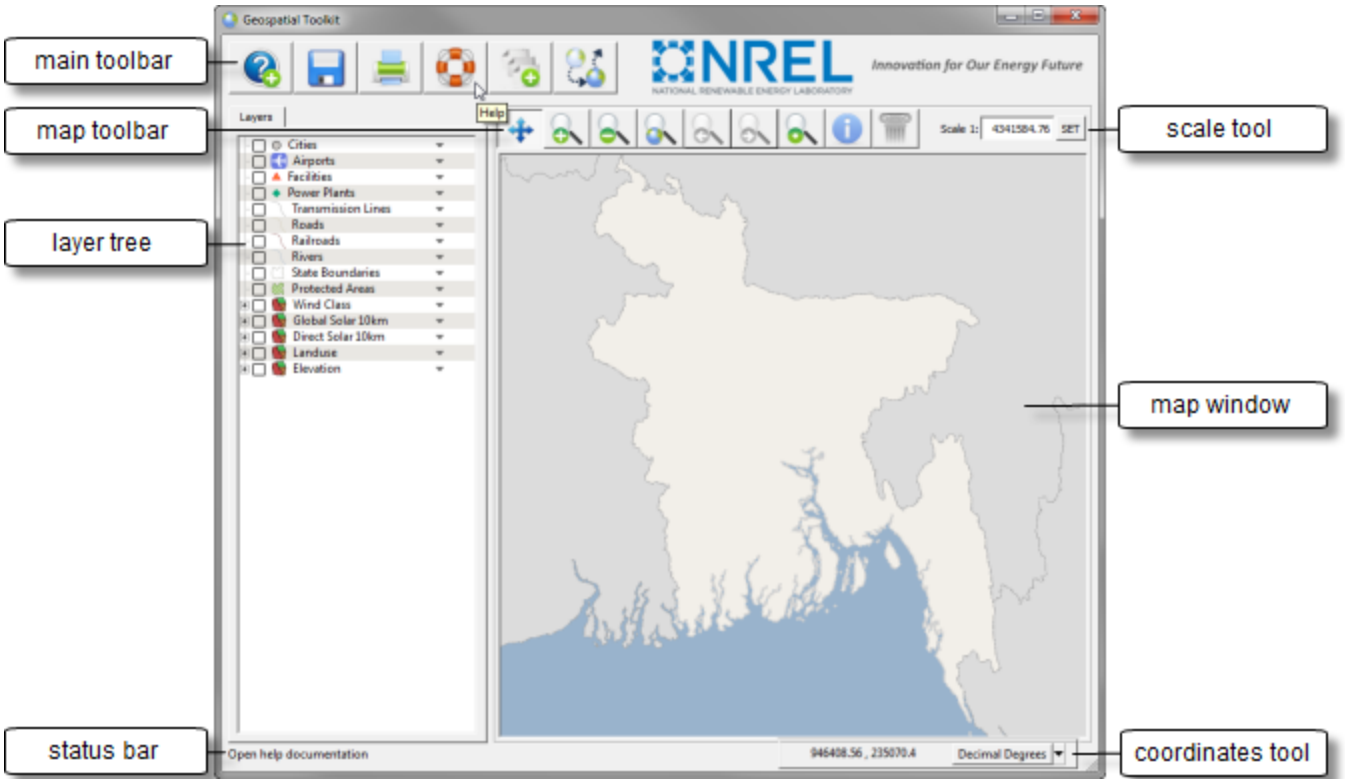
Geospatial Toolkit Help



October 2010

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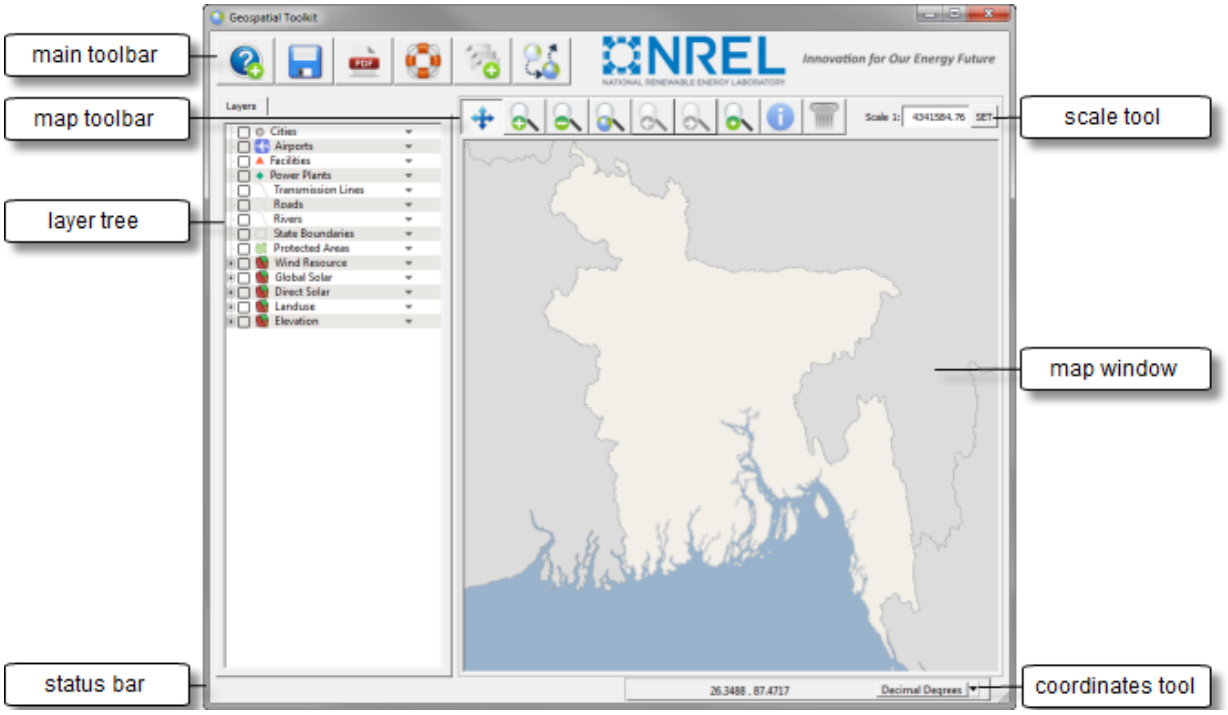
Getting started

When you first start the Geospatial Toolkit, it displays the base map. The base map shows the country borders without any geographic features.



Use the layer tree to:

- Show and hide layers
- Change layer transparency

Use the map toolbar buttons to:

- Move around the map (zoom and pan)
- Display information about a point on the map
- Run HOMER to simulate power systems at a point on the map

Use the main toolbar to:

- Work with queries
- Saving the map as PDF
- Change the country

Related Topics:

- About the Geospatial Toolkit
- Glossary

About the Geospatial Toolkit

The Geospatial Toolkit (GsT) is a map viewer developed by the National Renewable Energy Laboratory (NREL). The toolkit helps energy planners, project developers, researchers and others identify areas of a country that show good potential for renewable energy projects. The toolkit displays renewable energy

data along with information about the geography, location of population centers, borders, and transportation and power infrastructure.

The toolkit is integrated with HOMER, a power system simulation and optimization model, originally developed at NREL and currently owned by HOMER Energy LLC. HOMER integration with the toolkit makes it possible to automatically populate HOMER inputs using weather data from the toolkit to help you get started with your HOMER analysis. The toolkit also displays preliminary HOMER results that you can see without running the model.

NREL works with different funding partners to develop toolkits for different countries. Institutions in each country provide data for the toolkit, which NREL analyzes and prepares to meet the toolkit specifications. Geographic data for each country comes from different sources, including NREL's renewable resource database, resource assessment programs in each country, and government ministries and research institutions responsible for maintaining geographic datasets for the country.

For a list of available Geospatial toolkits and more information about NREL's partners in developing the toolkits, see NREL's Geospatial Toolkits website: http://www.nrel.gov/international/geospatial_toolkits.html .

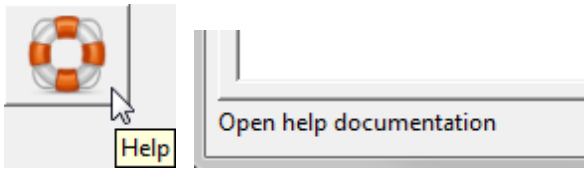
For information about HOMER, see http://www.homerenergy.com/.

Related Topics:

- Getting Started
- Glossary

Toolbar buttons

As you hover over a toolbar button, the toolkit displays the toolbar name in a tool tip, and a description of the toolbar in the status bar at the bottom left corner of the main window.



Main toolbar

Query resource data

Runs a query. See Working with queries and Run a query.

Save result

Saves the results of a query. See Save a query.

Save as PDF

Saves a copy of the map as a PDF file. See Saving and printing maps.

Help

Opens the toolkit's Help.

Add shapefile layer

Adds a layer to the map. See Adding your own data to the toolkit and Add a saved query.

Change country data

Displays a map for a different country if you have data for more than one country. See Opening data for a different country.

Map toolbar

Pan

Drag the map to move it around in the map window. See Using zoom and pan controls.

Zoom in

Click to zoom in (change map scale to see more detail in the map). See Using zoom and pan controls.

Zoom out

Click to zoom out (change map scale to see less detail in the map). See Using zoom and pan controls.

Zoom full extent

Show the entire country on the map. See Using zoom and pan controls.

Zoom previous

After you change the map scale, go back to the scale before you made the change. You can step backward through several changes. See Using zoom and pan controls.

Zoom next

After you change the map scale and zoom to a previous change, step forward to the next change. See Using zoom and pan controls.

Zoom to point

Type a latitude, longitude, and map scale to show a specific point on the map. See Using zoom and pan controls.

Identify

Show information about the current layers for a point on the map. Only displays information for layers checked in the layer tree. See Displaying information about a point on the map.

HOMER tool

Opens the window that displays inputs before you start HOMER. You must check the wind layer, solar layer, or both in the layer tree before you can use HOMER. See Running HOMER.

Related Topics:

- Changing the map scale
- Using map coordinates

Showing and hiding layers

The map window displays all layers that are checked in the layer tree. The map displays layers in the order that they appear in the tree, so that the topmost layer is the layer that appears first in the layer tree, and the bottom most layer will be the layer that appears last in the layer tree.

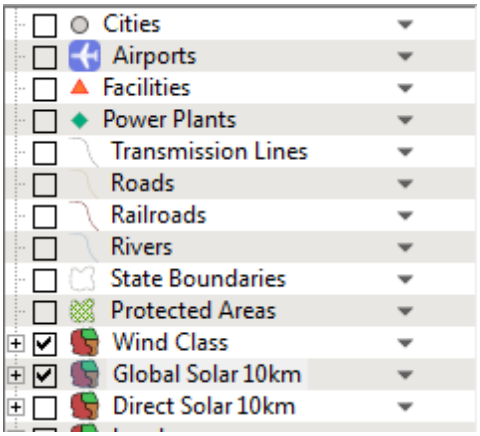
Tip. You can change the order of layers in the tree by clicking and dragging a layer to a new position in the tree.

