Inuvik Wind Energy
Pre-Feasibility Analysis

Prepared for

AURORA RESEARCH INSTITUTE
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By

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Executive Summary

There is world class wind energy potential near Inuvik that could be developed and integrated with the existing diesel facilities and be cost effective for the community. The key sites of interests are located north of Inuvik at Caribou Hills and Storm Hills.

Measurements from Environment Canada's Storm Hills weather station indicate a seven-year (2005-2011) average wind speed of 6.7 m/s at 10 m above ground level. This represents a Class 6 (out of 7) wind resource which is considered to be near the best for wind energy development.

In this prefeasibility study, three sites for a potential wind project were considered: Site One on a hill near Inuvik, Site Two on a high point in Caribou Hills, and Site Three at the top and centre of Storm Hills.

The initial project size for consideration consists of two wind turbines with a power capacity ranging from 1.5 to 1.8 MW (tower heights ranging from 65 to 75 m). This is a low penetration wind project which would not require significant addition of power quality controls to the existing plant. A wind project of this size (not including road and power line development) would cost from $7.6M to $8.5M to build.

A wind project at Site One would only require a short road and power line at a cost of about $1.1 million, but the wind resource is estimated at only 4.6 m/s at 75 m above ground level, and the resulting energy cost (LCOE) will be $0.70 to $0.80 per kWh. This is double the $0.39 per kWh diesel savings (LCOE) that would be realized.

The wind speed at Site Two, 35 km north of Inuvik, is estimated at 6.6 m/s at 75 m above ground. The road and power line cost would add about $12M to the project costs and the cost of energy would be $0.60 to $0.67 per kWh.

Site Three is located in the middle of Storm Hills (five km southwest of the old DEW Line Station and 60 km north of Inuvik). The wind speed is estimated at 8.0 m/s at 75 m above ground. The road and power line cost to access this site is estimated to be about $22 million. The cost of wind energy from this site would range from $0.64 to $0.72 per kWh.

Increasing the wind project size to a 4 MW capacity (using 5 Enercon E53 800 kW wind turbines) and including the full costs of power lines and roads, would produce electricity at a cost of about $0.38 per kWh at Caribou Hills and about $0.36 per kWh at Storm Hills. At this scale wind would be cheaper than the diesel savings. Some excess wind energy would be produced but could be fully utilized through load shifting, that is, running loads during periods of high winds.

If the proposed highway from Inuvik to Tuktoyaktuk was combined with this wind project, it would greatly reduce the road construction cost portion of the project. The wind project size could then be reduced from 4MW.

With careful planning wind energy could be developed for Inuvik at a lower cost than diesel.

Introduction

The cost of diesel fuel in remote communities continues to rise as world supplies become scarce. The need for developing renewable energy is becoming more urgent as NWT communities struggle with rising energy costs. Over the past several years, the authors (JP Pinard, P.Eng., Ph.D. and John Maissan, P.Eng.) have been retained by the Aurora Research Institute (ARI) to conduct pre-feasibility studies for wind energy generation in NWT communities, which are typically dependant on diesel for energy production. All of these studies are found at the ARI website (http://www.nwtresearch.com, search for "wind energy"). In the Inuvik area, there has been a decline in available natural gas to feed the existing gas power generators which have been providing electricity for the community. With this gas source running out the community may need to switch back to more expensive diesel generation.

Therefore, there is interest in finding an alternative energy source that is more cost effective than diesel. The questions that have been posed on the possibility for wind energy development in Inuvik are: how far from Inuvik would a world class wind resource be (within 50km); how economical would that wind resource be for Inuvik; and, are there any hills adjacent to Inuvik that could provide an economic wind resource for the community?

The community of Inuvik has about 3600 people and is located on the East Channel of the Mackenzie River Delta. Inuvik is located about 1086 km northwest of Yellowknife (see Figure 1). The community is accessible by air year round. It is also accessible by road (Dempster Highway) most of the year except during break-up (spring) and freeze-up (fall). Ice roads also link the communities of Aklavik and Tuktoyaktuk to Inuvik in the winter months. The average power use in the community is 3.47 megawatts (MW) and the 2012 annual energy requirement estimate is 30,400 megawatt-hours (MWh). The community power plant has three gas power generators with a total capacity of 7.7 MW and three diesel generators with a total capacity of 3.56 MW (smallest generator being 300 kW), owned and operated by Northwest Territories Power Corporation (NTPC). The marginal cost of producing electricity from diesel (fuel and variable maintenance only) is estimated at $0.39/kWh.

A study (Pinard, 2007) showed measured wind speeds of 4.3 m/s at a height of 60 m above ground on a communications tower just east of Inuvik. The report concluded that based on this measurement that wind energy development would not be feasible for Inuvik. The Arctic Energy Alliance has produced a summary of the wind potential for the community. In their online report (resource section at www.aea.nt.ca) it is stated that the average wind speed is considered low at 2.68 m/s (height was not noted, likely at 10 m/s).

The purpose of this study is to re-examine the economics of wind energy development in Inuvik.

In this study wind climate data is collected, analysed and used to model potential sites for wind energy developments and energy output of select wind turbine models. The economic analysis looks at the costs of building and operating a wind project in the area. Greenhouse gas emission reductions from these renewable energy forms are estimated. An outline of next steps is given regarding the pursuit of wind energy integration in Inuvik.

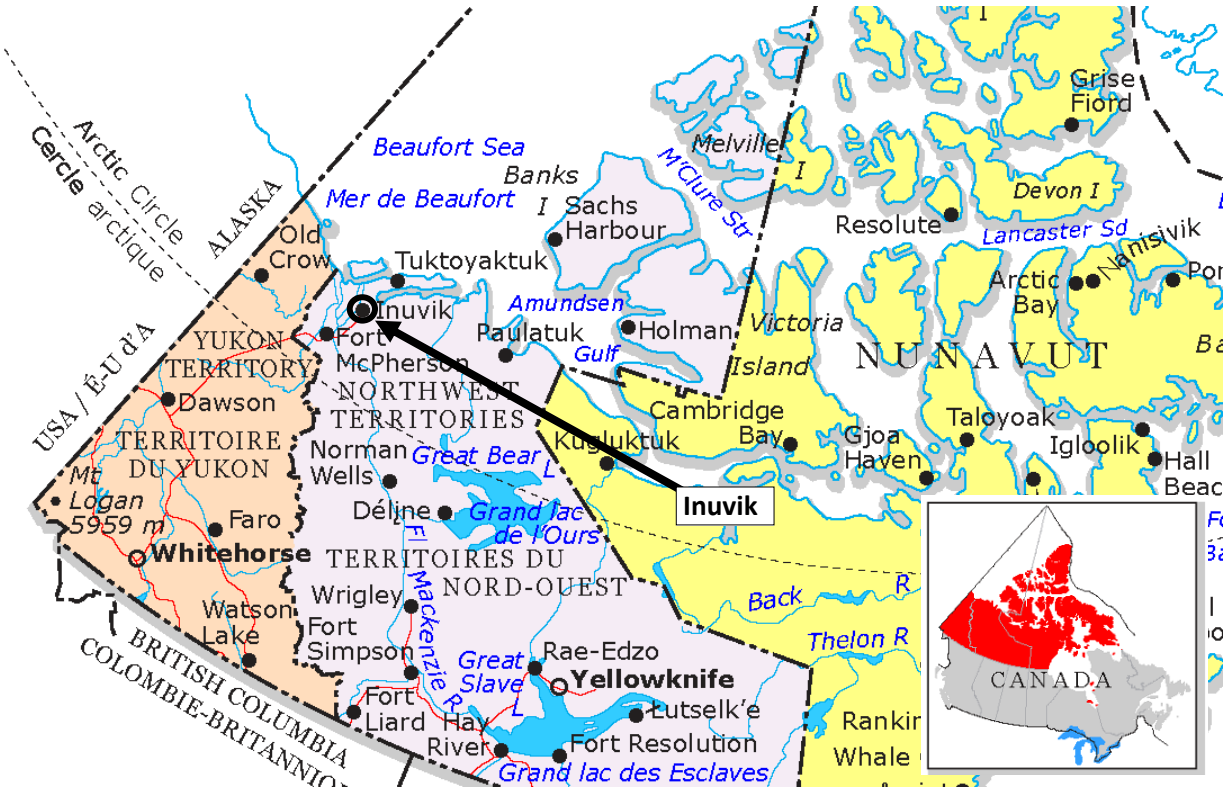

Figure 1: Inuvik is located in the Mackenzie Delta in northwestern NWT, about 1086 km northwest of Yellowknife.

Wind Climate Assessment

To estimate the wind energy potential in Inuvik wind speed measurements are required. The wind data used for the wind analysis was extracted from the Aurora Research Institutes wind monitoring station set up just east of Inuvik and from four of Environment Canada's (EC) climate station data. See Figure 2 for the locations of these stations.

The Environment Canada data is available online at their website (www.climate.weatheroffice.ec.gc.ca). According to EC there are two climate (weather) stations in Inuvik and two located towards the north. The data from these stations contain hourly measurements of wind speed and direction, temperature, pressure, humidity, and other parameters (solar measurements are not included in these data sets). The wind measurements at these stations appear to be made at 10 m above ground level (AGL) which is the standard height for airport weather measurements in Canada.

The ARI station was on a communications tower just east of Inuvik and the wind speed sensors were set up at 30 and 60 m above ground. The measurements were made at 2 second intervals and averaged to 10-minute intervals.

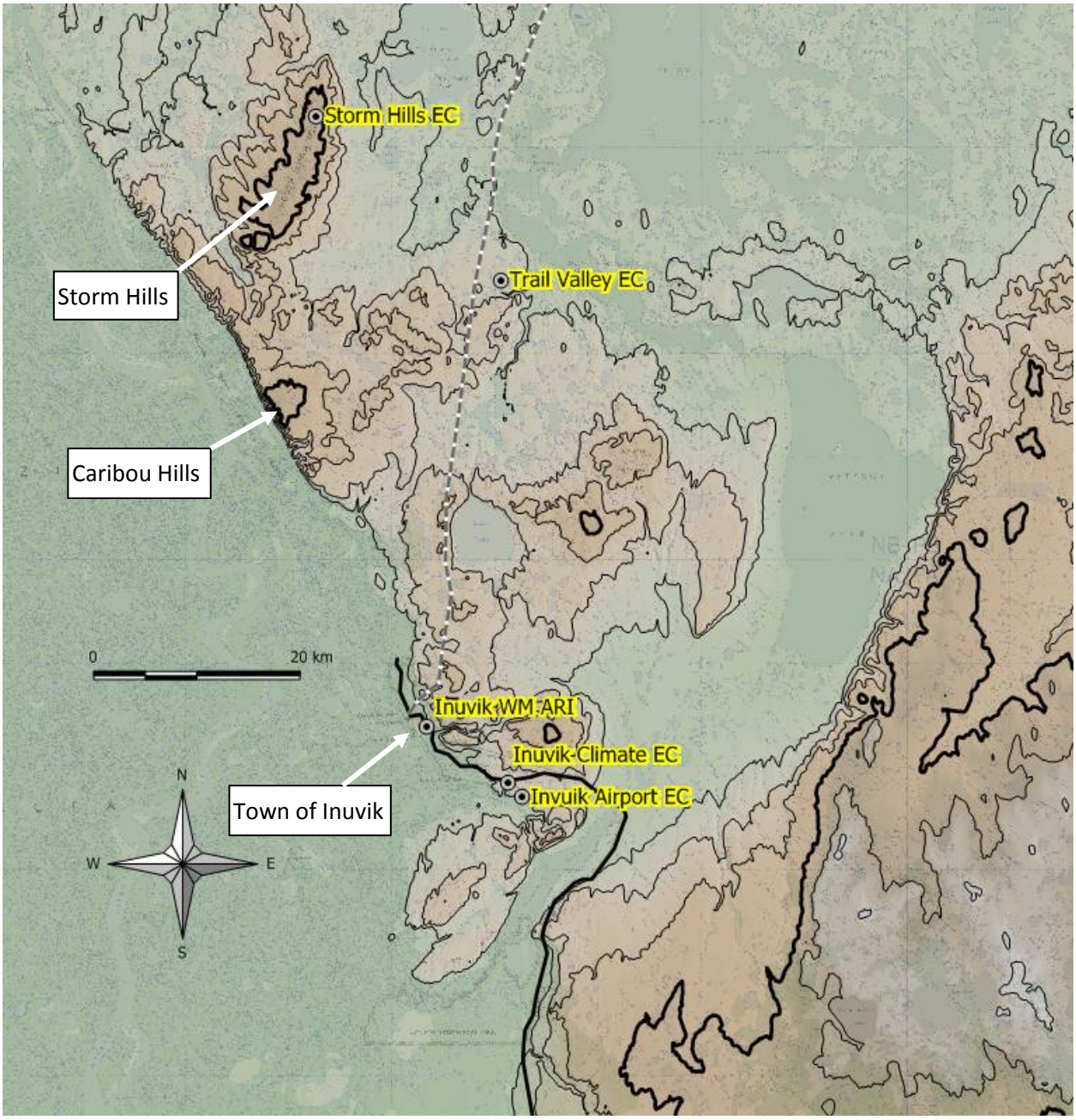

Figure 2: A map of the Inuvik area showing the weather stations (WM: ARI wind monitoring station, EC: Environment Canada weather station) and the topography. The elevation contour lines are at 50 m intervals with the lowest level being at 50 m above sea level. The thick line is at 200 m above sea level. The dashed gray line is a proposed route to Tuktoyaktuk.

Wind Speed

Wind data was collected from the website for each of the EC stations for at least six years in the period 2001 to 2011. The period that was used for the analysis for each station was: Inuvik airport, 2001-2006; Inuvik climate station, 2004-2010; Storm Hills, 2005-2011; and, Trail Valley, 2005-2011. The long term (> six years) average wind speeds from these stations are shown in Figure 3, which also show the monthly

average wind speeds (at 10 m AGL) for each station. The two southern stations, the airport and the climate stations, both reveal winds dropping to about 2 m/s in the winter and increasing to about 3.5 m/s in June. The Trail Valley station, is about 50 km to the north, is about 1 m/s higher than the Inuvik stations and has a similar seasonal pattern. The exception to this pattern is in the months of January and February where it exhibits faster winds than its southern counterparts.

The Storm Hills site shows the reverse pattern to the others: its maximum winds are in the winter instead of the summer. The Storm Hills station measured monthly average winds that reach a minimum of 5.8 m/s in July and August and reach a maximum of 8.4 m/s in January.

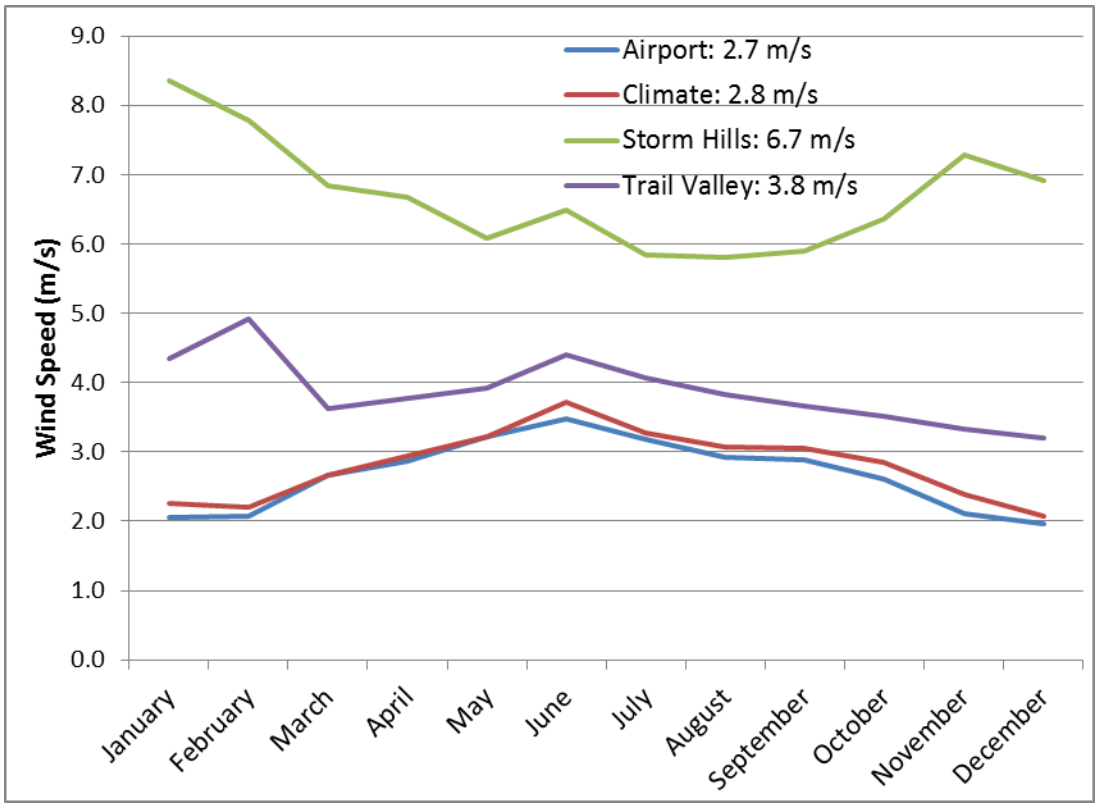

Figure 3: Long term monthly average wind speeds at four locations in the Inuvik area. Measurements are all at a height of 10 m above ground.

Wind Direction

Wind direction must also be taken into account when considering a wind energy project. A wind rose provides an indication of the dominant wind direction of the area and is very useful for planning the location of a wind project to ensure its maximum capture of wind energy. In Figure 3, the wind rose for the Inuvik area has a solid shaded area that represents the relative wind energy by direction. The wind energy by direction is calculated as the frequency of occurrence of the wind in a given direction sector

multiplied by the cube of the mean wind speed in the same direction. The given wind energy in each direction is a fraction of the total energy for all directions. According to the wind rose, the wind energy in the Inuvik area comes mainly from the northwest whereas in the Storm Hills area it comes from the west. Therefore, a wind energy project built in the Inuvik area should have good exposure to the northwest and in the Storm Hills area it should have expose to the west if possible.

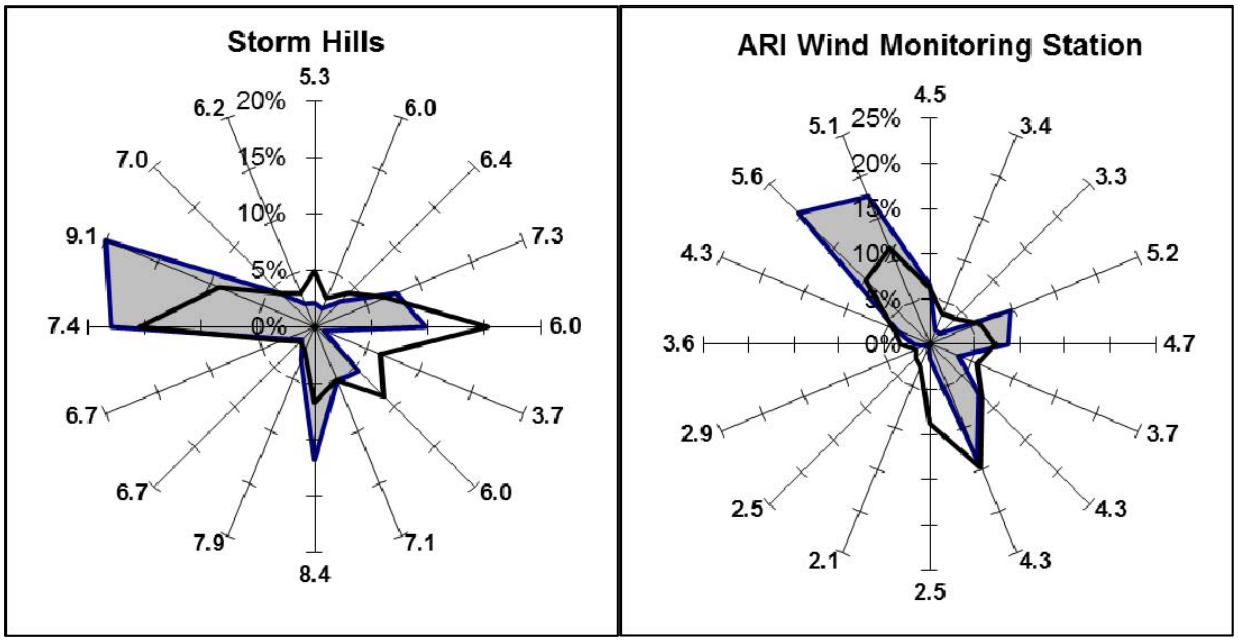

Figure 4: Wind rose showing the wind energy by direction for Storm Hills in the northern portion of the area of study and for ARI wind monitoring to the south, next to Inuvik. The numbers at the end of each axis indicate the average wind speed for that direction. This rose shows that the dominant wind directions are from the west in the northern portion and from the northwest in the southern portion of the study area.

Vertical Projection of Wind Speed

The wind speed measured at 10 m AGL needs to be projected to higher levels to estimate the mean wind speed for wind turbines with taller towers. The tower heights for the wind turbines used in this analysis are from 65 m (Aeronautica AW 54-750) to 75 m tall (Direct Wind DW 54-900), and are described later.

