 30MW wind farm in Northern Luzon, The Philippines. The review was commissioned by the World Bank under contract No. 7140284 and is intended as a brief second opinion desk review of the technical, contractual and financial aspects of the project. As such, the review has focussed on documents received from the World Bank and PNOC-EDC, who are developing the project. These documents have been referenced as necessary in the report.

The 30MW wind farm is currently at the pre-bidding stage and so no detail design for the wind farm exists, as this is the responsibility of the chosen contractor. The scope of the review is, therefore, to make an assessment of whether the contract documents (and the estimates of the annual energy production) are likely to lead to a successful project.

The report first addresses specific questions that were posed by the World Bank which usefully serve as an Executive Summary. In-depth comments are then given on the findings of the review in the subsequent sections.

1 Responses to Specific Questions

There were specific questions asked for the review to answer and the responses are given below. However, more detail is to be found in the following sections which contain the detailed comments.

a) Was the wind collection methodology consistent with international practice and adequate to support the investment decision?

The wind data collected appears to be of a sufficient quality to be used for the financial analysis. The duration of data collection used (one year) is regarded as the minimum that can be used by international standards. The extrapolation necessary to hub height introduces an uncertainty to the energy production result but it is still considered reasonable to use it in the financial analysis.

b) Is the selected wind turbine type compatible with the characteristics of the site?

As the documents are tender specifications, there is no selected wind turbine. However, the requirements are not very specific and may lead to a type of turbine being chosen that is not compatible with the site conditions. It is recommended that the contractor be required to propose a suitable class and that the standard turbine has a full Type Certificate according to IEC WT01. Modifications with a Design Evaluation certificate according to IEC WT01 may be acceptable.

Is the wind turbine layout optimal?

There is, as yet, no defined layout as this is the responsibility of the contractor to select the exact turbine positions. However, it seems that the locations chosen by PNOC-EDC are a good compromise within the constraints. The Risø calculations show only a minor improvement could be made by some small relocations.

Was there adequate consideration in the design of the potential impact of typhoons that are frequent in the area?

Again, as these are tender documents there is no design proposal to assess. However, the documents do contain adequate warnings to the Contractor about the particular conditions of the site. Please also refer to comments above on wind turbine type. The extreme winds stated in the specification appear to be based on an old edition of the National Structural Code of the Philippines. It is suggested that these are checked with the latest edition to ensure that they are in line with the current recommendations. It is also recommended that the IEC 61400-24 standard is applied for lightning protection.

c) Is the annual energy production estimate realistic?

The calculations carried out by Risø using the Vestas V80 2MW machine agree very closely with those by PNOC-EDC and would, therefore, be *considered to be realistic. We understand, however, that the layout to be used will yield a slightly lower production (2% by this review) than that given in the Feasibility Study Update. It should also be highlighted that the figure used in the financial analysis appears to be an average between that obtained with the Vestas V80 and that with the Mitsubishi MWT-1000. This does not have any practical meaning. As the viability of the project is very sensitive to the annual energy production this could give a misleading result. It is recommended that the analysis is carried out using the lowest production estimate so that the result is conservative.*

d) Were the potential impacts of integration into the grid properly analyzed and provided for in the final design?

The final design has not yet been done as the contract has not been awarded, but a System Impact Study (SIS) was commissioned by PNOC-EDC for the original 40MW wind farm which showed that, with some reactive power compensation measures, the grid integration was acceptable. The grid connection has now been downsized but PNOC-EDC considers that it is sufficient for the 30MW wind farm and no new SIS has been commissioned. The Contractor is, however, obliged to carry out a new SIS and this review agrees with this approach.

e) Are the investment cost estimates, especially of major equipment, reasonable?

Compared to standard international projects the estimates appear high. However, given the constraints and special conditions of the project (site access, typhoon risk, loan arrangements, etc.) they are considered realistic.

f) Critically review the technical specifications provided in the bidding documents: are the technical specifications adequate?

With the major exception of the certification of the wind turbines and some minor issues, the technical specifications appear adequate.

g) Please review the EPC bid document and comment on its consistency with international practice for turnkey wind farm projects. In particular, please comment on the sections referring to “Guaranteed Items” that are intended to protect the interests of PNOC-EDC in the event of defects in design or inadequate technical performance.

The documents appear to be what would be expected for this type of contract. The guaranteed items (defect liability, availability, power curve and main transformer losses) are consistent with each other and would give an adequate level of compensation if their use were necessary.

2 Contract Documents

2.1 General Comments on Volume 1 and 2

The contract documents appear to include what is general good practice. The structure is as would be expected for this manner of contract: Volume 1 [1] contains both the general and specific contract conditions and the technical requirements are all contained in Volume 2 [2]. As is normal, there are repetitions of some items between the general and the technical specifications, with some conflicts that will need to be sorted out (either now or on site during construction). Some spurious clauses are found now and then together with some missing, blank or incorrectly cross-referenced clauses. The Special Contract Conditions are also rather out of sequence but this does not reduce its functionality. In general the contract could be improved by some co-ordination and ensuring that consistent terms are used throughout.

2.2 Overall Comments on Volume 1 and 2

The following are overall comments that have been extracted from the review either because they are particularly important or some action is recommended. For more detail, please refer to the specific comments in section 2.3 and 2.4.

- The downsizing of the wind farm from 40MW to a minimum of 30MW appears to have been covered in the documents, although the minimum rating of 600kW for each WTG remains.
- The transmission connection (and associated works) from the wind farm to the Laoag substation has been removed from the JBIC ODA funded contract and is to be constructed separately by PNOC-EDC. This means any interface programme problems/delays are now the responsibility of PNOC-EDC. In the programme given in Table 8 of the Project Feasibility Update the completion of the transmission line is too close to the finishing of the wind farm. PNOC-EDC do, however, have a lot of experience in transmission line construction.
- It looks as if the existing System Impact Studies by Transco (2001) used a double 230kV circuit connection, operating at 115kV. We understand that PNOC-EDC have taken due consideration of the impact of reducing this to a single circuit 115kV. The contract requires the contractor to obtain an updated System Impact Study from the grid operator.
- The specification for the wind turbines is somewhat unclear and, in the reviewers' opinion, insufficient. The words "Certificate of Design Approval" are used in many places but this is not a recognised certificate under the IEC WT01 standard. No specific class is required and the turbine does not have to have full certification. Requirements for any site-specific modifications are equally low. It is recommended that a class is specified together with certification according to IEC WT01 and, at a minimum, the modifications required to make it suitable for the site conditions should have an IEC WT01 Design Evaluation certificate.
- The requirements for the wind turbines are rather spread throughout the documentation, so it is somewhat difficult to be sure that something is included or not included. Another advantage of requiring compliance with the Certification standard is that it ensures items are not forgotten.

