BURNS McDONNELL

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

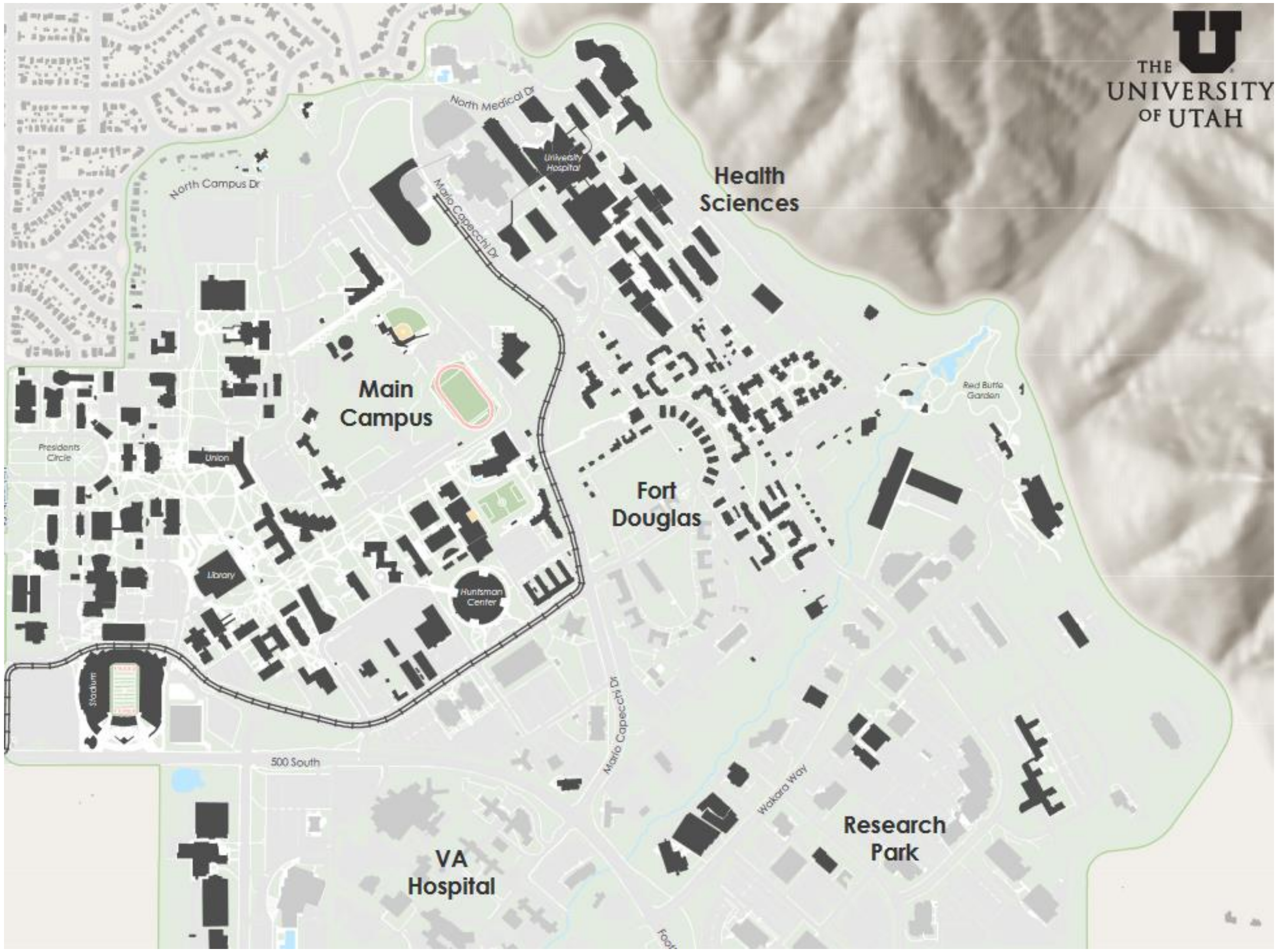
Comprehensive Energy Management & Utility Master Plan

UNIVERSITY OF UTAH HEALTH SCIENCES

OVERVIEW

- University of Utah & Health Science Campus Overview
- Campus Transformation
- Value Drivers and Challenges
- Integrated Energy Planning Approach
- Results

