Renewable EnerGIS User's Guide

Statement of Purpose

Renewable EnerGIS is designed to provide renewable energy resource and site information for specific Hawaii locations selected by the user. This tool is intended to help landowners, developers, and policy makers understand the renewable energy potential of sites statewide. It also provides information to help determine site permitting requirements. No special skills, software or experience with Geographic Information Systems (GIS) are needed.

Please note that the data are not "investment quality" and may not reflect the most recent information. Site surveys and initial due diligence are required to determine actual site attributes. *There is no substitute for obtaining on-site resource data!*

Renewable EnerGIS will help with "first cut" site decisions. In most cases, the data presented in these maps are calculated estimates; measurements for specific sites are very limited and may not be reflected in these maps. Links are provided to some helpful web sites with additional information.

The information presented is based on available data in public GIS files, also known as "layers." The data layers are updated periodically but be aware that data shown on these maps may not be up to date. Please see the GIS_Disclaimer for more information. More detail is available on the source GIS layers for users who have the appropriate software (e.g., ArcView) and experience. The State of Hawaii Office of Planning makes its GIS layers available to the public at http://hawaii.gov/dbedt/gis

Should you be interested in a project on Department of Defense property, early consultation on your plans is requested. Please see the DoD statement for more information.

Renewable EnerGIS does not show existing renewable energy projects. To view information on existing projects, go to Hawaii Renewable Energy Project Directory at the Hawaii State Energy Office website.

GIS Disclaimer

There are no expressed warranties associated with the release of these databases. Specifically, no warranty is made that the GIS data or any subsequent updates will be error free and no warranty is made regarding the positional or thematic accuracy of the GIS data. The GIS data and any features it depicts do not represent or confer any legal rights, privileges, benefits, boundaries or claims of any kind.

DoD Statement

Department of Defense Request for Early Consultation on Renewable Energy and Associated Energy Infrastructure Projects

Department of Defense (DoD) in Hawaii requests early consultation on plans for renewable energy and associated energy infrastructure projects to jointly analyze and mitigate impacts to current and future military training, testing, and readiness including, but not limited to; Military Operating Areas (MOAs), Military Training Routes (MTRs), air space, radar surveillance, coastal, and ground access and ocean use, when making any land use decisions regarding renewable energy. The DoD must also fulfill requirements found in Title 10 United States Code (USC) and the current National Defense Authorization Act (NDAA). Federal agency renewable energy contracting opportunities may be found at: https://www.fbo.gov/

Therefore the following notifications should be made:
Department of Defense (DoD) Energy Siting Clearinghouse (for all projects)
Mr. Michael Aimone
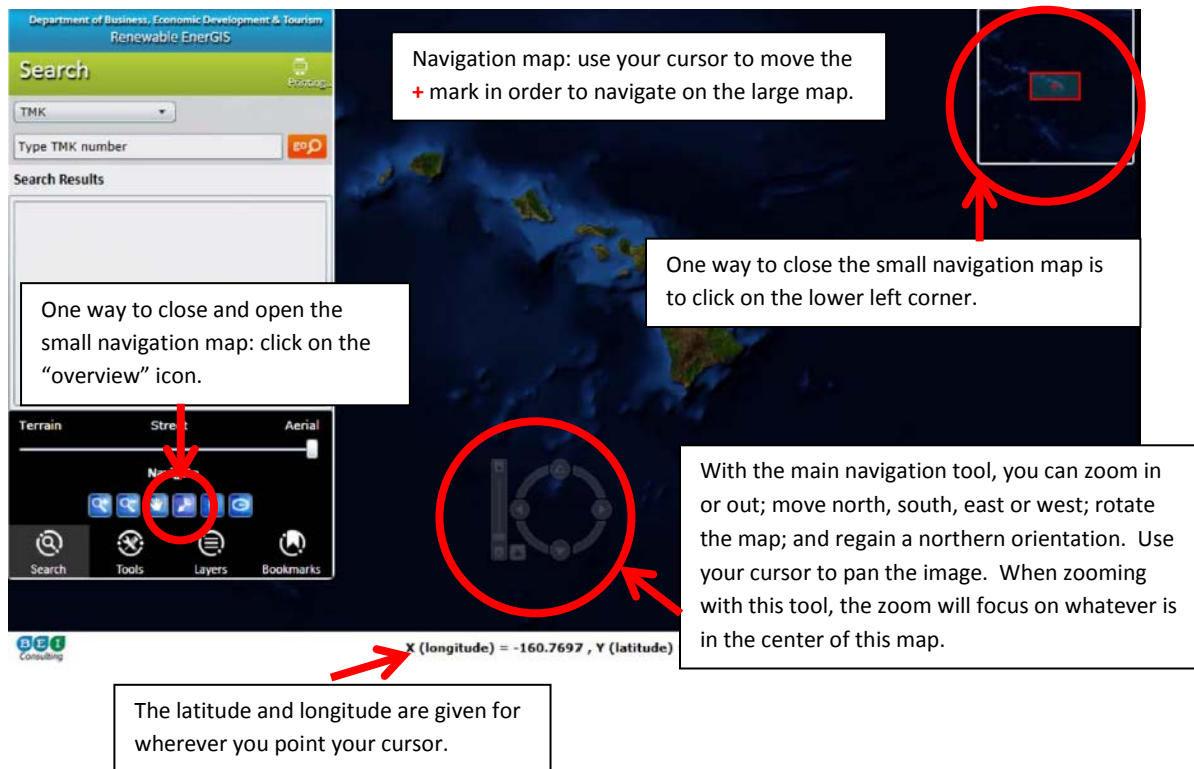mailto:DoDSitingClearinghouse@osd.mil
(572) 372-6745

