Installation Manual

for

Version 1.8

Disclaimer

The *ENERGY-10* computer program has been developed as a design tool for smaller buildings that can be characterized by one or two thermal zones. It was prepared under the leadership of the National Renewable Energy Laboratory and produced with funds made available by the United States Department of Energy. Neither the United States Department of Energy, the National Renewable Energy Laboratory, the Lawrence Berkeley Laboratory, the Berkeley Solar Group, the Sustainable Buildings Industry Council nor any of its member organizations, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any results or of any information disclosed, or represents that its use would not infringe privately owned rights. The program and manual were prepared with the assistance and participation of representatives from many organizations based on consensus and available information. Unanimous approval by all organizations is not implied.

This is the eighth update of the *ENERGY-10* program. It has been carefully and thoroughly reviewed by knowledgeable engineers and analysts, and to the best of our knowledge is accurate and error free. However, it is a complex program and it is impossible to guarantee that it is completely free of bugs. It could possibly contain errors and produce misleading results. Users should carefully review the results to make sure that they are credible and consistent.

ENERGY-10 was produced at the expense of the federal government and is copyrighted.

ENERGY-10

ENERGY-10 is a conceptual design tool for low-energy buildings utilizing hour-by-hour simulation for a typical year to predict the energy-use impact of various decisions faced by a design team.

In Version 1.8, the use of the program is intended primarily for residential and smaller non-residential buildings—generally less than 10,000 square feet (1,000 square meters)—that can be characterized by one or two thermal zones. However, the program can be used very effectively during the early phases of design for larger buildings.

Version 1.5 introduced major upgrades to *ENERGY-10* allowing use on newer operating systems, more flexible use of building component libraries and comparison cases within a project. Version 1.6 added refinements in handling libraries, some bug fixes, and added some new performance reports. Version 1.7 provides a new treatment of window characteristics, graph format revisions, reorganization of project directories and bug fixes. The significant change with Version 1.8 is the addition of Photovoltaic and Solar Service Hot Water as available energy strategies. (The underlying software was significantly restructured with Version 1.8 to ease future development.)

In this tool daylighting, passive solar heating, and low-energy cooling strategies are integrated with energy-efficient shell design and mechanical equipment. The package including related training materials was developed directly with the building industry through a task force that includes architects, engineers, builders, and utility representatives. The National Renewable Energy Laboratory (NREL), the Sustainable Buildings Industry Council (SBIC), the Lawrence Berkeley National Laboratory (LBNL), the Berkeley Solar Group (BSG) and InterWeaver Consulting—all funded by DOE—were the industry/laboratory collaborators on the project.

SBIC distributes *ENERGY-10* and provides user support and training. As of Fall of 2004, there were over 2000 licensed users of *ENERGY-10*. In addition, 83 site licensees have been established. Sixty of these are at colleges and universities where *ENERGY-10* is being used very successfully as a teaching tool. SBIC has trained and certified 9 workshop instructors. A total of 53 two-day workshops have been conducted, training a total of 1111 attendees. This is by far the best way to get started with the program.

Installing *ENERGY-10*

To load the program, place the *ENERGY-10* CD-ROM in the drive. If you have your computer set to start automatically, the installation screen will appear. Otherwise, click *Run* in the Start menu, type X:/SETUP (where "X" is the designation of the disk drive), and click *OK*. A screen will appear with several options.

Click the button labeled *Install ENERGY-10;* then follow the instructions on your screen.

To see more detailed instructions, click the button labeled *Installation Instructions*.

While you're still in the installation screen, you'll probably want to install the *WeatherMaker* program and additional weather files. Only 18 weather files out of over 300 available on the CD-ROM are installed automatically when *ENERGY-10* is installed, but it's easy to install the others. You get to select any or all of the files on each of three

lists. (All 239 U.S. TMY (typical meteorological year) weather files, 16 California Title-24 weather files, and a good sampling of foreign weather files).

Opening ENERGY-10

From the "Start\Programs" menu, select "Energy-10 \ Energy-10 v1.8 and click to get started. When the opening screen, *Welcome to ENERGY-10*, comes up, read the options. To save time in the long run, start by clicking the button labeled *First Time User*. This transfers you to Windows Help and opens the ENERGY-10 Version 1.8 Help.

