GLD Skill Booster #1:
Lifecycle Cost Analysis Modeling with the GSA Module

The GLD Skill Booster Series is a set of documents that guide you through the process of performing a specific task in GLD. With this series you can sharpen your functional skills in only a few minutes. This skill booster has been prepared using GLD2012.

In this Skill Booster module we will learn step by step how to conduct a lifecycle cost analysis (LCCA) in GLD. What is a LCCA? A LCCA is the industry standard method for making investment decisions. The analysis looks at present and future costs and savings and calculates the **net present value (NPV)** of those future costs and savings. The analysis uses what is known as the **discount rate** (equal to the economy's overall inflation rate, ie: around 3% in 1H2012 in the USA) to convert future costs and savings into today's dollars. By performing such an analysis for a geothermal and conventional system, one can see how much money a geothermal system will be able to save over many years.

As a geothermal designer, you will benefit from knowing how to do a LCCA because:

- It will enable you to quantify predicted costs and savings over many years of operation

- It will enable you to communicate costs and benefits to clients

- It will enhance your professional skills

Here is how you perform a LCCA in GLD (note that the designer can choose to include/exclude any of these steps as per the requirements of a specific project). Where to find the results of each step will be shown after the description of the entry:

1) Open the GSA module by clicking on this icon:
(which can be found at the top of the GLD program):

Click on the Incentives Tab: **Incentives**

2) Go to the section: Tax Incentives

- For investment tax credit enter "10%" for the current USA federal tax credit for commercial projects. Conversely enter a fixed tax credit instead. If your project benefits from other incentives (for example energy efficiency tax credits measured on a per square foot basis, feel free to modify the investment tax credit to achieve the desired total target tax incentive.

  Results Location:
  Results Tab – *Lifecycle* Subpanel – Tax Credits line.

3) Go to the section: Depreciation Schedule

In the tax rate input box, enter "35%". (which represents the highest marginal corporate tax rate in the USA) If your rate or your client's rate is different, please enter it here. *This number is critical for depreciation calculations.*

- For first year bonus depreciation, enter 50%. (for commercial projects designed/installed in the USA in 2012 that can take advantage of the bonus) If your bonus depreciation is different, please enter it here.

Click on the Results Tab: **Results**
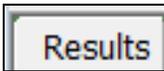
- For accelerated depreciation (standard for geothermal projects in the USA), click the MACRS (Modified Accelerated Cost Recovery System). If your project does not use MACRS, deselect the box and manually enter a geothermal straight line depreciation length. Typically, since energy efficiency investments benefit from one sort of accelerated depreciation or another, it enhances the LCCA accuracy to use some sort of accelerated depreciation.

- The Conventional equipment depreciation schedule will normally defaults to a 39 year period in the USA (39 years is the standard depreciation schedule for conventional mechanical equipment).

Results Location:
Results Tab – *Lifecycle* Subpanel – <u>Depreciation</u> line.

- Salvage Value Calculations for geothermal and conventional systems can be turned on or off. It is important to remember that after a capital investment has been made for a geothermal system, the system retains value over time. This value can be included in the LCCA by turning on the salvage value calculation. Because the loopfield and mechanical equipment have different expected lifetimes, the salvage value calculations are more complicated. The program uses the NPV 50 year "straight line" depreciation for the subsurface component (the loopfield) and a "straight line" depreciation period equal to the user defined life expectancy of the equipment (both geothermal and conventional).

Results Location:
Results Tab – *Lifecycle* Subpanel – <u>Salvage</u> line.

The RENEWABLE HEAT INCENTIVE

- The Renewable Heat Incentive (RHI) is a benefit that applies in certain European and Asian countries at present time. If you have this benefit, enter the benefit per kBTU or per kW.

Results Location:
Results Tab – *Analysis* Subpanel – <u>Annual RHI and NPV Total RHI</u> lines.

