



Treatment of District or Campus Thermal Energy in LEED for Existing Buildings: Operations and Maintenance

Pertains to the LEED 2009 for Existing Buildings: Operations and Maintenance Rating System and the LEED for Existing Buildings: Operations and Maintenance 2008 Rating System.

Version 1.1 10/18/2012

INTRODUCTION

This document describes the treatment of district and campus thermal energy in the LEED for Existing Buildings: Operations and Maintenance rating systems. The document applies to buildings using thermal energy produced from or delivered to a source outside the LEED project building. This is the initial release of such guidance for LEED EB: O&M projects, and it is aligned with the currently published guidance for LEED design and construction projects.

Administrative

All LEED projects registered under the Existing Buildings: Operations and Maintenance Rating System v2008 or v2009 have the option to follow this guidance if the project building uses district thermal energy. LEED EB: O&M projects are not formally required to use this guidance at this time, but it is highly recommended to help ensure a smooth LEED certification review. USGBC is working to incorporate this guidance into LEED EB: O&M more formally, but that process is not yet complete.

USGBC expects to refine and improve this document over time. To submit suggested improvements to this document send an e-mail to leedinfo@usgbc.org and reference the document title in the subject line of your e-mail.

Overview

In the U.S. a typical commercial building has its own energy conversion plants (chillers, boilers, furnaces) that serve only the heating and cooling energy needs of the building itself. Some buildings, however, are connected to a district or campus thermal energy system where the thermal energy is produced for or distributed to multiple buildings. These district or campus systems can vary widely in size, scope, and complexity, ranging from two small buildings sharing a common chiller to entire city-wide central distribution networks serving hundreds of buildings. Generally such systems are designed for high levels of energy efficiency or to use less environmentally damaging energy sources, but they may be old and have poor part-load performance, high parasitic energy consumption, or thermal losses in energy conversion or transport. From the global environmental perspective it doesn't matter whether the building heating or cooling is generated within the building itself or in an energy plant and delivered by a thermal distribution system – a green building should properly account for the performance of a district or campus system if it's connected to one.

The intent of this document is to clarify whether and to what degree project teams account for a district or campus energy system in the scope of the prerequisites and credits in LEED EB: O&M. This document defines requirements that apply to all district or campus systems - new or pre-existing, owned by the project owner or another entity. This document does not change the usage of prerequisites or credits; all prerequisites are required and all credits are optional.



Only the LEED for Existing Buildings: Operations and Maintenance, Energy and Atmosphere prerequisites and credits are affected by the presence of a district energy system; other credit categories are unaffected.

Changes made in the v1.1 document release

Additional guidance is provided to clarify the method for prorating building-owned DES energy to the building in Portfolio Manager. The methodology and metering requirements remain unchanged; however, the additional guidance is intended to formally address common questions that have been raised regarding this method.

Additionally, the exception related to several buildings grouped as part of a single LEED project has been removed, since the Application Guide for Multiple Buildings and On-Campus Building Projects specifically addresses the requirements for this type of application.

Terminology

District or Campus Energy System (DES) – a central thermal energy conversion plant and transmission and/or distribution system that provides thermal energy (heating via hot water or steam, and/or cooling via chilled water) to more than one building, and where some part of the system (whether the energy conversion, or the transmission and distribution) extends beyond the boundaries of the LEED project site. Examples include a 20,000-ton central cooling plant and network on a university campus serving dozens of buildings or a single 500-ton chiller located within one building that also serves a second, separate building. This definition includes only thermal energy systems; central energy supply systems that provide only electricity are excluded from this definition. Combined heat and power (cogeneration) plants that provide thermal energy are included.

Hereafter in this document, for simplicity the abbreviation “DES” is used to refer to all scenarios in which thermal energy is transported across the LEED project boundary, whether as part of a city-wide system, a campus network, or just two neighboring buildings.

Building Owned DES – any district energy systems in which the building owner organization also owns some or all of the DES. Separate organizational departments, divisions, etc. within a common umbrella organization are considered the same owner for DES purposes (e.g., different federal government organizations within a single military installation). This also includes systems in which the building ownership and/or DES ownership eventually reverts back to the same party through the expiration of a lease.

