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Recent Revisions to PVWATTS

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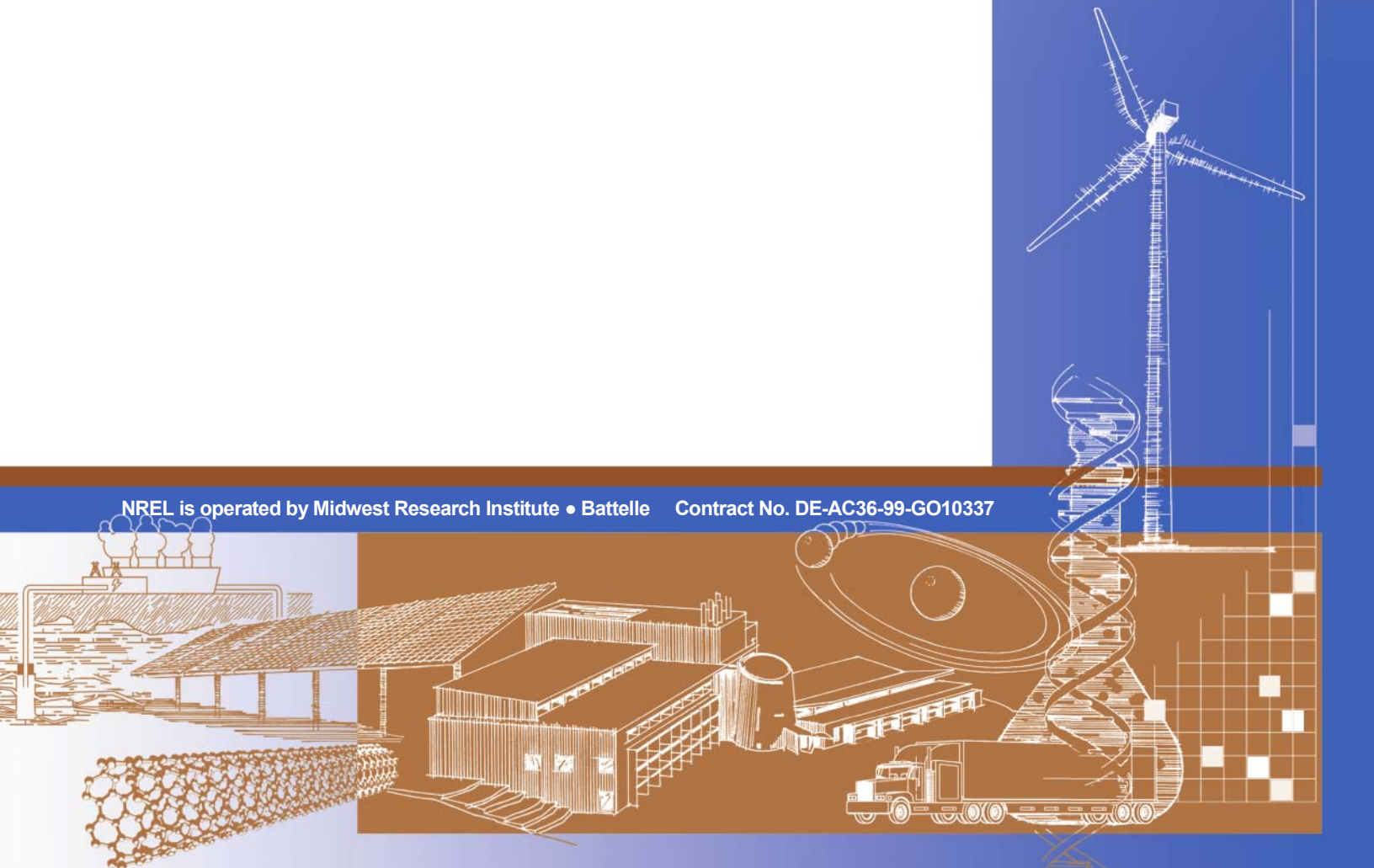

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Recent Revisions to PVWATTS

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ABSTRACT

PVWATTS is an Internet-accessible software program that allows the user to easily calculate the energy production and cost savings for grid-connected photovoltaic (PV) systems located throughout the United States. To ensure that PVWATTS continues to meet its users' needs, an online survey form was provided to users to identify areas for improvement. The results of the survey were used to prioritize improvements to PVWATTS in FY2005. PVWATTS was revised by changing the PV system specification input for system size from an AC power rating to a nameplate DC power rating; adding an input for an overall DC to AC derate factor; updating the residential electric rates; adding monthly and yearly solar radiation values for the PV array; and simplifying the user interface for Version 2.

1. Objectives

The purpose of this work was to add features to PVWATTS to improve the ease of use and provide more complete information on the performance of grid-connected photovoltaic (PV) systems. An easy-to-use PV-performance predictive model available to anyone via the internet facilitates the deployment and acceptance of grid-connected PV systems by providing a common predictor of expected performance for both buyers and sellers of PV systems.

2. Background and Technical Approach

The original PVWATTS[1] Version 1 (still available), released in 1999, is an Internet-accessible simulation tool for providing quick estimates of the electrical energy production of a grid-connected crystalline-silicon PV system for any of 239 locations. These locations correspond to the 239-station Typical Meteorological Year (TMY2) database[2] for the United States and its territories. Users select a location from a station map and set PV system parameters, or select default values, and PVWATTS performs an hour-by-hour simulation that provides monthly and annual alternating current (AC) energy production in kilowatts and energy value in dollars. The performance model used by PVWATTS is based on Sandia National Laboratories' PVFORM[3], but with fewer allowed specified inputs.