Turbulent air flow over rough surfaces tends to generate a vertical profile of horizontal winds that are fairly predictable. The wind speed profile near the ground is dependent on neutral well mixed air conditions and the roughness of the ground surface. This vertical profile can be defined by the natural log law equation (see Stull, 2000):

$$u_2 = u_1 \frac{\ln(z_2/z_o)}{\ln(z_1/z_o)}$$

Where u_1 is the known wind speed at z_1 (typically at 10 m AGL), and is projected to u_2 at the height z_2. The surface roughness is defined by z_o which as a rule of thumb is 1/10 the height of the grass, brush, or ground undulations surrounding the site where the measurements are made. This equation is considered most accurate up to approximately 100 m above the surface. The surface roughness z_o can be categorised by the type and size of vegetation as well as the hilliness of the ground itself.

In Inuvik the ARI wind monitoring station is just east of town in an area with sparse short trees. At the site the surface roughness is estimated to be z_o = 0.12 m using measurements from two heights (30 and 60 m AGL), which is typical of level rough grass fields with sparse trees (Stull, 2000). At Storm Hills the station is on a hill top near the Storm Hills Detection and Early Warning (DEW) site, where the surface is tundra and mainly smooth, a surface roughness of 0.01 m was estimated here (see Figure 5).

In the next stage of analysis, the information from the wind rose and the wind speed data are used to run and verify the wind flow models that calculate and visualize where the best wind sites might be for the area around Inuvik.

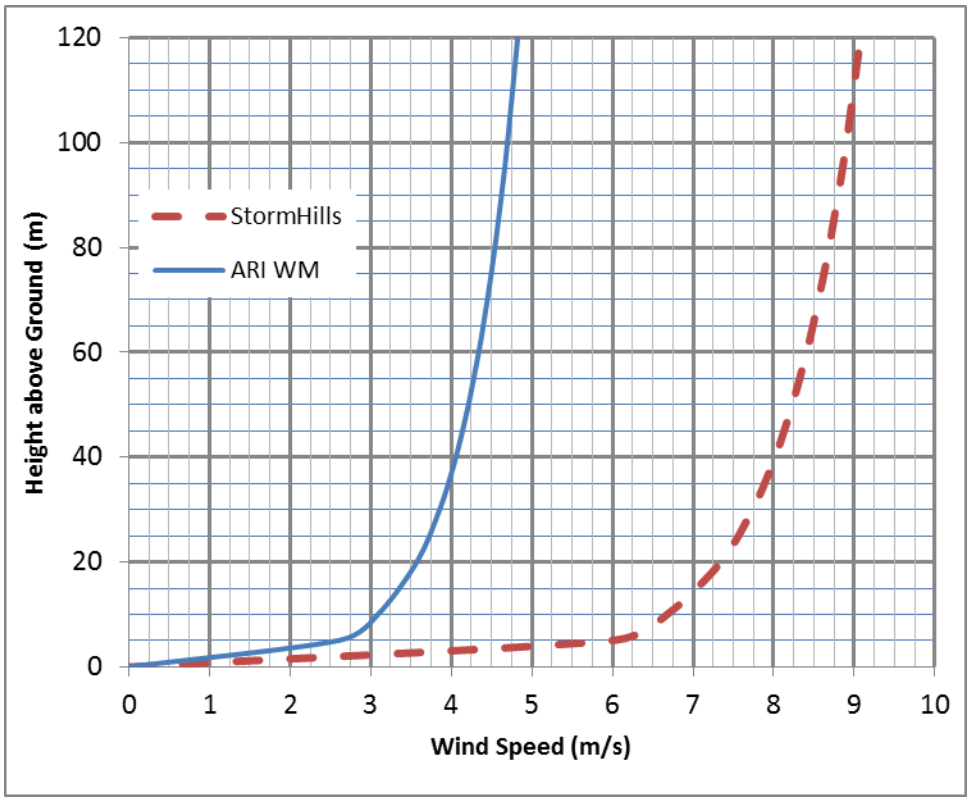

Figure 5: Vertical profile of horizontal wind speed estimated at Inuvik with the ARI WM (wind monitoring) station and at the Storm Hills weather station.

Wind Modelling of the Inuvik Area

There are two wind flow models that are used to evaluate the wind speeds in the vicinity of Inuvik. One is a large scale (often called mesoscale) model that uses wind climate data from the weather balloon station based in Inuvik. The other model is a micro scale model that uses wind speed and direction data from surface stations to interpolate wind flow over a topographic area around the stations.

Large Scale Wind Flow Model

The large scale model is the WEST (Wind Energy Simulation Toolkit) model developed by Environment Canada. It is a mesoscale model (large scale used for modelling large geographic areas of about 500 by 500 km) that uses complex equations that conserve momentum and mass to calculate wind fields at grid points within the modelling domain. The WEST has been successfully used to simulate the wind energy potential for several regions across Canada and other parts of the world and it is also being applied to compute a unified wind atlas (see www.windatlas.ca) for the entire country.

For the WEST modelling of the Inuvik area, the wind and temperature data from the weather balloon station at Inuvik was used. The weather balloon measurements indicate that the large scale wind speeds above Inuvik and above the influence of land features from the west. The temperature profiles show strong stratification in the atmosphere, especially in the first kilometre above the surface. The model domain covers an area of 400 km (north-south) by 280 (east-west) that includes the Richardson Mountains to the west of Inuvik. The model resolution is 2 km and so the terrain elevation ends up being smoothed; that is, some hill features are flattened out slightly. The model map is shown in Figure 6.

The WEST model runs indicate that the faster winds are located to the north of Inuvik in the Caribou Hills and Storm Hills area. The WEST model compares well with the stations around Inuvik, but underestimates the winds by roughly 0.8 m/s at the Storm Hills station. In the southern portion the model indicates that the winds are from the northwest at 4.5 to 4.8 m/s (75 m AGL) on the hills around Inuvik. In the northern portion the model estimates that the winds are almost westerly and are 6.6 to 7.0 m/s at the peak of Caribou Hills, and 7.8 to 8.0 m/s (all at 75 m AGL) at Storm Hills. The WEST model also indicates high winds southeast of Sitidgi Lake and about 50 km east of Inuvik, but this area is far and appears to be difficult to access considering that there are no roads that appear to go to this area.

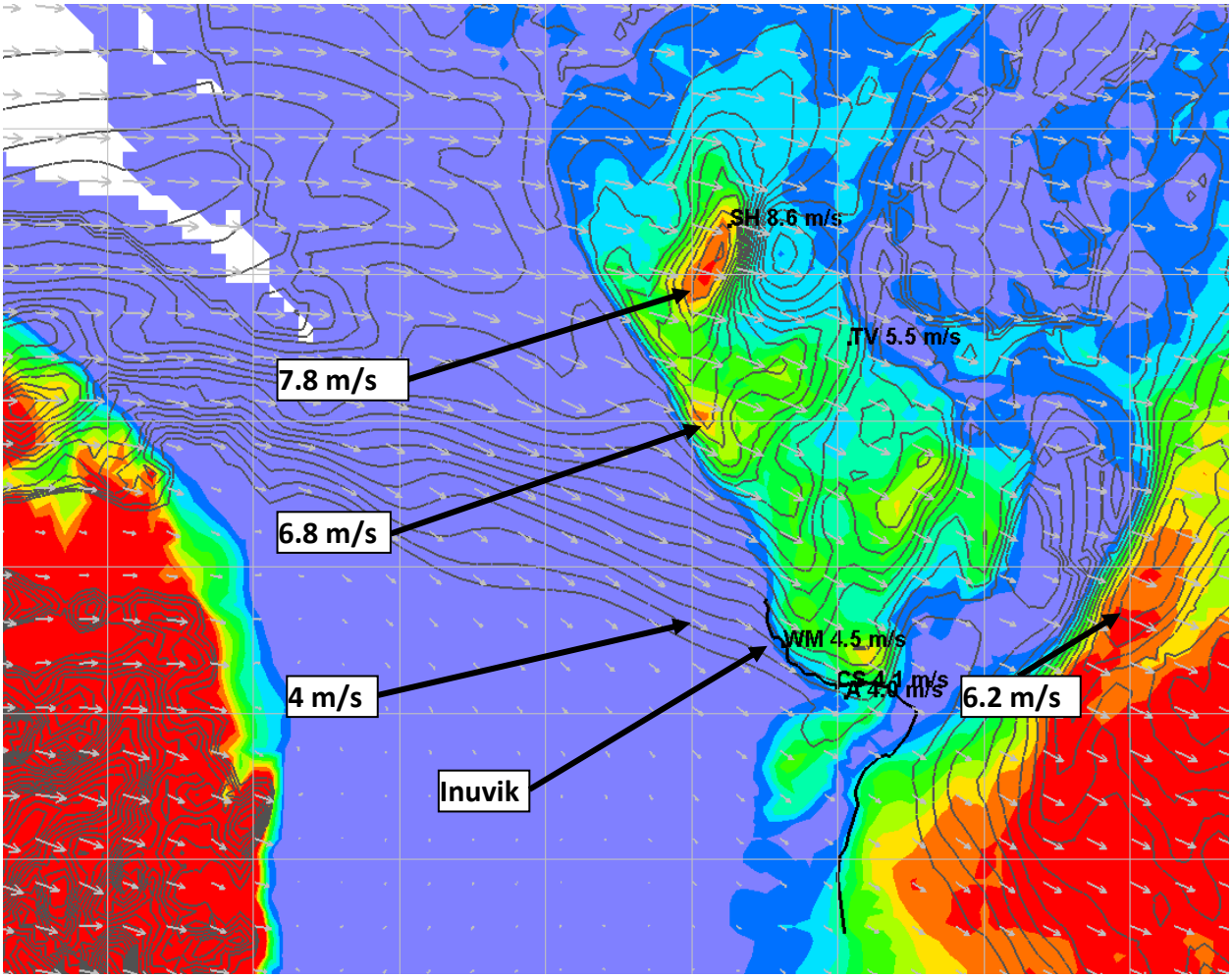

Figure 6: A wind map showing results from the mesoscale (large scale) WEST model. The contour lines indicate wind speeds; starting at 3.8 m/s (the interval is 0.2 m/s). The wind speeds are all modeled at 75 m above ground. The weather stations are also indicated with their wind speeds estimated at 75 m above ground. The stations are: SH – Storm Hills, TV – Trail Valley, WM – ARI wind monitoring station, CS – Environment Canada climate station just north of the airport, and A – the airport weather station. The elevation is indicated by the background colours; with intervals of 25 m. Purple is below 25 m above sea level and red is over 225 m above sea level. The model and the elevations are at 2 km resolution. The map also shows vectors (gray arrows) indicating the average wind directions that the model simulated.

Micro Scale Wind Flow Model

The next wind model used to create a wind map for the area is OpenWind by AWS Truewind (www.awstruewind.com). OpenWind uses equations that conserve mass only in a model to project winds from one location to another. As input, the model uses surface elevation data, surface roughness information, and a table of wind speed distribution by direction. The table of wind speed distribution is derived from the wind speed data at the weather stations noted in this study. The wind data from the ARI station is also included in the OpenWind model. The OpenWind model covers a smaller area than the WEST model but the grid resolution is also much finer at 200 m (horizontal grid spacing in two directions).

The result of the OpenWind model is very comparable to those of the WEST model. In the area immediate to Inuvik (within a 20 km radius) there are few hills where winds are just above 4.5 m/s (at 75 m AGL). This includes a hill overlooking Campbell Lake, about 5 km southeast of the airport. But generally the faster winds are found to north, as the WEST model is showing. The closest site to Inuvik that has significant wind speeds is at Caribou Hills. The highest point at Caribou Hills is a hill located along the ridge about 7 km southeast of Reindeer Station, overlooking the East Channel of the Mackenzie River. At this site the wind speeds range from 6 to 6.8 m/s (75 m AGL). The best site appears to be at the Storm Hills weather station, which is also at the old DEW line station. There the wind speeds range from 8 to 8.6 m/s (75 m AGL). However, to avoid potential interference with the communication systems around the DEW line station, another site 5 km to the southeast and more centred on Storm Hill shows another wind speed maximum. At this site the winds range from 7.8 to 8.2 m/s (75 m AGL). See Figure 7 for details.

Based on both the mesoscale and microscale models, the wind speeds that are chosen for modelling the energy production of the wind turbines in this study are: Inuvik area, 4.6 m/s; Caribou Hills, 6.6 m/s; and, Storm Hills, 8.0 m/s (all at 75 m AGL).

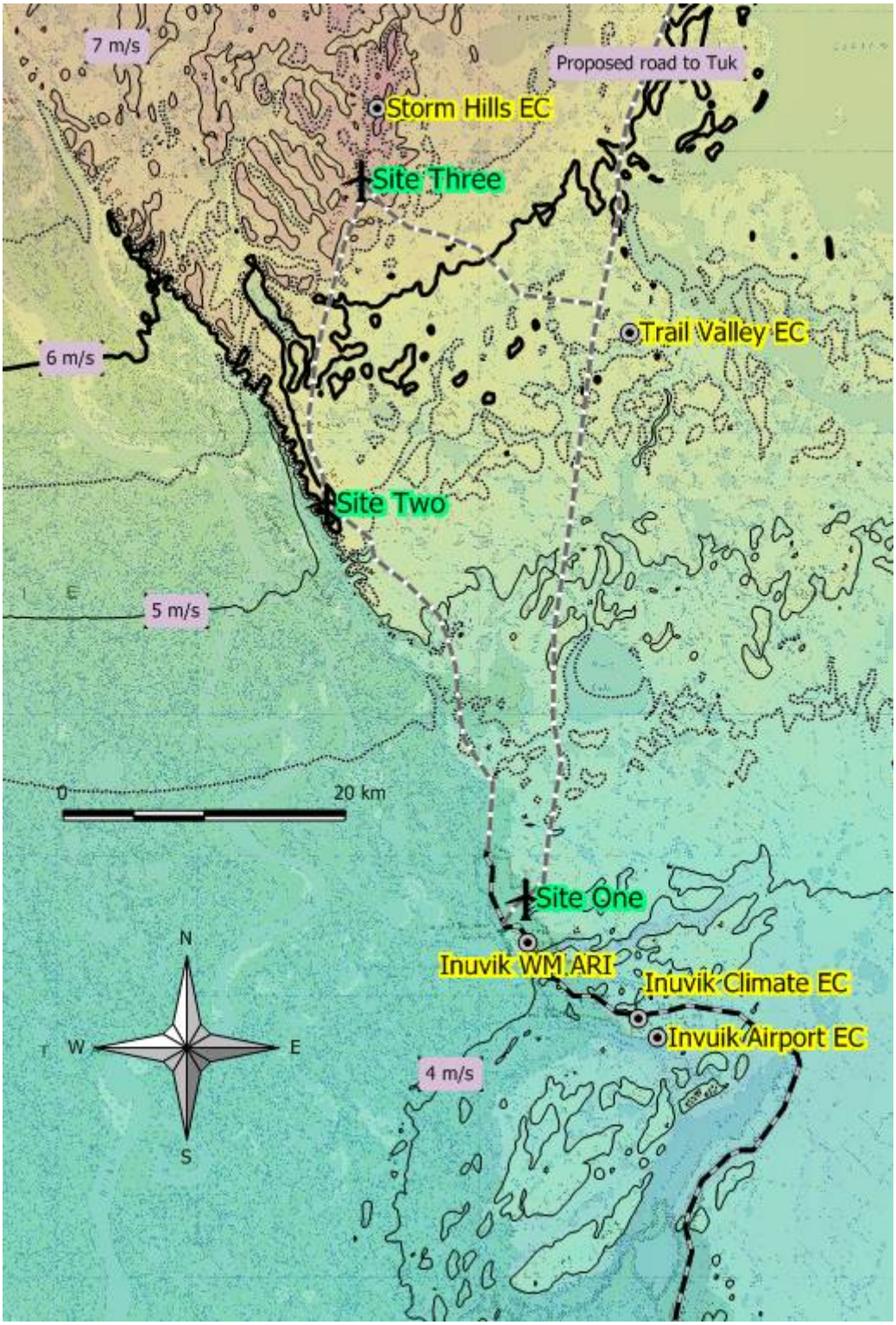

Figure 7: A wind map showing results from the microscale model OpenWind. The map is overlain by wind speed contours which are modelled at 75 m above ground level. The contour interval is 0.5 m/s, and the 6 m/s contour is thicker than the others. Roads shown by the gray dashed lines are suggested routes to the proposed wind energy sites.

Community Power Requirements and Costs

The power in Inuvik is supplied by an NTPC power plant fuelled principally by natural gas. The plant also contains diesel generators which are used as required. There are three natural gas reciprocating engine generators, two of 2.8MW and one of 2.1MW. These three generators supplied 28,000MWh in 2010/11. There are also three diesel generators, one of 2.5MW, one of 760kW, and one of 300kW, and these three supplied 2,400MWh in 2010/11. The NTPC general rate application (GRA) filed in late 2006 indicates that the gas engine efficiency is 3.399 kWh per cubic meter and the diesel generator efficiency is 3.635 kWh per litre.

The 2010/11 (gross) energy generated by the power plant was 30,400MWh indicating an average electrical load of 3.47MW. The peak demand was 5.7MW and the authors estimate that the minimum demand would be about 1.8MW. For the purpose of simplicity, this study is based on all of the power requirements for Inuvik being generated by diesel generation at the GRA listed fuel efficiency (3.635 kWh per litre), and at the cost of diesel fuel estimated by the authors to be about $1.10 per litre.

The levelized cost of energy (LCOE) for diesel over 20 years was calculated to be $0.390 based on diesel fuel starting at $1.10 per litre and increasing with general inflation at 2% per year. Variable operating and maintenance (O&M) costs of $0.03 per kWh (also increasing with inflation) were also included.

A wind project of 1.5 to 1.8MW was selected for this study. This represents the upper range of a low penetration system as there would be some surplus wind energy at times of very low electrical loads. This size of project allows the use of wind turbines that are larger than 100kW which are typically used in small communities, but smaller than full commercial wind turbines which are typically 1.5MW and larger. The turbines selected for this study are 750kW to 900kW in capacity. These “mid-sized” turbines are less costly per kW of capacity than small turbines.

Wind Power Project

Developer – Operator

For the purpose of this report it was assumed that a wind project would be at the upper end of a low penetration project and displace a reasonable amount of diesel consumption without the need for more sophisticated equipment to maintain the quality of the electrical grid. A larger wind project would require a more complex power and energy control system. A larger project would also reduce fixed costs per kW of installed capacity, driving energy costs per kWh down, and create an opportunity to utilize excess wind energy for space heating, electrical and heat storage, load shift and eventually other applications (such as local transportation). These opportunities would provide additional benefits from the wind project to the community. This high level of diesel displacement has, however, not been implemented to any great extent in Canada. High penetration systems are being used in Alaska and Australia and could be considered as a future possibility for Inuvik.

For this study it is also assumed that if a wind project were to be developed for Inuvik it would be done by a developer with wind project experience in the NWT. There is no allowance in the project cost estimates for overcoming a learning curve for inexperienced developers/operators. If a project were to be developed by an inexperienced firm the capital costs would almost certainly be higher. In the opinion of the authors, the project would ideally be developed by or in partnership with the current electrical power supplier in order to make the best use of existing experience, expertise, and infrastructure in remote communities. As well, the integration of the wind and diesel plants (including power purchase agreement issues) would then be relatively seamless and some overhead costs avoided.

Wind Turbines

Three wind turbines were selected for this study. The EWT "DIRECTWIND" DW 54-900 (54 meter rotor and 75 meter tower) was selected on the basis that there has been one operating near Delta Junction in Alaska for some years, and the climate there is also northern, although not quite as cold as Inuvik. It is reported that Kotzebue, Alaska (just north of the Arctic Circle) is going to install one or two as well. This turbine is available with generators as small as 500kW but this makes only $20,000 difference to the cost of the turbine so it made sense to select the 900kW generator. The Aeronautica AW 54-750 (54 meter rotor and 65 meter tower) was chosen as it represents lower capital cost older generation gearbox technology (designed by Norwin in Denmark some years ago) and yet has a relatively large rotor. Aeronautica is also trying to get into northern markets. The Enercon E53-800 (52.9 meter rotor and 73 meter tower) was selected on the basis that Enercon probably makes the most reliable turbines available today and is developing a low temperature version of this turbine for northern Quebec.

None of these three turbine manufacturers indicate that their turbines will operate in temperatures down to -40°C. However, they are all the cold weather versions designed to operate at full capacity to -30°C. In addition the DW 54-900 has a black blade option included and the E53 800 has a hot air internal blade heating system included. There has been a small cost allowance added to all three wind turbines to provide for additional low temperature modifications.

Energy Production

The annual energy production from each of the selected wind turbines is calculated using the HOMER model. HOMER was developed by the National Renewable Energy Laboratory of the US Government and is now distributed and supported by HOMER Energy (www.homerenergy.com). HOMER is a power system analysis and optimization model. The energy model uses published wind turbine power curves, diesel plant production specifications, and one-year hourly time series measurements of both wind speed and community power load to model the energy output of various power generators. A total of three project configurations were examined at each of the three sites identified for a total of nine cases. Each configuration consists of two identical turbines for each of the models selected.

