NREL North American Solar Radiation Atlas

Ray George
Pamela Gray-Hann
Presented to the American Solar Energy Society, Forum 2001
April 24, 2001
Disclaimer and Government License

This work has been authored by Midwest Research Institute (MRI) under Contract No. DE-AC36-99GO10337 with the U.S. Department of Energy (the “DOE”). The United States Government (the “Government”) retains and the publisher, by accepting the work for publication, acknowledges that the Government retains a non-exclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for Government purposes.

Neither MRI, the DOE, the Government, nor any other agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe any privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not constitute or imply its endorsement, recommendation, or favoring by the Government or any agency thereof. The views and opinions of the authors and/or presenters expressed herein do not necessarily state or reflect those of MRI, the DOE, the Government, or any agency thereof.
NREL Solar Atlas

• Http://www.nrel.gov/gis
• Currently includes 48 contiguous states of the US.
• Alaska and Hawaii will be added in the near future.
Goals of NREL Solar Atlas

• Deliver basic solar performance estimates to general users.
• Deliver a wide variety of additional information to more advanced users.
• Be easy to use, full featured, and extensible.
Components of NREL Solar Atlas

• Solar resource datasets from NREL Solar Resource Assessment function and other sources.
• Internet Map Server technology from ESRI™ including political and infrastructure data coverages.
• Links to Renewable Resource Data Center (rredc.nrel.gov) for supplemental documentation and datasets.
Typical Solar Atlas Users

Same users who currently use the Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors

Need to estimate performance for any of 14 different solar collectors, for any location, for any month and annually.

Include PV sellers, homeowners, as well as researchers and analysts (scientists, students, engineers)
NREL Solar Radiation Products

• National Solar Radiation Data Base (NSRDB) - U.S. only, 30 year time series, measured and modeled radiation.

• NSRDB derived products - Solar collector manual, buildings manual, TMYs.

• Solar Radiation Data Grids
NREL Solar Radiation Data Grid

- Uses CSR (Climatological Solar Radiation) model devised by Dr. Gene Maxwell.
- Produces monthly and annual estimates of the daily radiation for each of 14 different solar collector orientations (patterned after NREL “Red Book”).
- Estimated uncertainty of annual estimates is 11%.
Fixed Flat-Plate Collectors

- Flat-Plate Collector Facing South at Fixed Tilt=0
- Flat-Plate Collector Facing South at Fixed Tilt=Latitude-15
- Flat-Plate Collector Facing South at Fixed Tilt=Latitude
- Flat-Plate Collector Facing South at Fixed Tilt=Latitude+15
- Flat-Plate Collector Facing South at Fixed Tilt=90
Tracking Flat-Plate Collectors

- 1-Axis Tracking Flat-Plate Collector with North-South Axis, Axis Tilt=0
- 1-Axis Tracking Flat-Plate Collector with North-South Axis, Axis Tilt=Latitude-15
- 1-Axis Tracking Flat-Plate Collector with North-South Axis, Axis Tilt=Latitude
- 1-Axis Tracking Flat-Plate Collector with North-South Axis, Axis Tilt=Latitude+15
- 2-Axis Tracking Flat-Plate Collector
Tracking Concentrating Collectors

- 1-Axis Tracking Concentrating Collector with East-West Horizontal Axis
- 1-Axis Tracking Concentrating Collector with North-South Horizontal Axis
- 1-Axis Tracking Concentrating Collector with North-South Axis, Axis Tilt=Latitude
- 2-Axis Tracking Concentrating Collector
PV Atlas - Map GUI Features

• U.S. Map with terrain overlay, states, NSRDB sites.
• Legend window with 7 data selections (5 individual collectors, Data Grid spreadsheets, NSRDB spreadsheets).
• Multiple navigation aids (terrain, counties, cities, and highways).
• Variable size data retrieval window with file download capability.
• Map navigation and data retrieval toolbar.
Flat-Plate Collector

- Horizontal Flat Plate
- Flat Plate Tilted South at Latitude minus 15 Degrees
- Flat Plate Tilted South at Latitude
- Flat Plate Tilted South at Latitude plus 15 Degrees
- Vertical Flat Plate Facing South

