EXHIBIT NO. ___(RG-5HC)
DOCKET NO. UE-07___/UG-07___
2007 PSE GENERAL RATE CASE
WITNESS: ROGER GARRATT

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY, INC.,** **Respondent.**	**Docket No. UE-07____** **Docket No. UG-07____**

FOURTH EXHIBIT (HIGHLY CONFIDENTIAL) TO THE PREFILED DIRECT TESTIMONY OF ROGER GARRATT ON BEHALF OF PUGET SOUND ENERGY, INC.

REDACTED VERSION

DECEMBER 3, 2007

GEC
GLOBAL ENERGY CONCEPTS
THE Wind Resource

DRAFT

Technical Review of Wind Power Proposals

Report PSE4-001

CONFIDENTIAL

May 5, 2006

Prepared for:

Puget Sound Energy
10885 NE 4th Street
Bellevue, Washington 98003

1809 Seventh Avenue, Suite 900, Seattle, Washington 98101
Phone: (206) 387-4200 Fax: (206) 378-4201
www.globalenergyconcepts.com

Approvals

Prepared by ____________________ Date ____________

Reviewed by ____________________ Date ____________

Revision Block

Revision	Release Date	Summary of Changes

Table of Contents

List of Tables

Introduction

Puget Sound Energy (PSE) contracted with Global Energy Concepts, LLC (GEC) to provide wind energy assessment and general technical review of approximately 12 proposals received by PSE in connection with its 2005 All Source RFP. Several wind power proposals which were received outside the formal solicitation process were also included in GEC's evaluation. For each proposal, the review included the following tasks:

- Evaluation of the proposed project site to determine resource availability as well as site viability from an environmental and logistics perspective.
- Evaluation of the proposed site layout for reasonableness, including turbine locations, spacing along rows, spacing between rows, and distances from surrounding land uses.
- Evaluation of wind data collected at the project site, whether and how those data have been correlated to a long-term reference, and whether the data reasonably and completely support the proposal.
- Evaluation of the quality and quantity of both the on-site wind data and the long-term reference data.
- Review of seasonal and diurnal resource variations, as well as the uncertainty associated with each, and comparison of these patterns to PSE's resource needs.
- Review of the uncertainty analysis in energy projections to verify all appropriate variables have been considered reasonably.
- Reasonableness of energy loss estimates related to array effects, turbine downtime, electrical losses, and other factors.
- Evaluation of the experience of the parties making the energy projections.
- Assessment of the suitability of proposed turbine models for the proposed site.
- Assessment of the reasonableness of projected operations and maintenance costs.
- Recommendations concerning any additional information regarding wind resource or technology GEC believes should be obtained prior to moving forward with a specific project.
- Assessment of short-term variability of the wind resource and projected energy production, and the effects of this variability on integration costs of the energy.
- Computer-based economic feasibility analysis covering the entire expected project life. Parameters reviewed usually include assumptions regarding energy production, energy pricing, operations costs, maintenance costs, taxes, inflation, and other economic parameters. GEC maintains close contact with financial institutions and equity investors and, as a result, is fully aware of the economic criteria that must be satisfied for a project to receive support.
- Review of project capital cost estimates to understand the uncertainties in the estimated costs and determine the reasonableness of the projected costs.
- Review of the project participants to assess their ability to successfully complete their role in the proposed project.

In addition to the review of the proposals, this report provides a brief description of wind turbine technology generally as well as a summary of the U.S. market experience of leading wind turbine manufacturers. The turbine technology and market experience section is intended to provide context for considering the various wind turbines proposed for the various projects.

Proposals Received

Table 1 summarizes the key features of the proposals received. The table is split in two, with each part summarizing seven facilities. Appendix A provides additional summary information for the proposals.

Table 1. Proposal Summary

Proposer	
Project name	
Project location	
Project size, MW	
Turbine type	
Number of turbines	
Turbine hub height, m	
Average hub-height wind speed, m/s	Redacted
Net capacity factor as proposed	
Net capacity factor as evaluated by GEC	
Point of inter-connection /transmis-sion concept	
Business structures proposed	
Project commercial operation date	

Table 1 (Continued). Proposal Summary

Proposer	
Project name	
Project location	
Project size, MW	
Turbine type	
Number of turbines	
Turbine hub height, m	
Average hub-height wind speed, m/s	Redacted
Net capacity factor as proposed	
Net capacity factor as evaluated by GEC	
Point of Inter-connection/ transmission concept	
Business structures proposed	
Project commercial operation date	

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Proposal Pro Forma Assessment

Introduction

GEC's economic evaluation process included the following key steps:

- Reading the proposals.
- Filling in missing, unclear, or inconsistent information from proposals to facilitate a fair and complete comparison across the proposals. This information has been completed based on GEC's industry experience.
- Normalizing the expected capacity factor at the proposed facilities based on information found in the proposal's wind resource assessment and GEC's industry experience.
- Developing a list of further information and clarifications to be obtained from proposers as part of the proposal evaluation process and as part of any subsequent contract negotiations.
- Solving for PSE's levelized cost of energy and return on investment under each of the proposed business structures.

Summary of Proposal Economics

A total of 19 business structures have been evaluated for the 13 proposed facilities. (The business structure and proposed pricing for one proposed facility is not clear.) The structures evaluated include:

- Development rights: 4 projects (including 1 with wind turbine purchase rights)
- Turnkey project: 7 projects
- Power purchase agreement: 8 projects

When considering the economics of the proposed facilities, the fundamental factors that favor a particular project are its wind resource, its location relative to PSE's service territory, its location relative to transmission system constraints, and the strength and experience of the proposer. Relatively small changes in a location's wind resource can have large impacts on a project's economic viability. Projects closer to PSE's load and/or located such that transmission constraints are not significant, will generally have lower transmission costs, lower transmission losses, and a lower risk of increased losses or transmission costs during the project's useful life.