UNIVERSITY OF UTAH



- Founded in 1850
- 23,000+ Students
- 3 Campuses
- 298 Buildings
- 1,534 Acres

HEALTH SCIENCE CAMPUS

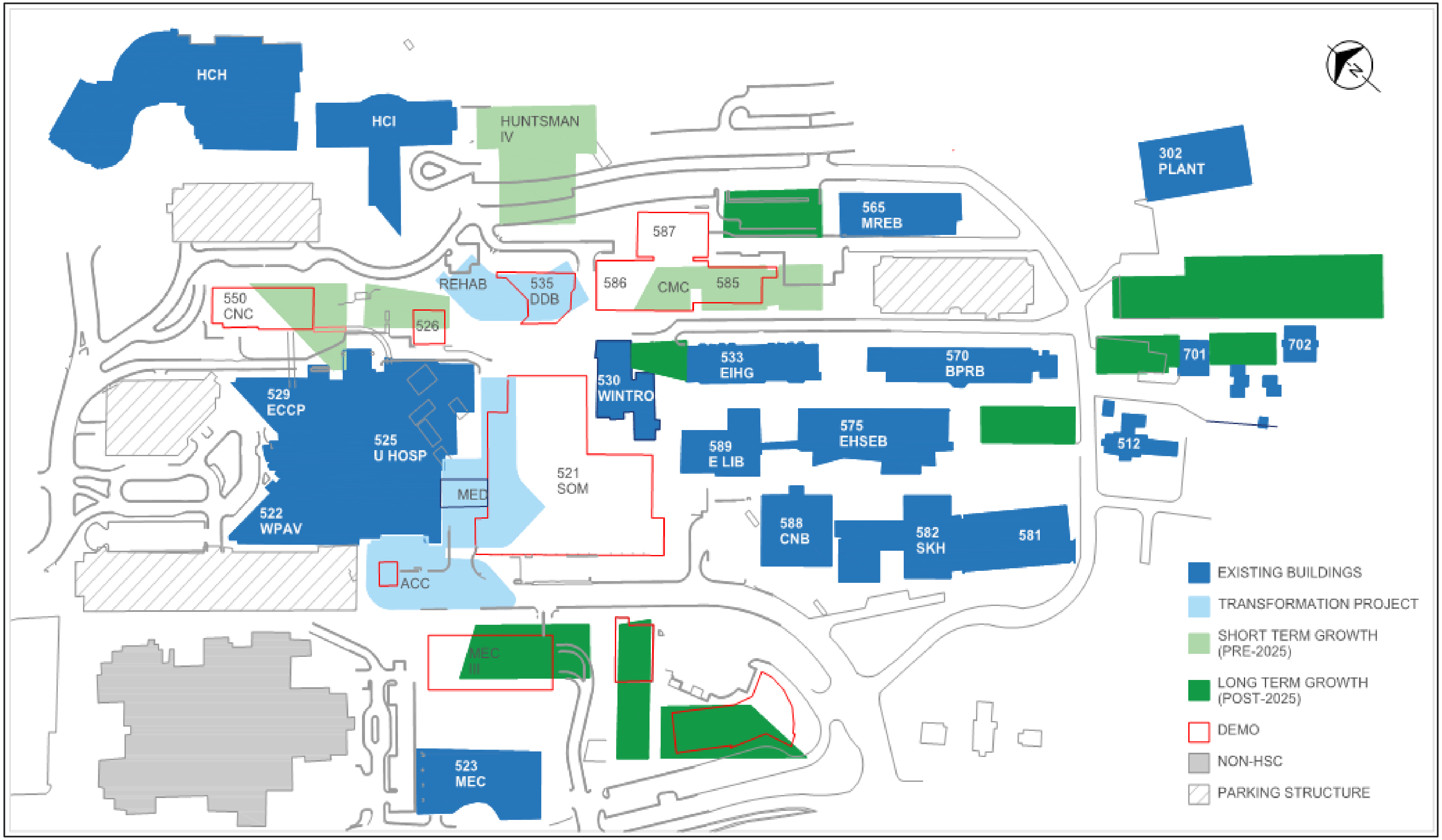
- 25 associated buildings
- Central utilities via East Plant:
  - HTHW
  - CHW
- Health Science Campus:
  - University Hospital
  - Cancer Research
  - Cancer Treatment
  - Moran Eye Center
  - Research Labs
  - Vivarium's

LOOKING TO THE FUTURE

The University of Utah HSC is entering into a period of significant change. This change includes both immediate near-term construction as well as intermediate and long term growth and renewal.

Recognizing the importance of long-term strategic vision with respect to campus energy, the University of Utah sought a solution that balanced immediate needs, lifecycle performance, and value proposition across a wide array of driving criteria..

