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U.S. On-Grid Photovoltaic Capacity: A Baseline for the National Energy Modeling System

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S. Price, C. Herig, and H.L. Goldstein
National Renewable Energy Laboratory

L. Gillette
U.S. Department of Energy, EERE

E. Boedecker and J. Holihan
U.S. Department of Energy, EIA

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National Renewable Energy Laboratory

1617 Cole Boulevard
Golden, Colorado 80401-3393

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U.S. ON-GRID PHOTOVOLTAIC CAPACITY: A BASELINE FOR THE NATIONAL ENERGY MODELING SYSTEM

Selya Price, Christy Herig, H. Lawrence Goldstein
National Renewable Energy Laboratory
901 D Street, SW, Suite 930, Washington, DC 20024
1617 Cole Boulevard,Golden, CO 80401
selya_price@nrel.gov
cherig@nrel.gov
larry_goldstein@nrel.gov

Lynne Gillette
Department of Energy
Office of Energy Efficiency and Renewable Energy
Office of Power Technologies
1000 Independence Avenue, SW, EE-11
Washington, DC 20585
lynne.gillette@ee.doe.gov

Erin Boedecker
Department of Energy
Energy Information Administration
Office of Integrated Analysis and Forecasting
1000 Independence Avenue, SW, EI-84
Washington, DC 20585
erin.boedecker@eia.doe.gov

James (Peter) Holihan
Department of Energy
Energy Information Administration
Office of Coal, Nuclear, Electric and Alternate Fuels
1000 Independence Avenue, SW, EI-52
Washington, DC 20585
james.holihan@eia.doe.gov

ABSTRACT

How much photovoltaics (PV) is installed in the United States? This basic question poses a data collection challenge, as PV systems are generally small and there is no systematic, nationwide reporting scheme for electric plants under 1 MW in size. This paper presents results and methods from an effort to arrive at an accurate estimate of grid-connected PV capacity and a database of installations underlying this number.

Two main products resulted from these efforts, the first being a spreadsheet summarizing knowledge of PV capacity in the U.S. The second product, presented in this paper, is a database of PV installations, yielding a total on-grid capacity of 26.6 MW at the end of 2000. Compared to sources giving an upper bound of between 30 and 40 MW for cumulative on-grid PV capacity in the U.S., 26.6 MW is still low, but this number is the largest to date that is based on a database of installations.

1. BACKGROUND

Who is interested in installed photovoltaic data? The Department of Energy's (DOE) Energy Information Administration (EIA) Office of Integrated Analysis and Forecasting (OIAF) needs a baseline of installed capacity as a starting point from which to model future growth for its Annual Energy Outlook (AEO). The DOE's Office of Energy Efficiency and Renewable Energy (EERE) Office of Power Technologies relies on data to assess effectiveness of its programs, for example to assess how well a technology is being deployed. The DOE's EIA Office of Coal, Nuclear, Electric and Alternate Fuels (CNEAF) collects data on renewable energy, on which are based its analysis work and publications such as the *Renewable Energy Annual 2000* and *Renewable Energy Issues and Trends 2000*.

In addition to DOE, data is used by other government agencies, by Congress, by the private sector, by the renewable energy industry, and is leveraged in business and state-level planning, research and development, environmental analysis, and analysis of policies.

Overall numbers capturing cumulative photovoltaic capacity are valuable. However, a database supporting these numbers can continue to be maintained and validated, thus serving as a foundation for ongoing work. A database also provides confidence that the systems are actually installed.

Another benefit of having a database to support capacity numbers is that important additional questions can be answered. Installation data provides details such as location, size of the plant, and the market sector served by the plant (residential, commercial, utility).

2. RESULTS

2.1 Assessment of Existing Information

Cumulative installed PV capacity in the U.S. through year 2000, as measured by several expert sources, is presented in Tables 1 and 2 below [2, 4]. The numbers from EIA and from Maycock/Bower were determined by collecting PV module and cell shipment data from manufacturers (and for Maycock/Bower, distributors and installers as well). Possible reasons for the variation between sources include: (1) different tracking periods, (2) different estimates of exports (Maycock/Bower numbers include distributor as well as manufacturer exports), (3) cells counted twice by one source and not another (if cells are shipped to a module manufacturer and then counted again as modules), (4) Paul Maycock collects data via phone calls to manufacturers, distributors, and installers, whereas EIA obtains data via mandatory survey forms, (5) a difference in the time of year that data is collected, (6) Maycock/Bower data in Table 2 does not include systems of size < 40W [2, 4].