The inputs for the HOMER model consist of the six generators described earlier (all assumed to be diesel), the wind system and the community load data. The wind resource data used as input for the HOMER is a one-year data set synthesized from the longer term data set from the climate station measurements at Storm Hills. This wind data was then adjusted for each of the three proposed wind

project sites from the WEST and OpenWind wind flow model resulting in a prediction of an average annual wind speed of 4.6 m/s at 75m AGL at Site One; 6.6 m/s at 75m AGL at Site Two; and 8.0 m/s at 75m AGL at Site Three.

The energy produced by each of the three selected turbines is based on the published power curves less 5% to adjust for a turbine availability of 95%. An additional 10% of the production is then subtracted to account for losses (turbulence losses, array losses, mechanical losses, cold and icing performance losses, transformer losses, and transmission line losses) to arrive at the net energy production available to displace diesel energy. Net generation is the HOMER calculated ideal generation less availability and other losses (total deduction of 15% from the ideal generation). Appendix 2 presents a table of energy production from the three project configurations at each of the three sites for a total of nine cases. The capacity factor achieved in each case is also provided. The net energy production by each of the project configurations at each of the three sites is presented in Table 1 below. Often there is an adjustment for increased production at higher air densities due to cold temperatures which, in this case, would likely be 5% or a bit higher. However, to be conservative no air density adjustments were made in this study.

Table 1: Net energy generation and diesel displaced by each configuration at each site (kWh)

Turbine Configuration	Site One		Site Two		Site Three	
	Net generated	Diesel displaced	Net generated	Diesel displaced	Net generated	Diesel displaced
Two DW 54-900s	1,565,250	1,565,250	3,773,116	3,768,461	5,305,267	5,291,853
Two AW 54-750s	1,377,517	1,377,517	3,327,367	3,326,083	4,580,483	4,576,419
Two E53 800s	1,651,644	1,651,644	3,813,307	3,810,244	5,229,070	5,219,911

Capital Costs

The estimated capital costs for the three project configurations are presented in Appendix 3. The costs without road or power line infrastructure are summarized in Table 2. The reason road and power line infrastructure costs are not included is that for sites two and three they are very high. Appendix 3, however, presents the capital costs of the projects with the road and power line infrastructure included.

Table 2: Wind project costs excluding road and power line infrastructure.

Wind Project Configuration	Installed Capacity	Capital Cost, $	Cost per kW of Capacity, $/kW
Two DW 54-900s	1,800 kW	$8,541,700	$4,745
Two AW 54-750s	1,500 kW	$7,584,953	$5,057
Two E53 800s	1,600 kW	$7,965,300	$4,978
Cost for one additional E53	800 kW	$3,085,390	$3,857

Also included in Table 2 is the incremental cost of including one additional E53 in a project at each of the three sites (i.e. project size increases from two to three turbines). Table 3 provides the road and power line costs for each of the three sites.

Table 3: Road and power line costs for each of the three sites.

Wind Project Site	Estimated Road Cost	Estimated Power Line Cost	Total Estimated Infrastructure Cost
Site One: 2.5km road, 3km line	$562,500	$525,000	$1,087,000
Site Two: 29km road, 35km line	$6,525,000	$5,250,000	$11,775,000
Site Three: 54km road, 60km line	$12,150,000	$9,625,000	$21,775,000

The road and power line required to connect the wind project to Inuvik's power system is modest for Site One, but this site has a low wind resource – only 4.6m/s at 75m AGL. Site Two has a reasonable wind resource of 6.6m/s at 75m AGL but the road and power line infrastructure costs would more than double the wind project costs. Site Three has a very good wind resource of 8.0m/s at 50m AGL but the infrastructure costs alone are almost three times the wind project cost. The authors wish to emphasize that the estimated costs of $175,000 per kilometer for power line (25kV assumed) and $225,000 per kilometer for a road (basic resource access road only – not a government standard all-weather road) is based on their knowledge of southern Yukon costs but increased for Inuvik's location. This was felt to be adequate for a study of this level. The effort required for preparing detailed cost estimates based on local quotes for the sites and routes were beyond the scope of this study.

The annual operating and maintenance cost for a project of two mid-size turbines was estimated to be about $150 per kW of capacity per year based on a detailed study carried out in New Brunswick. The New Brunswick study on a 15MW project concluded that the O&M costs would be about $78.50 per kW per year, and in the authors judgment, the comparable O&M cost in Inuvik for a smaller project was likely to be close to twice that experienced in eastern Canada. These costs are based on the simple requirements to keep a project running and do not include costs that may be associated with establishing and running a corporation for the wind project only. The effective assumption is that the

wind project is owned and operated by an appropriate existing organization involved in other similar activities (e.g. an independent power producer that owns several renewable energy projects of which the Inuvik project would be one). The operating and maintenance cost is intended to include all overhead, insurance, lease, and tax costs as well as the actual maintenance costs. This annual cost is equivalent to about 3% of the installed capital costs of wind projects (without roads and power lines). The annual costs converts to about $0.046 to $0.17 per kWh, which ranges from modest to quite high because of the variation in energy production from the wind projects depending on the site. The O&M cost at Site Three would be at the low end of the range and the O&M cost at Site One would be at the high end of the range.

For the economic analysis (presented in the following subsection) the cost of capital was assumed to be 7.5%, which represents a regulated utility. Incorporated in the cost of capital is a return on equity which would be earned by the project owners and is separate and distinct from the annual operating and maintenance costs. The authors believe that a private wind project developer may consider a project in this area to represent a high risk and may require a higher return on equity than a regulated utility would. A project developer would need to calculate the economics of a project based on their own circumstances.

Cost of Wind Energy and Economic Analysis

The levelized cost of energy (LCOE) for wind over a 20 year project life was calculated to compare the cost of wind generated electricity to the cost of diesel generation. Appendix 4 presents the economic model outputs of the levelized cost of wind energy for the three project configurations at each of the three sites both with and without road and power line costs included. Appendix 5 presents the economic model outputs for continued diesel generation. The variables and assumptions used in the economic model include the project capital cost, its capacity in kW, its annual diesel displacing energy production, the useful life of a wind project (20 years), the cost of capital (7.5%), the general inflation rate (2%), and the annual operating costs. The model calculates the levelized cost of energy over the life of the projects.

For continued diesel generation, the assumptions include a variable operating and maintenance cost of $0.03 per kWh, a plant efficiency of 3.635 kWh per litre, and diesel fuel is assumed to inflate at 2% per year, the same as general inflation. Also the authors based the diesel fuel pricing of $1.10 per litre on the last NTPC GRA and more recent pricing information available for other NWT communities. $1.10 per litre was considered to be reasonable and consistent with fuel costs assumed for other communities for which prefeasibility studies are also being completed at this time (Trout Lake $1.00, Jean Marie River $1.15, Whati $1.25, and Deline $1.35). The modeling indicates that the 20 year levelized cost of diesel generation under the stated assumptions is $0.390 per kWh. Table 4 summarizes the results of the economic modeling for the wind projects.

Table 4: Summary of economic modeling without and with the cost of roads and power lines at each of the three sites.

Configuration	Levelized cost of Wind Energy, $ per kWh		
	Site One (4.4 m/s)	Site Two (6.3 m/s)	Site Three (7.6 m/s)
Without roads or power lines			
Two DW 54-900s	$0.725	$0.301	$0.215
Two AW 54-750s	$0.719	$0.298	$0.217
Two E53 800s	$0.633	$0.274	$0.167
With roads and power lines			
Two DW 54-900s	$0.799	$0.631	$0.648
Two AW 54-750s	$0.802	$0.671	$0.718
Two E53 800s	$0.702	$0.600	$0.640

The economic analyses summarized in the table above indicate that when reasonable wind speeds are available to a wind project (Sites Two and Three), power can be generated cost effectively if the roads and power lines required to service the site are not excessive. The estimated costs to access either of Sites Two and Three are such that when added to the cost of power it makes wind energy more expensive than diesel generation. A significant portion of the capital costs of the roads and power lines required for these wind projects would need to be subsidized to make the electricity cost competitive with diesel generation. However, if a road or power line is being built or considered for other purposes, it may make sense to choose route options that bring them towards or nearer sites where economic wind generation is possible with these in place. For example, if the Inuvik to Tuktoyaktuk highway is to be built, routing it along either (or both) of Site Two or Three would substantially reduce the cost of developing a wind project, and thus the cost of energy would be substantially lower.

Site Two with $4.5 million in road and power line costs would break even with the cost of diesel and Site Three with $10 million in road and power line costs would similarly break even.

The fixed costs for a project in the Inuvik area, including roads, power lines, crane mobilization and demobilization, as well as others, are substantial. To add an additional wind turbine to any of the projects would incur incremental costs that are well below the average costs. The net electricity generated from an additional turbine at Site One would cost $0.529 per kWh, not competitive with diesel generation. At Site Two the incremental net generation would cost $0.229 per kWh and at Site Three the incremental generation would only cost $0.167 per kWh, both well below the incremental cost of diesel generation.

If wind projects of five Enercon E53 800 kW wind turbines (4,000kW or 4MW total) were installed at Sites Two or Three, and selling all of their net generation was possible, the cost of wind generated electrical energy would be reduced substantially. At Site Two, with road and power line costs included,

the net electricity generated was calculated to cost $0.377 per kWh, and at Site Three (again road and power line costs included) the net electricity generated was calculated to cost $0.356 per kWh. Both are below the incremental cost of diesel generation ($0.390 per kWh). These numbers illustrate the effect of spreading the high infrastructure costs over a larger project and the modest incremental cost of purchasing and installing more wind turbines at the same time. In this scenario there would about 3 to 6% excess energy compared to the present demand in Inuvik. But this excess energy could be easily utilized by shifting loads to times when wind energy is being produced (e.g. running clothes dryers, hot water tanks). The excess wind energy could also be used for commercial and/or residential space heating, though using wind energy for space heating is more expensive than oil or gas heating (unless a wind project larger than 4MW is developed). More power controls such as smart grid technology would be needed to manage the loads in conjunction with a larger wind project, such as the 4MW scenario presented here.

The cost of energy from either Site Two or Three would also be lower if the costs of the roads and power lines were to be spread over a longer period of time, more in line with their useful lives (about 50 years in the case of power lines). This would be justified if the wind project were to be replaced with a similar one after its 20 year life was over, or if there were other justifiable uses for this infrastructure continuing past the 20 year timeframe.

Greenhouse Gas Reductions

Table 5 outlines the diesel fuel and greenhouse gas (GHG) reductions that would be achieved by the wind projects examined for Inuvik. The calculations are based on a diesel plant efficiency of 3.635 kWh per litre, and GHG emissions of 3.0 kg carbon dioxide (CO_2) equivalent per litre of diesel fuel consumed.

Table 5: Greenhouse Gas (GHG) Reductions from Inuvik area wind projects

Project configuration and site	Diesel Electricity Displaced, kWh	Diesel fuel saved, litres	GHG reductions, kg CO_2 equivalent
Site One			
Two DW 54-900	1,565,250	430,605	1,291,816
Two AW 54-750	1,377,517	378,959	1,136,878
Two E53 800	1,651,644	454,372	1,363,117
Site Two			
2 DW 54-900	3,768,461	1,036,716	3,110,147
2 AW 54-750	3,326,083	915,016	2,745,048
2 E53 800	3,810,244	1,048,210	3,144,631
Site Three			
2 DW 54-900	5,291,853	1,455,806	4,367,417
2 AW 54-750	4,576,419	1,258,987	3,776,962
2 E53 800	5,219,911	1,436,014	4,308,042

Conclusions

1. The 20 year levelized variable cost of diesel generation was calculated to be $0.390 per kWh.
2. The area immediately around Inuvik does not appear to have sites with a wind resource adequate for power generation that is cost competitive with diesel generation.
3. Two areas north of Inuvik have been identified by measurements and modeling as having a wind resource adequate for cost competitive commercial power generation. The sites are the Caribou Hills (Site Two) about 30km north of Inuvik and Storm Hills (Site Three) about 60 km north of Inuvik.
4. The annual average wind speed at the best sites in the area immediately around Inuvik (Site One) is 4.6 m/s at 75 m AGL; at Site Two is 6.6 m/s at 75 m AGL; and at Site Three is 8.0 m/s at 75 m AGL.
5. Sites Two and Three have excellent wind speeds, but the costs of roads and powerlines makes the wind generated electricity costs higher than diesel generation.
6. Without roads or power lines included, wind generated electricity from the Inuvik area (Site One) would cost about $0.63 to $0.73 per kWh (levelized over 20 years); from Site Two would cost $0.27 to $0.30 per kWh; and from Site Three would cost $0.20 to $0.22 per kWh.
7. With roads and power lines included the costs at the three sites would be $0.70 to $0.80 per kWh at Site One; $0.60 to $0.67 per kWh at Site Two; and $0.64 to $0.72 per kWh at Site Three.
8. In order to produce electrical energy cost competitively with diesel generation the cost of roads and power lines at Site Two would need to be limited to about $4.5 million; and at Site Three would need to be limited to about $10 million.
9. Expanding the size of a wind projects would be cost effective at Sites Two and Three. In projects using Enercon E53 800kW wind turbines, increasing the project size from two turbines to three turbines at each of the three sites would produce additional electrical energy costing about $0.53 at Site One; $0.23 at Site Two; and $0.17 per kWh at Site Three.
10. If opportunities are found to install road and power line infrastructure to either of the Caribou Hills (Site Two) or Storm Hills (Site Three) areas at no cost to a wind project, the cost of wind generated electricity would be reduced significantly.
11. If opportunities are found to increase the market for electricity at Inuvik to enable a larger wind project to be installed at either Site Two or Site Three the cost of wind generated electricity could be significantly reduced.
12. A wind project of five Enercon E53 800 kW turbines (4MW total) at Site Two with roads and power lines included, would result in net generation costing about $0.38 per kWh, less than the cost of diesel generation (all kWh generated would need to be sold). A similar five turbine 4MW project at Site Three with the cost of roads and power lines included would generate electrical energy costing about $0.356 per kWh.

Next Steps

1. If a wind project at Caribou Hills (Site Two) or Storm Hills (Site Three) is considered of interest the next step would be to install a meteorological mast to more accurately evaluate the wind resource at the chosen site(s).
2. In parallel with the above, investigations and discussions with respect to the possibility of sharing road or power line infrastructure costs should take place. This includes discussions with the GNWT with respect to a road link to Tuktoyaktuk that has been discussed from time to time. If there are plans being drawn up for such a road the possibility of accessing a reasonable wind project site by appropriate routing decisions should be considered.
3. As well, consideration needs to be given to the possibility of increasing a wind project size by increasing the level of wind energy displacement of diesel generation. Displacing oil fired space heating is a possibility too, and the wind project may be sized large enough that the cost of wind energy is lower than that of heating oil. This opportunity should be explored.
4. If some alignment of the above factors (shared infrastructure costs and increased wind generated electricity market) can be achieved and a wind project becomes a realistic possibility, a detailed feasibility study based on actual site wind resource data would need to be completed.

References

Pinard 2007. **Executive Progress Report for Wind Energy Monitoring in Six communities in the NWT.** Report for the Aurora Research Institute.

Stull, R.B., 2000. **Meteorology for Scientists and Engineers**, Second Edition. Published by Brooks/Cole.

Appendix 1

NORTHWEST TERRITORIES
POWER
CORPORATION

Department of Finance, 4 Capital Drive, Hay River, NT X0E 1G2; *Phone (867) 874-5200 Fax (867) 874-5251*

November 24, 2006

John Hill, Chair
Northwest Territories Public Utilities Board
203-62 Woodland Drive
Box 4211
Hay River, NT

Dear Mr. Hill,

Enclosed are seven copies of Northwest Territories Power Corporation's ("NTPC's") 2006/07 and 2007/08 Phase I General Rate Application and supporting materials ("Phase I Application"). The Phase I Application sets out the forecast costs to supply customers for the two test years, the revenues that are forecast to arise at existing rates, and a consequent shortfall requiring changes to rates.

The Phase I Application addresses company-wide costs, revenues and investments required to determine the NTPC overall revenue requirement. Also included in the Phase I Application is the NTPC's response to various directives of the Northwest Territories Public Utilities Board ("PUB" or "Board") related to revenue requirement matters.

Community-specific revenue requirements and resulting final rate proposals will be addressed as part of NTPC's Phase II Application. In addition, the Phase II Application is expected to address three remaining Board directives from the 2001/03 GRA[1].

[1] Board Directive 10 from Decision 3-2003 regarding time of use rates, Directive 2 from Decision 7-2003 regarding legacy assets in cost-of-service and Directive 3 from Decision 7-2003 regarding cost-of-service for Rae/Edzo (now Behchoko) and Dettah are all properly cost-of-service or rate design topics and are more properly suited to a Phase II filing.

NORTHWEST TERRITORIES POWER CORPORATION Schedule 3.3.2

2007/08 FORECAST PRODUCTION FUEL COST

Line No.	Plant No.		Generation (kWh)	Plant Efficiency (kWh/L)	Fuel Required (Litres)	Fuel Price ($/L)	Fuel Cost ($000's)
1	101	Yellowknife	1,379,000	3.500	394,000	0.755	297
2	104	Wha Ti	1,730,422	3.711	466,256	0.897	418
3	105	Gameti	975,320	3.398	287,008	0.927	266
4	108	Behchoko	21,125	3.250	6,500	0.778	5
5	110	Lutsel K'e	1,637,723	3.778	433,468	0.896	388
6	201	Fort Smith	465,700	3.277	142,102	0.793	113
7	203	Fort Resolution	60,000	3.459	17,345	0.860	15
8	205	Fort Simpson	8,238,565	3.755	2,193,767	0.862	1,890
9	206	Fort Liard	2,719,334	3.725	730,105	0.877	641
10	207	Wrigley	667,892	3.525	189,491	0.885	168
11	208	Nahanni Butte	372,594	2.511	148,360	0.877	130
12	209	Jean Marie River	339,598	2.749	123,547	0.858	106
13	301	Inuvik Power - D	1,675,500	3.635	460,935	0.797	367
14	304	Norman Wells - D	63,000	3.414	18,451	0.841	16
15	305	Tuktoyaktuk	4,584,515	3.697	1,240,016	1.001	1,241
16	306	Fort McPherson	3,422,267	3.609	948,301	0.926	878
17	307	Aklavik	2,776,285	3.475	798,914	0.914	730
18	308	Deline	2,658,924	3.546	749,826	1.015	761
19	309	Fort Good Hope	2,874,492	3.576	803,823	1.001	804
20	310	Tulita	2,200,488	3.634	605,551	0.905	548
21	311	Paulatuk	1,350,941	3.492	386,914	1.090	422
22	312	Sachs Harbour	907,022	3.189	284,401	1.075	306
23	313	Tsiigehtchic	864,359	3.537	244,353	0.985	241
24	314	Colville Lake	338,554	2.957	114,488	1.133	130
25	315	Ulukhaktok	1,986,962	3.616	549,489	1.111	610
26	**Subtotal - Diesel**		**44,310,582**	**3.603**	**12,337,411**	**0.931**	**11,491**

NATURAL GAS

Line No.	Plant No.		Generation (kWh)	Plant Efficiency (kWh/L)	Fuel Required (m^3)	Fuel Price (m^3)	Fuel Cost ($000's)
27	301	Inuvik	29,773,906	3.399	8,758,336	0.430	3,769
28	**Subtotal - Natural Gas**		**29,773,906**		**8,758,336**		**3,769**

PURCHASED POWER

Line No.	Plant No.		Generation (kWh)	Price ($/kWh)	Cost ($000's)
29	304	Norman Wells	9,305,234	0.279	2,593
30	**Subtotal - Purch. Power**		**9,305,234**	**0.279**	**2,593**

Schedule A.15

Northwest Territories Power Corporation
2006/07 - 2007/08 General Rate Application
Summary of Generation, Sales, and Revenue
301 Inuvik