Third Party DES – any district energy system in which neither the building owner organization nor any of its parent or umbrella organizations has a financial interest in or legal ownership of any part of the DES.

Site energy use – the amount of energy consumed by the project building as metered and billed at the project’s site boundary. In other words, the energy that “crosses the curb”.

Source energy use – the amount of primary fuel consumed by the project building, based on the site energy use but as measured earlier and at a higher level in the energy production and delivery system. The source energy use includes the effects of losses in the energy supply chain and thus is always larger than the site energy use.

Upstream equipment – all heating or cooling systems, equipment, and controls associated with the DES, but not part of the project building’s thermal connection or interface with the DES. This includes the central energy plant and all the transmission and distribution equipment associated with transporting the thermal energy to the project building and/or site.



Downstream equipment – all heating or cooling systems, equipment, and controls located within the project building and/or on the project site associated with transporting the thermal energy of the DES into heated or cooled spaces. This includes the thermal connection or interface with the DES, secondary distribution systems in the building, and terminal units.

Exception: When the building housing the district thermal energy plant is itself seeking LEED certification, the project documentation for that building shall treat the DES equipment as "downstream equipment" for the following credits:

EA Credit 3.1

EA Credit 3.2

DISTRICT THERMAL ENERGY GUIDANCE

Energy Efficiency Best Management Practices (EAp1)

All downstream equipment is included in the scope of EAp1. Downstream equipment includes heat exchangers, steam pressure reduction stations, pumps, valves, pipes, building electrical services, and controls.

All upstream equipment is *excluded* from the scope of EAp1.

Energy Efficiency Performance (EAp2 and EAcl)

LEED EB: O&M requires that the total energy use of the project building be metered. Therefore, the DES heating or cooling energy output serving the LEED building must be separately and fully metered and tracked. The project team will enter this data into the Portfolio Manager tool as site energy, and Portfolio Manager then converts it to source energy based on ENERGY STAR's standard methodology¹. One exception to this method for converting DES thermal energy to source energy is permitted in Portfolio Manager, whereby buildings served by a Building-Owned DES may at their option enter the actual DES source energy into Portfolio Manager in lieu of using the ENERGY STAR default values for source energy conversion. This means that for the DES energy use they report a prorated portion of the metered input energy consumption at the DES central plant based on the metered thermal energy entering the building instead of directly reporting the thermal energy entering the building. This alternative approach is also allowed in LEED EB: O&M for projects served by a Building Owned DES.

This approach requires a greater level of metering and analysis than the default ENERGY STAR data entry approach. However, it allows the opportunity for projects served by energy-efficient building-owned DES systems to take credit for the DES system efficiencies. Table 1 identifies the metering that is required in order to prorate the DES energy to the building:

¹ For a DES the source to site conversion ratios are based on 5-year national averages for U.S. electric, steam, and hot water plants. Chilled water is based on average equipment efficiencies and distribution losses (from *Energy Star Performance Ratings Methodology for Incorporating Source Energy Use*).



