CASE STUDY

Sacramento State University
Ernest E. Tschannen Science Complex

MEPT DESIGN SERVICES
PROVIDED BY P2S INC.

Sacramento State University

Ernest E. Tschannen Science Complex

Sacramento State embarked on an ambitious expansion plan with direction from their latest campus master plan. One of the first steps in that journey is the new, $91 million Ernest E. Tschannen Science Complex (formerly Science II) which features 94,000 SF of classroom and laboratory space with an on-site observatory and planetarium, supporting astronomy and physics programs. It consolidates the College of Natural Science's Biology and Chemistry departments under one roof and include areas that are open to the public for community events. This design-build collaboration with CO Architects and Sundt Construction debuted in August 2019, in time for the start of the fall semester and has earned a LEED Gold Certification.

PROJECT TEAM

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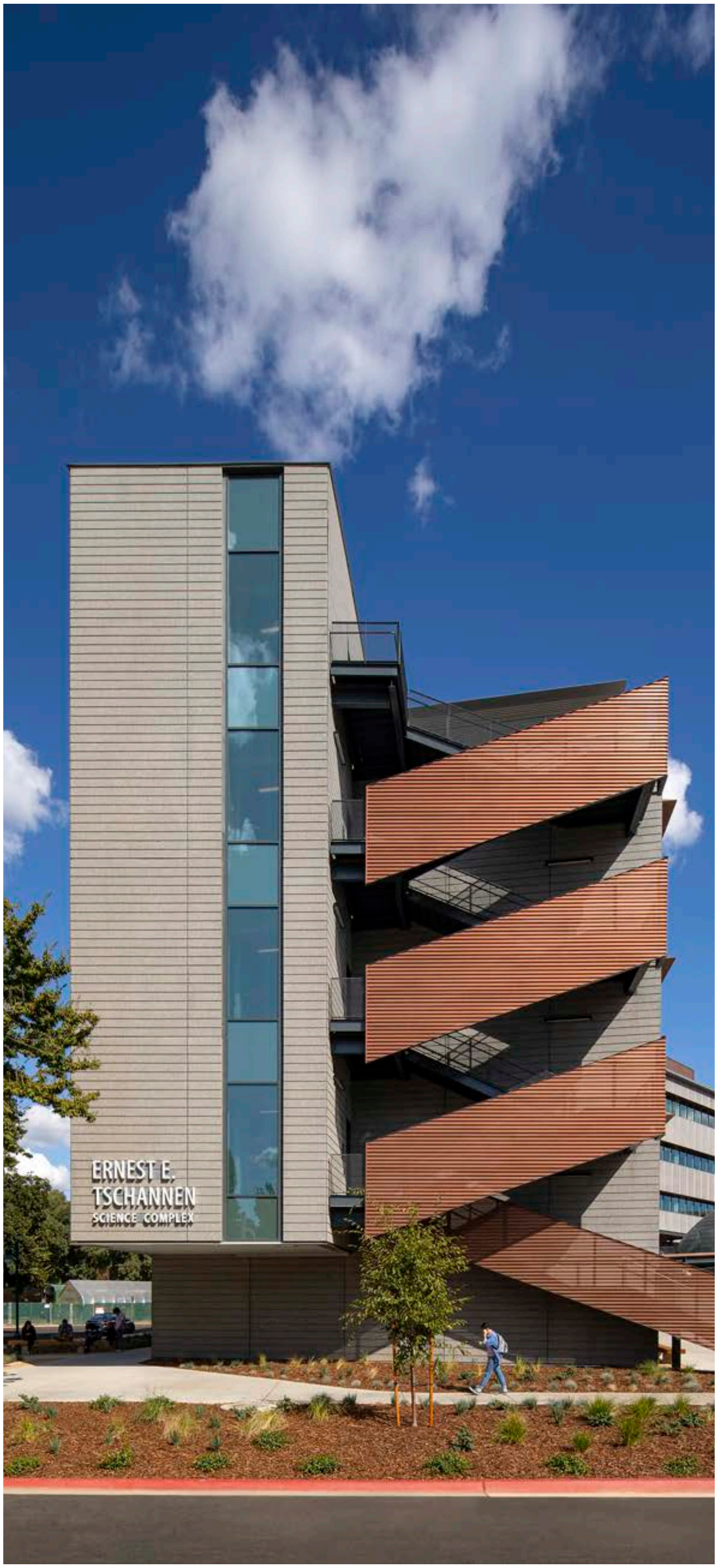
P2S provided the MEPT solutions for this pursuit. The following case study will highlight the mechanical solutions designed by our team.