Definitions and Abbreviations

- ALISH: Agricultural Lands of Importance to the State of Hawaii.
- ALUM: Agricultural Land Use Maps.
- Calories/cm2/day: a measurement of solar energy, calories per square centimeter per day. To convert to other common units, see http://energy.hawaii.gov/wp-content/uploads/2011/10/SolarEnergyUnitConversionTable.pdf.
- DBEDT: Hawaii State Department of Business, Economic Development and Tourism.
- DNI: Direct Normal Insolation (also, Direct Normal Irradiance), a measure of sunlight received on a surface perpendicular to the rays that come straight from the sun. This is of particular interest to concentrating solar technologies.
- GHI: Global Horizontal Insolation (also, Global Horizontal Irradiance), a measure of total sunlight, including both direct and diffuse radiation.
- GIS: Geographic Information Systems.
- kW/m: Kilowatts per meter, used here as a measure of wave energy.
- LUO: Land Use Ordinance.
- m/s: Meters per second, used here as a measure of wind speed.
- mph: Miles per hour, used here as a measure of wind speed.
- REST: Representational State Transfer, a computer architecture which allows peers to exchange information.
- SMA: Special Management Areas are in coastal regions and have special permitting procedures administered by each county as part of the Coastal Zone Management Program.
- TMK: Tax Map Key number. In Hawaii, every parcel has a unique TMK. If you are a landowner, you can locate your TMK on your property tax documentation. TMKs are also identified in maps produced by each county, usually by the planning and/or taxation agencies. Links to each county are given at the bottom of the Detail Page once you have completed a search and also in the "Disclaimers and Helpful Links" link on the **Renewable EnerGIS** landing page.
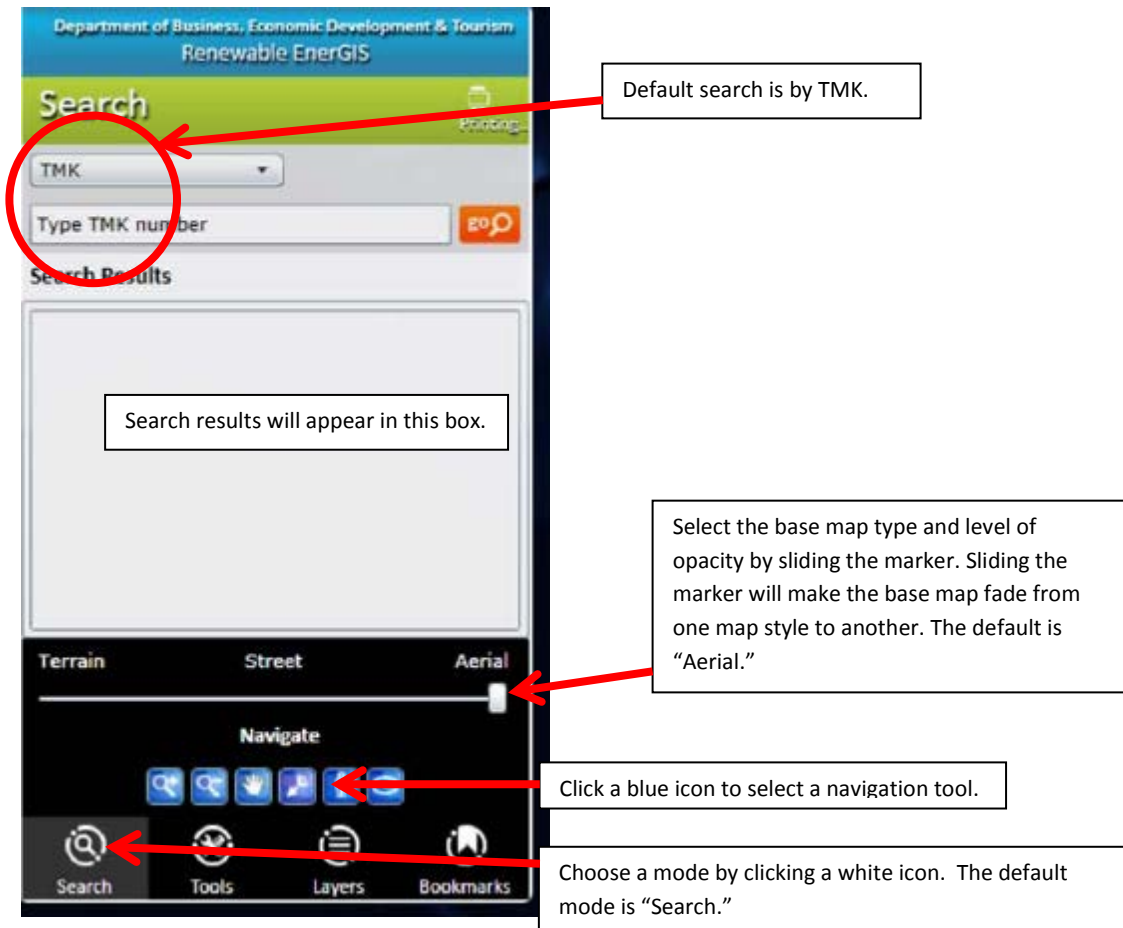- W/m2: Watts per square meter, a measurement of energy density (used in this application for wind).

How to Use Renewable EnerGIS

Getting Started

1. Disable Pop-Up Blockers for Renewable EnerGIS. Some of Renewable EnerGIS functions, such as producing a Detail Page or using the Streetview/Birds' Eye tool, function as separate pop-up windows. You can instruct your computer to allow pop-ups for Renewable EnerGIS without affecting the pop-up blocks for other applications.

2. Set the Proper Screen Resolution. When you first open Renewable EnerGIS, check that the entire application is visible. Along the bottom, you should see the longitude and latitude bar. At the bottom of the pane at the left, which is set to "Search" as a default, you should see a black section containing a slider bar labeled "Terrain – Street – Aerial," followed by six blue Navigation tools, followed by four white mode icons (Search, Tools, Layers and Bookmarks.) If any of those items are cut off, reset the resolution of your computer monitor. A resolution of 1280x768 (or similar) will display the entire application. The resolution of your computer monitor is usually set through your computer's Control Panel.

3. Using the Navigation Map. When you first open Renewable EnerGIS, you'll see a map of the Hawaiian Islands. In the upper right hand corner is a navigation map; by pointing your cursor at the red "**+**" mark and moving it on the small map, you can navigate on the large map.

Navigation map: use your cursor to move the + mark in order to navigate on the large map.

One way to close the small navigation map is to click on the lower left corner.

One way to close and open the small navigation map: click on the "overview" icon.

With the main navigation tool, you can zoom in or out; move north, south, east or west; rotate the map; and regain a northern orientation. Use your cursor to pan the image. When zooming with this tool, the zoom will focus on whatever is in the center of this map.

The latitude and longitude are given for wherever you point your cursor.

4. Closing the Navigation Map. You can close the small navigation map in two ways: by clicking on the bottom left hand corner of the small map's white border, or by clicking on the blue "overview" icon in the Navigate section. To make the small navigation map reappear, click on the small white dot in the upper right hand corner of the map or on the "overview" icon.

5. Using the Gray Navigation Tools. In the lower part of the large navigation map are standard navigation tools colored gray. Hover your cursor over the tools to activate them. The vertical slider bar will zoom in to the center of the map as you slide upwards, toward the "+" sign, or zoom out as you slide down, toward the "–" sign. The circular navigation tool allows you to move north, south, east or west if you click on the arrows. If you point to the circle itself and drag around its perimeter, you will rotate the entire map. To recover a north orientation, click on the "reset north" button between the vertical slider bar and the circle.

Default search is by TMK.

Search results will appear in this box.

Select the base map type and level of opacity by sliding the marker. Sliding the marker will make the base map fade from one map style to another. The default is "Aerial."

Click a blue icon to select a navigation tool.

Choose a mode by clicking a white icon. The default mode is "Search."

6. Using the Blue Navigation Tools. Additional navigation tools are in the black section at the bottom of the search pane: six blue icons labeled "Navigate." From left to right, they allow you to: 1) zoom in, 2) zoom out, 3) pan, 4) hide or unhide the overview window (as described above), 5) obtain a street/bird's eye view, and 6) select features by point. Click on any of these

icons to select them, then move your cursor to the map to apply them. To activate the Zoom tools, drag the tool onto the map, then create a rectangle by dragging your cursor. For the Street/Bird's Eye View tool, click on the tool and then on the map where you want to activate the view function. A "pushpin" icon will appear, and the Street/Bird's Eye maps will open in a separate window (your pop-up blocker needs to be deactivated for this feature to work).

7. Selecting the Base Map. In the black section at the bottom of the search pane at the left of the page, there is a slider bar marked "Terrain," "Street," and "Aerial." Slide this bar to display different versions and opacities of the base map. It may be helpful to select "Terrain" or "Street" if you are also trying to display data shown by gradations of color, such as solar or wind resources, or rainfall.