Help is a huge file with more than 400 topics that is organized like a book with chapters and topics within each chapter. Double-click a chapter to open it, and several topics appear. Scan through the chapter topics and note that there is general information in addition to the context-sensitive Help that you'll be using later. You can easily move around in Help. Notice that some words are green and underlined, which are links to other topics

Help is your user manual—learn to use it. There is a progression from basic information, through a set of exercises, a series of *How to* topics for all the standard operations, to advice on becoming a power user. Help contains entrees to every dialog box in ENERGY-10 , which can also be accessed from the Help button that is on each dialog box. Help contains a lot of background information that you will find useful, such as data about each of the 239 US weather files, typical energy use in US buildings, and a full discussion on discounted cash flow analysis—a new feature introduced in Version 1.5

Close Help. This puts you back in the ENERGY-10 start screen.

What's New in Version 1.8

Along with the significant addition of Photovoltaics and Solar Hot Water modeling in Version 1.8, the underlying structure of Energy-10 has been extensively altered. A number of exploratory display features are included in the Beta1 test version as well as a variety of bug fixes.

### ENERGY-10 PV: Photovoltaics, A New Capability

A new feature in Version 1.8 of *ENERGY-10* is the ability to model and simulate the performance of a photovoltaic (PV) system that is either stand-alone or integrated with the building. This is an energy efficient strategy (EES), appearing as one of 14 strategies in the APPLY dialog box. This adds a powerful and unique capability to the program allowing the user to study the hourly interaction between the building load and the PV array.

The Sandia PV performance model ("Photovoltaic Array Performance Model", David L. King, Sandia National Labs, December 2003) included in the EnergyPlus simulation program is used to evaluate PV performance but unlike an earlier exploratory version of E-10 (Version 1.4) with PV, the control and execution of EnergyPlus is integrated into the main E10 program. PV is tied into the Apply and Rank, Building, Simulation control and Life cycle costing features of E10. The Sandia PV model is used to evaluate hour-by-hour PV system behavior. E10 translates the "ET1-type" weather file into EnergyPlus format and retrieves EnergyPlus results into standard E10 graphs and reports. Results may be viewed graphically using the DVIEW tool and a new PV hourly summary graph.

PV Hourly Electric Load Profile Graph
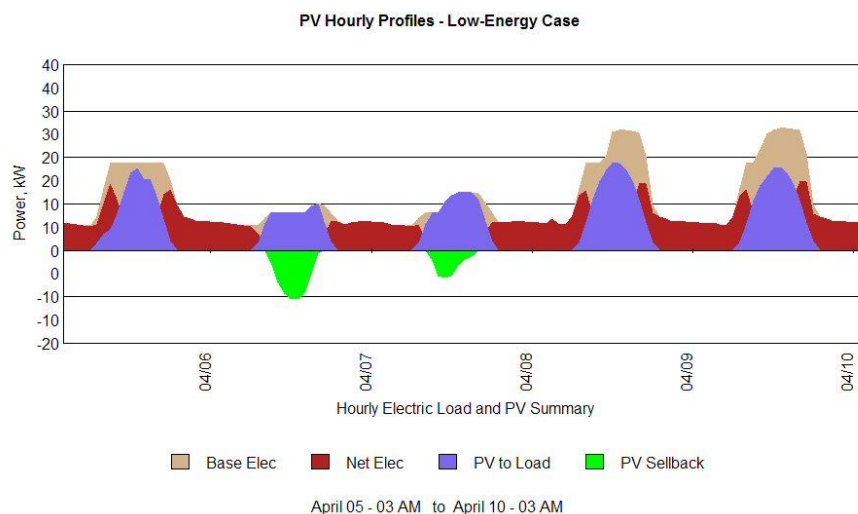
DVIEW Hourly Electric Load Comparing Building with and without PV
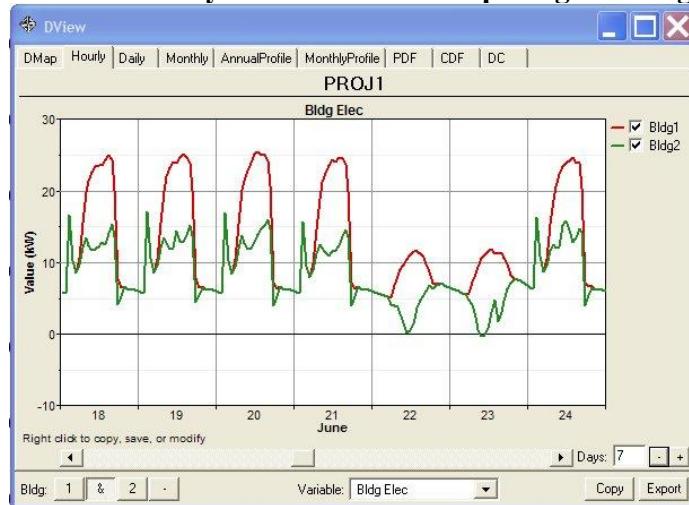
The new PV capability helps *ENERGY-10* users evaluate how a PV system will offset realistic building electrical loads, whereas very stylized loads have been used in other programs. If the PV system is integrated into the building skin, there will be thermal effects that are accounted for by changes in the building description, which is passed to the *ENERGY-10* thermal simulation engine. Thus results produced by tool show the overall consequences of building electrical load requirements before and after the PV system contribution, PV system output, and when and how much of the PV output is available to be sold back to the utility. These results are available as annual summaries, typical monthly plots, and hourly plots.

