

Solutions Development for Renewable and CHP Projects For the Federal Government

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INTRODUCTION

Many federal ESPC projects have more opportunities than the traditional demand-side energy conservation measures (ECMs). More advanced technologies, like renewable project, can be incorporated into the project bundle when the energy services company (ESCO) takes advantage of creative financing, incentives and rebates available. This article will cover the following aspects of solutions development for renewable and CHP projects for the federal government. Included will be a discussion of more advanced ECMs available to a particular location.

1. Solutions Development Process Overview
2. Samples of Normal ECM Projects
3. Samples of More Advanced ECM Technologies
4. Combined Heating and Power Projects
5. Renewable Projects

Normal demand-side ECMs help federal facilities reach their energy savings goals. Executive Order 13123 requires federal facilities to aggressively save 35% of energy by the year 2010, compared to a base year of 1985^[1]. ESPC is one way to help federal agencies reach these goals. Most government agencies are not meeting their energy goals and need to take advantage of less traditional ECMs and creative financing and incentives available. If energy savings utilize renewable fuel, the agency will benefit greatly toward meeting this energy savings goal. federal agencies do not need to count the Btus from renewable sources and the result is two-fold. The energy consumed does not need to count in the annual energy usage and the energy is still consumed to power a building system.

A positive result from the demand-side energy savings projects reduce energy consumption and provide infrastructure improvements by shifting utility savings dollars to pay for the capital investments. Most areas of the country have utility rates that do not allow incorporating advanced ECMs to be implemented without other savings and incentive dollars.

Accurate baseline development is still the place where accurate savings starts and makes the difference between a successful and unsuccessful project in the solutions development process. Adding more advanced technologies, like CHP and renewable projects, normally hurt the cash-flow of the total ESPC bundle. The ESCO needs to research the technologies available beyond lighting, water and HVAC ECMs, and determine if rebates and incentive dollars are available in a particular area to help cash-flow the project.

This article will review how to develop accurate and cost effective baseline methods used for more advanced ECMs. Accurate baseline energy estimating is required so the follow-up measurement and verification will determine real savings. Performance contracting solutions development for various types of energy conservation measures (ECM) has an infinite selection of calculating to choose. How does an engineer measure and collect the proper system and utility data to achieve a calibrated baseline?

SAMPLES OF NORMAL ECM PROJECTS

1. Lighting
2. Water and sewer for plumbing fixtures
3. HVAC Retrofits
4. Central plant retrofits (boiler and chiller systems)
5. Energy management control systems
6. Building system improvements

This article will not cover a discussion of traditional ECMs.

MORE ADVANCED ECM TECHNOLOGIES

The following are samples of more advanced technologies an ESCO should consider when bundling an ESPC project. Not all these system

are represented in this article.

1. Plate & Frame Tower-Free Cooling and Thermal Storage
2. Combined Heating and Power
3. Energy Information Systems and Advanced Metering
4. Solar PV Roofs, PV Streetlights, Solar Charging Stations
5. Solar Hot Water or Solar Preheating HVAC
6. Natural Daylighting
7. Landfill Gas (LFG) Electric Generation and LFG Engine-driven Chillers

The article will cover what is required in modeling and analyzing these ECMs and performing the solutions development. Recommendations for capturing incentives and rebates for these ECMs will be discussed. The preliminary analysis is a cost-effective calculation necessary to be able to recommend the economic viability of the different types of ECMs.

Tower-free Cooling System

Figures 1, 2 and 3 shows a plate & frame heat exchanger normally used for the tower-free cooling system in a typical chiller plant.

When evaluating tower-free cooling systems the solutions developer needs to consider the impact in the listed areas.