TABLE 1: CUMULATIVE INSTALLED PV CAPACITY IN THE U.S.

Source	Capacity (MW)	Years Included
Paul Maycock and Ward Bower	139	1992-2000
Strategies Unlimited	149	1992-2000
EIA, James Holihan	181	1982-2000

Table 2 separates the capacity into on and off-grid, where data were available. The EIA on and off-grid estimates in Table 2 are calculated from shipment numbers categorized by end-use [2]. Paul Maycock obtains on-grid and off-grid numbers via phone calls with distributors and installers.

TABLE 2: CUMULATIVE ON-GRID AND OFF-GRID PV CAPACITY IN THE U.S.

Source	On-Grid Capacity (MW)	Off-Grid Capacity (MW)	Years Included
Paul Maycock and Ward Bower	40.1	98.7	1992-2000
EIA, James Holihan	30.6	150.4	1982-2000

Renewable energy analyses and forecasts often rely on data collected by the EIA's CNEAF. The EIA CNEAF office, with authority to collect data from utility and non-utility electricity generators, surveys systems of 1 MW or larger. As PV systems are almost always smaller than this, most PV systems are not included.

Other databases have attempted to capture data for all sizes of PV systems. The EIA's OIAF maintains spreadsheets of both distributed and central generation PV systems to develop baseline capacity estimates for the Annual Energy Outlook. The AEO forecasts, relied upon by many U.S. decision-makers, are produced via OIAF's National Energy Modeling System (NEMS).

Another source of PV installation data is the National Renewable Energy Laboratory's REPiS (Renewable Electric Plant Information System). REPiS tracks on-grid PV installations of all sizes, as well as other renewable energy technologies. REPiS has undercounted PV installations in the past due to its origin as a utility-scale installations database. In addition to the OIAF NEMS data and the REPiS data, other sources included the Million Solar Roofs Initiative (MSRI), the TEAM-UP (Technology Experience to Accelerate Markets in Utility Photovoltaics) program, the Sacramento Municipal Utility District (SMUD), and the California Energy Commission (CEC).

Independently, none of the above databases or sources captured all the PV installation data. Motivated to have an accurate baseline or starting point for the NEMS model, as well as for many studies relying on accurate capacity estimates, a combined database was created to pool resources. In addition to the technical aspects of combining different data sources, a process was developed to identify and eliminate duplicate records once the data were successfully integrated.

2.2 Combined Database Results

The Combined Database consists of 42 variables, with records representing 2149 on-grid PV installations. Capacity calculations were done by sector, by state or census region, and by year. The database accounts for a larger capacity than contributing databases taken individually, yielding a cumulative capacity through 2000 of 26.6 MW.

While the combined database total of 26.6 MW is still lower than the on-grid capacity range of 30-40 MW provided by EIA's James Holihan and Paul Maycock/Ward Bower, the PV capacity captured by the combined database provides a starting point for a database with installation specific details. The installation specific detail allows future database maintenance and validation. Additionally, the detail provided by actual installation information provides the capability to break the data out by market sector (residential, commercial, utility) and/or by geographic region, as needed by NEMS. Finally, the Combined Database has been used to update the contributing databases, including the NREL REPiS database, which is publicly available.

Tables 3 and 4 below present the capacity numbers calculated from the Combined Database, broken out by sector and by census region, respectively.

TABLE 3: CUMULATIVE ON-GRID PV CAPACITY IN THE U.S. THROUGH 2000, BY SECTOR

Sector	Capacity (MW)
Residential	4.6
Commercial	14.6
Central Station	7.4
Total	26.6

TABLE 4: CUMULATIVE ON-GRID PV CAPACITY IN THE U.S. THROUGH 2000, BY CENSUS REGION

Census Region	Capacity (MW)
Pacific	17.231
Mountain	3.467
West North Central	0.097
East North Central	0.567
Middle Atlantic	1.669
New England	0.684
West South Central	0.831
East South Central	0.066
South Atlantic	2.034
Total	26.646

3. METHODS

3.1 Overview

There were two aspects to assessing PV capacity in the U.S. One was to assess what information was already available, to summarize this information, and to identify gaps and discrepancies. The second part of the task was to fill some of the gaps, in particular the need for an accurate capacity estimate, and a database of installations supporting it.

A Summary Spreadsheet was created to provide an overview of the current knowledge of PV capacity. The cumulative capacity numbers presented in Tables 1 and 2 were obtained or calculated as part of this task. The values presented in the spreadsheet were obtained by review of reports from various sources, question and answer with those maintaining the sources, and obtaining data and performing calculations. Explanations of the calculations were documented as comments in the spreadsheet.

