

## **Understanding the Wind Protocol Worksheets**

# Understanding the Wind Protocol Worksheets

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## Introduction

There are four worksheets in the -protocol workbook to evaluate the economic feasibility of a particular project. The bold type below indicates the actual name of the worksheet in the Excel workbook.

- A financial calculation worksheet called **FinancialCalculation**.
- A construction and associated costs worksheet called **ConstructionCost**.
- A regulatory cost worksheet called **RegulatoryCost**.
- A final results worksheet called **SpreadsheetResults**<sup>1</sup>.

The worksheets are designed to operate interactively, so that results from one worksheet will automatically update other worksheets within the workbook. The actual protocol, which is available at [www.ruralpa.org](http://www.ruralpa.org) and X, uses color for each cell to indicate actions or inputs. It may be helpful to log onto the website as you work through these instructions to get a better understanding of the worksheets and the various color-coded cells.

The color for each worksheet cell is as follows:

- Green cells require user input;
- Yellow cells indicate a result; and
- Red cells indicate a total.

Each of these worksheets will now be discussed in more detail.

### **Financial Calculation Worksheet**

The financial calculation worksheet (see Figure 1) generates economic results based on input from the following sources:

- Construction and associated costs worksheet; and

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<sup>1</sup> Note: Only a portion of the spreadsheet is included since there are more than 300 rows in the worksheet.

- User-supplied information on
  - Loan information
  - Tax rate
  - Incentives and credits
  - Turbine energy production
  - Household energy consumption (from the household electricity usage estimation sheet).