AT A GLANCE

- Building Location: Sacramento, CA
- Project Size: 94,000 SF
- Market Sector: Science & Technology
  Higher Education (Public)
- Building Type: Mixed-Use Research and Teaching Facility
- Delivery Method: Collaborative Design-Build
- Construction Cost: $91 million

MECHANICAL SYSTEM INNOVATIONS

Our design team came up with several innovations to minimize the new building's energy demands with a building design that included the following features:

1 Four-Pipe VAV System with Neutral Air Handling System

2 Indirect Evaporative Cooling System

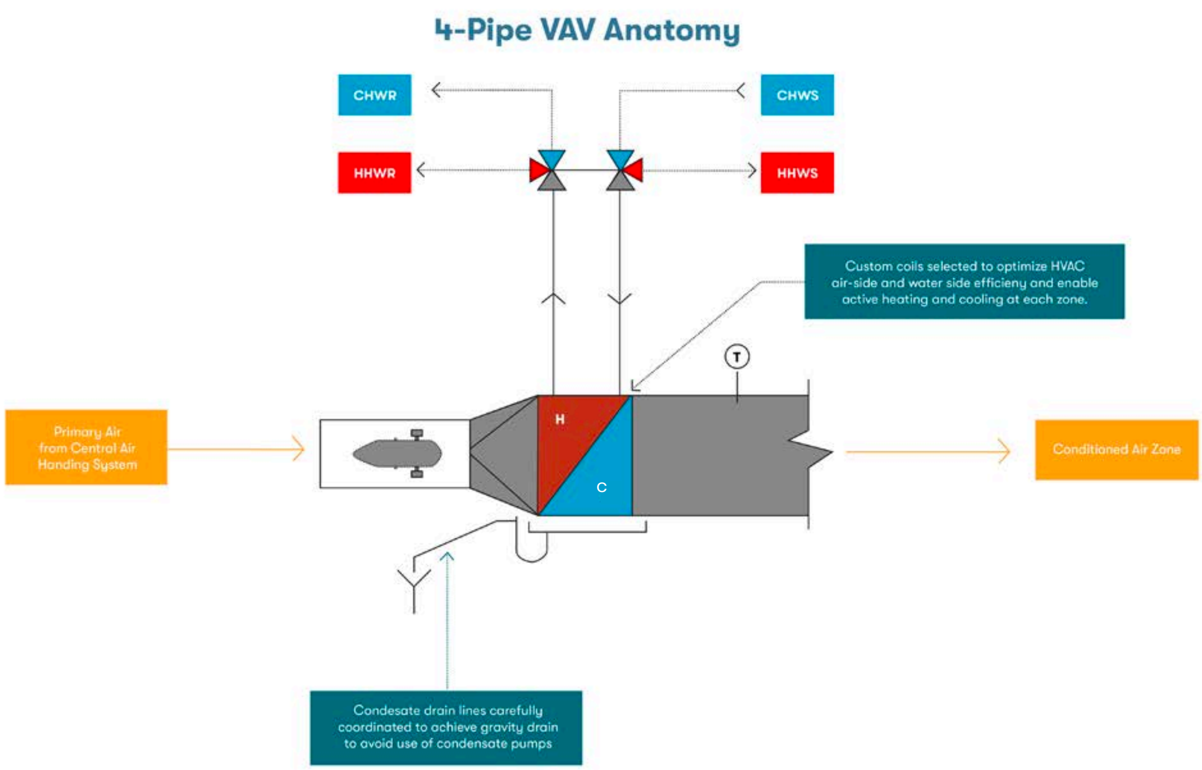
3 Central Laboratory Exhaust with Cluster Stack Design

With these design features the facility achieved a ~44% energy cost reduction vs. the LEED NC baseline and efficiency 27.5% higher than California Title 24 energy requirements.