- Adequate warning seems to have been given of the site location, difficulty of access, remoteness, corrosive atmosphere, lightning strikes and typhoon occurrence. The Contractor cannot say he was not made aware of these.
- By signing the contract, the Contractor is bound to operate and maintain the wind farm for two years following completion. The price is fixed for the O&M at 288 000 USD per year. This ensures a simpler evaluation procedure, although it is somewhat unusual. The O&M contract documents have not been reviewed here.
- The Defects Liability period is two years. This appears to be at the lower end of defect liability periods being currently contracted and the trend is more towards five years.
- There appears to be no Liquidated Damages if the wind farm fails to meet the power factor requirement in the specification. However, we understand that there are also no penalties to be paid to the grid operator if reactive power consumption is too high.
- As PNOC-EDC are constructing the 115kV line themselves, the Contractor should be specifically asked to state when they need the grid connection (the earliest will probably be for testing, etc.). This should be a milestone item on the Contractor's programme. It is not clear if an evaluation has been made of how much of the testing and commissioning can be done on a temporary (site) supply.
- The in-depth requirements for the SCADA system may well mean that they cannot be met by a manufacturer's standard system. Manufacturers may then increase their price to give a bespoke system or may just provide a standard one in the hope that it will be accepted. This may mean two bids are not comparable.
- Usually, there is a statement in contracts of this nature about who receives the payment for the electricity generated during testing and commissioning.
- It should be noted that the contract documents contain quite a lot of work that is to be done by PNOC-EDC. Not only is there the 115kV transmission line but also some works at the Laoag sub-station and the main access road(s) to the wind farm are the responsibility of PNOC-EDC. They have also taken on all responsibility for negotiations with landowners and forbid the Contractor to enter into any discussions.
- The documents also place quite a heavy load on PNOC-EDC's site "supervision" team. There is a lot of documentation required from the Contractor at various times and at various levels of details. This concerns design, QA, construction and testing documentation. There are also opportunities to go to factory tests and to attend site testing. This is a very good thing (providing the resources are available) because it is an excellent way to get to know the wind farm and how it is put together, but there is much mention of "approvals". Whilst there is the standard disclaimer that an "approval" by PNOC-EDC does not relieve the Contractor of any of his obligations, it can sometimes be used as a delaying tactic by a Contractor who is pushed for time/money. Of course, PNOC-EDC is very experienced in the construction of geothermal plants and it would be expected that they would draw heavily on this when administering this wind farm contract.
- From this review, the rules for interim payments as the project progresses are a little confusing. Detailed comments are in section 2.3, but initially it seems if the Contractor has to propose payments at readily identifiable milestones (the "Disbursement Schedule"). Then, it seems that the contractor will get payments monthly. Later, 75 % payments are said to be made on delivery of equipment and completion of services. Then at the end of the Special Conditions, there is a table that states 90% payments at various

milestones. How these match up with the Disbursement Schedule and the 75% and 90% payments are reconciled is not clear.

- It is not clear if Liquidated Damages are able to be applied at stages during the project if there is a delay or if they can only be applied if the Time for Completion is exceeded.
- There should be some mention of creating a list of outstanding actions at the stages of Taking over and Final Payment.
- There appears to be no Escrow agreement required, whereby confidential detailed design and manufacturing information is made available if the manufacturer becomes insolvent.

2.3 Detailed comments on Volume 1: Commercial Provisions

Part I Invitation for Bids

No comments.

Part II Instructions to Bidders

Clause 2.6.33 p. 4 “Performance testing of 10%...” It is recommended that only one turbine is tested for performance. See comments under Volume 2, Appendix 1, page 163, “Performance Tests”.

If the area is subject to significant precipitation and/or flooding then drainage should be mentioned in this section, together with a warning to this effect.

Clause 15.6.2 “Bidder’s Proposed Disbursement Schedule” It is recommended that the “readily identifiable milestones” that are proposed by the Contractor are required to match up with specific items on their programme. In this way payments and progress can be checked easily. Quite often these two items are produced separately by the Contractor which makes monitoring of them difficult.

Annex 2 Evaluation Methodologies for Price Proposals p. 32. The evaluation is carried out on a bid price per kWh basis, i.e. without considering O&M costs. This is simple and straightforward, if a little unusual.

Part III General Conditions of Contract

Tests and completion, p.2 - 3 : It is assumed that the “Taking Over” certificate equivalent to a “Substantial Completion” certificate.

Clause 2.6, p.9, para 5, “prosecution of the works”: it should be checked if this gives the intended meaning.

Clause 3.1.4.1, p.17, para 1. The Programme of Performance should definitely include the projected Taking-Over Certificate date. It should also align with the milestones that are proposed in the Contractor’s Disbursement Schedule.

Clause 3.15 (b), p.19. “…shall cause to be inserted….” is not very clear wording.

Clause 4.1, p.22, there should be some mention of International Standards.

Clause 6.6, p.30, para 6. This implies that for the Tests after Completion that the Contractor does not have to supply labour, etc. However, it could be envisaged that the Contractor will need to provide some input. It should also be clarified if these are the performance warranty tests.

Clause 6.6, p.30, para 8. This implies that PNOC-EDC is to issue test certificates or endorse the Contractor's certificates. It should be noted that this may mean PNOC-EDC attracts quite some responsibility for the tests.

Clause 7.2, p.32. "Time for Completion". This states that, "The whole of the Works and its various stages, as applicable, shall be completed …..within the time stated…". It is not clear what is meant by "…various stages…". It may be that there are stages at which, if the contractor is delayed, then penalties can be applied. Or it could be that this is only at the project completion.

Clause 7.3 Extension of time for completion. This should just be an extension of time – no money payable to the contractor. It is sometimes normal to allow the Contractor an extension of time if the wind speed exceeds a value beyond which it is not safe for the erection of the wind turbines.

Clause 7.5, p. 33. Liquidated Damages for Delays. This states that "…the Contractor shall pay…as liquidated damages…for every day or part of a day of delay which shall elapse from the relevant Time for Completion at various periods, if required, for different stages of Works…". It is unclear if it is intended to have different stages of the works at which liquidated damages can be applied or not. This should be clarified.

Clause 10 page 37: Tests after Completion. It is not entirely clear if there are Tests after Completion in this contract.

Clause 10.1, page 37, para 3. "…complied…" should read "…compiled".

Clause 11.2, page 39, para 1. Remedying defects. It is not clear why it should be PNOC-EDC's responsibility to notify the contractor of defects during the O&M contract period, as the contractor responsible for O&M. This should be clarified so that PNOC-EDC does not become responsible if it fails to report a defect.

Clause 11.3, page 39. Cost of remedying Defects. This seems to say that there is the possibility for a defect to be PNOC-EDC's responsibility. This shouldn't be in the definition of a "defect".

Clause 12.5 a), page 42. It appears here that applications fro interim payments are to be made when milestones are completed but in Vol. I, Clause 15.6.2 page 17 it seems as if payments are to be made monthly. It could be simpler to administrate if applications are made monthly as well.

