

A Developer's Dilemma:

How Best to Plan, Design, and Operate an All-Electric Life Science Lab Facility



Paul Erickson | Affiliated Engineers, Inc
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Learning Objectives

1



Develop awareness of the various electrification technologies available for meeting full electrification of a large lab building, inclusive of process loads.

2



Understand the mechanical and electrical planning considerations for a large all-electric lab facility.

3



Gain appreciation for the benefits and challenges of an all-electric facility.

4



Learn about the startup, commissioning, and operational lessons gleaned from this project.

Agenda

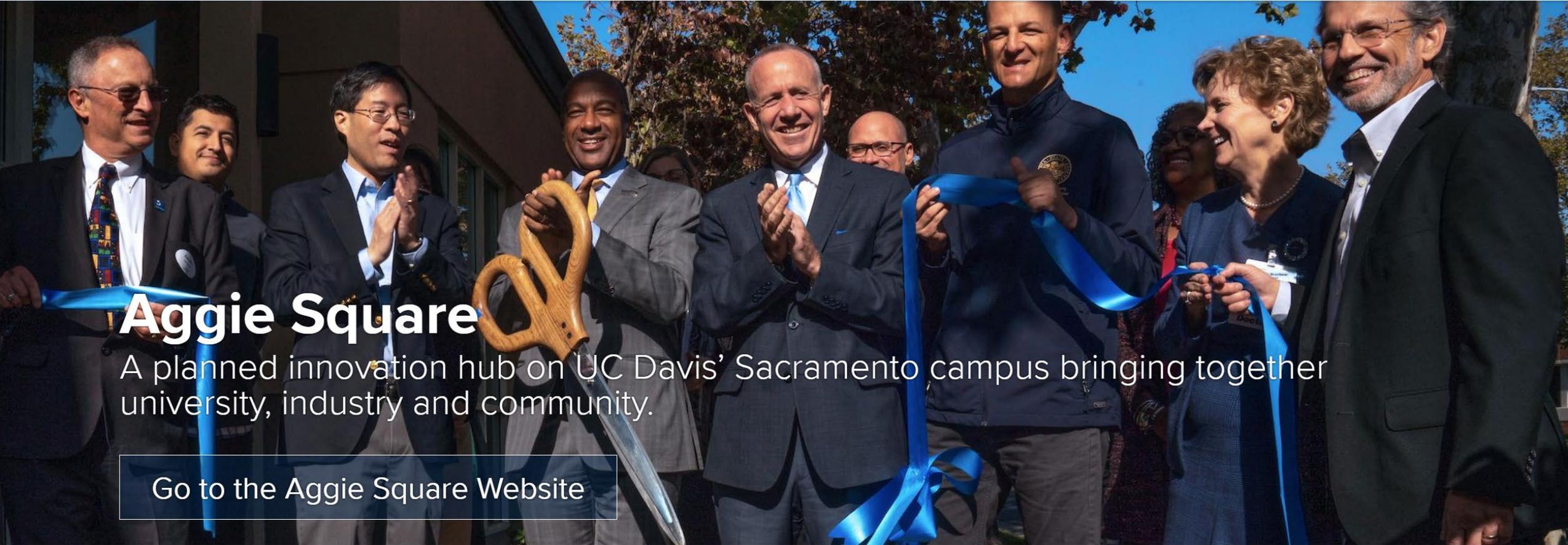
1 Project Vision & Outcomes

2 Electrification Strategies

3 Startup, Cx & Operations Insights

4 Q&A

Project Vision

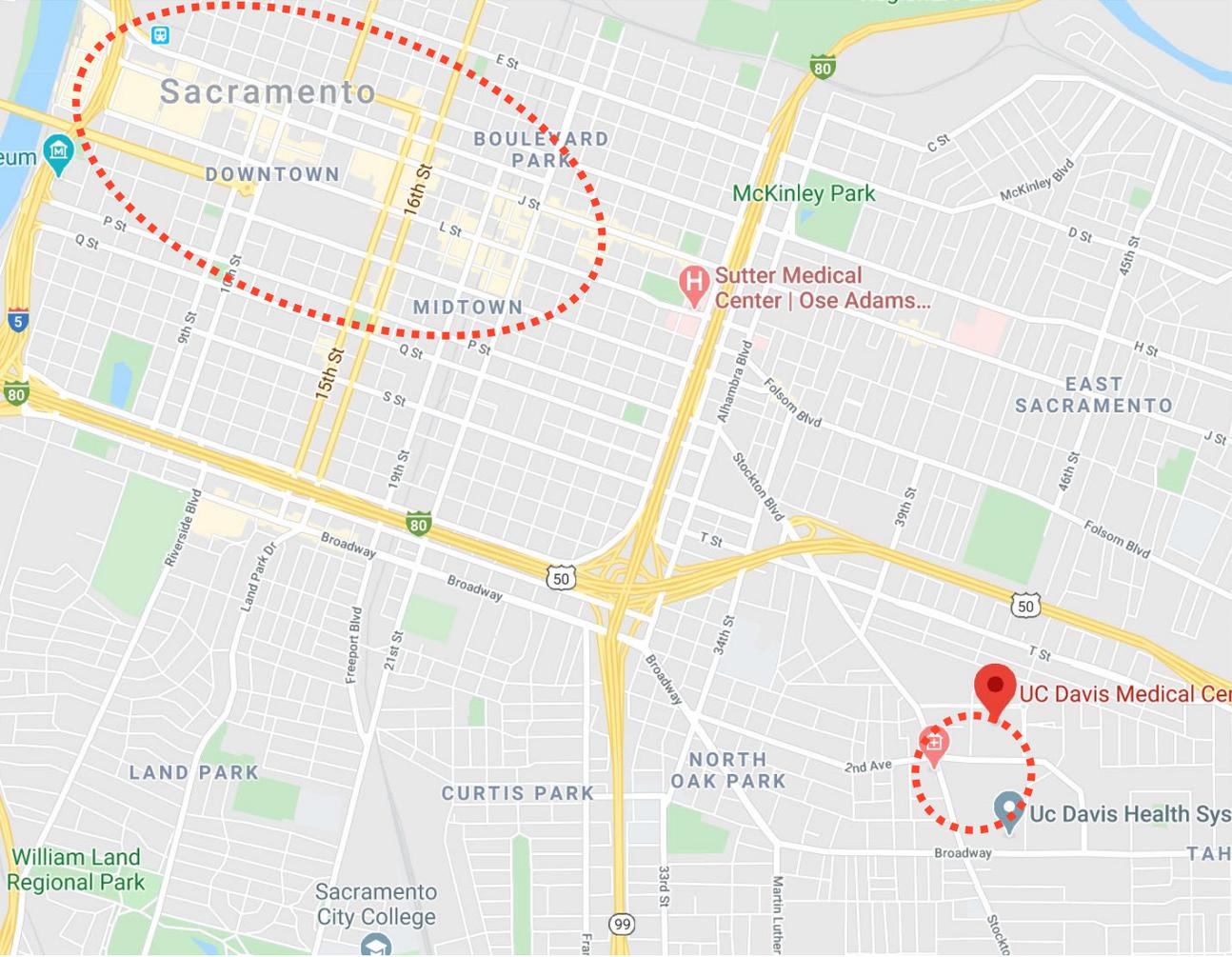


Aggie Square

A planned innovation hub on UC Davis' Sacramento campus bringing together university, industry and community.

[Go to the Aggie Square Website](#)

Project Vision



Project Vision



Housing and Market Plaza

Uniting community need and local talent with the health and nutrition expertise of a world-class university.



Life Sciences

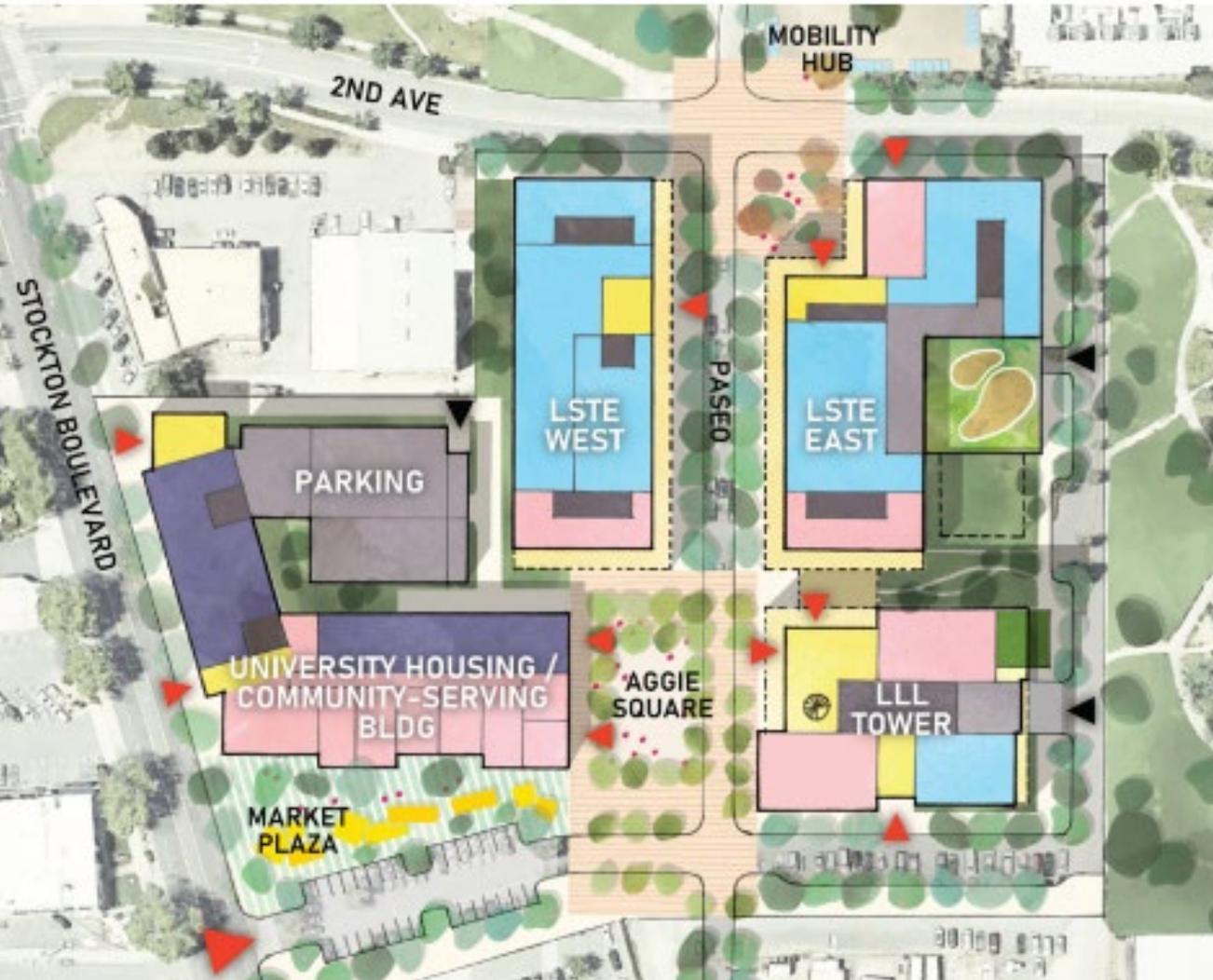
High-tech labs and large-scale facilities needed to make discoveries not only possible, but scalable.