FOUR-PIPE VAV SYSTEM WITH NEUTRAL AIR HANDLING SYSTEM

The four-pipe VAV system design eliminates wasteful reheat and associated coincidental cooling energy by using only the minimum required heating or cooling energy to achieve air temperatures that are specific to each conditioned thermal zone within the building. Reheat is the process by which cold air is supplied throughout the building to satisfy spaces with the highest demands for cooling where spaces that do not need cooling are then required to reheat the air temperature to keep the room from being over-cooled. Modern VAV systems are able to minimize the energy penalty of this process to differing degrees of success, but not eliminate it. The thermodynamic process involved in conventional VAV reheat systems is similar to driving with one foot on the accelerator pressed down and the other foot throttling the brake pedal to maintain speed. By making the coldest air needed, the most demanding thermal zone is always satisfied, but at the expense of all other spaces requiring additional heating energy to avoid being overcooled.

Eliminating reheat energy waste is made possible by providing “neutral” air from the central air handling system that regulates the supply air within a boundary of no colder than 55°F (adjustable) and no warmer than 72°F (adjustable). These parameters were selected as they coincide with the lowest potential supply air temperature that could be demanded from a space that requires cooling as well as the warmest supply air temperature that could potentially be provided for a space that is lightly loaded and only requires airflow for ventilation purposes. When the air entering the air handling units is between 55°F and 72°F, then no heating or cooling energy will be expended by the central air handling units. By minimizing the tempering of the central air supply, much of the heating and cooling is performed at an individual thermal-zone level. This allows the HVAC system to avoid a scenario where simultaneous heating and cooling occurs. By synchronizing the central air handling system supply air temperature boundaries with the space demands within the building, wasteful reheat energy consumption can be eliminated.