Building designers can take advantage of this capability to easily perform preliminary investigations of PV. While the PV capability in Energy-10 is not intended to replace detailed PV system design, the analysis that is performed is an integrated accounting for 8760 hours including hourly schedules for lights, plug loads, etc., time-variable HVAC loads, time-variable dimming of lights due to daylighting. The approach can accommodate future technology, such as new PV products integrated into building elements such as thin-film coatings on windows.

The program distinguishes building-integrated (wall-integrated, roof-integrated, or window-integrated), and stand-alone systems as defined by up to 4 building-integrated arrays and one stand-alone array, all fed through a single inverter bank. Only grid-connected systems are modeled in this version.

If the automatic APPLY function is used to evaluate a building-integrated PV system, the program creates wall, window, or roof elements in the thermal model corresponding to the active PV array areas of the building envelope. Thus both thermal and electrical contributions of the building-integrated system can be modeled. (NOTE: In this implementation, the user must insure that the thermal properties of the placeholders in the building description suitably model the building-integrated construction being evaluated.) For example, a roof-mounted system which adds insulating value to the roof construction can be evaluated for both direct electrical power generated and the whole-building impact on heating and cooling by the alternate roof construction.

ENERGY-10 SDHW: Solar Domestic Hot Water, A Simple Model for Early Assessment.

Energy-10 Version 1.8 also includes a new solar domestic/service hot water modeling capability. A straight-forward collector efficiency, storage tank accounting type model has been embedded in E10 and integrated with the APPLY and RANK features of the program. Selection of this strategy launches an hourly simulation of the SDHW system that is then used to adjust the service hot water load in the main whole-building simulation.

DVIEW Monthly DHW Profiles with and without Solar DHW
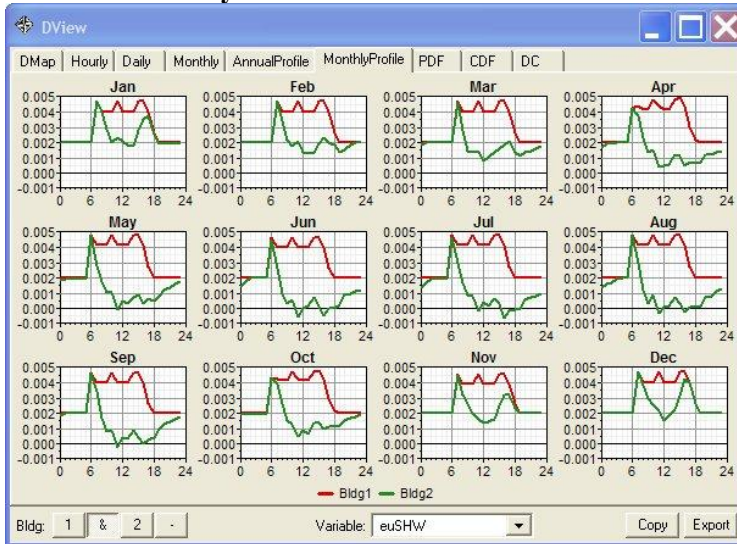
Performance Rating Studies (ASHRAE 90.1-2004 Appendix G).