Line no.	Description	2002/03 Negotiated Settlement	2004/05 Actual	2005/06 Actual	2006/07 Forecast @ Existing Rates	2007/08 Forecast @ Existing Rates
	SALES AND REVENUE					
	Residential					
1	Sales (MWh)	8,939	9,043	9,082	8,879	9,057
2	Customers	1,526	1,371	1,371	1,410	1,454
3	Av. MWh Sales/Cust.	5.86	6.60	6.62	6.30	6.23
4	Revenue (000s)	3,791	3,806	3,883	3,742	3,821
5	Cents /kWh	42.41	42.10	42.76	42.15	42.19
	General Service					
6	Sales (MWh)	16,236	18,601	18,502	18,458	18,643
7	Customers	411	463	463	463	461
8	Av. MWh Sales/Cust.	39.46	40.18	39.96	39.90	40.44
9	Revenue (000s)	5,736	6,627	6,573	6,558	6,615
10	Cents /kWh	35.33	35.63	35.52	35.53	35.48
	Wholesale					
11	Sales (MWh)					
12	Customers					
13	Revenue (000s)					
14	Cents /kWh					
	Industrial					
15	Sales (MWh)					
16	Customers					
17	Av. MWh Sales/Cust.					
18	Revenue (000s)					
19	Cents /kWh					
	Streetlights					
20	Sales (MWh)	234	238	299	234	259
21	Revenue (000s)	121	139	139	128	127
22	Cents /kWh	51.94	58.52	46.56	54.44	48.99
	Total Community					
23	**Sales (MWh)**	**25,409**	**27,881**	**27,884**	**27,571**	**27,958**
24	Customers	**1,937**	**1,834**	**1,834**	**1,873**	**1,915**
25	Revenue (000s)	**9649**	**10,572**	**10,596**	**10,428**	**10,563**
26	Cents /kWh	37.97	37.92	38.00	37.82	37.78
	GENERATION (MWh)					
27	**Total Station Service**	1,422	1,783	1,612	1,612	1,612
28	**Total Losses**	2,020	1,221	1,318	1,854	1,880
29	***Losses - % of Gen.***	*7.0%*	*4.0%*	*4.3%*	*6.0%*	*6.0%*
30	**Total Generation**	**28,851**	**30,885**	**30,813**	**31,036**	**31,449**
	Source (MWh)					
31	Hydro Generation					
32	Gas Generation	25,966	23,484	22,907	29,397	29,774
33	Gas Efficiency	3.600	3.391	3.409	3.399	3.399
34	*Cubic Meters (000s)*	*7,213*	*6,926*	*6,720*	*8,647*	*8,758*
35	Diesel Generation	2,885	7,401	7,906	1,639	1,676
36	Diesel Efficiency	3.450	3.693	3.524	3.635	3.635
37	*Liters (000s)*	*836*	*2,004*	*2,243*	*451*	*460*
38	Purchased Power					
39	Total Generation	28,851	30,885	30,813	31,036	31,449
	% of Total Generation					
40	Hydro					
41	Gas	*90.0%*	*76.0%*	*74.3%*	*94.7%*	*94.7%*
42	Diesel	*10.0%*	*24.0%*	*25.7%*	*5.3%*	*5.3%*
43	Purchased					
	Peak (kW)					
44	Total Peak	5,098	5,670	5,670	5,616	5,691
45	Load Factor	64.6%	62.2%	62.0%	63.1%	63.1%

NORTHWEST TERRITORIES POWER CORPORATION

RATE SCHEDULE

Effective Date: December 1, 2010
Supersedes: November 1, 2008

Zone: Thermal

Residential Government

Monthly Service Charge:	$18.00

Energy Charge

Wha Ti	84.57 ¢/kWh
Gameti	129.80 ¢/kWh
Lutsel K'e	78.53 ¢/kWh
Fort Simpson	73.44 ¢/kWh
Fort Liard	78.06 ¢/kWh
Wrigley	137.92 ¢/kWh
Nahanni Butte	166.40 ¢/kWh
Jean Marie River	148.70 ¢/kWh
Inuvik	60.35 ¢/kWh
Tuktoyaktuk	70.80 ¢/kWh
Fort McPherson	81.59 ¢/kWh
Aklavik	64.84 ¢/kWh
Deline	83.20 ¢/kWh
Fort Good Hope	72.41 ¢/kWh
Tulita	89.51 ¢/kWh
Paulatuk	122.92 ¢/kWh
Sachs Harbour	152.12 ¢/kWh
Tsiigehtchic	112.71 ¢/kWh
Colville Lake	230.26 ¢/kWh
Ulukhaktok	70.75 ¢/kWh

Minimum Monthly Bill:	$18.00

Residential Non-Government

Monthly Service Charge:	$18.00
Energy Charge:	47.39 ¢/kWh
Minimum Monthly Bill:	$18.00

NORTHWEST TERRITORIES POWER CORPORATION

RATE SCHEDULE

Effective Date: December 1, 2010
Supersedes: November 1, 2008

Zone: Thermal

General Service Government

Demand Charge:	$8.00/kW

Energy Charge

Wha Ti	78.50 ¢/kWh
Gameti	149.18 ¢/kWh
Lutsel K'e	73.03 ¢/kWh
Fort Simpson	64.34 ¢/kWh
Fort Liard	70.37 ¢/kWh
Wrigley	147.49 ¢/kWh
Nahanni Butte	214.65 ¢/kWh
Jean Marie River	200.65 ¢/kWh
Inuvik	53.68 ¢/kWh
Tuktoyaktuk	62.87 ¢/kWh
Fort McPherson	74.64 ¢/kWh
Aklavik	61.95 ¢/kWh
Deline	78.50 ¢/kWh
Fort Good Hope	63.42 ¢/kWh
Tulita	86.46 ¢/kWh
Paulatuk	116.15 ¢/kWh
Sachs Harbour	142.58 ¢/kWh
Tsiigehtchic	99.84 ¢/kWh
Colville Lake	200.26 ¢/kWh
Ulukhaktok	64.04 ¢/kWh

Minimum Monthly Bill:	$40.00
Stand-by Charge:	$24.00 /kW

* General Service – Billing Demand shall be the greater of the current month's maximum Demand or the maximum Demand experienced during the 12 month period ending with the current billing month.

* Stand-by eligibility is negotiated with NTPC on a per customer basis and subject to all applicable energy rates and riders.

NORTHWEST TERRITORIES POWER CORPORATION

RATE SCHEDULE

Effective Date: December 1, 2010
Supersedes: November 1, 2008

Zone: Thermal

General Service Non-Government

Demand Charge:	$8.00 /kW
Energy Charge:	40.20 ¢/kWh
Minimum Monthly Bill:	$40.00
Stand-by Charge:	$24.00 /kW

* General Service – Billing Demand shall be the greater of the current month's maximum Demand or the maximum Demand experienced during the 12 month period ending with the current billing month.

* Stand-by eligibility is negotiated with NTPC on a per customer basis and subject to all applicable energy rates and riders.

Total installed capacity of the plant is 1,140 kW, generated one 500 kW and two 320 kW diesel generators.

Fort Good Hope

The plant has three diesel generators with a total installed capacity of 1,230 kW.

Fort Liard

The facility contains three diesel generators with a total output of 1,320 kW.

Fort McPherson

Total installed capacity of the plant is 1,825 kW. The plant also provides residual heat to various buildings using the Aadrii heating system.

Fort Simpson

The power plant consists of four diesel generators with a total output capacity of 3,210 kW.

Inuvik

The Thermal Operations regional office complex is located in Inuvik. Two power plants consist of:

- three natural gas fuelled generators rated at 2.8 MW, 2.8 MW, and 2.1 MW
- two 2.5 MW diesel generators
- one 760 kW diesel generator
- one 300 kW diesel generator

Jean Marie River

The power plant has three small diesel generators with a total output of 230 kW.

Nahanni Butte

The power plant has three small diesel generators with a total output capacity of 245 kW.

Norman Wells

The Norman Wells power plant is a standby plant with two generating units. NTPC purchases the electrical energy from ESSO and then resells it to the community. Total installed capacity of Norman Wells standby plant is 2,120 kW.

Paulatuk

Appendix 2

Inuvik wind project calculation of net diesel displaced from HOMER model output

Minimum diesel plant load 90 kW (30% of 300 kW smallest generator)

		Losses from generation					Reductions in surplus			
Project configuration	HOMER generation kWh	Availability 95%	Electrical & other 10%	Net generation	Capacity factor	HOMER surplus energy kWh	Availability	Electrical & other losses	Net surplus	Diesel displaced kWh
Site 1: 4.4 m/s @ 50 m										
2 DW 54-900 (4.6 m/s @ 75 m)	1,841,471	92,074	184,147	1,565,250	9.9%	0	0	0	0	1,565,250
2 AW 54-750 (4.5 m/s @ 65 m)	1,620,608	81,030	162,061	1,377,517	10.5%	0	0	0	0	1,377,517
2 E53 800 (4.6 m/s @ 73 m)	1,943,110	97,156	194,311	1,651,644	11.8%	0	0	0	0	1,651,644
Site 2: 6.3 m/s @ 50 m										
2 DW 54-900 (6.6 m/s @ 75 m)	4,438,960	221,948	443,896	3,773,116	23.9%	5,477	274	548	4,655	3,768,461
2 AW 54-750 (6.5 m/s @ 65 m)	3,914,549	195,727	391,455	3,327,367	25.3%	1,510	76	151	1,284	3,326,083
2 E53 800 (6.6 m/s @ 73 m)	4,486,244	224,312	448,624	3,813,307	27.2%	3,604	180	360	3,063	3,810,244
Site 3: 7.6 m/s @ 50 m										
2 DW 54-900 (8.0 m/s @ 75 m)	6,241,490	312,075	624,149	5,305,267	33.6%	15,781	789	1,578	13,414	5,291,853
2 AW 54-750 (7.8 m/s @ 65 m)	5,388,803	269,440	538,880	4,580,483	34.9%	4,781	239	478	4,064	4,576,419
2 E53 800 (7.9 m/s @ 73 m)	6,151,847	307,592	615,185	5,229,070	37.3%	10,775	539	1,078	9,159	5,219,911

Notes:

Tower Heights		The tallest available tower is used for the selected wind turbines
EWT Directwind 54-900		The DW 54-900 kW with 54 m rotor diameter is on a 75 m tall tower
Aeronautica AW 54-750		The AW 54-750 kW with 54 m rotor diameter is on a 65 m tall tower
Enercon E53 800		The E53 800 kW with 53 m rotor diameter is on a 73 m tall tower
Assumptions in reductions of surplus		
For any 2 turbines	1	One half of downtime is non-coincident making remaining generation all diesel displacing
	2	One tenth of losses are systematic like electrical that occur during high output reducing surplus differentially

Appendix 3

Inuvik Wind Project Capital, O&M, and Energy Cost Summary

Costs independent of site

Cost category	low penetration 2 DW 54-900, 75m tower	low penetration 2 AW 54-750 65m tower	low penetration 2 E53 800, 73m tower
Project design and Management			
project design	$100,000	$100,000	$100,000
environmental assessment & permitting	$100,000	$100,000	$100,000
project management	$300,000	$300,000	$300,000
Site Preparation			
road construction ($225,000 per km) x km			
road construction 300m per added turbine	$70,000	$70,000	$70,000
site & crane pad construction $20,000 per turbine	$40,000	$40,000	$40,000
powerline const. ($175,000 per km) x km			
powerline const. ($300,000 per km) 300m per turbine	$180,000	$180,000	$180,000
Wind Equipment Purchase			
wind turbines with towers	$4,137,000	$3,197,230	$4,218,000
Supervisory control and data acquaisition - included			
shipping to Inuvik	$420,000	$490,000	$70,000
transformers	$125,000	$125,000	$0
Installation			
geotehnical & foundation design	$250,000	$250,000	$250,000
foundations $300k (concrete spread footing)	$600,000	$600,000	$600,000
equipment rental	$200,000	$200,000	$200,000
crane mob and de-mob	$400,000	$400,000	$400,000
crane site work	$50,000	$50,000	$20,000
control building	$25,000	$25,000	$25,000
utility interconnection	$100,000	$100,000	$100,000
labour - assembly & supervision	$100,000	$100,000	$25,000
commissioning	$50,000	$50,000	$25,000
travel and accommodation	$75,000	$75,000	$75,000
Diesel Plant Modifications			
radio / high speed communications	$50,000	$50,000	$50,000
PLC modifications	$50,000	$50,000	$50,000
other plant modifications	$25,000	$25,000	$25,000
Other			
initial spare parts	$25,000	$25,000	$25,000
Insurance	$75,000	$75,000	$75,000
other overhead costs (contracts etc.)	$150,000	$150,000	$150,000
Subtotal construction	**$7,697,000**	**$6,827,230**	**$7,173,000**
Contingency 10%	$769,700	$682,723	$717,300
TOTAL CONSTRUCTION	**$8,466,700**	**$7,509,953**	**$7,890,300**
Owners Costs			
staff training	$75,000	$75,000	$75,000
Subtotal owners costs	**$75,000**	**$75,000**	**$75,000**
TOTAL PROJECT COST	**$8,541,700**	**$7,584,953**	**$7,965,300**
Installed capacity kW	1800	1500	1600
Installed cost per kW	**$4,745**	**$5,057**	**$4,978**
Annual O&M costs $150 per year per kW	$270,000	$225,000	$240,000
Total annual costs	$270,000	$225,000	$240,000
Annual total wind energy kWh at hub height			
Annual diesel energy displaced			
Levelized cost of energy (LCOE) 20 year life			
O&M cost per kWh diesel displaced			

Appendix 3

Inuvik Wind Project Capital, O&M, and Energy Cost Summary

Site one costs

Cost category	low penetration 2 DW 54-900, 75m tower	low penetration 2 AW 54-750 65m tower	low penetration 2 E53 800, 73m tower
Project design and Management			
project design	$100,000	$100,000	$100,000
environmental assessment & permitting	$100,000	$100,000	$100,000
project management	$300,000	$300,000	$300,000
Site Preparation			
road construction ($225,000 per km) x 2.5km	$562,500	$562,500	$562,500
road construction 300m per added turbine	$70,000	$70,000	$70,000
site & crane pad construction $20,000 per turbine	$40,000	$40,000	$40,000
powerline const. ($175,000 per km) x 3km	$525,000	$525,000	$525,000
powerline const. ($300,000 per km) 300m per turbine	$180,000	$180,000	$180,000
Wind Equipment Purchase			
wind turbines with towers	$4,137,000	$3,197,230	$4,218,000
Supervisory control and data acquaisition - included			
shipping to Inuvik	$420,000	$490,000	$70,000
transformers	$125,000	$125,000	$0
Installation			
geotehnical & foundation design	$250,000	$250,000	$250,000
foundations $300k (concrete spread footing)	$600,000	$600,000	$600,000
equipment rental	$200,000	$200,000	$200,000
crane mob and de-mob	$400,000	$400,000	$400,000
crane site work	$50,000	$50,000	$20,000
control building	$25,000	$25,000	$25,000
utility interconnection	$100,000	$100,000	$100,000
labour - assembly & supervision	$100,000	$100,000	$25,000
commissioning	$50,000	$50,000	$25,000
travel and accommodation	$75,000	$75,000	$75,000
Diesel Plant Modifications			
radio / high speed communications	$50,000	$50,000	$50,000
PLC modifications	$50,000	$50,000	$50,000
other plant modifications	$25,000	$25,000	$25,000
Other			
initial spare parts	$25,000	$25,000	$25,000
Insurance	$75,000	$75,000	$75,000
other overhead costs (contracts etc.)	$150,000	$150,000	$150,000
Subtotal construction	**$8,784,500**	**$7,914,730**	**$8,260,500**
Contingency 10%	$878,450	$791,473	$826,050
TOTAL CONSTRUCTION	**$9,662,950**	**$8,706,203**	**$9,086,550**
Owners Costs			
staff training	$75,000	$75,000	$75,000
Subtotal owners costs	**$75,000**	**$75,000**	**$75,000**
TOTAL PROJECT COST	**$9,737,950**	**$8,781,203**	**$9,161,550**
Installed capacity kW	1800	1500	1600
Installed cost per kW	**$5,410**	**$5,854**	**$5,726**
Annual O&M costs $150 per year per kW	$270,000	$225,000	$240,000
Total annual costs	$270,000	$225,000	$240,000
Annual total wind energy kWh at hub height	1,565,250	1,377,517	1,651,644
Annual diesel energy displaced	1,565,250	1,377,517	1,651,644
Levelized cost of energy (LCOE) 20 year life $/kWh	$0.799	$0.802	$0.702
LCOE no road or power line $/kWh	$0.725	$0.719	$0.633
O&M cost per kWh of diesel displaced	$0.172	$0.163	$0.145

Appendix 3

Inuvik Wind Project Capital, O&M, and Energy Cost Summary

Site two costs

Cost category	low penetration 2 DW 54-900, 75m tower	low penetration 2 AW 54-750 65m tower	low penetration 2 E53 800, 73m tower
Project design and Management			
project design	$100,000	$100,000	$100,000
environmental assessment & permitting	$100,000	$100,000	$100,000
project management	$300,000	$300,000	$300,000
Site Preparation			
road construction ($225,000 per km) x 29km	$6,525,000	$6,525,000	$6,525,000
road construction 300m per added turbine	$70,000	$70,000	$70,000
site & crane pad construction $20,000 per turbine	$40,000	$40,000	$40,000
powerline const. ($175,000 per km) x 30km	$5,250,000	$5,250,000	$5,250,000
powerline const. ($300,000 per km) 300m per turbine	$180,000	$180,000	$180,000
Wind Equipment Purchase			
wind turbines with towers	$4,137,000	$3,197,230	$4,218,000
Supervisory control and data acquaisition - included			
shipping to Inuvik	$420,000	$490,000	$70,000
transformers	$125,000	$125,000	$0
Installation			
geotehnical & foundation design	$250,000	$250,000	$250,000
foundations $300k (concrete spread footing)	$600,000	$600,000	$600,000
equipment rental	$200,000	$200,000	$200,000
crane mob and de-mob	$400,000	$400,000	$400,000
crane site work	$50,000	$50,000	$20,000
control building	$25,000	$25,000	$25,000
utility interconnection	$100,000	$100,000	$100,000
labour - assembly & supervision	$100,000	$100,000	$25,000
commissioning	$50,000	$50,000	$25,000
travel and accommodation	$75,000	$75,000	$75,000
Diesel Plant Modifications			
radio / high speed communications	$50,000	$50,000	$50,000
PLC modifications	$50,000	$50,000	$50,000
other plant modifications	$25,000	$25,000	$25,000
Other			
initial spare parts	$25,000	$25,000	$25,000
Insurance	$75,000	$75,000	$75,000
other overhead costs (contracts etc.)	$150,000	$150,000	$150,000
Subtotal construction	**$19,472,000**	**$18,602,230**	**$18,948,000**
Contingency 10%	$1,947,200	$1,860,223	$1,894,800
TOTAL CONSTRUCTION	**$21,419,200**	**$20,462,453**	**$20,842,800**
Owners Costs			
staff training	$75,000	$75,000	$75,000
Subtotal owners costs	**$75,000**	**$75,000**	**$75,000**
TOTAL PROJECT COST	**$21,494,200**	**$20,537,453**	**$20,917,800**
Installed capacity kW	1800	1500	1600
Installed cost per kW	**$11,941**	**$13,692**	**$13,074**
Annual O&M costs $150 per year per kW	$270,000	$225,000	$240,000
Total annual costs	$270,000	$225,000	$240,000
Annual total wind energy kWh at hub height	3,773,116	3,327,367	3,813,307
Annual diesel energy displaced	3,768,461	3,326,083	3,810,244
Levelized cost of energy (LCOE) 20 year life $/kWh	$0.631	$0.671	$0.600
LCOE no road or power line $/kWh	$0.301	$0.298	$0.274
O&M cost per kWh of diesel displaced	$0.072	$0.068	$0.063

Appendix 3

Inuvik Wind Project Capital, O&M, and Energy Cost Summary

Site three costs

Cost category	low penetration 2 DW 54-900, 75m tower	low penetration 2 AW 54-750 65m tower	low penetration 2 E53 800, 73m tower
Project design and Management			
project design	$100,000	$100,000	$100,000
environmental assessment & permitting	$100,000	$100,000	$100,000
project management	$300,000	$300,000	$300,000
Site Preparation			
road construction ($225,000 per km) x 54km	$12,150,000	$12,150,000	$12,150,000
road construction 300m per added turbine	$70,000	$70,000	$70,000
site & crane pad construction $20,000 per turbine	$40,000	$40,000	$40,000
powerline const. ($175,000 per km) x 55km	$9,625,000	$9,625,000	$9,625,000
powerline const. ($300,000 per km) 300m per turbine	$180,000	$180,000	$180,000
Wind Equipment Purchase			
wind turbines with towers	$4,137,000	$3,197,230	$4,218,000
Supervisory control and data acquaisition - included			
shipping to Inuvik	$420,000	$490,000	$70,000
transformers	$125,000	$125,000	$0
Installation			
geotehnical & foundation design	$250,000	$250,000	$250,000
foundations $300k (concrete spread footing)	$600,000	$600,000	$600,000
equipment rental	$200,000	$200,000	$200,000
crane mob and de-mob	$400,000	$400,000	$400,000
crane site work	$50,000	$50,000	$20,000
control building	$25,000	$25,000	$25,000
utility interconnection	$100,000	$100,000	$100,000
labour - assembly & supervision	$100,000	$100,000	$25,000
commissioning	$50,000	$50,000	$25,000
travel and accommodation	$75,000	$75,000	$75,000
Diesel Plant Modifications			
radio / high speed communications	$50,000	$50,000	$50,000
PLC modifications	$50,000	$50,000	$50,000
other plant modifications	$25,000	$25,000	$25,000
Other			
initial spare parts	$25,000	$25,000	$25,000
Insurance	$75,000	$75,000	$75,000
other overhead costs (contracts etc.)	$150,000	$150,000	$150,000
Subtotal construction	**$29,472,000**	**$28,602,230**	**$28,948,000**
Contingency 10%	$2,947,200	$2,860,223	$2,894,800
TOTAL CONSTRUCTION	**$32,419,200**	**$31,462,453**	**$31,842,800**
Owners Costs			
staff training	$75,000	$75,000	$75,000
Subtotal owners costs	**$75,000**	**$75,000**	**$75,000**
TOTAL PROJECT COST	**$32,494,200**	**$31,537,453**	**$31,917,800**
Installed capacity kW	1800	1500	1600
Installed cost per kW	**$18,052**	**$21,025**	**$19,949**
Annual O&M costs $150 per year per kW	$270,000	$225,000	$240,000
Total annual costs	$270,000	$225,000	$240,000
Annual total wind energy kWh at hub height	5,305,267	4,580,483	5,229,070
Annual diesel energy displaced	5,291,853	4,576,419	5,219,911
Levelized cost of energy (LCOE) 20 year life $/kWh	$0.648	$0.718	$0.640
LCOE 20 year life no road or power line $/kWh	$0.215	$0.217	$0.200
O&M cost per kWh of diesel displaced	$0.051	$0.049	$0.046