Table 1: Metering required to prorate Building-Owned DES to building

Energy Meters	DES – Chilled Water	DES – Hot Water/Steam/DHW
<p>Building-Level Metering</p> <p>(at least one year of data required, matching the same performance period as for Plant)</p>	<p>ELEC_B: Electric energy consumption</p> <p>FUEL_B: Fossil fuel energy consumption (if applicable)</p> <p>CHW_B: Chilled water consumption¹</p>	<p>ELEC_B: Electric energy consumption</p> <p>FUEL_B: Fossil fuel energy consumption (if applicable)</p> <p>HEAT_B: Hot water/Steam consumption¹. If domestic hot water (DHW) from the DES system is provided from a different loop than the space heating hot water or steam, meter each loop separately.</p>
<p>DES Plant Metering for Building-Owned DES</p> <p>(at least one year of data required, matching the same performance period as for Building)</p>	<p><u>Energy Inputs:</u></p> <p>ELEC_{CHW}: Total electric energy consumption associated with chilled water generation including energy for chillers, cooling towers, and pumps. It is acceptable to use the more conservative data from a plant electric meter if the energy associated with chilled water generation is not separately metered.</p> <p>FUEL_{CHW}: Total fuel energy consumption associated with chilled water generation if applicable (i.e. for absorption or engine-driven chillers)</p> <p><u>Energy Outputs:</u></p> <p>CHW_P: Total chilled water energy generated.</p>	<p><u>Energy Inputs:</u></p> <p>FUEL_{HEAT}: Total fuel energy consumption associated with hot water/steam generation and distribution. If more than one fuel type is used, include the total annual fuel energy associated with each fuel source separately. If a separate loop is provided for domestic hot water, meter the fuel consumption associated with that loop separately.</p> <p>ELEC_{HEAT}: Total electric energy consumption associated with hot water/steam generation and distribution (i.e. pumps)³</p> <p><u>Energy Outputs:</u></p> <p>HEAT_P: Total hot water/steam energy generated. If separate distribution loop at the district plant level distributes domestic water heating, meter the DHW heating energy generated for that loop separately.</p>
<p>¹ At the building level, chilled water consumption, hot water consumption, and domestic hot water consumption may be calculated based on the building-level DES flow rates, and the building supply and return water DES temperatures. This method would require building-level flow sensors and building-level supply and return water temperature sensors.</p> <p>² At the district level, chilled water energy generated, hot water energy generated, and domestic hot water energy generated may be calculated based on the flow rates through the chillers/boilers, and the chiller/boiler entering and leaving water temperatures</p> <p>³ In the absence of metered data for HHW/Steam pumps, trend data regarding pump speed may be used along with data regarding the pump brake horsepower and motor efficiency to calculate the annual HHW/Steam pumping energy consumption.</p>		



If the project is served by a building-owned Combined Heat and Power plant, additional metering (beyond the metering listed in Table 1 above) is required to allow the building to prorate the combined heat and power to the building. Table 2 (below) lists the CHP metering requirements.

Table 2: Metering required to prorate Building-Owned CHP to building

<p>Building-Level Metering</p> <p>(at least one year of data required, matching the same performance period as for Plant)</p>	<p>ELEC_B: Electric energy consumption</p> <p>FUEL_B: Fossil fuel energy consumption (if applicable)</p> <p>HEAT_B: Hot water/Steam consumption.¹</p> <p>CHW_B: Chilled water consumption¹</p>
<p>DES Plant Metering for Building-Owned DES</p> <p>(at least one year of data required, matching the same performance period as for Building)</p>	<p><u>Energy Inputs:</u></p> <p>ELEC_{PC}: Total campus purchased electricity consumption for electric energy crossing the curb into the campus.</p> <p>L_{COGEN}: Total cogeneration parasitic losses as a percentage of total electricity generated (such as cooling of the intake air). Assume 5% of the total cogeneration electrical generation if not metered.</p> <p>FUEL_P: Plant Fuel Consumption, for fuel energy crossing the curb into the plant, with the exception of energy fuel that is directly used to generate chilled water.</p> <p>ELEC_{CHW}: Total electric energy consumption associated with chilled water generation including energy for chillers, cooling towers, and pumps.</p> <p>HEAT_{CHW}: Campus Plant Steam or Hot Water Consumption for Chilled Water Generation</p> <p><u>Energy Outputs:</u></p> <p>FUEL_{CHW}: Total fuel energy input for chillers if applicable (i.e. for absorption or engine-driven chillers). This does not include any fuel required to generate steam to drive the chillers.</p> <p>ELEC_{HEAT}: Total electric energy consumption associated with hot water/steam generation and distribution (i.e. pumps)³</p> <p>ELEC_{PG}: Plant Electricity generated by cogeneration.</p> <p>CHW_P: Total chilled water energy generated.</p> <p>HEAT_P: Total hot water/steam energy generated either by fuel boilers or as recovered waste heat from cogeneration. If separate distribution loop at the district plant level distributes domestic water heating, meter the DHW heating energy generated for that loop separately, and include it in the total.</p>



Building-owned DES thermal distribution losses

Thermal distribution losses shall be consistent with those required by ENERGY STAR or documentation shall be provided to justify alternative losses:

- **L_{CHW}**: Chilled Water: 2.5%
- **L_{STEAM}**: Steam: 7.5%
- **L_{HW}**: District Hot Water: 2.5%
- **L_{CHP}**: Combined Heat and Power: 7.5%

Note: References to LOSSES_{HEATING} below shall use L_{HW} or L_{STEAM} based on the type of heating (steam or hot water).