Secondary factors affecting project economics include the proposed wind turbine, ownership/lease structures and pricing for project lands, and local sales and property tax differences. While each of these factors has a significant impact on project economics, to a large extent the projects operate in the same market (for wind turbines and other hardware, for example) or one issue offsets another (sales taxes adversely impact a project's economics in Washington, while higher property taxes may impact a project in Oregon). These factors are important to consider in the evaluation but small changes in the fundamentals listed in the previous paragraph can override disadvantages associated with these secondary factors.

When considering the proposals and business structures, it should be recognized that the various alternative purchase scenarios (e.g., project ownership, PPA, etc.) have markedly different risk profiles, and many of these risk elements are outside the bounds of this economic comparison.

Impacts on Existing Nearby Wind Power Facilities

It is important for PSE to understand the potential for impacts on nearby facilities under scenarios where PSE is considering project ownership. It is common in the wind power industry to develop a wind resource area in phases, and the phases may or may not be on land controlled by the same developer. (Sometimes the incremental development is called Phase I, II, III, etc. of the same project name, while other times different project names are used, particularly when different developers are involved.) Impacts of new turbines on existing facilities can be significant even when industry-standard turbine spacing guidelines are used.

For example, [redacted] is known to be in a location near [redacted] Because the developer of [redacted] is also involved with [redacted] it would be normal for [redacted] to provide "make whole" payments to the earlier phases to the extent [redacted] diminishes the output of the earlier phases.[1] This could be a significant operational cost for [redacted] and so needs to be understood.

Redacted

None of the proposals addressed operational costs related to downwind losses at existing facilities, and no consideration of downwind losses has been made in the economic evaluation.

It is also important for PSE to consider how it will be impacted by future development in the vicinity of the two wind power projects it owns. To the extent that PSE owns both the existing and proposed facility in the same vicinity, the "make whole" payments would be an internal transaction to PSE. However, if a third party is developing a project in the vicinity, other things being equal, it may be to PSE's advantage to be involved with that project to help ensure its existing assets are appropriately considered.

Table 2 provides a description of various downwind loss scenarios for consideration.

Table 2. Downwind Loss Scenario Matrix

	New Project Located Near Existing PSE Wind Power Facility	New Project Located Near Existing Third-Party Wind Power Facility
PSE Owns New Project (Turnkey and Development Rights Cases)	Cost of "downwind losses" can be considered as an operational cost of new project.	PSE may be liable to third party for paying cost of "downwind losses"; consider impact and potential cost.
PSE Does Not Own New Project (PPA cases)	Cost of "downwind losses" may or may not be reimbursed to PSE by third party owner of new project. Any "make whole" payments would depend on agreements written with developer of existing project (if the same developer is doing the new project). If a different developer is behind the new project, then PSE may not be able to obtain "make whole" payments.	New project developer may be liable to third party for paying cost of "downwind losses"; consider impact and potential cost in terms of due diligence on offered PPA rates.

[1] These "make whole" payments typically include both the value of the lost energy as well as the lost PTC.

Highly Confidential
Per WAC 480-07-160

Pro Forma Evaluation

GEC developed a spreadsheet-based pro forma evaluation of each proposal. The evaluation solves for the 20-year life cycle levelized cost of energy at the facility's busbar. Where available, specific pricing and technical information from the proposals is used to conduct the evaluation. Where specific information was not provided in proposals, or where different proposals contained different information on items that should not differ, GEC used comparable assumptions across the range of proposals. For example, GEC used a consistent set of technical loss assumptions for the proposed projects so that a proposal with an assumed 100% turbine availability could be compared on an equal basis as one that assumed 96%.[2] It has been GEC's experience that many project developers underestimate these technical losses; absent compelling evidence that one project would have lower technical losses from another, GEC decided to standardize these losses to facilitate a fair comparison of the proposals.

The pro forma considers costs at the project busbar only; this evaluation does not consider any value of different generation patterns (for example, diurnal or seasonal patterns that have a better "fit" to PSE's load profile), transmission costs, or PSE's imputed debt. GEC understands that PSE is running in-house models to account for these issues. The differences between GEC's analysis and PSE's analysis are summarized in at the end of this section.

The pro forma evaluation is found in Appendix B. Specific methods used to evaluate the PPA proposals, the turnkey proposals, and the development rights proposals are described in the following subsections.

PPA Proposals

Proposals had tenors ranging from 20 to 30 years. For those with tenors longer than 20 years, only the first 20 years are included in the evaluation. Capital and recurring (operations, maintenance, taxes, etc.) costs were requested in the RFP for purposes of better understanding a proposal, but were not used in the evaluation of life cycle costs under the PPA scenarios.

Proposed PPA pricing from the proposals was used to define the pricing applicable in any particular year. Some proposals specified pricing for each year, while others included a starting price and defined escalation rate. For each of the 20 years in the evaluation, the annual cost of energy was derived from the product of the applicable PPA price and the expected energy generation. The cost was then levelized by discounting future expenditures by PSE's cost of capital (8.4% per year discount rate), to derive an equivalent constant cost per year for comparison purposes. This levelized cost per year was then divided by typical-year energy generation to derive a levelized unit cost in dollars per MWh for comparison purposes.

[2] There may be valid reasons that one facility would have slightly different technical losses than another facility. However, the differences assumed in the various proposals were far larger than any differences (that can be discerned at this time) in actual losses that would likely occur during facility operation. Therefore, a consistent set of technical loss assumptions was used in the evaluation. The losses totaled to a factor of 11.5% and include turbine and balance-of-plant equipment availability, electrical line losses, blade soiling losses, blade degradation losses, weather-related losses, and turbine control system losses.