Clause 12.7 Taking over certificate and outstanding actions – there may need to be some formal arrangement for recording the actions that are remaining after the Taking Over or Final Taking over.

Clause 13, page 45. Variations. All variations, unless otherwise stated, shall be carried out according to the conditions of contract.

Clause 14.2, page 46, para 1. "…therefor…" should be "…therefore…"

Part IV Special Conditions of Contract

Clauses 9.2 and 9.3 should not be blank.

Clause 9.4. Blank space should be filled in.

Clause 9.5 As the number of wind turbines in the wind farm will probably be less than originally envisaged (due to the reduction in total capacity and also the likelihood of larger turbines being used) then using 10% as a figure to start the defect liability obligation is rather small. An actual number could be considered to be used instead.

Clause 9.6.2, page 4, para 1., It is not clear where “Appendix 4 to the Form of Contract Agreement” is to be found.

Clause 9.6.2, page 4, para 2., Aggregated Liquidated Damages. The use of “…such as..” appears a little weak. It is fairer to state all the possible LDs that cannot exceed the 10%.

Clause 9.6.2, page 4, It is not clear if the max 10% of the contract price of LDs for not meeting programme deadlines is completely separate or not.

Clause 9.6.4.1 page 5. Section 1.0 of Appendix 2 of the Technical Documents (assume this means specification) refers to maps and drawings, and not availability demonstration as indicated by this clause. It may be that it should refer to Appendix 1.

Clause 9.6.4.2 sub-clause 1, 1st month…..the equation needs to be cleared up i.e. what is written, (Ag/Av-1), is not mathematically the same as ((Ag/Av)-1), which is what is meant.

Clause 9.6.4.2 sub-clause 1, All remaining periods…The method of computing Av should be stated, as has been done in the other periods.

Clause 9.6.5.1, page 7. This should refer to section 2, not section 3.

Clause 9.6.5.2, page 7,. There appears to be no clause 12.3.3 of the SCC which should detail the sums payable to PNOC-EDC.

Clause 9.6.5.4, page 8., definition of AEP_{Test} : A definition of the Consultant is given in the Technical Specifications but it is recommended that it should also be in Volume 1.

Clause 9.6.6.1, page 8. There appears to be some incorrect cross-reference as there are no clauses 12.3.1 and 12.3.2 as stated here.

Clause 9.6.6, page 8. Reference should be made as to where the Noise Level Guarantee and relevant requirements can be found.

Clause 11.2.1 page 10 This states that 75% of the CIF cost is to be paid on delivery of equipment to the site and a further 10% is paid when the Power Curve Performance Certificate is issued. It is unclear what happens about the remainder and how these part payments work with the previous clauses about payments which indicate payments are to be according to the Schedule of Disbursements and/or monthly payments. Furthermore, Clause 11.2.4 on page 12 indicates, for instance, that 90% of the payment will be made upon delivery of (it is not clear if this means all) wind turbines to the site. It is not immediately apparent how these clauses work together.

Clause 11.2.1.4 This clause appears unfinished.

Clause 11.2.3 page 12. This clause refers to a schedule of milestones in clause 15.1.3 but there is no 15.1.3. It could be that it should be 11.2.4. This also states a 75% - 10% split for the payments for works and services. It is unclear how this works with the 90% payments stated in Clause 11.2.4.

Clause 11.2.4 page 14. This states that 90% payment is to be made "…upon completion of all installation work of all WTGs…". It would be usual to split this up into groups of turbines.

Summary of Guaranteed Items and Liquidated Damages

1. Guarantee against defects in design, materials, equipment and workmanship.

This states that Contractor has two years in which he repairs/replaces defects. If 10% of the same equipment falls within the Warranty period then this is deemed a generic/serial defect. This equipment is then re-designed, re-certified, and all parts in all WTGs replaced. It is not clear when the warranty for this equipment starts.

2. Availability Guarantee

First month after Take Over Certificate – minimum availability =	65%
Second month	75%
Third month	85%
Subsequent until end of defects liability	95%

An energy deficit is calculated using the actual and guaranteed availabilities, which is then used together with the average price of electricity to give the LD payable to PNOC-EDC. There is no incentive for the Contractor to over-perform.

During months 22 – 24 of the defects liability period there are additional LDs:

95%	0
92.5-94.99%	1.25M USD
90-92.49	3.25M USD
Below 90%	7.25M USD

3. Guaranteed Performance Curve

One WTG should be tested in accordance with IEC61400-12:1998 and a capacity deficit for the wind farm calculated. If there is a capacity deficit then the Contractor makes a one off payment to PNOC-EDC, if the WTGs are not corrected, of:

Deficit	<1000kW	1500 USD per kW
	>1000kW < 2000kW	3000 USD per kW
	>2000kW	4000 USD per kW

4. Guaranteed Noise Level

If the wind farm does not meet the guaranteed noise levels then the Contractor shall pay any fines, etc., that are due. Also, they must either gain an exemption from the relevant authority or put right the installation such that it complies.

5. Main Transformer Loss

If the transformer losses are greater than those guaranteed in the bid documents then the Contractor shall pay PNOC-EDC:

No-load losses	10.5 USD per W over the guarantee
Full-load losses	2.5 USD per W over the guarantee

Overall comment

These items are in line with international practice and will provide reasonable compensation should the performance fall below the guarantees. The payments do, however, stop after the defects liability period so the loss of earnings is not covered for the lifetime of the wind farm. The sums involved are big enough, however, to serve as encouragement to provide equipment that performs well.

2.4 Detailed comments on Volume 2: Technical Specifications

1. General Provisions

Clause 1.2, para 2, page 1: It should be ensured that the O&M contract is co-ordinated with the warranty and defects liability.

Clause 1.3, page 2, Defects Liability – starts on Take Over and finishes 24 months after the Final Acceptance. In Volume 1 it states that the Defects Liability period is two years from the Take Over (not Final Acceptance). This should be clarified, especially as the O&M obligations always refer to the period of Defects Liability.

Clause 1.6.1, page 4. It is unclear if the electrical termination point is the outgoing terminals on the HV circuit breaker.

Clause 1.6.3, page 9, "Wind Turbines". The description of the requirements is repeated many times in the document and the review comments apply to them all but, for simplicity, they will only be stated once here. These are also the most important comments.

The wording used is not very clear and "Certificate of Design Approval" is considered insufficient for the project. It could be that this is referring to the Design Evaluation module of IEC WT01 but even so it is considered that this is not sufficient. We recommend that a full Type Certificate according to IEC WT01 be requested. It is possible that only the special modifications needed to make the turbine suitable for the site conditions are covered by a Design Evaluation, providing the standard machine, of a particular Class, has a Type Certificate.

It appears from the requirements that a standard production model would be accepted with only "details of any changes" and "documentary evidence" being necessary for the modifications that are necessary to make it suitable for the site. (Only if the Contractor proposes a Class S machine is a site-specific certification required. It is unlikely that a Contractor will go to the expense of obtaining a Class S certificate if it is not a requirement.) There should also be some statement about the major components of the standard WTG that meet the Type Certificate also meeting the site-specific conditions. The "associated model" should be close to the site-specific WTG.