To make a layer visible in the map, show the layer. To make a layer not visible on the map, hide the layer.

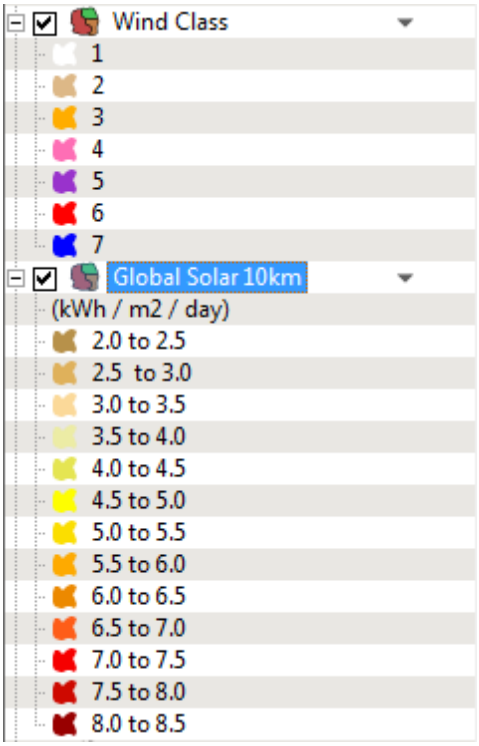
The toolkit displays the measurement units of layers that show quantitative layers at the top of the layer's branch.

To show and hide layers:

1. In the layer tree, check the box for each layer you want to appear in the map. The map will display all checked layers in the order that they appear in the tree. In this example, it will display the wind and global solar layers, and display the wind layer on top of the solar layer.



2. To show the layer units and legend, click the plus icon in the layer tree to expand the layer. The units appear in the first row beneath the layer label. In the example below, the units for the global solar layer are kWh/m2/day, or kilowatt-hours per square meter per day. There are no units for Wind Class since wind power class is a unitless quantity. Each color indicates a range of wind power class and solar radiation values.

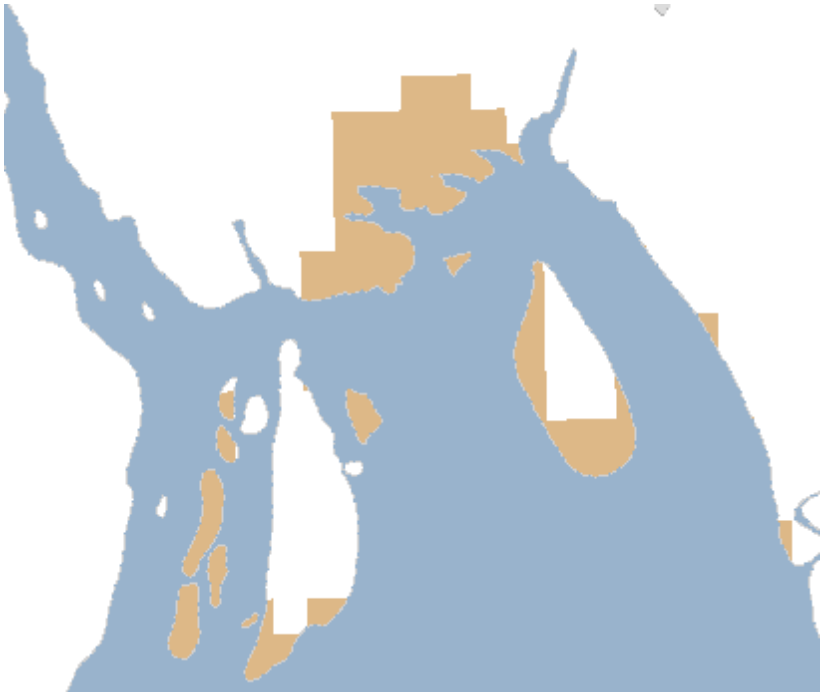


Related Topics:

- Changing layer transparency
- Changing the order of layers
- Running queries

Changing layer transparency

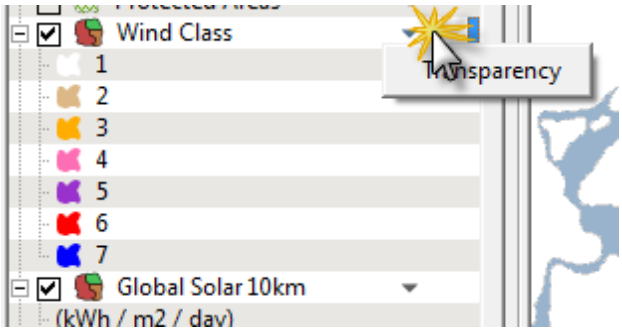
If one layer is hidden by another, you can change layer transparency to make more than one layer visible. For example, in the map below displaying the wind and global solar layers, Wind Class 1 (white) and Wind Class 2 (beige) of the wind layer are hiding the global solar layer, which is under the wind layer. By changing the wind layer transparency to 50% as described below, you can make both layers visible.



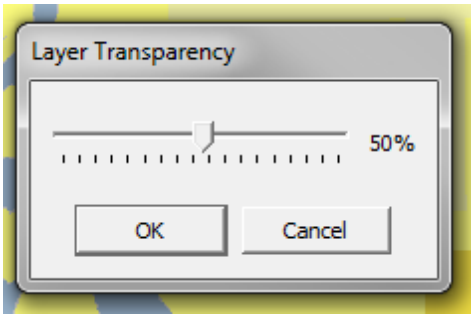
Tip. You can also make a layer visible by changing its position in the layer tree. See Changing the order of layers for details.

To change layer transparency:

1. Click the arrow in the layer tree for the layer whose transparency you want to change.



2. In the Layer Transparency window, move the slider to display the new transparency value. Zero is opaque, and 100% is completely transparent (invisible on the map).



3. Click OK. The map displays both layers. Note that without the 50% transparent wind layer, the yellows of the global solar layer would be brighter.

Related Topics:

- Showing and hiding layers
- Changing the order of layers

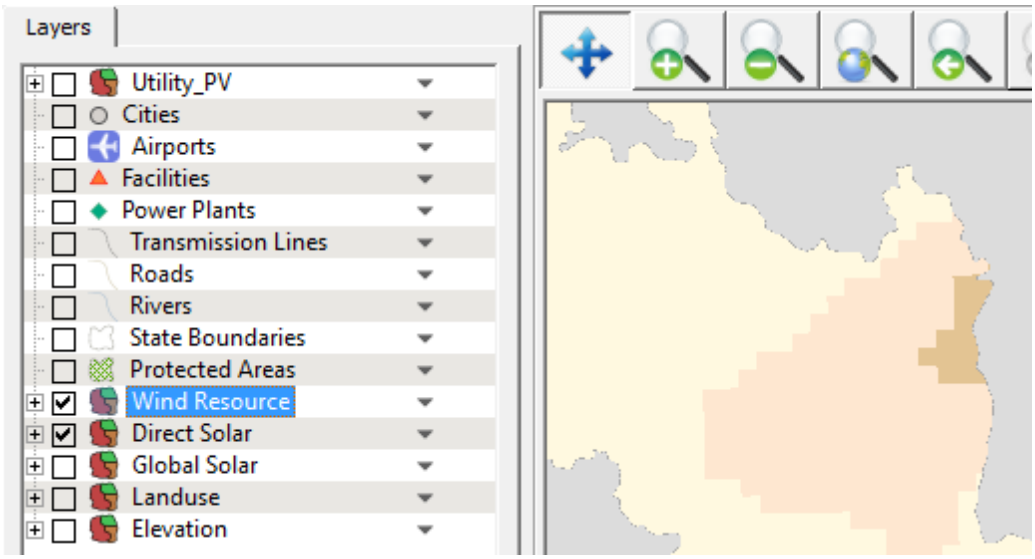
Changing the order of layers

The toolkit displays layers in the order they appear in the layer tree. In some cases, one layer may obscure another. You can change layer transparency to make more than one layer visible, or you can change the order of layers to make a hidden layer visible.

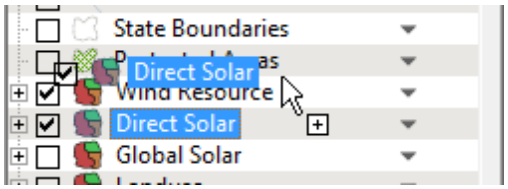
To change the order of a layer:

- In the layer tree, use your mouse to drag the layer you want to move to a new position.

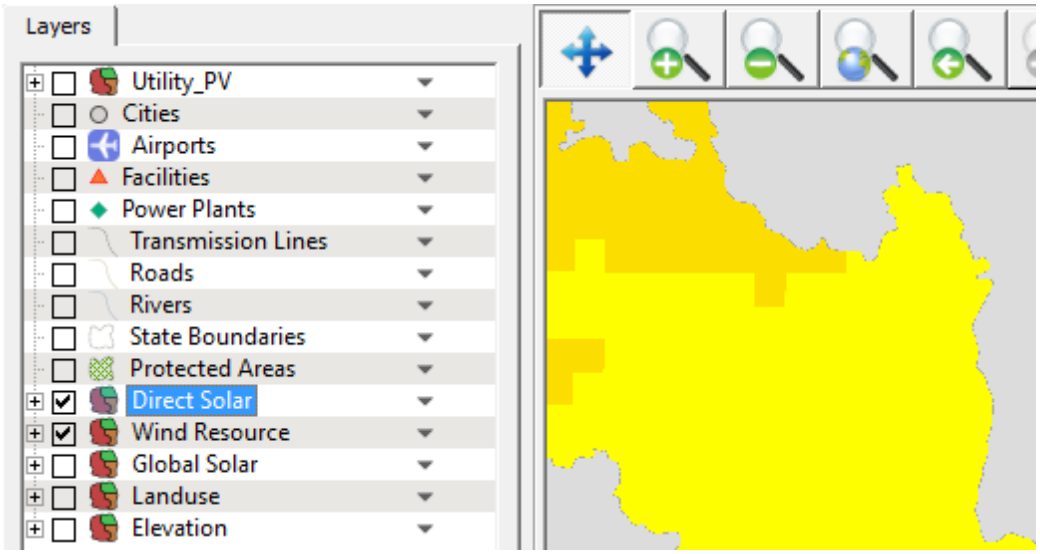
For example, on this map segment, the Wind Resource layer is hiding the Direct Solar layer because it appears first in the layer tree:



By moving the Direct Solar to a position in the tree above Wind Resource, we can see the Direct Solar layer.



Now the Direct Solar layer is visible, but hides the Wind Resource layer.



