New Mexico Wind Plant Site Screening Model User's Manual

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1 Introduction

The purpose of the New Mexico Wind Plant Site Screening Model is to provide a means to economically screen potential sites for wind plant development in the State. The model requires a minimum number of inputs from the user in order to arrive at representative results, and is self-contained in terms of its data requirements with the exception of mean annual wind speed and surface roughness. This data can be obtained from the companion New Mexico Interactive Wind Map CD developed by Brower & Company of Andover, MA for the State of New Mexico Energy, Minerals & Natural Resources Department.

The following sections describe each of the model's worksheets.

2 Inputs and Results

The minimum inputs required by the site screening model are:

- # of acres of land available for the project,
- Site name,
- Average elevation in meters,
- Mean wind speed at 50 meters (from Interactive Wind Map CD),
- Surface roughness in meters (from Interactive Wind Map CD), and
- Installation year.

# of Acres of Land Available for the Project and *# of Acres per Turbine*

The model uses these two input values to estimate the size of the wind plant in MW that could be developed on the site assuming each individual wind turbine is rated at 1.5 MW. The actual land required for the project may or may not be under the control or lease by the user. A default value of 40 acres per turbine is assumed, however this value can be changed at the user's discretion. Typical values range anywhere from 20-100 acres per turbine depending on the complexity of the local terrain, land use issues, proximity to homes/farm houses, obstructions to the wind flow, and other factors. Estimates of total installed capacity are rounded to the nearest 0.5 MW.

Site Name

This input is used only to provide a title for any printed output from the model.

Average Elevation in Meters

The average elevation of the available land area can be estimated from US Geological Survey topographic maps.

Mean Wind Speed at 50 m and Surface Roughness

These data can be obtained from the New Mexico Interactive Wind Map CD. The user should first zoom in on the area of interest until data points appear on the map. Then click on the

information icon on the ArcExplorer toolbar and position it over the data point closest to the project site. Clicking on the data point will then bring up a data window showing the wind speed and surface roughness values for the site that are required as inputs to the site screening model, as well as the coordinates (latitude and longitude) of the data point. The coordinates of the data point selected may not exactly fall within the available land area for the project. Although this introduces an additional degree of uncertainty in the wind speed and roughness values used for the analysis due to local terrain affects on the wind flow, the results are still considered to be reasonable for screening purposes. If the available land area for the project is very large, the user may wish to use average values for these inputs based on the data from multiple points on the map.

Installation Year

The results of the model's calculations are expressed in terms of this year's dollars. The installation year of the project is also used in the calculation of the Federal Production Tax Credit (or Renewable Energy Production Incentive for public entities). The Federal Production Tax Credit, or PTC, is equal to 1.8 ¢/kWh in 2002, and is adjusted annually for inflation. The amount of the credit in future years is then rounded to the nearest tenth of a cent per kWh.

Energy Losses

The default value for Energy Losses is set at 13.0% and consists of the following:

- Average Array (or Wake) Losses between turbines – 4.0%
- Availability Losses – 2%
- Blade Soiling/Icing – 1.5%
- Electrical Losses – 3%
- Power Curve – 2%
- Other Losses – 1%

Annual Land Lease Payments

The default value is set at $2,750 per MW. A typical range of values may be $2,500-3,000 per MW, although higher values have been reported. This value does not include potential payments to neighboring landowners that do not have turbines located on their property, but may need to be compensated for electrical easements or simply to gain their support for the project development.

Operation and Maintenance (O&M) Expenses

The default value for O&M expenses/costs is 0.6 ¢/kWh. A typical range for these costs is 0.5 to 0.75 ¢/kWh. These costs do not include land lease payments, taxes, or insurance which are separate inputs into the model.

Number of Years that the PTC or REPI is Available

The model assumes that the PTC, which is scheduled to expire December 31, 2003, will be extended by Congress. The PTC applies to the first 10 years of a project's life. The model also assumes that the Renewable Energy Production Incentive for public entities, which is subject to annual appropriations by Congress, is funded. The impact of a failure to secure an extension of the PTC or REPI funding on the resulting sales price for electricity from a proposed wind project can be tested by setting this value to zero.

Financial Inputs

The default values used for other financial-related inputs are as follows:

- Property Tax – 0.8% of total project (installed) costs
- Insurance - 0.52% of total project (installed) costs
- Tax Depreciation on Wind Equipment – 5 year 97% MACRS
- Tax Depreciation on Property – 15 year 3% MACRS
- Effective Income Tax Rate (Federal and State) – 39%
- Inflation – 2.5%/year
- Discount Rate – 10%
- Equity Invested in the Project – 30%
- Debt Rate – 8%
- Debt Term –12 years

Results

The model results of most interest to potential developers, investors, and policymakers are:

- The levelized electricity sales price that would be required by a private developer to meet his debt service obligations to the financial institution,
- The projected Return on Equity for potential investors,
- The projected Payback Period, and
- The Cumulative Net Present Value (NPV) After-Tax Cash Flow.

Other results produced by the model and included at the bottom of the Inputs and Results Worksheet are total installed capacity, total installed cost, net annual energy production, and mean annual wind speed at turbine hub height (65 meters).

The range of uncertainty in the levelized electricity sales price resulting from the analysis is estimated to be +/- 10%. Public financing of wind projects is estimated to lower the electricity sales price by 35% due to the lower cost of debt compared to privately owned and financed wind projects and more favorable debt terms.

3 Site Air Density Calculation

The air density at a site affects the amount of power produced by a wind turbine. This worksheet calculates the air density for the study site using the elevation information input into the model. If the air density at the study site is a known value, it can be entered directly into cell B16, but caution should be used to save the results under a different name when the analysis is completed so that the integrity of the model's formulation is not compromised for further investigations.