8. Selecting a Search Mode. In the black section at the bottom of the Search pane are four white icons. The default is the "Search" icon, which allows you to search by TMK or Site Address (see below for instructions.) You can also search by Tools—that is, by drawing a point or polygon on the map, which is helpful if you don't know the street address or TMK.

9. Selecting Tools. The white "Tools" icon in the black section at the bottom of the Search pane allows you to choose a variety of tools to identify and get information about a site. See the Tools instructions, below.

10. Selecting Layers. The white "Layers" icon in the black section at the bottom of the Search pane allows you to view the energy resource and other helpful GIS "layers" of information. See the Layers instructions, below.

11. Designating Bookmarks. The white "Bookmarks" icon in the black section at the bottom of the Search pane will let you bookmark a site that you have researched. Several bookmarks are already created for you, corresponding to the individual counties plus a "statewide" map. Create a bookmark by entering a bookmark name and clicking the "+" button.

12. Linking to the Energy Office Homepage. To link to the State Energy Office's main website, click on the words "Hawaii State Energy Office" or the DBEDT logo at the top of the detail page you have researched.

13. Linking to the Office of Planning GIS Homepage. To link to the State Office of Planning's GIS website, click on the words "Hawaii Statewide GIS Program" at the bottom of the detail page you have researched.

14. Printing Your Results. There is a "Print this Page" function at the top right of your detail page, as well as a Print icon at the top right of the green field in the Search pane.

Searching by TMK

1. Search by TMK. This is your default option. Enter the TMK of the parcel you wish to research. Do not enter any punctuation such as colons or hyphens. As you begin to type, the application will provide a list of TMK numbers sharing the numerals you have entered. To select one, click on it in the list. Or, continue typing to completely enter a unique TMK number. If you are a landowner, you can locate your TMK on your property tax documentation. Otherwise, TMKs are identified in maps produced by each county, usually by the planning and/or taxation departments. Links to each county are given at the bottom of the Detail Page once you have

completed a search, and in the "Helpful Links" page accessed on the **Renewable EnerGIS** landing page.

2. <u>Getting TMK Parcel Information</u>. Once a TMK is entered, click on the red "go" button to the right of the entry field. The map will automatically zoom to that specific property and provide its street address. It will also offer you three action options: "Go To," "Details," and "Street/Birds Eye."

   a. If you only have one TMK result from your search, you don't need "Go To." However, if your search resulted in multiple TMKs, as is likely if you searched by polygon (see below) or a fragment of a TMK number, rather than by entering a specific complete TMK, you can click on the "Go To" command for the individual TMK you want.

   b. Clicking on "Details" will provide you with a Detail Page on a separate browser window consisting of a map of the site, information on the renewable energy resources for the site, and helpful links.

   c. Clicking "Street/Bird's Eye" will give you the ability to see the site using Google's Streetview or Bing's Bird's Eye functions on a separate browser window. Note that these views are not available for every location, especially those not viewable from public roads.

To search by site address instead of TMK, pull down the menu using the inverted triangle and click on "site address."

Entering a partial TMK may result in multiple results when you select "go." Do not enter punctuation such as colons or hyphens.

For each record found, you can select "Go To," "Details," or "Street/Bird's Eye" view.

Searching by Site Address

1. <u>Changing the Search to use Site Address instead of TMK.</u> In the Search pane, you are offered TMK as the default search method. To change it to Site Address, pull down the menu designated by the inverted triangle and click on "Site Address." Please note that the site address is the physical address of the property, which is not necessarily the same as the mailing address, and that not every location has a site address.
2. <u>House Number and Street Name.</u> You are then offered two fields: one to enter a house number, the other to enter a street name. It's best to enter the street name without the addition of words like "Street," "Drive," or "Place," as the database may not recognize those words. If there are multiple records (for instance, the same name for a "Street" as for a "Place"), you can choose which one you want from the displayed list. Try entering a partial number (e.g., "41" instead of "4110") and/or a partial name (e.g., "ber" instead of "Beretania") if entering the exact number or name returns no results. Entering a partial number or name may give you multiple potential results, allowing you to select the one you want from the list.
3. <u>Getting Parcel Information.</u> The TMK for each property identified in the search will be displayed, along with the "Go To," "Details," and "Street/Bird's Eye" options for you to select. These options are described in the TMK Search section, above.

<u>Searching with "Tools"</u>

1. <u>Change to Tools Mode.</u> You can change the Search pane to the Tools pane by clicking on the white "Tools" icon in the black Navigate box at the bottom of the left hand window.
2. <u>Available Tools.</u> The tools available to you are labeled. You can measure distance; measure an area; select features within a set buffer distance of a point; select features by point, line, polygon or rectangle (see below); or view the details of an area on the ocean.
3. <u>Using "Select Features".</u> Click on the words "Select Features" to reveal six new tools to identify areas of the map you wish to research. Passing your cursor over each tool gives you additional instructions on their use. Once you have selected a tool by clicking on it, move your cursor to the map to indicate the area you want to research.
4. <u>Using "Ocean Search".</u> This search tool is provided since you cannot locate an area in the ocean by TMK or site address. Click on "Ocean Search," draw a polygon on the ocean, and a Detail Page will open in a separate tab on your browser for the sea area selected. If you draw an area larger than 20 square miles, details will not be returned; redraw a smaller area to return details. See information on Detail Pages, below.

Select the "Tools" mode by clicking on the Tools icon at the bottom of the navigation pane.
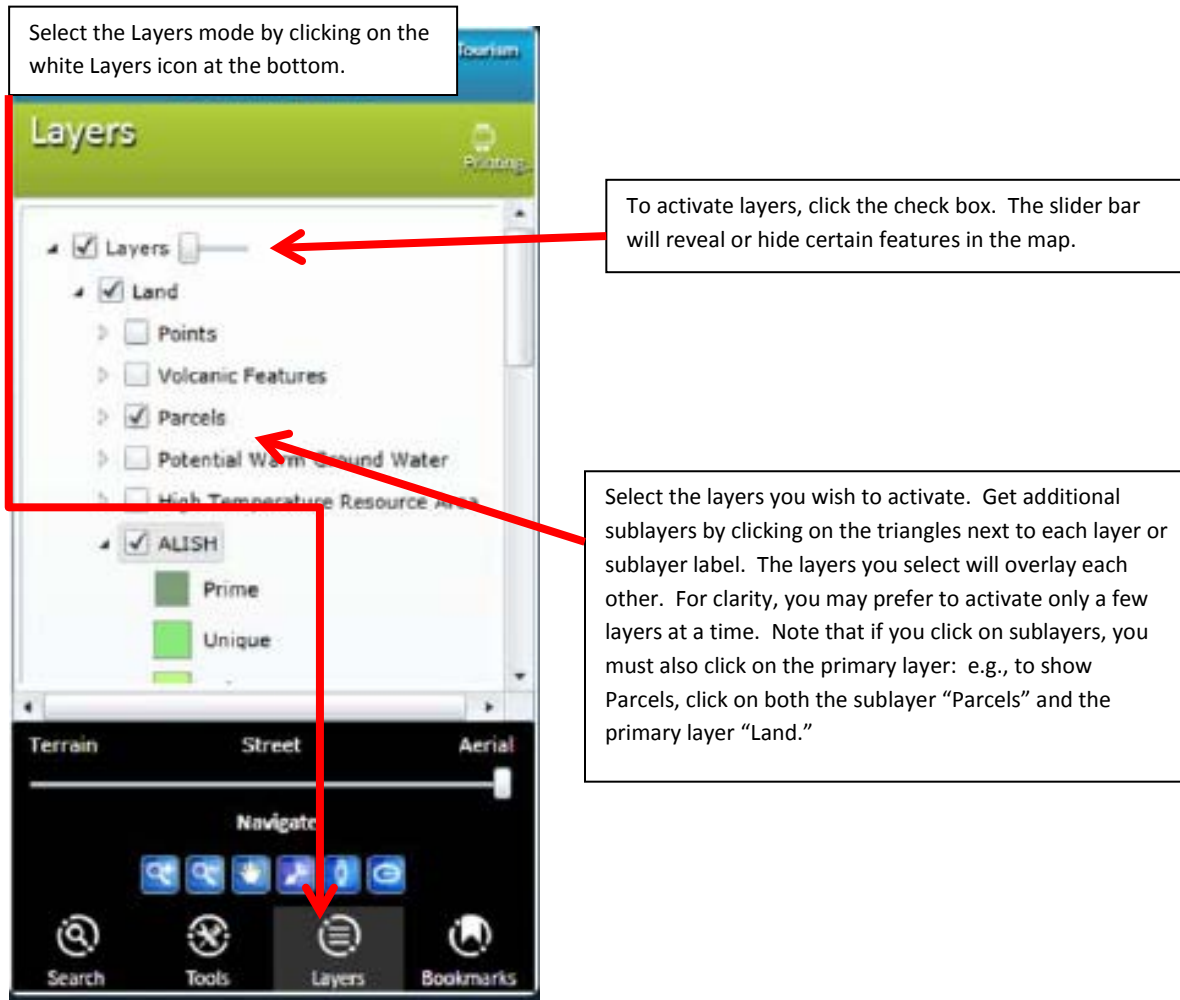