Turnkey Project Proposals

Capital costs were obtained from proposals, and in some cases adjusted to provide a common comparison basis. Recurring costs were obtained from proposals, as adjusted to provide similar comparison basis. As these costs were often not provided in proposals, the pro forma typically used GEC assumptions from industry experience. (Any adjustments to proposed pricing and use of assumed costs by GEC are noted in the pro forma assumptions in Appendix B.)

The evaluation provides pre-tax comparisons as well as after-tax results which include the benefit of federal renewable energy Production Tax Credits (PTCs) and accelerated depreciation. The tax evaluation does not include deduction of any interest expense that may be possible if project financing is used for the facility, or any income tax liabilities.

Most proposals assume completion prior to the current PTC expiration of December 31, 2007. It has been assumed that these projects fully qualify for PTCs, although delays in project development or construction may invalidate this assumption.

Redacted

The [redacted] project, located in Canada, would not be eligible for PTCs, although a variety of other [redacted] provincial incentives may apply. (Eligibility for these incentives may be clouded by ownership by PSE, Canadian incentives are in a state of flux, and no project development schedule was provided, so no incentives were assumed in the pro forma.)

Some of the proposed projects are located in Oregon, which has its own set of incentives such as the Business Energy Tax Credit and funding from the Energy Trust of Oregon. These programs or incentives may bring economic benefit to PSE, although purchase of a facility by a Washington-state utility may not fit well with the "mission" of some of the funding mechanisms. No Oregon-specific incentives have been assumed in the pro forma.

Capital costs for the facility are amortized at PSE's cost of funds (10.8%, which is based on a pre-tax rate of 7.01% and a tax gross-up factor of 1/0.65) over an assumed 20-year project lifetime, with zero residual value. Amortized capital costs are combined with recurring expenses to determine total pre-tax costs in a given year. The total annual cost was then levelized by discounting future expenditures by PSE's cost of capital (8.4% per year discount rate), to derive an equivalent constant cost per year for comparison purposes. This levelized cost per year was then divided by typical-year energy generation to derive a pre-tax levelized unit cost in dollars per MWh for comparison purposes

Tax benefits due to accelerated depreciation and PTCs were then factored in, with the assumption that PSE would have the full ability to use any tax savings in the current year (i.e., full tax benefit utilization with no carryforwards). After-tax costs were then determined and levelized and unitized in the same fashion as the pre-tax costs.

Development Rights Proposals

Development rights proposals were evaluated similar to turnkey proposals, except that usually less supporting information was provided in proposals and therefore more assumptions or inputs had to be provided from GEC's industry knowledge.

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Redacted

Most proposals assume completion prior to the current PTC expiration of December 31, 2007. It has been assumed that these projects fully qualify for PTCs, although delays in project development or construction may invalidate this assumption. In the [redacted] Orion's project schedule assumes half the facility is completed in 2007 and half in 2008, so the pro forma evaluation assumed that half the project is eligible for PTCs, and the other half is not. If the PTC is extended, then all of the project would likely be eligible.

The Development Rights proposals that do not include turbine rights pose a unique risk to PSE, in that PSE's preferred wind turbines may not be available in the marketplace in time for the PTC deadline of December 31, 2007. This may force PSE to buy less desirable wind turbines, to pay a premium for more desirable turbines that are in short supply, or to wait until after 2007 for project completion (with the attendant risk that the PTC may not be extended, or only be extended with diminished value).

Summary of Economic Evaluation

Table 3 provides a summary of the economic evaluation. Key points from the economic evaluation are described below.

Five projects offer PPA proposals for near-term (2007) completion with levelized pricing in the [redacted] The apparent lowest priced proposal, from [redacted] for the [redacted] also appears to have a relatively high technical risk, as it proposes Clipper wind turbines that have not yet been deployed in a commercial wind energy facility. This proposal with more proven GE wind turbines would be about [redacted] per MWh higher initially but apparently is not subject to increases in subsequent years, so on a levelized basis is about the same cost. These [redacted] prices are lower than the other PPA proposals offering near-term project completion. In general, the PPA proposals offer lower risk to PSE as PSE would not bear construction or operational risks associated with the facility (but would also have less operational control over the facility).

Seven projects offer turnkey proposals for near-term (2006 or 2007) completion with levelized pricing in the [redacted] per MWh range. The apparent lowest priced proposal, from [redacted] using Suzlon turbines, represents a fairly high technical and pricing risk compared to the others because the Suzlon turbine is not yet proven, and the pricing on which the proposal is based appears to be speculative. The next lowest priced proposal, from [redacted] project, offers the advantage of being located [redacted] wind power facility, which should offer operational efficiencies should PSE also own the proposed [redacted] facility.

Three projects offer development rights proposals for near-term (2007 or 2008) completion with levelized pricing in the [redacted] per MWh range. These projects offer a relatively high level of risk to PSE because PSE would be responsible for procuring equipment and constructing the facility.

Two other proposals offer potential opportunities that are more distant in time (unspecified and 2011 completion) and location (British Columbia and Montana).

Key unknowns that should be addressed in future discussions or negotiations with the various proposers are found in the right-most column of Table 3.

Table 3. Summary of Life Cycle Cost Analysis

Proposer and Facility	Structure	Approx. Completion	Levelized $/MWh	Key Open Issues Related to Economic Evaluation

Redacted

Comparison to PSE Evaluation

We understand that PSE has performed related pro forma comparisons of the proposals, and that the pro forma analysis performed by PSE differs in some respects to that performed by GEC and described above. Table 4 summarizes the most significant differences we are aware of.