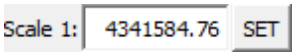
Related Topics:

- Showing and hiding layers
- Changing layer transparency

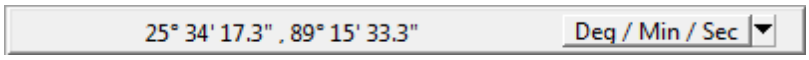
Using zoom and pan controls

The zoom and pan controls are buttons on the map toolbar that allow you to change the size of the map, and the portion of the map that appears in the map window.

As you use the zoom and pan controls, you can see the current map scale in the Scale tool at top right corner of the maps window:



and the coordinates of the current point or position of the cursor in the Coordinates tool at the bottom right corner of the map window:



Pan: Move a point on the map

1. Click Pan.
2. Click a point on the map.
3. Drag the point to a new position in the map window.

Zoom in: Show more detail

1. Click Zoom In.
2. Click a point on the map. The toolkit will position the point in the center of the map, and increase the map scale to show more detail, or

   Draw a rectangle on the map to zoom into the rectangle.

Zoom out: Show less detail

1. Click Zoom Out.
2. Click a point on the map. The toolkit will position the point in the center of the map, and decrease the map scale to show less detail.

Note. If your computer's mouse is equipped with a roller, you also zoom in and out by hovering over a point on the map and moving the roller.

Zoom full extent: Show entire country

- Click Zoom Full Extent.

Zoom previous: Step backward through map changes

Zoom Previous is only active after you have changed the map scale or moved the map.

- Click Zoom Previous. The map will go back to the scale and position displayed before you

made the change. You can step backward through several changes.

Zoom next: Step forward through map changes

Zoom Next is only active after you have changed the map scale or moved the map and used Zoom Previous to step backward through changes..

- Click Zoom Next. The map will change to the scale and position displayed before you clicked the Zoom Previous button. You can step forward through several changes.

Zoom to point: Find a particular point on the map

1. Click Zoom to Point.
2. Type a latitude and longitude. See Using map coordinates for details
3. Type a scale value. Type a 1 or 0 to display the map at the current scale. Type a positive number to show more detail. Type a negative value to show less detail.

Related topics

- Displaying information about a point on the map
- Changing the map scale
- Using map coordinates

Displaying layer details

You can display details about any point on the map using Identify Results. The Identify Results window displays information for a point on the map from the layers currently displayed in the map window. The window only displays information for checked layers in the layer tree, including queries.

Note. To see a legend explaining the colors of a visible layers, expand the layer in the layer tree. See Showing and hiding layers for details.

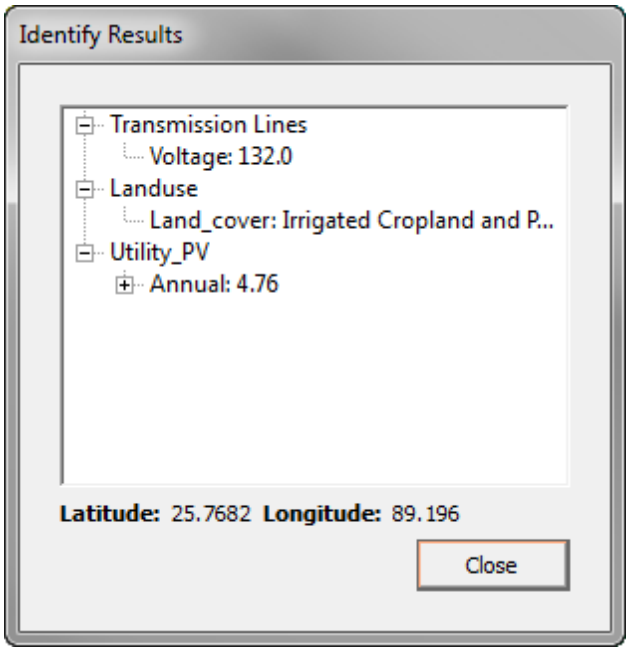
To display information about a point on the map:

1. Use the layer tree to show the layers whose details you want to see.
2. Use the zoom and pan controls to show the point on the map at an appropriate level of detail.
3. Click Identify.

4. If the Identify Results window is too small to display all of the information, drag an edge of the Identify Results window to make it bigger.

The Identify Results window shows information about each layer displayed on the map. In this example, the Transmission Lines and Landuse layers are visible, and a layer for the query result named "Utility_PV" is visible. You must know the parameters of the query to understand the information for the query. In this

case, we created the Utility PV query on the Global Solar layer, so the Annual value of 4.76 is in kWh/m2/day of global horizontal solar radiation. The window also displays the point's latitude and longitude.



Related topics

- Showing and hiding layers
- Show query parameters
- Using map coordinates

Displaying monthly average data

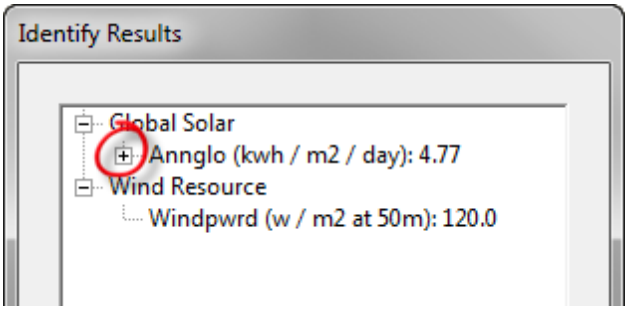
The toolkit displays annual average resource data on the map. For some countries, the toolkit also includes monthly average renewable resource data. If your toolkit includes monthly average renewable energy resource data, you can see the data in the Identify Results window.

If your toolkit includes integration with HOMER, you can also see monthly average renewable resource data in the HOMER Tool window displays. For details, see Running HOMER.

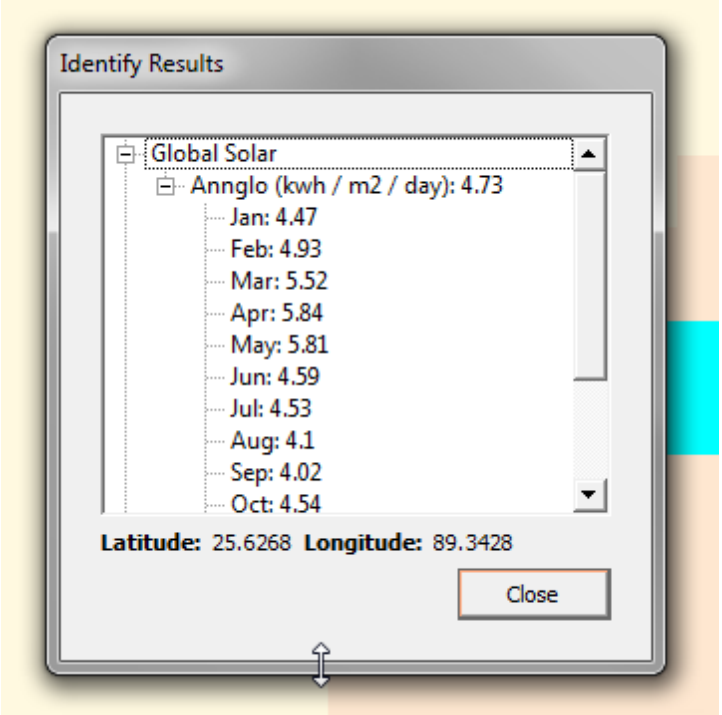
To display monthly average data in the Identify Results window:

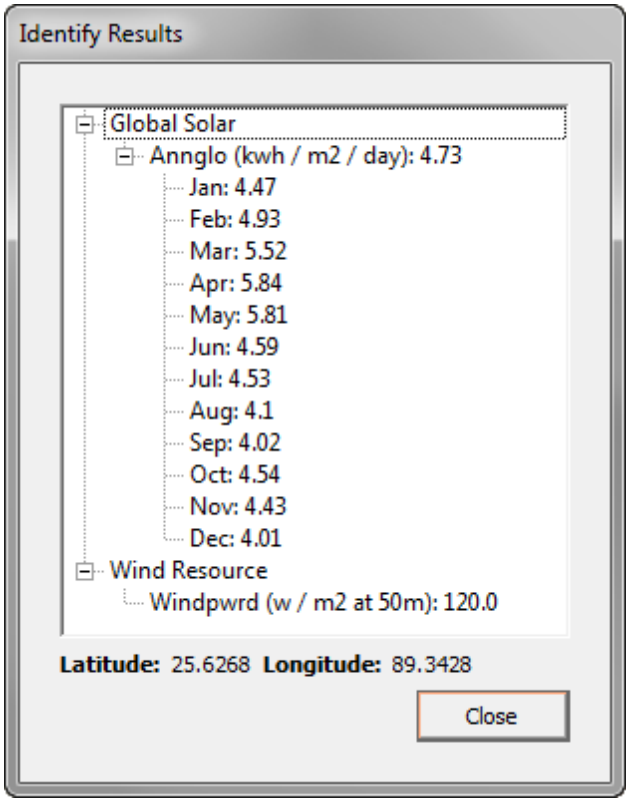
1. Use the layer tree to show layers for each renewable resource for which you want to see monthly average data.
2. Use the zoom and pan controls to show the point on the map at an appropriate level of detail. See Zoom and pan controls for details.
3. Click Identify.

4. In the Identify Results window, expand the tree for the resource category with monthly data. In this example, monthly data is available for the Global Solar layer, but not for the Wind Resource layer.



5. If the Identify Results window is too small to display all of the information, drag an edge of the Identify Results window to make it bigger.





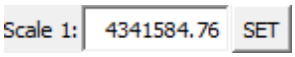
Changing the map scale

You can change the map scale typing a ratio in the Scale tool.

Note. You can also use the zoom and pan controls to change the map scale.

To change the map scale:

1. Type a value in the Scale tool at the top right corner of the toolkit window.



2. Click **Set**.

Related topics:

- Using zoom and pan controls
- Using map coordinates

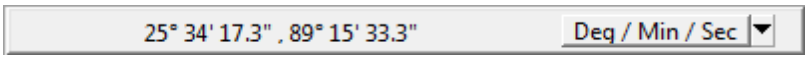
Using map coordinates

As you move your mouse over the map, the toolkit displays the coordinates of the current point in the Coordinates tool at bottom right corner of the map window.

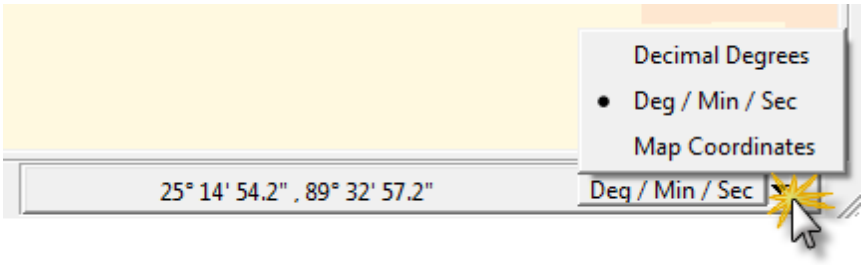
Note. To find a particular point on the map, use Zoom to Point. See Using zoom and pan controls for details.

