CHP Calculation Methodology for LEED-NC v2.2 EA Credit 1

Guidance on Combined Heat & Power (CHP) systems supplying electricity and/or recovered thermal energy to LEED applicant buildings

Background

Combined heat and power (CHP) captures the heat that would otherwise be rejected in traditional fossil fuel generation of electrical power so that the total efficiency of these integrated systems is much greater than from central station power plants and separate thermal systems. CHP systems also produce lower emissions compared to traditional fossil fuel generation. Other benefits include reduction in peak demand, releasing of electrical grid system capacity, and reduction in overall electrical system transmission and distribution losses.

The treatment of CHP under the ASHRAE 90.1 – 2004 Performance Rating Method (PRM, Appendix G) comes under the purview of G2.4 Energy Rates. G2.4 adequately addresses on-site CHP systems but does not provide a methodology for recognizing the potential benefits of district CHP. This document provides guidance for both cases, using a LEED-specific methodology for district systems.

CHP Cases and Calculation of Benefit

Table 1. Summary of CHP Cases. CHP cases can be categorized as follows:

Case	Ownership of CHP vs. Building	CHP Location	Electricity	Recovered Thermal
1	Same	Inside building	All in building and/or sold to the grid	All in building
2	Different (3rd party in building)	Inside building	All in building	All in building
3	Same (campus district energy plant)	District energy plant	Campus electrical supply and/or exported to grid	Campus thermal energy supply
4	Different (commercial district energy plant)	District energy plant	Campus or district electrical supply and/or exported to grid	District thermal energy supply

Case 1 – Same ownership, CHP inside building

In accordance with the PRM, the parameters of the calculation of the CHP benefit are as follows:

The Baseline Building heating and cooling plant utilizes the backup energy source(s) of the Design, or electricity if no backup source is present or specified.

When all electricity and thermal outputs (heating or cooling) of the CHP are used within the Design Building, the electricity produced is considered "free", as is the produced thermal energy. The input fuel for the CHP and any additional purchased energy is charged to the Design Building.

In some cases some electricity generated by the CHP is sold to the grid or an external customer. Thermal and electrical outputs of the CHP used within the Design Building are treated as above. All electricity sold externally is a "process", and both the Design and Baseline Buildings are charged with the input fuel associated with the generation of that electricity. (The sold electricity is irrelevant to the calculations other than for the purpose of determining the associated fuel input.) The thermal output generated from the process and used by the Design is considered "free".

Considerations for Simulation/Calculation:

The PRM requires hourly calculation of the CHP performance, either directly through simulation of the system or manual post-processing of the hourly simulation results. This captures hourly effects of load coincidence and electrical demand reduction, and any declining block or time-of-day utility rate structures. The general approach is to determine the net Design Building hourly energy use after the CHP contribution(s) and then apply the prevailing conventional utility rates. However, it may be possible to conduct the calculation on a net annual basis if hourly load, demand, and/or utility rate relationships are insignificant.

Case 2 – Different Ownership, CHP inside the building

The rates charged to a building by a CHP developer or operator for electricity and thermal outputs typically include factors for capital recovery, maintenance, and other non-energy costs. Since these types of costs are not included in the PRM calculation for other energy efficiency equipment and measures within the Design, they are also excluded for the CHP calculation regardless of the ownership of the system. Essentially the CHP system in Case 2 is treated the same as Case 1, with the input fuel charged to the Design Building (at the prevailing utility rate as it applies to the Design Building) for all CHP outputs used within the building, and charged to both the Design and Baseline Buildings for "process" electricity sold externally (again at the prevailing rate). As with Case 1, the Design realizes the benefit of thermal outputs resulting from the "process" generation.

Cases 3 and 4 – District CHP

In principle Cases 3 and 4 are analogous to Cases 1 and 2, except that the Design utilizes a "virtual" CHP system within the building with the same performance/efficiency characteristics as the district plant. As with Cases 1 and 2, ownership of the CHP system is irrelevant. The calculation of the CHP benefit only considers energy inputs and outputs,

and ignores all other non-energy cost factors. The parameters of the calculation are as follows:

The Baseline Building heating and cooling plant utilizes the backup energy source(s) of the Design, or electricity if no backup source is present (as per Cases 1 and 2).

All electricity and thermal output obtained from the district CHP is considered "free". Fuel input is charged as follows:

a) When the amount of "virtual" CHP electricity associated with the amount of thermal output used by the Design Building at a given point in time is equal to or less than the amount of electricity actually obtained from the district CHP, then the Design is charged with the input fuel associated with the generation of (all) the electricity obtained from the district CHP. The fuel is charged to the Design Building at the prevailing rate as it applies to the Design Building. Any additional energy used by the Design Building is also charged at market rates.

b) When the amount of "virtual" CHP electricity associated with the amount of thermal output used by the Design at a given point in time exceeds the amount of electricity actually obtained from the district CHP, then the excess virtual electricity generation is deemed to be a "process" (as in Case 1). The associated (excess) input fuel is charged to both the Design and Baseline at the prevailing rate.

Considerations for Simulation/Calculation:

Considerations are analogous to Cases 1 and 2. While hourly calculation is necessary for most cases, either through simulation or manual post-processing of the hourly simulation results, for Cases 3 or 4 it may be possible to conduct the calculation on a net annual basis if hourly load, demand, and/or utility rate relationships are insignificant.

CHP System Qualifications

The intent of this guidance protocol is not to grant performance advantages under EAc1 to large-scale utilities, but rather to support and reward the implementation of smaller scale CHP installations. Consequently the CHP system must meet the following criteria in order to be eligible for consideration under EAc1.

1. The minimum annual CHP system efficiency must be at least 60%. Efficiency is expressed by the following equation:

Annual CHP Efficiency = (Annual Btu electrical output of the fuel-driven electricity generator + Annual Btu Thermal Product) / Annual Btu fuel input (Lower Heating Value of input fuel)

2. The environmental performance of district CHP systems must be validated by a narrative addressing emissions and showing that the environmental impact of the system is lower than if the building heating requirements were met with a natural gas boiler and the cooling requirements with electric chillers using electricity provided from the local grid.

3. The Design Building must still meet EA Prerequisite 2 without the benefit of CHP**.**

4. Additionally, in order to qualify for EA Credit 1 consideration under Case 4 – external ownership of the CHP plant with multiple customers – a project must conform to all of the following criteria:

a) Long Term Commitment from the Building Owner – The project must have a long-term agreement in place (minimum ten years) to purchase CHP thermal output from the district CHP system.

b) Building Reliance on District System – The project must be reliant on the district system for 90% of its thermal energy (heating, cooling, or both depending on district service provided to the building), exclusive of any renewable energy (as defined in EA Credit 2).