Table 4 Comparison of Basis of Pro Forma Evaluation

Issue	GEC	PSE
Transmission Costs	Costs to project bus bar	Costs to PSE's service territory
PTC Value	100% PTC Value - adequate tax appetite	[redacted] PTC Value - tax investor losses
Allowance for Funds Used During Construction	Not included	Assumed at 4.84% of project costs
PSE Development Costs	Not included	Flat development fee of [redacted] or ownership proposals and [redacted] for PPAs

Redacted

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Proposal Wind Energy Assessment Information

Due to the nature of wind projects, there is substantial uncertainty in the energy production of any project over its life and year-to-year variation due to wind resource and equipment performance. Even sites that have been reasonably well characterized may produce as much as 15% below the pre-construction estimates. However, these uncertainties can be mitigated or reduced through collection of a sufficient amount of high-quality meteorological data.

Several of the projects under consideration also benefit from the collective knowledge of other wind projects in the area. All but two of the proposed projects are located in eastern Washington and Oregon, where approximately ten commercial wind power projects are now operational, and some of the proposed projects are either expansions of existing projects or immediately adjacent to such projects. The performance of these projects, the existence of long-term wind monitoring data that are publicly available through organizations such as Oregon State University's Energy Resources Research Laboratory, and high-resolution wind maps that have been validated by the National Renewable Energy Laboratory can help produce reasonable upper and lower bounds on the wind resource at sites with similar terrain. Not surprisingly, the proposals for projects in these areas all estimate site-wide hub-height wind speeds within a relatively narrow range, of approximately 6.9 m/s on the low end to approximately 7.6 m/s on the high end. Given the uncertainties on wind speeds quantified for these sites, each of them is within the range of expected uncertainty of the others at a 95% confidence level. However, while the wind resource at the various proposed sites may not vary greatly, the quality/quantity of the data and resource assessment at each will affect the ability to successfully finance the projects at favorable rates.

This section discusses the wind resource and energy assessment and other technical issues for each proposed project in turn, scoring each in several areas. These areas include the following:

- quality and quantity of data used for the energy assessment;
- appropriateness and completeness of methodology used for the energy assessment;
- appropriateness of the site layout and proposed equipment;
- expected long-term most-likely case energy production relative to the stated estimate;
- environmental or institutional concerns regarding the project;
- appropriateness and experience of the project team; and
- overall "financibility" of the project based on the wind data and evaluation.

Each of these items is numerically scored from 1 to 5, with the following general definitions of each score:

5: Excellent – Data and information appear complete and indicate no concerns.
4: Good – Minor weaknesses or deficiencies that can likely be easily resolved.
3: Problems/Missing Data – Data are lacking, either because they do not exist (e.g., limited wind data collection) or have not been provided in sufficient detail in the proposal.
2: Significant Problems – Large problems are apparent that would need to be resolved before the project could be successfully completed.

1: Fatal Flaw – A problem exists that cannot be easily resolved and will likely prevent the project from being completed.

A discussion of each topic is provided to explain the scores assigned by GEC.

Redacted

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Redacted

Text in box is Highly Confidential

Highly Confidential

Per WAC 480-07-160

Redacted

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Redacted

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Text in box is Highly Confidential

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Redacted

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Redacted

Highly Confidential
Per WAC 480-07-160

Redacted

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Redacted

Wind Resource Summary

Table 5 presents a ranking of the projects based on GEC's technical assessment and the scores assigned to the projects. In terms of the quality of wind data and energy assessment for the projects, there is not much separation among the majority of the projects. All but two [redacted] project and [redacted] Wind Farm) appear sufficiently well developed as to make a 2007 financing and construction date possible, although in some cases this would require additional instrumentation and data collection over the next twelve months. The following table presents GEC's technical ranking and our assessment of the largest technical problem or data gap for each project. Note that in some cases, the primary issue is a lack of information that may be possible to resolve relatively easily.

Table 5. Proposal Ranking Based on Wind Resource Review

Project	Largest Technical Problem(s)/Data Gap(s)
Top-Ranked Projects	
[redacted]	
Middle-Ranked Projects	
[redacted]	
Low-Ranked Projects	
[redacted]	

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

Wind Turbine Technology

This section presents an overview of wind turbine technology, the manufacturers active in the industry, and the models currently available from major manufacturers.

Technology Basics

In the United States, all currently available, utility-scale wind turbines from established turbine manufacturers utilize the 'Danish concept' turbine configuration. This configuration uses a three-bladed rotor, an upwind orientation (blades positioned upwind of the tower), and an active yaw system to keep the rotor oriented into the wind. The drive train consists of a low-speed shaft connecting the rotor to the gearbox, a 3-stage speed increasing gearbox, and a high-speed shaft connecting the gearbox to the generator. Generators are typically asynchronous, induction type operating at 550-690 V. Each turbine is equipped with a transformer to step up the voltage to the on-site collection system voltage. Sometimes this transformer is mounted within the wind turbine, and sometimes pad-mounted transformers are used near the base of the turbine.

Variations on the standard design described above are seen in some manufacturers' designs. For example, Enercon has maintained a substantial market share in Germany and a growing presence elsewhere with its low-speed generator technology, which eliminates the gearbox. Enercon wind turbines, and others using low-speed generators, have yet to be installed at utility-scale wind farms in the United States. The new turbine designed by Clipper uses a unique multiple-generator design.