Clause 1.6.4, page 12, "Civil Works". The Contractor is required to submit calculations for the turbine foundations. As the foundations will almost certainly not be the standard ones that are covered by the Type Certificate, it is recommended that the calculations are checked by an independent designer.

Clause 1.15, page 26, Project completion within 18 months of Contract effectivity. This does not seem to agree with the Special Conditions of Contract Part IV, clause 3 which allows up to 24 months.

2. Site Location and Design Particulars

Clause 2.2.2, page 27, "Site air density". The air density is stated as an average of 1.16kg/m^3. In order to calculate extreme loads correctly it is not sufficient to just use an average. A range of densities would be more appropriate.

Clause 2.2.3, page 27-28, “Extreme wind speed”. General note: if there is the likelihood of sand being carried by the high winds then consideration should be given to the paint protection being sufficient to withstand this.

Clause 2.2.3, page 28, “Extreme wind speed”. It is understood that the figures given for the extreme winds at different heights are derived from the assessment carried out in 2001 [6]. This uses the 4th edition of the National Structural Code for the Philippines (1992) as a reference for the calculation of the extreme wind speeds. Comparing this to the 5th edition (2001), it appears that there are some changes in the calculation methodology. It is recommended that the differences are checked to ensure that the extreme wind speeds quoted in the specification are still current.

Clause 2.2.3, page 28, “Extreme wind speed”. It is noted that there is a statement saying that “Extreme site wind speeds can be linearly interpolated for higher heights not given herein”. The 5th edition of the National Structural Code of the Philippines gives a table of height-dependent coefficients that are not linear, but which extend up to 150m above ground level. Therefore, it may be considered that extrapolation *beyond* the heights given in the specification is not necessary, although the Code does consider linear interpolation *between* the heights given to be acceptable.

General note: there should be a turbulence intensity figure associated with the extreme winds, together with a recurrence interval for the extreme winds.

Clause 2.2.4, page 28, “Seismic forces”. It should be checked if the reference to Zone 4 relate specifically to a code in The Philippines. If this is as onerous as it is in other earthquake codes (USA, India, etc.) then operational as well as standing-still situations are to be analyzed. The figure given indicates a static figure which would not give the worst case. If it is an area of intense seismic activity then a time simulation is needed.

Clause 2.2.6, page 29, “Additional climatic conditions”. It might be helpful to the contractor if some of the following are mentioned : site slope, liability to flooding, solar radiation levels (the standard solar radiation considered in the Type Certification is $1000 W/m^2$ – it should be considered if this is sufficient for this site) and any possibility of hailstones/snow/ice.

3. The Wind Farm

Clause 3.1.1, page 33, para 1 “…multiple wind turbines of similar make and model in the range 600kW minimum.” It is suggested that they should be the same.

Clause 3.1.7, page 25. Lightning Protection. The standard “Wind Turbine Generator Systems, Part 24: Lightning Protection”, IEC 61400-24 is recommended as the standard to be used for lightning protection specification.

Clause 3.2.4, page 37-38, “Standards and Codes”. This should include IEC WT01.

Clause 3.2.6, page 39, Noise Levels. The point of measurement is not specified.

Clause 3.2.9, page 43, paragraph 2. Manual lubrication being preferred to automatic seems a little strange.

Clause 3.2.9, page 43, paragraph 3. The requirement is that following an emergency stop the brakes must automatically reset or be able to be reset from ground level. Automatic resetting is not recommended.

Clause 3.2.10, page 43, “Drive train requirements”. If ambient temperatures can be excessive then this should be brought to the attention of the Contractor as some special measures may be required.

Clause 3.2.25, page 48, “WTG Lightning Protection”. The WTG should be protected according to IEC 61400-24 “Wind Turbine Generator Systems, Part 24: Lightning Protection” such that the requirements for the severity lightning activity in the local area are fulfilled. This comment is also relevant to Clause 3.1.7, page 35, and the IEC standard should be included in the list of standards in Clause 3.2.4, page 38.

Clause 3.2.31 Power factor correction. There is some confusion over the requirements. Clause 3.1.6 says wind farm output shall be controllable from 0.97 inductive to 0.99 capacitative and says that pf correction equipment can be in either WTG or substation or both. Clause 3.2.31 says the wind farm is required to deliver at unity power factor and that pf correction is at both WTG and substation. Only if synchronous generators are to be used does this clause require a controllable pf of between 0.95 lagging to 0.95 leading.

Clause 3.2.33, page 52, “Maintenance and Safety Characteristics”. “Means of securing nacelle or nacelle parts in case of temporary removal”. This is not very clear. There is mention of securing the rotor by means other than the brakes but this goes for the yaw and blade pitch mechanisms, as well. (A good reason for adhering to the Type Certificate standard is that it ensures nothing is forgotten.)

Clause 3.3, page 57, SCADA system. This section seems rather out of proportion to the rest of the technical specification. The requirements also seem to be somewhat excessive and may result in a non-standard package which could be costly. For example, the ability to provide derived data points (Clause 3.3.2.2.6, page 62) is rather unusual.

Clause 3.3.5.6, page 80, Site Acceptance Test of the SCADA system to be carried out by PNOC-EDC. It is not clear if this forms part of the Tests on Completion. The readiness of the rest of the Works should be stated so that the Contractor is aware of when this should be programmed in.

Clause 3.3.8, page 82, para 5. “Accommodation, transportation and meals for the Contractor’s stall shall be provided by the Contractor while on site.” This, and other clauses in section 3.3 read as if there is a separate contract for the SCADA system, which is not the case.

Clause 3.4.9.1, page 119, para 3. There should be an item (d) about essential control of the wind turbines during loss of grid connection. Some wind turbines may require to be yawed for extreme wind survivability. It does appear to be mentioned in the following paragraph but not explicitly.

Clause 3.4.11.2, page 128, para 3-5. This rightly requires a re-run of the System Impact Study by TRANSCO with the project-specific data from the Contractor. It should be noted that TRANSCO may have other reasons for power factor correction other than the provision of reactive power (e.g. voltage stability).

Clause 3.10, page 135, Met stations. This specification appears somewhat thin. For example, there should be more specified about the anemometers.

It is not clear who is providing the telecommunications line to the sub-station (e.g. telephone) or if it is all by GSM.

4. Installation, Commissioning and Testing

Clause 4.1.8.5, page 147, Cable Labelling: it is a good idea if the cable labelling and schedules allow tracing of the cables back to the drum number and manufacturer.

Clause 4.2.2, page 150. The SCADA tests on completion imply that it is the contractor who does these. In Section 3.3 there are tests specified that PNOC-EDC carry out by themselves prior to the issue of the Completion Certificate. It is uncertain how these two tests co-ordinate, especially with respect to any payment related to the completion of the SCADA system.