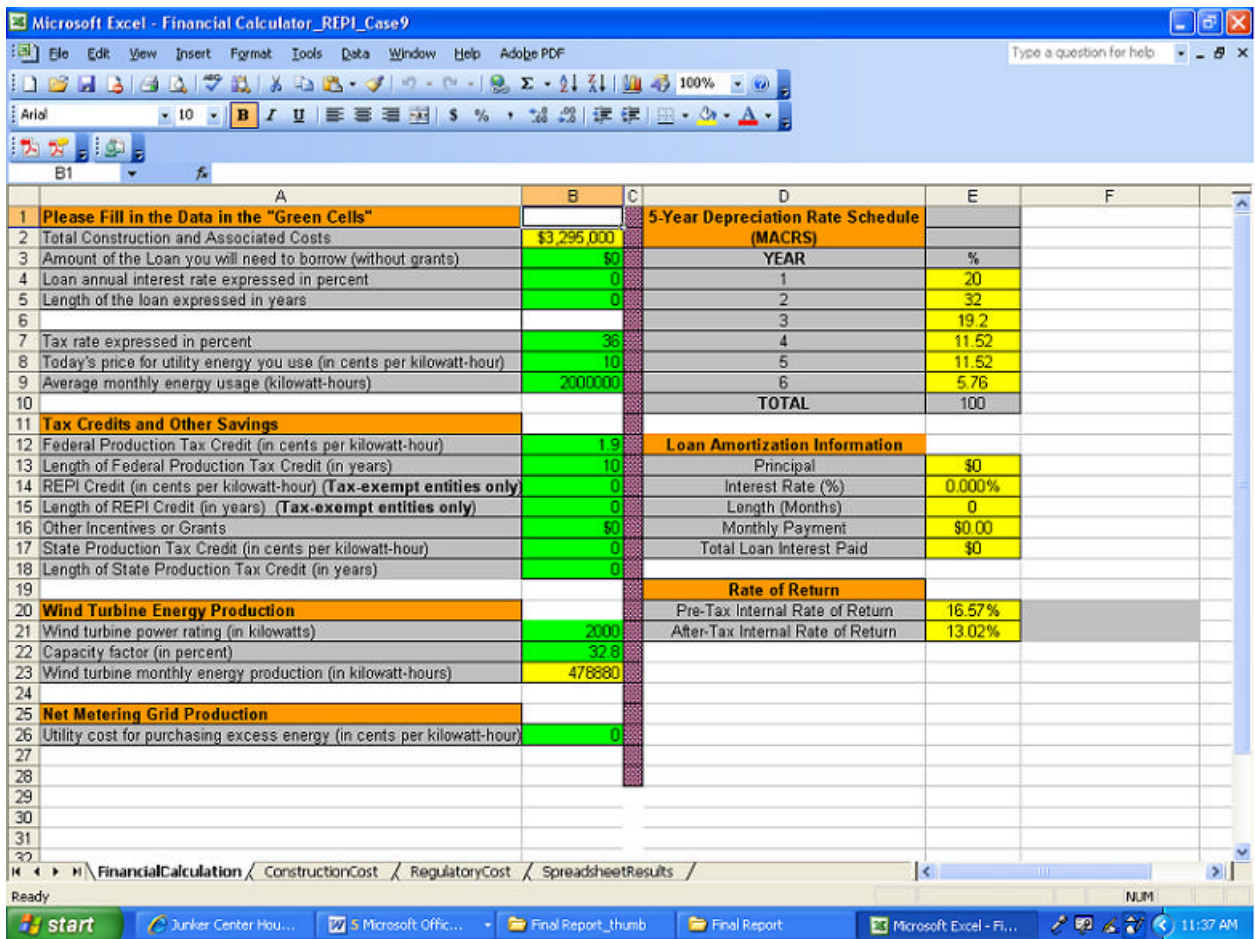


Figure 1. FinancialCalculation Worksheet

### Depreciation

The financial calculation worksheet also includes information regarding depreciation of wind energy equipment for federal tax purposes. According to the Internal Revenue Service (IRS)

tax code, section 168(e)(3)(B)(vi)(I), any commercial entity that invests in or purchases wind (as well as solar) energy equipment can depreciate the purchase over a five-year time frame using a Modified Accelerated Cost Recovery System (MACRS) [1, 2,3]<sup>2</sup>. Depreciation of equipment enables the landowner to recoup some of the expense associated with the purchase of such equipment. A five-year time frame is considered to be an accelerated length of time, which can be advantageous because it allows lower taxation on the landowner during the early years after the purchase of the equipment. These lower taxes enable the landowner to use the tax savings for other purposes, such as other investment vehicles. The MACRS is therefore a widely used and credible system for depreciation of capital costs associated with wind energy systems.

### Loans and Incentives

The financial calculation worksheet is designed to enable the user to take the results from the construction and associated costs worksheet, and decide how much money to borrow in the form of a loan. At this time, it is assumed that any money borrowed would be for a length not to exceed 15 years. For no-interest loans, users should input a very small interest rate (e.g., 0.001 percent). Shorter time periods can be considered without compromising the monthly cash flow results in the **SpreadsheetResults** worksheet. That worksheet is laid out for up to 25 years, since that is the typical manufacturer's suggested life span of a turbine. The loan information, such as

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<sup>2</sup> The MACRS table in the financial calculation worksheet represents the five-year depreciation schedule used. As shown in the worksheet, there is actually depreciation over a period of six years, but the first and sixth years are only considered to represent half a year. In fact, the numbers in the MACRS table are based on the double declining balance depreciation method [4]. If one were to assume a "straight-line" depreciation rate of 20 percent over five years, the first year would result in a depreciation of 20 percent in the first year. In the double declining balance depreciation method, the depreciation is doubled to 40 percent the first year, but since the first year only counts as half a year, the depreciation remains at 20 percent. In the second year, 80 percent of the value of the capital cost of the equipment remains to be depreciated. Assuming a straight-line depreciation rate of 20 percent/yr, only 16 percent of the remaining cost of the equipment would be depreciated. Using the double declining balance depreciation method, the depreciation rate is doubled to 32 percent in the second year. This process continues until the sixth year, where the last 5.8 percent of the cost is finally depreciated. It is noted that the RETScreen software does not include this option of using the MACRS table for a five-year double declining balance depreciation schedule.

loan rate, monthly payment, and total interest paid on the loan, are provided in column E of the **FinancialCalculation** worksheet. Users of the protocol should not assume that they will be able to finance with loans an entire wind energy system. A more realistic scenario is to assume no more than 50 percent of the overall cost of the system may be financed with loans. Assuming 100 percent financing will also yield unrealistic values for the internal rate of return (IRR).

In addition to loan information, the **FinancialCalculation** worksheet enables the user to input tax credits and other savings, such as other incentives and grants that may (or may not) currently exist for the landowner to use. For example, in row 16, column B of that worksheet, the user may input any additional (one time) incentives or grants that would reduce either the loan principal, or (if no loan is required) the upfront cost of the purchase, and thus make the system more cost-effective. This enables the user to investigate the effects that such one-time incentives may have on the overall economic viability of a wind energy system. An example of incentives is provided by the state of New Jersey [5], where up to 30 percent of eligible system costs may be subsidized by the state.