A new library ("ASHRAELIB") is included with Version 1.8 defining constructions (wall, roof, window, etc.) as spelled out in ASHRAE 90.1-2004 Table 5.5. This combined with some new default building use profiles allows a quick-start in setting up Baseline cases for performance rating studies as described in Appendix G of the 2004 Standard. For more information see the help topic on ASHRAE Performance Rating from within the Energy-10 software.

ASHRAE 90.1-2004 Climate Zones
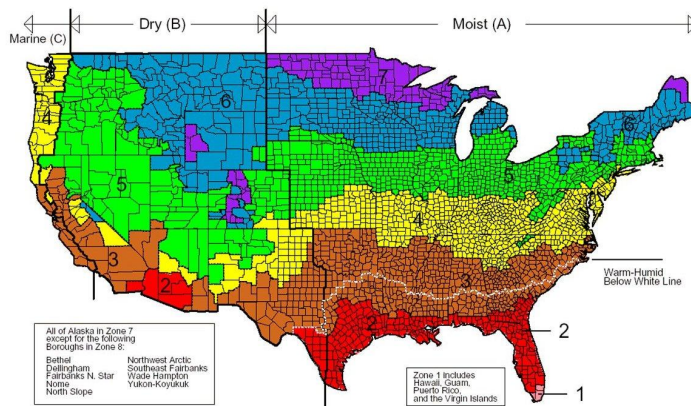
Other Changes in Version 1.8:

·   The code-base in Version 1.8 has been reorganization into six DLL (dynamic link libraries) modules to ease future development of the program

·   The main toolbar and toolbar icons have been revised. The visual style of menus and buttons has been updated.

·   Work has begun to creation of a group of Settings dialogs to collect together user options in one place. Most settings can be found under a new "Misc\Options" menu item. As part of this feature, a master and user "config" file is now created to retain user settings. This approach does not use the Windows Registry and should offer better functionality for using E10 in the classroom setting.

·   The code-base has been updated for development in Microsoft Visual Studio 2003 (Visual C++ v7.1)

·   The CNE simulation engine is now attached as a DLL with new progress indicator. This window no longer forces itself in front of other applications.

·   A grid-style summary view has been added on a trial basis (for eventual display of more than two schemes)

·   Context-sensitive help has been extensively updated to including a revised "new user" topic and treatment of new features including PV and Solar DHW. For example, see Orientation to Energy-10

·   WeatherMaker's comfort chart and typical days psychrometric chart display an approximate comfort zone.

What's Been Fixed in Version 1.8

The following bug fixes appear in Version 1.8:

·   An incorrect conversion factor for metric U-value in the summary report has been corrected.

·   Weathermaker Version 1.04 corrects an inconsistency in creating TMY2 weather files. E10/CNE does not share the same sign convention for western times zones. WeatherMaker now sets TMY2 time zones as negative for the Western hemisphere.

·   Weathermaker places a placeholder year number in the first two columns of TMY2 output to satisfy the EnergyPlus weather converter.

·   Average Monthly Use graph now reports correctly when displaying partial year results

·   A trap and warning message was added to avoid a simulation crash when window area is specified as larger area than the parent wall area or when window areas exceeded the defined rough opening.

·   A revised WeatherMaker (v1.0.4) is included with Energy-10 v1.8. Time zone and longitude reported in the header of TMY2 files created by WeatherMaker now adhere to TMY2 conventions. (Also a placeholder for year is added to the first two columns to satisfy the EnergyPlus weather converter.)

·   The labeling in the summary report for Heat Pump energy use was reversed – this has been corrected.