TRANSFORMATION PROJECT



TRANSFORMATION PROJECT

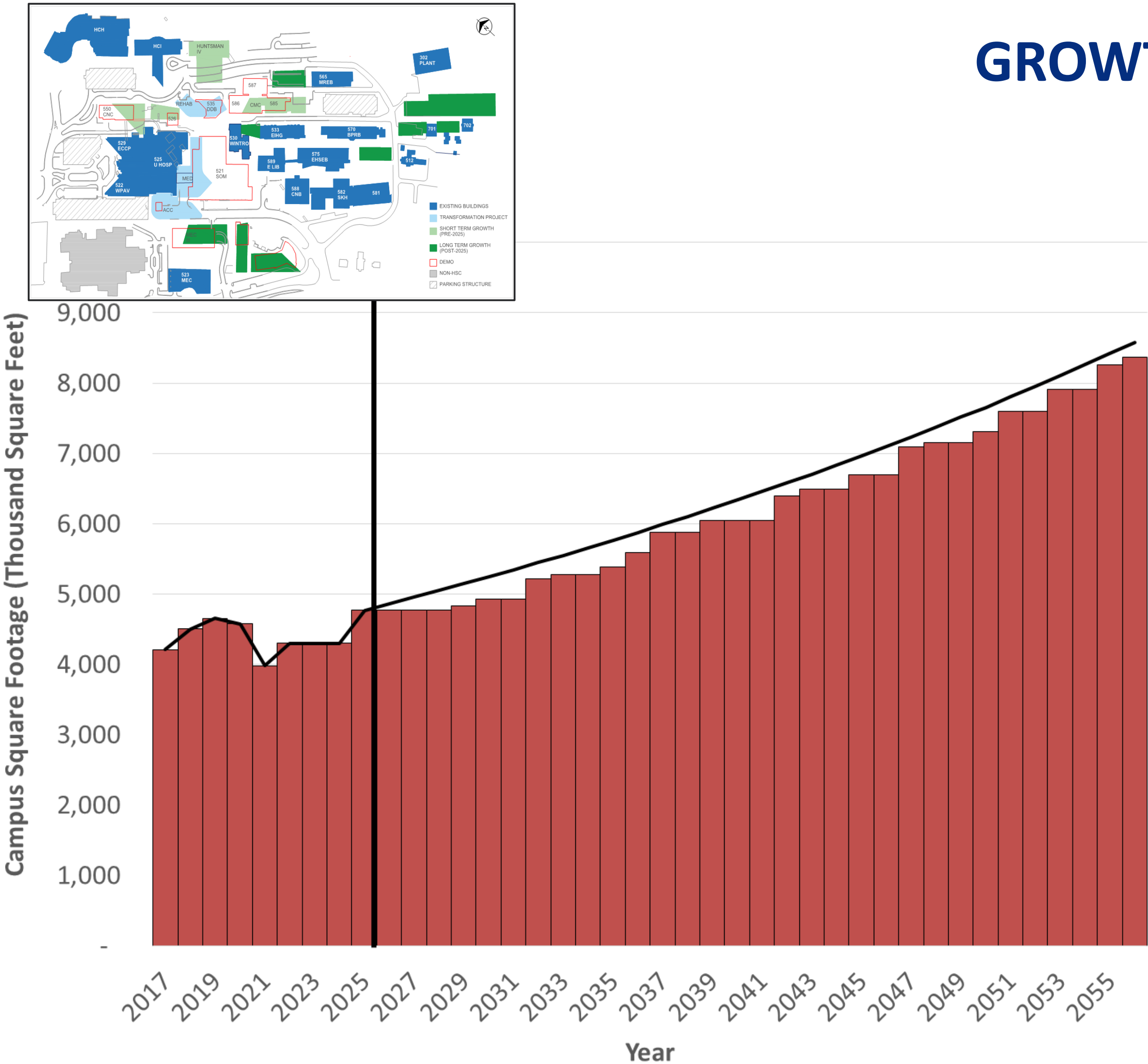
The transformation project will occur over the next five years which will include the construction of three new campus buildings starting in 2017, as well as the demolition of three campus buildings and the HSC Boiler Plant which provides local backup steam in the event of a failure at the HTHW plant.

TRANSFORMATION PROJECT

- ***Demolish the HSC Boiler Plant - 2017***
- ***Demolish the existing Dumke - 2018***
- ***Build the new Acute Critical Care - 2019***
- ***Build the new Rehab – 2019***
- ***Demolish the existing School of Medicine – 2019***
- ***Demolish the existing Medical Research and Education building - 2019***
- ***Build the new Medical Education Building - 2022***

In 2019 the University of Utah will hit a peak in Chilled Water load requirements of 10,300 Tons with only 9,380 Tons currently available at the East Plant.