#### Turbine Power and Capacity Factor

The **FinancialCalculation** worksheet includes cells for the user to input the rated power output of the turbine, along with a capacity factor. The capacity factor is an efficiency rating that takes into account the reality that a wind turbine will not always be generating to its full (rated) capacity. Thus, the energy that is generated by the wind turbine will be a fraction of what would be generated if the wind turbine were generating its rated power all day, every day.

A typical range for capacity factor is between 25 percent and 40 percent, according to EnXco [6]. However, the project subcontractor (a firm with significant wind energy experience) has indicated that such a range is higher than what has been observed in the field. The investigators have looked at the Waymart Wind Farm in Wayne County, Pa., as an example for determination of capacity factor [7]. That site uses 43 General Electric wind turbines that are each

rated to produce 1.5 megawatts (MW) of power. Thus, the wind farm can potentially generate 64.5 MW of power. If the wind farm were providing its peak power all day, every day, it would produce, for one year (8,760 hours), a total of 565,000 megawatt-hours (MWh) of energy. However, the information in [7] shows that the wind farm has an approximate annual generation of only 141,900 MWh of energy. Thus, the Waymart Wind Farm has a capacity factor equal to  $(141,900/565,000)$  or approximately 25.1 percent.

A second example is from the Somerset Wind Farm in Somerset County, Pa. [8]. That site uses six wind turbines that are each rated to produce 1.5 megawatts (MW) of power, yielding a rated power of 9 MW. If the wind farm were providing its peak power all day, every day, it would produce a total of 78,840 megawatt-hours (MWh) of energy for one year. However, the information in [8] shows that the wind farm has an annual generation of approximately 25,000 MWh of energy. Thus, the Somerset Wind Farm has a capacity factor equal to  $(25,000/78,840)$  or approximately 31.7 percent.

The investigators have compared these numbers with those provided by AWEA. AWEA has indicated that a reasonable range for capacity factor is between 25 percent and 30 percent for a wind turbine or wind farm [9]. However, it also includes an example on its website that assumes only 20 percent capacity factor. To be conservative, parties using the protocol should **assume a capacity factor between 15 percent and 30 percent for typical wind resources in Pennsylvania**. The low range is based on capacity factors that the investigators have identified for various wind turbines using the data acquired from the meteorological towers in the real world cases discussed later. Users of the protocol should remember that capacity factors higher than 25 percent typically occur at wind farms that have been specifically located in areas with high, sustained wind. Rural landowners and communities often will not have access to such preferable locations.

### Household Electricity Use Estimation Sheet

The only program that is not included in this workbook is the household electricity use estimation sheet. That program has additional capabilities that will enable the user to identify if he/she has considered all of the electrical loads on the property, and will be discussed later. The results of that program are input into the financial calculation worksheet by the user (column B of the **FinancialCalculation** worksheet) including the average monthly energy use, as well as the current cost of electricity. This yields an overall energy savings that is included as part of the monthly cash flow. These savings are then adjusted for inflation. The investigators have assumed that the cost of electricity will increase by 2.5 percent each year. The value of 2.5 percent is equivalent to the inflation rate over the last 10 years from the Department of Labor, Bureau of Labor Statistics, Consumer Price Index (CPI) [10]. This is intended to be a conservative amount. To assume no cost of inflation increase is unrealistic. However, to assume a higher rate of inflation may be overly optimistic.

### Net Metering

As part of the state's initiative to promote renewable energy technologies, a working group affiliated with the Pennsylvania Public Utility Commission (PUC) was tasked to develop rules regarding **net metering**, whereby excess generation of renewable energy (such as wind energy) could be acquired by the utility that accepts such energy [11]. The PUC adopted net-metering rules in June 2006 for customers who generate electricity using wind as well as other forms of renewable or alternative energy. Residential customers are limited to turbines rated no more than 50kW, although non-residential customers can employ net metering with a system rated up to 3MW [12]. Net metering rules were implemented as part of Act 35 of 2007. The act states that excess generation from net-metered customer-generators shall receive full retail value for all energy produced on an annual basis.

As an example, suppose a landowner installs a wind energy system that generates 600kWh of energy each month. If the landowner consumes only 500kWh of energy during the month, the landowner can sell back 1200kWh (100 kWh per month) of energy that year.

