LOW CARBON CAMPUS GUIDANCE

THERMAL DISTRICT ENERGY SYSTEMS

VERSION: 10/1/2020

INTRODUCTION

The purpose of this document is to provide strategic guidance to Agency project teams regarding their campus thermal district energy systems and associated building systems, along with what actions may be taken to reduce their associated environmental impacts, reduce operational costs and achieve carbon reduction goals.

CARBON CONTEXT

Executive Order 20-01 established requirements for Washington State agencies to consider and lower the emissions associated with building systems, as stated below:

(1) When making purchasing, construction, leasing, and other decisions that affect state government's emissions of GHGs or other toxic substances, agencies shall explicitly consider the benefits and costs (including the social cost of carbon) of available options to avoid those emissions. Where cost-effective and workable solutions are available that will reduce or eliminate emissions, decision makers shall select the lower-emissions options.

(1b) Directors shall ensure that all newly- constructed state-owned (including lease- purchase) buildings shall be designed to be zero energy or zero energy-capable, and include consideration of net-embodied carbon.

It is therefore imperative that low-carbon decisions be made surrounding the development and maintenance of campus loop infrastructure. This will help establish a plan for the State to create combustion-free, zero energy buildings and achieve the targets that have been established.

DESIRED END STATE

The 2050 target for Washington agencies is to operate **net zero carbon campus loops**; district systems that use **combustion-free** electric heating/cooling and source only renewable energy. While electricity sourcing may be out of scope, many actions can be taken by agencies to minimize their combustion, including by electrifying their campus loop systems. Low carbon systems will be put in place in a way that is cost-effective, operationally efficient and offers the most long-term benefits for building operators and users.

CONSIDERATIONS

The end state above alludes to a vision for a future with campuses that have zero emissions; they only use clean, renewable energy to address all electricity demand and have no on-site combustion. In order for this to be feasible, these campuses operate using highly efficient systems and lose minimal to no waste heat. Their systems are monitored rigorously to ensure all systems continually operate at maximum efficiency.

All new construction campus projects should align with this vision and projects involving existing campuses should prioritize setting up all future systems to be capable of meeting these targets. This vision should be at the forefront for all campus development projects as to make this end state a reality.

STRATEGY + PROCESSES

The overall strategy to transition towards zero carbon campus loops is to incrementally reduce the loads on the system to the point that transitioning to an electric-based setup is technologically and financially feasible. The following are recommended strategies that should be considered for each project, in order of preference and cost effectiveness:

Reduce total heating demand. Increase the energy efficiency of properties on the loop; improve the thermal performance of buildings, install modern controls or new equipment to more effectively utilize heat, and/or upgrade to low temperature building heating systems.

Reduce or eliminate peak demands. Assess heat cycles and identify opportunities to shift or isolate peak loads. This may include pre-heating or installing separate systems for specialized heat loads (e.g. laboratory or industrial processes). Integrate thermal storage, low temperature heat recovery, and technologies that support waste stream to feedstock principles.

Convert district steam to hot water. Transition to low-temperature hot water systems that permit heat exchange. Consider new pumping, pipe capacities and connections as needed.

Electrify central heating systems. Once hot water supply is established, convert central systems to electric-based systems. Consider the use of heat pumps that are either air-sourced or ground-sourced for maximum efficiency.

PROJECT INTERVENTION POINTS

Incremental steps towards zero carbon can be made throughout a campus loop system life cycle. Below are key intervention points and tactics teams should consider to support system transitions.

NEW CONSTRUCTION + RENOVATIONS

Pre-Design:

- ☐ Review energy and carbon goals at the project team kickoff meeting(s) that align with campus loop; set target for Zero Energy with highest building energy efficiency
- ☐ Specify heating load isolation strategy and system-level performance metrics in the Owner's Project Requirements (OPR)

Design:

- ☐ Prioritize high-efficiency envelope design or upgrades to reduce overall heating demands
- ☐ Select highest efficiency HVAC systems and water fixtures that utilize hot water
- ☐ Design campus loop connections and controls to accommodate hot water in the future
- ☐ Pursue all opportunities to take advantage of air or water-based heat recovery (e.g. HRVs)
- ☐ Install meters to support energy monitoring
- ☐ Incorporate thermal storage capacity to support load management on the campus loop
- ☐ Incorporate campus loop infrastructure upgrades into new, retrofit, and major renovation projects

OPERATIONS + MAINTENANCE

On-going Monitoring:

- ☐ Regularly audit energy systems to identify and repair leaks or component failures
- ☐ Install metering to identify top heating uses, cycle times and peak loads
- ☐ Analyze peak loads to identify potential to shift timing or isolate to a separate system

Replacements + Upgrades:

- ☐ Insulate all heating conveyance
- ☐ Streamline runs to best match demands/loads
- ☐ Integrate controls that permit advanced management of heating/cooling cycles
- ☐ Upgrade components to variable speed to reduce system cycling, match heating loads
- ☐ At component end-of-life, consider whole-system improvements; bundle upgrades to demand and supply side (e.g. replace boilers and use low temperature terminal units)

TOOLS

Zero Energy Toolkit – Washington State Department of Commerce
www.commerce.wa.gov/growing-the-economy/energy/state-efficiency-and-environmental-performance-seep/zero-energy-toolkit

Owner's Project Requirements (OPR) Guidance
www.commerce.wa.gov/wp-content/uploads/2019/07/ZE_Toolkit-OPR_Guidance.pdf

RESOURCES

Case Study: Stanford Energy System Innovations (SESI): Steam to Hot Water Conversion
sustainable.stanford.edu/sites/default/files/documents/SESI_Hot_Water_-_Steam.pdf

Case Study: University of British Columbia District Heat Conversion
energy.ubc.ca/ubcs-utility-infrastructure/district-energy-hot-water