HyGCHP modeling tool

HYBRID GROUND-COUPLED HEAT PUMP

DEVELOPED BY ENERGY CENTER OF WISCONSIN   SEL

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College of Engineering's Solar Energy Lab

Sponsored by ASHRAE and the U.S. Department of Energy

Quick Start

To begin using HyGCHP immediately:
1. Open the program from the Start menu, click **OK** to pass the title screen.
2. Choose one of the eight system configurations to model. Click **OK**.
3. On the *Main* tab, choose your 8760 loads file using the 'Building loads file' box. This can be a series of hourly loads created by any building simulation program (see the help for formatting).
4. Proceed through each input on each tab (see tabs along the top of the window), changing those you feel require revision for your project.
5. On the final tab (*Design*) choose to A) **Run a single simulation** using a set of design parameters, or B) **Run an optimization** that will give you the lowest life cycle cost for your project. Enter the appropriate parameters, then choose **Run Single Simulation** or **Run Optimization** from the *Calculate* menu.

Getting Started

HyGCHP is a simulation tool to assist in the design of hybrid ground-coupled heat pump systems. This software determines equipment sizes and control setpoints, as well as calculating a life cycle cost for comparing different equipment configurations (including hybrid, ground-source-only, and boiler/tower type configurations).

This software contains an extensive online help feature to answer specific questions regarding the meaning of the inputs and outputs (simply click on **help** or press **F1** at any input). This document supplements that online help by guiding the user through the installation and initial operation of the program.

The first part of the *Getting Started* section discusses installation of HyGCHP. The second section discusses how to run the program. For additional details or backup documentation, contact shackel@ecw.org

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Installing the HyGCHP Program

1.) The file HyGCHP.exe should be downloaded. Copy this file onto the root directory of your hard drive.

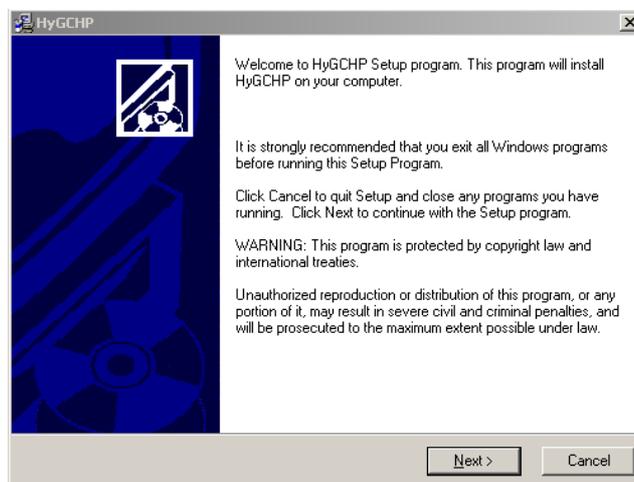2.) The hybrid simulation is installed by the program HyGCHP.exe. Double click on the HyGCHP.exe icon to install this program (Figure 1).

Figure 1. Installation screen for HyGCHP Program

3.) Click **Next** to reach the *Destination Location* screen (Figure 2). The hybrid simulation will be installed in the directory C:\HyGCHP.
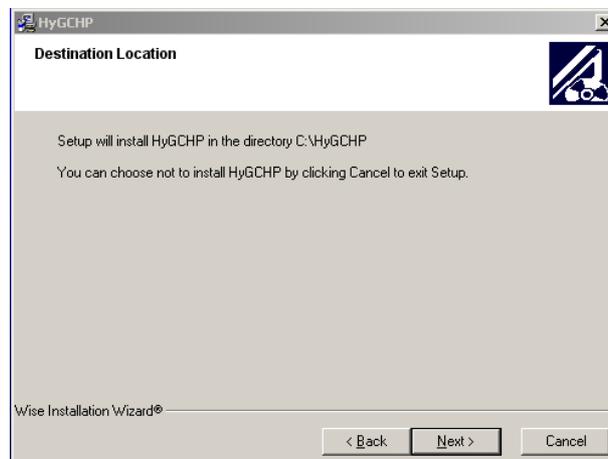
Figure 2. Destination Location Screen