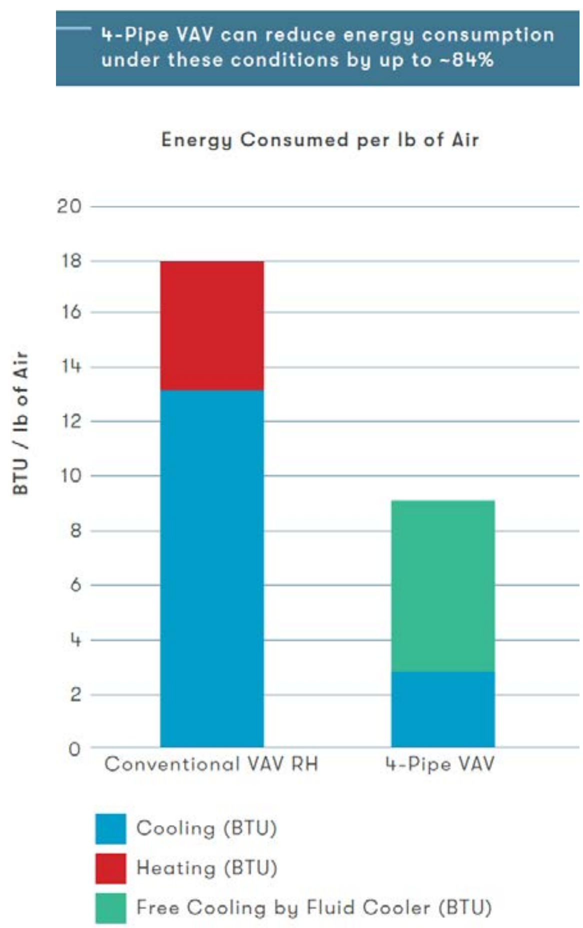


INDIRECT EVAPORATIVE COOLING SYSTEM

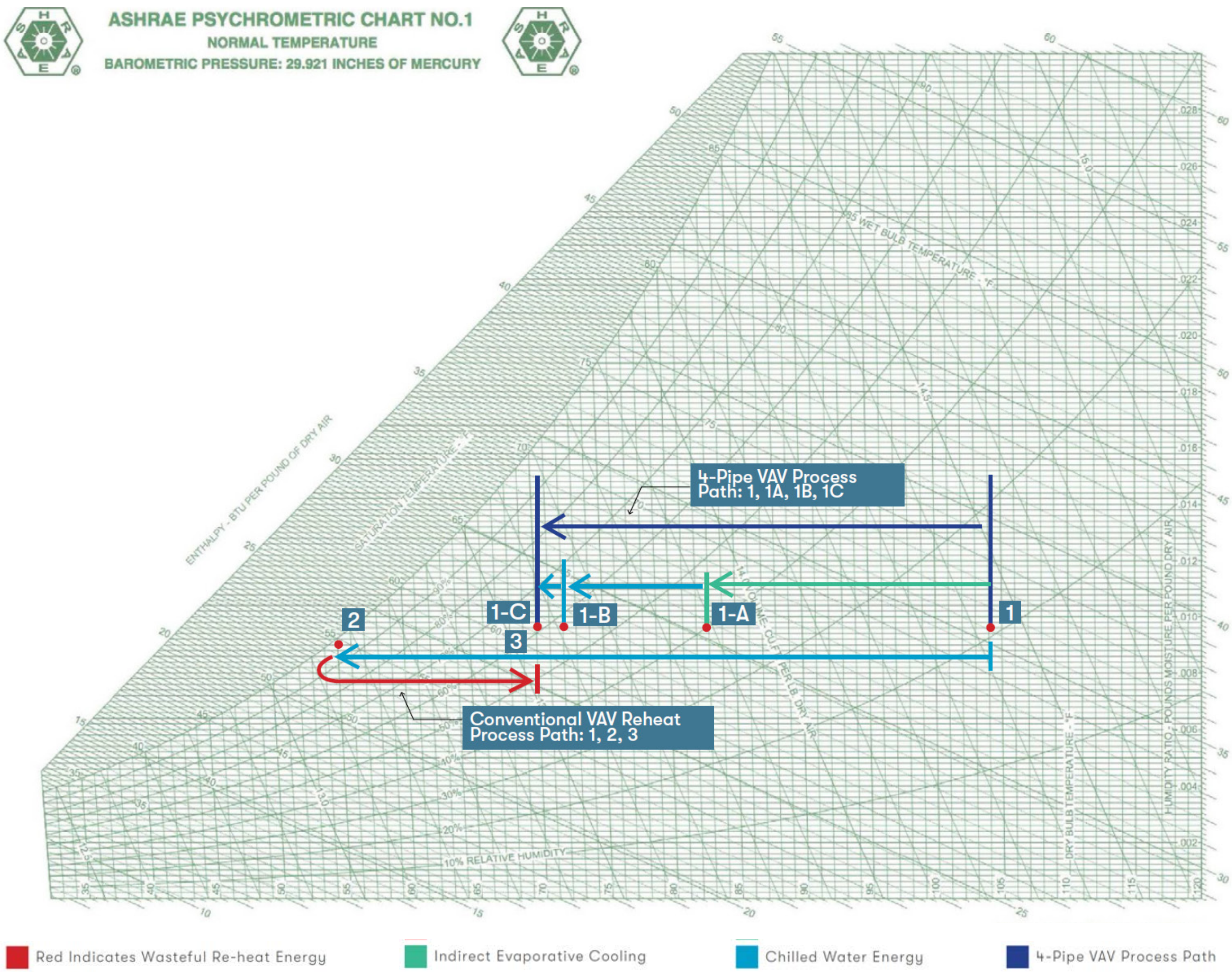
Our design also includes an indirect evaporative cooling system to pre-cool outdoor air to further reduce the building's peak demand as well as overall chilled water consumption. The evaporative cooling coil is equipped with the ability to change over to heating duty; utilizing one coil to perform both indirect cooling and heating eliminates the need for an extra heating coil, which reduces fan energy consumption. Additionally, since this coil is sized for the indirect evaporative cooling load, it provides exceptional heating hot water system ΔT which in turn reduces pump energy and enhances the overall heating system efficiency.