Lifelong Learning

A comprehensive network of partners and programs dedicated to training for the next generation economy.

Project Vision



Life Science, Technology & Engineering

- Wet/dry labs
- Specialty labs (i.e. CGMP, vivarium)
- Maker space
- Office/meeting

Lifelong Learning

- Workforce training
- Industry innovation
- Community space

Housing/Alice Waters Institute

- Housing
- Retail food
- Training kitchen
- UCD catering kitchen
- Meeting

Project Sustainability Goals



Green Building Design, Energy Efficiency and Climate Neutrality

Target EUI (95 kbtu/sf-yr Labs, 50 kBtu/sf-yr Office)

or

20% improvement over T24-2019

All Electric Space and Water Heating (+ cooking and process loads per UC Davis)

LEED Silver Certification

Clean Energy (onsite or purchased)

Climate – Emissions reduction (supported via all-electric design)



Sustainable Water Systems

2 LEED points under Water Efficiency (min. 20% reduction)

Support campus 36% water reduction by 2025 goal

No-potable once through cooling

Minimize irrigation

Project Sustainability Goals



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Project Sustainability Goals



Sustainable Transportation

LSTE and LLL buildings/site have limited or no design scope for parking/vehicle acquisition



Sustainable Operations

LEED O&M certification (n/a)
Green Labs – TI scope



Zero Waste

Waste reduction and Zero waste TI scope



Sustainable Foodservices

Foodservice and product purchasing TI or operations scope (n/a to C&S)



Sustainable Procurement

Furnishings and operations product purchasing TI or operations scope (n/a C&S)

Project Team



Construction Manager



Architect



MEP/FP/Energy/IT/AV/Sec



Structural



Lighting Design



Landscape



Life Safety



Commissioning



Mechanical Contractor (TI)



Mechanical Contractor (C&S)



Electrical Contractor



Fire Protection Contractor

Wexford Science & Technology / UC Davis

Aggie Square: Life Science, Technology & Engineering - East

~325k GSF

Neuroscience, Biology,
Gross Anatomy, Specialty

All-electric design

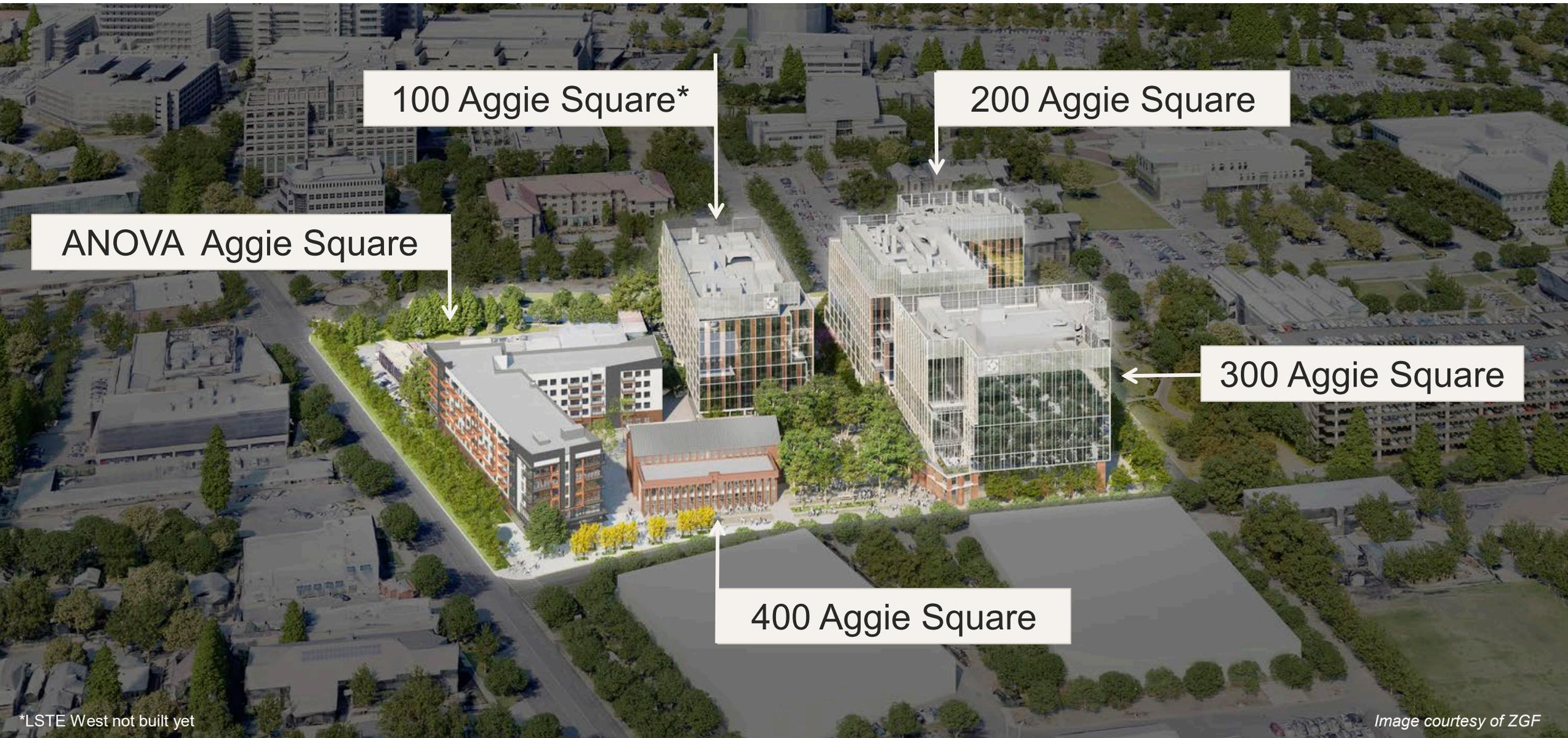
- Heating
- DHW
- Humidification
- Lab equipment
- Cafe

LEED target: v4 Gold

EUI target: 95 kBtu/sf-yr

100% renewables (grid)