4) Next, Click on the Other Costs Tab: Other Costs
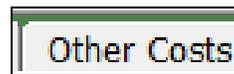
EMISSIONS COSTS

- The CO_2 emissions rate is the pounds/kg of CO2 emitted for each kWh of electricity generated in the project region. A nuclear power plant produces zero carbon. An old coal fired plant may produce 2 lbs/kWh.

In the USA, State by state information can be found online at http://www.eia.doe.gov/oiaf/1605/ee-factors.html

- The emissions cost is your estimate of what CO2 will cost in the future. Many leading economists believe the future cost will be in the $30-$100 per ton range within the next decade. If you do not want to consider future carbon emissions fees in your LCCA, leave this at 0.00. Total C02 emissions are multiplied by the cost per ton.

- If you think carbon emissions fees won't start right away (five years for example), enter the number 5 here. Results from CO_2 calculations appear on the CO_2 Emissions line on the Results tab.

Results Location:
Results Tab – *Lifecycle* Subpanel – C02 Emissions line
Results Tab – *Annual* Subpanel – C02 Emissions line
Results Tab – *Analysis* Subpanel – Annual C02 Reduction and Total C02 Reduction lines.

AVERAGE BUILDING COSTS

- Enter the area (square footage) of the space to be conditioned by the geothermal project. This number is used in conjunction with per square foot costs for equipment, maintenance fees, controls, etc. to calculate various costs. This is a critical input for subsequent calculations.

- Enter the average building construction costs if this is a new construction project and the user wishes to include mechanical room construction costs in the LCCA. This per square foot construction cost is multiplied by the footprint of the mechanical room as defined by the user on the *Geothermal* and *Conventional* tabs in the "Mechanical Room Installation Area" text boxes. Note that this input also impacts tax credits and depreciation results.

Results Location:
Results Tab – *Lifecycle* Subpanel – Installation Equipment line.

- Enter the per square foot per year lease value/cost. This value is multiplied by the footprint of the mechanical room as defined on the *Geothermal* and *Conventional* tabs in the "Mechanical Room Installation Area" text boxes. This input box typically is used for retrofit projects in which a former mechanical room is downsized/converted to other uses when a new geothermal system that requires a smaller footprint is installed. The freed up space has a value that optionally can be quantified. If the designer does not want to include this value into the analysis, set the per year lease value at 0.00.

Results Location:
Results Tab – *Lifecycle* Subpanel – Mechanical Room Lease line
Results Tab – *Annual* Subpanel – Mechanical Room Lease line.

SYSTEM RELATED COSTS

- On the *Subsurface* Tab, enter the combined cost per unit length (vertical foot or meter) to drill, install, grout and header a heat exchanger system. Conversely, for a horizontal system, enter the cost per area excavated/trenched. This value is multiplied by the drilling length or area defined on the *Geothermal* tab.

Results Location:
Results Tab – *Lifecycle* Subpanel – Installation: Subsurface line.

- On the *Equipment* Tab, select a piece of equipment of interest (such as a Geothermal Heat Pump/Electrical) and then enter per square foot (of conditioned space) installation, controls and maintenance costs. These values are multiplied by the total structure floor space input found above. In the replacement input box, enter the expected lifetime for the mechanical equipment. When a lifecycle analysis is longer than the replacement time, replacement costs are reported on the Results tab. Note that since replacement costs are accrued in the future, the future costs are discounted and reported in NPV terms.

Results Location:
Results Tab – *Lifecycle* Subpanel –Maintenance line
Results Tab – *Lifecycle* Subpanel – Installation: Equipment line
Results Tab – *Lifecycle* Subpanel – Installation: Controls line

Results Tab – *Lifecycle* Subpanel – <u>Equipment: Replacement </u>line

5) Click on the Utilities Tab: | Utilities |

UTILITIES

- Enter two utility rates (they can be the same or different) for each fuel time you intend to use in your LCCA. *Note that for each fuel type both rates must be entered.*

- Enter the predicted fuel inflation rates for fuels of interest. Inflation rates are used to calculate the future cost of using fuels. These values, which are critical to accurate LCCA calculations, should not be ignored.