PROCESS PATH NARRATIVE

The psychrometric diagram on the next page illustrates a summer cooling scenario where there may be lightly-loaded interior spaces within the building that require only a very mild amount of cooling. On larger volume buildings such as the Ernest E. Tschannen Science Complex, this condition may represent a substantial portion of the overall building. Under this condition, a space may only need a very mild supply air temperature (i.e. 70°F) to maintain the room at it's temperature set-point to account for light fixtures, mild occupant activity, and mild equipment power loads within a space. A conventional VAV re-heat system may be required to make air as cold as 55*F at the central air handling unit to satisfy the spaces with the highest demand for cooling while the interior zones may need to re-heat the air to ~70°F to avoid over-cooling the space. 4-Pipe VAV: Outside air comes in at point 1, then is cooled by the indirect evaporative fluid cooler to point 1-A then cooled by the central AHU to point 1-B and is distributed through the building supply air ductwork. The air is then cooled further at the zone 4-pipe VAV terminal unit to point 1-C and supplied into the zone served. Conventional VAV Re-heat: Outside air comes in at point 1, then is cooled by the central AHU to point 2 and is distributed through the building supply air ductwork. The air is then heated at the zone VAV re-heat terminal unit to point 3 and is supplied into the zone served.



PSYCHROMETRIC CHART ANALYSIS



CONDITIONS

1
Incoming Outside Air at Central Air Handling Unit @ 104°F dB / 72°F wB (~ 35.8 BTU / lb Air)

1-A
Evaporative Cooling Coil Leaving Air Temperature @ @ 82.7°F dB / ~65.5°F wB (~ 30 BTU / lb Air) [Indirect Evaporative Cooling]

1-B
Central AHU Leaving Air Temperature @ 72°F dB / ~62.2°F wB (~27.8 BTU / lb Air) [4-Pipe VAV System]

1-C
Supply Air Temperature to Zone from 4-Pipe VAV System @ 70°F dB / 61.2°F wB (~27.2 BTU / lb Air) [4-Pipe VAV System]