Planned Project Scope



100 Aggie Square*

200 Aggie Square

ANOVA Aggie Square

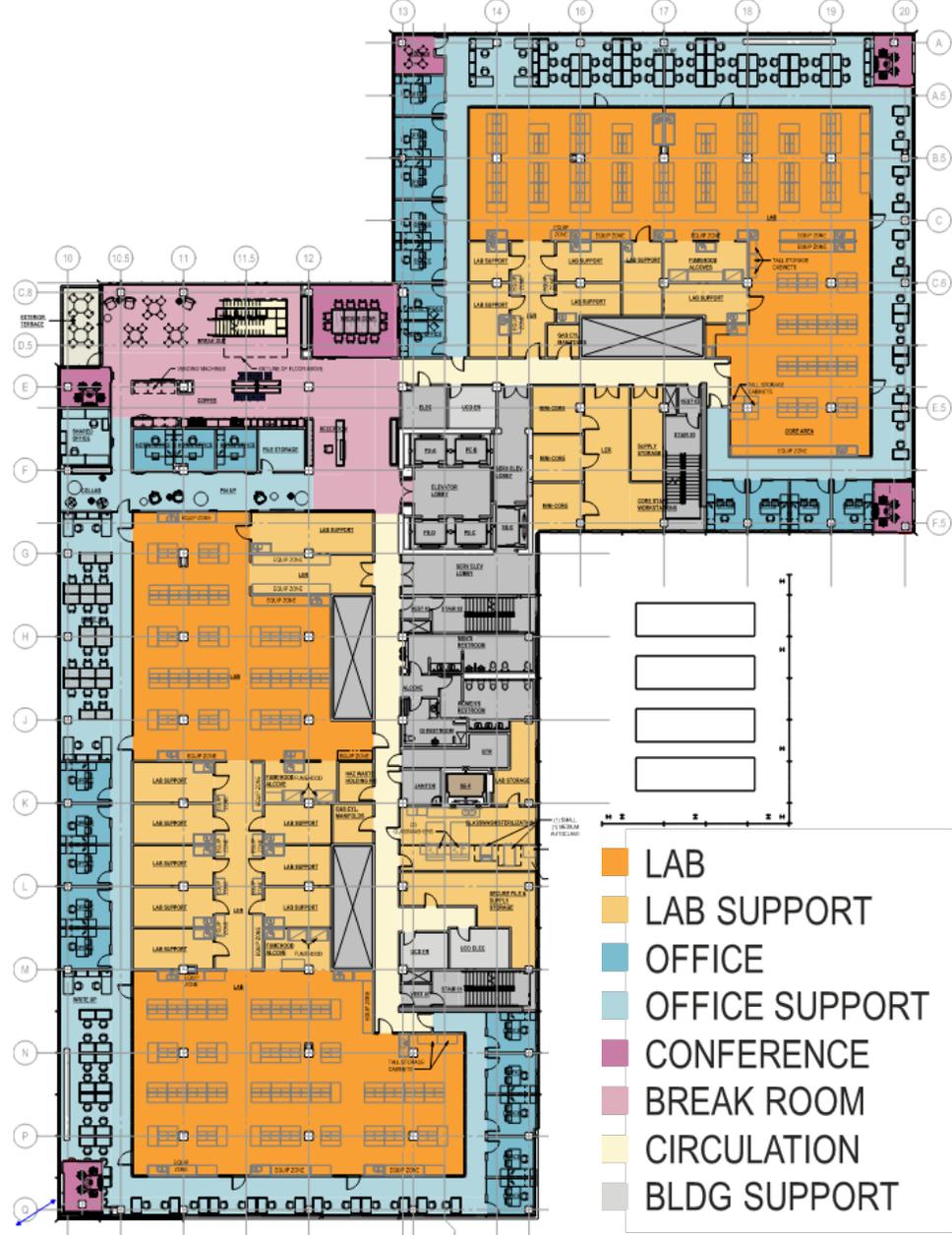
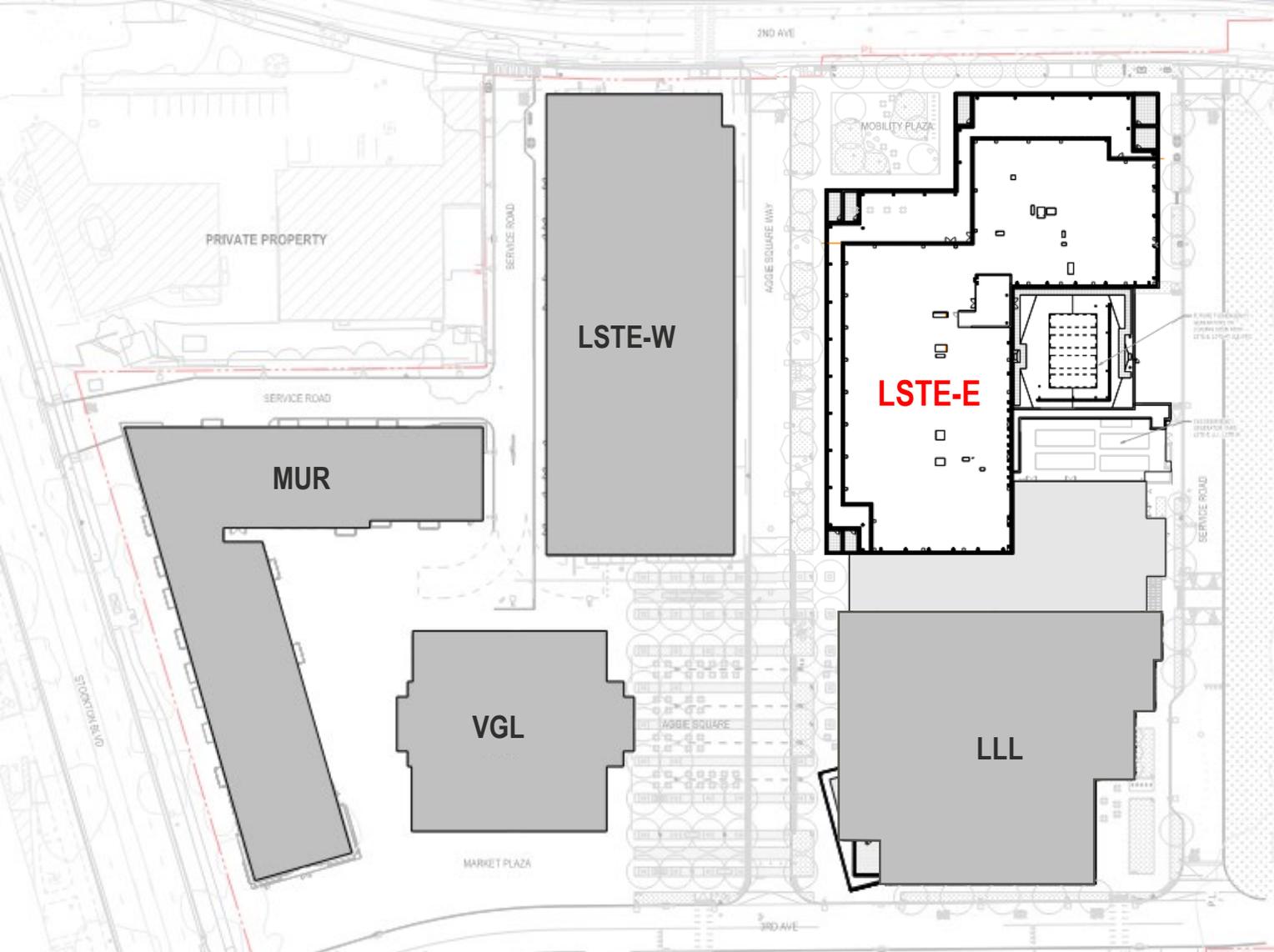
300 Aggie Square