- Enter the expected maintenance inflation rate. This rate is used to estimate how maintenance costs rise over time.

- The discount rate is the value the program uses to conduct the LCCA. This value typically is the inflation rate. *This value is critical to the LCCA calculation.*

6) Click on the Conventional Tab: | Conventional |
(entering info on this tab is necessary to compare a geothermal system to a conventional system).

After entering information in this Tab, energy consumption results are reported on the top of the *Conventional* tab.

SYSTEM DETAILS

- The equivalent full load hours are transferred automatically from the Geothermal tab. They cannot be entered here.

- Choose a cooling and heating type of equipment.

- Choose a power/energy source for each type of equipment.

- Input the installed capacity of the equipment. Typically these values will be identical to the values entered for the geothermal peak capacity.

- Enter average efficiency values for the cooling and heating equipment.

- Extra power can be entered optionally.

- The square footage area required for the mechanical equipment optionally can be entered if desired. The square footage will be multiplied by the building construction costs and reported:

Results Location:
Results Tab – *Lifecycle* Subpanel – <u>Installation: Equipment</u> line.

- In addition, the square footage will be multiplied by the lease value and reported:

Results Location:
Results Tab – *Lifecycle* Subpanel – <u>Mechanical Room Lease</u> line.

- Water usage rates (for a cooling tower for example) may be entered. A typical cooling tower uses approximately 0.033 gallons/minute/ton of peak cooling load. The usage rate is multiplied by the load and the cost is then calculated and reported.

Results Location:
Results Tab – *Lifecycle* Subpanel – <u>Water</u> line.

7) Click on the Geothermal Tab: Geothermal
(entering info on this tab is necessary to define a geothermal system.)
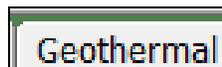
Note that when a user imports a heat exchanger design into the GSA module, this data is entered automatically. After entering information in this Tab, energy consumption results are reported on the top of the *Geothermal* tab.

GEOTHERMAL SYSTEM

- Enter the total length of drilling (not length of pipe but length of drilling) or the total excavated area (for horizontal systems). This number is multiplied by the Subsurface cost per unit length

entered on the *Other Costs* tab to calculate subsurface installation costs.

Results Location:
Results Tab – *Lifecycle* Subpanel – Installation: Subsurface line.

PRIMARY GEOTHERMAL TAB

- Equivalent full load hours, peak capacity and average equipment efficiencies should be entered for cooling and heating. Note that it is important to enter the average efficiencies rather than the worst case efficiencies.

- Enter circulation pump power and efficiencies to auto-calculate the pump input power.

- Enter any additional power requirements.

- The square footage area required for the heat pump equipment can be entered if desired. The square footage will be multiplied by the building construction costs (entered on the *Other Costs)* and reported:

Results Location: *Results* Tab – *Lifecycle* Subpanel – Installation: Equipment line.

- In addition, the square footage will be multiplied by the optional lease value and reported:

Results Location:
Results Tab – *Lifecycle* Subpanel – Mechanical Room Lease line.

HYBRID COMPONENT TAB

- Enter details pertaining to a hybrid component, if any.

8) Click on the Results Tab: Results
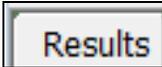
- Enter a LCCA modeling time period and hit Calculate.

- Review the results on the Lifecycle tab, the Annual tab and the Analysis tab. Hit the graph button to review graphs.

- On the analysis tab, review the financial metrics summary.

- Note that the simple payback looks only at total geothermal and total conventional installation costs, tax credits, first year bonus depreciation (if any) and annual total operational savings. It does not include depreciation (beyond first year bonus), equipment replacement and salvage values.

- The IRR (internal rate of return) calculation is sensitive to a range of inputs and in certain circumstances will give an "N/A" result.

10) Modify your inputs as necessary and hit Calculate again to see how the modifications impact the final results

In summary, the GSA model provides you with powerful, quick, comprehensive and accurate LCCA capabilities. Knowing how to use it properly will make it easier for clients to understand, appreciate and "go" geothermal.