Appendix 3

Inuvik Wind Project Capital, O&M, and Energy Cost Summary

Costs independent of site & incremental cost for the addition of one E53 turbine

	low penetration	low penetration	Incremental	low penetration
Cost category	**2 DW 54-900, 75m tower**	**2 AW 54-750 65m tower**	**1 E53-800**	**2 E53 800, 73m tower**
Project design and Management				
project design	$100,000	$100,000	$0	$100,000
environmental assessment & permitting	$100,000	$100,000	$0	$100,000
project management	$300,000	$300,000	$25,000	$300,000
Site Preparation				
road construction ($225,000 per km) x km				
road construction 300m per added turbine	$70,000	$70,000	$70,000	$70,000
site & crane pad construction $20,000 per turbine	$40,000	$40,000	$20,000	$40,000
powerline const. ($175,000 per km) x km				
powerline const. ($300,000 per km) 300m per turbine	$180,000	$180,000	$0	$180,000
Wind Equipment Purchase				
wind turbines with towers	$4,137,000	$3,197,230	$2,109,900	$4,218,000
Supervisory control and data acquaisition - included				
shipping to Inuvik	$420,000	$490,000	$70,000	$70,000
transformers	$125,000	$125,000	$0	$0
Installation				
geotehnical & foundation design	$250,000	$250,000	$25,000	$250,000
foundations $300k (concrete spread footing)	$600,000	$600,000	$300,000	$600,000
equipment rental	$200,000	$200,000	$75,000	$200,000
crane mob and de-mob	$400,000	$400,000	$0	$400,000
crane site work	$50,000	$50,000	$20,000	$20,000
control building	$25,000	$25,000	$0	$25,000
utility interconnection	$100,000	$100,000	$0	$100,000
labour - assembly & supervision	$100,000	$100,000	$15,000	$25,000
commissioning	$50,000	$50,000	$15,000	$25,000
travel and accommodation	$75,000	$75,000	$15,000	$75,000
Diesel Plant Modifications				
radio / high speed communications	$50,000	$50,000	$0	$50,000
PLC modifications	$50,000	$50,000	$0	$50,000
other plant modifications	$25,000	$25,000	$0	$25,000
Other				
initial spare parts	$25,000	$25,000	$0	$25,000
Insurance	$75,000	$75,000	$25,000	$75,000
other overhead costs (contracts etc.)	$150,000	$150,000	$20,000	$150,000
Subtotal construction	**$7,697,000**	**$6,827,230**	**$2,804,900**	**$7,173,000**
Contingency 10%	$769,700	$682,723	$280,490	$717,300
TOTAL CONSTRUCTION	**$8,466,700**	**$7,509,953**	**$3,085,390**	**$7,890,300**
Owners Costs				
staff training	$75,000	$75,000	$0	$75,000
Subtotal owners costs	**$75,000**	**$75,000**	**$0**	**$75,000**
TOTAL PROJECT COST	**$8,541,700**	**$7,584,953**	**$3,085,390**	**$7,965,300**
Installed capacity kW	1800	1500	800	1600
Installed cost per kW	**$4,745**	**$5,057**	**$3,857**	**$4,978**
Annual O&M costs $150 per year per kW	$270,000	$225,000	$120,000	$240,000
Total annual costs	$270,000	$225,000	$120,000	$240,000
Annual total wind energy kWh at hub height				
Annual diesel energy displaced				
Levelized cost of energy (LCOE) 20 year life				
O&M cost per kWh diesel displaced				

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site one; 2 DW 54-900 wind turbines - low penetration $150/kW O&M, 4.4m/s wind at 50m, no road or line

Capital cost	$8,541,700	$4,745/kW	Capacity	1,800	kW	Fixed O&M	$270,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	1,565,250	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$8,541,700	$640,628	$427,085	$270,000	$0	$1,337,713	1,565,250	$0.855	$1,337,713	1,565,250	$0.855
2	$8,114,615	$608,596	$427,085	$275,400	$0	$1,311,081	1,565,250	$0.838	$1,244,003	1,485,167	$0.838
3	$7,687,530	$576,565	$427,085	$280,908	$0	$1,284,558	1,565,250	$0.821	$1,156,477	1,409,182	$0.821
4	$7,260,445	$544,533	$427,085	$286,526	$0	$1,258,145	1,565,250	$0.804	$1,074,746	1,337,084	$0.804
5	$6,833,360	$512,502	$427,085	$292,257	$0	$1,231,844	1,565,250	$0.787	$998,441	1,268,675	$0.787
6	$6,406,275	$480,471	$427,085	$298,102	$0	$1,205,657	1,565,250	$0.770	$927,219	1,203,766	$0.770
7	$5,979,190	$448,439	$427,085	$304,064	$0	$1,179,588	1,565,250	$0.754	$860,757	1,142,178	$0.754
8	$5,552,105	$416,408	$427,085	$310,145	$0	$1,153,638	1,565,250	$0.737	$798,751	1,083,741	$0.737
9	$5,125,020	$384,377	$427,085	$316,348	$0	$1,127,810	1,565,250	$0.721	$740,917	1,028,294	$0.721
10	$4,697,935	$352,345	$427,085	$322,675	$0	$1,102,105	1,565,250	$0.704	$686,987	975,684	$0.704
11	$4,270,850	$320,314	$427,085	$329,128	$0	$1,076,527	1,565,250	$0.688	$636,711	925,765	$0.688
12	$3,843,765	$288,282	$427,085	$335,711	$0	$1,051,078	1,565,250	$0.672	$589,853	878,400	$0.672
13	$3,416,680	$256,251	$427,085	$342,425	$0	$1,025,761	1,565,250	$0.655	$546,194	833,459	$0.655
14	$2,989,595	$224,220	$427,085	$349,274	$0	$1,000,578	1,565,250	$0.639	$505,526	790,817	$0.639
15	$2,562,510	$192,188	$427,085	$356,259	$0	$975,533	1,565,250	$0.623	$467,655	750,356	$0.623
16	$2,135,425	$160,157	$427,085	$363,384	$0	$950,626	1,565,250	$0.607	$432,400	711,966	$0.607
17	$1,708,340	$128,126	$427,085	$370,652	$0	$925,863	1,565,250	$0.592	$399,589	675,540	$0.592
18	$1,281,255	$96,094	$427,085	$378,065	$0	$901,244	1,565,250	$0.576	$369,064	640,977	$0.576
19	$854,170	$64,063	$427,085	$385,626	$0	$876,774	1,565,250	$0.560	$340,674	608,183	$0.560
20	$427,085	$32,031	$427,085	$393,339	$0	$852,455	1,565,250	$0.545	$314,278	577,067	$0.545
									$14,427,953	19,891,555	$0.725
Real levelized cost of energy					**$0.725**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site one; 2 AW 54-750 wind turbines - low penetration $150/kW O&M, 4.4m/s wind at 50m, no road or line

Capital cost	$7,584,953	$5,057 per kW	Capacity	1,500	kW	Fixed O&M	$225,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	1,377,517	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$7,584,953	$568,871	$379,248	$225,000	$0	$1,173,119	1,377,517	$0.852	$1,173,119	1,377,517	$0.852
2	$7,205,705	$540,428	$379,248	$229,500	$0	$1,149,176	1,377,517	$0.834	$1,090,381	1,307,039	$0.834
3	$6,826,458	$511,984	$379,248	$234,090	$0	$1,125,322	1,377,517	$0.817	$1,013,118	1,240,168	$0.817
4	$6,447,210	$483,541	$379,248	$238,772	$0	$1,101,560	1,377,517	$0.800	$940,986	1,176,717	$0.800
5	$6,067,962	$455,097	$379,248	$243,547	$0	$1,077,892	1,377,517	$0.782	$873,659	1,116,513	$0.782
6	$5,688,715	$426,654	$379,248	$248,418	$0	$1,054,319	1,377,517	$0.765	$810,832	1,059,389	$0.765
7	$5,309,467	$398,210	$379,248	$253,387	$0	$1,030,844	1,377,517	$0.748	$752,217	1,005,188	$0.748
8	$4,930,219	$369,766	$379,248	$258,454	$0	$1,007,468	1,377,517	$0.731	$697,547	953,760	$0.731
9	$4,550,972	$341,323	$379,248	$263,623	$0	$984,194	1,377,517	$0.714	$646,568	904,963	$0.714
10	$4,171,724	$312,879	$379,248	$268,896	$0	$961,023	1,377,517	$0.698	$599,044	858,662	$0.698
11	$3,792,477	$284,436	$379,248	$274,274	$0	$937,957	1,377,517	$0.681	$554,754	814,731	$0.681
12	$3,413,229	$255,992	$379,248	$279,759	$0	$914,999	1,377,517	$0.664	$513,487	773,047	$0.664
13	$3,033,981	$227,549	$379,248	$285,354	$0	$892,151	1,377,517	$0.648	$475,049	733,496	$0.648
14	$2,654,734	$199,105	$379,248	$291,061	$0	$869,414	1,377,517	$0.631	$439,257	695,968	$0.631
15	$2,275,486	$170,661	$379,248	$296,883	$0	$846,792	1,377,517	$0.615	$405,939	660,360	$0.615
16	$1,896,238	$142,218	$379,248	$302,820	$0	$824,286	1,377,517	$0.598	$374,933	626,574	$0.598
17	$1,516,991	$113,774	$379,248	$308,877	$0	$801,899	1,377,517	$0.582	$346,088	594,517	$0.582
18	$1,137,743	$85,331	$379,248	$315,054	$0	$779,633	1,377,517	$0.566	$319,263	564,100	$0.566
19	$758,495	$56,887	$379,248	$321,355	$0	$757,490	1,377,517	$0.550	$294,325	535,239	$0.550
20	$379,248	$28,444	$379,248	$327,783	$0	$735,474	1,377,517	$0.534	$271,150	507,855	$0.534
									$12,591,718	17,505,801	$0.719
Real levelized cost of energy					**$0.719**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site one; 2 E53 800 wind turbines - low penetration $150/kW O&M, 4.4m/s wind at 50m, no road or line

Capital cost	$7,965,300	$4,978 per kW	Capacity	1,600	kW	Fixed O&M	$240,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	1,651,644	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$7,965,300	$597,398	$398,265	$240,000	$0	$1,235,663	1,651,644	$0.748	$1,235,663	1,651,644	$0.748
2	$7,567,035	$567,528	$398,265	$244,800	$0	$1,210,593	1,651,644	$0.733	$1,148,655	1,567,141	$0.733
3	$7,168,770	$537,658	$398,265	$249,696	$0	$1,185,619	1,651,644	$0.718	$1,067,403	1,486,962	$0.718
4	$6,770,505	$507,788	$398,265	$254,690	$0	$1,160,743	1,651,644	$0.703	$991,542	1,410,885	$0.703
5	$6,372,240	$477,918	$398,265	$259,784	$0	$1,135,967	1,651,644	$0.688	$920,730	1,338,700	$0.688
6	$5,973,975	$448,048	$398,265	$264,979	$0	$1,111,293	1,651,644	$0.673	$854,647	1,270,208	$0.673
7	$5,575,710	$418,178	$398,265	$270,279	$0	$1,086,722	1,651,644	$0.658	$792,992	1,205,221	$0.658
8	$5,177,445	$388,308	$398,265	$275,685	$0	$1,062,258	1,651,644	$0.643	$735,482	1,143,559	$0.643
9	$4,779,180	$358,439	$398,265	$281,198	$0	$1,037,902	1,651,644	$0.628	$681,852	1,085,051	$0.628
10	$4,380,915	$328,569	$398,265	$286,822	$0	$1,013,656	1,651,644	$0.614	$631,853	1,029,537	$0.614
11	$3,982,650	$298,699	$398,265	$292,559	$0	$989,522	1,651,644	$0.599	$585,252	976,863	$0.599
12	$3,584,385	$268,829	$398,265	$298,410	$0	$965,504	1,651,644	$0.585	$541,830	926,884	$0.585
13	$3,186,120	$238,959	$398,265	$304,378	$0	$941,602	1,651,644	$0.570	$501,381	879,462	$0.570
14	$2,787,855	$209,089	$398,265	$310,466	$0	$917,820	1,651,644	$0.556	$463,713	834,466	$0.556
15	$2,389,590	$179,219	$398,265	$316,675	$0	$894,159	1,651,644	$0.541	$428,646	791,772	$0.541
16	$1,991,325	$149,349	$398,265	$323,008	$0	$870,623	1,651,644	$0.527	$396,010	751,263	$0.527
17	$1,593,060	$119,480	$398,265	$329,469	$0	$847,213	1,651,644	$0.513	$365,645	712,826	$0.513
18	$1,194,795	$89,610	$398,265	$336,058	$0	$823,933	1,651,644	$0.499	$337,404	676,356	$0.499
19	$796,530	$59,740	$398,265	$342,779	$0	$800,784	1,651,644	$0.485	$311,147	641,752	$0.485
20	$398,265	$29,870	$398,265	$349,635	$0	$777,770	1,651,644	$0.471	$286,743	608,918	$0.471
									$13,278,590	20,989,470	$0.633
Real levelized cost of energy					**$0.633**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site two; 2 DW 54-900 wind turbines - low penetration $150/kW O&M, 6.3m/s wind at 50m, with road & line

Capital cost	$8,541,700	$4,745/kW	Capacity	1,800	kW	Fixed O&M	$270,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	3,768,461	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$8,541,700	$640,628	$427,085	$270,000	$0	$1,337,713	3,768,461	$0.355	$1,337,713	3,768,461	$0.355
2	$8,114,615	$608,596	$427,085	$275,400	$0	$1,311,081	3,768,461	$0.348	$1,244,003	3,575,656	$0.348
3	$7,687,530	$576,565	$427,085	$280,908	$0	$1,284,558	3,768,461	$0.341	$1,156,477	3,392,715	$0.341
4	$7,260,445	$544,533	$427,085	$286,526	$0	$1,258,145	3,768,461	$0.334	$1,074,746	3,219,135	$0.334
5	$6,833,360	$512,502	$427,085	$292,257	$0	$1,231,844	3,768,461	$0.327	$998,441	3,054,435	$0.327
6	$6,406,275	$480,471	$427,085	$298,102	$0	$1,205,657	3,768,461	$0.320	$927,219	2,898,161	$0.320
7	$5,979,190	$448,439	$427,085	$304,064	$0	$1,179,588	3,768,461	$0.313	$860,757	2,749,883	$0.313
8	$5,552,105	$416,408	$427,085	$310,145	$0	$1,153,638	3,768,461	$0.306	$798,751	2,609,192	$0.306
9	$5,125,020	$384,377	$427,085	$316,348	$0	$1,127,810	3,768,461	$0.299	$740,917	2,475,698	$0.299
10	$4,697,935	$352,345	$427,085	$322,675	$0	$1,102,105	3,768,461	$0.292	$686,987	2,349,034	$0.292
11	$4,270,850	$320,314	$427,085	$329,128	$0	$1,076,527	3,768,461	$0.286	$636,711	2,228,851	$0.286
12	$3,843,765	$288,282	$427,085	$335,711	$0	$1,051,078	3,768,461	$0.279	$589,853	2,114,817	$0.279
13	$3,416,680	$256,251	$427,085	$342,425	$0	$1,025,761	3,768,461	$0.272	$546,194	2,006,617	$0.272
14	$2,989,595	$224,220	$427,085	$349,274	$0	$1,000,578	3,768,461	$0.266	$505,526	1,903,953	$0.266
15	$2,562,510	$192,188	$427,085	$356,259	$0	$975,533	3,768,461	$0.259	$467,655	1,806,541	$0.259
16	$2,135,425	$160,157	$427,085	$363,384	$0	$950,626	3,768,461	$0.252	$432,400	1,714,114	$0.252
17	$1,708,340	$128,126	$427,085	$370,652	$0	$925,863	3,768,461	$0.246	$399,589	1,626,415	$0.246
18	$1,281,255	$96,094	$427,085	$378,065	$0	$901,244	3,768,461	$0.239	$369,064	1,543,203	$0.239
19	$854,170	$64,063	$427,085	$385,626	$0	$876,774	3,768,461	$0.233	$340,674	1,464,248	$0.233
20	$427,085	$32,031	$427,085	$393,339	$0	$852,455	3,768,461	$0.226	$314,278	1,389,333	$0.226
									$14,427,953	47,890,464	$0.301
Real levelized cost of energy					**$0.301**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site two; 2 AW 54-750 wind turbines - low penetration $150/kW O&M, 6.3m/s wind, no road or line

Capital cost	$7,584,953	$5,057 per kW	Capacity	1,500	kW	Fixed O&M	$225,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	3,326,083	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$7,584,953	$568,871	$379,248	$225,000	$0	$1,173,119	3,326,083	$0.353	$1,173,119	3,326,083	$0.353
2	$7,205,705	$540,428	$379,248	$229,500	$0	$1,149,176	3,326,083	$0.346	$1,090,381	3,155,911	$0.346
3	$6,826,458	$511,984	$379,248	$234,090	$0	$1,125,322	3,326,083	$0.338	$1,013,118	2,994,446	$0.338
4	$6,447,210	$483,541	$379,248	$238,772	$0	$1,101,560	3,326,083	$0.331	$940,986	2,841,242	$0.331
5	$6,067,962	$455,097	$379,248	$243,547	$0	$1,077,892	3,326,083	$0.324	$873,659	2,695,876	$0.324
6	$5,688,715	$426,654	$379,248	$248,418	$0	$1,054,319	3,326,083	$0.317	$810,832	2,557,947	$0.317
7	$5,309,467	$398,210	$379,248	$253,387	$0	$1,030,844	3,326,083	$0.310	$752,217	2,427,076	$0.310
8	$4,930,219	$369,766	$379,248	$258,454	$0	$1,007,468	3,326,083	$0.303	$697,547	2,302,900	$0.303
9	$4,550,972	$341,323	$379,248	$263,623	$0	$984,194	3,326,083	$0.296	$646,568	2,185,077	$0.296
10	$4,171,724	$312,879	$379,248	$268,896	$0	$961,023	3,326,083	$0.289	$599,044	2,073,282	$0.289
11	$3,792,477	$284,436	$379,248	$274,274	$0	$937,957	3,326,083	$0.282	$554,754	1,967,207	$0.282
12	$3,413,229	$255,992	$379,248	$279,759	$0	$914,999	3,326,083	$0.275	$513,487	1,866,560	$0.275
13	$3,033,981	$227,549	$379,248	$285,354	$0	$892,151	3,326,083	$0.268	$475,049	1,771,061	$0.268
14	$2,654,734	$199,105	$379,248	$291,061	$0	$869,414	3,326,083	$0.261	$439,257	1,680,449	$0.261
15	$2,275,486	$170,661	$379,248	$296,883	$0	$846,792	3,326,083	$0.255	$405,939	1,594,472	$0.255
16	$1,896,238	$142,218	$379,248	$302,820	$0	$824,286	3,326,083	$0.248	$374,933	1,512,895	$0.248
17	$1,516,991	$113,774	$379,248	$308,877	$0	$801,899	3,326,083	$0.241	$346,088	1,435,491	$0.241
18	$1,137,743	$85,331	$379,248	$315,054	$0	$779,633	3,326,083	$0.234	$319,263	1,362,047	$0.234
19	$758,495	$56,887	$379,248	$321,355	$0	$757,490	3,326,083	$0.228	$294,325	1,292,361	$0.228
20	$379,248	$28,444	$379,248	$327,783	$0	$735,474	3,326,083	$0.221	$271,150	1,226,240	$0.221
									$12,591,718	42,268,623	$0.298
Real levelized cost of energy					**$0.298**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site two; 2 E53 800 wind turbines - low penetration $150/kW O&M, 6.3m/s wind, no road or line