4 Wind Shear Calculation

Surface roughness affects the increase in wind speed as a function of height above ground level (referred to as wind shear). This worksheet estimates the wind speed at turbine hub height (65 m) based on the surface roughness value input into the model. If tall tower (50 m) wind data is available for the study site from a previous measurement/monitoring program, then a site-specific wind shear can be calculated based on the 30 and 50 m measurements. This value could then be entered directly into cell B6, but caution should be used to save the results under a different name when the analysis is completed so that the integrity of the model's formulation is not compromised for further investigations.

5 Gross Energy Production

This worksheet determines the gross annual energy production of a GE Wind 1.5 MW wind turbine at a hub height of 65 m as a function of the mean annual hub height wind speed and site air density values calculated in the two previous worksheets.

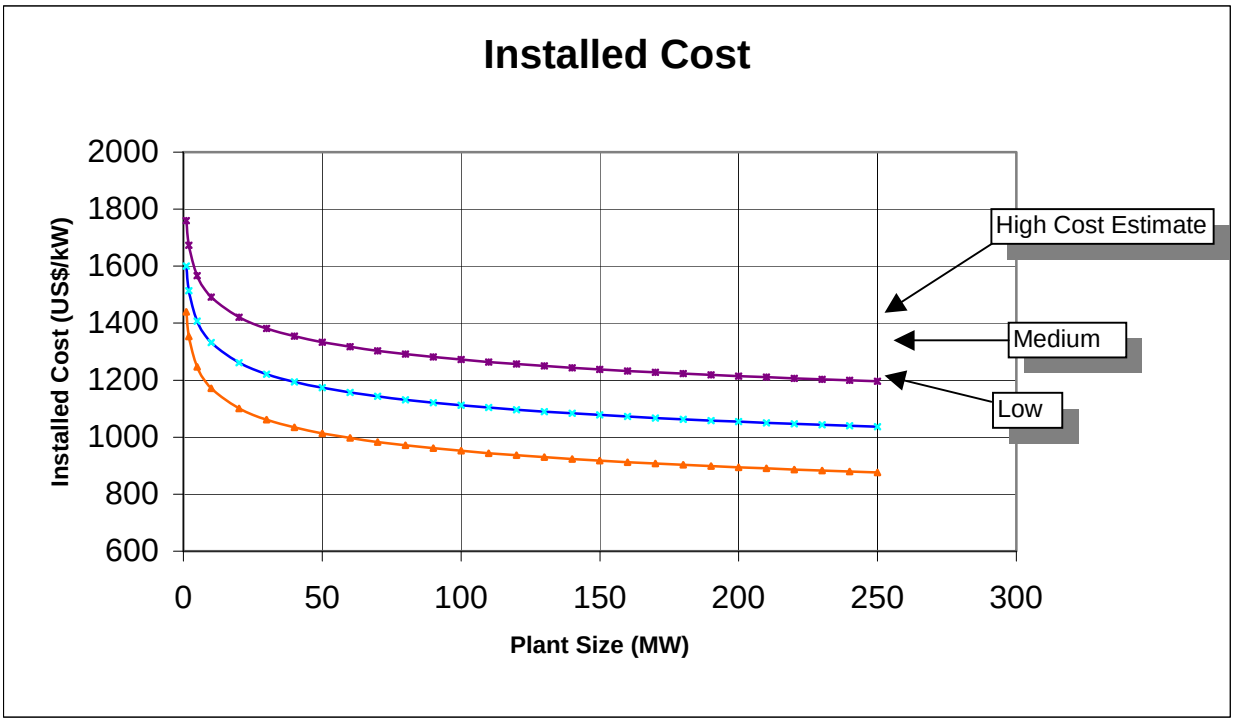
6 Debt Service Amortization

This worksheet calculates quarterly principal and interest payments over the life of the loan based on the percentage of debt used to finance the study project (100% minus the percent Equity input into the model), the debt term, and the debt rate. The model assumes equal quarterly principal payments and a six-month grace period during which only interest is paid.

7 Pro Forma Cash Flows

This worksheet generates pro forma cash flows based on the user's inputs to the model and the results produced by previous worksheets. This worksheet calculates the total installed cost of a wind project at the study site based on the size of the project. The installed cost is further based on the medium estimate shown in Figure 1. The estimates shown in Figure 1 are based on a survey of project announcements in the literature and industry experience, however actual costs are highly dependent on soil conditions at the site, road access/egress, interconnection costs, and other factors. If the user would like to substitute a different estimate of total installed costs (in thousands of dollars), this value can be entered directly into cell B6, but caution should be used to save the results under a different name when the analysis is completed so that the integrity of the model's formulation is not compromised for further investigations.

Figure 1. Total Installed Cost Estimates as a Function of Project Size



The worksheet calculates the electricity sales price required to meet a Debt Service Coverage Ratio (DSCR) in year 3 of 1.25, and then keeps this price constant over the term of the loan. This results in a revenue stream that is roughly equivalent to optimizing the actual sales price on an annual basis to maintain a constant minimum DSCR of 1.4 in each year of the debt period. After the project debt has been paid off, the electricity sales price is set such that electricity sales revenues are equal to 1.5 times total annual O&M and non-operating expenses.

The resulting levelized electricity sales price is representative of privately owned and financed wind projects. The range of uncertainty in this result is estimated to be +/- 10%. Public financing of wind projects can lower the electricity sales price resulting from this analysis by 35% due to the lower cost of debt and more favorable debt terms available to public entities.