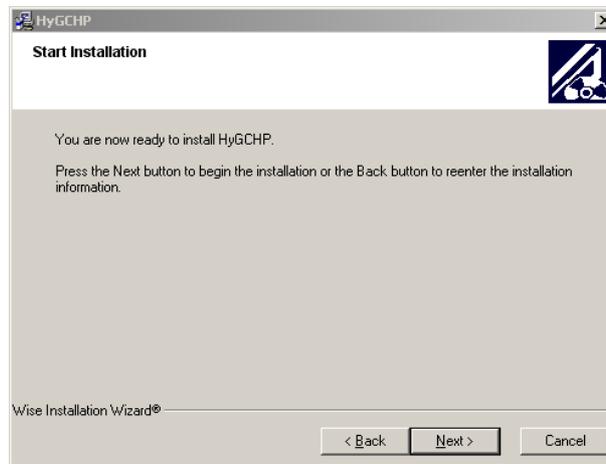4.) Click **Next** to reach the *Start Installation* screen (Figure 3).

Figure 3. Start Installation Screen

5.) Click **Next** to start the installation (Figure 4); when the installation is complete select **Finish** (Figure 5).
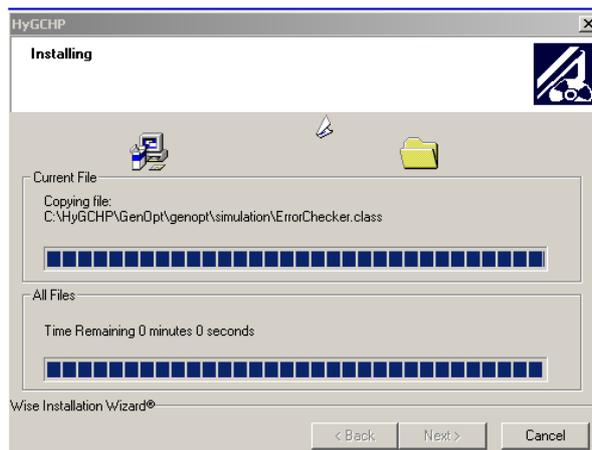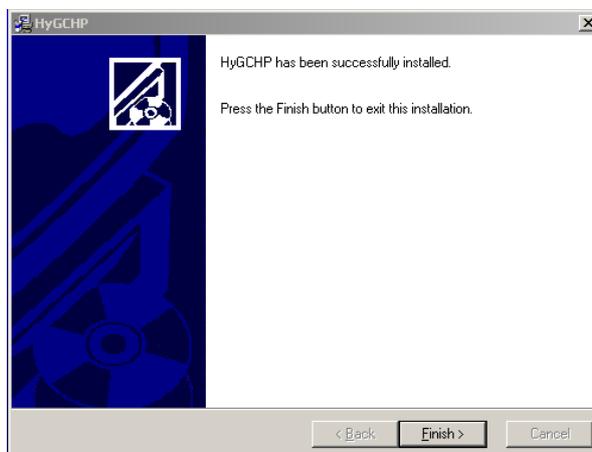