400 Aggie Square

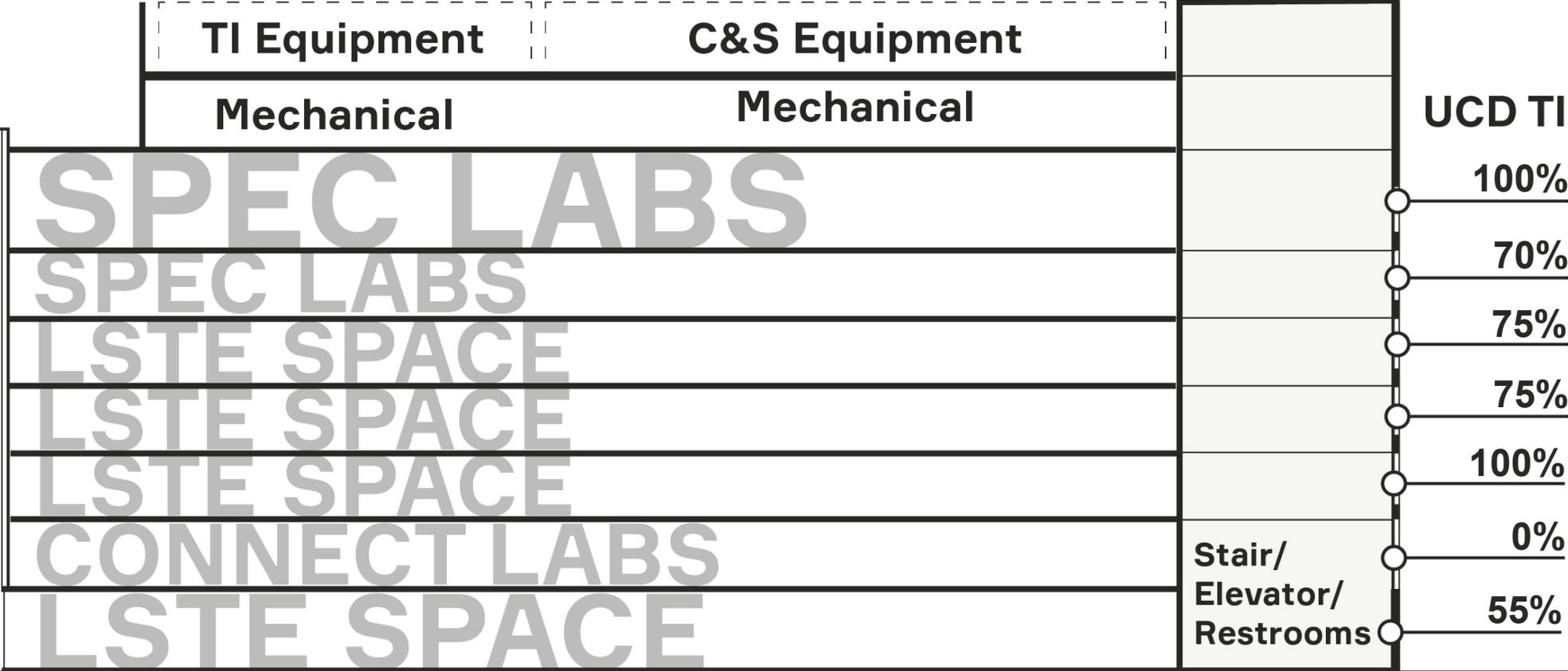
*LSTE West not built yet

Image courtesy of ZGF

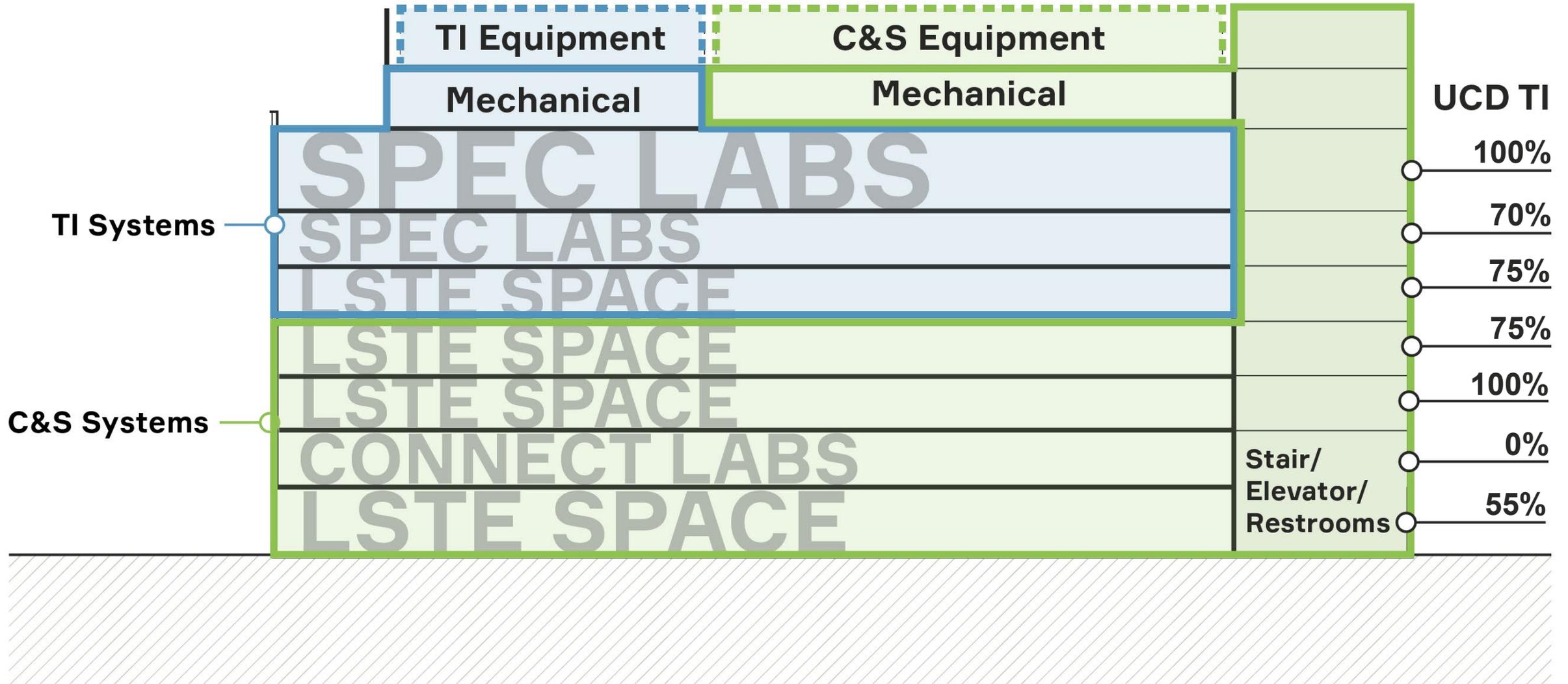
Planned Project Scope



Program Overview

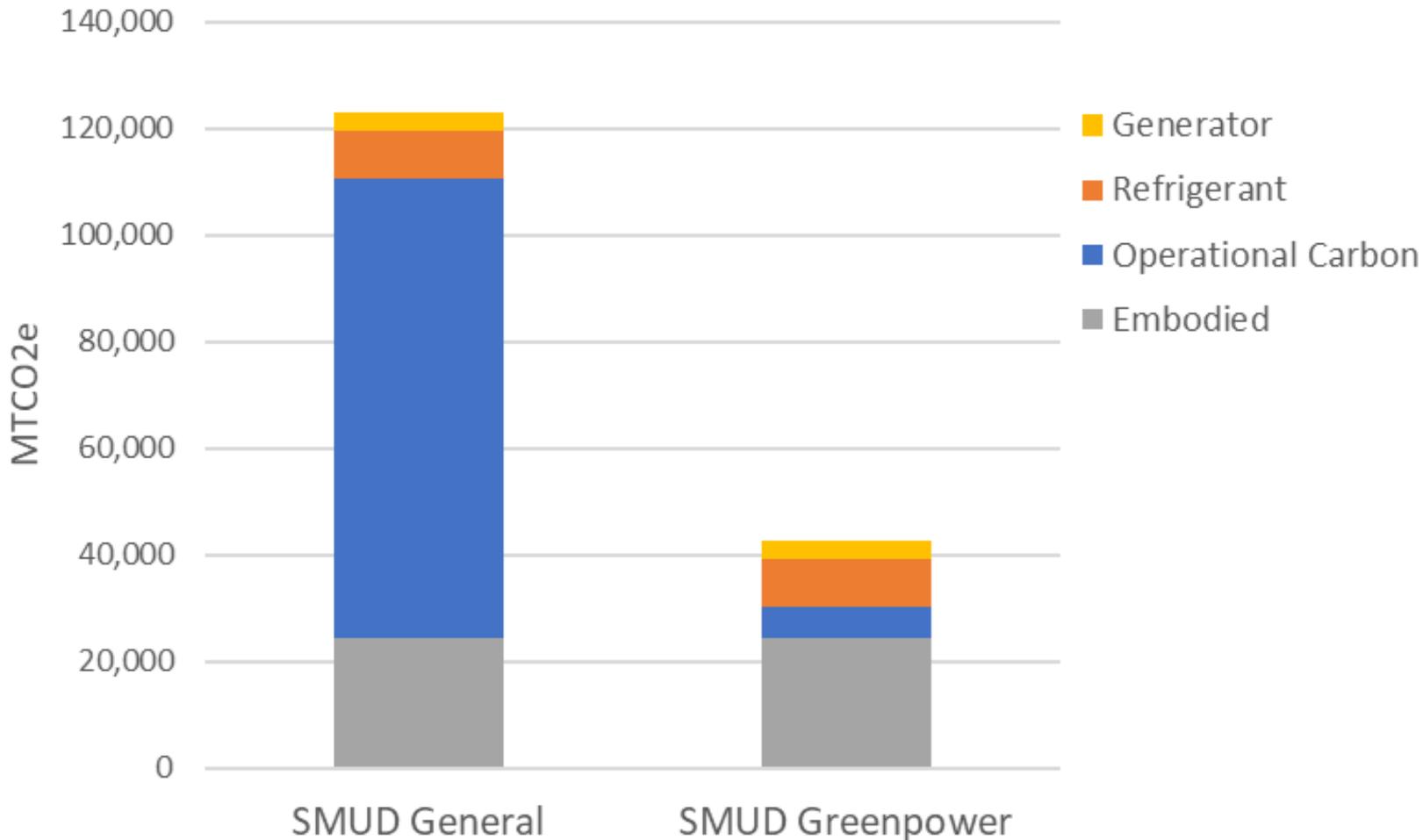


Program Overview



Carbon Emissions Summary

Life Cycle Carbon Emissions (60 years)



Generators

(1) 1500kW; (1) 1000kW
Monthly testing (30 min)
Annual outage (24 hr)
3-year testing (4 hr)

Refrigerants

R134a: 3360 lbs
R410a: 870 lbs
5% leakage (ASHRAE 228P)

Operational Carbon

All-electric design
96 kbtu/sf-yr EUI

Embodied Carbon

CLF general data
400 kg-GHGe/m² (C&S, TI)

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1 Project Vision & Outcomes

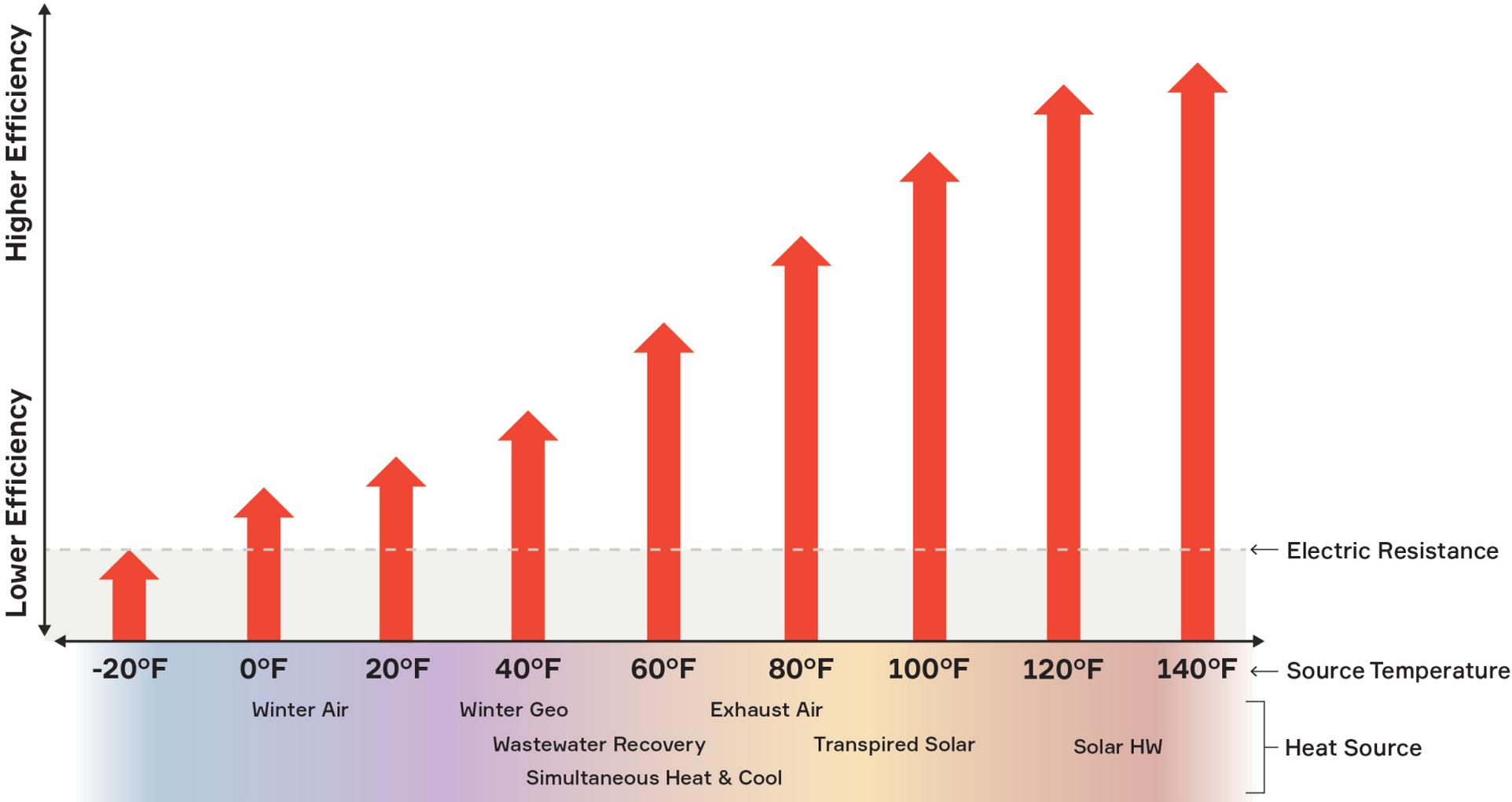
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Electrifying Heating Hot Water

Relative Efficiency of Heating Based on Source Temperature



Electrifying Heating Hot Water



Electric Boiler

COP* = 1.0



Air Source Heat Pump (ASHP)

COP = 2.5

(at 35° F outdoors & 115 °F heating water)



