Building Decarbonization Framework for CSU

CSU Capital Planning, Design, and Construction

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California State University (CSU) is the high quality, affordable, inclusive higher education for California. 15 CSU campuses have signed a Carbon Neutrality pledge. CSU's has achieved its 2020 carbon emissions reductions goal primarily through the decarbonization of electric supplies. In order to meet its 2040 carbon emissions reductions goals CSU will have to reduce and eventually eliminate emissions from natural gas combustion. The tension between maintaining CSU's world class performance at increasing social mobility for our students by remaining affordable and inclusive results in needing to operate capital assets for twice as long as typical industry expected useful lifetimes (EULs). These facts require CSU's carbon reduction efforts to avoid stranding previous investments and quickly and with very limited capital and operating budgets make smarter low-carbon infrastructure decisions at replacement at (near) burnout or unrepairable stages of equipment life.

The California State University is seeking a professional services consultant to create a framework and guidelines to evaluate and assist CSU in making informed decisions on what, why, how, when and where to implement building decarbonization, primarily from campus heating systems given the constraints described above. One of the strategies that must be included is to operating existing assets more efficiently/effectively in addition to evaluating lifecycle costs and options for transitioning to low carbon heating systems at burnout.

The documents and resources created by the consultant shall follow the formatting and style of CSU's Mechanical Review Board Utilities Infrastructure Master Plan Guide and Utility Recharge Rate Computation Guide.

CSU shall provide:

1. Access to monthly energy reports and available campus electrical interval data through its Energy Information System.
2. Access to space and facilities database (SFDB)
3. Copies of the campus Utility Master Plans, Utility Master Plan maps and Critical Infrastructure reports.
4. Access to CSU's Facility Condition Assessments covering almost all of the state funded facilities.
5. Copies of the Mechanical Review Board's recommendation and modelling guidance for Title 24 part 6, performance standard proposal.
6. Copies of CSU's Utilities Infrastructure Master Plan guideline.
7. Provide copies of samples of formal and informal campus thermal comfort policies and potential policies.
8. 1 half-day kick off meeting to describe efforts to date on Building Decarbonization.
9. CSU staff will be available for scheduled phone calls and emails to discuss/clarify provide project management oversight of this effort.
10. Access to campus facilities, if necessary.

The consultant shall:

1. Utilize the ProSci ADKAR change management framework to organize this work into an effective guideline/vision document or series of document to introduce change into CSU's decision-making process with regard to zero carbon building design. (https://www.prosci.com/adkar/adkar-model) The overall project must describe a successfully decarbonized campus from the perspectives of engaged stakeholders including but not limited to building occupants, Design staff Facilities Operations staff, Budget & Finance, EH&S, etc. All of the work product shall include footnotes, references and links to primary sources of studies supporting the conclusions made in these documents.
2. Create a report on the policies (statute, regulations, building code, energy models, green building rating systems, IEPR, outcome-based energy code pilots, Architecture 2030 – Zero Code and utility incentives, etc.) that erect barriers and create opportunities to intervene in proceedings or law to advance building decarbonization. This report shall include a comprehensive inventory of policies from the federal government, California government, UC, CEC, CPUC and major investor owned and municipal utilities related to building decarbonization.
3. Create a guideline document that describes design of climate change adapted structures using forward looking weather/climate zone data compared to industry standard practices. Make a recommendation for a CSU model practice. The guideline document may be used to establish CSU standards. Provisions of the guideline document should not adversely impact the life and safety of the occupants and must include:
    a. an analysis of setting design day criteria and
    b. a cost-benefit analysis between current industry practices versus design of mechanical ventilation, heating, and cooling of structures to meet up to 80-90% of the building occupants comfort expectations.
    c. Draft an adoptable and capital/operating budget efficient model thermal comfort policy.
4. Create a technology review report that includes physical capabilities and limitations of low to no carbon heating technologies. The reviewed technologies shall be grouped into commercially available and cost competitive, commercially available but at a cost premium, near commercially available and emerging technologies with a Technology Readiness Level of 6 or greater. The technology review should include:
    a. The report must address conceptual approaches to phasing the transition from current state(s) to combustion free campuses and decarbonized buildings. This must include addressing the phasing issues with existing coils, replacement coil selection, energy efficiency and effectiveness at maintaining thermal comfort.

b. The report will address products that are commercially availability, competitively biddable status, strengths and weaknesses, and engineer's estimates of capital and operating costs for each technology. This should cover issues including, but not limited to:

    i. Low to no carbon heating systems design can meet campus specific climate zone heating design day and CSU operating parameters.
    ii. Total cost of ownership analysis of capital and operating budgets compared to business as usual (BAU) mixed fuel buildings/central plants.
    iii. Externalities associated with fugitive refrigerants
    iv. Building occupant acceptance/satisfaction with the use of electric heating technologies and the costs and benefits of a range of thermal comfort policies.
    v. Technologies and approaches to manage peak demand charges
    vi. Opportunities for flexibly deploying existing and/or new thermal storage (hot / chilled water tanks)
    vii. Opportunities to develop a standardized "boiler replacement" packages that can be specified and installed on timelines associated with boiler failures

