

greenius – A free Software Tool for Simulating Electricity and Heat Generation Systems with Concentrating and Non-Concentrating Solar Collectors

Jürgen Dersch¹, Javier Inigo Labairu¹, Tobias Hirsch¹,

¹Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institute of Solar Research, Köln
juergen.dersch@dlr.de

The figure displays four screenshots of the greenius software interface. The top-left window shows the 'Collector Assembly' configuration, including collector type (SL4600+ Huiyin70 2015), dimensions, and thermal storage capacity (50 MWh). The top-right window is the 'Collector Field' configuration, detailing field parameters like number of rows, land use factor, and pipe specifications. The bottom-left window shows 'Meteorological Data' with a contour plot of solar radiation and a table of meteorological parameters. The bottom-right window is the 'Load Curve' configuration, showing a bar chart of hourly load and options for temporal resolution and graph display.

Four figures showing some of the greenius input windows. In the technology window the sizing of the system is shown. The collector field window allows manipulation of solar field size and orientation. The meteorological data is read from a file and greenius offers tools for analysis. The load curve may be defined by users as table containing a single value for each time step. The figure above shows a graphical representation of the load curve table.

Software tool

The software tool greenius has been developed at DLR for several years. It is designed to facilitate fast and simple performance calculations of concentrating solar technologies (CST) and other renewable energy systems based on hourly plant performance simulations for a typical operating year. Finer temporal resolutions can be used too, e.g., 30, 15, and 10 minutes.

A free version is available, and in a current project funded by the German Federal Ministry for Economic Affairs and Climate Action (Ref: 03EN6032A) the process heat simulation capabilities of greenius will be extended.

Utilization

greenius comes with several examples which may be used as starting points for own simulation projects. Users may modify the examples and load their own meteorological datasets as well as component datasets, e.g., for certain collector models.

Load curves can be defined and manipulated by users to adapt the simulated load to their needs. Import filters for common meteorological data formats are included to ease their utilization.

An economic calculation is also included in greenius which allows for detailed analysis of cash flows, etc. It should be mentioned that users must update the preliminary cost estimates delivered with greenius in order to get reliable costs. There is no up-to-date cost database included.

Complete simulation of a typical year needs only a few seconds on a modern notebook or desktop computer. greenius runs only on MS Windows systems.

Users may save their own projects in a single ASCII file for documentation purposes or to rerun it later if required. Result files can be exported to MS Excel, CSV, or plain text format.

Result presentation and analysis

The results of the technical simulation are presented as a table containing one line for each time step of the typical operating year and one column for each output variable. Tables with daily, weekly and monthly sums are generated too.

The results can be plotted and users may zoom into the table to analyze the plant's operation and performance for single days. This is particularly useful to check whether the plant operates as expected and fulfills the defined load curve.

An example is given on the right-hand side. The 3rd figure from above is actually an enlarged section of the 2nd figure showing results for just 10 days. The blue line represents the load which is satisfied by the solar field, the thermal storage, or the auxiliary boiler. The green line represents solar heat provided either by the solar field or the thermal storage, and the red line shows the heat output of the solar field.

Potential users

greenius is particularly made for engineers who are planning such installations or are going to implement them for their own company. It might be used for comparing different thermal technologies and also PV installations. Typical use cases are feasibility studies and checks of proposals from different suppliers. The software comes with online help and a manual, but due to the large number of adjustable parameters, sometimes depending on others, some knowledge about the basics of these thermal systems is required to achieve meaningful results.

Availability

A free version of greenius is available for download. Currently, the DLR Solar Research website is being restructured and therefore the download link doesn't work. If you need a version immediately, please send an email request to juergen.dersch@dlr.de

The figure displays three screenshots of the greenius software interface showing simulation results. The top screenshot is a 'Typical Operation Year' table with columns for time, solar radiation, and various energy outputs. The middle screenshot is a 'Typical Operation Year' graph showing three data series: Thermal power solar field (red), Thermal load (blue), and Thermal load covered by solar field/thermal storage (green). The bottom screenshot is a 'Cash Flow' table showing financial data from 2024 to 2030, including Total Revenues, Investment Costs, and Payback Period.

The figures above show different windows with simulation results which are available in greenius after running a project.