View Data Tables with Hot Link

NREL Locations with Hot Link to RReDC

- Flows
- Counters
- Highways
- Terrain
- > 3000
- 2000 - 3000
- 1200 - 2000
- 800 - 1200
- 600 - 800
- 400 - 600
- 100 - 400
- 0 - 100

Produced by the Distributed Energy Resources Center. This is a draft of this service. For documentation on how to use the map and tool, please go to PV Atlas Help. Please provide comments to Pamela_Grey-Hamn@nrel.gov

NREL
Single Collector Data Retrieval

- Zoom into your desired area until grey cell outlines appear.
- Select one of 5 collector types in legend window (Tilt=Latitude is the default).
- Select “Data Identity” tool.
- Choose any desired cell with the mouse.
- Monthly and annual radiation for the collector appears in data window on right side of screen.
14 Collector Spreadsheet Data Table Retrieval

- Zoom into your desired area until grey cell outlines appear.
- Select ‘View Data Tables with Hotlink” in the legend.
- Select “Hotlink” tool.
- Choose any desired cell with the mouse.
- Spreadsheet data table with monthly and annual radiation for all 14 collectors appears in data window on right side of screen.
Download Spreadsheet Data Table

- Selected spreadsheet data table appears in data window on right side of screen.
- Select the data window “Frame” with the mouse.
- Choose “File:Save Frame As” on menu.
- File “idno.txt” appears in your directory.
- For Data Grid, idno is a 6 digit cell id.
- For NSRDB, idno is a 5 digit WBAN number.
Spreadsheet Data Table