Table 6 provides a summary of the commercially available wind turbines in the U.S. market. The first four companies have an established presence in North America while the last four companies (Suzlon, Gamesa, Clipper, and REpower) have collectively installed fewer than 200 turbines in North America as of December 2005. Other manufacturers that are just entering the U.S. market are not shown in Table 6 but are discussed in the next section of this report. Also, the table does not included turbines specifically designed for the off-shore market as they tend to be larger than land-based turbines.

Table 6. Currently-Offered Utility-Scale Wind Turbines in the United States

Country	Manufacturer	Model	Rating (kW)	Rotor Diameter (meters)	Specific Rating (kW/m^2)	Control Scheme
USA/ Germany	General Electric (GE)	1.5s	1500	70.5	0.38	VS,VP
		1.5sle	1500	77	0.32	
		1.5xle [1]	1500	82.5	0.28	
Denmark	Vestas [2]	V52	850	52	0.40	CS, VP
		V82	1650	82	0.31	CS, VP
		V80	1800	80	0.36	CS w/Generator Slip, VP
		V90	3000	90	0.47	VS, VP
Denmark	Siemens	600kW	600	44	0.39	2 speed, FP
		1MW	1000	54	0.43	2 speed, VP
		1.3MW	1300	62	0.43	
		2.3MW	2300	93	0.34	VS, VP
Japan	Mitsubishi	MWT-600	600	45	0.38	CS, VP
		MWT-1000	1000	57	0.39	2-speed, VP
		MWT-1000a	1000	61.4	0.34	
India	Suzlon	S.64/950	950	64	0.30	2 speed, VP
		S.60/1000	1000	60	0.35	
		S.62/1000	1000	62	0.33	
		S.64/1000	1000	64	0.31	
		S.60/1250	1250	60	0.44	
		S.64/1250	1250	64	0.39	
		S.66/1250	1250	66	0.37	
		S.88/2000	2000	88	0.33	CS w/Generator Slip, VP
Spain	Gamesa Eólica	G52	800	52	0.38	VS, VP
		G80	2000	80	0.40	
		G83	2000	83	0.37	
		G87	2000	87	0.34	
		G90	2000	90	0.31	
USA	Clipper Windpower	Liberty C89 [1]	2500	89	0.40	VS, VP
		Liberty C93	2500	93	0.37	
		Liberty C96 [1]	2500	96	0.35	
		Liberty C99 [1]	2500	99	0.32	
Germany	REpower	MD70	1500	70	0.39	VS, VP
		MD77	1500	77	0.32	
		MM70	2000	70	0.52	
		MM82	2000	82	0.38	
		MM92	2000	92.5	0.30	

VS = Variable Speed VP = Variable Pitch
CS = Constant Speed FP = Fixed Pitch
[1] Expected to be available soon.
[2] Vestas acquired NEG Micon in 2004 and consolidated their combined turbine fleet.

The rotor diameters and rated capacities of wind turbines have increased in the past decade, driven by technology improvements, refined design tools, and the need to improve energy capture and reduce the cost of energy. In 2004, utility-scale turbines installed in the United States ranged in capacity from 660 kW to 1.8 MW, with an average of 1,283 kW. For comparison, the average turbine rating in 2001 was 893 kW. In 2006, turbines with rated capacities of 1.5 MW to 2.0 MW are expected to represent the vast majority of the turbines installed.

In Table 6, three size classes of turbines are apparent: sub-megawatt (600 to 800 kW), megawatt (900 to 1250 kW), and multi-megawatt (1.3 to 3 MW). Manufacturers have developed this range of turbine models in response to the varying site conditions, wind environments, and construction/logistic issues that are unique to each site. Sites where the terrain is complex tend to favor the sub-megawatt to megawatt size turbines since they are smaller, more easily transported, and require smaller cranes for assembly. Where space is available and terrain is moderate, utilizing megawatt to multi-megawatt turbines is more cost effective.

The ratio of a turbine's rotor swept area to the rating of the turbine is known as the specific rating. There is no set relationship between rotor diameter and generator rating; it varies based on site-specific issues. Modern turbines typically have a specific rating between 0.28 and 0.47 kW/m^2. Sites with lower wind speeds (such as around 7 m/s annual average at hub height) tend to utilize turbines with larger rotors and lower specific ratings to improve energy capture. High-wind-speed sites (exceeding 9 m/s) tend to utilize turbines with smaller rotors and higher specific ratings. The smaller rotor helps to reduce loads on components and thus allows the turbine to meet design and site suitability requirements at these aggressive sites.

The control scheme employed to operate the turbine and produce grid-quality electricity varies among turbine manufacturers. Each has advantages and disadvantages; however, they all successfully deliver energy into utility grids. Variable-speed turbines produce energy at slightly higher efficiencies over the operational range of wind speeds than constant-speed turbines; however, the power electronics necessary in variable-speed turbines to produce grid-quality electricity add a level of complexity and cost to the design. Variable-speed machines also provide the ability for the turbine to supply reactive power to the grid and dynamically control the reactive power supply (power factor) to the grid. Turbines that do not utilize variable-speed technology provide close to unity power factor by using switched capacitors at the turbine and, in some cases, at the project substation.

Fixed-pitch turbines generally have fewer moving parts and are less complex than variable-pitch turbines, resulting in lower manufacturing and maintenance costs. However, in locations with large variations in temperature, and thus atmospheric density, fixed-pitch turbines can experience difficulties with excessive power production during high-density periods if the blades are pitched in a manner that optimizes production throughout the year. Variable-pitch turbines are better able to consistently achieve the design rated power by adjusting blade pitch to account for changes in air density or blade contamination. The use of a pitch system also facilitates the use of lower specific ratings. For these and other reasons, the energy output from a variable-pitch turbine is generally higher than an otherwise identical fixed-pitch turbine, usually offsetting the higher costs. The specific wind and climate characteristics at a given site ultimately determine which type of control scheme generates energy most cost effectively.