**Water Source Heat Pump/
Heat Recovery Chiller (HRC)**

COP = 3.5

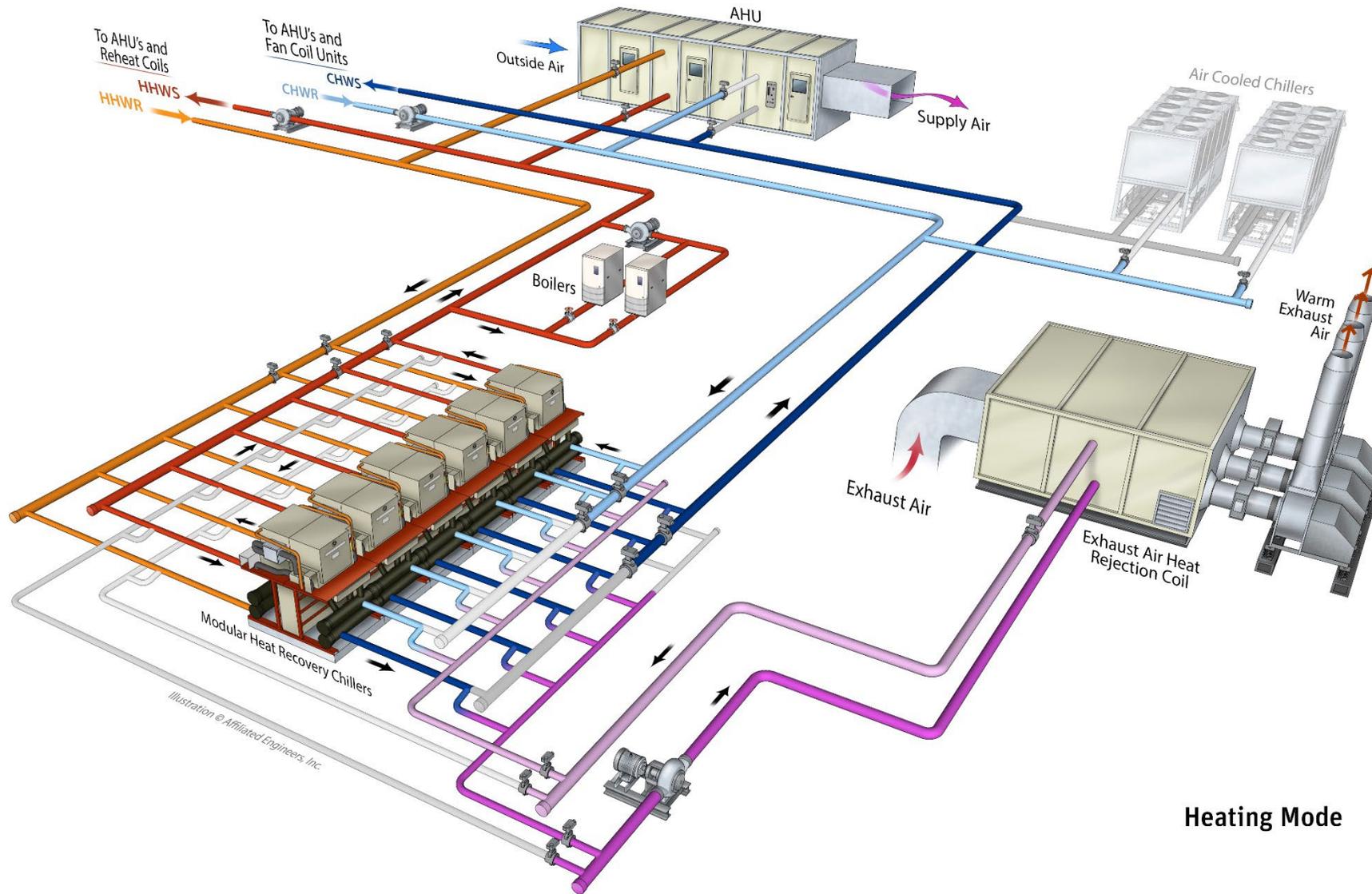
(at 56° F CHWR & and 115°F heating water temp)

COP = 3.8

(at 70° F indoors & 115 °F heating water)

*COP = kW of heating output divided by 1 kW of electrical input

Aggie Heating Hot Water Strategy



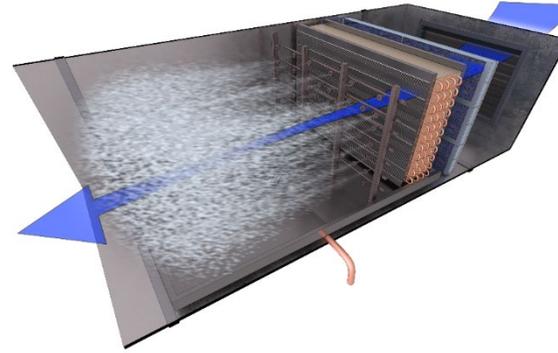
Electrifying Process Loads



Sterilization



Washing



Humidification



Cooking

Aggie Heating Electrification Strategy

C&S Loads

Heating
HW



DHW



TI Loads

Specialty
Equipment
(dry heat)



Specialty
Equipment
(steam)



Specialty
Equipment
(steam & HW)



Lab HW



Specialty
Equipment
(steam)



Sterilizers
(small)