Clause 4.3, page 152. Performance testing – this refers to Section 8 which does not appear to exist. Maybe Section 7 is meant, although this just refers to Appendix 1.

Clause 4.4, page 152. Noise level tests – this section just reiterates the design requirements. It may be worthy to note that, it is general practice not to carry out noise level tests of wind farms. It is considered more appropriate and sufficient to carry out design calculations using internationally acknowledged methods and software simulations (for example using WindPRO) that demonstrate that the wind farm meets the noise criteria.

(5. Cranes, hoists, lifting equipment and maintenance equipment
This is an item in the table of contents but is missing from the body of the text.)

5. Spares and Tools

Clause 5.1, page 155. There is a little confusion over the spare parts. Clause 6.7 of the General Conditions of Contract say that the contractor should provide “such spare parts and special tools as PNOC-EDC may elect to purchase from the Contractor”, which indicates they are not part of the contract but extra purchase by PNOC-EDC. This clause 5.1 seems to imply that the supply of spares is part of the contract. This also needs to be tied in with Clause 8 of the Special Conditions of Contract which is rather blank. Overall co-ordination is required. The procedure for working out how many spares are to be provided is rather inventive.

Contracts sometimes require that spares be guaranteed to be available for a certain number of years.

6. Packing, Shipping and Transport

No comments.

7. Warranty Agreements.

Clause 7, page 160, para 1. “The Contractor shall specify the conditions of the warranty to be provided.” Consideration should be given to stating some requirements for these warranty conditions in the contract. Also, it may be that defect liability and performance warranty are being confused.

Appendix 1 Performance warranties

Clause 2: page 163. 2.1.5 Test Procedure: IEC61400-12:1998 Wind Turbine Generator Systems – Part 12 Wind Turbine power Performance Testing. It is recommended that the test is based on the latest edition of the IEC 61400-12-1 December 2005.

Clause 2.1.3, page 163. This refers to 5 (five) tests at various times during the defects liability period. However, they are not referred to later on in the test descriptions. It is, therefore, not clear how many tests are intended.

Clause 2.2 page 164-165. It is not clear how many WTGs are to be subjected to the “Test”. Clause 1.6.2.4 of the Tech Spec says 10% of the total installed. This Clause 2.2.5 is written: “The power curve will be measured on the Test WTG’s selected by PNOC-EDC…”. Clause 2.2.1 says that ”It is the aim of the Test to ensure that all WTG’s Achieve their WPC”. This is ambiguous. We recommend that the most suitable WTG location is selected by PNOC-EDC and all the performance tests are carried out on this one WTG.

Clause 2.2.2, page 164, 2.2.2: It is recommended that the same consultant is used together with the same instruments to do the site calibration (if applicable) and the power performance test. It is especially important to use the same instruments and, if at all possible, to leave them on the site from the site calibration to the power performance test in order to minimize uncertainties.

Clause 3.2 page 168, (Noise) Measurements. Please refer to comments under Clause 4.4, page 152.

Appendix 2 List of Attachments

No comments on this list.

3 Comments on the System Impact Study

The System Impact Study [3]&[4] that is associated with this project is one carried out by TRANSCO for the previous version of this project. That project was intended to have a dual 230kV connection line to Laoag substation and it appears that this was the basis for the study. Therefore, there is no System Impact Study carried out by TRANSCO that considers the present 30MW wind farm as a single 115kV connection.

However, we understand that PNOC-EDC have reviewed this and consider that there is no need for a study of a single 115kV line until after the contractor has been appointed. This action appears logical. It should be noted that TRANSCO may well place power factor compensation requirements on the connection for various reasons. This is covered by the contract.

NLWPP-1 SIS Main Report Dec2001
The wind farm under investigation in this report has an installed capacity of 42MW. The results state that there is satisfactory operation but "….requires special dynamic reactive compensation…." i.e. dynamically switched capacitors. It appears that the simulations with 230kV lines are initially intended to be operated at 115kV. It is not clear if the 115kV line simulations are a dual or single circuit.

Plots of results:

Annex B-1	40MW wind farm & 115kV line (year 2004 config)
Annex C-1	40MW wind farm & dual 230kV line (year 2004 configuration).
Annex D-1	40MW wind farm & dual 230kV line (year 2010 configuration)
Annex E-1	40MW wind farm & 115kV - stability plots.
Annex F-1	40MW wind farm & 115kV - stability plots.
Annex G-1	40MW wind farm & 230kV - stability plots.
Annex G-1	40MW wind farm & 230kV - stability plots.
Annex I-1	40MW wind farm – dynamic compensation. Connection voltage sis unclear.

NLWPP-1 Additional Report
This deals with the impact of tripping of the WTG generators. The results show that situation is satisfactory. It should be noted that the 115kV connection to Laoag appears to be single.

4 Comments on the Investment Cost Estimates

The investment cost estimates are quoted in Table 1 below and are based on the bids received by PNOC-EDC in November 2004 [5] considering the later changes in the project contents and project down-scaling from 40 to 30 MW.

Wind Farm Cost Components	Quantity	Unit Prices, Million US $	Total Price, Million US $
Equipment			
1 Wind Turbine Generator	30 Units	0.98	29.43
2 Tower	30 Units	0.29	8.59
3 SCADA System	1 Lot	0.73	0.73
4 Electrical	1 Lot	4.28	4.28
5 Main Crane	1 Lot	0.98	0.98
Works and Services			
6 Preliminary and General	1 Lot	0.47	0.47
7 Detailed Engineering	1 Lot	2.51	2.51
8 Civil Works	1 Lot	2.61	2.61
9 Structural	1 Lot	5.43	5.43
10 Electrical	1 Lot	0.16	0.16
11 Inspection and Training	1 Lot	0.14	0.14
12 Testing and Commissioning	1 Lot	0.04	0.04
Spare Parts			
13 Spare Parts	1 Lot	1.62	1.62
Total			**57.00**

Table 1: Wind Farm invest estimate by PNOC-EDC. Attachment 5 of Project Feasibility Update document [5].

The investment of the 30 MW wind farm is estimated at 57 million US$ equivalent to 1.9 mio US$/MW on a turn-key basis excluding the 42 km transmission line to Laoag. The 2004 bids for the 40 MW NLWPP Phase I are probably the best available basis for estimation of project cost for a 30 MW wind farm in the Philippines under the JBIC financial scheme.

Compared to an international benchmark the specific investment of 1.9 mio US$/MW is considered high. An average project cost for a 30 MW wind farm in Europe on a plain site without too many complications would be 1.10–1.30 mio Euro/MW (corresponding to 1.40 – 1.65 mio US$/MW). This is a recent (2006) benchmark considering the price increases due to the present market situation with a strong demand and basically saturated production lines of wind turbines.