5. Create a guideline document that makes general (conceptual) recommendations that matches CSU's existing buildings, infrastructure and capital plans (new construction) to the least cost, best fit low carbon heating systems reviewed. This document shall include engineer's estimates of capital and operating budget costs based on types of CSU campus cooling and heating loads and infrastructures as derived from the CSU supplied utility master plans.

Existing Infrastructure	Campuses
Central HHW and CHW Plants & Loops	SLO, SA, ST, FR, BA, NO, SB, SO, CI, SM, PO, LB, DH
Central CHW Plant & Loop with Distributed Boilers	LA
Central HHW Plant and Loop, No Central CHW	MB, SF
No Central CHW/HHW Loops, Distributed Boilers	EB, HU, MA
Cogeneration, Steam Loop	SS, SD
Cogeneration, HHW Loop	FL, SLO
Central Steam Plant with Steam Loop & CHW	CH

Table 1: Existing Central Plant/HVAC Infrastructure & Associated Campuses

a. Provide an overview of potential low to no carbon heating systems given the installed infrastructure, climate zone, and a generic scope of work/phasing plan to install the best fit least cost low to no carbon heating technology.
b. Identify opportunities for adaptive reuse of heating hot water and chilled water conveyance systems and guidelines for additional investments of HHW/CHW within a low carbon heating energy framework. This shall include, but not be limited to:
    i. Age/condition of conveyance system
    ii. Distance to new loads
    iii. Adaptive reuse opportunities
c. Technologies shall include, but not be limited to:

    i. Heat Recovery Chillers
    ii. Eco-Loop with Distributed Water Source Heat Pumps

iii. Ground Source Heat Pump
iv. Water-to-Water Heat Pump
v. Air Source Heat Pump
    1. Split / VRF systems
    2. Centralized Air-to-water Heat pump systems
vi. Heat recovery from recycled water lines or sanitary sewer lines on campus
vii. Renewable natural gas potential to scale to meet CSU's and California's climate goals, in particularly scalability to carbon neutrality.

d. Other considerations include:

    i. Systems with and without chilled / hot water thermal energy storage
    ii. Centralized hot and chilled water
    iii. Centralized chilled water and decentralized hot water
    iv. Central steam conversion
    v. Low Global Warming Potential (GWP) refrigerants
    vi. Building-scale boilers and hot water circulation loop heating

6. Provide a high-level study using monthly energy use data of the potential simultaneous heating and cooling that occurs on CSU campuses benchmarked against similar industries/uses.
    a. For campuses where the detailed central plant energy use data is not available, develop annual cooling and heating load profiles to estimate simultaneous heating and cooling from the data sources supplied by CSU and energy use benchmarking data.
    b. Identify potential heat rejection/waste over the course of a year.
    c. Develop natural gas use benchmarks to inform Heating Plant operations to reduce carbon emissions during the phase in process.

7. Provide an Excel based Life Cycle Cost Analysis Tool comparing low to no carbon heating systems to BAU using parameters which include but are not limited to:
    a. CSU's practice of replacement of equipment at burnout, long past the normal end of useful life
    b. Value of co-produced products capacity such as heat recovery chillers
    c. Accommodate both greenfield vs phased conversion to low carbon heating systems
    d. Incorporate a range of natural gas prices that include Cap and Trade cost escalation
    e. Accommodate a range of time of use electric prices under Direct Access and bundled services tariffs, reflect impact of distributed energy resources like on-site solar or storage.
    f. Capital Costs
    g. Operating costs (maintenance, utilities)
    h. Forward-Looking CDD/HDD assuming 50-year life of the core and shell of the buildings
    i. Envelope Efficiency improvements
8. Publish guidance for design teams and their energy modelers that is congruent with CSU's Mechanical Review Board modelling guidance for Title 24 policy and assists design teams through Title 24 compliance for Decarbonized Buildings.

Deliverables:

1. Attend a half-day kick off meeting to on-board and describe efforts to date on Building Decarbonization at CSU.
2. A draft report with chapters for each of the sections above and incorporating CSU staff and CSU's Mechanical Review Board comments
3. Attend 2 MRB meetings to discuss, defend and incorporate feedback into the reports.
4. Attend 1 CSU Energy & Utility Manager Council (EUMC) meeting to present work and educate attendees.
5. Final reports, guidelines and LCCA calculator with instructions.