Figure 4. Installing Screen

Figure 5. Installation Complete

Running a HyGCHP Simulation or Optimization

1.) A program icon entitled HyGCHP should have been added to the list of programs in your Start menu (Figure 6). Select the HyGCHP program to activate the simulation. Alternatively, navigate to the C:\HyGCHP\Trnsys folder on your hard drive and double click the HyGCHP.exe application (Figure 7).
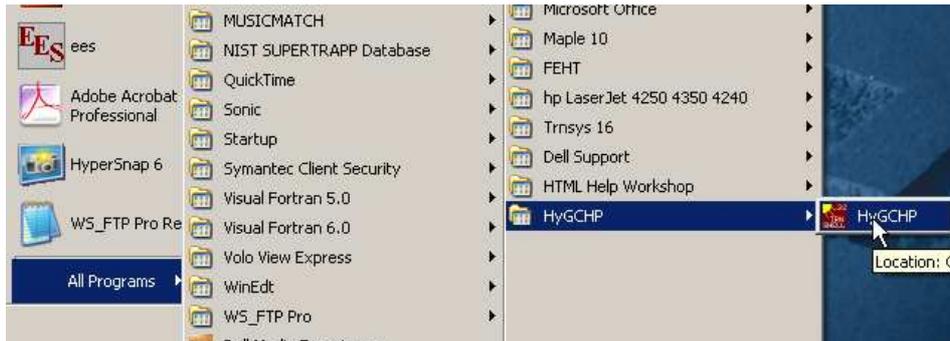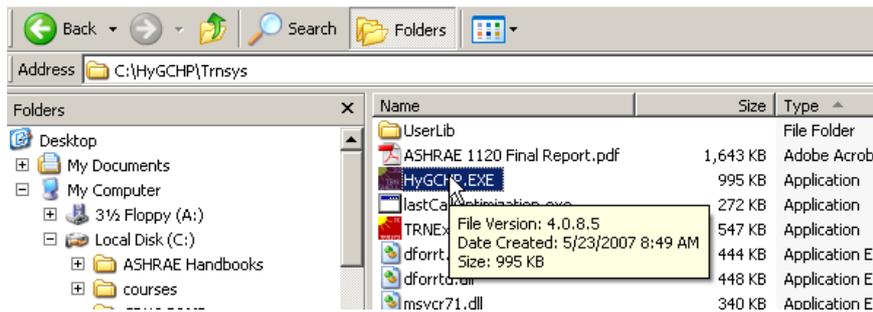

Figure 6. HyGCHP Program in the Start Menu

Figure 7. HyGCHP Application in the C:\HyGCHP\Trnsys folder

2.) The splash screen for the HyGCHP program should appear (Figure 8); select **OK** to run the program (Figure 9, or click Info to launch the online help).
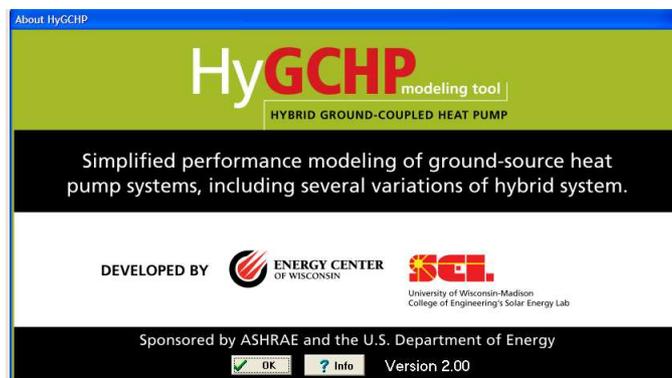

Figure 8. HyGCHP Splash Screen

3.) Select the system to be simulated (Figure 9). Six systems can be selected from. For now, select **Hybrid system: ground heat exchanger and cooling tower** and press **OK**.
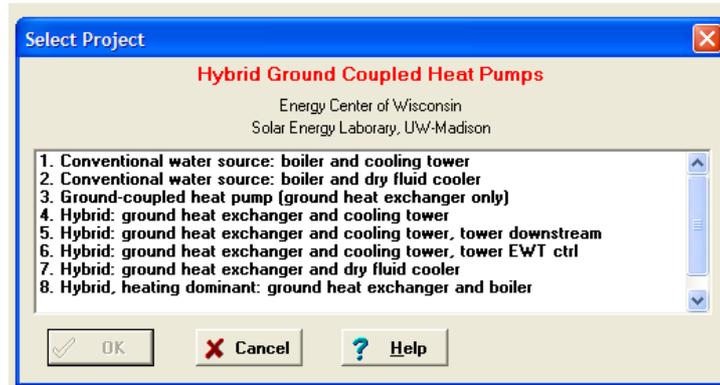

