CHP Capacity Optimizer Identifies "Best Fit" to Maximize Cost Savings

Spreadsheet Tool Determines Optimum Capacities of Distributed Energy Components

Background

Distributed energy cooling, heating, and power (CHP) applications can save both money and natural resources when system components are properly selected and installed. The accurate determination of distributed generator and absorption chiller capacities is critical to optimized system performance, yet a complex task. The electric and thermal demands of a facility are influenced by building size and location and may vary with time of day and season. Improved efficiency due to waste heat recovery must also be taken into account, and the cost of energy provided by the CHP system must be balanced with that of the conventional electricity grid and on-site boiler. The CHP Capacity Optimizer is an efficient, user-friendly tool that allows both system designers and end users to assess the "best fit."

Technology

Electric and thermal energy supply and demand must be modeled on an hourly basis in order to adequately assess the demand behavior at a specific facility or building. Using hourly load data generated by building simulation programs such as the BCHP Screening Tool[1] or Building Energy Analyzer[2], the CHP Capacity Optimizer simulates the operation of a distributed energy system and provides a "make-or-buy" recommendation. For given prime mover and absorption chiller capacities, the optimizer software calculates the life-cycle net present value savings of the CHP system relative to the conventional grid and on-site boiler arrangement. By coupling the

A CHP system with reciprocating engines

operation simulation to a non-linear optimization algorithm, "best fit" equipment capacities that maximize life-cycle CHP system savings can be determined. Both the operation simulation and capacity optimization are displayed in a single Microsoft Excel™ spreadsheet file, which features intuitive user controls for providing input, performing optimization, and assessing the results.
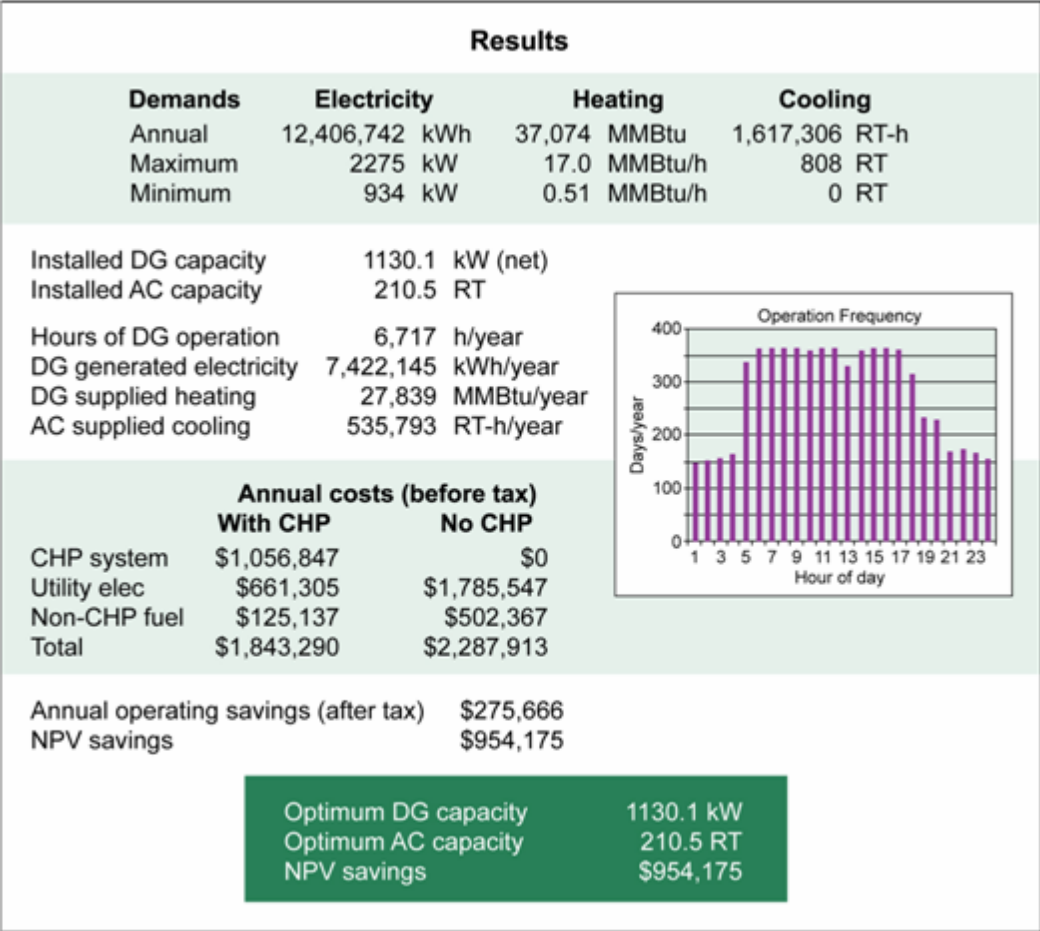
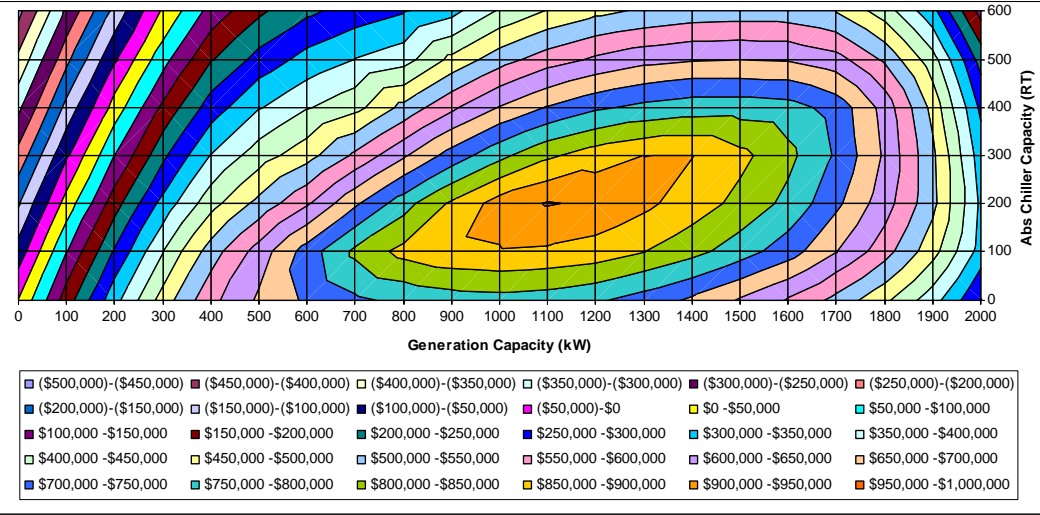### Benefits