Capital cost	$7,965,300	$4,978 per kW	Capacity	1,600	kW	Fixed O&M	$240,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	3,810,244	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$7,965,300	$597,398	$398,265	$240,000	$0	$1,235,663	3,810,244	$0.324	$1,235,663	3,810,244	$0.324
2	$7,567,035	$567,528	$398,265	$244,800	$0	$1,210,593	3,810,244	$0.318	$1,148,655	3,615,301	$0.318
3	$7,168,770	$537,658	$398,265	$249,696	$0	$1,185,619	3,810,244	$0.311	$1,067,403	3,430,332	$0.311
4	$6,770,505	$507,788	$398,265	$254,690	$0	$1,160,743	3,810,244	$0.305	$991,542	3,254,827	$0.305
5	$6,372,240	$477,918	$398,265	$259,784	$0	$1,135,967	3,810,244	$0.298	$920,730	3,088,301	$0.298
6	$5,973,975	$448,048	$398,265	$264,979	$0	$1,111,293	3,810,244	$0.292	$854,647	2,930,295	$0.292
7	$5,575,710	$418,178	$398,265	$270,279	$0	$1,086,722	3,810,244	$0.285	$792,992	2,780,373	$0.285
8	$5,177,445	$388,308	$398,265	$275,685	$0	$1,062,258	3,810,244	$0.279	$735,482	2,638,121	$0.279
9	$4,779,180	$358,439	$398,265	$281,198	$0	$1,037,902	3,810,244	$0.272	$681,852	2,503,148	$0.272
10	$4,380,915	$328,569	$398,265	$286,822	$0	$1,013,656	3,810,244	$0.266	$631,853	2,375,080	$0.266
11	$3,982,650	$298,699	$398,265	$292,559	$0	$989,522	3,810,244	$0.260	$585,252	2,253,564	$0.260
12	$3,584,385	$268,829	$398,265	$298,410	$0	$965,504	3,810,244	$0.253	$541,830	2,138,265	$0.253
13	$3,186,120	$238,959	$398,265	$304,378	$0	$941,602	3,810,244	$0.247	$501,381	2,028,866	$0.247
14	$2,787,855	$209,089	$398,265	$310,466	$0	$917,820	3,810,244	$0.241	$463,713	1,925,063	$0.241
15	$2,389,590	$179,219	$398,265	$316,675	$0	$894,159	3,810,244	$0.235	$428,646	1,826,572	$0.235
16	$1,991,325	$149,349	$398,265	$323,008	$0	$870,623	3,810,244	$0.228	$396,010	1,733,119	$0.228
17	$1,593,060	$119,480	$398,265	$329,469	$0	$847,213	3,810,244	$0.222	$365,645	1,644,448	$0.222
18	$1,194,795	$89,610	$398,265	$336,058	$0	$823,933	3,810,244	$0.216	$337,404	1,560,313	$0.216
19	$796,530	$59,740	$398,265	$342,779	$0	$800,784	3,810,244	$0.210	$311,147	1,480,483	$0.210
20	$398,265	$29,870	$398,265	$349,635	$0	$777,770	3,810,244	$0.204	$286,743	1,404,738	$0.204
									$13,278,590	48,421,452	$0.274
Real levelized cost of energy					**$0.274**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site three; 2 DW 54-900 wind turbines - low penetration $150/Wk O&M, 7.6m/s wind at 50m, no road or line

Capital cost	$8,541,700	$4,745/kW	Capacity	1,800	kW	Fixed O&M	$270,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	5,291,853	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$8,541,700	$640,628	$427,085	$270,000	$0	$1,337,713	5,291,853	$0.253	$1,337,713	5,291,853	$0.253
2	$8,114,615	$608,596	$427,085	$275,400	$0	$1,311,081	5,291,853	$0.248	$1,244,003	5,021,107	$0.248
3	$7,687,530	$576,565	$427,085	$280,908	$0	$1,284,558	5,291,853	$0.243	$1,156,477	4,764,213	$0.243
4	$7,260,445	$544,533	$427,085	$286,526	$0	$1,258,145	5,291,853	$0.238	$1,074,746	4,520,463	$0.238
5	$6,833,360	$512,502	$427,085	$292,257	$0	$1,231,844	5,291,853	$0.233	$998,441	4,289,183	$0.233
6	$6,406,275	$480,471	$427,085	$298,102	$0	$1,205,657	5,291,853	$0.228	$927,219	4,069,737	$0.228
7	$5,979,190	$448,439	$427,085	$304,064	$0	$1,179,588	5,291,853	$0.223	$860,757	3,861,518	$0.223
8	$5,552,105	$416,408	$427,085	$310,145	$0	$1,153,638	5,291,853	$0.218	$798,751	3,663,952	$0.218
9	$5,125,020	$384,377	$427,085	$316,348	$0	$1,127,810	5,291,853	$0.213	$740,917	3,476,494	$0.213
10	$4,697,935	$352,345	$427,085	$322,675	$0	$1,102,105	5,291,853	$0.208	$686,987	3,298,626	$0.208
11	$4,270,850	$320,314	$427,085	$329,128	$0	$1,076,527	5,291,853	$0.203	$636,711	3,129,860	$0.203
12	$3,843,765	$288,282	$427,085	$335,711	$0	$1,051,078	5,291,853	$0.199	$589,853	2,969,727	$0.199
13	$3,416,680	$256,251	$427,085	$342,425	$0	$1,025,761	5,291,853	$0.194	$546,194	2,817,788	$0.194
14	$2,989,595	$224,220	$427,085	$349,274	$0	$1,000,578	5,291,853	$0.189	$505,526	2,673,622	$0.189
15	$2,562,510	$192,188	$427,085	$356,259	$0	$975,533	5,291,853	$0.184	$467,655	2,536,832	$0.184
16	$2,135,425	$160,157	$427,085	$363,384	$0	$950,626	5,291,853	$0.180	$432,400	2,407,040	$0.180
17	$1,708,340	$128,126	$427,085	$370,652	$0	$925,863	5,291,853	$0.175	$399,589	2,283,890	$0.175
18	$1,281,255	$96,094	$427,085	$378,065	$0	$901,244	5,291,853	$0.170	$369,064	2,167,039	$0.170
19	$854,170	$64,063	$427,085	$385,626	$0	$876,774	5,291,853	$0.166	$340,674	2,056,168	$0.166
20	$427,085	$32,031	$427,085	$393,339	$0	$852,455	5,291,853	$0.161	$314,278	1,950,968	$0.161
									$14,427,953	67,250,078	$0.215
Real levelized cost of energy					**$0.215**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site three; 2 AW 54-750 wind turbines - low penetration $150/kW O&M, 7.6m/s wind at 50m, with road & line

Capital cost	$7,584,953	$5,057/kW	Capacity	1,500	kW	Fixed O&M	$225,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	4,576,419	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$7,584,953	$568,871	$379,248	$225,000	$0	$1,173,119	4,576,419	$0.256	$1,173,119	4,576,419	$0.256
2	$7,205,705	$540,428	$379,248	$229,500	$0	$1,149,176	4,576,419	$0.251	$1,090,381	4,342,277	$0.251
3	$6,826,458	$511,984	$379,248	$234,090	$0	$1,125,322	4,576,419	$0.246	$1,013,118	4,120,114	$0.246
4	$6,447,210	$483,541	$379,248	$238,772	$0	$1,101,560	4,576,419	$0.241	$940,986	3,909,317	$0.241
5	$6,067,962	$455,097	$379,248	$243,547	$0	$1,077,892	4,576,419	$0.236	$873,659	3,709,306	$0.236
6	$5,688,715	$426,654	$379,248	$248,418	$0	$1,054,319	4,576,419	$0.230	$810,832	3,519,527	$0.230
7	$5,309,467	$398,210	$379,248	$253,387	$0	$1,030,844	4,576,419	$0.225	$752,217	3,339,458	$0.225
8	$4,930,219	$369,766	$379,248	$258,454	$0	$1,007,468	4,576,419	$0.220	$697,547	3,168,602	$0.220
9	$4,550,972	$341,323	$379,248	$263,623	$0	$984,194	4,576,419	$0.215	$646,568	3,006,488	$0.215
10	$4,171,724	$312,879	$379,248	$268,896	$0	$961,023	4,576,419	$0.210	$599,044	2,852,667	$0.210
11	$3,792,477	$284,436	$379,248	$274,274	$0	$937,957	4,576,419	$0.205	$554,754	2,706,717	$0.205
12	$3,413,229	$255,992	$379,248	$279,759	$0	$914,999	4,576,419	$0.200	$513,487	2,568,234	$0.200
13	$3,033,981	$227,549	$379,248	$285,354	$0	$892,151	4,576,419	$0.195	$475,049	2,436,836	$0.195
14	$2,654,734	$199,105	$379,248	$291,061	$0	$869,414	4,576,419	$0.190	$439,257	2,312,161	$0.190
15	$2,275,486	$170,661	$379,248	$296,883	$0	$846,792	4,576,419	$0.185	$405,939	2,193,864	$0.185
16	$1,896,238	$142,218	$379,248	$302,820	$0	$824,286	4,576,419	$0.180	$374,933	2,081,620	$0.180
17	$1,516,991	$113,774	$379,248	$308,877	$0	$801,899	4,576,419	$0.175	$346,088	1,975,118	$0.175
18	$1,137,743	$85,331	$379,248	$315,054	$0	$779,633	4,576,419	$0.170	$319,263	1,874,066	$0.170
19	$758,495	$56,887	$379,248	$321,355	$0	$757,490	4,576,419	$0.166	$294,325	1,778,183	$0.166
20	$379,248	$28,444	$379,248	$327,783	$0	$735,474	4,576,419	$0.161	$271,150	1,687,206	$0.161
									$12,591,718	58,158,179	$0.217
Real levelized cost of energy					**$0.217**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site three; 2 E53 800 wind turbines - low penetration $150/kW O&M, 7.6m/s wind at 50m, no road or line

Capital cost	$7,965,300	$4,978 per kW	Capacity	1,600	kW	Fixed O&M	$240,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	5,219,911	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$7,965,300	$597,398	$398,265	$240,000	$0	$1,235,663	5,219,911	$0.237	$1,235,663	5,219,911	$0.237
2	$7,567,035	$567,528	$398,265	$244,800	$0	$1,210,593	5,219,911	$0.232	$1,148,655	4,952,846	$0.232
3	$7,168,770	$537,658	$398,265	$249,696	$0	$1,185,619	5,219,911	$0.227	$1,067,403	4,699,444	$0.227
4	$6,770,505	$507,788	$398,265	$254,690	$0	$1,160,743	5,219,911	$0.222	$991,542	4,459,008	$0.222
5	$6,372,240	$477,918	$398,265	$259,784	$0	$1,135,967	5,219,911	$0.218	$920,730	4,230,872	$0.218
6	$5,973,975	$448,048	$398,265	$264,979	$0	$1,111,293	5,219,911	$0.213	$854,647	4,014,409	$0.213
7	$5,575,710	$418,178	$398,265	$270,279	$0	$1,086,722	5,219,911	$0.208	$792,992	3,809,021	$0.208
8	$5,177,445	$388,308	$398,265	$275,685	$0	$1,062,258	5,219,911	$0.204	$735,482	3,614,141	$0.204
9	$4,779,180	$358,439	$398,265	$281,198	$0	$1,037,902	5,219,911	$0.199	$681,852	3,429,231	$0.199
10	$4,380,915	$328,569	$398,265	$286,822	$0	$1,013,656	5,219,911	$0.194	$631,853	3,253,782	$0.194
11	$3,982,650	$298,699	$398,265	$292,559	$0	$989,522	5,219,911	$0.190	$585,252	3,087,310	$0.190
12	$3,584,385	$268,829	$398,265	$298,410	$0	$965,504	5,219,911	$0.185	$541,830	2,929,354	$0.185
13	$3,186,120	$238,959	$398,265	$304,378	$0	$941,602	5,219,911	$0.180	$501,381	2,779,480	$0.180
14	$2,787,855	$209,089	$398,265	$310,466	$0	$917,820	5,219,911	$0.176	$463,713	2,637,274	$0.176
15	$2,389,590	$179,219	$398,265	$316,675	$0	$894,159	5,219,911	$0.171	$428,646	2,502,344	$0.171
16	$1,991,325	$149,349	$398,265	$323,008	$0	$870,623	5,219,911	$0.167	$396,010	2,374,317	$0.167
17	$1,593,060	$119,480	$398,265	$329,469	$0	$847,213	5,219,911	$0.162	$365,645	2,252,840	$0.162
18	$1,194,795	$89,610	$398,265	$336,058	$0	$823,933	5,219,911	$0.158	$337,404	2,137,579	$0.158
19	$796,530	$59,740	$398,265	$342,779	$0	$800,784	5,219,911	$0.153	$311,147	2,028,214	$0.153
20	$398,265	$29,870	$398,265	$349,635	$0	$777,770	5,219,911	$0.149	$286,743	1,924,445	$0.149
									$13,278,590	66,335,823	$0.200
Real levelized cost of energy					**$0.200**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site one; 2 DW 54-900 wind turbines - low penetration $150/kW O&M, 4.4m/s wind at 50m, with road & line

Capital cost	$9,737,950	$5,410/kW	Capacity	1,800	kW	Fixed O&M	$270,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	1,565,250	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$9,737,950	$730,346	$486,898	$270,000	$0	$1,487,244	1,565,250	$0.950	$1,487,244	1,565,250	$0.950
2	$9,251,053	$693,829	$486,898	$275,400	$0	$1,456,126	1,565,250	$0.930	$1,381,627	1,485,167	$0.930
3	$8,764,155	$657,312	$486,898	$280,908	$0	$1,425,117	1,565,250	$0.910	$1,283,022	1,409,182	$0.910
4	$8,277,258	$620,794	$486,898	$286,526	$0	$1,394,218	1,565,250	$0.891	$1,190,984	1,337,084	$0.891
5	$7,790,360	$584,277	$486,898	$292,257	$0	$1,363,431	1,565,250	$0.871	$1,105,096	1,268,675	$0.871
6	$7,303,463	$547,760	$486,898	$298,102	$0	$1,332,759	1,565,250	$0.851	$1,024,968	1,203,766	$0.851
7	$6,816,565	$511,242	$486,898	$304,064	$0	$1,302,204	1,565,250	$0.832	$950,231	1,142,178	$0.832
8	$6,329,668	$474,725	$486,898	$310,145	$0	$1,271,768	1,565,250	$0.813	$880,541	1,083,741	$0.813
9	$5,842,770	$438,208	$486,898	$316,348	$0	$1,241,453	1,565,250	$0.793	$815,575	1,028,294	$0.793
10	$5,355,873	$401,690	$486,898	$322,675	$0	$1,211,263	1,565,250	$0.774	$755,029	975,684	$0.774
11	$4,868,975	$365,173	$486,898	$329,128	$0	$1,181,199	1,565,250	$0.755	$698,619	925,765	$0.755
12	$4,382,078	$328,656	$486,898	$335,711	$0	$1,151,264	1,565,250	$0.736	$646,076	878,400	$0.736
13	$3,895,180	$292,139	$486,898	$342,425	$0	$1,121,461	1,565,250	$0.716	$597,152	833,459	$0.716
14	$3,408,283	$255,621	$486,898	$349,274	$0	$1,091,792	1,565,250	$0.698	$551,610	790,817	$0.698
15	$2,921,385	$219,104	$486,898	$356,259	$0	$1,062,261	1,565,250	$0.679	$509,231	750,356	$0.679
16	$2,434,488	$182,587	$486,898	$363,384	$0	$1,032,869	1,565,250	$0.660	$469,808	711,966	$0.660
17	$1,947,590	$146,069	$486,898	$370,652	$0	$1,003,619	1,565,250	$0.641	$433,148	675,540	$0.641
18	$1,460,693	$109,552	$486,898	$378,065	$0	$974,515	1,565,250	$0.623	$399,068	640,977	$0.623
19	$973,795	$73,035	$486,898	$385,626	$0	$945,559	1,565,250	$0.604	$367,400	608,183	$0.604
20	$486,898	$36,517	$486,898	$393,339	$0	$916,754	1,565,250	$0.586	$337,983	577,067	$0.586
									$15,884,413	19,891,555	$0.799
Real levelized cost of energy					**$0.799**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site one; 2 AW 54-750 wind turbines - low penetration $150/kW O&M, 4.4m/s wind at 50m, with road & line

Capital cost	$8,781,203	$5,854 per kW	Capacity	1,500	kW	Fixed O&M	$225,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	1,377,517	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$8,781,203	$658,590	$439,060	$225,000	$0	$1,322,650	1,377,517	$0.960	$1,322,650	1,377,517	$0.960
2	$8,342,143	$625,661	$439,060	$229,500	$0	$1,294,221	1,377,517	$0.940	$1,228,005	1,307,039	$0.940
3	$7,903,083	$592,731	$439,060	$234,090	$0	$1,265,881	1,377,517	$0.919	$1,139,663	1,240,168	$0.919
4	$7,464,023	$559,802	$439,060	$238,772	$0	$1,237,634	1,377,517	$0.898	$1,057,225	1,176,717	$0.898
5	$7,024,962	$526,872	$439,060	$243,547	$0	$1,209,480	1,377,517	$0.878	$980,314	1,116,513	$0.878
6	$6,585,902	$493,943	$439,060	$248,418	$0	$1,181,421	1,377,517	$0.858	$908,580	1,059,389	$0.858
7	$6,146,842	$461,013	$439,060	$253,387	$0	$1,153,460	1,377,517	$0.837	$841,691	1,005,188	$0.837
8	$5,707,782	$428,084	$439,060	$258,454	$0	$1,125,598	1,377,517	$0.817	$779,337	953,760	$0.817
9	$5,268,722	$395,154	$439,060	$263,623	$0	$1,097,838	1,377,517	$0.797	$721,227	904,963	$0.797
10	$4,829,662	$362,225	$439,060	$268,896	$0	$1,070,181	1,377,517	$0.777	$667,087	858,662	$0.777
11	$4,390,602	$329,295	$439,060	$274,274	$0	$1,042,629	1,377,517	$0.757	$616,662	814,731	$0.757
12	$3,951,541	$296,366	$439,060	$279,759	$0	$1,015,185	1,377,517	$0.737	$569,710	773,047	$0.737
13	$3,512,481	$263,436	$439,060	$285,354	$0	$987,851	1,377,517	$0.717	$526,007	733,496	$0.717
14	$3,073,421	$230,507	$439,060	$291,061	$0	$960,628	1,377,517	$0.697	$485,342	695,968	$0.697
15	$2,634,361	$197,577	$439,060	$296,883	$0	$933,520	1,377,517	$0.678	$447,515	660,360	$0.678
16	$2,195,301	$164,648	$439,060	$302,820	$0	$906,528	1,377,517	$0.658	$412,341	626,574	$0.658
17	$1,756,241	$131,718	$439,060	$308,877	$0	$879,655	1,377,517	$0.639	$379,647	594,517	$0.639
18	$1,317,180	$98,789	$439,060	$315,054	$0	$852,903	1,377,517	$0.619	$349,268	564,100	$0.619
19	$878,120	$65,859	$439,060	$321,355	$0	$826,275	1,377,517	$0.600	$321,052	535,239	$0.600
20	$439,060	$32,930	$439,060	$327,783	$0	$799,772	1,377,517	$0.581	$294,855	507,855	$0.581
									$14,048,177	17,505,801	$0.802
Real levelized cost of energy					**$0.802**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site one; 2 E53 800 wind turbines - low penetration $150/kW O&M, 4.4m/s wind at 50m, with road & line

Capital cost	$9,161,550	$5,726 per kW	Capacity	1,600	kW	Fixed O&M	$240,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	1,651,644	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$9,161,550	$687,116	$458,078	$240,000	$0	$1,385,194	1,651,644	$0.839	$1,385,194	1,651,644	$0.839
2	$8,703,473	$652,760	$458,078	$244,800	$0	$1,355,638	1,651,644	$0.821	$1,286,280	1,567,141	$0.821
3	$8,245,395	$618,405	$458,078	$249,696	$0	$1,326,178	1,651,644	$0.803	$1,193,948	1,486,962	$0.803
4	$7,787,318	$584,049	$458,078	$254,690	$0	$1,296,816	1,651,644	$0.785	$1,107,780	1,410,885	$0.785
5	$7,329,240	$549,693	$458,078	$259,784	$0	$1,267,554	1,651,644	$0.767	$1,027,385	1,338,700	$0.767
6	$6,871,163	$515,337	$458,078	$264,979	$0	$1,238,394	1,651,644	$0.750	$952,396	1,270,208	$0.750
7	$6,413,085	$480,981	$458,078	$270,279	$0	$1,209,338	1,651,644	$0.732	$882,466	1,205,221	$0.732
8	$5,955,008	$446,626	$458,078	$275,685	$0	$1,180,388	1,651,644	$0.715	$817,272	1,143,559	$0.715
9	$5,496,930	$412,270	$458,078	$281,198	$0	$1,151,546	1,651,644	$0.697	$756,510	1,085,051	$0.697
10	$5,038,853	$377,914	$458,078	$286,822	$0	$1,122,814	1,651,644	$0.680	$699,895	1,029,537	$0.680
11	$4,580,775	$343,558	$458,078	$292,559	$0	$1,094,194	1,651,644	$0.662	$647,160	976,863	$0.662
12	$4,122,698	$309,202	$458,078	$298,410	$0	$1,065,690	1,651,644	$0.645	$598,053	926,884	$0.645
13	$3,664,620	$274,847	$458,078	$304,378	$0	$1,037,302	1,651,644	$0.628	$552,339	879,462	$0.628
14	$3,206,543	$240,491	$458,078	$310,466	$0	$1,009,034	1,651,644	$0.611	$509,798	834,466	$0.611
15	$2,748,465	$206,135	$458,078	$316,675	$0	$980,887	1,651,644	$0.594	$470,222	791,772	$0.594
16	$2,290,388	$171,779	$458,078	$323,008	$0	$952,865	1,651,644	$0.577	$433,418	751,263	$0.577
17	$1,832,310	$137,423	$458,078	$329,469	$0	$924,969	1,651,644	$0.560	$399,204	712,826	$0.560
18	$1,374,233	$103,067	$458,078	$336,058	$0	$897,203	1,651,644	$0.543	$367,409	676,356	$0.543
19	$916,155	$68,712	$458,078	$342,779	$0	$869,568	1,651,644	$0.526	$337,874	641,752	$0.526
20	$458,078	$34,356	$458,078	$349,635	$0	$842,068	1,651,644	$0.510	$310,449	608,918	$0.510
									$14,735,050	20,989,470	$0.702
Real levelized cost of energy					**$0.702**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site two; 2 DW 54-900 wind turbines - low penetration $150/kW O&M, 6.3m/s wind at 50m, with road & line