3.2 Combined Database

3.2.1 Description of Combined Database

The Combined PV Database is an 11.4 MB Excel 2000 workbook, consisting of 17 worksheets. The worksheets consist of (1) contributing data, (2) worksheets that combine, sort, process, and sum the data, and (3) summaries of information verified in the process of creating the database. Contributing sources include REPiS, CEC, NEMS buildings (mostly distributed systems), NEMS plants, TEAM-UP, MSRI, and SMUD, as detailed in Table 5.

TABLE 5: WORKSHEETS FOR CONTRIBUTING DATA SOURCES

Worksheet	Description
REPiS	1481 records. All sectors and years.
NEMS buildings	848 records. Commercial and residential sectors, some central station.
NEMS plants	46 records. Central station data.
Million Solar Roofs Initiative	884 records, of which 585 have been processed, and 299 are yet to be processed.
TEAM-UP	667 records. Data maintained by UPVG (now SEPA) for the TEAM-UP program [6, 7].
SMUD	51 records. Records comprising SMUD PV installations [5], provided by Don Osborn on August 16, 2001.
CEC	6 records.

The CEC worksheet consists of 6 records representing 5 utility scale PV systems and 1 record reflecting total aggregate capacity associated with the CEC rebate program.

The single record aggregating CEC rebate data totals the capacity for the data collected between March 1998 and July 2001, provided by Abolghasem Edalati (CEC). As an estimate, 0.577 MW was subtracted out for the period of Jan-July 2001, since we were interested in cumulative capacity through 2000. Capacity installed between January and June 2000 (0.4 MW) was used as a starting point to make the estimate for the January through July 2001 time period [1]. A 23.5% average annual growth rate was used for PV, based on REPIS data from 1998 through 1999. An extra month of capacity was added to the 0.4 MW to account for July 2001. Additionally, to be conservative, 0.948 MW of MSRI data (state of California data, covering 1998 and on) was subtracted out for potential overlap between CEC records and MSRI records. In sum, 0.577 + 0.948 = 1.525 MW was subtracted from the 2.836 MW reported by CEC in July 2001, resulting in an estimate of 1.311 MW. Thus, 1.311 MW was included as the non-redundant CEC contribution to the on-grid PV capacity and as the aggregate CEC rebate data contribution to the Combined Database.

The residential component of the CEC rebate data was estimated to be 40% of 1.311 MW, which is 0.524 MW. The commercial component of the CEC rebate data was estimated to be 60% of 1.311 MW, which is 0.787 MW.

The NEMS plants worksheet contains 46 records, consisting of data originating from EIA CNEAF's electric generator database (utility database), plus additional data obtained by EIA's OIAF (Thomas Petersik, Chris Namovicz, and Thomas Leckey). Thomas Leckey maintains the PV plant data as well as other data, which is used in NEMS for the Annual Energy Outlook. This worksheet was provided by OIAF on August 20, 2001. In addition to the NEMS Plants worksheet, an extra worksheet was created for information taken directly from the EIA utility database. The original records provided extra fields not selected for inclusion in the NEMS plants worksheet. Also, the EIA database was accessed directly when the NEMS plants records could not be validated against records in other databases. Several records representing large systems were still not verifiable via the original data plus data from other databases. This led to further validation, for quality control, of many records in the Combined Database with a capacity over 50 kW.

The NEMS buildings worksheet consists of 848 records, comprising all records in the NEMS buildings database as of August 20, 2001, provided by Erin Boedecker of EIA's OIAF. Lynne Gillette of EERE's Office of Power Technologies provided the initial data in 1999, based on information from REPiS, MSRI, TEAM-UP, and the Federal Energy Management Program. Additional data have been added from publicly available sources including the Utility PhotoVoltaic Group (UPVG) website, press releases, DOE announcements, and newsletters such as *Solar and Renewable Energy Outlook* and DOE's *EREN Network News*. Records in this worksheet represent individual installations, though they are eventually aggregated by sector and Census division to estimate the baseline distributed PV capacity for the NEMS model.

The TEAM-UP worksheet included 667 records, comprising all records in the TEAM-UP database as of July 30, 2001. Steve Hester of UPVG, the organization responsible for managing the DOE-funded TEAM-UP program, provided this database to NREL's Christy Herig. The UPVG is now the Solar Electric Power Association (SEPA).

A first set of MSRI data, included in the combined database, consisted of 585 records. An additional 299 records are still to be processed (1.007 MW). The MSRI data was obtained from Lynne Gillette on July 24, 2001.