- The CHP Capacity Optimizer is an efficient, easy-to-use tool that can benefit both CHP system designers and end users.
- The tool's determination of optimum capacity components in CHP systems will maximize cost savings of a CHP system.
- Contour plot guidance and quick manual entry capabilities allow users to explore the economic impact of alternative equipment sizes.

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Results

Demands	Electricity		Heating		Cooling	
Annual	12,406,742	kWh	37,074	MMBtu	1,617,306	RT-h
Maximum	2275	kW	17.0	MMBtu/h	808	RT
Minimum	934	kW	0.51	MMBtu/h	0	RT

Installed DG capacity	1130.1	kW (net)
Installed AC capacity	210.5	RT
Hours of DG operation	6,717	h/year
DG generated electricity	7,422,145	kWh/year
DG supplied heating	27,839	MMBtu/year
AC supplied cooling	535,793	RT-h/year

Annual costs (before tax)

	With CHP	No CHP
CHP system	$1,056,847	$0
Utility elec	$661,305	$1,785,547
Non-CHP fuel	$125,137	$502,367
Total	$1,843,290	$2,287,913

Annual operating savings (after tax)	$275,666
NPV savings	$954,175

Optimum DG capacity	1130.1 kW
Optimum AC capacity	210.5 RT
NPV savings	$954,175

Example summary output from CHP Capacity Optimizer

Contour plot of total solution space from CHP Capacity Optimizer

Future Work

The CHP Capacity Optimizer is being distributed to interested users and to the Regional Application Centers. Suggestions are being solicited to improve the user-friendliness of the tool.

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[1]Available from ORNL (fischersk@ornl.gov)
[2]Available from InterEnergy Software, www.interenergysoftware.com