Five tools are available.

Click on "Select Features" to show additional tools you can use to select features by point, line, polygon or rectangle, and to clear your selection.

Using "Layers"

1. <u>Change to "Layers" Mode.</u> To change to "Layers" mode, click on the white "Layers" icon at the bottom of the black Navigate pane. The "Layers" mode allows you to select representations of various renewable energy resources, as well as other features of the State of Hawaii and surrounding waters. Using "Layers" will give you a bigger picture of the distribution of resources and may allow you to focus your search accordingly. You can also apply the "Layers" to a specific property you have identified through a Search.

2. <u>Layers Categories.</u> There are three categories of Layers: Land, Ocean, and Wind Power Density at 50m.

3. <u>Check Boxes</u>. To activate the layers, click on the appropriate check boxes. The Land layers are checked as a default. Note that the data layers are overlaid on each other on the map so that
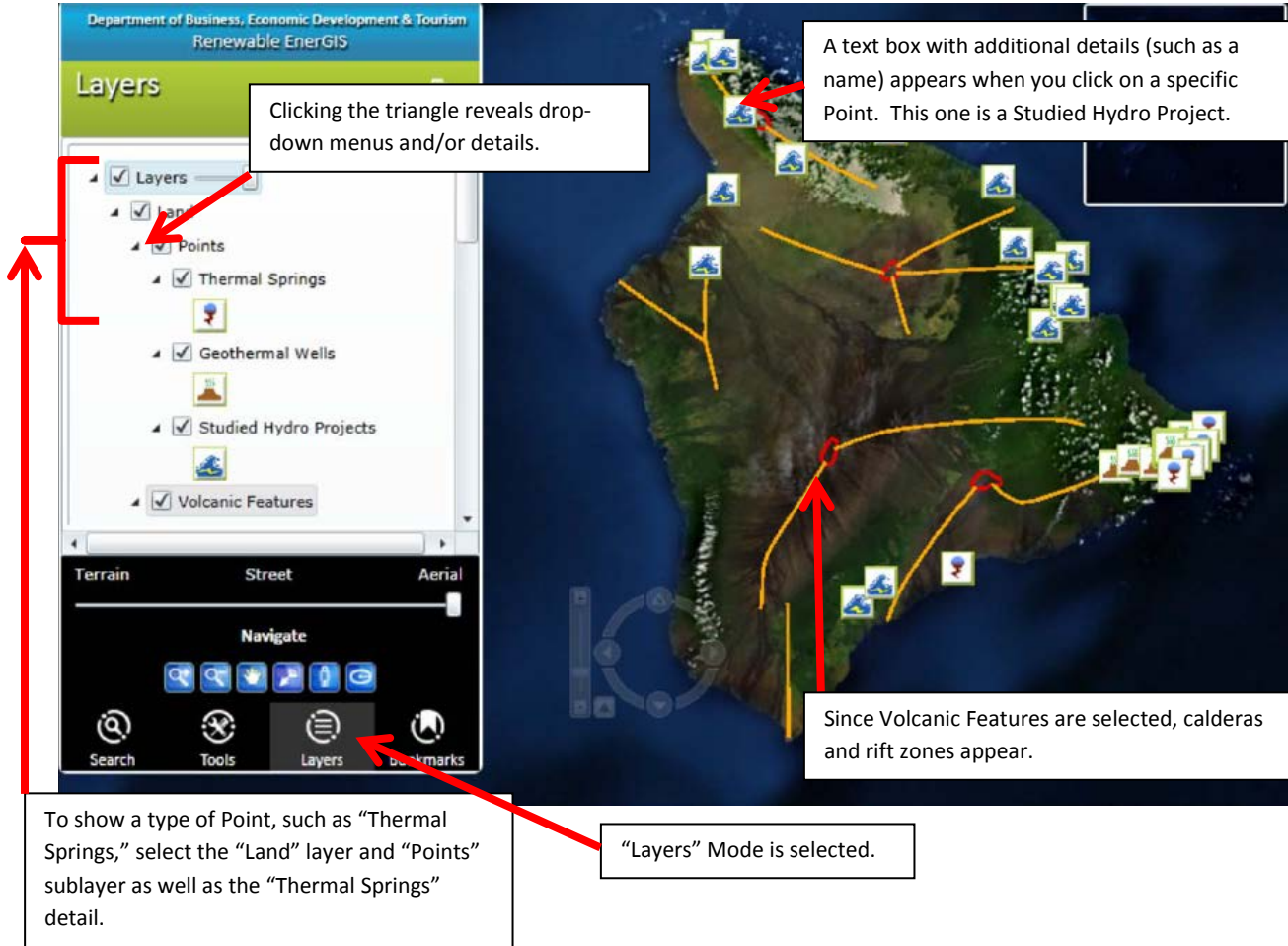
the more layers you choose, the more complex the image generated. You may find it helpful to be selective in which layers are activated.

Select the Layers mode by clicking on the white Layers icon at the bottom.

To activate layers, click the check box. The slider bar will reveal or hide certain features in the map.