Table 6 summarizes worksheets used for processing of data.

TABLE 6: WORKSHEETS FOR PROCESSING OF DATA

Worksheet	Description
All records	3690 records. Records combined from all contributing databases, including redundant records.
Good records	2149 records. Records which count toward the cumulative year 2000 on-grid capacity.
Omitted records	1541 records. Records from the "All records" worksheet which were duplicates or which were omitted for another reason.

Criteria that are met by all records in the "Good records" worksheet are: (1) Originated from one of the contributing data sources. (2) U.S. on-grid. (3) Non-duplicate. (4) Status code=OP, meaning operational. (5) Status year is available and is year 2000 or earlier. (6) Status Year is not available, but record is from TEAM-UP, for which all records are dated between 1994-2000 [7].

Of the 3690 records in the "All records" worksheet, 1541 records were copied to the "Omitted records" worksheet. These 1541 records were those which had a non-blank value for the "Why omitted" variable. Reasons for omission from the cumulative year 2000 capacity total included:
(1) Record is a duplicate. (2) Status is non-operational, planned. (3) Status is non-operational, not planned (example: cancelled). (4) Status year is 2001. (5) Status year is post-2001. (6) Record has missing value for date.
(7) Record has missing value for state. (8) Record could not be verified to exist. (9) Record was confirmed to be non-existent. (10) System is outside the U.S.

3.2.2 Creation of Combined Database

3.2.2.1 Steps Taken

Contributing databases were obtained, and explanations of variables were provided by the source. A master variable list of 42 variables was created, starting with 21 REPiS variables and adding variables occurring in other databases as well as new variables used for processing data.

The variables from REPiS included in the Combined Database were: ID Code, Plant Name, Utility Name, Owner Name, Owner Code, Status Year, Capacity (kW), Status Code, Relationship (of plant to utility), # of Units, City, County, State1, State2, Zip Code, Unit Code, Tech Code, Landmark, System Type Code, % Unit Owned, and Notes. Variables added to the Combined Database were: Entry/Inclusion Date, Data Source 1, Data Source 2, Record #, Dup #, Why omitted, Sector 1, Sector 2, Sector 3, Owner Code Information, Year, Status Information, Census Region, Other 1 through Other 8 (to capture variables in contributing databases that might be useful but were not mapped to specific variables on the Master List).

Records from contributing databases were combined into one worksheet. Variables in contributing databases were mapped to the master variable list by determining which variables from each database matched the master variables or could be used to derive values for the master variables.

Record numbers were assigned in the "Record #" variable to all records. Data was then processed to identify duplicates, which were tracked using the "Dup #" variable. The duplicate identification process is detailed in a later section, "Data Sorting and Identification of Duplicate Records." Data was subjected to additional verification, as detailed in the section: "Additional Verification of Large Systems."

The "Why omitted" variable was added to facilitate separation of records into the "Good records" and the "Omitted records" so that the capacity for "Good records" could be totaled. Capacity was summed by sector, by census region and sector, by state, and by year.

3.2.2.2 Data Sorting and Identification of Duplicate Records

The following characteristics of records made duplicate identification challenging: (1) Missing values, especially for basic data such as city, utility name, and plant name. (2) Different names for the same utility or plant, within and across databases. (3) Different spellings or abbreviations for the same state. (4) Non-specific names, such as Plant name = "Solar" or Plant name = "Residential Installation in AZ." (5) Records representing more than one installation. (6) Records representing systems that will be upgraded in the future, resulting in a record capturing current capacity, and also a record representing a planned, upgraded capacity. Eliminating the record representing current capacity results in an undercount.

Adjustments of data to make the sorting more effective included: (1) State variable values were changed to a two-letter designation. (2) Utility names were modified or added so that records for the same utility would mix amongst each other, facilitating identification of duplicates by plant name. (3) After redundant records were identified, sometimes data that was missing from one record and present in a duplicate was added to make a later sort more effective.

Records were sorted many different ways in order to find duplicates, for example: (1) By state, utility name, plant name. (2) By utility name, plant name. (3) By utility name, city, plant name. (4) By state, year, capacity. (5) By state, city, capacity. (6) By plant name.

How did we choose between redundant records? (1) As a default, the NEMS buildings record was chosen among duplicate records. In some cases, a missing value in the NEMS record could be filled with data from a duplicate record. At times, as many as 4 records representing the same installation were identified. (2) Records that appeared to be duplicates were assumed to be duplicates, to avoid possible double counting. These records were given a designation to allow future verification. Overall, an attempt was made to match as many records as possible.