1. Tower-free cooling economics need dry climate, year-round run-hours or high electric costs to have a good payback



Figure 1. Plate & Frame Piping



Figure 2. 1,700-Ton Tower Free-Cooling System

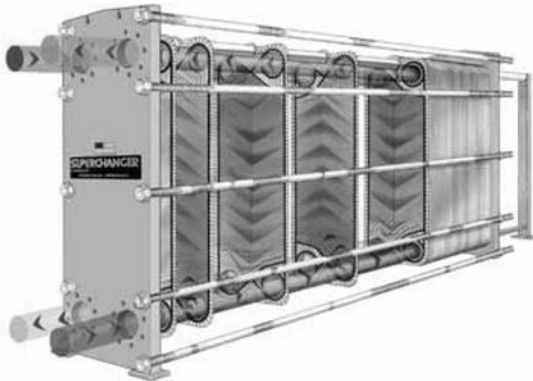


Figure 3. Plate & Frame Heat Exchanger

2. Some rate structures only capture energy savings (not demand). If the rate structure has a ratchet the savings will not include demand savings (kW) and only capture energy savings (kWh).
3. DOE2 Energy Simulation Model using eQuest may be necessary to adequately simulate the results.
4. The cooling towers will need to be sized larger than the chiller(s) normally need to get adequate cooling from a plate and frame heat exchanger.

Baseline = Cooling Energy of Cooling System

Cooling System Energy = Cooling Equipment, chillers, towers, pumps, and HVAC

Energy Savings = Cooling System Energy Saved for not running cooling equipment – Extra energy required for towers, pumping and HVAC

Note: Tower-free cooling requires more tower energy and possibly more AHU and pumping energy because of higher chilled water temperatures generated.

Combined Heating and Power Plants

Combined heating and power plants can take many shapes and sizes. In addition, depending on the heating (and/or cooling) and power needs, the types of fuels, engines, turbines and waste heat equipment can vary depending on the nature of the existing system connected.

Honeywell is developing packaging and control technologies for various size CHP plants to optimize the offering and reduce the capital costs for the system. A large (5 MW) CHP plant has been installed at a military base in support of an energy services performance contract (ESPC) for the U.S. Army. This system was installed at the Central Plant on the base and provides electrical power and chilled water. Figures 4, 5 and 6 show details of this installed CHP plant. This two year program is funded by the U.S. Dept. of Energy, and is being administered by Oak Ridge National Labs.

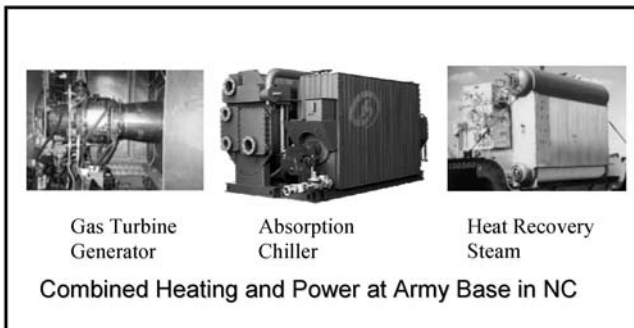


Figure 4. CHP Typical Components

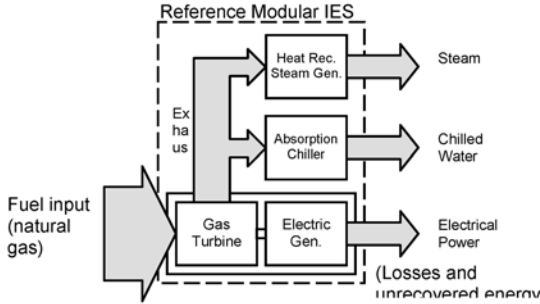


Figure 5. CHP Heat Balance

This 5 MW CHP included the typical demand-side projects—lighting, controls, HVAC, efficiency upgrades. With integrated energy services and natural gas and power procurement programs with the following upgrades and additional systems.

1. Central Plant Modernization—\$30 million
2. Cogeneration project—\$11 million
3. Energy Security & Reliability
4. Integrated Energy Management Center
5. Micro-Grid with on-site generation
6. CHP works best in locations with good utility and state incentives
7. Alternate fuels such as Landfill Gas (LFG) can make the economics better than using natural gas or fuel oil

Baseline = Cooling and Heating System Energy

Clg & Htg System Energy = Chillers, boilers, pumps, towers, and HVAC

Energy Savings = Difference between the fuels used for generating chilled water, steam and hot water and electrical savings difference in off-setting electricity generated.