Figure 9. Select the system to be considered

4.) The model should launch with the *Main* tab foremost on your screen (Figure 10).
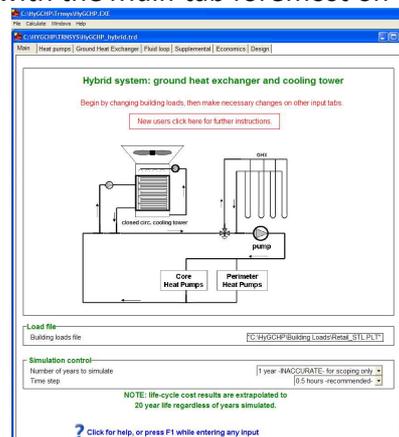

Figure 10. Main Tab for the Hybrid Configuration

5.) Specify the building load file to be used as the basis of the simulation. Click inside of the box to the right of *Building loads file* and a File Selection Window will appear (Figure 11).
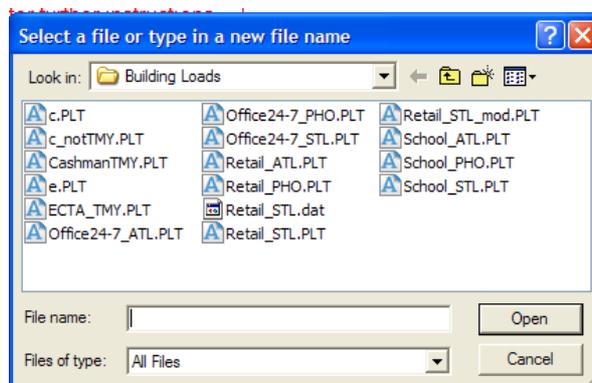

Figure 11. Building Load Selection Window

For now we will use a sample building load; select any and click **Open**. For the user's projects, building loads can be generated using any software that creates 8760 loads (one per hour for a year). The online help (see step 6) describes how to format the loads for HyGCHP to use. Common programs that will generate these types of loads include:

- Trane TRACE 700 – see online help for instructions on using TRACE loads.
- Equivalent Full Load Hours program – a program produced by ASHRAE TRP-1120 that can use a simple building description to create 8760 loads.
- eQUEST, or other DOE2 packages.
- EnergyPlus
- Many others

6.) To get specific help relative to any input (including Building Loads) just press **F1** while you're entering that input in the box (for example, while your cursor is still in the *Building loads file* box). The help can also be accessed by clicking on the help button at the bottom of each tab. Further note that the *Index* and *Search* features on the left side of the help screen (Figure 12) also provides a convenient way to find specific information. Close the help when you are done (using the x in the upper right corner) and return to the simulation.
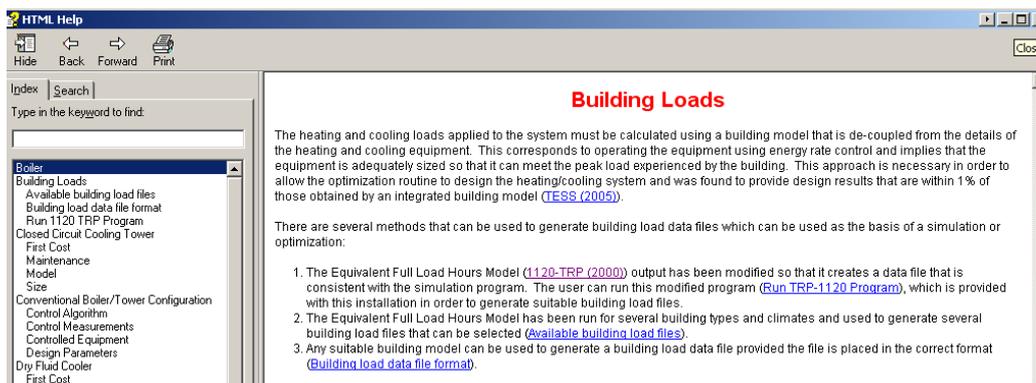

Figure 12. Building loads help page.