To use map coordinates:

1. Move your mouse to a point on the map. When you move the cursor off of the map, the toolkit displays the coordinates for the position at the edge of the map where the pointer exited the map.
2. Read the coordinates in the Coordinates tool at the bottom right corner of the map window.



3. To change the units, click the arrow and choose an option from the list.



The toolkit uses the following conventions for displaying coordinates:

- A positive latitude indicates a latitude north of the Equator.
- A positive longitude indicates a latitude east of the Prime Meridian.
- The toolkit displays the latitude first, and the longitude second followed by a comma.

The following is an example of the coordinates of Dhaka, Bangladesh at 23 degrees 42 minutes north latitude and 90 degrees 22 minutes east longitude displayed using each of the three options:

- Decimal Degrees: 23.7, 90.375
- Deg / Min / Sec: 23°42'03, 90°22'303
- Map Coordinates: The map coordinates displays the coordinates of a point using the coordinate system of the projection used to map the country. The toolkit displays these coordinates for people familiar with geographic information systems (GIS) who may be using their own GIS data in the toolkit. See Adding and removing your own data and Using toolkit data in your own GIS for details.

Related topics:
- Using zoom and pan controls

Saving the map as PDF

The toolkit saves an image of the visible map to a PDF file. The PDF file includes a picture of the map, a map title, legend and scale in the PDF file of the map.

Notes.
The toolkit does not allow you to save map views. To save a picture of the map, you can save it as a PDF file as described below, or you can use screen capture software to save the picture as an image file. See Copying map images for details.

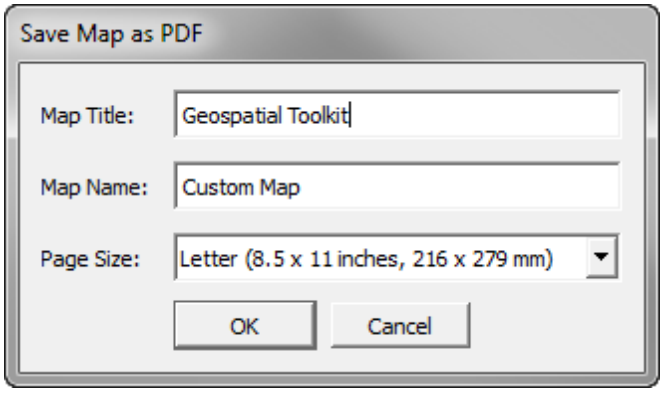
The Save button on the main toolbar is for saving query results, not for

saving images of the map itself. See Save a query for details.

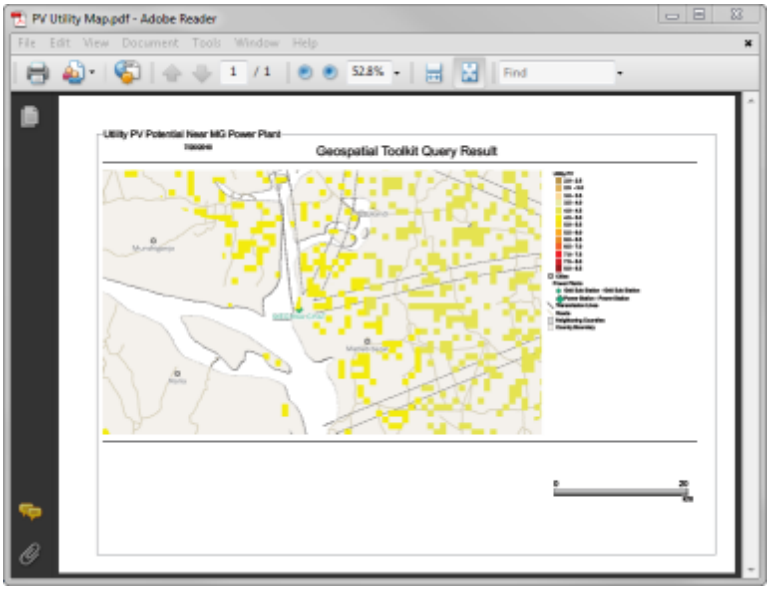
To save and print a copy of the current map:

1. Use the layer tree, zoom and pan controls, and query to display the map in the Map window as you want it to appear in the printed copy.
2. Click Save as PDF.

3. In the Save Map as PDF window, type options as you want them to appear on the map.



4. Click **OK**.
5. Type a name for the PDF file and choose a folder to save the file.
6. Navigate to the folder where you saved the PDF file and open the file in your PDF viewer.



7. Print the file.

Related topics
- Saving and opening query results
- Copying map images

Copying map images

A map image is a picture of the map as it appears in the Map window. There are two options for copying map images to other programs for use in reports and presentations:

- Save the map to a PDF file. See Saving the map as PDF for details.
- Use screen capture software to copy an image of the map. Screen capture software allows you to save a picture of your screen as an image file or to copy the picture to your computer's clipboard. See below for instructions.

To copy a map image using screen capture software:

1. Use the layer tree, zoom and pan controls, and query to display the map in the Map window as you want it to appear in the printed copy.
2. Open the document in which you want to insert the map image.
3. Use one of the following options to capture an image of the map and copy it to your computer's clipboard: In Windows XP, press the Alt and Print Screen keys simultaneously, on Windows 7 and Vista run the Snippet tool, or on Mac OS run the Grab tool.
4. Paste the image into the document.

Related topics:
- Saving the map as PDF

Working with queries

A query is a request to display a map showing only data that meets the criteria that you specify.

Examples of queries are:

- Show solar resource data only for areas with between 4.0 kWh/m2/day and 7 kWh/m2/day average annual global horizontal radiation within 5 km of an existing power line and 10 km of an existing road.
- Show wind resource data only for areas with a wind power class between 5 and 7, within 5 km of an existing power line, and on land with slope of less than 10 percent.

The toolkit treats a query like any other layer. When you run a query or add a saved query, the query appears in the layer tree.

The toolkit only allows you to run certain queries as described in Run query. The query options allowed by the toolkit should be sufficient for most renewable energy project screening applications. To run different queries, you will need to use toolkit data in your own GIS.

Working with queries involves the following tasks:

- Run a query
- Show query parameters
- Save a query
- Show the land area of a query
- Add a saved query
- Remove a query
- Troubleshoot a query

Run a query

The toolkit allows you to choose from a set of pre-defined query options. Different queries may be available for different countries.Your query may include all or some of the following query options:

Energy Resource

Specify a range of annual average values for solar, wind, or other renewable resource data included in the toolkit. Note that you can run a query on only one renewable resource at a time. For example, it is not possible to run a single query to show areas that have both good solar and wind potential.

> **Note.** When you run queries on the wind resource, the toolkit displays the wind power density rather than the wind power class. See Renewable resource data for a discussion of the relationship between wind power class and wind power density.

Protected Areas

Choose whether or not to exclude areas marked as protected. Renewable energy projects may not be allowed in areas protected by the government for environmental or cultural preservation, or for military use. The definition of protected area depends on the country.

Land Use

Choose whether to limit the query to areas with certain land uses. Examples of land uses include urban, savanna, and water bodies.

Roads

Limit the query to areas within a certain distance of roads. For this query option, the toolkit considers all roads included in the Roads layer.

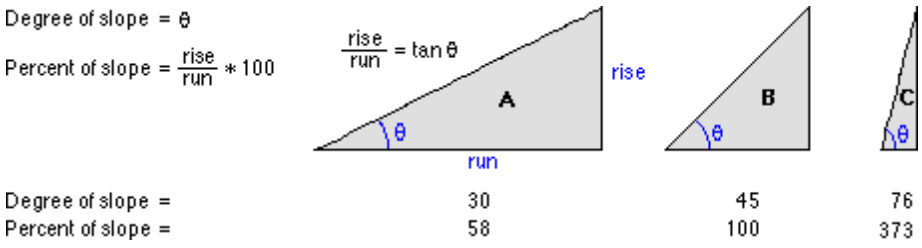
Transmission Lines

Limit the query to areas within a certain distance of electric transmission lines. For this query options, the toolkit considers all roads included in the Transmission Lines layer.

Slope

Include only land areas with a slope within a specified range, where 0% is completely flat, and 5% represents land tilted at an inclination of about 2.25 degrees from horizontal. (A slope of 100% is equivalent to inclination of 45 degrees from horizontal.) Some renewable energy projects, especially large solar projects, are limited to relatively flat land for several reasons, such as minimizing land grading costs, avoiding potential shading between solar collectors, and avoiding the cost and risk during construction associated with moving heavy equipment around the site.

In the following diagram, "percent of slope" is equivalent to the toolkit's slope value:



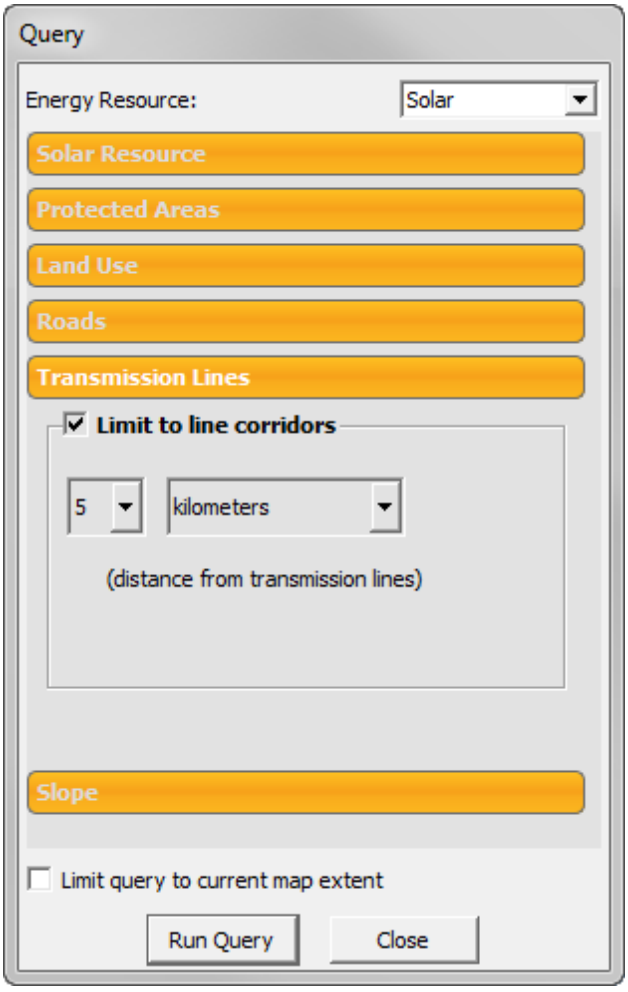
Note. The toolkit does not include a slope layer. It calculates slope using data displayed in the elevation layer.

Limit query to current map extent
Include only the portion of the map visible in the map window in the query.