Capital cost	$21,494,200	$11,941/kW	Capacity	1,800	kW	Fixed O&M	$270,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	3,768,461	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$21,494,200	$1,612,065	$1,074,710	$270,000	$0	$2,956,775	3,768,461	$0.785	$2,956,775	3,768,461	$0.785
2	$20,419,490	$1,531,462	$1,074,710	$275,400	$0	$2,881,572	3,768,461	$0.765	$2,734,142	3,575,656	$0.765
3	$19,344,780	$1,450,859	$1,074,710	$280,908	$0	$2,806,477	3,768,461	$0.745	$2,526,648	3,392,715	$0.745
4	$18,270,070	$1,370,255	$1,074,710	$286,526	$0	$2,731,491	3,768,461	$0.725	$2,333,324	3,219,135	$0.725
5	$17,195,360	$1,289,652	$1,074,710	$292,257	$0	$2,656,619	3,768,461	$0.705	$2,153,258	3,054,435	$0.705
6	$16,120,650	$1,209,049	$1,074,710	$298,102	$0	$2,581,861	3,768,461	$0.685	$1,985,598	2,898,161	$0.685
7	$15,045,940	$1,128,446	$1,074,710	$304,064	$0	$2,507,219	3,768,461	$0.665	$1,829,543	2,749,883	$0.665
8	$13,971,230	$1,047,842	$1,074,710	$310,145	$0	$2,432,697	3,768,461	$0.646	$1,684,341	2,609,192	$0.646
9	$12,896,520	$967,239	$1,074,710	$316,348	$0	$2,358,297	3,768,461	$0.626	$1,549,288	2,475,698	$0.626
10	$11,821,810	$886,636	$1,074,710	$322,675	$0	$2,284,021	3,768,461	$0.606	$1,423,723	2,349,034	$0.606
11	$10,747,100	$806,033	$1,074,710	$329,128	$0	$2,209,871	3,768,461	$0.586	$1,307,025	2,228,851	$0.586
12	$9,672,390	$725,429	$1,074,710	$335,711	$0	$2,135,850	3,768,461	$0.567	$1,198,615	2,114,817	$0.567
13	$8,597,680	$644,826	$1,074,710	$342,425	$0	$2,061,961	3,768,461	$0.547	$1,097,946	2,006,617	$0.547
14	$7,522,970	$564,223	$1,074,710	$349,274	$0	$1,988,207	3,768,461	$0.528	$1,004,509	1,903,953	$0.528
15	$6,448,260	$483,620	$1,074,710	$356,259	$0	$1,914,589	3,768,461	$0.508	$917,824	1,806,541	$0.508
16	$5,373,550	$403,016	$1,074,710	$363,384	$0	$1,841,111	3,768,461	$0.489	$837,443	1,714,114	$0.489
17	$4,298,840	$322,413	$1,074,710	$370,652	$0	$1,767,775	3,768,461	$0.469	$762,947	1,626,415	$0.469
18	$3,224,130	$241,810	$1,074,710	$378,065	$0	$1,694,585	3,768,461	$0.450	$693,941	1,543,203	$0.450
19	$2,149,420	$161,207	$1,074,710	$385,626	$0	$1,621,543	3,768,461	$0.430	$630,056	1,464,248	$0.430
20	$1,074,710	$80,603	$1,074,710	$393,339	$0	$1,548,652	3,768,461	$0.411	$570,948	1,389,333	$0.411
									$30,197,894	47,890,464	$0.631
Real levelized cost of energy					**$0.631**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site two; 2 AW 54-750 wind turbines - low penetration $150/kW O&M, 6.3m/s wind, with road & line

Capital cost	$20,537,453	$13,692 per kW	Capacity	1,500	kW	Fixed O&M	$225,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	3,326,083	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$20,537,453	$1,540,309	$1,026,873	$225,000	$0	$2,792,182	3,326,083	$0.839	$2,792,182	3,326,083	$0.839
2	$19,510,580	$1,463,294	$1,026,873	$229,500	$0	$2,719,666	3,326,083	$0.818	$2,580,520	3,155,911	$0.818
3	$18,483,708	$1,386,278	$1,026,873	$234,090	$0	$2,647,241	3,326,083	$0.796	$2,383,290	2,994,446	$0.796
4	$17,456,835	$1,309,263	$1,026,873	$238,772	$0	$2,574,907	3,326,083	$0.774	$2,199,564	2,841,242	$0.774
5	$16,429,962	$1,232,247	$1,026,873	$243,547	$0	$2,502,667	3,326,083	$0.752	$2,028,476	2,695,876	$0.752
6	$15,403,090	$1,155,232	$1,026,873	$248,418	$0	$2,430,523	3,326,083	$0.731	$1,869,210	2,557,947	$0.731
7	$14,376,217	$1,078,216	$1,026,873	$253,387	$0	$2,358,475	3,326,083	$0.709	$1,721,003	2,427,076	$0.709
8	$13,349,344	$1,001,201	$1,026,873	$258,454	$0	$2,286,528	3,326,083	$0.687	$1,583,137	2,302,900	$0.687
9	$12,322,472	$924,185	$1,026,873	$263,623	$0	$2,214,681	3,326,083	$0.666	$1,454,939	2,185,077	$0.666
10	$11,295,599	$847,170	$1,026,873	$268,896	$0	$2,142,938	3,326,083	$0.644	$1,335,780	2,073,282	$0.644
11	$10,268,727	$770,154	$1,026,873	$274,274	$0	$2,071,301	3,326,083	$0.623	$1,225,068	1,967,207	$0.623
12	$9,241,854	$693,139	$1,026,873	$279,759	$0	$1,999,771	3,326,083	$0.601	$1,122,248	1,866,560	$0.601
13	$8,214,981	$616,124	$1,026,873	$285,354	$0	$1,928,351	3,326,083	$0.580	$1,026,802	1,771,061	$0.580
14	$7,188,109	$539,108	$1,026,873	$291,061	$0	$1,857,042	3,326,083	$0.558	$938,240	1,680,449	$0.558
15	$6,161,236	$462,093	$1,026,873	$296,883	$0	$1,785,848	3,326,083	$0.537	$856,108	1,594,472	$0.537
16	$5,134,363	$385,077	$1,026,873	$302,820	$0	$1,714,770	3,326,083	$0.516	$779,977	1,512,895	$0.516
17	$4,107,491	$308,062	$1,026,873	$308,877	$0	$1,643,811	3,326,083	$0.494	$709,446	1,435,491	$0.494
18	$3,080,618	$231,046	$1,026,873	$315,054	$0	$1,572,973	3,326,083	$0.473	$644,140	1,362,047	$0.473
19	$2,053,745	$154,031	$1,026,873	$321,355	$0	$1,502,259	3,326,083	$0.452	$583,708	1,292,361	$0.452
20	$1,026,873	$77,015	$1,026,873	$327,783	$0	$1,431,671	3,326,083	$0.430	$527,820	1,226,240	$0.430
									$28,361,658	42,268,623	$0.671
Real levelized cost of energy					**$0.671**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site two; 2 E53 800 wind turbines - low penetration $150/kW O&M, 6.3m/s wind, with road & line

Capital cost	$20,917,800	$13,074 /kW	Capacity	1,600	kW	Fixed O&M	$240,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	3,810,244	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$20,917,800	$1,568,835	$1,045,890	$240,000	$0	$2,854,725	3,810,244	$0.749	$2,854,725	3,810,244	$0.749
2	$19,871,910	$1,490,393	$1,045,890	$244,800	$0	$2,781,083	3,810,244	$0.730	$2,638,795	3,615,301	$0.730
3	$18,826,020	$1,411,952	$1,045,890	$249,696	$0	$2,707,538	3,810,244	$0.711	$2,437,574	3,430,332	$0.711
4	$17,780,130	$1,333,510	$1,045,890	$254,690	$0	$2,634,090	3,810,244	$0.691	$2,250,120	3,254,827	$0.691
5	$16,734,240	$1,255,068	$1,045,890	$259,784	$0	$2,560,742	3,810,244	$0.672	$2,075,547	3,088,301	$0.672
6	$15,688,350	$1,176,626	$1,045,890	$264,979	$0	$2,487,496	3,810,244	$0.653	$1,913,026	2,930,295	$0.653
7	$14,642,460	$1,098,185	$1,045,890	$270,279	$0	$2,414,353	3,810,244	$0.634	$1,761,778	2,780,373	$0.634
8	$13,596,570	$1,019,743	$1,045,890	$275,685	$0	$2,341,317	3,810,244	$0.614	$1,621,072	2,638,121	$0.614
9	$12,550,680	$941,301	$1,045,890	$281,198	$0	$2,268,389	3,810,244	$0.595	$1,490,223	2,503,148	$0.595
10	$11,504,790	$862,859	$1,045,890	$286,822	$0	$2,195,571	3,810,244	$0.576	$1,368,589	2,375,080	$0.576
11	$10,458,900	$784,418	$1,045,890	$292,559	$0	$2,122,866	3,810,244	$0.557	$1,255,566	2,253,564	$0.557
12	$9,413,010	$705,976	$1,045,890	$298,410	$0	$2,050,276	3,810,244	$0.538	$1,150,591	2,138,265	$0.538
13	$8,367,120	$627,534	$1,045,890	$304,378	$0	$1,977,802	3,810,244	$0.519	$1,053,133	2,028,866	$0.519
14	$7,321,230	$549,092	$1,045,890	$310,466	$0	$1,905,448	3,810,244	$0.500	$962,696	1,925,063	$0.500
15	$6,275,340	$470,651	$1,045,890	$316,675	$0	$1,833,215	3,810,244	$0.481	$878,815	1,826,572	$0.481
16	$5,229,450	$392,209	$1,045,890	$323,008	$0	$1,761,107	3,810,244	$0.462	$801,053	1,733,119	$0.462
17	$4,183,560	$313,767	$1,045,890	$329,469	$0	$1,689,126	3,810,244	$0.443	$729,003	1,644,448	$0.443
18	$3,137,670	$235,325	$1,045,890	$336,058	$0	$1,617,273	3,810,244	$0.424	$662,281	1,560,313	$0.424
19	$2,091,780	$156,884	$1,045,890	$342,779	$0	$1,545,553	3,810,244	$0.406	$600,530	1,480,483	$0.406
20	$1,045,890	$78,442	$1,045,890	$349,635	$0	$1,473,966	3,810,244	$0.387	$543,413	1,404,738	$0.387
									$29,048,531	48,421,452	$0.600
Real levelized cost of energy					**$0.600**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site three; 2 DW 54-900 wind turbines - low penetration $150/Wk O&M, 7.6m/s wind at 50m, with road & line

Capital cost	$32,494,200	$18,052/kW	Capacity	1,800	kW	Fixed O&M	$270,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	5,291,853	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$32,494,200	$2,437,065	$1,624,710	$270,000	$0	$4,331,775	5,291,853	$0.819	$4,331,775	5,291,853	$0.819
2	$30,869,490	$2,315,212	$1,624,710	$275,400	$0	$4,215,322	5,291,853	$0.797	$3,999,654	5,021,107	$0.797
3	$29,244,780	$2,193,359	$1,624,710	$280,908	$0	$4,098,977	5,291,853	$0.775	$3,690,276	4,764,213	$0.775
4	$27,620,070	$2,071,505	$1,624,710	$286,526	$0	$3,982,741	5,291,853	$0.753	$3,402,180	4,520,463	$0.753
5	$25,995,360	$1,949,652	$1,624,710	$292,257	$0	$3,866,619	5,291,853	$0.731	$3,133,994	4,289,183	$0.731
6	$24,370,650	$1,827,799	$1,624,710	$298,102	$0	$3,750,611	5,291,853	$0.709	$2,884,433	4,069,737	$0.709
7	$22,745,940	$1,705,946	$1,624,710	$304,064	$0	$3,634,719	5,291,853	$0.687	$2,652,291	3,861,518	$0.687
8	$21,121,230	$1,584,092	$1,624,710	$310,145	$0	$3,518,947	5,291,853	$0.665	$2,436,434	3,663,952	$0.665
9	$19,496,520	$1,462,239	$1,624,710	$316,348	$0	$3,403,297	5,291,853	$0.643	$2,235,803	3,476,494	$0.643
10	$17,871,810	$1,340,386	$1,624,710	$322,675	$0	$3,287,771	5,291,853	$0.621	$2,049,401	3,298,626	$0.621
11	$16,247,100	$1,218,533	$1,624,710	$329,128	$0	$3,172,371	5,291,853	$0.599	$1,876,295	3,129,860	$0.599
12	$14,622,390	$1,096,679	$1,624,710	$335,711	$0	$3,057,100	5,291,853	$0.578	$1,715,610	2,969,727	$0.578
13	$12,997,680	$974,826	$1,624,710	$342,425	$0	$2,941,961	5,291,853	$0.556	$1,566,525	2,817,788	$0.556
14	$11,372,970	$852,973	$1,624,710	$349,274	$0	$2,826,957	5,291,853	$0.534	$1,428,273	2,673,622	$0.534
15	$9,748,260	$731,120	$1,624,710	$356,259	$0	$2,712,089	5,291,853	$0.513	$1,300,133	2,536,832	$0.513
16	$8,123,550	$609,266	$1,624,710	$363,384	$0	$2,597,361	5,291,853	$0.491	$1,181,430	2,407,040	$0.491
17	$6,498,840	$487,413	$1,624,710	$370,652	$0	$2,482,775	5,291,853	$0.469	$1,071,531	2,283,890	$0.469
18	$4,874,130	$365,560	$1,624,710	$378,065	$0	$2,368,335	5,291,853	$0.448	$969,845	2,167,039	$0.448
19	$3,249,420	$243,707	$1,624,710	$385,626	$0	$2,254,043	5,291,853	$0.426	$875,816	2,056,168	$0.426
20	$1,624,710	$121,853	$1,624,710	$393,339	$0	$2,139,902	5,291,853	$0.404	$788,926	1,950,968	$0.404
									$43,590,625	67,250,078	$0.648
Real levelized cost of energy					**$0.648**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site three; 2 AW 54-750 wind turbines - low penetration $150/kW O&M, 7.6m/s wind at 50m, with road & line

Capital cost	$31,537,453	$21,025/kW	Capacity	1,500	kW	Fixed O&M	$225,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	4,576,419	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$31,537,453	$2,365,309	$1,576,873	$225,000	$0	$4,167,182	4,576,419	$0.911	$4,167,182	4,576,419	$0.911
2	$29,960,580	$2,247,044	$1,576,873	$229,500	$0	$4,053,416	4,576,419	$0.886	$3,846,032	4,342,277	$0.886
3	$28,383,708	$2,128,778	$1,576,873	$234,090	$0	$3,939,741	4,576,419	$0.861	$3,546,917	4,120,114	$0.861
4	$26,806,835	$2,010,513	$1,576,873	$238,772	$0	$3,826,157	4,576,419	$0.836	$3,268,420	3,909,317	$0.836
5	$25,229,962	$1,892,247	$1,576,873	$243,547	$0	$3,712,667	4,576,419	$0.811	$3,009,212	3,709,306	$0.811
6	$23,653,090	$1,773,982	$1,576,873	$248,418	$0	$3,599,273	4,576,419	$0.786	$2,768,046	3,519,527	$0.786
7	$22,076,217	$1,655,716	$1,576,873	$253,387	$0	$3,485,975	4,576,419	$0.762	$2,543,751	3,339,458	$0.762
8	$20,499,344	$1,537,451	$1,576,873	$258,454	$0	$3,372,778	4,576,419	$0.737	$2,335,230	3,168,602	$0.737
9	$18,922,472	$1,419,185	$1,576,873	$263,623	$0	$3,259,681	4,576,419	$0.712	$2,141,454	3,006,488	$0.712
10	$17,345,599	$1,300,920	$1,576,873	$268,896	$0	$3,146,688	4,576,419	$0.688	$1,961,458	2,852,667	$0.688
11	$15,768,727	$1,182,654	$1,576,873	$274,274	$0	$3,033,801	4,576,419	$0.663	$1,794,338	2,706,717	$0.663
12	$14,191,854	$1,064,389	$1,576,873	$279,759	$0	$2,921,021	4,576,419	$0.638	$1,639,243	2,568,234	$0.638
13	$12,614,981	$946,124	$1,576,873	$285,354	$0	$2,808,351	4,576,419	$0.614	$1,495,381	2,436,836	$0.614
14	$11,038,109	$827,858	$1,576,873	$291,061	$0	$2,695,792	4,576,419	$0.589	$1,362,005	2,312,161	$0.589
15	$9,461,236	$709,593	$1,576,873	$296,883	$0	$2,583,348	4,576,419	$0.564	$1,238,417	2,193,864	$0.564
16	$7,884,363	$591,327	$1,576,873	$302,820	$0	$2,471,020	4,576,419	$0.540	$1,123,963	2,081,620	$0.540
17	$6,307,491	$473,062	$1,576,873	$308,877	$0	$2,358,811	4,576,419	$0.515	$1,018,030	1,975,118	$0.515
18	$4,730,618	$354,796	$1,576,873	$315,054	$0	$2,246,723	4,576,419	$0.491	$920,044	1,874,066	$0.491
19	$3,153,745	$236,531	$1,576,873	$321,355	$0	$2,134,759	4,576,419	$0.466	$829,468	1,778,183	$0.466
20	$1,576,873	$118,265	$1,576,873	$327,783	$0	$2,022,921	4,576,419	$0.442	$745,798	1,687,206	$0.442
									$41,754,389	58,158,179	$0.718
Real levelized cost of energy					**$0.718**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site three; 2 E53 800 wind turbines - low penetration $150/kW O&M, 7.6m/s wind at 50m, no road or line

Capital cost	$31,917,800	$19,949/kW	Capacity	1,600	kW	Fixed O&M	$240,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	5,219,911	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$31,917,800	$2,393,835	$1,595,890	$240,000	$0	$4,229,725	5,219,911	$0.810	$4,229,725	5,219,911	$0.810
2	$30,321,910	$2,274,143	$1,595,890	$244,800	$0	$4,114,833	5,219,911	$0.788	$3,904,307	4,952,846	$0.788
3	$28,726,020	$2,154,452	$1,595,890	$249,696	$0	$4,000,038	5,219,911	$0.766	$3,601,202	4,699,444	$0.766
4	$27,130,130	$2,034,760	$1,595,890	$254,690	$0	$3,885,340	5,219,911	$0.744	$3,318,976	4,459,008	$0.744
5	$25,534,240	$1,915,068	$1,595,890	$259,784	$0	$3,770,742	5,219,911	$0.722	$3,056,283	4,230,872	$0.722
6	$23,938,350	$1,795,376	$1,595,890	$264,979	$0	$3,656,246	5,219,911	$0.700	$2,811,861	4,014,409	$0.700
7	$22,342,460	$1,675,685	$1,595,890	$270,279	$0	$3,541,853	5,219,911	$0.679	$2,584,526	3,809,021	$0.679
8	$20,746,570	$1,555,993	$1,595,890	$275,685	$0	$3,427,567	5,219,911	$0.657	$2,373,165	3,614,141	$0.657
9	$19,150,680	$1,436,301	$1,595,890	$281,198	$0	$3,313,389	5,219,911	$0.635	$2,176,738	3,429,231	$0.635
10	$17,554,790	$1,316,609	$1,595,890	$286,822	$0	$3,199,321	5,219,911	$0.613	$1,994,267	3,253,782	$0.613
11	$15,958,900	$1,196,918	$1,595,890	$292,559	$0	$3,085,366	5,219,911	$0.591	$1,824,836	3,087,310	$0.591
12	$14,363,010	$1,077,226	$1,595,890	$298,410	$0	$2,971,526	5,219,911	$0.569	$1,667,586	2,929,354	$0.569
13	$12,767,120	$957,534	$1,595,890	$304,378	$0	$2,857,802	5,219,911	$0.547	$1,521,713	2,779,480	$0.547
14	$11,171,230	$837,842	$1,595,890	$310,466	$0	$2,744,198	5,219,911	$0.526	$1,386,461	2,637,274	$0.526
15	$9,575,340	$718,151	$1,595,890	$316,675	$0	$2,630,715	5,219,911	$0.504	$1,261,124	2,502,344	$0.504
16	$7,979,450	$598,459	$1,595,890	$323,008	$0	$2,517,357	5,219,911	$0.482	$1,145,039	2,374,317	$0.482
17	$6,383,560	$478,767	$1,595,890	$329,469	$0	$2,404,126	5,219,911	$0.461	$1,037,587	2,252,840	$0.461
18	$4,787,670	$359,075	$1,595,890	$336,058	$0	$2,291,023	5,219,911	$0.439	$938,185	2,137,579	$0.439
19	$3,191,780	$239,384	$1,595,890	$342,779	$0	$2,178,053	5,219,911	$0.417	$846,290	2,028,214	$0.417
20	$1,595,890	$119,692	$1,595,890	$349,635	$0	$2,065,216	5,219,911	$0.396	$761,391	1,924,445	$0.396
									$42,441,262	66,335,823	$0.640
Real levelized cost of energy					**$0.640**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site one; 1 E53 800 wind turbines - low penetration $150/kW O&M, 4.4m/s wind at 50m, incremental calculation only