Select the layers you wish to activate. Get additional sublayers by clicking on the triangles next to each layer or sublayer label. The layers you select will overlay each other. For clarity, you may prefer to activate only a few layers at a time. Note that if you click on sublayers, you must also click on the primary layer: e.g., to show Parcels, click on both the sublayer "Parcels" and the primary layer "Land."
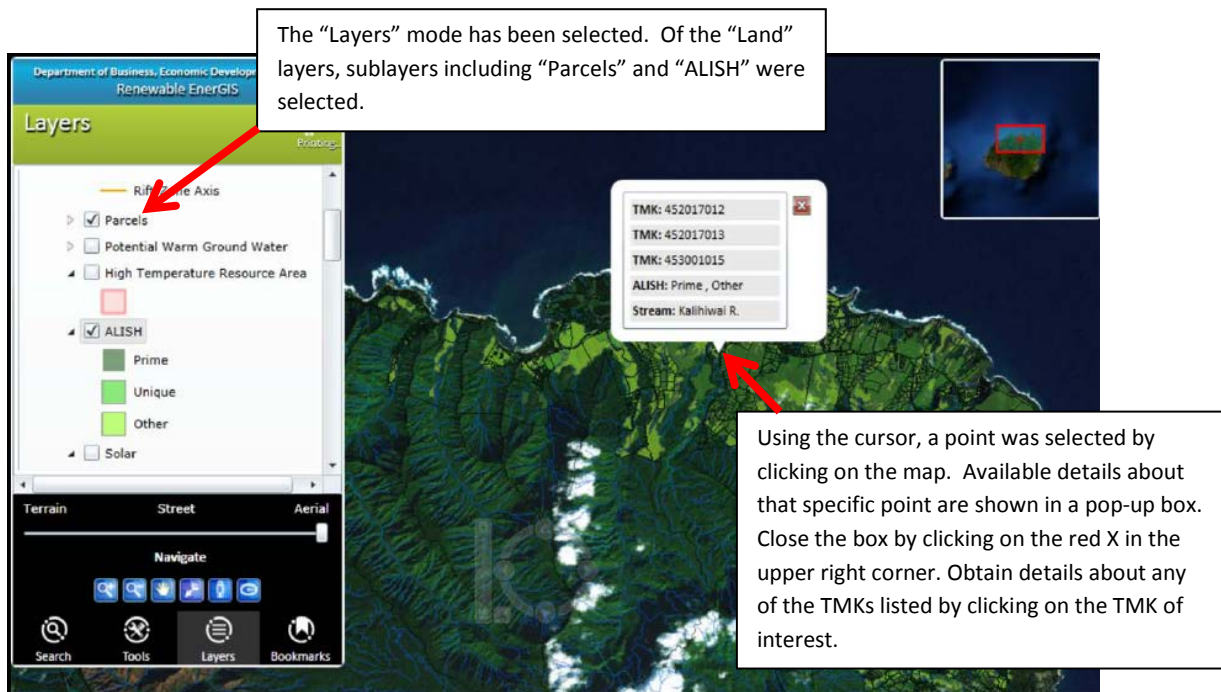
4. <u>If Selected Features Do Not Appear.</u> If a layer is activated by checking the appropriate boxes but no features appear on your map, there may be no resources in that category within the area selected. For instance, the "Geothermal Well" Points will only appear in the Puna District of Hawaii Island, since that is the only location where geothermal wells exist. If you activate a layer and no images result, your site probably does not have that feature or resource; you can zoom out to an islandwide or statewide view to see where the resource exists elsewhere in Hawaii.

5. <u>Drop-Down Menus.</u> Once you have checked one (or more) of the three main categories of Layers (Land, Ocean and Wind Power Density), click on the adjacent arrow—which is a drop-down menu—to see the individual sublayers which can be selected. For instance, under the primary layer, "Land," there is a sublayer called "Points." The three kinds of points which can be selected are "Thermal Springs," "Geothermal Wells," and "Studied Hydro Projects." In order to

see a specific type of point, such as Thermal Springs, both the primary layer ("Land") and the sublayer ("Points") must be selected in addition to the "Thermal Springs" detail.

6. <u>Point Cursor To Map.</u> Once you have layers selected, you can point your cursor to a spot on the map, either on land or in the ocean, to show details about that specific site

Clicking the triangle reveals drop-down menus and/or details.

A text box with additional details (such as a name) appears when you click on a specific Point. This one is a Studied Hydro Project.

Since Volcanic Features are selected, calderas and rift zones appear.

To show a type of Point, such as "Thermal Springs," select the "Land" layer and "Points" sublayer as well as the "Thermal Springs" detail.

"Layers" Mode is selected.

The "Layers" mode has been selected. Of the "Land" layers, sublayers including "Parcels" and "ALISH" were selected.

TMK: 452017012
TMK: 452017013
TMK: 453001015
ALISH: Prime , Other
Stream: Kalihiwai R.

Using the cursor, a point was selected by clicking on the map. Available details about that specific point are shown in a pop-up box. Close the box by clicking on the red X in the upper right corner. Obtain details about any of the TMKs listed by clicking on the TMK of interest.

7. Explanation of the Land Layers:
   a. Land/Points/Thermal Springs: identified warm springs.
   b. Land/Points/Geothermal Wells: geothermal wells which have been drilled as of 2000[1].
   c. Land/Points/Studied Hydro Projects: selected hydroelectric sites which have been studied prior to 2011 and which met certain feasibility criteria assigned by the U.S. Army Corps of Engineers in a 2011 resource assessment[2]. More information on each of these sites may be found in the 2011 resource assessment, including estimated power output.
   d. Land/Volcanic Features/Inferred Caldera Boundary: the approximate extent of the calderas of the volcanoes which formed the Hawaiian Islands[3].
   e. Land/Volcanic Features/Rift-Zone Axis: the approximate axes of the rift zones for the volcanoes which formed the Hawaiian Islands.
   f. Land/Parcels: outlines of the property parcels; the parcels correspond to individual TMKs.
   g. Land/Potential Warm Ground Water: areas where there is evidence of warm ground water.

[1] GeothermEx, Inc., 2000. *Update of the Statewide Geothermal Resource Assessment of Hawaii*. Prepared for Hawaii Department of Business, Economic Development and Tourism. Available at: http://energy.hawaii.gov/resources/hawaii-state-energy-office-publications
[2] *Hydroelectric Power Assessment – State of Hawaii Section 905(b) WRDA 1986 Analysis Report Reconnaissance*. Prepared for the U.S. Army Corps of Engineers, May 2011. Available at: http://energy.hawaii.gov/resources/hawaii-state-energy-office-publications
[3] GeothermEx, Inc., 2005. *Assessment of Energy Reserves and Costs of Geothermal Resources in Hawaii*. Prepared for Hawaii Department of Business, Economic Development and Tourism. Available at http://energy.hawaii.gov/resources/hawaii-state-energy-office-publications

h. Land/High Temperature Resource Area: areas where it is likely that high temperature geothermal resources exist[4].
i. Land/ALISH: Agricultural Lands of Importance to the State of Hawaii, as designated by the Hawaii State Department of Agriculture, are indicated by color: Prime, Unique and Other.
j. Land/Solar: the estimated solar resource, in calories per square centimeter per day, is indicated by color. For a table converting these units to other commonly-used units, see http://energy.hawaii.gov/wp-content/uploads/2011/10/SolarEnergyUnitConversionTable.pdf
k. Land/Rainfall: annual inches of rainfall are indicated by color.
l. Land/Ditches: constructed ditches are part of the base map, and are shown in light blue.
m. Land/Streams: natural watercourses are part of the base map and are shown in dark blue.