### Production Tax Credit

In addition, the financial calculation worksheet includes the option of allowing a state production tax credit (similar to the federal production tax credit described earlier), whereby the state would provide a tax credit based on the amount of energy produced [13]. Currently, only three states have adopted a production tax credit (Oklahoma, Minnesota and New Mexico)<sup>3</sup>. For municipalities and other tax-exempt entities, the federal production tax credit does not apply. However, there exists a Renewable Energy Production Incentive (REPI) [16] that works in a manner similar to the federal production tax credit. The REPI will yield financial incentive payments for electricity generated and sold by new qualifying renewable energy generation facilities.

### Internal Rate of Return

The most important results from the financial calculation worksheet are based on the internal rate of return (IRR) calculations performed in the worksheet. The IRR is a measure of how much an investment in a wind turbine will yield for a landowner, due to savings on their electric bill, tax credits, etc. It may be thought of as similar to the rate of return on an investment. Since each user has a different threshold for what he/she considers an acceptable IRR, each user should develop his/her own acceptance criteria for the IRR. For example, even if the IRR calculation turns out to be positive, it may not be a worthwhile investment if it has a small value (say less than 5 percent). However, if the IRR turns out to be negative, the user should be wary of

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<sup>3</sup> Minnesota, for example, provides a production tax credit of 1.5 cents/kWh for 10 years for qualified wind energy projects of less than 2 MW [14]. Although Pennsylvania does not have a state production tax credit, such an option may be useful for those considering the effects of such a credit. The federal production tax credit for 2005 was 1.9¢/kWh for wind energy systems, and applies to systems installed prior to the beginning of calendar year 2008 [15].

continuing to pursue the purchase and installation of a wind turbine. Generally, the IRR will not give a reasonable answer (i.e., a result for the rate of return that will likely occur at that particular site for that installed wind energy system) until all of the information is provided to the protocol.

The IRR calculation is based on a function that is built in as a part of MS Excel. The equation for the IRR is solved recursively, which means that there is no closed form solution. Rather, the IRR function provides a default “initial guess” as to what the IRR will be. From this guess the solution proceeds to recursively correct the guess until the equation balances (the solution converges).

One key feature of the IRR calculation is that the calculation will not converge to the correct answer if the data used in the calculation is either always positive or always negative. In these cases, the IRR calculation will return an error. The data may be always negative when the annual savings due to installation of the wind turbine is exceeded by the operation and maintenance costs. The data may always be positive when the wind energy system is purchased for no money down and immediately yields an annual positive cash flow. The investigators consider this latter case to be unrealistic in most cases.

Again, a positive IRR yields an overall positive investment, while a negative IRR yields an overall negative investment. It can also help the user decide whether a given rate of return is acceptable. For example, if a landowner indicates that he/she is looking for a minimum 10 percent rate of return on the investment into a wind energy system, then an IRR of 5 percent, while positive, would probably result in the landowner not purchasing a system since it did not meet his/her expectation.

### **Construction and Associated Cost Worksheet**

The construction and associated cost worksheet is intended to layout for the user all of the potential ‘capital’ costs that may be incurred in the purchase and installation of a wind energy system (see Figure 2). In addition to providing a summation of these costs, the protocol also

hopes to educate the landowner as to what types of costs *could* be realized during this process. One of the costs identified on this worksheet is a total from the zoning/regulatory and permit costs worksheet. The sum total of the construction and associated cost worksheet becomes the total required cost (also referred to as the installed cost) of the wind energy system that is used in the **FinancialCalculation** worksheet.

The **ConstructionCost** worksheet also includes a cell for identifying annual operations and maintenance costs. Such annual costs may include maintenance of the turbine and/or tower, insurance, etc. A reasonable initial guess would be between 2 percent and 3 percent of the total determined construction cost.