7.) Before proceeding with more input, if you'd like to specify a different unit system, select the *Calculate* menu and check either **SI** (metric) or **IP** (English) units, as shown in Figure 13; the input quantities and results will be expressed in these units.
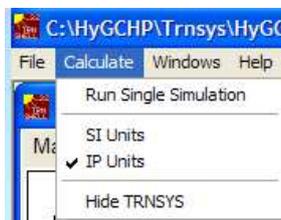

Figure 13. Select either Primary (SI) or Secondary (English) units.

8.) Navigate through the additional tabs (*Heat Pumps, Ground Heat Exchanger, Fluid Loop, Supplemental,* and *Economics*) and set the input values according to your application.

For example, Figure 14 illustrates the Ground Heat Exchanger tab; note that the default values of each input related to the Ground Heat Exchanger are listed. To change one, place your cursor in the appropriate cell and input a different number. To obtain online help regarding one of the input, press **F1** while your cursor is in the cell (e.g., Figure 15 illustrates the online help page that is opened if **F1** is pressed in the Grout thermal conductivity cell).

Figure 14. Ground Heat Exchanger Tab

Figure 15. Online help page for grout thermal conductivity.

9.) Finally, go to the *Design* Tab (Figure 16). On the *Design* tab, the user must now make a decision to either:

A. Run Single Simulation – with this choice, the simulation will run one time with the design parameters shown in the box labeled *A. Run Single Simulation*. Adjust the parameters in box A to test different designs. The results will then show the costs, temperatures, and other results for a system with these design parameters.

OR

B. Run Optimization – with this choice, the simulation instead runs a series of different simulations until the optimal (lowest life-cycle cost) design parameters are found. The results will then show the costs and temperatures associated with the optimal, along with the design parameters that result in that optimal design.

Note: When choice B is used, the optimizer will limit the design to only those that result in temperatures within the limits shown in box *B. Run Optimization*. The optimizer will choose a design with operating temperatures that result in the lowest life-cycle cost within these limits. (For example, if broad limits such as $20^{o}F - 110^{o}F$ are chosen, the optimizer may show that the optimal design operates at a minimum of $33^{o}F$. If the Minimum limit is instead set to $35^{o}F$, a different optimal design will be chosen that operates at a temperature over 35).
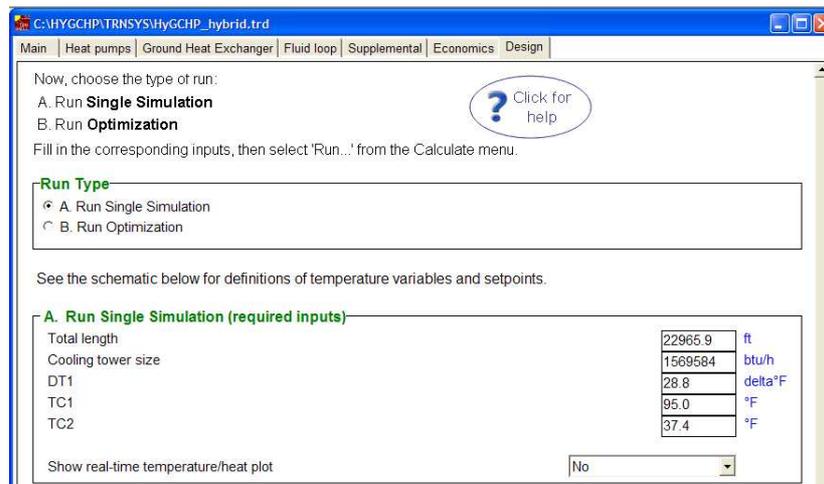

Figure 16. Design Tab (top)