GROWTH ASSUMPTIONS



Assumed existing and future building plan – Growth in built ft2

- Current campus expansion estimates substantial growth over next 40 years
- Up to 4M ft2 could be added to campus
- Densely occupied campus

UNIVERSITY VALUE DRIVERS

These value drivers formed the basis for analyzing and evaluating utility system strategies

- Satisfy heating and cooling loads
  - Transformation project needs and impact on balance of system
- Satisfy utility service reliability / resilience criteria
  - Production AND distribution
- Seek Lifecycle cost optimization
- Satisfy sustainability / energy efficiency goals
- Limit air permitting impact
- Balance short term needs with long term strategic vision
  - Proactive vs. reactive

SPECIFIC CHALLENGES

Each Campus

- Seismic risk
- Limited capability to expand within existing central utility intrastructure and limited available real estate on campus
- Transformation project schedule
  - Long term strategic position impacts Transformation Project design

SHIFT IN MINDSET

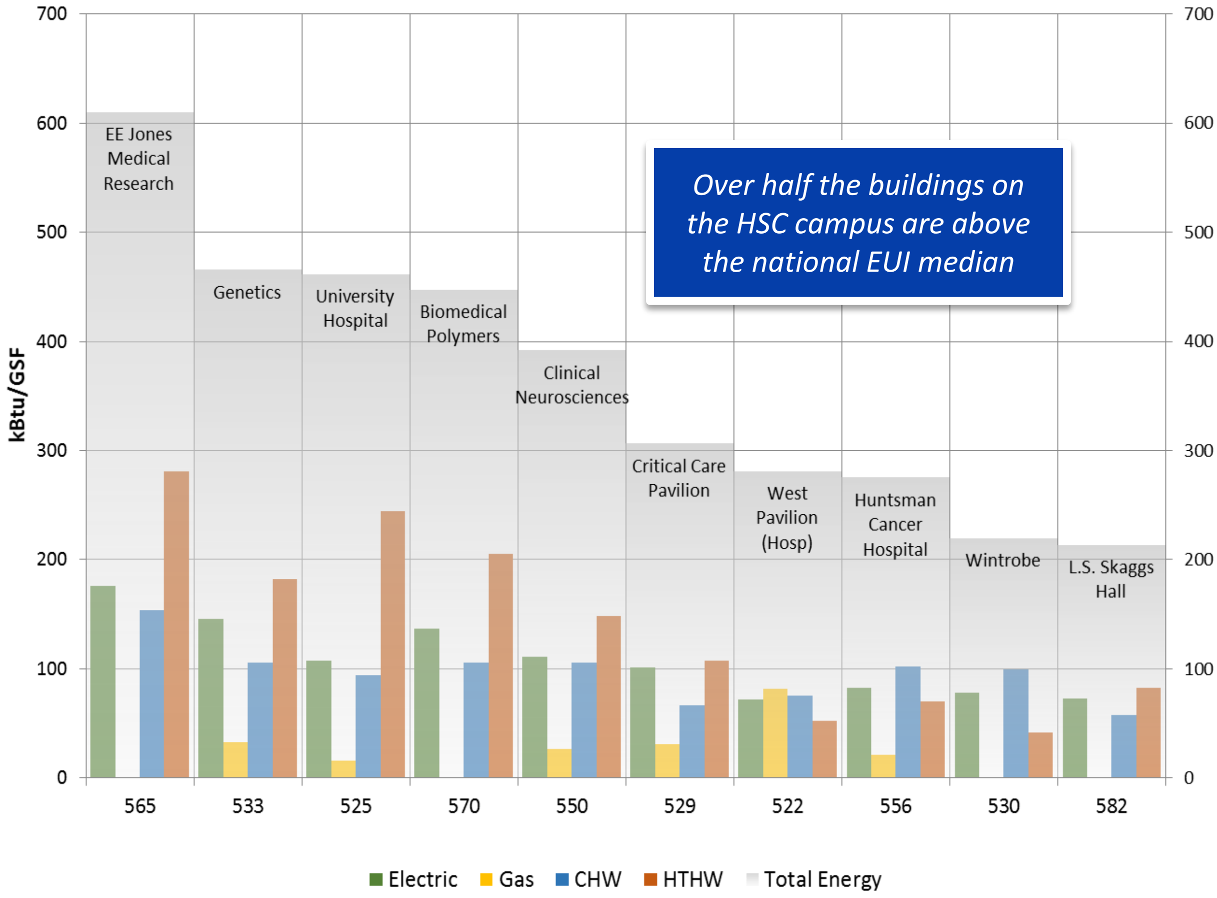
INTEGRATED ENERGY SYSTEM PLANNING

Identifying and executing the optimal long term utility system strategy requires the integration of production, distribution and consumption components of the energy system. The energy use characteristics of the associated buildings are critical in the holistic evaluation of a campus energy system. Building energy reduction strategies, when evaluated with and against other utility system investments, can become an extremely important asset that helps define the optimum investment strategy within the integrated campus energy system.