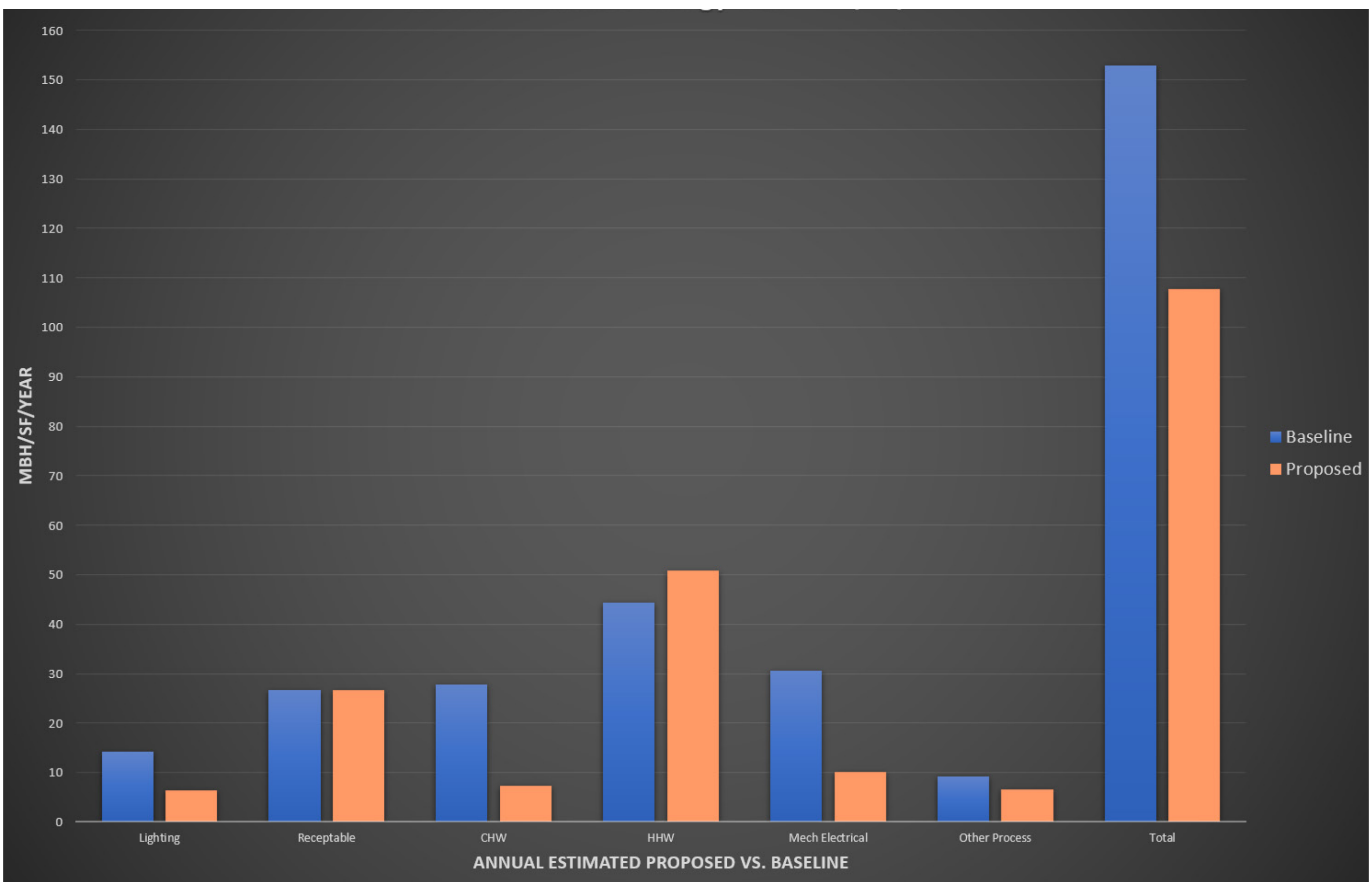
2
Central AHU Leaving Air Temperature @ 55*F dB / ~54°F wB (~22.6 BTU / lb Air) [Conventional VAV Re-heat System]

3
Supply Air Temperature to Zone from Conventional VAV Re-heat System @ 70°F dB / 61.2°F wB (~27.2 BTU / lb Air) [Conventional VAV Re-heat System]