CHP Plants Using LFG

One of the projects evaluated by the author is for an Air Force base located close to a city landfill. Natural gas costs for the base are \$8.30 per million Btus (MMBtu). LFG is currently being negotiated and will vary between \$2 to \$5 per MMBtu. The following performance parameters are being studied for feasibility of this CHP plant.

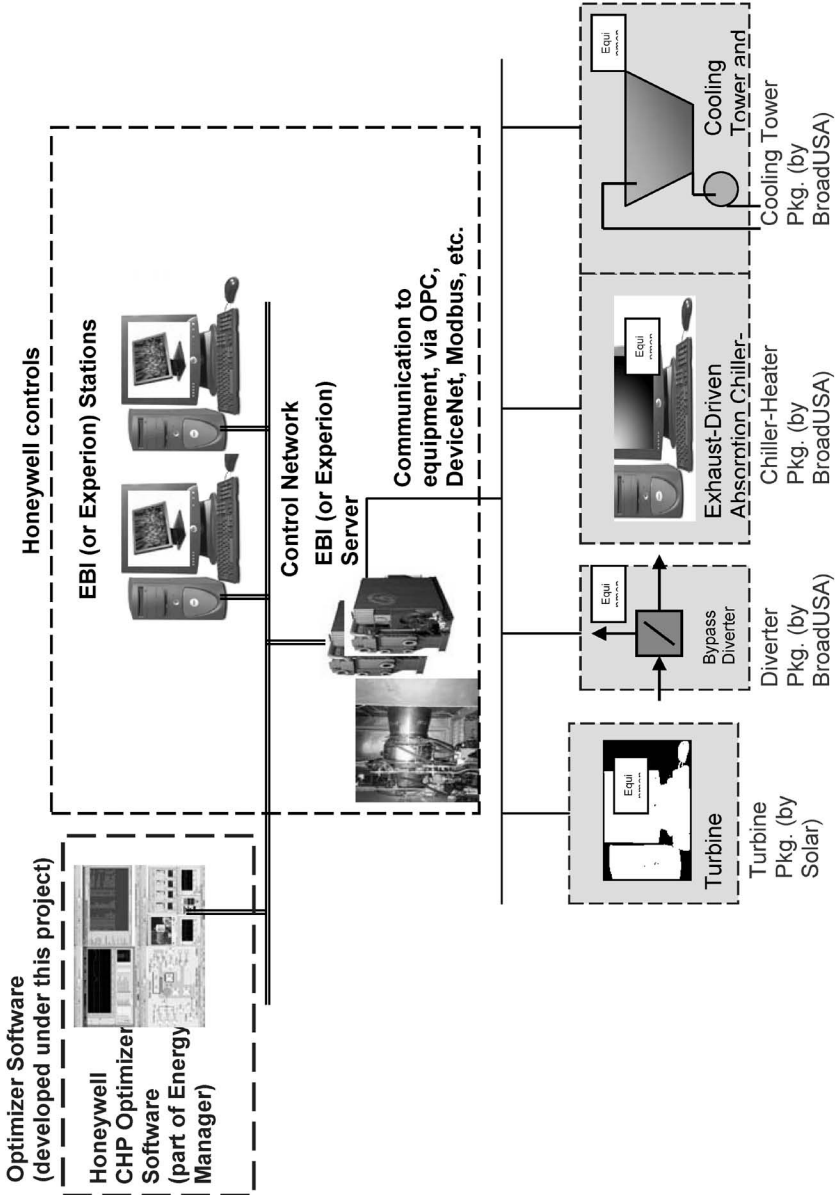


Figure 6. Modular CHP System: Controls

1. 1,500 kW generation
2. 400 to 1000 tons of absorption cooling
3. Connect CHP system to existing 1,500 ton central plant with 2 gas-fired absorbers and 2 electric-driven chillers
4. Evaluate piping chilled water (CHW) and hot water (HW) to area buildings to utilize a high percentage of the waste heat from the CHP
5. Optimize the tower-free cooling and thermal storage system in the CHW Plant
6. Connect the CHW/CHP Plant to more buildings to gain better economic from the system

Solar Hot Water Systems

Figure 7 shows a typical solar hot water system for a domestic hot water system.