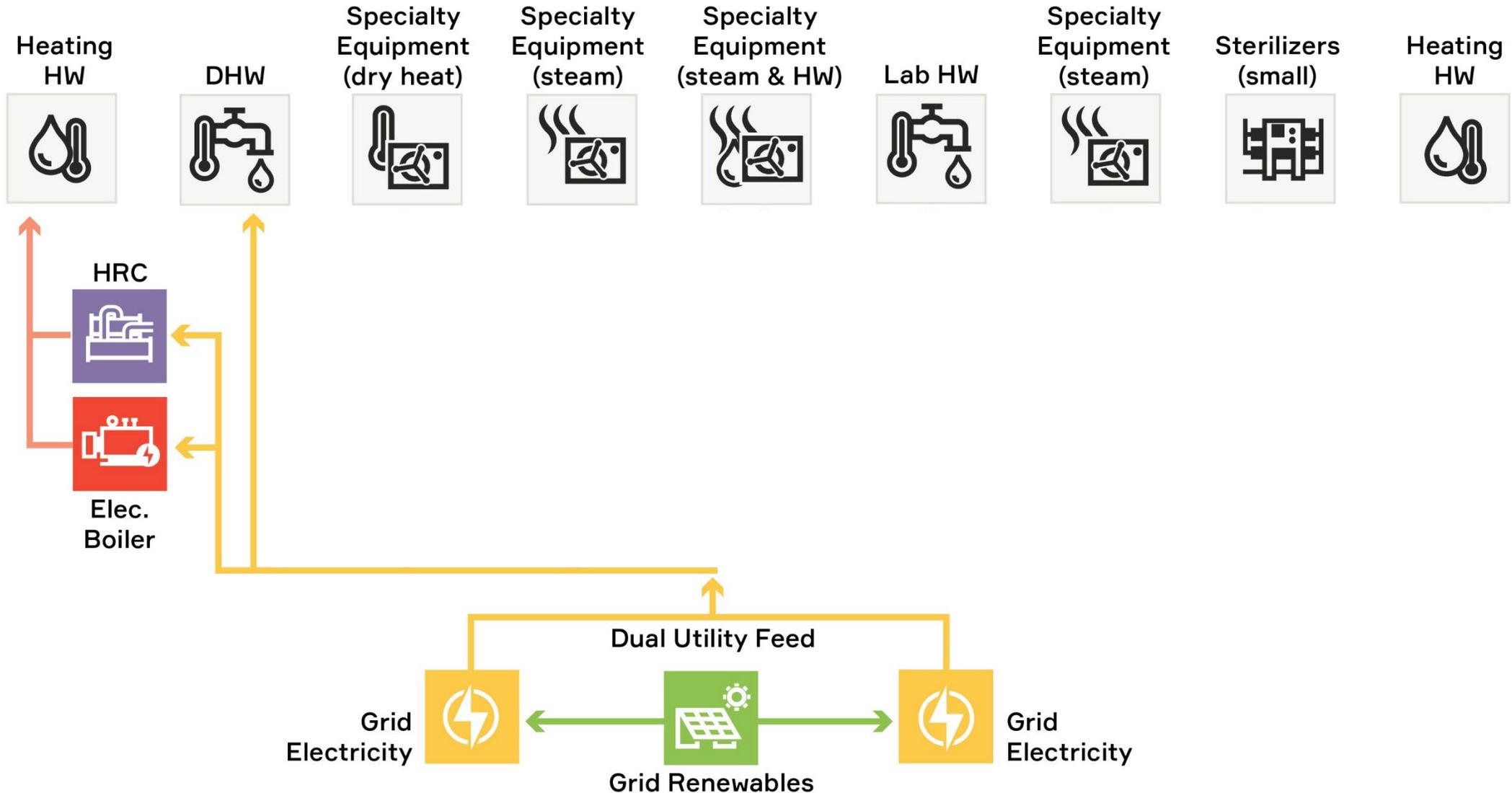
Heating
HW



Aggie Heating Electrification Strategy

C&S Loads

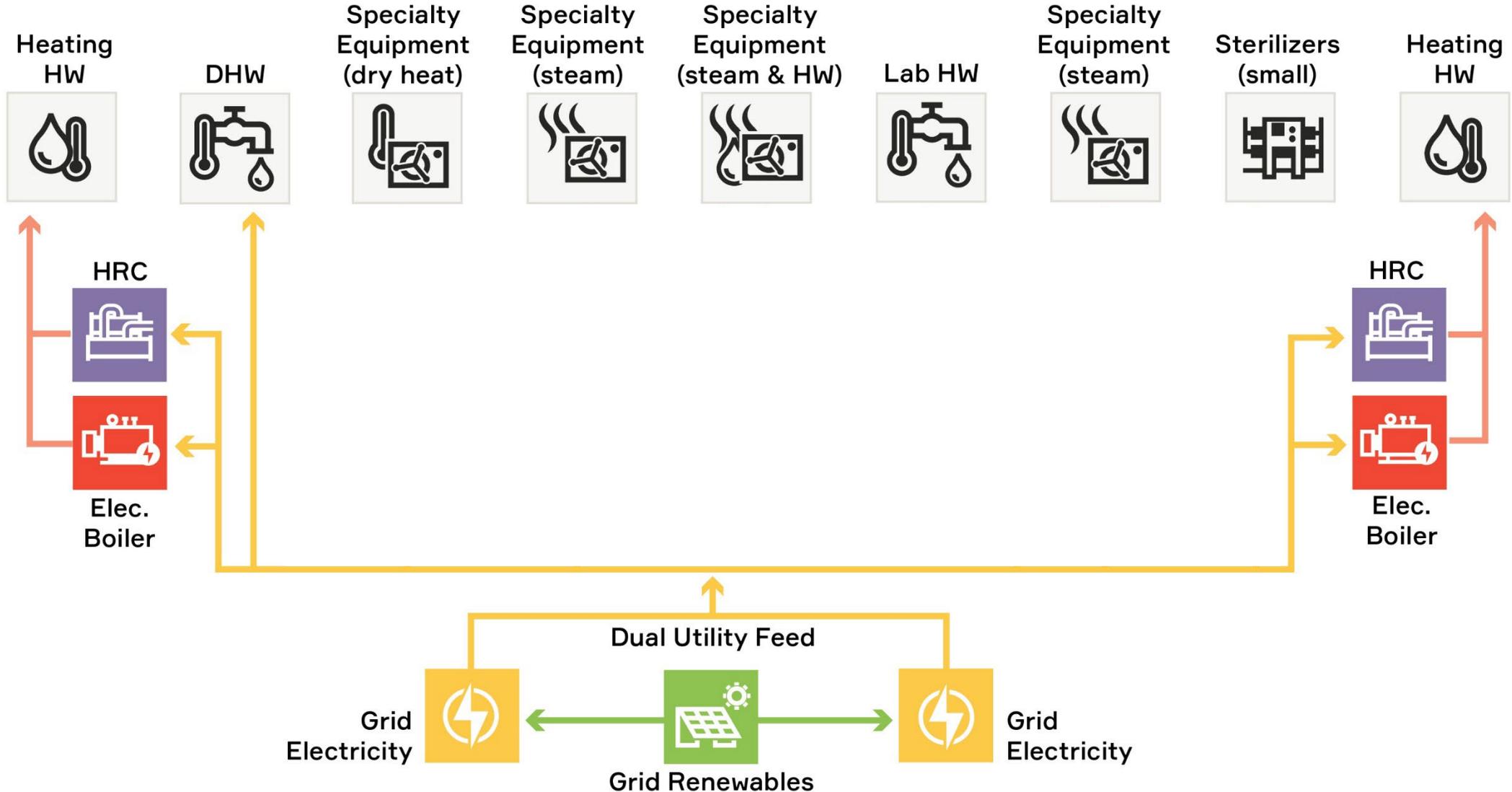
TI Loads



Aggie Heating Electrification Strategy

C&S Loads

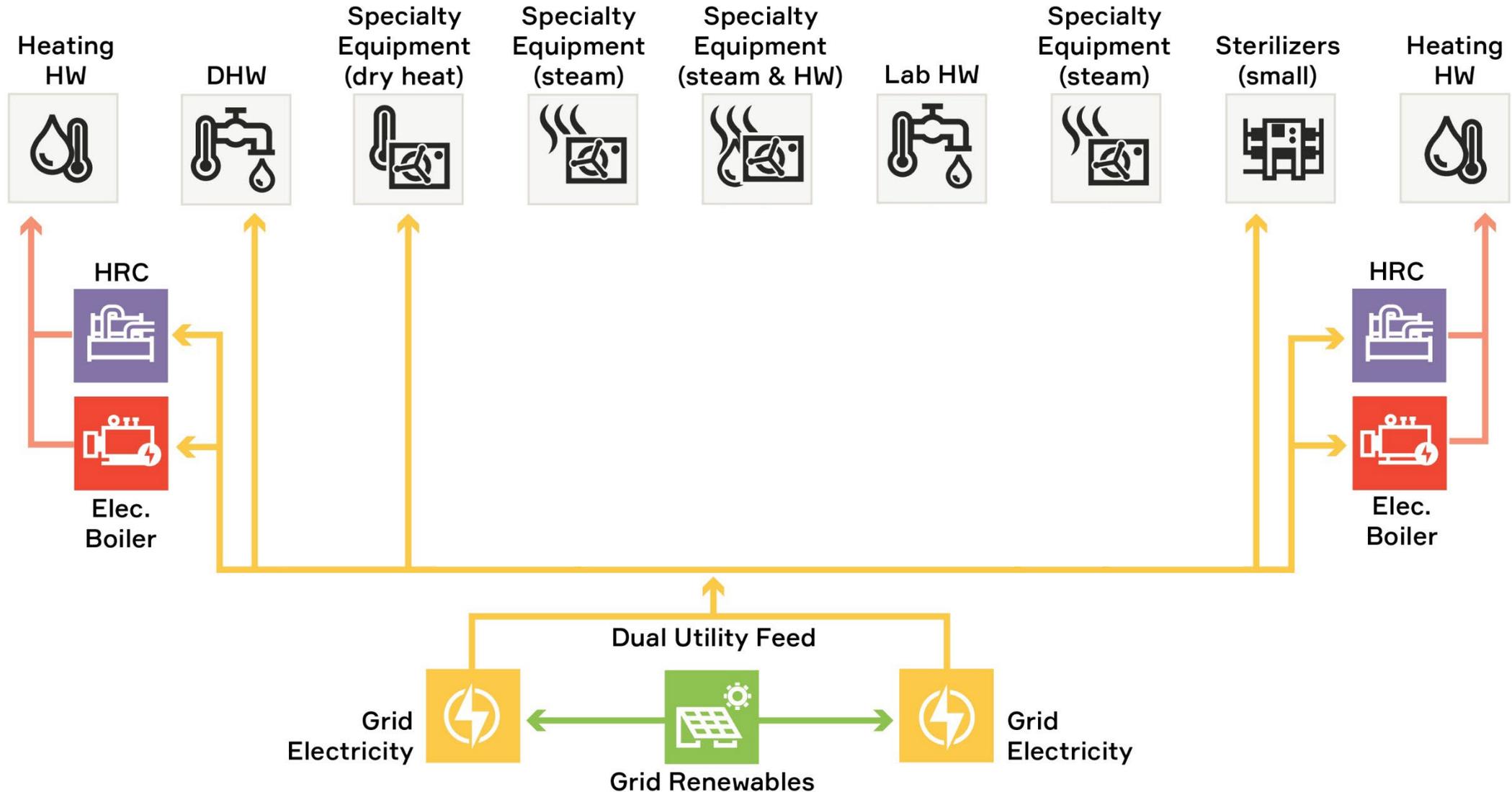
TI Loads



Aggie Heating Electrification Strategy

C&S Loads

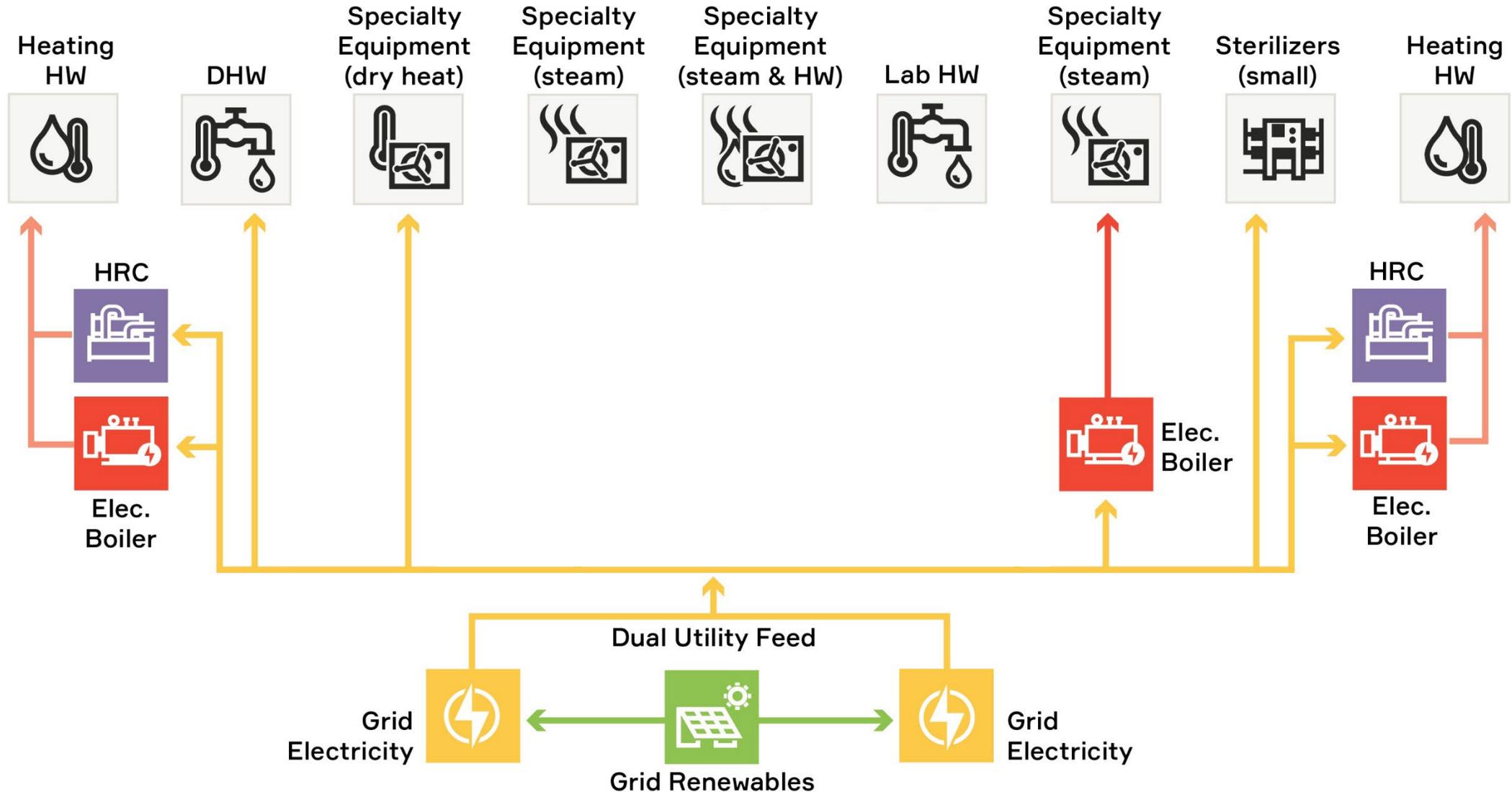
TI Loads



Aggie Heating Electrification Strategy