Building-owned DES methodology for prorating Building-Owned DES to the building (except for CHP Plants):

To prorate the Building-owned DES energy consumption to the building, multiply the thermal energy measured at the building by the ratio of the DES energy inputs to the DES energy generated. Account for thermal losses by multiplying this total by (1 + Thermal distribution losses) to determine the total energy consumption that should be entered into the ENERGY STAR Portfolio Manager. Ensure the units are consistent for the building-level chilled water consumption and the DES plant chilled water consumption:

- *Chilled Water Electricity Allocation*: Multiply the building level chilled water consumption by the total annual electric energy associated with DES chilled water generation, and divide by the total annual DES chilled water generated. Multiply this total by (1 + Thermal distribution losses).
- *Chilled Water Fuel Allocation* (if applicable): Multiply the building level chilled water consumption by the total annual fuel energy associated with DES chilled water generation, and divide by the total annual DES chilled water generated. Multiply this total by (1 + Thermal distribution losses).
- *Hot Water/Steam/DHW Fuel Allocation*: For each DES fuel source, multiply the building level hot water/steam/DHW water consumption by the total annual fuel energy associated with DES hot water/steam/DHW generation, and divide by the total annual DES hot water/steam/DHW generated. Multiply this total by (1 + Thermal distribution losses). If a separate loop is provided for domestic hot water, perform a separate calculation for the domestic hot water loop.
- *Hot Water/Steam/DHW Electricity Allocation*: Multiply the building level hot water/steam/DHW water consumption by the total annual electric energy associated with DES hot water/steam/DHW generation, and divide by the total annual DES hot water/steam/DHW generated. Multiply this total by (1 + Thermal distribution losses). If a separate loop is provided for domestic hot water, perform a separate calculation for the domestic hot water loop.

Calculate the monthly energy prorated to the building based on the monthly metered data as follows:

$$ELEC_{B2} = ELEC_B + \frac{(CHW_B) \times (ELEC_{CHW}) \times (1 + L_{CHW})}{(CHW_P)} + \frac{(HEAT_B) \times (ELEC_{HEAT}) \times (1 + L_{HEAT})}{(HEAT_P)}$$



$$FUEL_{B2} = FUEL_B + \frac{(CHW_B) \times (FUEL_{CHW}) \times (1 + L_{CHW})}{(CHW_P)} + \frac{(HEAT_B) \times (FUEL_{HEAT}) \times (1 + L_{HEAT})}{(HEAT_P)}$$

The energy costs associated with the CHP energy shall be prorated to the building using the virtual electric rate and virtual fuel rate at the building level (or at the campus level if the fuel or electricity is centrally billed).

Building-owned DES methodology for prorating Building-Owned Combined Heat and Power to the building:

The production efficiency for conventional steam and electricity generation shall be used to determine the building-level energy consumption associated with steam and electrical generation using the campus cogeneration plant. The following efficiencies are from the ENERGY STAR Guidance Document: "ENERGY STAR Performance Ratings Methodology for Incorporating Source Energy Use"

$\eta_{HEAT,T}$ = Production Efficiency - Conventional Heating = 80%

$\eta_{E,T}$ Production Efficiency - Conventional Electricity = 32%

Calculate the effective delivered efficiency for the heating ($\eta_{HEAT,CHP}$), electricity ($\eta_{E,CHP}$), and chilled water ($\eta_{CHW,CHP}$) as follows. Ensure the units are consistent for the electricity, chilled water consumption, and hot water consumption, and represent site energy (not source energy values):

$$\eta_{HEAT,CHP} = \frac{\left(\frac{HEAT_P}{FUEL_P}\right) \times \left[\left(\frac{HEAT_P}{\eta_{HEAT,T}}\right) + \left(\frac{ELEC_{PG}}{\eta_{E,T}}\right)\right]}{\left(\frac{HEAT_P}{\eta_{HEAT,T}}\right)} \times (1 - L_{CHP})$$

$$\eta_{E,CHP} = \frac{\left(\frac{ELEC_{PG}}{FUEL_P}\right) \times \left(\frac{HEAT_P}{\eta_{HEAT,T}} + \frac{ELEC_{PG}}{\eta_{E,T}}\right)}{\left(\frac{ELEC_{PG}}{\eta_{E,T}}\right)} \times (1 - L_{Cogen})$$

$$\eta_{CHW,CHP} = \frac{(CHW_P)}{\left(\frac{HEAT_{CHW}}{\eta_{HEAT,CHP}}\right) + \left(\frac{ELEC_{CHW}}{\eta_{E,CHP}}\right) + FUEL_{CHW}} \times (1 - L_{CHW})$$