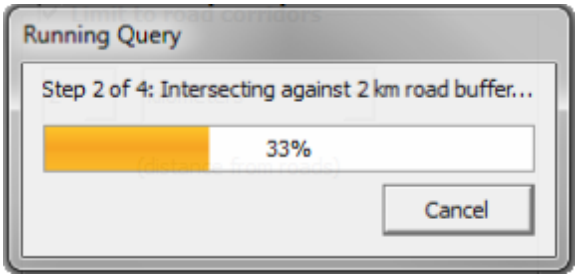
To run a query:

1. Click Query Resource Data. If you want to limit your query to a portion of the map, use the zoom and pan controls to show the portion of the map you want to include in the query.

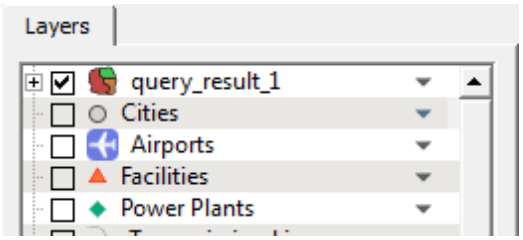
2. In the Query window, specify options for your query. See descriptions above for details.



3. Click **Run Query**. Depending on the number of options you specified, the volume of data for the area covered by the query, and your computer's speed, the query may take a few seconds or many minutes to run. The Running Query window displays a status bar showing you the query's progress.



4. When the query is finished running, click **Close**. The toolkit will add a layer for the query at the top of the layer tree.



Related topics:

- Show query parameters
- Show the land area of a query
- Displaying information about a point on the map
- Remove a query
- Using zoom and pan controls

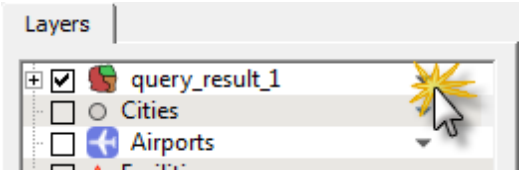
Rename a query

By default the toolkit assigns the name *query_results_n* to each query you run in a toolkit session. For the first query you run in a session, *n*=1. For the second query, *n*=2, etc.

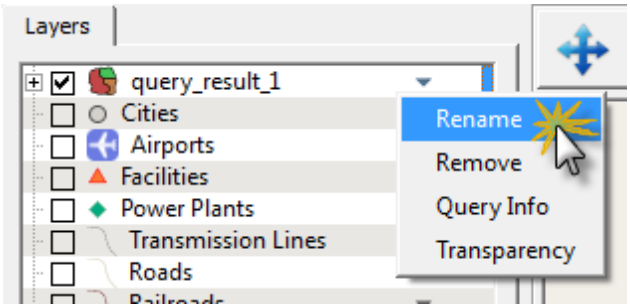
You can change the name of the query to make it easier to remember what the query means. The query name appears in the layer tree, and is saved when you save a query to use in a later session.

To rename a query:

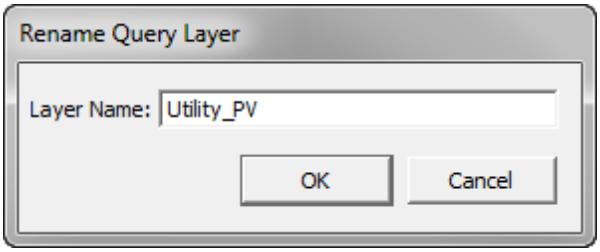
1. Either run a query or add a saved query to display the query in the layer tree.
2. Click the arrow in the query's layer on the tree.



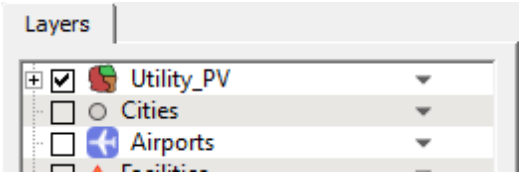
3. In the shortcut menu, click **Rename**.



4. Type a name for the query in Layer Name. The name must not include spaces.



5. Click **OK**. The toolkit displays the query's name in the layer tree.



Related Topics:

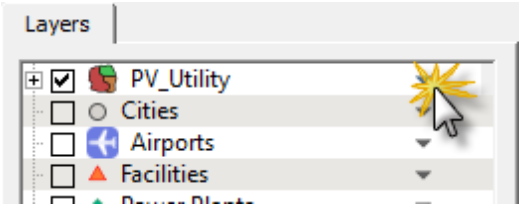
- Run a query
- Save a query
- Remove a query
- Add a saved query

Show query parameters

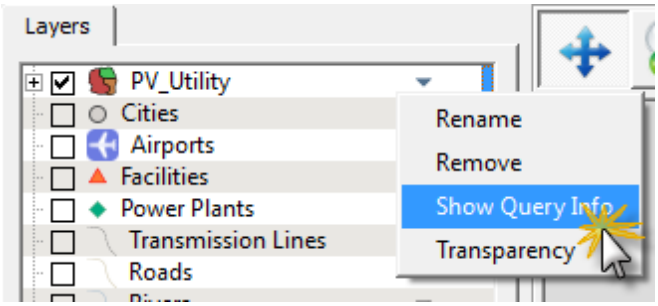
After you run a query, you can show the parameters you specified for the query in the Query Info window.

To show query parameters:

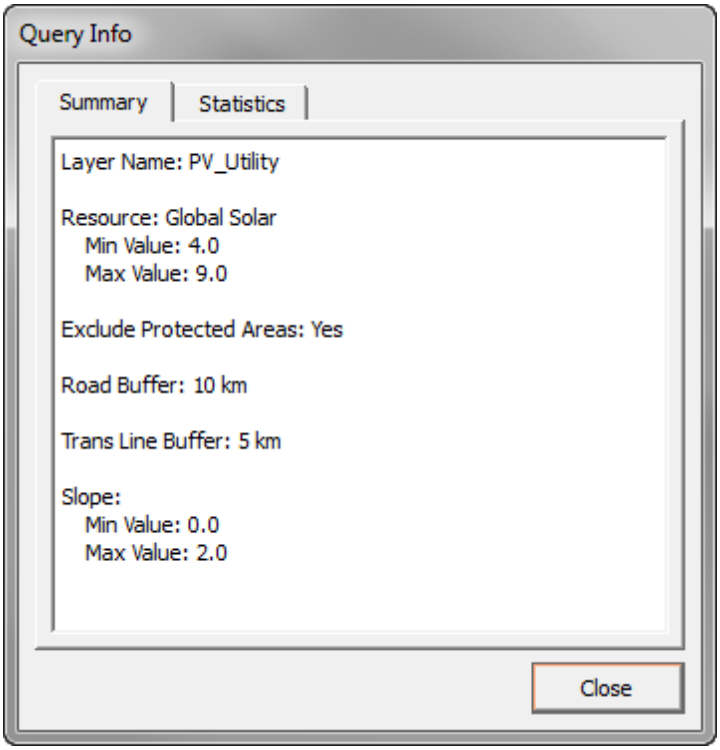
1. Either run a query or add a saved query to display the query in the layer tree.
2. Click the arrow in the query's layer on the tree.



3. In the shortcut menu, click **Query Info**.



4. Click **Summary**. If necessary, resize the Query Info window to show all of the information.



Related topics

- Run a query
- Add a saved query
- Show the land area of a query
- Displaying information about a point on the map

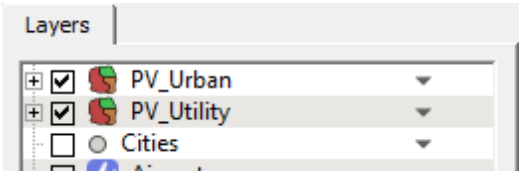
Save a query

When you save a query result, the toolkit saves the query as a set of files (*.dbf*, *.prj*, *.qml*, *.qpj*, *.shp*, and *.shx*) that you can open after closing the toolkit. After saving a query, you can add it to the layer tree of any toolkit session, or use it with other compatible geospatial software.

Note. The amount of storage space required to save the files depends on the query and country. A single query may require approximately 25 MB of storage space, or in some cases as much as 100 MB.

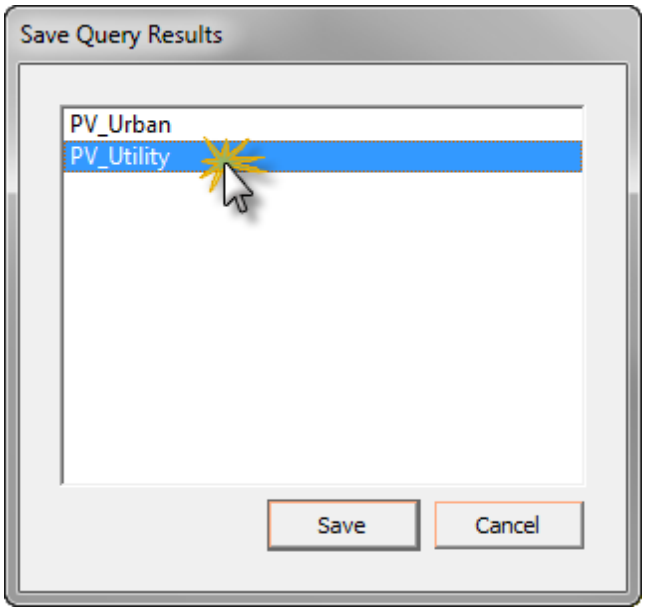
To save a query:

1. Run one or more queries. The layer tree should display at least one query.



2. Click Save Query in the main toolbar.

3. In the Save Query Results window, click the query that you want to save. You can save only one query at a time.



4. Click **Save**.
5. Type the name of a file to store the query results, and navigate to a folder to store the files. Note that the toolkit saves the query result as a set of six files.
6. Click **Save**.

Related topics

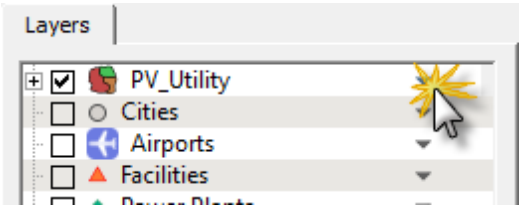
- Run a query
- Add a saved query
- File format reference
- Remove a query

Show the land area of a query

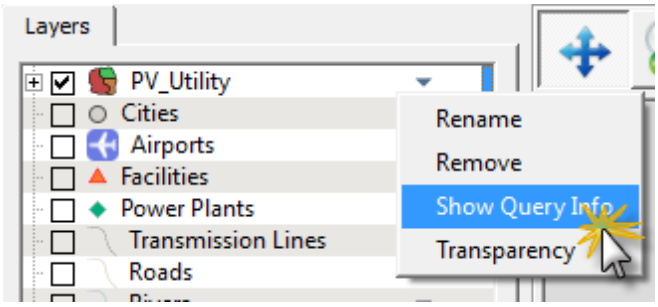
After you run a query, you can show the area in kilometers of the land that meets the query requirements. The toolkit shows the land area for each range of renewable energy resource.