A typical breakdown of wind farm costs would be:

Item	Share of Total Costs (%)	Typical Share of other costs (%)
Turbine (ex works)	74-82	
Foundation	1-6	20-25
Electric Installation	1-9	10-15
Grid-connection	2-9	35-45
Consultancy	1-3	5-10
Land	1-3	5-10
Financial Cost	1-5	5-10
Road Construction	1-5	5-10

Table 2: Break down of costs for a medium sized wind turbine (850-1500 kW). Based on data from Denmark, Germany, Spain and UK in 2001-02. From Wind Energy, The Facts, EWEA 2004.

The project contains a number of challenges such as difficult site access involving most probably a beach operation to take the major equipment to the wind farm site, typhoon risk, and a JBIC tied loan, which all will act to increase the cost. Taking into account these issues the project cost estimate (Table 1) is considered to be realistic.

Comparing the estimated project cost from table 1 to the break-down above (Table 2) we assume that item 1, 2, 3 and 4 is the total ex works supply for the wind farm. The estimated cost of these four items is 43 mio US$ or 75% of the wind farm cost. This share is in a reasonable agreement with the typical breakdown of costs.

5 Comments on the Annual Energy Production

5.1 Digital map

PNOC-EDC prepared a digital map in WASP format describing terrain elevation and surface roughness. At the wind farm the terrain was digitized with contour levels for each 5m and further away the contour-level step was raised to 20m. The digitized area and the inner area of fine resolution extend respectively 3700m and 200m from the turbine sites. This is less detailed than desirable, and we recommend that the area of fine resolution is extended to 500m from any turbine site and that spot heights are included. This amendment is not expected to change the annual energy production (AEP) estimates dramatically, but it is good practise and not much extra work.

Evaluation of a surface roughness map in a desk review has its limitations. However, the roughness lengths in the map seem in accordance with the photographs showing bushes of a few meters height. There is little detail in the roughness map south and east of the wind farm but the prevailing onshore wind allows such simplification. The reference measurements are made at a lower level than the turbine height, so an overestimated roughness with associated enhanced wind shear would tend to overestimate the energy production.

WASP wind resource estimates are potentially biased in complex terrain. To quantify this effect, terrain complexity is gauged by the ruggedness index (RIX), where a rule of thumbs is that WASP tends to overestimate the wind by 1.5% when the turbine site RIX number is 1% larger than at the reference site. With the proposed wind-farm layout, RIX number differences range from -0.3% to +1.7%, so terrain complexity is not expected to compromise the production estimates significantly.

5.2 Wind measurements

The data used in the PNOC-EDC Burgos phase one feasibility update study [5] was measured by a NRG 9210 logger. The mast was locally fabricated and equipped with three NRG anemometers and two NRG wind vanes. These measurement seem better than the ones used in an earlier site assessment (Garrad Hassan, 2001 [6]) since

- The new anemometers had individual calibration certificates
- The mast position had been moved within the area of the proposed wind farm
- The height of the top anemometer had increased from 30m to 50m above ground level

The measurement height is still lower than the planned turbine hub height, and vertical extrapolation makes the AEP estimates a little less certain. Another limitation is that data are only available for full year.

Risø received meteorological measurement from the period Mar01-Feb02 in an MS Excel file [7], where data points with simultaneous zero wind speed and direction had been marked as suspicious. We agree that these data points should be excluded from the analysis and note that the correction only reduces the data recovery rate from 100% to 99.6%, which is still nearly perfect. Unfortunately, even when the marked data points removed, we are unable to find the same wind distribution as in the PNOC-EDC feasibility update report suggesting that we are not using exactly the same data. The discrepancies are however modest 0.2% for both average wind speed and wind power density. Our results are shown in Figure 1 and Table 3.

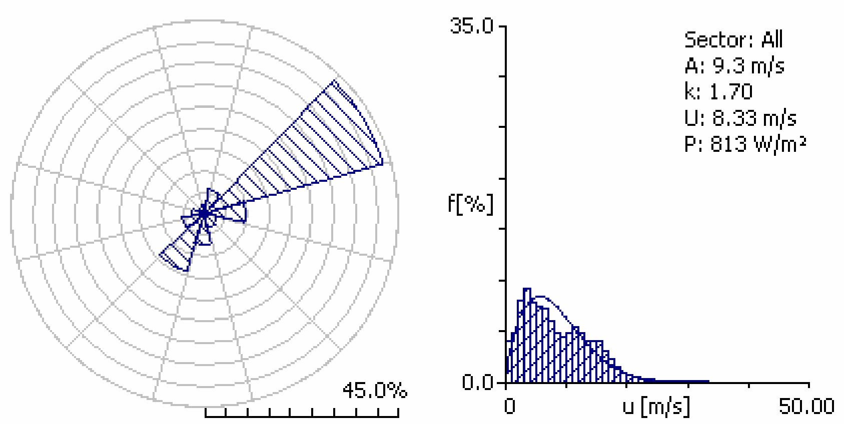

Figure 1 Wind rose and wind-speed histogram of measured data March 2001-February 2002

Table 3 Weibull distributions parameters (A, k) mean wind speed (U) energy density (E) and frequency of occurrence (f) in 30 degree wind sectors.

	0	30	60	90	120	150	180	210	240	270	300	330	All
A [m/s]	3.3	7.3	13.9	5.1	3.0	3.9	5.6	7.9	6.8	5.8	4.1	3.1	9.3
K	0.75	1.69	3.57	1.43	1.78	1.85	1.92	2.28	2.42	2.29	1.77	0.77	1.70
U [m/s]	3.97	6.51	12.55	4.66	2.68	3.45	4.97	7.04	6.02	5.11	3.68	3.58	8.33
E [W/m²]	553	392	1561	182	26	52	149	362	216	138	67	370	813
f [%]	2.3	5.7	43.2	9.7	2.9	3.3	7.1	14.2	5.4	3.1	1.7	1.3	100

In principle the observed wind climate might deviate from the long-term wind climate. However, NCEP/NCAR reanalysis wind data from the 10m level at the computational grid point 18ºN 120ºE had very similar distributions during the 29 year period 1977-2005 and the actual measurement period, see Figure 2 and Figure 3. Reanalysis data are not perfectly correlated with local observations, but they similarity indicates that it is unnecessary to correct the measured data for deviations from the long-term climate.