C&S Loads

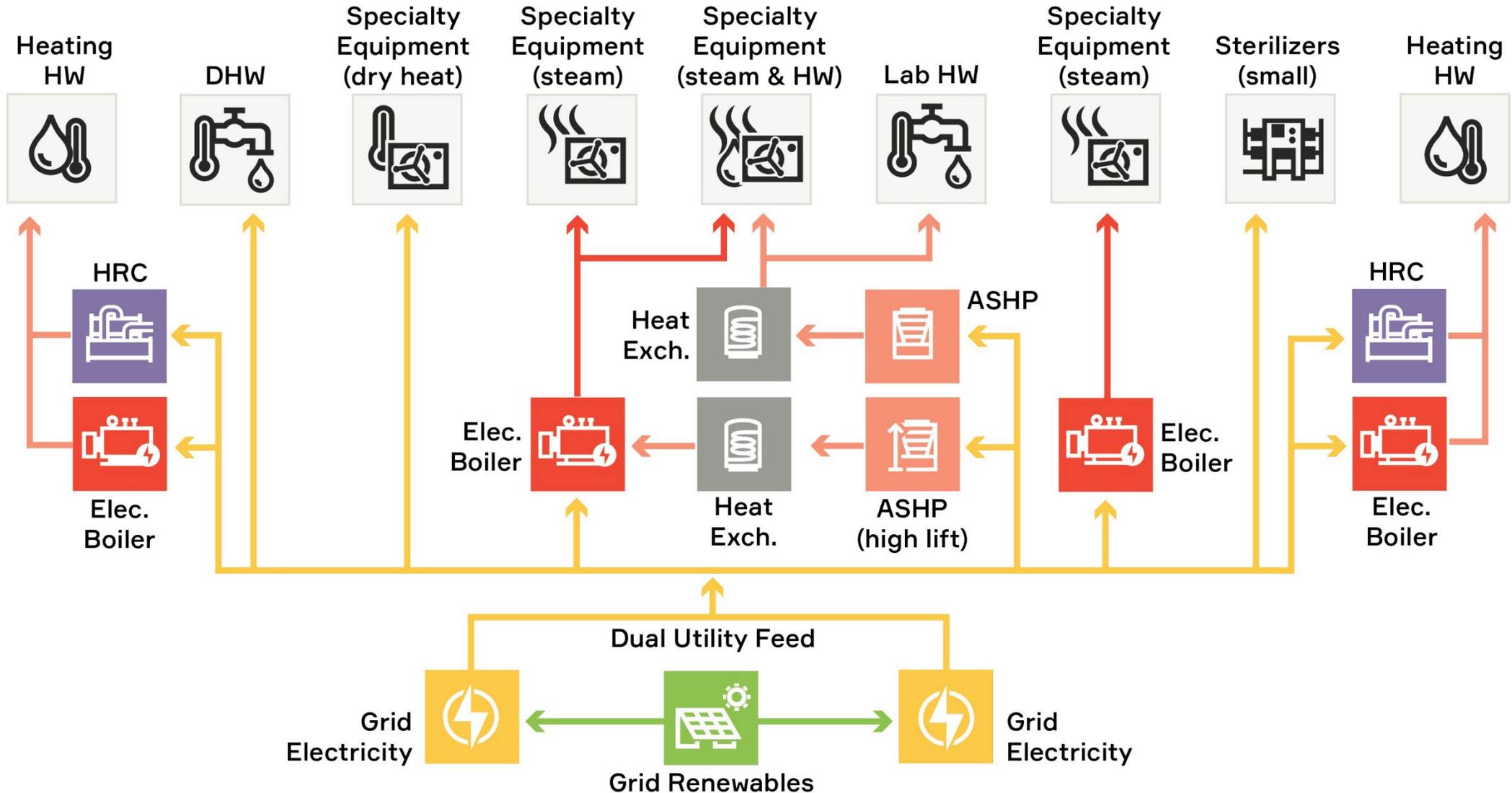
TI Loads



Aggie Heating Electrification Strategy

C&S Loads

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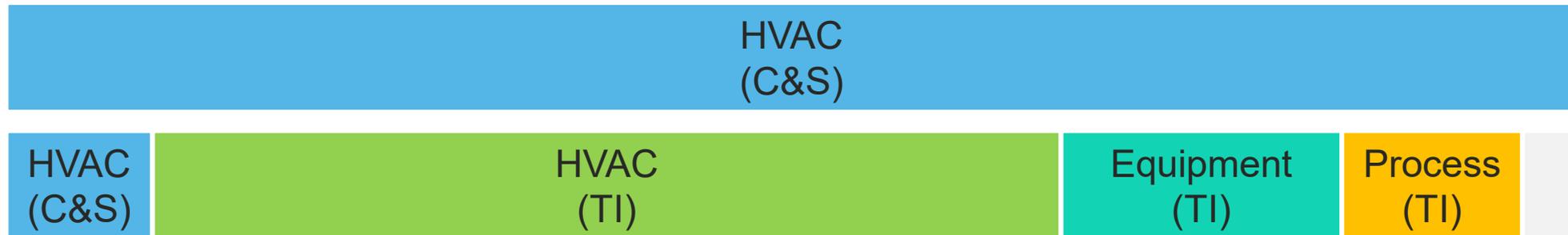


LSTE-East Electrical Sizing

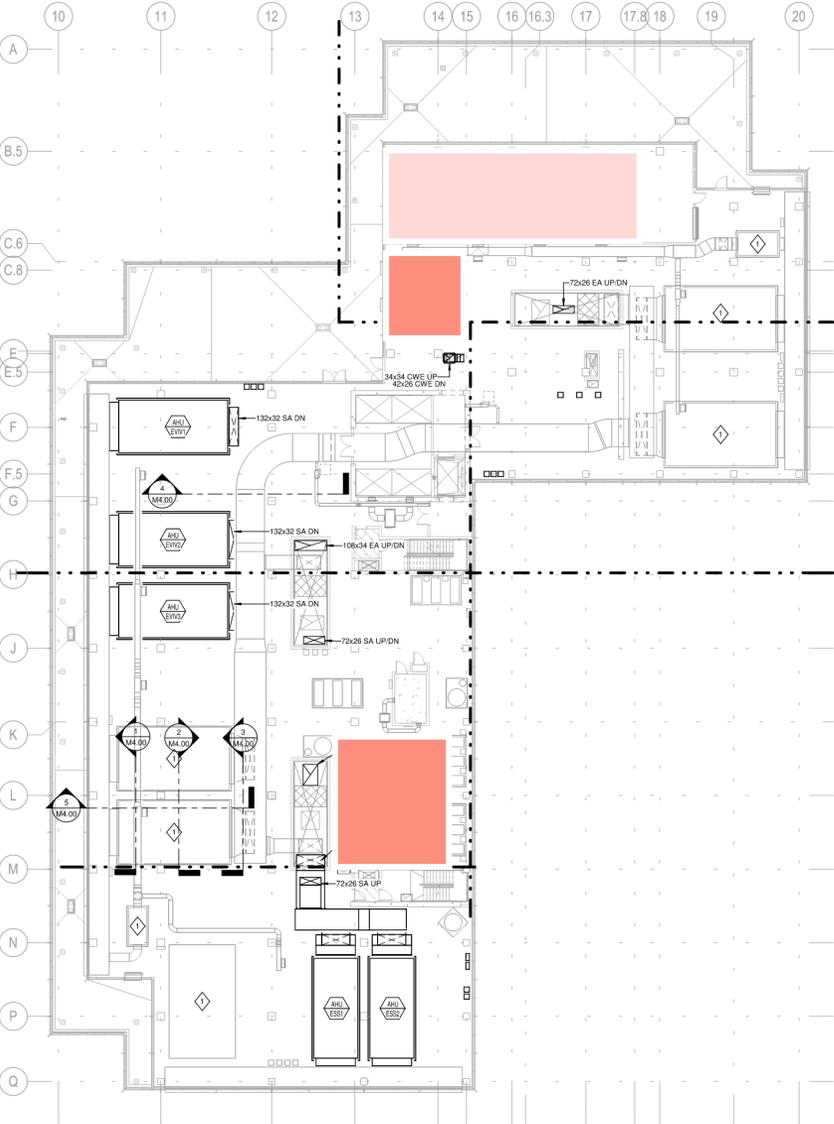
Typical High-Efficiency Lab (air-cooled chillers/HRCs/condensing boilers/gas-fired steam)