8. Explanation of the Ocean Layers:
a. Ocean/Wave Energy Transects: these lines indicate areas of windward coastline where the ocean wave energy resource has been estimated.[5] Point and click on a transect line to show the estimated energy potential, given in kilowatts per meter. For more information on wave energy, go to http://hinmrec.hnei.hawaii.edu/about/.
b. Ocean/Whale Sanctuaries: the shading indicates the extent of the Hawaiian Islands Humpback Whale National Marine Sanctuary. For more information on the Sanctuary, go to http://hawaiihumpbackwhale.noaa.gov/.
c. Ocean/Bathymetry: shows contour lines indicating the slope of the sea floor surrounding Hawaii.
d. Ocean/3 Mile Boundary: shows the area of ocean from the coastline to 3 miles, which defines State of Hawaii waters.
e. Ocean/12 Mile Boundary: shows the area of ocean from the coastline to 12 miles.
f. Ocean/Average Temperature Difference: colors indicate a range of temperature differences between the average temperature at 20 meters depth and the average temperature of water at 1,000 meters depth. Temperatures are in degrees Celsius.
g. Ocean/Temperature Amplitude Difference: a measure of how the ocean thermal resource deviates from the average in time. Around Hawaii, it broadly follows a decreasing North-South trend. Temperatures are in degrees Celsius.

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[4] GeothermEx, Inc., 2005. *Assessment of Energy Reserves and Costs of Geothermal Resources in Hawaii*. Prepared for Hawaii Department of Business, Economic Development and Tourism. Available at http://energy.hawaii.gov/resources/hawaii-state-energy-office-publications
[5] SEASUN Power Systems, 1992. *Wave Energy Resource and Economic Assessment for the State of Hawaii*. Available at: http://energy.hawaii.gov/resources/hawaii-state-energy-office-publications

The Temperature Average Difference sublayer has been selected (the selection would show if you scrolled down in the Layers pane), but these data are only given for deeper waters where OTEC may be feasible. Therefore, the specific point selected in this example does not have this detail.
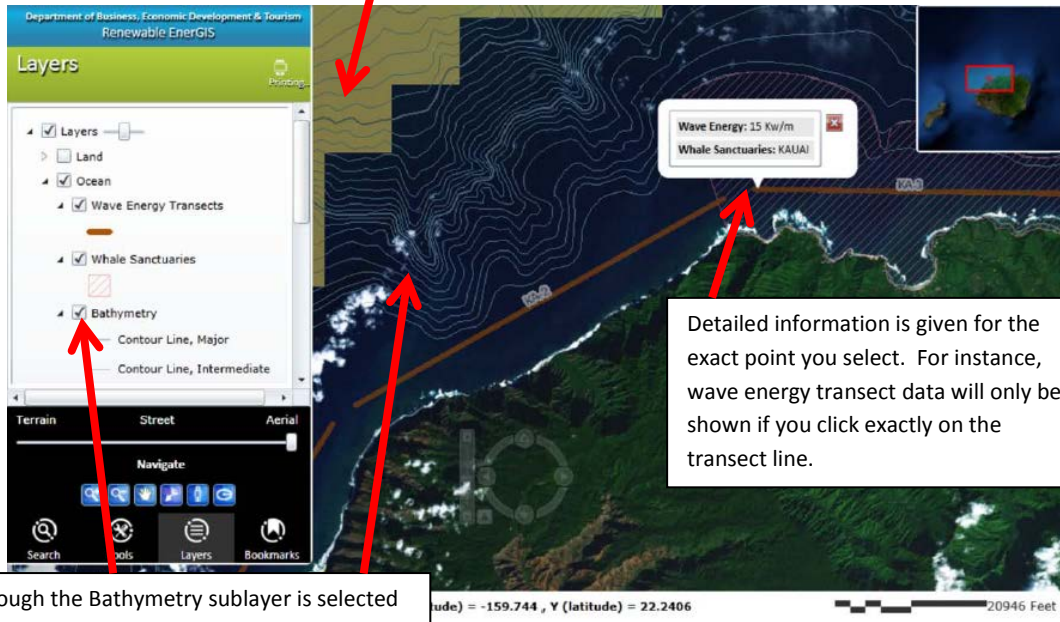
Detailed information is given for the exact point you select. For instance, wave energy transect data will only be shown if you click exactly on the transect line.

Although the Bathymetry sublayer is selected and the bathymetric contours are shown on the map, in this example no ocean depth is given for the selected point since it is not exactly on a bathymetric contour.

Click to toggle the scale bar from feet to miles.

9. Explanation of the Wind Power Density at 50m Layer:
   a. Wind Power Density is an indication of the power available in the wind as expressed in watts per square meter. The density is shown as colors and extends over the land as well as the sea. Estimates were made by the National Renewable Energy Laboratory at a height of 50 meters.

Once You Have Selected a Property by Searching

1. As previously noted, you can search by TMK, by Site Address, or by designating a point or polygon (see above instructions on searching.)
2. Once you have searched, the pane at the left side of your screen will show you how many records were found. There may be multiple records, depending on the scope of your search.
3. You can clear or export the results of your search by clicking on the "Clear Results" or "Export Results" links, and you can print by selecting the Print icon at the top of the pane.

4. Each record which resulted from your search will be listed with the site address (if applicable), TMK, and three functions: "Go To," "Details," and "Street/Bird's Eye." These functions are explained in "Search by TMK," above.

5. To obtain the Detail Page for a specific site, click on "Details" for the address, TMK, or ocean area you want to research. The Detail Page will list additional information on the site's zoning, energy resources, and other features.

6. Once you click on "Details," the Detail Page will appear in a separate tab on your browser. Click on that tab to open the Detail Page. Your pop-up blocker must be deactivated to obtain a detail page. The home Renewable EnerGIS page will remain open on its own tab.

In this sample, the "point select" tool was used to select a point in central Oahu. The search returned a single TMK, which is outlined in blue and listed as the sole record found.

The navigation box shows where on Oahu the TMK is located.

The base map is set to show an aerial view.