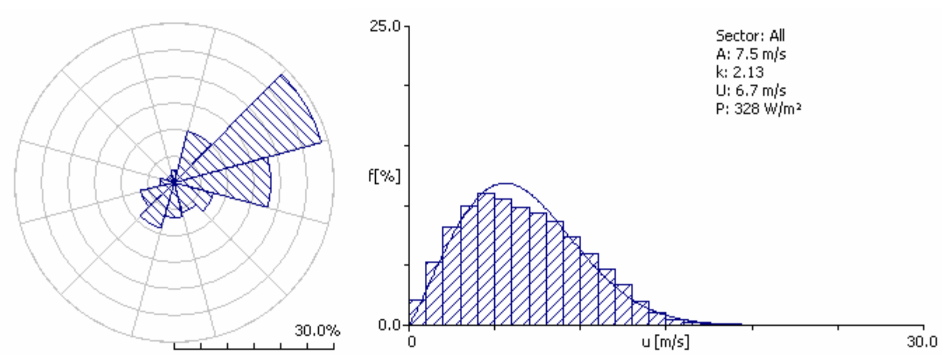

Figure 2 Wind rose and wind-speed histogram of reanalysis data 1977-2005

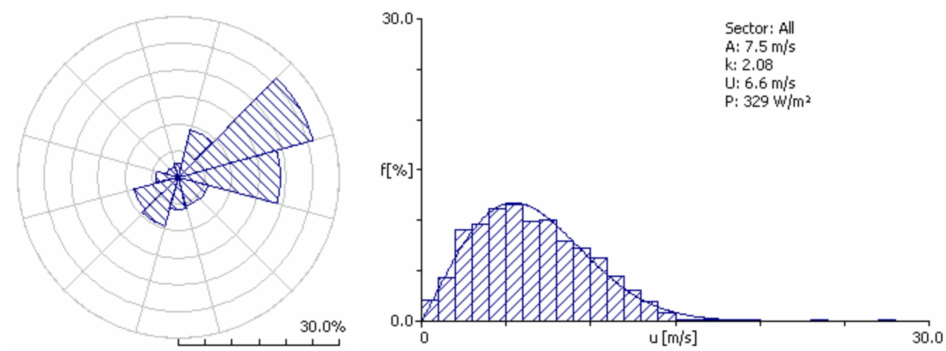

Figure 3 Wind rose and wind-speed histogram of reanalysis data March 2001-February 2002

5.3 Turbine data

The power curve authorized by the manufacture is valid for a turbine height of 67m and an air density of 1.16 kg/m³. We can verify that this air density is in accordance with the elevation and the measured annual mean temperature.

5.4 Estimates of annual energy production

The current plan is to install the fifteen easternmost turbines sites of the original 40MW layout. However, to enable comparison with table 7 of the PNOC-EDC feasible report, we also calculate AEP for the subset of fifteen turbines sites with the highest production. In either case the installed turbine type is the Vestas V80 2MW turbine with 67m hub height. The results are shown in Table 4 to Table 7, where the turbine ID corresponds to the numbering in table 5 of the PNOC-EDC feasibility study report.

The results in Table 5 differ about 0.2% from the values for the 30MW optimized wind farm in table 7 of the PNOC-EDC feasibility study, which is consistent with the slightly different wind climates analysed by Risø and PNOC-EDC.

The net AEP of the layout consisting of the easternmost turbines is about 2% lower than that of the optimized one. This is both because of a slightly lower wind resource and larger wake losses in a denser turbine array.

We have not corrected the results for turbine and grid availability or transmission losses.

Table 4 Summary results for the fifteen easternmost turbines

Parameter	Total	Average	Minimum	Maximum
Net AEP [GWh]	111.080	7.405	6.994	8.057
Gross AEP [GWh]	117.820	7.855	7.493	8.166
Wake loss [%]	5.72	-	-	-

Table 5 Summary results for the fifteen most productive turbines

Parameter	Total	Average	Minimum	Maximum
Net AEP [GWh]	114.009	7.601	7.273	8.081
Gross AEP [GWh]	119.134	7.942	7.587	8.286
Wake loss [%]	4.3	-	-	-

Table 6 Site results for the fifteen easternmost turbines

Site	Location [m]	Elevation [m a.s.l.]	Height [m a.g.l.]	Net AEP [GWh]	Wake loss [%]
1	(462853.0,2050567.0)	30	67	7.485	4.29
2	(463120.0,2050386.0)	40	67	7.952	2.39
3	(462456.0,2050466.0)	31	67	7.350	7.55
4	(462600.0,2050273.0)	48	67	7.501	7.01
5	(462816.0,2050123.0)	30	67	6.994	6.66
6	(461930.0,2049378.0)	70	67	7.241	4.55
9	(462236.0,2050098.0)	55	67	7.210	10.65
10	(462272.0,2049825.0)	59	67	7.199	7.54
14	(462001.0,2050298.0)	30	67	7.242	6.9
15	(461746.0,2049592.0)	60	67	7.205	7.42
16	(462221.0,2049264.0)	105	67	7.593	5.56
17	(461936.0,2048971.0)	106	67	7.138	6.1
18	(462454.0,2048997.0)	112	67	8.057	1.34
19	(462562.0,2049349.0)	90	67	7.475	3.26
20	(461369.0,2049661.0)	60	67	7.437	4.71

Table 7 Site results for the fifteen most productive turbines

Site	Location [m]	Elevation [m a.s.l.]	Height [m a.g.l.]	Net AEP [GWh]	Wake loss [%]
1	(462853.0,2050567.0)	30	67	7.538	3.59
2	(463120.0,2050386.0)	40	67	8.008	1.69
3	(462456.0,2050466.0)	31	67	7.376	7.21
4	(462600.0,2050273.0)	48	67	7.530	6.64
6	(461930.0,2049378.0)	70	67	7.384	2.67
9	(462236.0,2050098.0)	55	67	7.273	9.87
10	(462272.0,2049825.0)	59	67	7.400	4.97
15	(461746.0,2049592.0)	60	67	7.291	6.32
16	(462221.0,2049264.0)	105	67	7.697	4.27
18	(462454.0,2048997.0)	112	67	8.081	1.06
19	(462562.0,2049349.0)	90	67	7.500	2.94
20	(461369.0,2049661.0)	60	67	7.475	4.22
11	(461378.0,2050646.0)	35	67	7.777	2.84
7	(461729.0,2050648.0)	25	67	7.620	3.55
8	(462063.0,2050654.0)	43	67	8.060	2.72