To show query parameters:

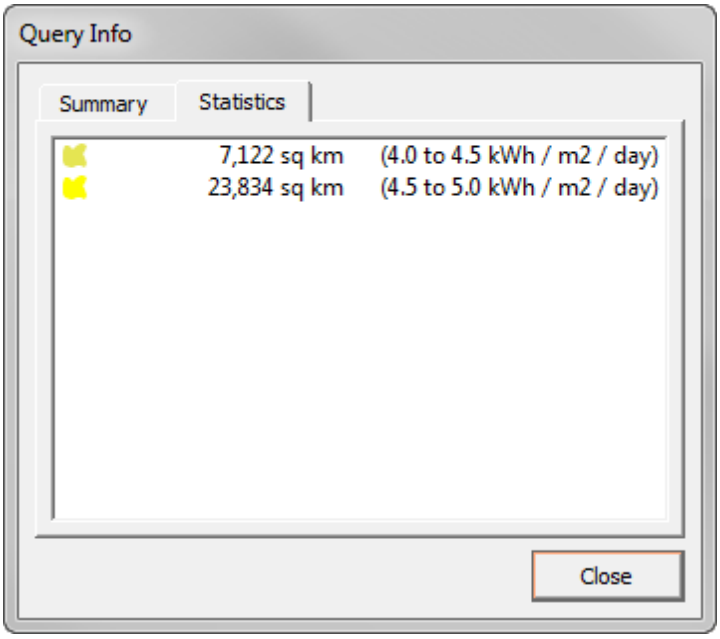
1. Either run a query or add a saved query to display the query in the layer tree.
2. Click the arrow in the query's layer on the tree.



3. In the shortcut menu, click **Query Info**.



4. Click **Statistics**. If necessary, resize the Query Info window to show all of the information.



Related topics

- Run a query
- Add a saved query
- Show query parameters
- Displaying information about a point on the map

Add a saved query

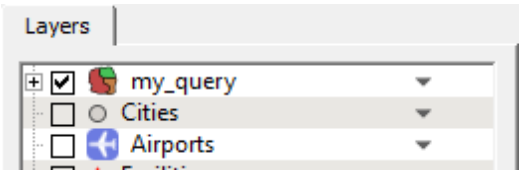
If you saved one or more queries in a previous toolkit session, you can add the queries to your current session by adding the query as a layer.

To add a saved query:

1. Click Add Shapefile Layer.

2. In the Open Shapefile window, navigate to the folder containing the query files. The window will only list files with the *.shp* extension, but to properly display the layer, the toolkit requires a complete set of files (*.dbf*, *.prj*, *.qml*, *.qpj*, *.shp*, and *.shx*).

3. Click **Open**. The query appears in the layer tree.



Related topics

- Save a query
- Rename a query
- Remove a query

Remove a query

You can remove a query from the layer tree.

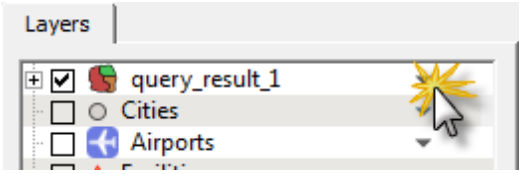
Important Note! When you remove a query, the toolkit deletes all information associated with the query. If you do not want to delete the query information, save the query before removing the layer.

If you want to hide a query layer without deleting the information, clear the query's checkbox in the layer tree. See Showing and hiding layers for details.

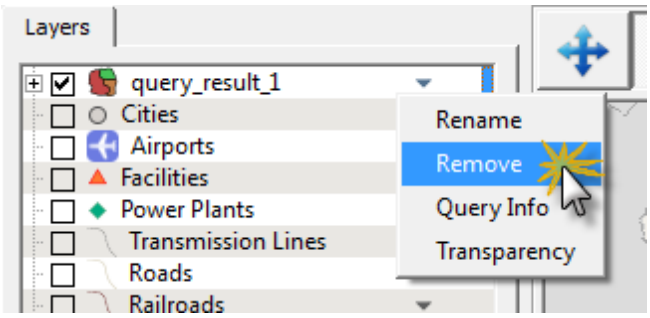
To remove a query:

1. Either run a query or add a saved query to display the query in the layer tree.

2. Click the arrow in the query's layer on the tree.



3. In the shortcut menu, click **Remove**.



Related topics

- Run a query
- Save a query
- Add a saved query
- Showing and hiding layers

Troubleshoot a query

Query is not visible on the map

Make sure that the query layer in the layer tree is checked. Query layers appear at the top of the tree.

Verify that there is not a layer for another query hiding the query layer. If there is, clear the checkbox for the query layer that is on top of the layer you want to see. You can also change layer transparency and the order of layers to make different layers visible. See Changing layer transparency and Changing the order of layers for details.

For some queries, the results may only be for a few small areas on the map that are not visible in the current map view. Use the zoom and pan controls to try to find the areas. You can also show layers included in the query to help find the areas of interest. For example, if the query is limited to urban areas, then you can show the land use layer to help find the urban areas.

Query window does not close

You cannot close the Query window while a query is running. The Running Query window displays a progress bar showing that the query is running, but in some cases you may not see the window. To close the Query window while a query is running, you must click **Cancel** in the Running Query window first.

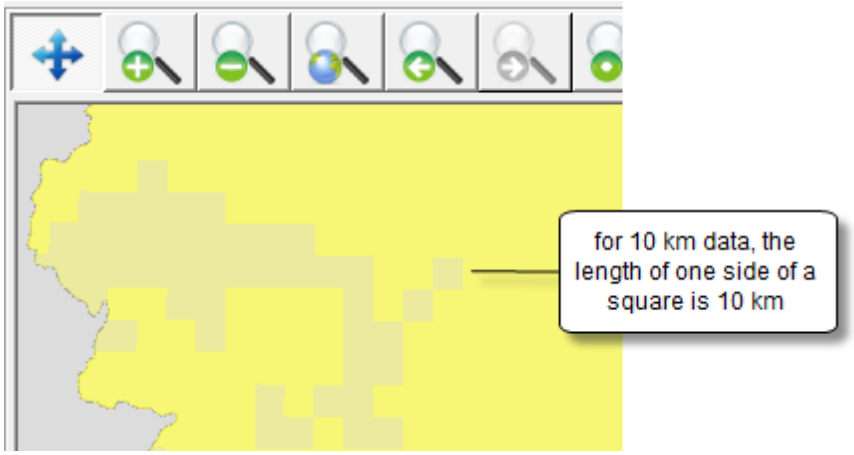
Query result message: No records matched your query criteria. Please make another selection and try again.

You specified a query that was too narrow, and the toolkit could not find any land areas that met the criteria. Try broadening the query parameters. Examples of queries that could result in this message are: Limit the solar resource to global horizontal radiation values greater than 6 kWh/m2/day for a country whose maximum solar resource is 5.9 kWh/m2/day, Limit the wind resource to wind power class of 6 or greater and land slope of less than 2% for a country with good wind resource only in mountainous areas.

Renewable resource data

The renewable resource data included in your toolkit describes the geographic distribution of annual average renewable energy resources for the country, and may include data describing the solar, wind, biomass, geothermal, or hydropower resource. The renewable resource data included in each country's toolkit depends on data that was made available to the toolkit developers.

The spatial resolution of the resource data is different for different countries, and for different datasets within a single toolkit. In general, the spatial resolution of renewable resource data ranges from 1 km to 40 km. The data's spatial resolution describes the land area represented by one square on the map. For example, the following map shows solar resource data for a dataset with a resolution of 10 km, which means that the length of each side of a square on the map is 10 km.



Notes.

If you have data for renewable resource data in the correct format, you can add the data to your toolkit. See Adding and removing your own data for details.

Not all of the resource data listed below is available for all countries.

Some of the resource data included in a toolkit for a particular country may not be available for queries. This is particularly true for hydro, biomass, and geothermal resource data.

Solar Resource

The solar resource data included in the toolkit describes the average energy available from the sun, also called solar radiation, at a particular location over a period of one year. The data is expressed as an annual average of the amount of radiation available in a single day in kilowatt-hours per square meter of collector surface area per day (kWh/m2/day).

Toolkits for some countries include monthly and seasonal solar resource data in addition to the annual data. See Displaying monthly average data for details.

Depending on the country, the toolkit may include the following types of solar resource data:

Global horizontal radiation (abbreviated as GLO or GHI)

Global horizontal radiation data is appropriate for evaluating sites for flat solar collectors, including most photovoltaic and solar hot water systems. Global horizontal radiation data represents the amount of solar energy that reaches one square meter of a flat surface parallel to the ground in a

single day. This is an average daily value over the period of one year. Global radiation includes radiation that reaches a collector both in a straight line from the sun, and reflected from the ground, nearby objects, clouds, and particles in the atmosphere.

Global radiation at latitude tilt (abbreviated as TILT or PV)

System designers often assume that a flat collector is tilted at an angle from the horizontal equal to the latitude of the system's location for preliminary analyses. For some systems, using the latitude as the tilt angle results in the maximum collection of solar energy over a one year period. The global irradiance at latitude tilt data is appropriate for evaluating sites for photovoltaic collectors with flat collectors. Global radiation at latitude tilt data represents the amount of solar energy that reaches one square meter of a flat surface tilted toward the equator at an angle from the horizontal equal to the location's latitude over a period of a single day. This is an average daily value over the period of one year.

Direct normal radiation (abbreviated as DNI or CSP)

Direct normal irradiance data is appropriate for evaluating sites for parabola-shaped concentrating solar collectors, such as parabolic trough, power tower, dish-Stirling, concentrating photovoltaic systems, and some types of solar hot water systems. Direct normal radiation includes only radiation reaches a collector in a direct line from the sun.

Wind Resource

Wind resource data describes the average energy in the wind at a particular location over a period of one year. The wind power density is a measure of the wind energy available for conversion to electricity by a wind turbine, and accounts both for the speed of the wind and the density of the air. Wind power density in the toolkits is expressed in watts per square meter (W/m2) of rotor swept area for a tower height of 50 meters above the ground. The rotor swept area is equal to the area of a circle whose radius is the length of a single wind turbine blade.

Biomass Resource

Biomass resource data generated by NREL may be included in the toolkit as estimates of potential annual electricity generation in kilowatt-hours per year (kWh/yr) from municipal solid waste by region.

Geothermal Resource

Geothermal resource data may be included in the toolkit, showing hot spring or well point locations with temperature information in degrees Celsius. This data may have been collected by the country, NREL, or other organizations.

Hydro Resource

Hydro resource data generated by NREL may be included in the toolkit as estimates of annual and monthly average potential hydro power in kilowatts (kW). The estimates are of theoretical potential, assuming system efficiency at 100%, no losses, and diversion of 100% of the streamflow. The data intended for evaluation of locations for small hydro systems with small diversion distances, returning water to the stream within 200 meters of the diversion point.