The Tools mode was selected by clicking on the icon at the bottom of the pane.
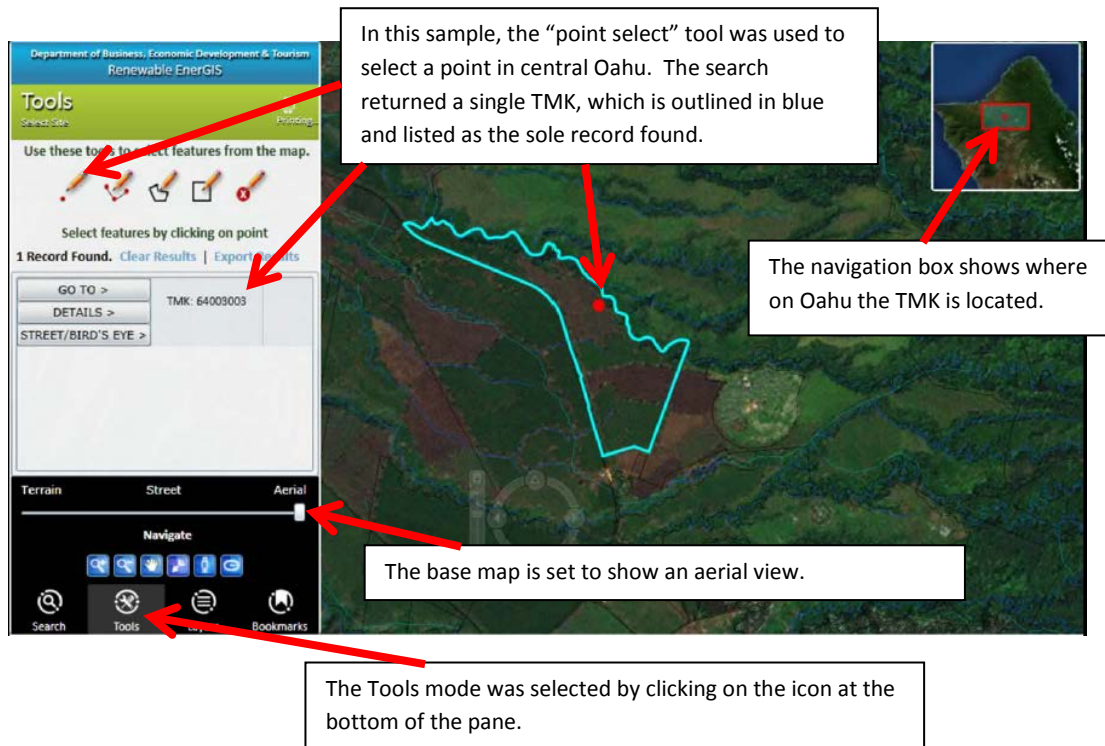
To open a Detail Page for the search such as that illustrated above, click on "Details" for the TMK you wish to research. In this example, there is only one record found. Some searches will find multiple records and you will need to choose which of the resulting TMKs you want to research further. The Detail Page for the selected TMK will open in a separate tab on your browser.

Features of the Detail Page

1. At the top of the page appear the DBEDT logo and the words "Hawaii State Energy Office **Renewable EnerGIS**," which are also links to the State Energy Office main website.
2. A "Print This Page" feature at the upper right of the page allows you to print a pdf or hardcopy of the Detail Page.
3. A map shows the outlines of the property and other selected features. In some cases, the words "map data not yet available" may appear instead of a map. Simply zoom out slightly (by scrolling down using your mouse) to obtain a map. This map uses the same three base maps as the main navigation map, and reflects the choice of base map and the opacity that you selected.
4. Immediately beneath the map, the TMK and site address (if applicable) appear.
5. Seven different energy resources are listed. These bars can be expanded by clicking on the icon or on the "+" sign. The resources are: biomass, geothermal, hydroelectric, OTEC, solar, wave and wind. Opening a resource bar reveals detailed information pertinent to that resource (see details below.) Note that pertinent details about your selected parcel appear under different resource bars; even if you're only researching solar energy, for instance, you may want to look under other resources to get even more information about your selected parcel.

6. If no data are available for a particular resource, the words "no data available" appear on the bar. For instance, if you are researching a land-based site, the ocean energy bars (OTEC and Wave) should read "no data available."

These logos are links to the State's energy website.

You can zoom in and out on the detail map using the scroll wheel on your mouse.

The TMK for the location you selected is given. In this example, there is a TMK but no site address.

You can open details for any of the seven renewable energy resources by clicking on the "+" sign or on the icon. This will expand the category selected. For this land-based site, no data are available for ocean energy resources.

7. Below the list of resources are links to GIS REST Services. For those wanting the background information which was used to develop Renewable EnerGIS, links are provided to Operational Layers, Detail Layers, and the State GIS Data website. Those with the appropriate experience and software can access the State of Hawaii's GIS data and create customized maps.
8. Additional Resources are given as links to a variety of county, state and national websites.

9. At the bottom of the page, a series of agency logos will connect you to additional helpful websites. Contact information for **Renewable Ener**GIS project manager is also provided.
10. Please also see the terms of use and privacy policy; links are at the very bottom of the Detail Page. A feedback form is provided for your comments.

GIS professionals can access the data layers used in **Renewable Ener**GIS.

These links may be of interest. The logos are links as well.

Your feedback is welcome!

Biomass Details

1. State Land Use District: lists the Land Use District(s)—Urban, Rural, Agriculture and Conservation—for the property you have selected.
2. Zoning LUO Designation: The zoning according to Land Use Ordinance. These are county-level data and at this time are available only for the City and County of Honolulu and the County of Hawaii. NOTE: if the Zoning LUO Designation is given as F-1, Federal & Military Preservation District, or if military use of the site is otherwise indicated, the Department of Defense requests early consultation. See the DoD statement.
3. Soil Type (Land Study Bureau): Soil types are rated from A to E. Refer to Hawaii Revised Statutes Chapter 205-4.5 for information on permissible uses of agricultural lands. The URL is: http://www.capitol.hawaii.gov/hrscurrent/Vol04_Ch0201-0257/HRS0205/HRS_0205-0004_0005.htm.
4. ALISH: If the property has Agricultural Lands of Importance to Hawaii, as designated by the Hawaii State Department of Agriculture, the designation is listed.
5. ALUM: If the property is listed on the Agricultural Land Use Maps, promulgated by the Hawaii State Department of Agriculture, the designation is given here.
6. Rainfall: the annual inches of rainfall for the selected property are given.

7. Flood Zone: If the selected property is in a flood zone, the designation(s) are given. Note that flood zone data are not available for Hawaii County. For a key to the designations, go to http://hawaii.gov/dbedt/gis/data/dfirm.pdf.
8. Reserve: Parks, forest reserves, game management areas and similar areas are listed as "Reserves." If the property includes any reserves, they are listed here.
9. Critical Habitat: If the property includes any areas identified by the U.S. Fish and Wildlife Service as critical habitats for threatened and endangered species, the word "Yes" will appear here. To find out more about the habitats, go to criticalhabitat.fws.gov/crithab/.
10. SMA: Indicates if the selected property is within a coastal Special Management Area. Check with the appropriate county agency regarding permit procedures for projects within SMAs.

Geothermal Details
1. Geothermal Resources: indicates if the selected property contains a geothermal feature such as a caldera or a rift-zone axis.
2. Warm Ground Water: indicates if the selected property overlies a region likely to have warm ground water.
3. State Land Use District: lists the Land Use District(s)—Urban, Rural, Agriculture and Conservation—for the property you have selected.
4. Zoning LUO Designation: The zoning according to Land Use Ordinance. These are county-level data and at this time are available only for the City and County of Honolulu and the County of Hawaii. NOTE: if the Zoning LUO Designation is given as F-1, Federal & Military Preservation

District, or if military use of the site is otherwise indicated, the Department of Defense requests early consultation. See the DoD statement.

5. Soil Type (Land Study Bureau): Soil types are rated from A to E. Refer to Hawaii Revised Statutes Chapter 205-4.5 for information on permissible uses of agricultural lands. The URL is: http://www.capitol.hawaii.gov/hrscurrent/Vol04_Ch0201-0257/HRS0205/HRS_0205-0004_0005.htm.

6. Reserve: Parks, forest reserves, game management areas and similar areas are listed as "Reserves." If the property includes any reserves, they are listed here.

7. Critical Habitat: If the property includes any areas identified by the U.S. Fish and Wildlife Service as critical habitats for threatened and endangered species, the word "Yes" will appear here. To find out more about the habitats, go to criticalhabitat.fws.gov/crithab/.

8. SMA: Indicates if the selected property is within a coastal Special Management Area. Check with the appropriate county agency regarding permit procedures for projects within SMAs.