Wind Turbine Suppliers

The global wind turbine market is dominated by ten companies. In recent years, over two-thirds of the market has been controlled by the top three or four manufacturers, only two of whom (Vestas and GE Wind) have historically been active in North America. Table 7 provides a summary of world market share as percent of capacity installed.

Table 7. Wind Turbine Manufacturers' World Market Share

Company	2001	2002	2003	2004	2005
Vestas	24% (NEG Micon: 13%)	22% (NEG Micon: 14%)	22% (NEG Micon: 10%)	34%	28%
Gamesa	10%	12%	12%	18%	13%
Enercon	15%	19%	15%	15%	13%
Enron/GE Wind	13%	9%	18%	11%	18%
Bonus/ Siemens	9%	7%	7%	6%	6%
Suzlon	2%	1%	2%	4%	6%
REpower	2%	3%	4%	3%	3%
Mitsubishi	3%	<1%	3%	2%	2%
Ecotècnia	1%	2%	1%	2%	2%
Nordex	7%	7%	3%	2%	3%

Source: BTM Consult *World Market Updates*

In 2005, GE, Suzlon, and Nordex gained market share at the expense of the other major manufacturers. Of the leading companies, Enercon, REpower, Ecotecnia, and Nordex currently have limited or no activity in North America. Rapid growth in 2005's market, and continued growth leading to at least the perception of shortages of wind turbines, has led many purchasers to consider alternative suppliers.

Within the United States, GE accounted for nearly 60% of the new capacity in 2005 and Vestas accounted for nearly 30%. Mitsubishi was the third largest wind turbine supplier to the U.S. market, supplying about 8% of the new capacity. Suzlon and Gamesa round out the top five suppliers to the U.S. market in 2005.

Suzlon, Gamesa, and Clipper have recently established manufacturing facilities in the United States. Gamesa is making its first investment within the North American market and plans to open three new manufacturing centers for the production of turbine blades and towers as well as the assembly of wind turbine nacelles.

The supply of high-quality major components such as hub and mainframe castings, gearboxes, and generators is of concern to wind turbine manufacturers because of a limited number of suppliers able to provide the required sizes, quantities, and quality. As a result, several wind turbine manufacturers are taking steps to become more vertically integrated and gain better control of sub-contract component issues. For example, Siemens owns Winergy, the industry's largest gearbox supplier, Suzlon recently acquired Hansen Transmissions International NV, one of the largest wind energy and industrial gearbox manufacturers in the world, and we understand that GE is working to have their transmission division provide wind turbine gearboxes. Most wind turbine manufacturers own at least a portion of their blade manufacturing capability and Vestas has purchased a large foundry to produce castings for mainframes and hubs.

U.S. Market Experience

This section compares the manufacturers active in the U.S. market.

GE

GE is well established in the U.S. market, with approximately 2000 operating turbines similar to those contemplated for the projects in the proposals, and an established service and support infrastructure. While the GE turbines have had their share of operational difficulties, GE has the technical and financial resources to address the challenges. The GE turbines employ a relatively complex technology (variable speed, variable pitch) for wind turbines compared to some others installed in North America. GE's wind turbine business is challenged with rapid growth and integration into the larger GE organization (after GE's acquisition of the business from Enron). This has resulted in more time than might be expected being required to address customer concerns and identify the root causes of problems that do exist.

Vestas

Vestas is well established in the U.S. market, with approximately 500 operating turbines similar to those contemplated for the projects in the proposals, and thousands more on a smaller scale, dating back to 20-year old 65 kW machines still operating in California. Vestas has an established service and support infrastructure. While it is the world market leader and has excellent technical skills, Vestas lacks the financial resources of GE. Vestas's business is also challenged with rapid growth as well as the integration of NEG Micon into the Vestas organization subsequent to NEG Micon's acquisition in 2004. This has resulted in project delays and lower levels of customer service and support than might be normally expected. Vestas has recognized these issues and is proactively working to address them.

Siemens

Siemens has approximately 250 megawatt-scale turbines operating in the United States, and is working to re-establish its presence in the market. Bonus was acquired by Siemens in 2005 and, in recent years, has held a niche position with a higher priced turbine that has not won a significant market share in the United States. Bonus has not had a significant sales operation in the United States in the past decade. (Smaller scale Bonus turbines were also sold in the United States in the 1980s and some still operate.) The Bonus/Siemens technology is generally mature and well respected in the industry. Siemens appears to be well positioned for significant expansion in North America. Siemens has announced significant orders for 2006 and 2007 with major developers for projects in the United States. Like GE and Mitsubishi, Siemens has strong financial and technical resources to draw upon.

Mitsubishi

Mitsubishi has moderate experience in the United States. While it sold many units of its previous-generation equipment (at a smaller scale, 600 kW and less), it did not gain a strong reputation in the United States. Its current product line (with 1000 kW turbines) appears to have addressed some of the shortcomings of earlier Mitsubishi designs, though it has not gained a substantial market share. Mitsubishi has about 600 of the 1000 kW machines operating in North America. Mitsubishi has strong financial resources and has historically offered relatively long warranties compared to the industry norm.

Gamesa

Gamesa is a relatively new entrant to the U.S. market and appears intent on establishing a significant presence. It is setting up domestic manufacturing, sales, and service facilities, and is dealing with rapid growth. Its 2 MW machines were first deployed in the United States in 2005, so operating experience is limited. Gamesa turbines share common design origins with Vestas. Gamesa has enjoyed a huge market share in its home (Spanish) market, and has strong financial support from its parent company.