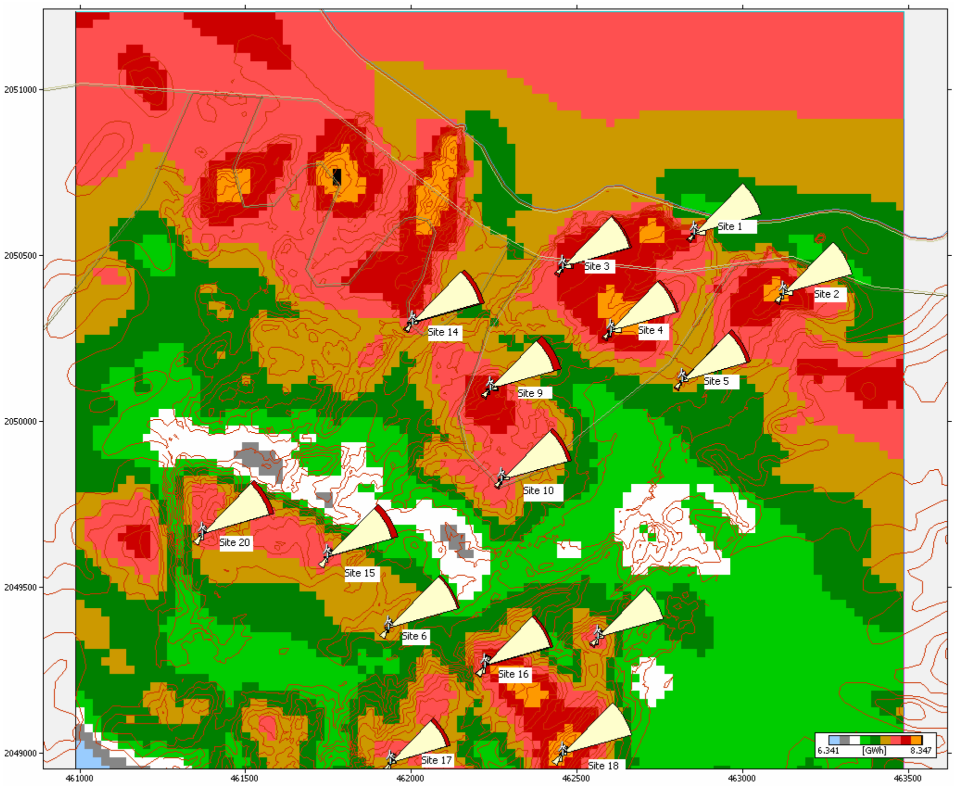

Figure 4 Wind resource map of Gross AEP with directional distributions and wake losses at turbine positions.

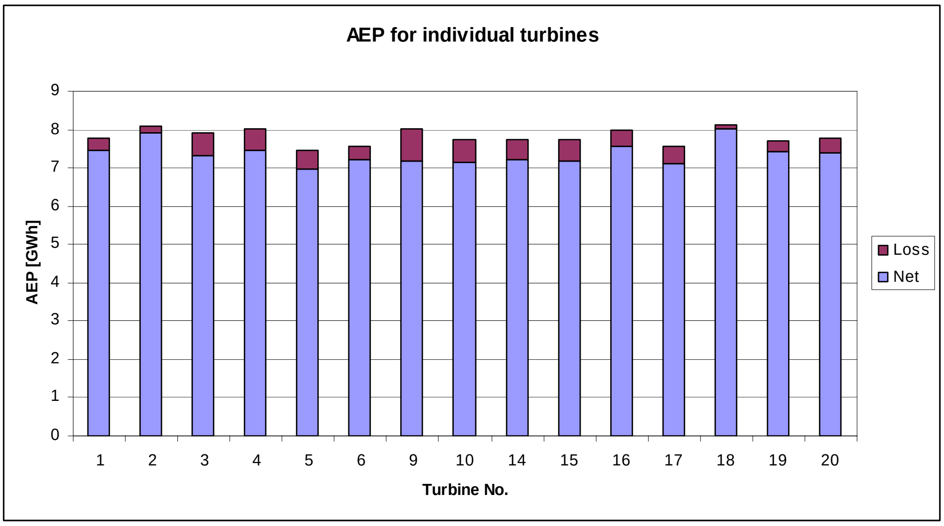

Figure 5 Comparison of AEP for the turbine in the 30 MW layout.

5.5 Wind farm layout

Figure 4 shows a wind resource map of gross AEP for a Vestas V80 2 MW turbine with 67m hub height. Also shown are the directional AEP distributions at the turbine positions with correction for wake losses. The layout is a reasonable compromise between having turbines near local optima in the spatial wind resource distribution and keeping a proper distance between the turbines. Further optimization might be possible, e.g. by moving turbine site 1 westward near a local optimum or moving turbine 9 backward to reduce its relatively high wake loss. These adjustments will only be fine-tuning since the turbine AEP are not too different, see Figure 5

5.6 Wind farm assessment

Risø has not calculated local extreme winds, fatigue loads, wind profile shear, or tilt of flow lines. Preliminary assessments are

- The terrain is not particularly complex, so wind profiles and flow angles are unlikely to cause problems.
- The turbines are deployed with reasonable separation, so fatigue load from wake turbulence should be manageable.
- Even though Burgos is not the most exposed area of the Philippines, the local extreme winds are still very severe. We agree with the PNOC-EDC feasibility study report stating that a site-dedicated Class I or Class S turbine is necessary.

5.7 Conclusion

The evaluation of the Annual Energy Production of the site by PNOC-EDC seems to follow accepted practice and where shortcomings have been found by the review, it is considered that their correction would not change the outcome significantly. For example, only data from one year has been used but the review has found that it is probably unnecessary to correct the data for long term deviations, having looked at historical data from other sources.

The review carried out its own energy assessment using the Vestas V80 2MW turbine and found the results to be very close to those provided by PNOC-EDC. Two wind turbine layouts were assessed and it was seen that, apart from some minor adjustments, the layout is more or less optimal. The precise layout and optimisation will, in any case, be done by the Contractor.

Reference Documents

[1] Contract Volume 1: "EDC bid No. 06-106, Engineering, Procurement and Construction of 30MW Wind Farm and Appurtenant Facilities, Northern Luzon Power Project, Phase 1, Volume 1, Commercial Provisions, July 2006", PNOC-Energy Development Corporation, document references: "Vol 1_Commercial Provisions_June 2006" & "Commercial Bid Docs_WF_Rev2.docFinal_Rev0".

[2] Technical Specifications Volume 2: "EDC bid No. 06-106, Engineering, Procurement and Construction of 30MW Wind Farm and Appurtenant Facilities, Northern Luzon Power Project, Phase 1, Volume 2, Technical Specifications", document reference: "Vol2_Technical Specifications_rev5_0718806.doc".

[3] System Impact Study: NLWPP-1 SIS Main Report Dec 2001 "PNOC-EDC 42-MW Wind Power Project, in Burgos, Ilocos Norte" & Annexes B-1 to I-1, TransCo.

[4] System Impact Study: NLWPP-1 Additional report April 2002 "Additional Study, PNOC-EDC 42-MW Wind Power Project, in Burgos, Ilocos Norte", TransCo.

[5] Project Feasibility Update, Northern Luzon Wind Power Project, Phase 1. Updated as of June 12, 2006. PNOC-EDC.

[6] Assessment of the Northern Luzon Wind Farm Site, Philippines. Document ref: 1077/WR/01 issue 2, 31 October 2001, Garrad Hassan Pacific Ltd.

[7] Wind data file name: "NLWPP1 Mast 1 Mar2001-Feb2002.txt"

Mission

To promote an innovative and environmentally sustainable technological development within the areas of energy, industrial technology and bioproduction through research, innovation and advisory services.

Vision

Risø's research **shall extend the boundaries** for the understanding of nature's processes and interactions right down to the molecular nanoscale.

The results obtained shall **set new trends** for the development of sustainable technologies within the fields of energy, industrial technology and biotechnology.

The efforts made **shall benefit** Danish society and lead to the development of new multi-billion industries.