·   HVAC values in the summary report for zone2 were incorrectly reported as zone1 values – this is corrected.

·   Default sizing is provided for Heat Pumps if autosizing fails – previously this was not checked resulting in CNE runtime errors.

·   Wording of CNE "coiling coil" messages have been corrected.

·   Incorrect labeling of standard vs. heat pump heating has be corrected.

With Build 1080:
·   PV derating factors are enabled.
·   A 300 VDC inverter options was added to the PV components database.

Version 1.8 Cautions

1. Project Files – IMPORTANT!
        Energy-10 V1.8 will read projects created by version 1.5, 1.6 and 1.7. However, because of new project data items introduced by the revised window construction dialog, if an old project is saved from within v1.7, the project will no longer be readable by earlier versions of Energy-10.

2. Installation Errors – If errors are reported during the installation of Energy-10 ("files not found" or the like) you should cancel the installation. There may be some compatibility problem with Energy-10 and your system or you may have a bad installation CD. If you proceed past reported errors the outcome may be unpredictable including corruption of some system files.

3. Installation to a non-standard path – If you install to a non-standard path, you will need to edit the path options in "energy10.config" and "energy10myName.config" files.

Known Problems with Version 1.8

Inevitably, there are a few nagging problems that do not get addressed as a new version is released. The most critical of these will be corrected in the next release.

Version1.8 problem notes:
- Partial year runs using the PV and SDHW model models may produce incorrect results.
- Use of alternate directory paths during the installation process has not been tested.
- "Misc\Options" settings may not take effect until E10 has been restarted.
- Grid-type summary view units labels do not change when unit system changes until E10 is restarted
- Multiple PV "applies" does not retain correct parameters.
- Reading of v1.5, 1.6, and 1.7 projects has not been extensively tested
- EES Apply of PV ahead of the Daylighting ESS causes an error message – PV should be applied after Daylighting.
- Utility Cost Breakdown and Emissions graphs give suspect results for schemes with large PV arrays that produce negative annual electric use.
- Summary LCC results may not be up-to-date until after opening the Cost Analysis dialog.
- Change of units in the Summary Grid view doesn't take effect until E10 is restarted.
- Metric units in E10 do not carry through to DVIEW graphs.
- Handling of metrics units is not correct in window construction dialog
- If E10 is installed to a non-standard location on a Windows 2000 system, the PV simulation may not work correctly due to inconsistent handling of directory paths.

Other Known Problems:

1. If you should experience a program crash, the CNE program may be left showing as running. If this happens, just close it.

2. If you do a partial year simulation the monthly graphs are not available, however, the hourly graphs can be accessed.

3. The life cycle calculations are predicated on having annual results for the fuel and electric costs. Therefore, if you do a partial year simulation, the results will not be correct, even though they still will be calculated and there is no warning displayed to alert you.

4. There can be situations where Rankings by either simple payback or internal rate of return (IRR) are not on the right order. This happens when simple payback is negative: this is reported as either "winner" or "loser" in the *Analysis* dialog box, depending on whether the numerator or the denominator is negative. There is no differentiation of these cases beyond the fact that "winners" are place up top and "losers" down below in the rank graph. Ignore all but the values with numbers, Similarly, there are cases where the IRR does not exist (legitimately) and this is shown as "NA" in the *Analysis* dialog box. However, in the Ranking, these are all shown at the bottom whereas they should be at the top.

5. Two of the library dialog boxes, schedules and shade, listed in the two *Update Library* menus are ghosted and thus cannot be accessed from this point. To assess these, move down through the *Buildings* menu to the dialogs box.

6. Scaling laws for the Life Cycle Costing routines are not correctly converted to the SI or other unit systems.

7. In a two-zone model, if a VAV system is specified, both zones must use VAV. Currently, CNE autosizing runs for VAV are not working and sizing is done by "per floor area" default values.

8. E-10's automatic launching of the CNE simulation appears to be disabled by the action of Veritas Software's SGTRAY.EXE service which check's disk access activity. It is placed on system's that use Veritas backup or CD recording software. If E-10 seems to be unable to run simulations check for the presence of this service on your system and disable it.

(Energy-10 Installation Manual, revised 12December05)