Related topics

- Geographic data
- Using toolkit data in your own GIS

Geographic data

In addition to renewable resource data, the toolkit includes geographic data describing political borders, roads, transmission lines, cities, land use, and other information useful in screening sites for renewable

energy projects.

The geographic data included in a given toolkit depends on data that was made available to the toolkit developers and varies from country to country

If you have data for geographic features in the correct format, you can add the data to your toolkit. See Adding and removing your own data for details.

Elevation

The elevation data included in the toolkit provides information about the terrain. If enhanced data for a country was not available, elevation data was extracted from a U.S. Geological Survey (USGS) GTOPO30 global dataset, with a spatial resolution of 1 kilometer. All elevation values are in meters. Percent slope is derived from this elevation dataset.

Land Use

The land use data included in the toolkit provides information about the land, such as whether it is forest, urban, or wetland. If land use data for a country was not available, it was extracted from a USGS Global Land Use/Land Cover dataset, with a spatial resolution of 1 kilometer.

Political Boundaries

The political boundaries in the toolkit may include country, province or state, and district or county level boundaries. Wherever possible, the names of the political units are included in the attributes.

Transportation and Electric Infrastructure

The transportation data in the toolkit may include roads (paved and unpaved) and railroads. The electric infrastructure data in the toolkit may include transmission lines and power plants. These data are provided by country partners.

Potential Exclusions

The potential exclusions used in the toolkit may include parks, wildlife areas, historic sites and cultural areas. These data are provided by country partners or extracted from the 2005 World Database on Protected Areas maintained by the UNEP-World Conservation Monitoring Centre (UNEP-WCMC).

Other Reference Data

Other reference data in the toolkit may include cities, villages, lakes, and rivers. These data are provided by country partners or extracted from publicly available global datasets.

Related topics

- Renewable resource data
- Adding and removing your own data
- Using toolkit data in your own GIS

Running HOMER

Running HOMER from the toolkit makes it possible for you to make a very preliminary evaluation of technology options for an off-grid power system at a location on the map. When you run HOMER from the toolkit, the toolkit passes renewable energy data from the toolkit's renewable resource database to a HOMER file. Each HOMER file included with the toolkit is called an application, and you choose the application from a list of up to five applications. Each application contains a set of HOMER inputs that define the assumptions for the analysis. The application files are very generalized examples of off-grid renewable energy systems designed to work for several different countries. When you run HOMER from

the toolkit, HOMER simulates hundreds of system configurations, but displays only the six systems with the lowest cost of generating electricity in the toolkit.

> **Important Notes!** HOMER's integration with the Geospatial Toolkit is intended to help you get started with your HOMER analysis. If you plan to make any decisions based on HOMER results, you should run the model outside of the toolkit, using inputs from the toolkit as a starting point for your analysis.
>
> The toolkit uses HOMER version 2.19, which was last updated in June 2005. The most up-to-date free version of HOMER is version 2.68, updated in July 2009. To download the latest version of HOMER, visit http://www.homerenergy.com/. After running HOMER from the toolkit, you can save your HOMER file, and then open it with a more recent version of HOMER.

You should consider the results from running HOMER through the toolkit to be very preliminary, and not appropriate for any real decision making for the following reasons:

- The economic assumptions in the application files are based on very general guesses for what it might cost to install and operate a power system anywhere in the world. Those assumptions are unlikely to be appropriate for any particular project.
- Each application file includes a set of assumptions about the range of sizes to consider for each piece of equipment in the system, also called the optimization search space. The search space in each application file is designed to be broad enough to work for a range of different countries with different renewable resource characteristics. A rigorous analysis requires specifying a search space based on the renewable resource at the project site, taking into consideration the range of equipment sizes being studied.
- The toolkit stores annual averages of wind and solar data. HOMER uses an hourly simulation model that requires hourly resource data. The toolkit passes estimates of either monthly or annual wind and solar data to HOMER, depending on the country. HOMER uses special algorithms to estimate hourly data from those monthly and annual averages. That means that the accuracy of the hourly renewable resource data used with the applications is not very high.
- The toolkit only passes wind and solar data to HOMER. For some countries, the toolkit includes data for biomass and hydropower resources, and although HOMER can model systems that use those resources, the toolkit is not designed to pass that data to HOMER.

Running HOMER from the toolkit involves the following overall steps:

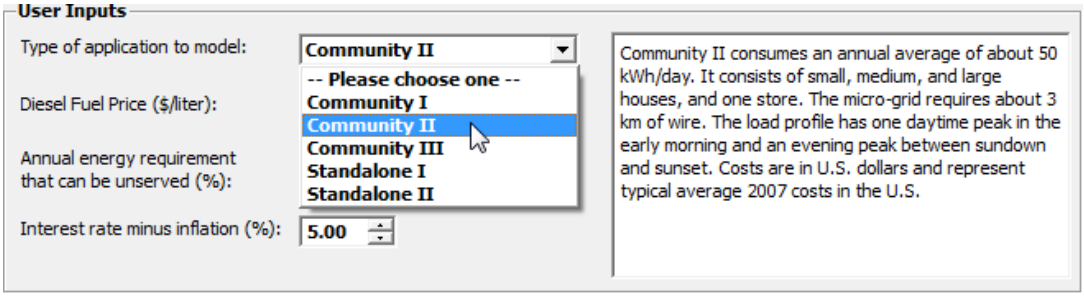
1. Click a location on the map.
2. Choose an application and specify the values of three basic inputs: Diesel fuel price, system reliability, and discount rate.
3. Run HOMER.
4. Review the list of systems.
5. For a rigorous analysis, open the HOMER file and modify inputs for your analysis.

To run HOMER from the toolkit:

1. Click HOMER Tool.

2. Click a location on the map. Before choosing a location, you may want to do some initial site screening by showing different layers, zooming and panning, or running queries to find locations with good renewable energy potential.

3. In the HOMER Tool window, choose an application. When you choose an application, a description of the application appears in the Description box.

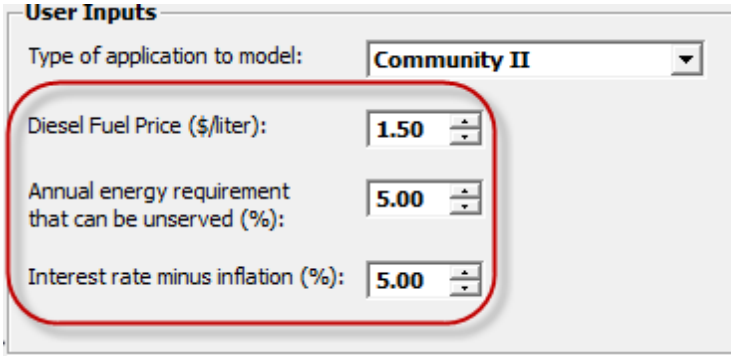


Under User Inputs, enter values for the Diesel Fuel Price, Annual energy requirement that can be unserved, and Interest rate minus inflation.

The diesel fuel price should include the cost of delivery to the project location. HOMER considers systems with and without a diesel generator for all applications.

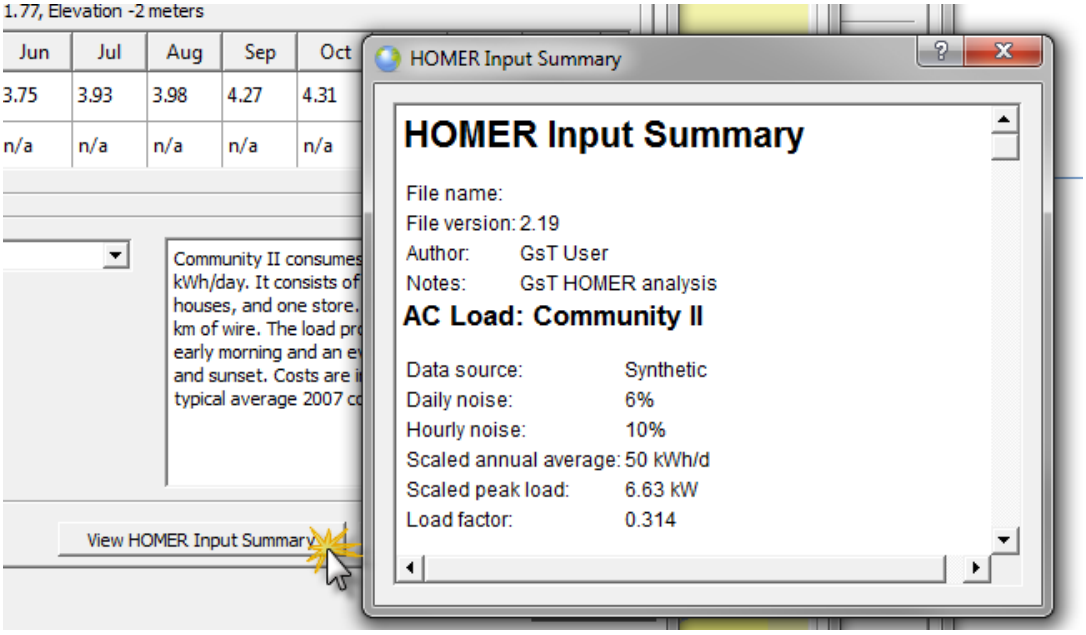
The Annual energy requirement that can be unserved is a measure of the system's reliability. A value of 0 would require that the system meet the electric demand 100% of the time. A value of 10% would allow the system to not meet 100% of the load requirement for up to 10% of the time on average over a single year.

The interest rate minus inflation is the discount rate HOMER uses to calculate the present worth of annual costs in the project cash flow.