Duplicate records were tracked with the variable "Dup #." For a redundant record, the value in "Dup #" reflected which record it was a duplicate of. A record chosen out of a set of duplicates was given a special designation.

3.2.2.3 Additional Verification of Large Systems

An additional verification process was performed on many records representing systems of size 50 kW or larger. This extra verification was initiated when information on several large systems could not be corroborated by duplicate information in more than one data source. Also, records from the NEMS plants spreadsheet representing aggregated systems were separated into individual installations to allow comparison with records in other databases.

3.2.2.4 Updating of Contributing Databases

The data in the "Good Records" worksheet of the Combined Database was incorporated into NREL's REPiS database in December, 2001. Other contributing data sources such as the EIA's OIAF data and the EIA's CNEAF data may be updated using the Combined Database. The TEAM-UP program is no longer active, and will not contribute further data. The MSRI program is active and collects data at the state or partnership level, but no longer at the national level.

4. TO SEND UPDATES TO THE PV DATA, CONTACT THE AUTHORS OR ACCESS THE REPIS WEBSITE

To send updates to the PV data, contact the authors or send revisions and additions via the REPiS website: http://www.eren.doe.gov/repis/.

5. SUMMARY

With growth rates for U.S. on-grid PV installations being 23.3% from 1999 to 2000, and 33.8% from 2000 to 2001 [3], keeping up with data collection of installations will continue to pose a challenge. The collaborative approach of integrating data resources has been shown to be fruitful. Some of the methods presented in this paper may be useful for collecting and processing data for other smaller-scale and distributed generation technologies for which there is currently no systematic reporting.

Future strategies for PV data collection could include: (1) collaboration at the data collection stage, (2) facilitating the sharing of data by adding data management variables to databases to track when records are added and updated, (3) aggregating data at a higher level, and (4) expanding on existing channels such as the EIA survey forms, for example, by collecting data for systems smaller than 1 MW or by accessing other sources in addition to manufacturers.

6. ACKNOWLEDGMENTS

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Thank you to Thomas Leckey (EIA, OIAF) for sharing his expertise in extracting data from EIA CNEAF's electric generator databases, for his work in maintaining the OIAF central station PV data, and for explaining details about the OIAF data.

Thank you to Paul Maycock for answering questions regarding his report *The 2000 National Survey Report of Photovoltaic Power Applications in the United States*, and for his participation in a PV working group meeting, where he explained his data collection strategies, and gave suggestions for improving data collection of PV systems.

Thank you to Louise Guey-Lee and Mark Gielecki (EIA, CNEAF) for ongoing review of the work, for valuable questions raised at PV working group meetings, and for sharing their expertise with regard to data collection.

Thank you to Jim Leyshon, the REPiS webmaster, for his support in updating the REPiS website and database.

7. REFERENCES

(1) California Energy Commission, Renewable Energy Program: Annual Project Activity Report to the Legislature, report P500-00-021: California Energy Commission, 2000

(2) Energy Information Administration, Solar Collector Manufacturing Activity, annual reports (1982-1992), and Renewable Energy Annual, annual reports (1993-2000) (Photovoltaic Cell and Module Shipments by Type, Price, and Trade, 1982-1999, as obtained from EIA website, Annual Data from 1949, Renewable Energy, Table 10.5: http://www.eia.doe.gov/emeu/aer/txt/tab1005.htm, and Photovoltaic Cell and Module Shipments by End Use and Market Sector, 1989-1999, as obtained from EIA website, Annual Data from 1949, Renewable Energy, Table 10.6: http://www.eia.doe.gov/emeu/aer/txt/tab1006.htm): Energy Information Administration, 2001

(3) Maycock, Paul D. World PV Cell/Module Production (1988-2001) (in Megawatts): PV News, yearly February edition, 2002

(4) Maycock, Paul D. and Ward Bower, The 2000 National Survey Report of Photovoltaic Power Applications in the United States prepared for The International Energy Agency Co-Operative Programme on Photovoltaic Power Systems. Task I - Exchange and Dissemination of Information on Photovoltaic Power Systems: PV Energy Systems, Inc. and Sandia National Laboratories, 2001

(5) Osborn, Donald E., Sustained Orderly Development and Commercialization of Grid-Connected Photovoltaics: SMUD as a Case Example: SMUD, 2000

(6) Solar Electric Power Association, TEAM-UP Final Summary Report: SEPA, Washington, DC, 2001

(7) Utility PhotoVoltaic Group, 4.5 Megawatts of PV and Counting… Technical and Business Experiences of TEAM-UP Program Partnerships: UPVG, Washington, DC, 1999

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