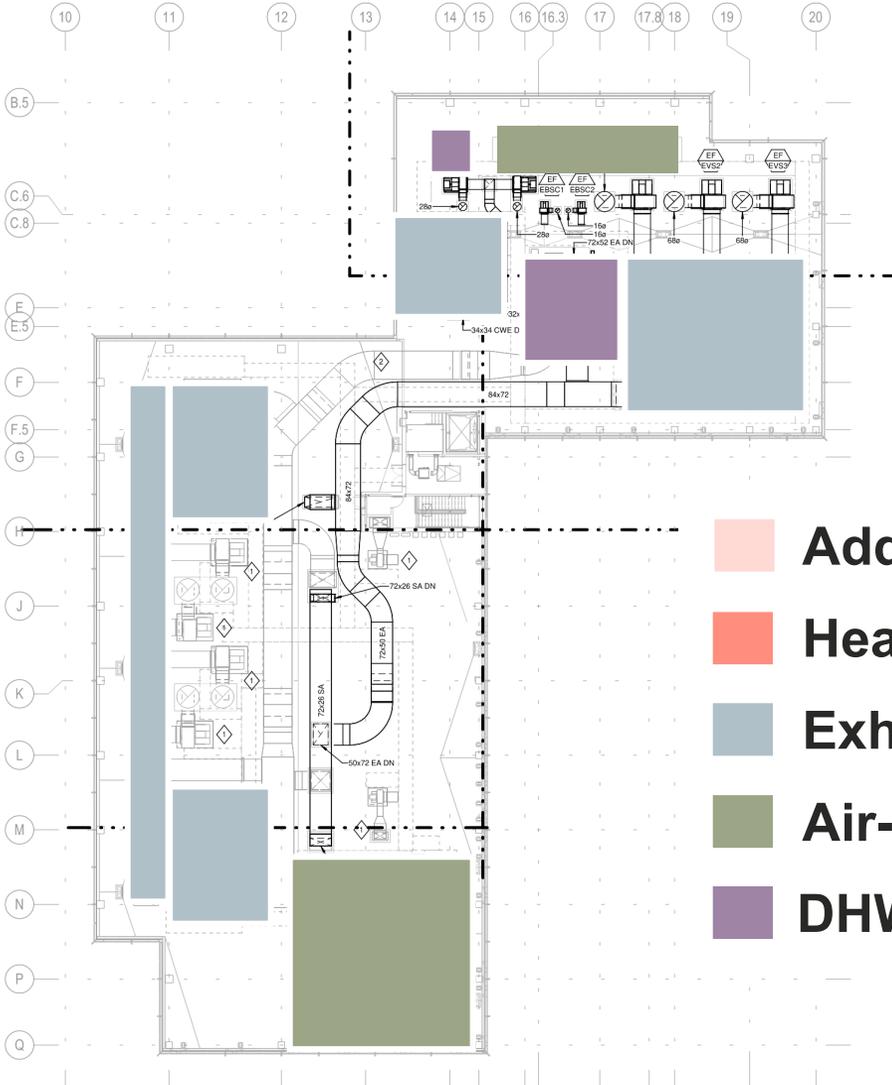
All-Electric High-Efficiency Lab (air-cooled chillers/HRCs/electric HW & steam boilers)



LSTE-East Electrification Space Impacts



1 MECH LEVEL MECHANICAL DUCT PLAN - OVERALL
SCALE: 1/16"=1'-0"



1 ROOF MECHANICAL DUCT PLAN - OVERALL
SCALE: 1/16"=1'-0"

- Additional Electrical
- Heat Recovery Chillers
- Exhaust Heat Recovery Units
- Air-cooled Chillers
- DHW Air-source Heat Pumps

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Startup & Cx: General

More systems, more complexity, can translate to more time for a fully-electric lab

Troubleshooting system performance

- BAS trends not always set up initially
- Sensors and diagnostic control points are like gold

Consider: investing more in these points for troubleshooting and performance optimization.

Timing of startup for plant

- Seasonal system dynamics
- Waiting on building startup to provide loads for heat recovery

Consider: taps for temporary tanks to provide load testing and future resilience



Startup & Cx: Heat Pumps and HRCs

Industry changing rapidly, each project is a bit of a test case

- Equipment failures are not uncommon given evolution of products in terms of hardware, refrigerant, and controls.

Consider: strong local support, redundant equipment, taps for temporary equipment

HRC and modular heat pump controls 'out of the box' are not always what expected

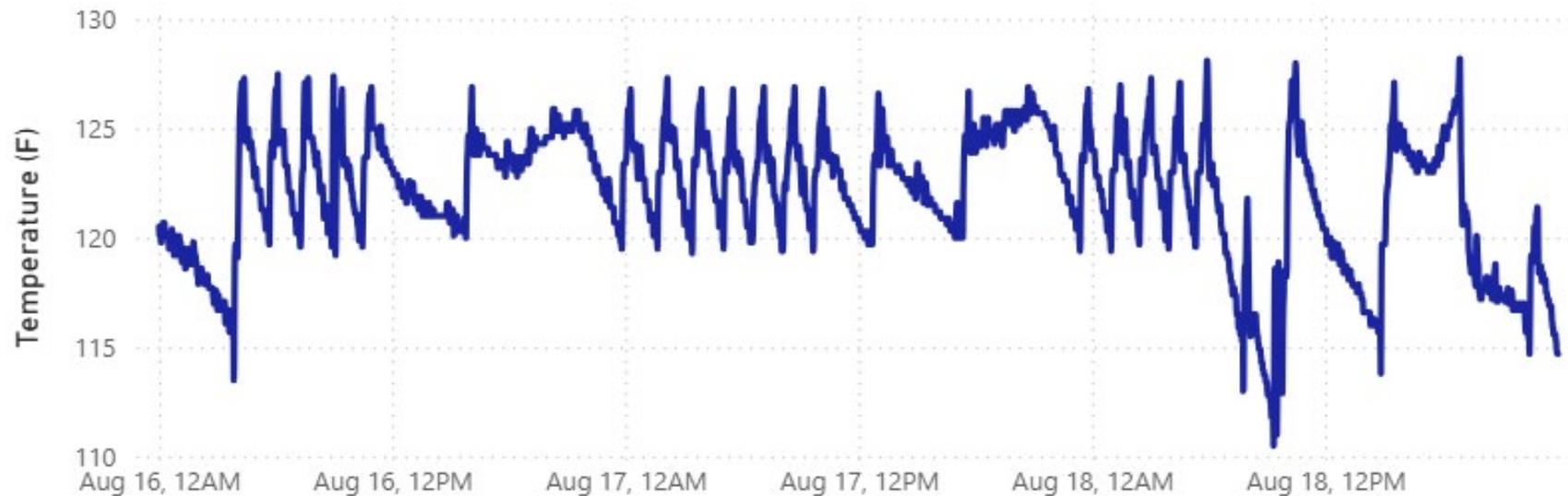
- Establish a relationship with the manufacturer and their local reps early
- Tech vs. Rep vs. Factory knowledge varies

Consider: additional troubleshooting support in bidding



Operations

- Determining if Tenant going to operate
- Having capable team in place
- Develop understanding of “normal” for these systems



Other Developer Takeaways

- All-electric comes with many additional design components and concerns
- Early discussions about expectations and risks of all-electric should occur, particularly around critical programs and solution sets available for meeting project goals.
- Perhaps budget contingency needs to be more strategic





Full electrification of complex labs is possible, inclusive of process loads

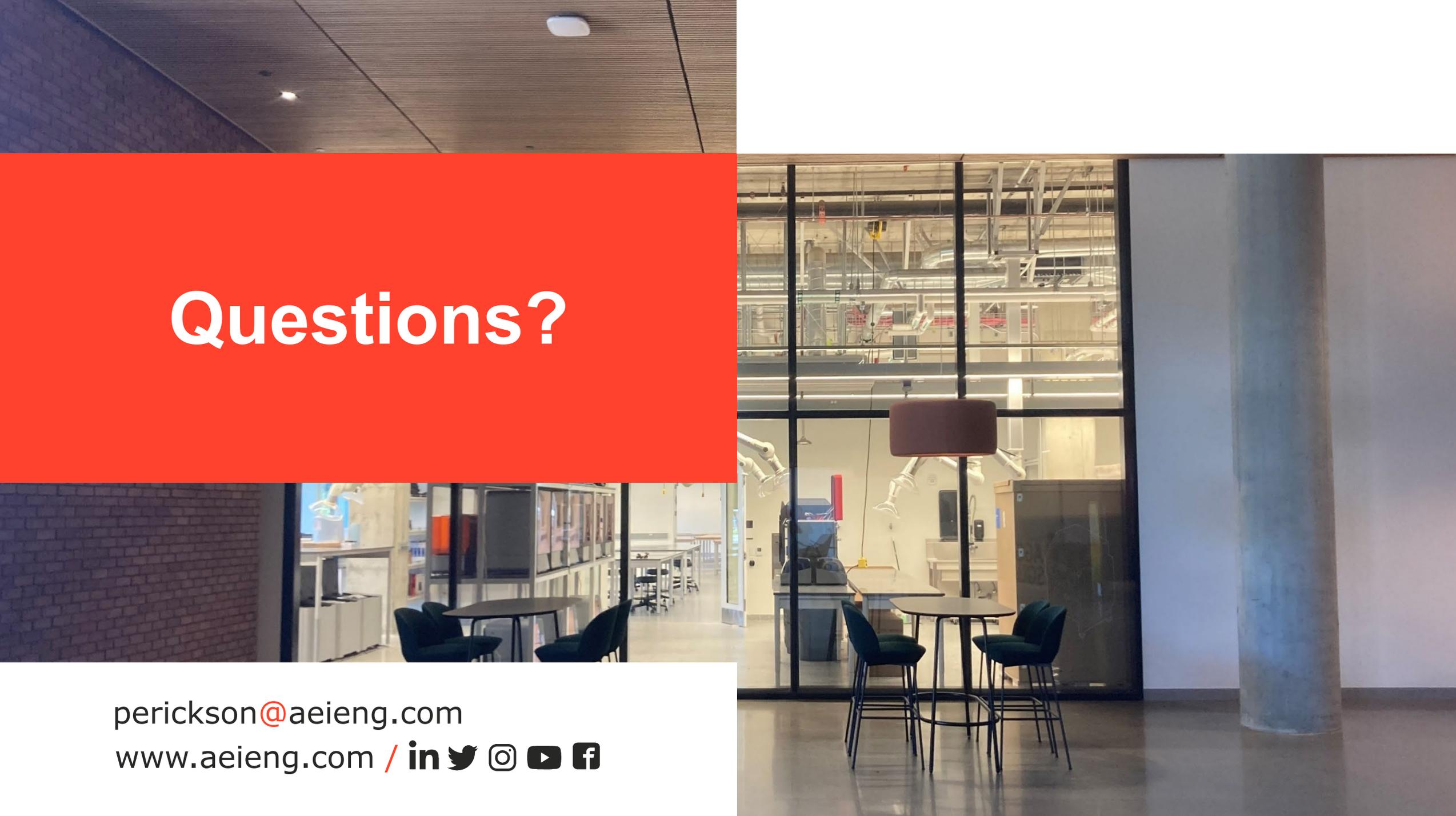


Space, reliability, and cost planning should be approached early



Startup, Cx, and operations bring new challenges that can be managed





Questions?

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