Capital cost	$3,085,390	$3,857 per kW	Capacity	800	kW	Fixed O&M	$120,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	825,822	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$3,085,390	$231,404	$154,270	$120,000	$0	$505,674	825,822	$0.612	$505,674	825,822	$0.612
2	$2,931,121	$219,834	$154,270	$122,400	$0	$496,504	825,822	$0.601	$471,101	783,571	$0.601
3	$2,776,851	$208,264	$154,270	$124,848	$0	$487,381	825,822	$0.590	$438,786	743,481	$0.590
4	$2,622,582	$196,694	$154,270	$127,345	$0	$478,308	825,822	$0.579	$408,585	705,442	$0.579
5	$2,468,312	$185,123	$154,270	$129,892	$0	$469,285	825,822	$0.568	$380,367	669,350	$0.568
6	$2,314,043	$173,553	$154,270	$132,490	$0	$460,312	825,822	$0.557	$354,006	635,104	$0.557
7	$2,159,773	$161,983	$154,270	$135,139	$0	$451,392	825,822	$0.547	$329,385	602,610	$0.547
8	$2,005,504	$150,413	$154,270	$137,842	$0	$442,525	825,822	$0.536	$306,393	571,779	$0.536
9	$1,851,234	$138,843	$154,270	$140,599	$0	$433,711	825,822	$0.525	$284,927	542,525	$0.525
10	$1,696,965	$127,272	$154,270	$143,411	$0	$424,953	825,822	$0.515	$264,890	514,768	$0.515
11	$1,542,695	$115,702	$154,270	$146,279	$0	$416,251	825,822	$0.504	$246,191	488,431	$0.504
12	$1,388,426	$104,132	$154,270	$149,205	$0	$407,606	825,822	$0.494	$228,744	463,442	$0.494
13	$1,234,156	$92,562	$154,270	$152,189	$0	$399,020	825,822	$0.483	$212,469	439,731	$0.483
14	$1,079,887	$80,991	$154,270	$155,233	$0	$390,494	825,822	$0.473	$197,291	417,233	$0.473
15	$925,617	$69,421	$154,270	$158,337	$0	$382,028	825,822	$0.463	$183,138	395,886	$0.463
16	$771,348	$57,851	$154,270	$161,504	$0	$373,625	825,822	$0.452	$169,946	375,632	$0.452
17	$617,078	$46,281	$154,270	$164,734	$0	$365,285	825,822	$0.442	$157,652	356,413	$0.442
18	$462,809	$34,711	$154,270	$168,029	$0	$357,009	825,822	$0.432	$146,197	338,178	$0.432
19	$308,539	$23,140	$154,270	$171,390	$0	$348,799	825,822	$0.422	$135,527	320,876	$0.422
20	$154,270	$11,570	$154,270	$174,817	$0	$340,657	825,822	$0.413	$125,591	304,459	$0.413
									$5,546,862	10,494,735	$0.529
Real levelized cost of energy					**$0.529**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site two; 1 E53 800 wind turbines - low penetration $150/kW O&M, 6.3m/s wind, incremental cost only

Capital cost	$3,085,390	$3,857/kW	Capacity	800	kW	Fixed O&M	$120,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	1,905,122	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$3,085,390	$231,404	$154,270	$120,000	$0	$505,674	1,905,122	$0.265	$505,674	1,905,122	$0.265
2	$2,931,121	$219,834	$154,270	$122,400	$0	$496,504	1,905,122	$0.261	$471,101	1,807,651	$0.261
3	$2,776,851	$208,264	$154,270	$124,848	$0	$487,381	1,905,122	$0.256	$438,786	1,715,166	$0.256
4	$2,622,582	$196,694	$154,270	$127,345	$0	$478,308	1,905,122	$0.251	$408,585	1,627,414	$0.251
5	$2,468,312	$185,123	$154,270	$129,892	$0	$469,285	1,905,122	$0.246	$380,367	1,544,150	$0.246
6	$2,314,043	$173,553	$154,270	$132,490	$0	$460,312	1,905,122	$0.242	$354,006	1,465,147	$0.242
7	$2,159,773	$161,983	$154,270	$135,139	$0	$451,392	1,905,122	$0.237	$329,385	1,390,186	$0.237
8	$2,005,504	$150,413	$154,270	$137,842	$0	$442,525	1,905,122	$0.232	$306,393	1,319,061	$0.232
9	$1,851,234	$138,843	$154,270	$140,599	$0	$433,711	1,905,122	$0.228	$284,927	1,251,574	$0.228
10	$1,696,965	$127,272	$154,270	$143,411	$0	$424,953	1,905,122	$0.223	$264,890	1,187,540	$0.223
11	$1,542,695	$115,702	$154,270	$146,279	$0	$416,251	1,905,122	$0.218	$246,191	1,126,782	$0.218
12	$1,388,426	$104,132	$154,270	$149,205	$0	$407,606	1,905,122	$0.214	$228,744	1,069,133	$0.214
13	$1,234,156	$92,562	$154,270	$152,189	$0	$399,020	1,905,122	$0.209	$212,469	1,014,433	$0.209
14	$1,079,887	$80,991	$154,270	$155,233	$0	$390,494	1,905,122	$0.205	$197,291	962,532	$0.205
15	$925,617	$69,421	$154,270	$158,337	$0	$382,028	1,905,122	$0.201	$183,138	913,286	$0.201
16	$771,348	$57,851	$154,270	$161,504	$0	$373,625	1,905,122	$0.196	$169,946	866,560	$0.196
17	$617,078	$46,281	$154,270	$164,734	$0	$365,285	1,905,122	$0.192	$157,652	822,224	$0.192
18	$462,809	$34,711	$154,270	$168,029	$0	$357,009	1,905,122	$0.187	$146,197	780,157	$0.187
19	$308,539	$23,140	$154,270	$171,390	$0	$348,799	1,905,122	$0.183	$135,527	740,242	$0.183
20	$154,270	$11,570	$154,270	$174,817	$0	$340,657	1,905,122	$0.179	$125,591	702,369	$0.179
									$5,546,862	24,210,726	$0.229
Real levelized cost of energy					**$0.229**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site three; 1 E53 800 wind turbines - low penetration $150/kW O&M, 7.6m/s wind at 50m, incremental cost only

Capital cost	$3,085,390	$3,857/kW	Capacity	800	kW	Fixed O&M	$120,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	2,609,955	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$3,085,390	$231,404	$154,270	$120,000	$0	$505,674	2,609,955	$0.194	$505,674	2,609,955	$0.194
2	$2,931,121	$219,834	$154,270	$122,400	$0	$496,504	2,609,955	$0.190	$471,101	2,476,422	$0.190
3	$2,776,851	$208,264	$154,270	$124,848	$0	$487,381	2,609,955	$0.187	$438,786	2,349,722	$0.187
4	$2,622,582	$196,694	$154,270	$127,345	$0	$478,308	2,609,955	$0.183	$408,585	2,229,503	$0.183
5	$2,468,312	$185,123	$154,270	$129,892	$0	$469,285	2,609,955	$0.180	$380,367	2,115,436	$0.180
6	$2,314,043	$173,553	$154,270	$132,490	$0	$460,312	2,609,955	$0.176	$354,006	2,007,204	$0.176
7	$2,159,773	$161,983	$154,270	$135,139	$0	$451,392	2,609,955	$0.173	$329,385	1,904,510	$0.173
8	$2,005,504	$150,413	$154,270	$137,842	$0	$442,525	2,609,955	$0.170	$306,393	1,807,070	$0.170
9	$1,851,234	$138,843	$154,270	$140,599	$0	$433,711	2,609,955	$0.166	$284,927	1,714,615	$0.166
10	$1,696,965	$127,272	$154,270	$143,411	$0	$424,953	2,609,955	$0.163	$264,890	1,626,891	$0.163
11	$1,542,695	$115,702	$154,270	$146,279	$0	$416,251	2,609,955	$0.159	$246,191	1,543,654	$0.159
12	$1,388,426	$104,132	$154,270	$149,205	$0	$407,606	2,609,955	$0.156	$228,744	1,464,677	$0.156
13	$1,234,156	$92,562	$154,270	$152,189	$0	$399,020	2,609,955	$0.153	$212,469	1,389,740	$0.153
14	$1,079,887	$80,991	$154,270	$155,233	$0	$390,494	2,609,955	$0.150	$197,291	1,318,637	$0.150
15	$925,617	$69,421	$154,270	$158,337	$0	$382,028	2,609,955	$0.146	$183,138	1,251,172	$0.146
16	$771,348	$57,851	$154,270	$161,504	$0	$373,625	2,609,955	$0.143	$169,946	1,187,158	$0.143
17	$617,078	$46,281	$154,270	$164,734	$0	$365,285	2,609,955	$0.140	$157,652	1,126,420	$0.140
18	$462,809	$34,711	$154,270	$168,029	$0	$357,009	2,609,955	$0.137	$146,197	1,068,789	$0.137
19	$308,539	$23,140	$154,270	$171,390	$0	$348,799	2,609,955	$0.134	$135,527	1,014,107	$0.134
20	$154,270	$11,570	$154,270	$174,817	$0	$340,657	2,609,955	$0.131	$125,591	962,222	$0.131
									$5,546,862	33,167,905	$0.167
Real levelized cost of energy					**$0.167**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site two; 5 E53 800 wind turbines, all net generation used, $150/kW O&M, 6.3m/s wind, with road & line

Capital cost	$30,173,970	$7,543 /kW	Capacity	4,000	kW	Fixed O&M	$600,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	9,533,267	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$30,173,970	$2,263,048	$1,508,699	$600,000	$0	$4,371,746	9,533,267	$0.459	$4,371,746	9,533,267	$0.459
2	$28,665,272	$2,149,895	$1,508,699	$612,000	$0	$4,270,594	9,533,267	$0.448	$4,052,098	9,045,518	$0.448
3	$27,156,573	$2,036,743	$1,508,699	$624,240	$0	$4,169,681	9,533,267	$0.437	$3,753,931	8,582,724	$0.437
4	$25,647,875	$1,923,591	$1,508,699	$636,725	$0	$4,069,014	9,533,267	$0.427	$3,475,876	8,143,608	$0.427
5	$24,139,176	$1,810,438	$1,508,699	$649,459	$0	$3,968,596	9,533,267	$0.416	$3,216,649	7,726,959	$0.416
6	$22,630,478	$1,697,286	$1,508,699	$662,448	$0	$3,868,433	9,533,267	$0.406	$2,975,045	7,331,626	$0.406
7	$21,121,779	$1,584,133	$1,508,699	$675,697	$0	$3,768,529	9,533,267	$0.395	$2,749,933	6,956,519	$0.395
8	$19,613,081	$1,470,981	$1,508,699	$689,211	$0	$3,668,891	9,533,267	$0.385	$2,540,252	6,600,604	$0.385
9	$18,104,382	$1,357,829	$1,508,699	$702,996	$0	$3,569,523	9,533,267	$0.374	$2,345,005	6,262,899	$0.374
10	$16,595,684	$1,244,676	$1,508,699	$717,056	$0	$3,470,430	9,533,267	$0.364	$2,163,260	5,942,472	$0.364
11	$15,086,985	$1,131,524	$1,508,699	$731,397	$0	$3,371,619	9,533,267	$0.354	$1,994,140	5,638,438	$0.354
12	$13,578,287	$1,018,371	$1,508,699	$746,025	$0	$3,273,095	9,533,267	$0.343	$1,836,823	5,349,960	$0.343
13	$12,069,588	$905,219	$1,508,699	$760,945	$0	$3,174,863	9,533,267	$0.333	$1,690,540	5,076,241	$0.333
14	$10,560,890	$792,067	$1,508,699	$776,164	$0	$3,076,929	9,533,267	$0.323	$1,554,568	4,816,527	$0.323
15	$9,052,191	$678,914	$1,508,699	$791,687	$0	$2,979,300	9,533,267	$0.313	$1,428,230	4,570,100	$0.313
16	$7,543,493	$565,762	$1,508,699	$807,521	$0	$2,881,981	9,533,267	$0.302	$1,310,892	4,336,281	$0.302
17	$6,034,794	$452,610	$1,508,699	$823,671	$0	$2,784,979	9,533,267	$0.292	$1,201,958	4,114,424	$0.292
18	$4,526,096	$339,457	$1,508,699	$840,145	$0	$2,688,301	9,533,267	$0.282	$1,100,872	3,903,919	$0.282
19	$3,017,397	$226,305	$1,508,699	$856,948	$0	$2,591,951	9,533,267	$0.272	$1,007,111	3,704,183	$0.272
20	$1,508,699	$113,152	$1,508,699	$874,087	$0	$2,495,938	9,533,267	$0.262	$920,187	3,514,667	$0.262
									$45,689,118	121,150,937	$0.377
Real levelized cost of energy					**$0.377**						

Appendix 4

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik Site three; 2 E53 800 wind turbines, all net generation used, $150/kW O&M, 7.6m/s wind at 50m, with road & line

Capital cost	$41,173,970	$10,293/kW	Capacity	4,000	kW	Fixed O&M	$600,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	13,072,675	kWh	Variable O&M	$0.00	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor					

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$41,173,970	$3,088,048	$2,058,699	$600,000	$0	$5,746,746	13,072,675	$0.440	$5,746,746	13,072,675	$0.440
2	$39,115,272	$2,933,645	$2,058,699	$612,000	$0	$5,604,344	13,072,675	$0.429	$5,317,610	12,403,840	$0.429
3	$37,056,573	$2,779,243	$2,058,699	$624,240	$0	$5,462,181	13,072,675	$0.418	$4,917,559	11,769,225	$0.418
4	$34,997,875	$2,624,841	$2,058,699	$636,725	$0	$5,320,264	13,072,675	$0.407	$4,544,732	11,167,079	$0.407
5	$32,939,176	$2,470,438	$2,058,699	$649,459	$0	$5,178,596	13,072,675	$0.396	$4,197,386	10,595,740	$0.396
6	$30,880,478	$2,316,036	$2,058,699	$662,448	$0	$5,037,183	13,072,675	$0.385	$3,873,881	10,053,632	$0.385
7	$28,821,779	$2,161,633	$2,058,699	$675,697	$0	$4,896,029	13,072,675	$0.375	$3,572,681	9,539,261	$0.375
8	$26,763,081	$2,007,231	$2,058,699	$689,211	$0	$4,755,141	13,072,675	$0.364	$3,292,345	9,051,205	$0.364
9	$24,704,382	$1,852,829	$2,058,699	$702,996	$0	$4,614,523	13,072,675	$0.353	$3,031,520	8,588,120	$0.353
10	$22,645,684	$1,698,426	$2,058,699	$717,056	$0	$4,474,180	13,072,675	$0.342	$2,788,938	8,148,728	$0.342
11	$20,586,985	$1,544,024	$2,058,699	$731,397	$0	$4,334,119	13,072,675	$0.332	$2,563,409	7,731,817	$0.332
12	$18,528,287	$1,389,621	$2,058,699	$746,025	$0	$4,194,345	13,072,675	$0.321	$2,353,818	7,336,235	$0.321
13	$16,469,588	$1,235,219	$2,058,699	$760,945	$0	$4,054,863	13,072,675	$0.310	$2,159,119	6,960,893	$0.310
14	$14,410,890	$1,080,817	$2,058,699	$776,164	$0	$3,915,679	13,072,675	$0.300	$1,978,333	6,604,754	$0.300
15	$12,352,191	$926,414	$2,058,699	$791,687	$0	$3,776,800	13,072,675	$0.289	$1,810,539	6,266,837	$0.289
16	$10,293,493	$772,012	$2,058,699	$807,521	$0	$3,638,231	13,072,675	$0.278	$1,654,878	5,946,208	$0.278
17	$8,234,794	$617,610	$2,058,699	$823,671	$0	$3,499,979	13,072,675	$0.268	$1,510,542	5,641,983	$0.268
18	$6,176,096	$463,207	$2,058,699	$840,145	$0	$3,362,051	13,072,675	$0.257	$1,376,776	5,353,324	$0.257
19	$4,117,397	$308,805	$2,058,699	$856,948	$0	$3,224,451	13,072,675	$0.247	$1,252,871	5,079,433	$0.247
20	$2,058,699	$154,402	$2,058,699	$874,087	$0	$3,087,188	13,072,675	$0.236	$1,138,166	4,819,555	$0.236
									$59,081,848	166,130,544	$0.356
Real levelized cost of energy					**$0.356**						

Appendix 5

Leading Edge Projects Generation LCOE Economic Model

Project: Inuvik incremental diesel generation, 3.635 kWh per litre, fuel at $1.10 per litre, fuel inflation at 2% per year, variable O&M $0.03 per kWh

Capital cost	$0		Capacity		kW	Fixed O&M	$912,000	per year	Discount rate	5.39%	
Cost of capital	7.50%	Debt & equity	Annual Energy	30,400,000	kWh	Fuel	$0.3026	per kWh			
Inflation	2.00%	per year	Project life	20	Years	Capacity factor			Fuel inflation	2.00%	

Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
1	$0	$0	$0	$912,000	$9,199,040	$10,111,040	30,400,000	$0.333	$10,111,040	30,400,000	$0.333
2	$0	$0	$0	$930,240	$9,383,021	$10,313,261	30,400,000	$0.339	$9,785,606	28,844,651	$0.339
3	$0	$0	$0	$948,845	$9,570,681	$10,519,526	30,400,000	$0.346	$9,470,646	27,368,878	$0.346
4	$0	$0	$0	$967,822	$9,762,095	$10,729,917	30,400,000	$0.353	$9,165,823	25,968,610	$0.353
5	$0	$0	$0	$987,178	$9,957,337	$10,944,515	30,400,000	$0.360	$8,870,811	24,639,984	$0.360
6	$0	$0	$0	$1,006,922	$10,156,483	$11,163,405	30,400,000	$0.367	$8,585,295	23,379,333	$0.367
7	$0	$0	$0	$1,027,060	$10,359,613	$11,386,673	30,400,000	$0.375	$8,308,968	22,183,181	$0.375
8	$0	$0	$0	$1,047,601	$10,566,805	$11,614,407	30,400,000	$0.382	$8,041,535	21,048,228	$0.382
9	$0	$0	$0	$1,068,553	$10,778,142	$11,846,695	30,400,000	$0.390	$7,782,710	19,971,342	$0.390
10	$0	$0	$0	$1,089,924	$10,993,704	$12,083,629	30,400,000	$0.397	$7,532,216	18,949,552	$0.397
11	$0	$0	$0	$1,111,723	$11,213,578	$12,325,301	30,400,000	$0.405	$7,289,783	17,980,040	$0.405
12	$0	$0	$0	$1,133,957	$11,437,850	$12,571,807	30,400,000	$0.414	$7,055,154	17,060,131	$0.414
13	$0	$0	$0	$1,156,637	$11,666,607	$12,823,244	30,400,000	$0.422	$6,828,077	16,187,287	$0.422
14	$0	$0	$0	$1,179,769	$11,899,939	$13,079,708	30,400,000	$0.430	$6,608,308	15,359,100	$0.430
15	$0	$0	$0	$1,203,365	$12,137,938	$13,341,303	30,400,000	$0.439	$6,395,612	14,573,286	$0.439
16	$0	$0	$0	$1,227,432	$12,380,697	$13,608,129	30,400,000	$0.448	$6,189,763	13,827,676	$0.448
17	$0	$0	$0	$1,251,981	$12,628,311	$13,880,291	30,400,000	$0.457	$5,990,539	13,120,214	$0.457
18	$0	$0	$0	$1,277,020	$12,880,877	$14,157,897	30,400,000	$0.466	$5,797,727	12,448,947	$0.466
19	$0	$0	$0	$1,302,561	$13,138,494	$14,441,055	30,400,000	$0.475	$5,611,121	11,812,024	$0.475
20	$0	$0	$0	$1,328,612	$13,401,264	$14,729,876	30,400,000	$0.485	$5,430,521	11,207,688	$0.485
									$150,851,256	386,330,153	$0.390
Real levelized cost of energy					**$0.390**						