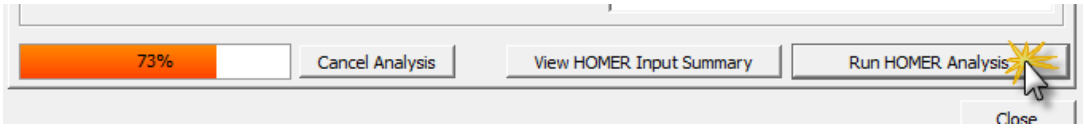


4. To review the inputs in the application, click **View HOMER Input Summary**. You cannot edit

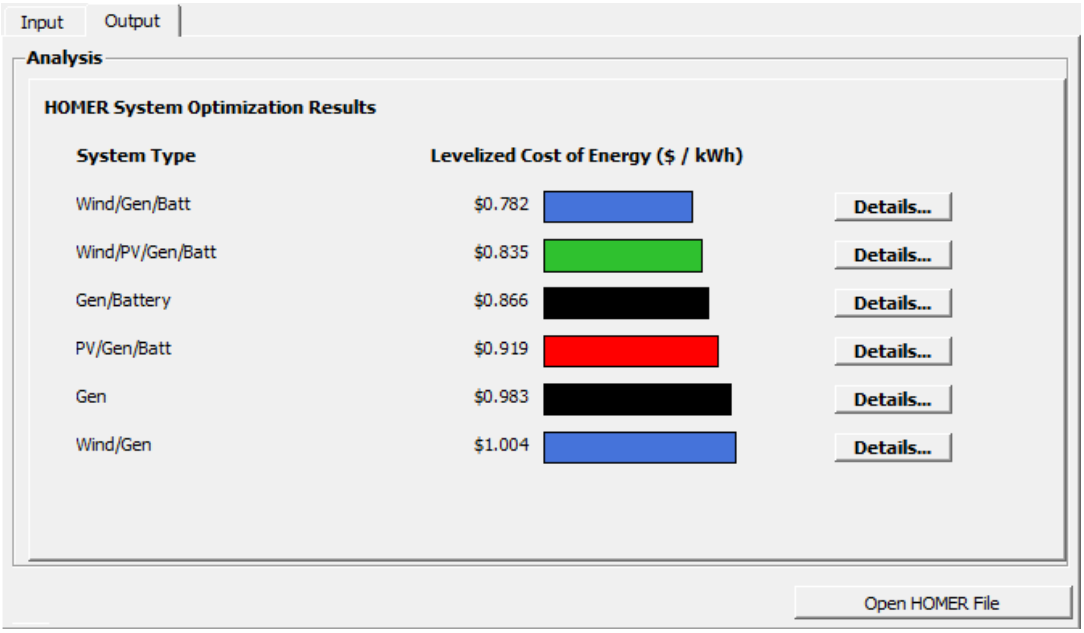
values in the input summary. If you want to change any values in the application file, you can open the HOMER file after running it.



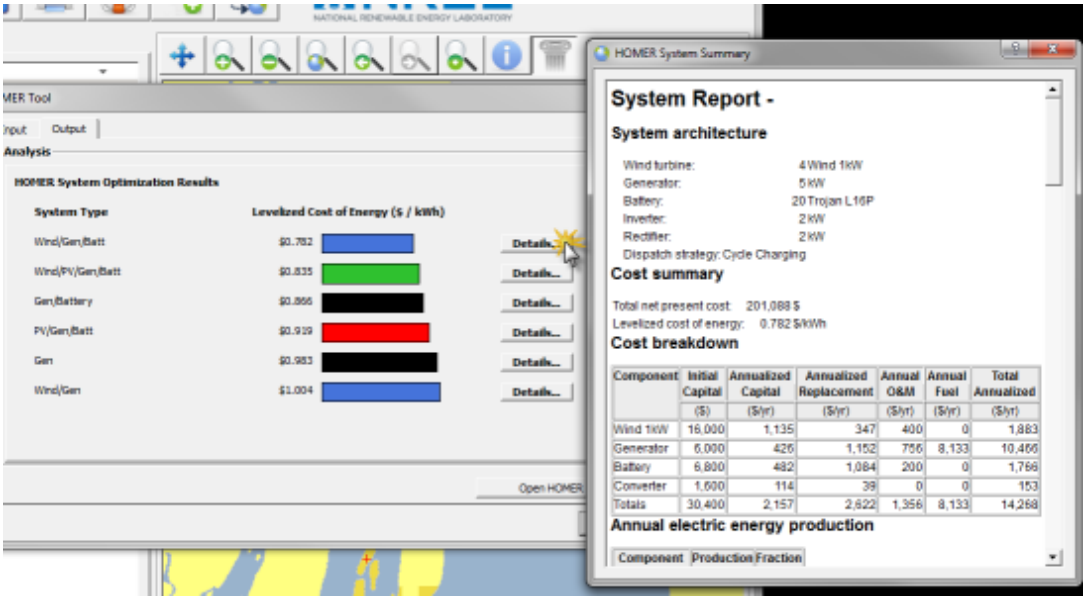
5. Click **Run HOMER Analysis**. HOMER runs in the background, and the toolkit displays HOMER's progress in the status bar. You can stop HOMER by clicking **Cancel Analysis**.



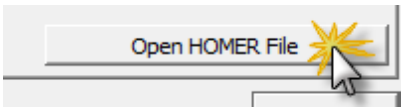
6. When HOMER is finished running, the toolkit displays an output summary on the Output tab. The summary displays a list of the top six system configurations from the HOMER results, in order of increasing cost of energy. The cost of energy is a measure of the cost of installing and operating the system over its lifetime, assumed to be 25 years in the toolkit application files. The toolkit uses the following abbreviations to display HOMER results: Batt, battery; Gen, diesel generator; PV, solar photovoltaic modules; Wind, wind turbine.



7. Click **Details** to view a summary of the results for one of the systems on the Output tab.



8. To open the toolkit application file in HOMER outside of the toolkit, click **Open HOMER File**.



Changing the country

If you install the toolkit for more than one country on your computer, you can change countries.

Note. When you install the toolkit for more than one country, only one copy of the toolkit is installed. If the installer detects a copy of the toolkit on your computer, then it only installs the data files for the new country.

To change the country:

1. Click Change Country Data.

2. Select the country from the list of available countries.

Adding and removing your own data

If you are familiar with geographic information systems (GIS) and have data in the correct format, you can add the data as layers to the map. The data can be in any folder on your computer.

Notes.

You should only attempt to use your own data with the toolkit if you are familiar with GIS data formats, can verify that your files are compatible with the toolkit, and if necessary, use your own GIS tools to change the projection of your data to match the toolkit's projection.

When you add your own data to the toolkit, you will not be able to customize line or fill colors.

Adding incorrectly formatted files to the toolkit will not damage the toolkit, but will result in your data being incorrectly displayed in the toolkit.

The toolkit does not check layers before adding them to the map. If you add a layer from incorrectly formatted files, or data for a different country, the toolkit displays the layer on the map. You can remove the layer if it does not display correctly in your toolkit.

The toolkit uses the shapefile GIS format.

The projection for your data must match the toolkit's projection. The toolkit does not perform any automatic reprojection of data.

You can find information about the toolkit's projection in the metadata file installed with the toolkit in the */data/[country name]/metadata* folder of the toolkit installation folder (*c:/Program Files/NREL/GsT* by default)

Depending on your operating system and where you installed the toolkit,

you may have trouble finding the toolkit installation folder. Your operating system may hide system folders, or you may need administrative privileges to open the folder. For instructions on showing hidden folders, refer to your operating system documentation, or search the internet for "hidden folder."

To add a shapefile layer to the map:

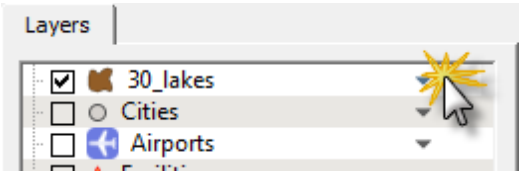
1. Click Add Shapefile Layer.

2. Navigate to the folder containing the file and click Open.

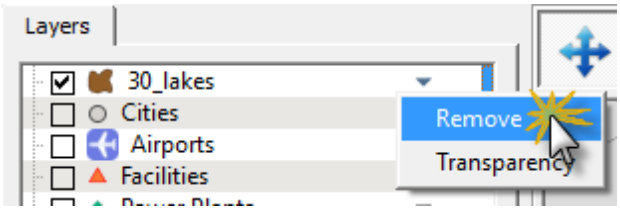
   The toolkit displays the new layer in the layer tree, and shows the layer on the map. If your layer hides other layers in the toolkit, you may need to move it down in the layer tree. See Changing the order of layers for details.

To remove a layer from the map:

1. Click the arrow in the layer on the tree.



2. In the shortcut menu, click **Remove**.



Related topics

- File format reference

Using toolkit data in your own GIS

When you install the toolkit, the installer copies the toolkit data files to the data folder in the toolkit's installation folder. The folder contains a folder for each country included in your toolkit.

You can make copies of the files for use in your own geographical information system (GIS) software.

You can also save query results and use them in your own GIS software. See Save a query for details.

Notes.

The toolkit uses the SpatiaLite GIS format.

You can find information about the toolkit data in the metadata file installed with the toolkit in the */data/[country name]/metadata* folder of the toolkit installation folder (*c:/Program Files/NREL/GsT* by default)

Depending on your operating system and where you installed the toolkit, you may have trouble finding the toolkit installation folder. Your operating system may hide system folders, or you may need administrative privileges to open the folder. For instructions on showing hidden folders, refer to your operating system documentation, or search the internet for "hidden folder."

Related topics

- File format reference

File format reference

The Geospatial Toolkit stores geographic and renewable resource data in a SpatiaLite database . Each layer requires a set of files that store information about each layer in the toolkit.

The toolkit requires a set of seven files for each layer:

dbf, attribute database
Store attributes of feature.

prj, projection format
Information about the coordinate system and projection.

sbn and sbx, spatial index
Index of features to improve performance of the toolkit

shp, shape format
Stores information about the feature geometry

shp.xml, metadata
Stores information describing the feature geometry in xml format

shx, shape index format
Positional index of the feature to improve performance of the toolkit

Glossary

collector
A device used to absorb energy from the sun. A flat collector collects global solar radiation, which includes radiation that reaches the collector directly from the sun and radiation reflected from the ground, nearby objects, clouds, and particles in the atmosphere. A concentrating collector absorbs only solar radiation that reaches the collector in a straight line from the sun. See Renewable resource data for details.

direct normal solar radiation
Solar energy that reaches a point on the earth by traveling in a straight line from the sun to the point. Concentrating solar collectors, including concentrating solar power systems, and some types of solar hot water and photovoltaic systems convert direct normal solar radiation into electricity or heat. See Renewable resource data for details.

global solar radiation
Solar energy that reaches a flat surface on the earth. Global solar radiation includes both direct

normal solar radiation that travels from the sun to the collector in a straight line, and diffuse solar radiation, which may reach the collector after being reflected from the ground, nearby objects, clouds, or particles in the atmosphere. Flat solar collectors, including photovoltaic modules and solar hot water collectors convert global solar radiation into electricity or heat.

layer
A set of geographic data displayed as a color in the map window. The toolkit displays renewable resource data and geographic data as layers on the map.

layer tree
The list of layers along the left edge of the toolkit window. See Showing and hiding layers for details.

pan
Move the map in the map window without changing the map scale. See Using the zoom and pan controls for details.

query
A request you make to the toolkit to display information that meets a set of criteria you specify. When you run a query, the toolkit adds a layer to the layer tree that shows areas on the map that meet the criteria of your query. See Working with queries for details.

scale
A ratio representing the relationship between a distance shown on the map and the actual distance. A map scale of 1:1,000,000 indicates that 1 square centimeter on the map represents 10 km on the ground.

shapefile
A set of files describing characteristics of a layer displayed in the map window. See File format reference for details.

wind power density
A measure of the energy available in the wind for conversion to electricity by a wind turbine. See Renewable resource data for details.

zoom
Display a larger or smaller region of a map. See Using the zoom and pan controls for details.