Calculate the monthly energy prorated to the building based on the monthly metered data as follows:

$$ELEC_{B2} = \frac{ELEC_B \times ELEC_{PC} + \frac{(CHW_B) \times (ELEC_{CHW})}{(CHW_P)} + \frac{(HEAT_B) \times (ELEC_{HEAT})}{(HEAT_P)}}{ELEC_{PG} + ELEC_{PC}}$$

$$FUEL_{B2} = FUEL_B + \frac{ELEC_B}{\eta_{E,CHP}} + \frac{CHW_B}{\eta_{CHW,CHP}} + \frac{HEAT_B}{\eta_{HEAT,CHP}}$$



(Note: for both equations, any portion of the equation that leads to a “divide by zero” error should be removed from the equation. For example, in the months where CHW_P is zero, the $(CHW_B * ELEC_{CHW} / CHW_P)$ portion of the equation should be removed.)

The energy costs associated with the CHP energy shall be prorated to the building using the virtual electric rate and virtual fuel rate at the building level (or at the campus level if the fuel or electricity is centrally billed).

Alternative compliance path for DES source energy allocation in ENERGY STAR

If for some reason the ENERGY STAR standard methodology for calculating DES source energy, or the modifications allowed for building-owned DES systems do not accurately reflect a project building's energy use, projects must submit a Credit Interpretation Request (CIR) to the Green Building Certification Institute (GBCI) in order to establish an acceptable alternative method. Note that projects with an above-average efficiency of the upstream DES system *will not* receive an exception on those grounds alone if they are served by a Third Party DES. If the project team wishes to make a case that the Portfolio Manager tool itself is not applicable to their project, that may also be attempted via CIR, but in general it is USGBC and GBCI policy that Portfolio Manager can and should be used to derive the source energy use for buildings suitable for certification in LEED EB: O&M.

Refrigerant Management (EAp3 and EAc5)

Scenario 1 – Building Owned DES

EAp3 and EAc5 requirements apply to both the downstream equipment and the upstream equipment.

Scenario 2 – Third Party DES

EAp3 and EAc5 requirements apply to the downstream equipment but not the upstream equipment.

Existing Building Commissioning (EAc2.1-2.3)

Scenario 1 – Building Owned DES

Commissioning and energy auditing requirements apply to all downstream equipment. Additionally, all applicable upstream equipment is also included if both of the following conditions are true for the project building; otherwise upstream equipment is excluded:

- the project building's gross floor area is greater than 50,000 square feet

AND

- The project building's connected load is 50% or more of the DES total connected load, as measured by the annual energy use

Scenario 2 – Third Party DES

Commissioning and energy auditing requirements apply to the downstream equipment but not the upstream equipment.



In either scenario 1 or scenario 2, if all applicable upstream DES equipment exempt from this guidance has been fully commissioned within the past 3 years of the project's date of application for LEED certification review, the project building is eligible for one innovation point (IOc1). This innovation point can be earned by each LEED EB: O&M project connected to the DES that meets this date requirement. Note that energy auditing, routine energy metering, and routine preventive &/or corrective maintenance do not qualify as commissioning; the full commissioning process discussed in Option 1 of EA credit 2.1 (v2009) must be performed on all upstream DES equipment to earn the innovation point.

Performance Measurement (EAc3.1-3.2)

EA Credit 3.1: Performance Measurement – Building Automation System

The credit requirements apply to downstream equipment only. Monitoring of DES components on the LEED project site must be covered by the BAS or through a similar electronic monitoring system.

EA Credits 3.2: Performance Measurement – System-Level Metering

The credit requirements apply to all end-use loads for the project building, regardless of whether the energy for the load is supplied by on-site, district, or electrical energy sources. No metering in upstream DES systems is required.