There are many types of solar hot water system to consider when developing a project. Honeywell has found that very high quality solar panels and system components are required to last the life of the ESPC contract. Solar systems are very expensive and needed capital or incentive dollars to cash-flow.

The following system characteristics are needed to provide good economics for solar hot water systems.

1. Good baseline domestic hot water usage
2. Incentives from State or utility company
3. Good location to place the solar panels

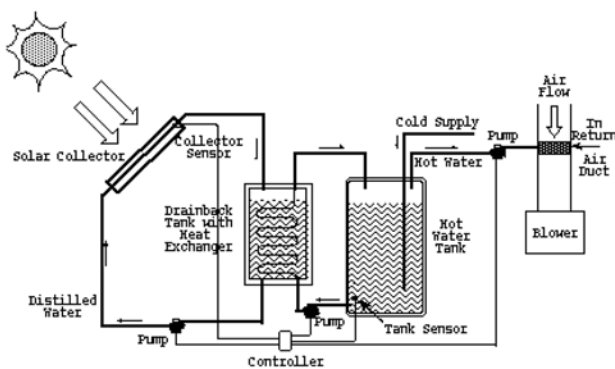


Figure 7. Solar Hot Water System

Baseline = Savings = All solar hot water energy generated by solar system (electricity and gas)

Ground-source Heat Pumps (GSHPs)

The following represent two types of ground-source heat pump systems. Figure 8 represents a GSHP system with vertical wells and Figure 9 shows a horizontal system.

GSHP systems analyzed for facilities needed soil information requiring expensive testing to provide the required soil conductivity and other parameters so the piping system could be designed for the heat pump units.

The listed parameters have been experienced when evaluating GSHP systems.

1. Heating COP of 3 to 5 w/32F EWT
2. Cooling EER of 13 to 25 w/77F EWT
3. 16 to 500 Mbh heating, 1.5 to 35 tons cooling
4. 150 to 300 ft deep pipe bore holes
5. 1.5 gpm per ton, 1 ton per well (~250 to 350 ft deep)
6. \$750 to \$950 per ton or \$2,500 to \$3,500 as retrofit costs
7. GSHP ECMs need capital dollars from the customer that are funded for upgrading the HVAC in order to provide good economics
8. High costs make GSHP ECM very difficult to cash-flow even when considering rebates

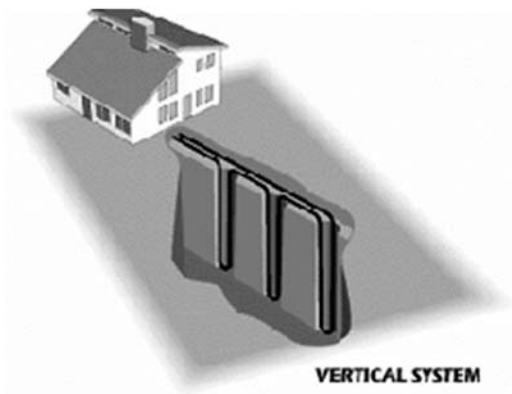


Figure 8. Vertical GSHP System

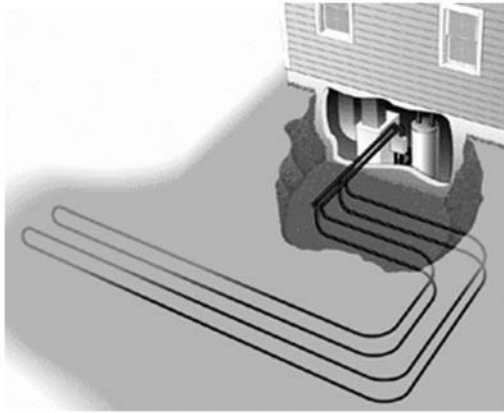


Figure 9. Horizontal GSHP System

Simple GSHP systems can provide a payback when bundling with other cash-generating ECMs. The next two pages show the system being considered for implementation.