Suzlon

Suzlon is another new entrant to the market. Suzlon is an Indian manufacturer with Danish engineering and technology in its current product line. It is establishing its sales and service base and, as a company, has very limited experience in the U.S. market, although many of the key personnel that Suzlon is hiring have significant prior experience in the United States with other wind power companies.

Clipper

Clipper is developing a 2.5 MW wind turbine utilizing a unique drive train developed under contract with the U.S. Department of Energy. One prototype turbine is operational, and Clipper intends to begin serial production in 2006. Clipper management has a past history of success in the wind power industry. The company went public in the United Kingdom in 2005. However, with only one prototype in operation, the machine is not yet proven.

Others

There are many smaller wind turbine manufacturers that are offering, or may offer, wind turbines for the U.S. market. Most of these are from Europe and have not sold turbines to the United States previously. Examples include REpower, Ecotècnia, and DeWind. Some, like Nordex, have sold turbines in the United States in the past but have not achieved a significant market share in recent times. Many of these turbine designs have operated successfully in other regions, typically in 50 Hz applications. These manufacturers may see an opportunity in the perceived shortage of wind turbines for the U.S. market (discussed below), but do not have an established sales or service base here, and generally have limited numbers of 60 Hz machines operating. They represent a higher level of technical and business risks than the more established players mentioned above.

Turbine Supply and Pricing

When Congress extended the eligibility period for PTCs through December 31, 2007, large participants in the U.S. wind energy market including among others FPL Energy, Babcock and Brown, PPM Energy, Horizon Wind, and Invenergy, each committed orders for substantial numbers of wind turbines that represent the most popular machines in the current market.

Developers are locking in the wind turbine supply, using it as a way to build market share, similarly to what was done in the combustion turbine industry in years past.

As a consequence of these large turbine orders, it is our understanding that Vestas and GE, the two major players in the U.S. market, have sold their entire manufacturing capacity for wind turbines in the North American market for 2006 and 2007, and are currently negotiating sales for 2008 delivery. Gamesa and Siemens have recently announced large orders for the U.S. market, but it is uncertain whether they have additional capacity they are willing or able to commit to the market. Suzlon, Clipper, and several new manufacturers to the North American market are actively pursuing sales in the U.S. market for 2007.

While it appears that GE and Vestas turbines are "sold out," discussions with industry participants indicate that many GE and Vestas wind turbines for delivery in the next two years were committed by major participants prior to these participants being certain which projects would use the turbines. This market strategy was apparently implemented to obtain favorable pricing and ensure turbine availability. Some of these major participants are presently working to purchase projects from smaller developers in order to ensure the turbines they have committed to purchase will have projects in which to be installed. Because some of these efforts may not be successful, some opportunities to purchase turbines late in 2007 (as the PTC expiration approaches) may arise, either from the manufacturers or from the major developers who bought/reserved turbines. The extent to which this situation could develop is difficult to assess. However, we are seeing increasing numbers of developers who are trying to finance projects that are in the relatively early stages of the development process and at least one manufacturer (Suzlon) still has turbines available for delivery in 2007. This may indicate that the supply of suitable projects in later stages of development is limited.

In addition to a strong market, losses sustained by certain turbine vendors in 2005, increases in the price of raw materials such as steel, the lower value of the U.S. dollar compared to the Euro, and price increases from sub-suppliers for equipment such as gearboxes have led to increased prices for wind turbines in the past year. At least some of the smaller developers are anticipating that lower prices will be available in late 2006 as those manufacturers that have not yet sold out move to solidify orders and developers with excess turbines move to find projects for them.

The substantial number of wind energy projects being built in Canada and the United States in 2006 and expected for 2007 is expected to put pressure on the transportation and construction industries' ability to supply the required resources. The availability of specialty equipment such as low-profile/high-capacity transport trailers, high-capacity cranes, and highly skilled construction contractors and crews is likely to be strained due to the surge in activity. This is expected to continue to put significant pressure on project costs and schedules, more so than what might otherwise be expected. This trend may mitigate any moderation in turbine pricing.

Recommendations

GEC recommends the following based on the issues considered in this evaluation. These recommendations also need to be considered in light of additional issues which PSE is considering, including but not limited to imputed debt, usefulness of the PTC in PSE ownership scenarios, power transmission, and resource/load matching.

For the PPA proposals, GEC recommends further discussions with [redacted] regarding its [redacted] proposal (with Clipper or GE turbine technology) and [redacted] regarding its [redacted] proposal. While these proposals have fairly weak technical detail in their wind resource assessments, they offer favorable pricing and are from credible sources with an acceptable industry track record. If PSE elects to pursue the [redacted] coal facility, adding wind turbines to that facility could offer a cost-effective scenario under a longer term development timeline. Other proposals come from credible sources but have higher pricing.

For the turnkey proposals, GEC recommends further discussions with [redacted] regarding the [redacted] While this proposal has weaker technical detail in its wind assessment, it offers favorable pricing and is from a credible source. Also, the [redacted] proposals for [redacted] and [redacted] offer competitive pricing, and the [redacted] proposal offers near-term (2006) completion should that be important to PSE.

[redacted]s [redacted] offers a solid, cost-effective development rights proposal [redacted], and their price would be quite attractive if the PTC were applicable to the entire project. These proposals are supported by good wind resource assessments, and the development rights approach may offer PSE cost savings and improved control, but with significantly more risk borne by PSE. An additional risk with [redacted] proposal is the fact that PSE would have to source turbines in a tight market, with the likelihood of paying a premium for desirable equipment, purchasing second-tier equipment, or waiting until market conditions change (with the potential to lose eligibility for the PTC).