	A	B	C	D	E	F	G	H	I
1	<b>Construction and Associated Costs</b>	<b>Cost</b>	<b>Other Costs</b>	<b>Cost</b>					
2	Administrative and Legal Expenses	\$0	Annual Operations and Maintenance Costs	\$116,272					
3	Land	\$0							
4	Right of Ways	\$0							
5	Appraisals	\$0							
6	Preliminary Site Assessment	\$0							
7	Wind Data (Meteorological) Study	\$0							
8	Equipment Transportation	\$0							
9	Architectural Engineering	\$0							
10	Other Engineering	\$0							
11	Construction	\$400,000							
12	Demolition and Removal of Equipment	\$0							
13	Equipment	\$2,400,000							
14	Insurance	\$0							
15	Zoning/Regulatory and Permit Costs	\$295,000							
16	Miscellaneous	\$200,000							
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27	<b>Total Construction and Associated Costs</b>	<b>\$3,295,000</b>							
28									
29									
30									
31									
32									

Figure 2. **ConstructionCost** Worksheet

## Zoning/Regulatory and Permit Cost Worksheet

The zoning/regulatory and permit cost worksheet (see Figure 3) is similar to the construction and associated cost worksheet in that it is a vehicle for calculating such costs in one worksheet. It is a means for the landowner to identify potential costs associated with getting the necessary permits and other approvals required in a township. Other costs in this worksheet include having the electrical output tied in with the utility grid (interconnection), or meeting Federal Aviation Administration (FAA) guidelines, etc. The total of these costs becomes an element of the **ConstructionCost** worksheet described above.

	A	B	C	D	E
	Zoning/Regulatory and Permit Costs	Cost	Necessary Conditions for Requiring Approval	Approval Authority	Reference Document
1	Erosion & Sediment Control (NPDES Construction Permit)	\$0	Disturbing 5 or more acres of land	Dept of Environmental Protection	PA Wind-Whistle Collaborative (unofficial)
2	Water Obstruction and Encroachment and Wetlands		Obstructions to waterways, floodways, lakes, wetlands, etc.	Dept of Environmental Protection	PA Wind-Whistle Collaborative (unofficial)
3			Examples:		
4			GP-05 Utility Line Stream Crossings		
5		\$0	GP-07 Minor Road Crossings		
6		\$0	GP-08 Temporary Road Crossings		
7		\$0	Must be completed (also known as PNDI Review)	Dept of Environmental Protection	DEP document 400-0200-001
8	PA Natural Diversity Inventory Coordination	\$0	Any system that ties into the utility grid	Utility	First Energy tariff information
9	Utility Interconnection Application Fee	\$0	Any system that ties into the utility grid	Utility	
10	Utility Interconnection	\$295,000	Systems that exceed utility limits for "small wind"	Utility	
11	Utility Inspection	\$0	Depends on the township requirements	Township	
12	Co-generation Costs	\$0	Depends on the township requirements	Township Engineer	
13	Zoning Permit	\$0	Depends on the township requirements	Building Inspector	Ohio Wind Power Conference Tool Kit
14	Engineering Approval	\$0	Depends on the township requirements	Township	Township of Ridgway PA ordinance
15	Building Permit	\$0	Depends on the township requirements	Township	Experience with met tower erection
16	Decommissioning Funds	\$0	Depends on the township requirements	Building Inspector	Experience with met tower erection
17	Town Board Hearing	\$0	Depends on the township requirements	Township	Ohio Wind Power Conference Tool Kit
18	Building Inspection	\$0	These costs depend on whether the Uniform Construction Code needs to be followed	Township	
19	Special Use Permit	\$0	Depends on the township requirements	FAA	web: <a href="https://oessaa.faa.gov/oessaaEXIT/portal.jsp">https://oessaa.faa.gov/oessaaEXIT/portal.jsp</a> form: FAA-OEAAA-eFiling_User_Guide.pdf
20	Labor & Industry Costs				
21	Drawings requiring PA licensed engineer approval	\$0			
22	Single line electrical diagram (PA engineer approval)	\$0			
23	Soil analysis (PA engineer approval)	\$0			
24	Height Ordinance	\$0	Depends on the township requirements	Township	Ohio Wind Power Conference Tool Kit
25	Federal Aviation Administration	\$0	Structures within 5 miles of an airport and/or over 200' above a nearby airport	FAA	
26					
27	<b>Total Zoning/Regulatory and Permit Costs</b>	<b>295000</b>			

Figure 3. **RegulatoryCost** Worksheet

For each potential cost identified in this worksheet, the investigators have attempted to identify the following:

- The necessary conditions for requiring approval;

- The approval authority; and
- A reference document.

In some cases, the cost was identified during the effort to erect the meteorological towers. This does not imply that all costs listed in this worksheet will be incurred by each landowner. Rather, it is likely that zoning/regulatory costs will vary from municipality to municipality. As an example, townships may or may not require installations to meet the requirements of the Uniform Construction Code (UCC) [17]. The investigators have received one account of additional costs accruing into the thousands of dollars due to the effects of meeting UCC requirements in one township. Thus, zoning/regulatory and permitting costs calculated using this worksheet may vary widely, depending on the location where the wind turbine is to be sited.