Below the input boxes, a diagram is shown (see Figure 17) that describes the control parameters in more detail. Consult this diagram for control setpoints used in both inputs and results.
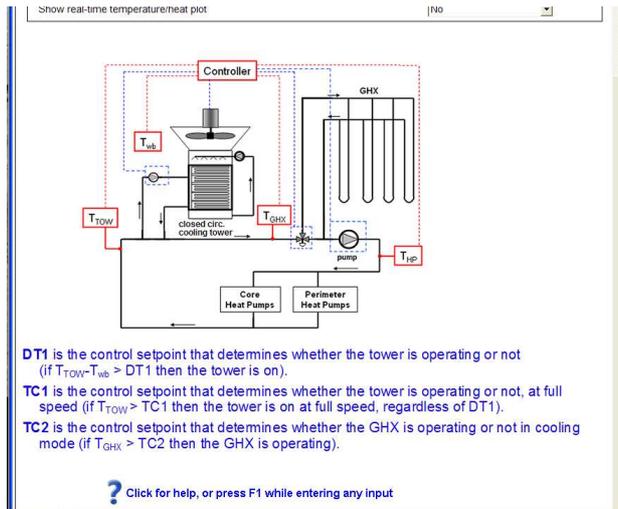
Figure 17. Design Tab (bottom)

10.) Now, choose either **Run Single Simulation** or **Run Optimization** from the *Calculate* menu (Figure 18 shows the **Run Single Simulation** case).
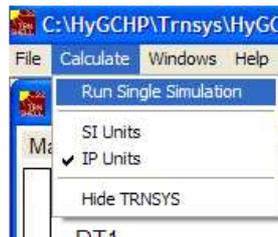

Figure 18. Calculate Menu

The simulation should take 1-5 minutes depending on the speed and settings of the machine; assuming the recommended 10 year simulation with 30 minute timesteps. While you are waiting you should see a plot of heat pump entering fluid temperature and equipment heat transfer rates, as shown in Figure 19.
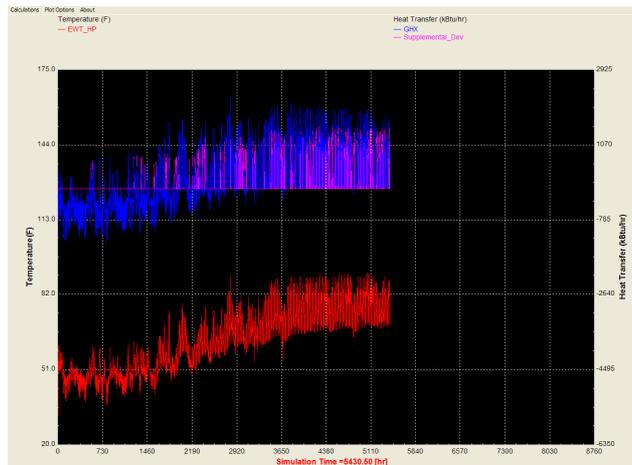

Figure 19. Screen that appears as simulation is running, with plot turned on.

11.) When the simulation is complete press **Continue** and the *Results* Window should appear (Figure 20).