Redacted

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Appendix A

Summary of Proposals

Redacted

Proposer
Project name
Project location
Project size, MW
Turbine type
Number of turbines
Turbine hub height, m
Avg hub height wind speed m/s
Net capacity factor as proposed
Net capacity factor as evaluated by OEC
Point of interconnection / transmission concept
Out-of-PSE-area transmission costs and losses to figure:
Transmission providers
Business Structure Proposed
Development rights
Development and turbine flip
Turnkey project (build-transfer)
PPA
Proposed Pricing
Development rights
Development and turbine flip
Turnkey project – capital
Turnkey project – service & warranty
PPA

V3 Bid summary xls

Redacted

Proposer	Pricing notes	Capital cost information in Proposal (Exhibit I)	Capital cost information in Proposal (Exhibit VI)	O&M cost information in Proposal (Exhibit I)	O&M cost information in Proposal (Exhibit VI)	12 by 24 matrix provided	Project commercial op dat	Technical Issues Scoring Summary	Quality and quantity of data used for the energy assessment	Appropriateness and completeness of methodology used for the energy assessment	Appropriateness of the site layout and proposed equipment	Expected long-term most-likely case energy production relative to the stated estimate	Environmental or institutional concerns regarding the project	Appropriateness and experience of the project team	Overall "financibility" of the project based on the wind data and evaluation	Average of above	Energy Loss Summary	Turbine Availability	Balance of Plant	Electrical	Blade Soiling	Blade Degradation	Weather/Force Majeure	Turbulence/Controls	Power Curve	Other	Total (straight addition	Adjustment factors for expected energy	Uncertainty / qualit

VS Bid summary xls

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

5/8/2008

Redacted

Proposer

Loss factors

Total adjustment

Wakes

Notes

3

Text in box is Highly Confidential

Highly Confidential

Per WAC 480-07-160

VS Bid summary.xls

Appendix B

Comparative Evaluation of Project Economics

Puget Sound Energy 2005 All Source RFP -- Comparative Evaluation of Wind Power Project Economics

This spreadsheet was created to evaluate proposals submitted to the All Source RFP, as well as other proposals submitted to PSE in the same time frame.

Created by Global Energy Concepts, April 2006, contact Steve Jones, (206) 387-4232

It should be recognized that the various alternative purchase scenarios (i.e., project ownership, PPA, etc.) have markedly different risk profiles.
Many of these risk elements are outside the bounds of this economic comparison.

Notes:

Costs for ownership scenarios described in this model include some tax treatment. Tax benefits due to production tax credits and accelerated depreciation are included, but any interest expense from project finance activity and tax liabilities are not considered.

Capital cost of ownership scenarios is assumed to be amortized over 20 years, at PSE's cost of capital, with zero value at end of 20 years.

Costs are modeled at the wind power facility busbar -- no transmission costs or losses are considered. Depending on location and transmission access, some projects may be more favorable than others.

Costs do not include any scheduling or imbalance fees that may be payable by PSE under project ownership or power purchase alternatives.

Proposals provide a mix of different completion dates. Inflationary cost escalation is modeled with the different timelines, but no value is being assigned to earlier completion dates.

Items highlighted yellow in the model are areas of key assumptions / uncertainties that bear discussion and/or additional information from proposers.

Summary of Results

Proposer and Facility	Structure	Approx. Completion	Levelized $/MWh	Key Open Issues Related to Economic Evaluation

Redacted

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

5/8/2006

Redacted

3

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

6/8/2006

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

V4 Economic Analysis.xls

5/8/2006

Redacted

5

V4 Economic Analysis.xls

Text in box is Highly Confidential

5/8/2006

Highly Confidential
Per WAC 480-07-160

Redacted

6

V4 Economic Analysis.xls

5/8/2006

Redacted

7

V4 Economic Analysis.xls

5/8/2006

Redacted

8

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

V4 Economic Analysis.xls

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

5/8/2006

Redacted

10

V4 Economic Analysis.xls

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

5/8/2006

Redacted

11

V4 Economic Analysis.xls

5/8/2006

Redacted

12

V4 Economic Analysis.xls

Highly Confidential
~~Per WAC 480-07-160~~

~~Text in box is Highly Confidential~~

5/8/2006

Redacted

13

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

5/8/2006

Redacted

14

V4 Economic Analysis.xls

5/8/2006

Redacted

15

V4 Economic Analysis.xls

5/8/2006

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Redacted

16

V4 Economic Analysis.xls

Redacted

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

5/8/2006

Redacted

18

V4 Economic Analysis.xls

Text in box is Highly Confidential

5/8/2008

Redacted

19

V4 Economic Analysis.xls

5/8/2006

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

Redacted

20

V4 Economic Analysis.xls

5/8/2005

Redacted

21

V4 Economic Analysis.xls

5/8/2006

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

Redacted

22

V4 Economic Analysis.xls

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

5/8/2006

23

Redacted

V4 Economic Analysis.xls

Redacted

Text in box is Highly Confidential

5/8/2006

Highly Confidential
Per WAC 480-07-160

Redacted

25

V4 Economic Analysis.xls

Redacted

Text in box is Highly Confidential

Redacted

Redacted

5/8/2006

Redacted

Text in box is Highly Confidential

29

Highly Confidential
Per WAC 480-07-160

V4 Economic Analysis.xls

5/8/2006

Redacted

30

Highly Confidential
Per WAC 480-07-160

Text in box is Highly Confidential

V4 Economic Analysis.xls

5/8/2006

Redacted

31

Text in box is Highly Confidential

Highly Confidential
Per WAC 480-07-160

V4 Economic Analysis.xls

5/8/2008

Redacted

Text in box is Highly Confidential

32

Highly Confidential
Per WAC 480-07-160

V4 Economic Analysis.xls