Renewable Energy (EAc4)

As defined in the LEED EB: O&M Reference Guides, renewable energy sources defined as electricity, heat, or chilled water energy produced from photovoltaics, solar thermal systems, wind turbines, geothermal, low-impact hydro, wave/tidal, untreated wood waste, agricultural crops or waste, animal and other organic waste, and landfill gas are the only renewable sources allowed for credit under EAc4. The use of air; ocean, lake, or river water; or ambient earth for a thermal heating or cooling sink is categorized as an efficiency strategy in LEED and falls under EAc1.

Qualifying renewable energy sources, according to the definition above, used in a DES may earn points in EAc4 for a connected building (i.e., they count as "on-site" renewable energy for the project building). Performance for EAc4 is based on the fraction of the project building's annual site energy use that comes from qualifying renewable energy sources. The project building's total annual site energy use in these calculations must be equal to the annual energy use value reported in EAp2 and EAc1.

DES On-Site Renewable Energy

For a DES LEED EB: O&M project, the total performance for EAc4 from on-site renewables can potentially have several components. The most basic component can be renewables physically located on the LEED project site itself, which is accounted for using standard LEED EB: O&M procedures. Output from such sources is metered, tracked, and entered into the ENERGY STAR Portfolio Manager tool in the usual way.

Additionally, projects may have further contributions to EAc4 from qualifying renewables located "upstream" within the DES. The DES's contribution to the performance depends on how much of the building's energy consumption the DES supplies as well as how much of the DES energy input is renewable. Calculate the DES's renewable performance contribution as follows:



1. Determine how many separate types or forms of thermal energy the DES provides to the connected building (i.e., steam, hot water, chilled water) and how many separate DES interfaces are used to supply the energy for each type (heat exchangers, pumping stations, etc.). All such DES thermal energy sources having qualifying renewable energy inputs on-site at the DES may contribute to EAc4 for the LEED project.
2. For all DES thermal energy sources having qualifying renewable energy inputs, determine the total annual upstream DES energy input provided by on-site qualifying renewable energy, and divide it by the total annual upstream energy input from all energy sources. This is the DES's overall fraction of energy met from renewables.
3. Divide the project building's annual metered energy use from all DES sources with renewables by the project's total annual site energy consumption (from EAp2/EAc1). This is the project building's relative annual load met by DES sources having renewables.
4. Multiply number 2 (above) by number 3 (above). This percentage is the DES's overall performance contribution to the project building for on-site renewables in EAc4.

DES Off-Site Renewable Energy

Green power generated offsite and used in a DES may contribute towards the total green energy purchased for a connected project building, as can Green-e certified offsets acquired by the DES operator for other fuel types. Either Green-e certified renewable electricity (including RECs) or Green-e certified offsets for other energy sources can qualify.

Calculate the DES's renewable performance contribution for off-site renewable energy using the same procedure described above for on-site sources. If the DES uses both on-site and off-site renewable energy inputs, both can contribute to the total renewable energy performance of the project building.

For either DES Off-Site or On-Site Renewable Energy

If renewable energy contributions from the DES are applied to a connected building, a letter must be provided from the DES owner or operator verifying all of the following:

- the reported quantity of renewable energy is allocated to the DES itself (i.e., the upstream generation and/or distribution equipment) and not directly to any building, and
- within the overall DES renewable energy allocation, no renewable energy assigned specifically to the DES central plant building, if any (in a separate LEED application), is also being counted towards the renewable energy contribution of the connected project building, and
- no renewable energy is being double-counted among any connected project buildings (in separate LEED applications), and
- either the DES owner or operator maintains rights to the environmental benefits of the site-generated renewable energy, OR the requirements under "Retention of Renewable Energy Environmental Attributes" in the LEED 2009 Green Building Operations & Maintenance Reference Guide (page 208, 1st edition) are met

Emissions Reductions Reporting (EAc6)



Projects that use district heating or cooling must incorporate GHG emissions from the relevant DES energy inputs based on the selected emissions accounting protocol. Use of accounting protocols that require DES-specific emissions factors (as opposed to national averages) is encouraged, though some protocols may not require this. In the absence of specific guidance for the protocol in use, include reasonable accounting of emissions from DES energy consumption.