### **Spreadsheet Results Worksheet**

The **SpreadsheetResults** worksheet (see Figure 4 for a portion of the worksheet) provides monthly and yearly accounts of information such as:

- Monthly loan amortization payment schedule, including annual interest and principal payments made;
- Monthly cash flows; and
- Annual pre-tax and (using the MACRS depreciation schedule) after-tax cash flows.

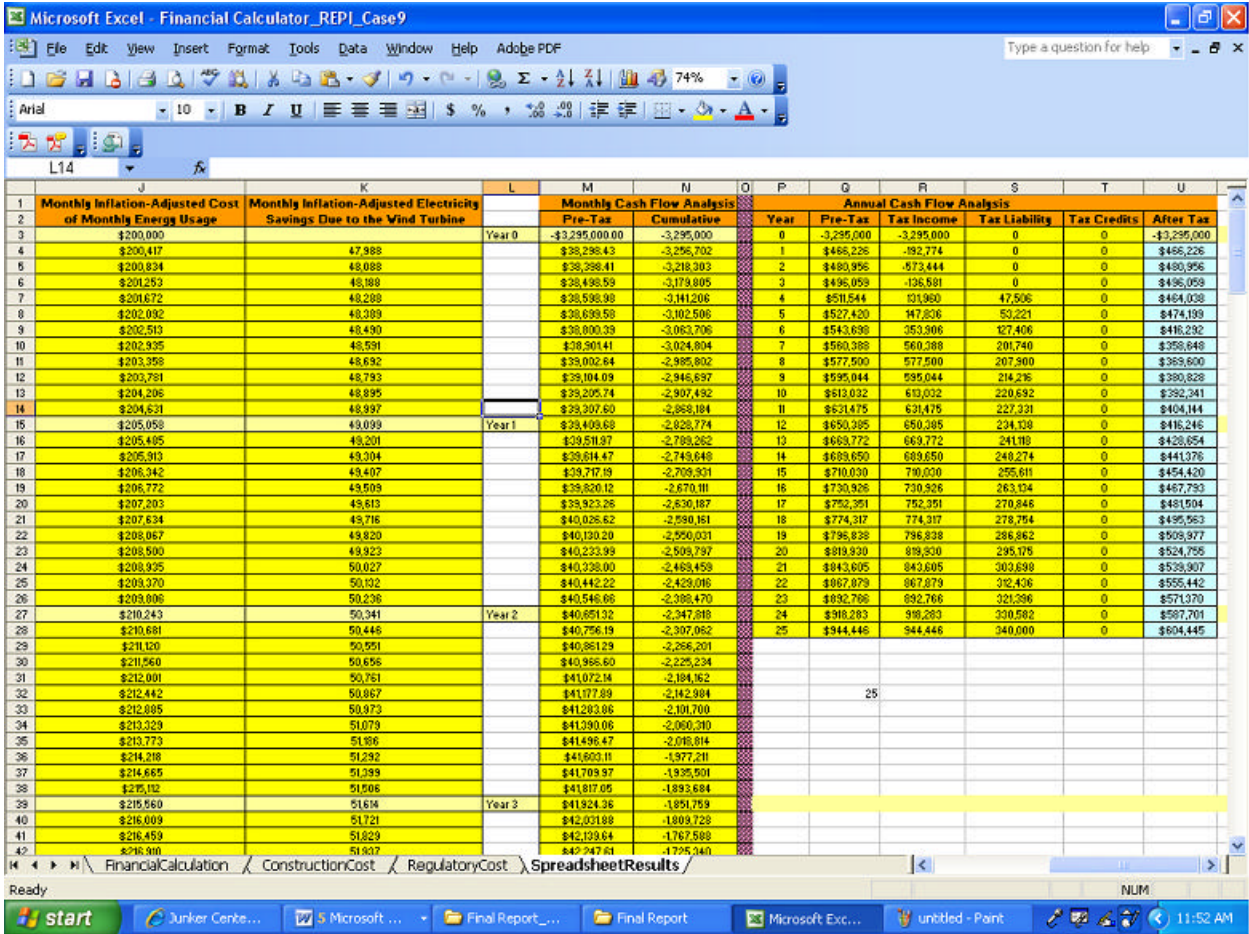


Figure 4. SpreadsheetResults Worksheet

The **SpreadsheetResults** worksheet is primarily intended to be used to help other parties validate the protocol, rather than be used as a decision-making tool. However, it is anticipated that some landowners will wish to look at payments and cash flows on a monthly basis, and the investigators have attempted to layout this worksheet in a reasonably organized manner.