Hydroelectric Details

1. Streams: the names of streams within the selected property are listed, along with whether they are perennial, non-perennial or intermittent.

2. Ditches: manmade ditch features such as aqueducts and siphons are listed here if they appear in the selected property.

3. Rainfall: the annual inches of rainfall for the selected property are given.

4. Flood Zone: If the selected property is in a flood zone, the designation(s) are given. Note that flood zone data are not available for Hawaii County. For a key to the designations, go to http://hawaii.gov/dbedt/gis/data/dfirm.pdf.

5. Studied Hydro Projects: if the selected property contains a site which was studied for hydroelectric potential and which met certain feasibility criteria established by the US Army Corps of Engineers during its 2011 hydroelectric assessment, it is listed here. For the assessment report, which contains details of the assessment and feasibility criteria, go to the publications page of the Hawaii State Energy Office website or this specific link: http://energy.hawaii.gov/wp-content/uploads/2011/10/HydroelectricPowerAssess.pdf.

6. Slope Percent: a range is given for the slope of terrain within the selected property.

7. Soil Drainage: a description of the soil drainage according to the NRCS Soil Survey Geographic Database is listed: http://soils.usda.gov/survey/geography/ssurgo

8. State Land Use District: lists the Land Use District(s)—Urban, Rural, Agriculture and Conservation—for the property you have selected.

9. Zoning LUO Designation: The zoning according to Land Use Ordinance. These are county-level data and at this time are available only for the City and County of Honolulu and the County of Hawaii. NOTE: if the Zoning LUO Designation is given as F-1, Federal & Military Preservation District, or if military use of the site is otherwise indicated, the Department of Defense requests early consultation. See the DoD statement.

9. Reserve: Parks, forest reserves, game management areas and similar areas are listed as "Reserves." If the property includes any reserves, they are listed here.

10. Critical Habitat: If the property includes any areas identified by the U.S. Fish and Wildlife Service as critical habitats for threatened and endangered species, the word "Yes" will appear here. To find out more about the habitats, go to criticalhabitat.fws.gov/crithab/.
11. SMA: Indicates if the selected property is within a coastal Special Management Area. Check with the appropriate county agency regarding permit procedures for projects within SMAs.

OTEC Details
1. Temperature Average Difference (20m-1000m depths): indicates the average temperature difference, in degrees Celsius, between shallow and deep water in the sea area selected. Note that these data are not available for nearshore waters which are not deep enough for OTEC.
2. Temperature Amplitude Difference (20m-1000m depths):   a measure of how the ocean thermal resource deviates from the average in time. Around Hawaii, it broadly follows a decreasing North-South trend. Temperatures are in degrees Celsius. Note that these data are not available for nearshore waters which are not deep enough for OTEC.
3. Marine Reserves: indicates if the selected sea area is within designated marine reserves.
4. SMA: Indicates if the selected property is within a coastal Special Management Area. Check with the appropriate county agency regarding permit procedures for projects within SMAs.
5. Benthic Zone: information on sea floor composition within the sea area selected.
6. Whale Sanctuary: indicates if the selected sea area is within the Hawaiian Islands Humpback Whale National Marine Sanctuary. For more information on the Sanctuary, go to http://hawaiihumpbackwhale.noaa.gov/.
7. Ocean Boundary: indicates if the selected sea area is within the 3-mile or 12-mile boundary from the coast.
8. Bathymetry: indicates the depths of the sea floor within the sea area selected.

Solar Details
1. Solar radiation: a general estimate of the solar resource on the selected property, expressed in calories per square centimeter per day. These figures are taken from the State of Hawaii's "sunshine maps" and are extrapolated from various sources, including cloud cover records but not necessarily including actual measured irradiance. These data are available only for land areas of selected major islands. To convert calories per square centimeter per day to other units, go to
 http://energy.hawaii.gov/wp-content/uploads/2011/10/SolarEnergyUnitConversionTable.pdf.
2. Annual Average DNI: From National Renewable Energy Laboratory data, reflecting Direct Normal Insolation within an area approximately 10 kilometers square. For areas with complex topography and microclimates, these data may be less accurate. See http://hawaii.gov/dbedt/gis/data/solar_resource_ghi.pdf for more information.
3. Annual Average GHI: From National Renewable Energy Laboratory data, reflecting Global Horizontal Insolation within an area approximately 10 kilometers square. For areas with

complex topography and microclimates, these data may be less accurate. See
http://hawaii.gov/dbedt/gis/data/solar_resource_ghi.pdf for more information.

4. Slope Percent: a range is given for the slope of terrain within the selected property.
11. State Land Use District: lists the Land Use District(s)—Urban, Rural, Agriculture and
    Conservation—for the property you have selected.
12. Zoning LUO Designation: The zoning according to Land Use Ordinance. These are county-level
    data and at this time are available only for the City and County of Honolulu and the County of
    Hawaii. NOTE: if the Zoning LUO Designation is given as F-1, Federal & Military Preservation
    District, or if military use of the site is otherwise indicated, the Department of Defense requests
    early consultation. See the DoD statement.
5. Reserve: Reserve: Parks, forest reserves, game management areas and similar areas are listed as
    "Reserves." If the property includes any reserves, they are listed here.
6. Critical Habitat: If the property includes any areas identified by the U.S. Fish and Wildlife Service
    as critical habitats for threatened and endangered species, the word "Yes" will appear here. To
    find out more about the habitats, go to criticalhabitat.fws.gov/crithab/.
7. SMA: Indicates if the selected property is within a coastal Special Management Area. Check
    with the appropriate county agency regarding permit procedures for projects within SMAs.

Wave Details

1. Wave Energy Transect: the transects are along northern and windward coasts only and reflect
    calculated estimates of wave energy. For the original report, go to the publications page of the
    Hawaii State Energy Office website, or directly to http://energy.hawaii.gov/wp-
    content/uploads/2011/10/Wave-Energy-Resource-and-Economic-Assessment-for-the-State-of-
    Hawaii.pdf .
2. Benthic Zone: information on sea floor composition within the sea area selected.
3. Whale Sanctuary: indicates if the selected sea area is within the Hawaiian Islands Humpback
    Whale National Marine Sanctuary. For more information on the Sanctuary, go to
    http://hawaiihumpbackwhale.noaa.gov/.
4. Marine Reserves: indicates if the selected sea area is within designated marine reserves.
5. Ocean Boundary: indicates if the selected sea area is within the 3-mile or 12-mile boundary from
    the coast.
6. Bathymetry: indicates the depths of the sea floor within the sea area selected.

Wind Details

1. Wind Power Density: provides an estimate of the wind's energy, expressed as watts per square
    meter at a 50-meter height.
2. Wind Speed: estimated wind speeds in both meters per second (m/s) and miles per hour (mph)
    at different heights are given.
3. State Land Use District: lists the Land Use District(s)—Urban, Rural, Agriculture and
    Conservation—for the property you have selected.

4. Zoning LUO Designation: The zoning according to Land Use Ordinance. These are county-level data and at this time are available only for the City and County of Honolulu and the County of Hawaii. NOTE: if the Zoning LUO Designation is given as F-1, Federal & Military Preservation District, or if military use of the site is otherwise indicated, the Department of Defense requests early consultation. See the DoD statement.
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7. SMA: Indicates if the selected property is within a coastal Special Management Area. Check with the appropriate county agency regarding permit procedures for projects within SMAs.