Figure 20. Results Window

The *Results* Window includes results and some of the details about the simulation. These should be saved for future reference by clicking on the Results window, typing 'Ctrl + A' to select the table, typing 'Ctrl+C' to copy, and pasting into a spreadsheet. Clarification for these outputs can be obtained by pressing **F1** to access the online help (Figure 21).
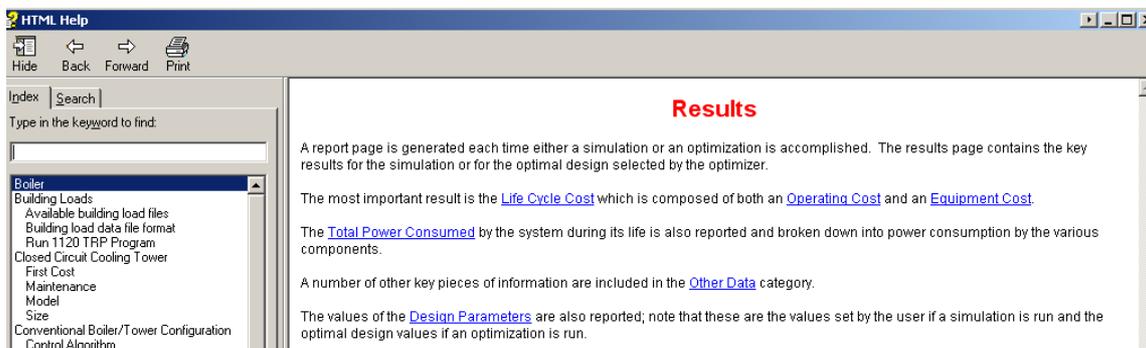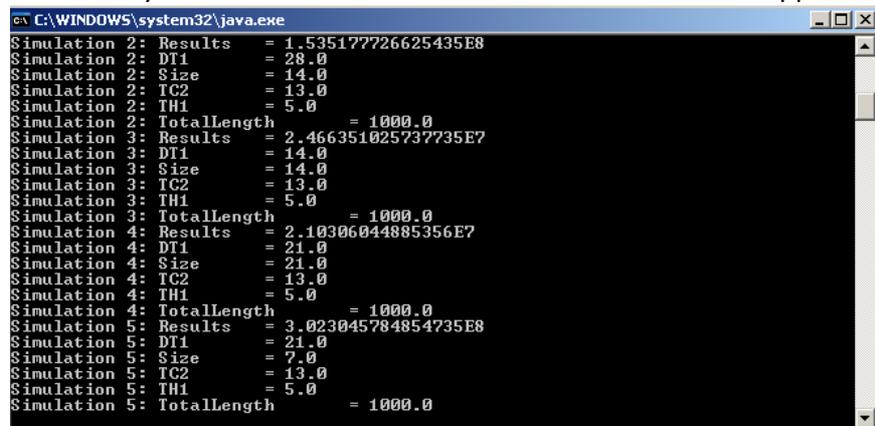

Figure 21. Online Help for the Report Window

12.) Hourly results in tabular format can also be obtained in the C:\HyGCHP\Results folder.

13.) Now try the optimization option. Run an optimization by selecting **B. Run Optimization** on the *Design* tab, and **Run Optimization** from the *Calculate* menu. WARNING – an optimization will take 30 minutes to a few hours to complete because it requires 100 or more individual simulations. Initially, a window will appear for a minute or more that simply says 'Initializing…'; then as the Optimization is running you should see the window

shown in Figure 22 which indicates how the optimizer is adjusting the design parameters. Every 2-5 minutes you should see the results of another simulation appear.

Figure 22. Screen that appears as the optimizer is running.

Note that your computer may not have java installed in which case you will get an error at this time. If this happens then either open your web browser, and go to http://www.java.com. Click on the link 'Free java download' and follow the instructions to install Java or contact us for help.

14.) When the optimization is complete, the *Results* Window will appear. As before, it will list costs, temperatures, and other data, this time associated with the <u>optimal</u> design parameters. The design parameters listed at the bottom of this results window are the optimal (lowest life-cycle cost) design parameters for this scenario.*

15.) Files can be saved in order to use similar assumptions in the future. You can also 'Save As' if you'd like to store inputs for a specific project (the .trd extension is used for HyGCHP files). Using 'Save As' will also keep the defaults at their original values for future use.

Note that under some infrequent circumstances, the optimization algorithm used in HyGCHP has been known to find false ('localized') minima, or points where the life cycle cost is low but not at its absolute lowest. If one or more of the results seem significantly off-base, this is a possible cause. In these cases optimization should be re-run with some slight changes in some of the input parameters on the various tabs - the slight changes will allow the optimizer to explore a different area of the field of results.