• Table can be loaded into Excel using Text Import Wizard as a “Delimited” file with “comma” as the delimiter.
• NREL can provide a macro program to load the file into Excel and create graphics for all 14 collectors.
<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cell No.</td>
<td>193355</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lat.</td>
<td>39.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Lang.</td>
<td>-112.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Elec(m)</td>
<td>1409</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Site Type</td>
<td>Data Grid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>SOLAR RADIATION FOR FLAT-PLATE COLLECTORS FACING SOUTH AT A FIXED-tilt (KWh/m²/day), Percentage Uncertainty = 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Tilt(º)</td>
<td>Jan</td>
<td>Feb</td>
<td>Mar</td>
<td>Apr</td>
<td>May</td>
<td>Jun</td>
<td>Jul</td>
<td>Aug</td>
<td>Sep</td>
<td>Oct</td>
<td>Nov</td>
<td>Dec</td>
<td>Year</td>
</tr>
<tr>
<td>8</td>
<td>Lat - 16 Average</td>
<td>3.87</td>
<td>4.74</td>
<td>5.61</td>
<td>6.55</td>
<td>7.04</td>
<td>7.47</td>
<td>7.34</td>
<td>7.2</td>
<td>6.7</td>
<td>5.63</td>
<td>3.81</td>
<td>3.59</td>
<td>5.78</td>
</tr>
<tr>
<td>9</td>
<td>Lat - 15 Average</td>
<td>4.61</td>
<td>5.02</td>
<td>5.66</td>
<td>6.21</td>
<td>6.41</td>
<td>6.72</td>
<td>6.73</td>
<td>6.63</td>
<td>6.54</td>
<td>5.87</td>
<td>4.12</td>
<td>4.02</td>
<td>5.7</td>
</tr>
<tr>
<td>10</td>
<td>15º Average</td>
<td>4.42</td>
<td>4.65</td>
<td>4.29</td>
<td>3.88</td>
<td>3.03</td>
<td>2.78</td>
<td>2.96</td>
<td>3.76</td>
<td>4.39</td>
<td>4.86</td>
<td>3.91</td>
<td>4.19</td>
<td>3.9</td>
</tr>
<tr>
<td>11</td>
<td>SOLAR RADIATION FOR 1-AXIS TRACKING FLAT-PLATE COLLECTORS WITH A NORTH-SOUTH AXIS (KWh/m²/day), Percentage Uncertainty = 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Axes Tilt</td>
<td>Jan</td>
<td>Feb</td>
<td>Mar</td>
<td>Apr</td>
<td>May</td>
<td>Jun</td>
<td>Jul</td>
<td>Aug</td>
<td>Sep</td>
<td>Oct</td>
<td>Nov</td>
<td>Dec</td>
<td>Year</td>
</tr>
<tr>
<td>14</td>
<td>Lat - 15 Average</td>
<td>4.61</td>
<td>5.79</td>
<td>7.12</td>
<td>8.6</td>
<td>9.56</td>
<td>10.61</td>
<td>10.44</td>
<td>10.06</td>
<td>8.83</td>
<td>7.15</td>
<td>4.64</td>
<td>4.25</td>
<td>7.63</td>
</tr>
<tr>
<td>15</td>
<td>Lat - 15 Average</td>
<td>5.05</td>
<td>6.16</td>
<td>7.34</td>
<td>8.55</td>
<td>9.3</td>
<td>10.21</td>
<td>10.1</td>
<td>9.89</td>
<td>8.83</td>
<td>7.49</td>
<td>4.92</td>
<td>4.71</td>
<td>7.72</td>
</tr>
<tr>
<td>16</td>
<td>15º Average</td>
<td>5.32</td>
<td>6.34</td>
<td>7.32</td>
<td>8.25</td>
<td>8.8</td>
<td>9.59</td>
<td>9.52</td>
<td>9.46</td>
<td>8.74</td>
<td>7.57</td>
<td>5.1</td>
<td>5</td>
<td>7.58</td>
</tr>
<tr>
<td>17</td>
<td>SOLAR RADIATION FOR 2-AXIS TRACKING FLAT-PLATE COLLECTORS (KWh/m²/day), Percentage Uncertainty = 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Tracker</td>
<td>Jan</td>
<td>Feb</td>
<td>Mar</td>
<td>Apr</td>
<td>May</td>
<td>Jun</td>
<td>Jul</td>
<td>Aug</td>
<td>Sep</td>
<td>Oct</td>
<td>Nov</td>
<td>Dec</td>
<td>Year</td>
</tr>
<tr>
<td>19</td>
<td>1-2X, N-S Average</td>
<td>3.2</td>
<td>3.65</td>
<td>3.92</td>
<td>4.52</td>
<td>5.18</td>
<td>6.12</td>
<td>6.86</td>
<td>5.9</td>
<td>5.18</td>
<td>4.73</td>
<td>3.21</td>
<td>3.29</td>
<td>4.63</td>
</tr>
<tr>
<td>20</td>
<td>1-2X, E-W Average</td>
<td>2.52</td>
<td>3.18</td>
<td>4.48</td>
<td>5.89</td>
<td>6.8</td>
<td>8.15</td>
<td>7.83</td>
<td>7.5</td>
<td>6.4</td>
<td>4.75</td>
<td>3.52</td>
<td>2.24</td>
<td>5.18</td>
</tr>
<tr>
<td>21</td>
<td>1-2X, H-S Average</td>
<td>3.49</td>
<td>4.26</td>
<td>5.24</td>
<td>6.21</td>
<td>5.73</td>
<td>7.67</td>
<td>7.47</td>
<td>7.63</td>
<td>7.16</td>
<td>5.91</td>
<td>3.63</td>
<td>3.49</td>
<td>5.75</td>
</tr>
<tr>
<td>22</td>
<td>2-2X Average</td>
<td>2.73</td>
<td>4.37</td>
<td>5.24</td>
<td>6.31</td>
<td>7.12</td>
<td>6.35</td>
<td>6.03</td>
<td>7.06</td>
<td>7.17</td>
<td>5.98</td>
<td>3.82</td>
<td>3.79</td>
<td>5.95</td>
</tr>
</tbody>
</table>

Ready
Solar Radiation Data for Flat-Plate and Concentrating Collectors

Cell No: 178355
Lat: 36.45
Long: -118.55
Elev(m): 2630
Stn Type: Data Grid

Average Solar Radiation for Flat Plate Collectors

- Fixed Tilt Collector Facing Equator
- Tracking Collector

Average Direct Beam Solar Radiation for Concentrating Collectors

- Tracking Collector

Developed by the National Renewable Energy Laboratory
PV Atlas - (near) future enhancements

- Alaska and Hawaii
- Two more map interfaces, one for Tracking Flat Plates and one for Tracking Concentrators.
- Maps of the solar resource.
- Map interface to various sources of solar radiation data (CONFFRM, BSRN, WRDC, etc.)