### **Household Electricity Use Estimation Sheet**

The household electricity use estimation sheet is a separate program from the rest of the worksheets developed for the protocol. The household electricity use estimation sheet enables a landowner to estimate the monthly energy consumption at a particular location (house, barn, business, etc.) by tallying up the energy consumption for all of the electrical appliances at the

location. This software has a second purpose as well: to enable the user to see which electrical appliances consume the most energy at the location. This encourages the landowner to consider conserving energy by reducing the energy consumption of the highest energy loads.

The household electricity use estimation sheet was generated in Visual Basic rather than Excel and is a stand-alone program. The only additional software required to run this program on a personal computer is a free runtime library available from Microsoft [18]. At this time, the program has only been verified to run on the Windows XP operating system.

[1] National Tax Timber Website, Section 168,

<http://www.timbertax.org/research/irc/sections/Sec168.asp>

[2] Solar Consultants, Tax Credits and Loans, website

<http://www.solarconsultants.com/taxcredits.php>

[3] United States Energy Information Administration (EIA), Wind Energy Developments: Incentives in Selected Countries, last modified 07/29/2002

[http://www.eia.doe.gov/cneaf/solar.renewables/rea\\_issues/windart.html](http://www.eia.doe.gov/cneaf/solar.renewables/rea_issues/windart.html)

[4] <http://campus.murraystate.edu/academic/faculty/larry.guin/FIN330/MACRS.htm>

[5] New Jersey Clean Energy Program Financial Incentives, website:

[http://www.njcep.com/html/2\\_incent.html](http://www.njcep.com/html/2_incent.html).

[6] EnXco, website [http://www.enxco.com/understanding\\_wind\\_faqs.php](http://www.enxco.com/understanding_wind_faqs.php)

[7] Waymart Wind Farm Information, via Safeway, website

[http://shop.safeway.com/corporate/safeway/windenergy/windenergy\\_waymart.htm](http://shop.safeway.com/corporate/safeway/windenergy/windenergy_waymart.htm)

[8] Somerset Wind Farm Information, via Exelon, website

[http://www.exeloncorp.com/ourcompanies/powergen/fossil/renewables/somerset\\_wind\\_farm.htm](http://www.exeloncorp.com/ourcompanies/powergen/fossil/renewables/somerset_wind_farm.htm)

[9] American Wind Energy Association FAQ, website <http://www.awea.org/faq/basicen.html>

[10] <http://data.bls.gov/cgi-bin/surveymost?cu> (All Urban Consumers)

[11] Pennsylvania Public Utility Commission Alternative Energy Portfolio Standards Act of 2004, Final Rulemaking Order (Net Metering) - Docket No. M-00051865 and L-00050174, website [http://www.puc.state.pa.us/electric/electric\\_alt\\_energy.aspx](http://www.puc.state.pa.us/electric/electric_alt_energy.aspx)

[12]

[http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive\\_Code=PA03R&state=PA&CurrentPageID=1&RE=1&EE=1](http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=PA03R&state=PA&CurrentPageID=1&RE=1&EE=1)

[13] National Conference of State Legislators website,

<http://www.ncsl.org/programs/energy/taxcreditFS.htm>

[14] Minnesota Department of Commerce, Energy Information Center, Renewable and Efficiency Incentives, website

<http://www.state.mn.us/portal/mn/jsp/content.do?contentid=536885915&contenttype=EDITORIAL&agency=Commerce>

[15] Internal Revenue Service Tax Form 8835, “*Renewable Electricity, Refined Coal, and Indian Coal Production Credit,*” website <http://www.irs.gov/pub/irs-pdf/f8835.pdf>

[16] United States Department of Energy website <http://www.eere.energy.gov/rep/about.cfm>

[17] Pennsylvania State Uniform Construction Code, Chapter 403, website

<http://www.pacode.com/secure/data/034/chapter403/chap403toc.html>

[18] <http://www.microsoft.com/downloads/details.aspx?FamilyID=262d25e3-f589-4842-8157-034d1e7cf3a3&displaylang=en>



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