Before the release of Version 2[4] in 2001, if the desired location was between TMY2 stations, the PVWATTS user needed to choose between two or more stations based on which station they judged to be climatically similar, or in some cases, the nearest. PVWATTS Version 2 provides better performance estimates in these instances by using 40-km resolution data grid values of monthly global horizontal, direct normal, and diffuse horizontal solar radiation and maximum daily temperature to translate performance from a nearby TMY2 station to the desired grid cell. To run PVWATTS Version 2, users select the 40-km resolution grid cell containing the desired location from an interactive map, and then in the same manner as for Version 1, specify the system parameters, or accept the default values, and click the calculate button to initiate the performance simulation.

To ensure that PVWATTS is continuing to meet its users' needs, an online survey form was provided on the PVWATTS website for two months in early FY2005 so users could identify areas for improvement. The results of the survey were then used to prioritize improvements to PVWATTS.

3. Results and Accomplishments

A total of 51 respondents completed the online PVWATTS survey, classifying themselves as to business/occupation as follows:

- PV module manufacturer (4)
- Balance-of-systems manufacturer (3)
- Designer/installer (18)
- Consultant (8)
- University (2)
- National laboratory (0)
- State energy office (1)
- Consumer/buyer (15).

The largest number of responses came from the designer/installer and consumer/buyer classifications. Based on the survey, and keeping with the original intent of providing non-experts (consumers/buyers) with quick performance estimates for grid-connected systems, the changes outlined in the following paragraphs were made to PVWATTS.

3.1 System Size

The PV system specification input for system size was changed from an AC power rating to a nameplate DC power rating. The nameplate DC power rating information is more readily available, and is less open to interpretation as to how it is determined, than is an AC power rating. A nameplate DC power rating is also more consistent with how energy performance is reported for fielded systems and how most PV systems are currently marketed.

3.2 DC-to-AC Derate Factor

Capability to input an overall DC-to-AC derate factor was added for calculating a reference AC power rating by PVWATTS. The user may also have PVWATTS calculate a new overall DC-to-AC derate factor by specifying previously determined individual PV system component derate factors[5]. The use of derate factors offers more transparency for the loss factors used by PVWATTS, and permits loss factors to be changed, if desired, to better match system-specific components or loss mechanisms. A default DC-to-AC derate factor allows novice users to obtain realistic results without a detailed knowledge of system components. The individual component derate factors and their allowable ranges are listed in Table 1.

Table 1. PVWATTS Component Derate Factors

Item	Default	Range
PV module nameplate DC rating	0.95	0.80-1.05
Inverter and transformer	0.92	0.88-0.95
Mismatch	0.98	0.97-0.995
Diodes and connections	0.995	0.99-0.997
DC wiring	0.98	0.97-0.99
AC wiring	0.99	0.98-0.993
Soiling	0.95	0.30-0.995
System availability	0.98	0.00 0.995
Shading	1.00	0.0-1.00
Sun-tracking	1.00	0.95-1.00
Age	1.00	0.70-1.00
Overall	0.77	

3.3 Residential Electric Rates

The residential electric rates were updated with the latest available data. For Version 1, the latest data were for 2003, and for Version 2, the latest data were for 2002. (Data for Version 2 are much more extensive and not as quickly available as that for Version 1.)

3.4 Solar Radiation

The results page was revised to include monthly and yearly solar radiation values for the PV array. This is useful information for understanding performance differences between locations.

3.5 Simpler Version 2 Interface

Version 2 may now be launched with NREL's IMS PVWATTS Version 2 site, which provides a much simpler user interface because default settings are used for the most frequently used settings. The original method for launching Version 2 with the map server was retained to accommodate users already familiar with Version 2.

4. Conclusions and Future Direction

To ensure that PVWATTS continues to meet its users' needs, an online survey form was provided to users to identify areas for improvement. The results of the survey were used to prioritize improvements to PVWATTS. In FY2005, PVWATTS was revised by changing the PV system specification input for system size from an AC power rating to a nameplate DC power rating; adding an input for an overall DC-to-AC derate factor; updating the residential electric rates; adding monthly and yearly solar radiation values for the PV array; and simplifying the user interface for Version 2.

For FY2006, we will be adding international TMY weather data for PVWATTS simulations for locations outside the United States. This will support international activities of the U.S. PV industry, build international interest in the use of PVWATTS for estimating the performance of grid-connected PV systems, and address a common FY2005 survey suggestion by PVWATTS users with international interests.

Both versions of PVWATTS reside on the National Renewable Energy Laboratory's Web site and may be accessed by pointing your browser to http://rredc.nrel.gov/solar/calculators/PVWATTS/.

ACKNOWLEDGEMENTS

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[4]B. Marion, M. Anderberg, R. George, P. Gray-Hann, and D. Heimiller, "PVWATTS Version 2 – Enhanced Spatial Resolution for Calculating Grid-Connected PV Performance," *Proceedings of the 2001 NCPV Program Review Meeting, Lakewood, CO*, pp. 143-144.

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14. ABSTRACT *(Maximum 200 Words)*

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