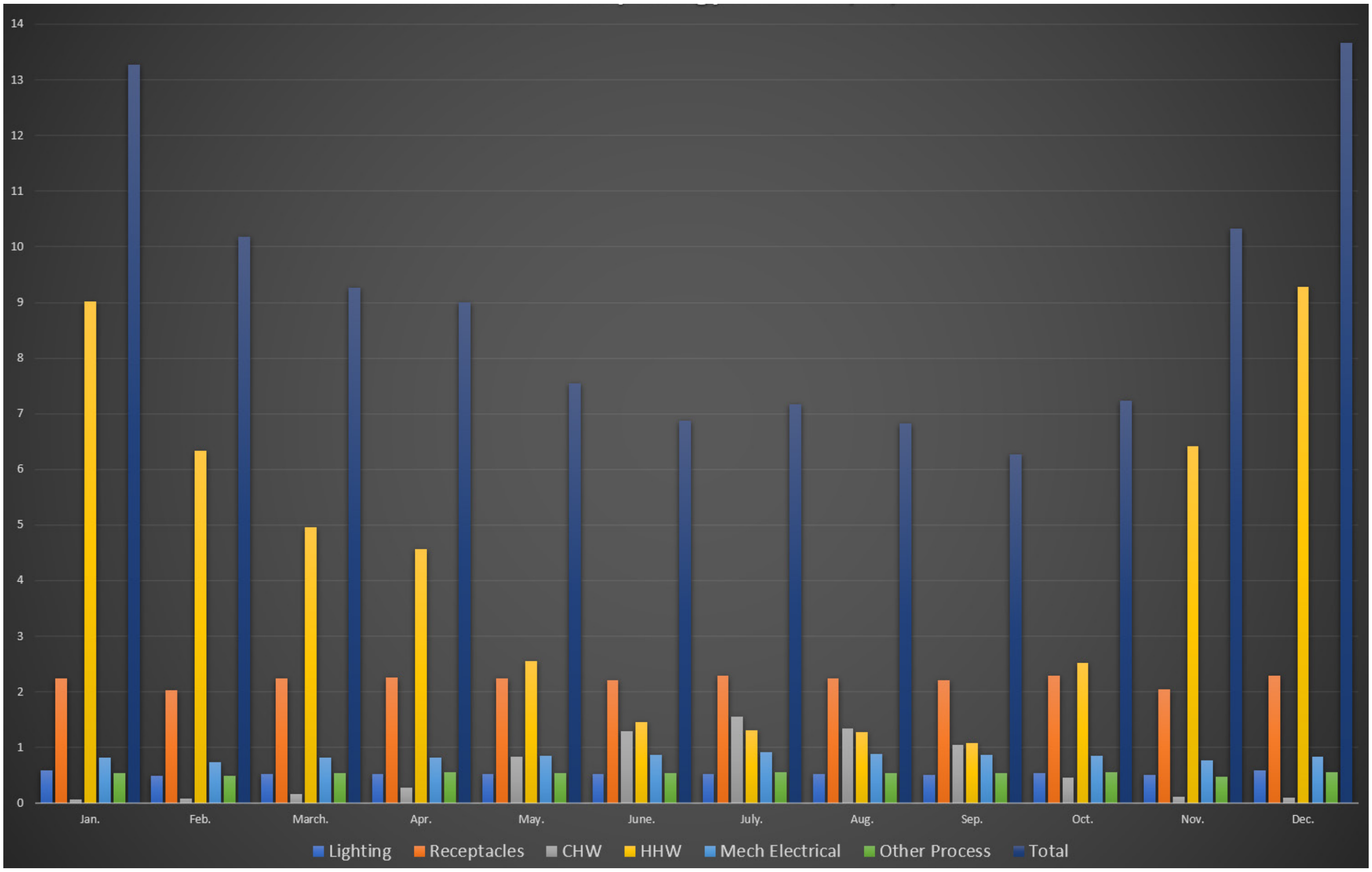
CENTRALIZED LAB EXHAUST SYSTEM UTILIZING A "CLUSTER" STACK DESIGN

The "cluster" stack design was informed by industry research and environmental boundary layer wind tunnel validation. Our design enhances the dispersion of the lab exhaust plume emitted from the stack by allowing the exhaust streams from various exhaust stacks to merge as they leave the stack, thus maximizing the momentum of the airstream and the elevation at which the plume rises into the atmosphere. The benefits are better air quality at the project site, optimum fan energy efficiency, and simpler building operation through a more elegant lab exhaust system design utilizing less controlled components than a traditional lab exhaust system with bypass air.

ESTIMATED ANNUAL ENERGY USE MBH/SF/YEAR



ESTIMATED MONTHLY ENERGY USE MBH/SF/MONTH



DESIGN AWARDS AND CERTIFICATIONS

Lab Manager Design Awards Finalist

Overall Sustainable Design (New construction)

USGBC LEED GOLD Certifies

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