LEED™ Energy Modeling for projects constructed to utilize the District Heating and Cooling Systems of Cornell University (Version 4.0 October 2011)

1.01 PURPOSE

This document provides information for LEED Energy Modelers to properly incorporate Cornell’s district heating and cooling system efficiencies into the energy analysis for the LEED New Construction (LEED-NC v2.2 or LEED-NC 2009), Energy & Atmosphere Credit 1 – Optimize Energy Efficiency (“EA Credit 1”) and associated prerequisite. This applies to all buildings utilizing Cornell’s district chilled water and/or heating systems.

This guidance was updated in 2011 to reflect actual measured annual values. Cornell’s Combined Heat and Power Plant went fully on-line at the end of 2009 and the system is now fully operational.

This document is intended to comply with the following United States Green Building Council (USGBC) directives as follows:

• Methodology for Modeling Combined Heat and Power for EAp2/c1 in LEED 2009.

Copies of these documents are appended to this guidance memo. Appendix A is also attached to provide additional background information, data, and analysis related to Cornell’s central utility systems.

1.02 EXPECTATIONS OF MODELING RESULTS

Cornell’s district energy system performs at a high level of efficiency and this investment in energy efficiency can be used to earn additional credit points for LEED projects.

Based on the analysis included in Appendix A, LEED projects which connect to Cornell’s district heating and cooling systems meet the requirements to obtain EA-1 points under the NC Energy and Atmosphere Credit EA-1 for efficient district energy systems.

Attaching this memo to LEED modeling results may help document this performance.

1.03 METHODOLOGY

In order to meet the LEED requirements for this credit, projects performing energy modeling of buildings connecting to the district energy systems (both heating and cooling) choose one of two performance options to show compliance with both EAp2 and EAc1. Even though LEED no longer requires the modeler to perform both options, Cornell requires that both options as described below be performed to maximize LEED EAc1 points using district systems, and also to meet University criteria referenced as “LEED/30” and document compliance with established EUI targets.
A. Option 1: Building Stand-Alone Scenario - Determine the efficiency of the building itself (not including supply-side system efficiencies):

1. A “base building” which is modeled using delivered energy (steam, chilled water, and electricity) at Cornell’s current billed steam, chilled water, and electric rates. Building baseline HVAC system types from ASHRAE 90.1 Appendix G shall be modified to be consistent with the purchased energy source.

2. An “as-designed building” which is modeled using delivered energy at Cornell’s current billed steam, chilled water, and electric rates.

3. For this first modeling exercise, the following BILLED ENERGY RATES shall be utilized in both the Base Case and As-Designed models (2011 rates listed; contact Facilities Engineering for updates):
   a. Electricity: $0.07/KW-hr
   b. Chilled Water: $0.20/ton-hr
   c. Steam: $28/MMBTU

4. The result of this first modeling step will demonstrate the efficiency of the building energy systems, independent of the upstream utility sources. In addition to LEED prerequisites, all new buildings shall comply with the requirements of Cornell’s companion memo “LEED/30 and LEED/0 Compliance Protocol”. Other directives or updates may be issued separately.

B. Option 2: Aggregate Building / DES Scenario - Determine the overall efficiency of the building and supply side systems, as follows:

1. A “base building” modeled as if it operated utilizing code-compliant on-site fossil-fuel (natural gas) heating and electric-powered cooling systems. These systems are defined in the LEED guidance documents.

2. An “as-designed” building modeled utilizing a “virtual” district energy system with the same operational efficiencies as Cornell’s district heating, cooling, and power systems, calculated using the same input fuel (gas and electric) rates as in the base building model.
   a. Cooling: The consultants shall model a “virtual chiller” with a COP of 25 or 0.14 kW/ton directly in the simulation program to model the efficiency of the Lake Source Cooling System. Distribution losses are already incorporated into these values.
   b. Heating and Power Systems: Modeling of Cornell’s CHP system will require that an exceptional calculation method be employed. See Section 1.04 for the calculation procedure.
3. For this second modeling exercise, the following **BILLED ENERGY RATES** shall be utilized in both the Base Case and As-Designed models (2011 rates listed; contact Facilities Engineering for updates):

   a. Electricity: \(0.07 \, \text{s/KW-hr}\)
   
   b. Natural Gas: \(0.70 \, \text{s/therm}\)

### 1.04 CHP CALCULATION PROCEDURE

The following values were derived from the analysis presented in Appendix A, and shall be used to determine the benefit of the district heating and power system as it applies to the project.

The building loads for the proposed facility are compared to the “matched” loads of the CHP output, which on an annual basis, produces an average of 144 kW-hr of “free” electricity for each 1.0 MBTU of heat (steam) energy used within the buildings on campus (accounting for all upstream system loses). The amount of natural gas (in therms) needed to produce that heat and electrical output has been documented to be **22.6 therms** for each **144 KW-hr** and **1.0 MMBtu** of heat. The CHP is unable to generate 100% of the campus electrical needs, so accounting for the baseline electricity purchase of 20%, a campus building match would have an annual electricity to steam ratio of **180 kW-hr/MMBtu**, which will serve as the basis of determining whether the project uses a Scenario A or B calculation as described below.

**A. Scenario A:** The building’s allocation of CHP-generated electricity is less than or equal to its modeled electricity consumption. For this scenario, the building will have a ratio equal to or above 180 kW-hr/MMBtu. The additional electricity shall be assumed to be purchased from the grid at the market rate. This has been found to be the typical case for new buildings on campus, especially for high-tech buildings.

**B. Scenario B:** The building’s allocation of CHP-generated electricity exceeds its modeled electricity consumption. For this scenario, the building will have a ratio less than 180 kW-hr/MMBtu. The additional steam shall be assumed to be generated using a “virtual” 73% efficient natural gas boiler (includes boiler + distribution efficiency) that bypasses the back-pressure steam turbines. Although this case may not be typical, it may represent a lower tech facility, such as a dormitory or athletic facility.

Please see the attached table “Sample Calculations of District Energy Savings” for sample calculations.