Baseline Energy = Electric and gas energy consumed by existing HVAC

Energy Savings = Difference between energy consumed because of higher COP of GSHPs

ABOUT THE AUTHOR

Jeff Stringfield works for Honeywell International and is the Solutions Development Team Leader for federal projects in the Western States and Asia Pacific. Jeff works in Honeywell's Federal Energy Services Business Unit and is responsible for solutions development of several federal customers, including many of the Region 5 Air Force projects (including South Korea).

Jeff is a mechanical engineer (Kansas State University), is registered in 15 states, and has an MBA from Arizona State University.

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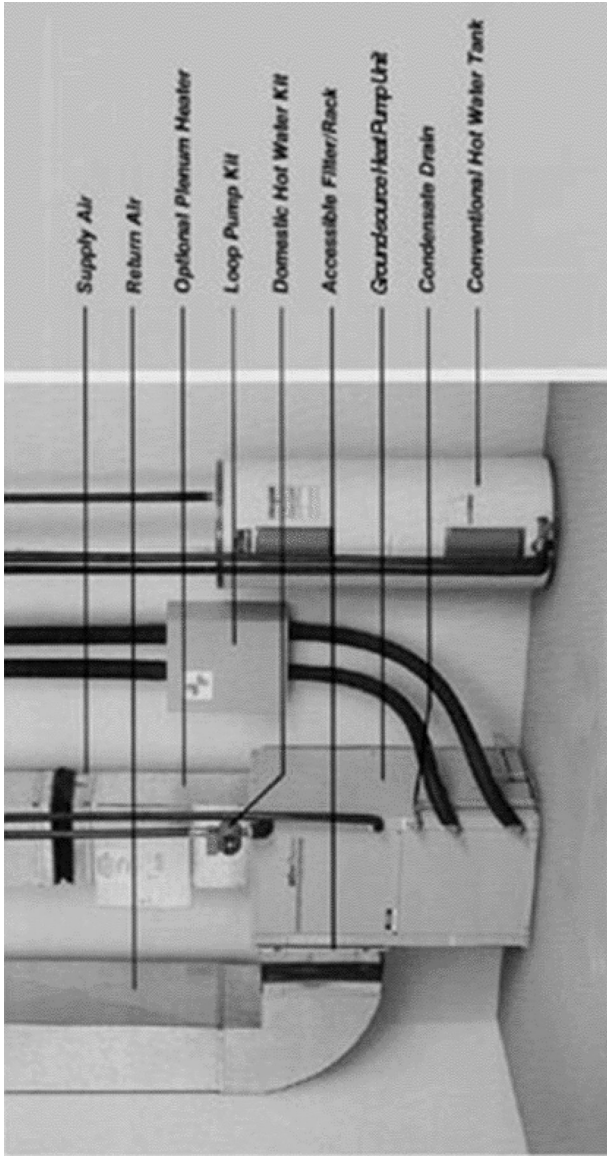


Figure 10

Table 1

Air Force Base Payback Example 37,000 ft ² of Office & VOQ					
Performance	Air-Source Heat Pump	Gas Furnace Air-source AC	Recommended Level GSHP	Best Available GSHP	
Heating/Cooling Efficiency	11.0 EER/ 2.9 COP	11.0 EER/ 90% AFUE	14.1 EER/ 3.3 COP	25.8 EER/ 4.9 COP	
Annual Cooling Energy Use, kWh	37,700	37,700	30,700	20,400	
Annual Heating Energy Use, kWh	29,800	1,970 therms	12,600	10,900	
Annual Energy Cost	\$4,050	\$3,838	\$2,598	\$1,878	
Annual Savings	na	\$212	\$1,452	\$2,172	
Lifetime Energy Cost	\$81,000	\$76,760	\$51,960	\$37,550	
Lifetime Savings	\$0	\$4,240	\$29,040	\$43,440	
Installation Cost	\$24,130	\$20,109	\$10,217	\$18,251	
Simple Payback	na	94.9	27.7	22.2	
O&M or Incentive \$	na	\$15,869	\$11,777	\$4,821	
Note: Electric cost = \$0.06 per kWh, \$0.80 per therm, 15-years, 0% escalation					