- <u>Detailed</u> review of building efficiency retrofits
  - Magnitude of utility peak demand/capacity reductions
  - Magnitude of energy reductions
  - Investment required to achieve
- Integrate into utility asset planning process
  - Resultant loads
  - Investment efficiency

EMP BASELINE ENERGY

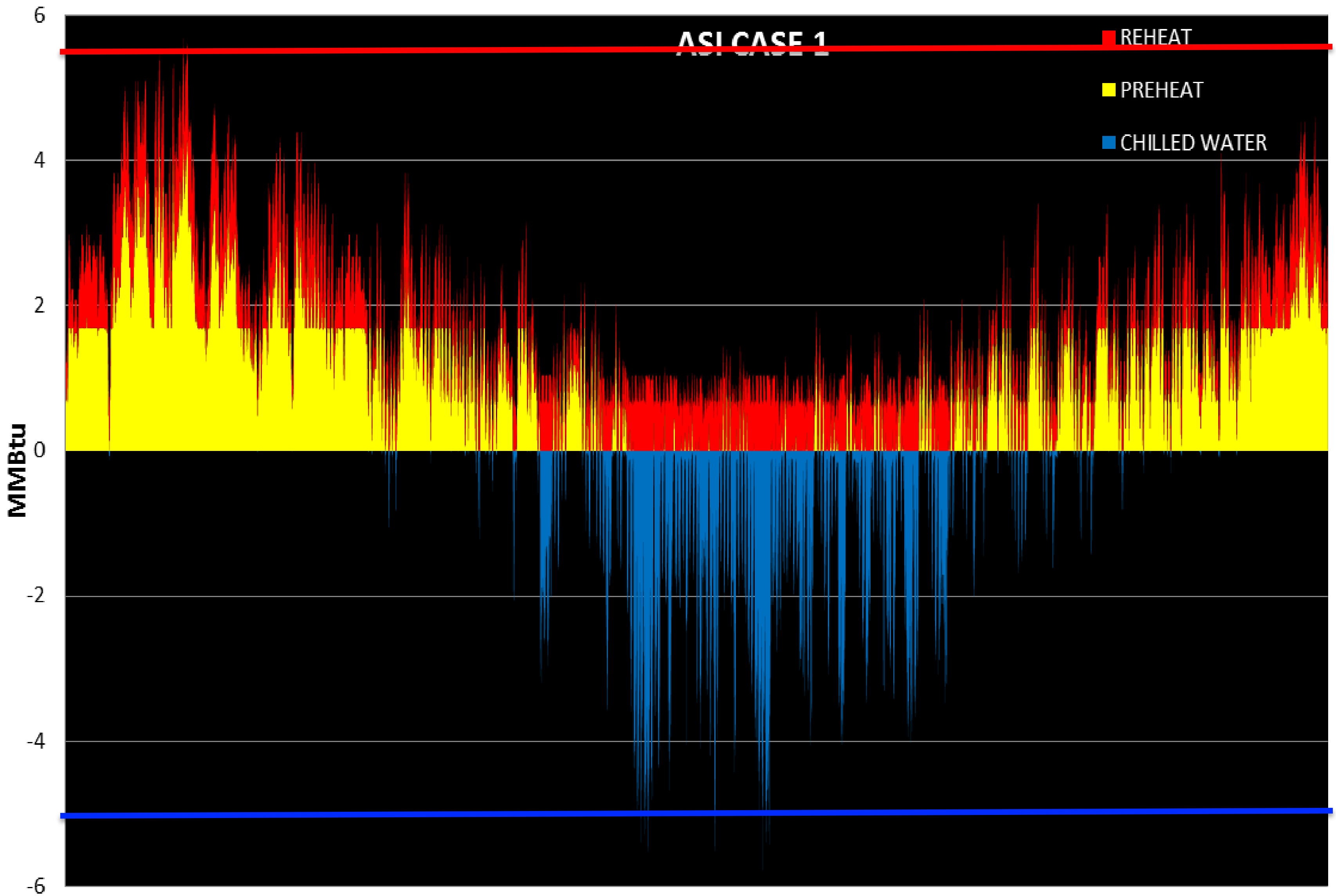
Years of deferred maintenance, lack of funding, and minimal visibility in to building energy consumption resulted in high energy use on campus.



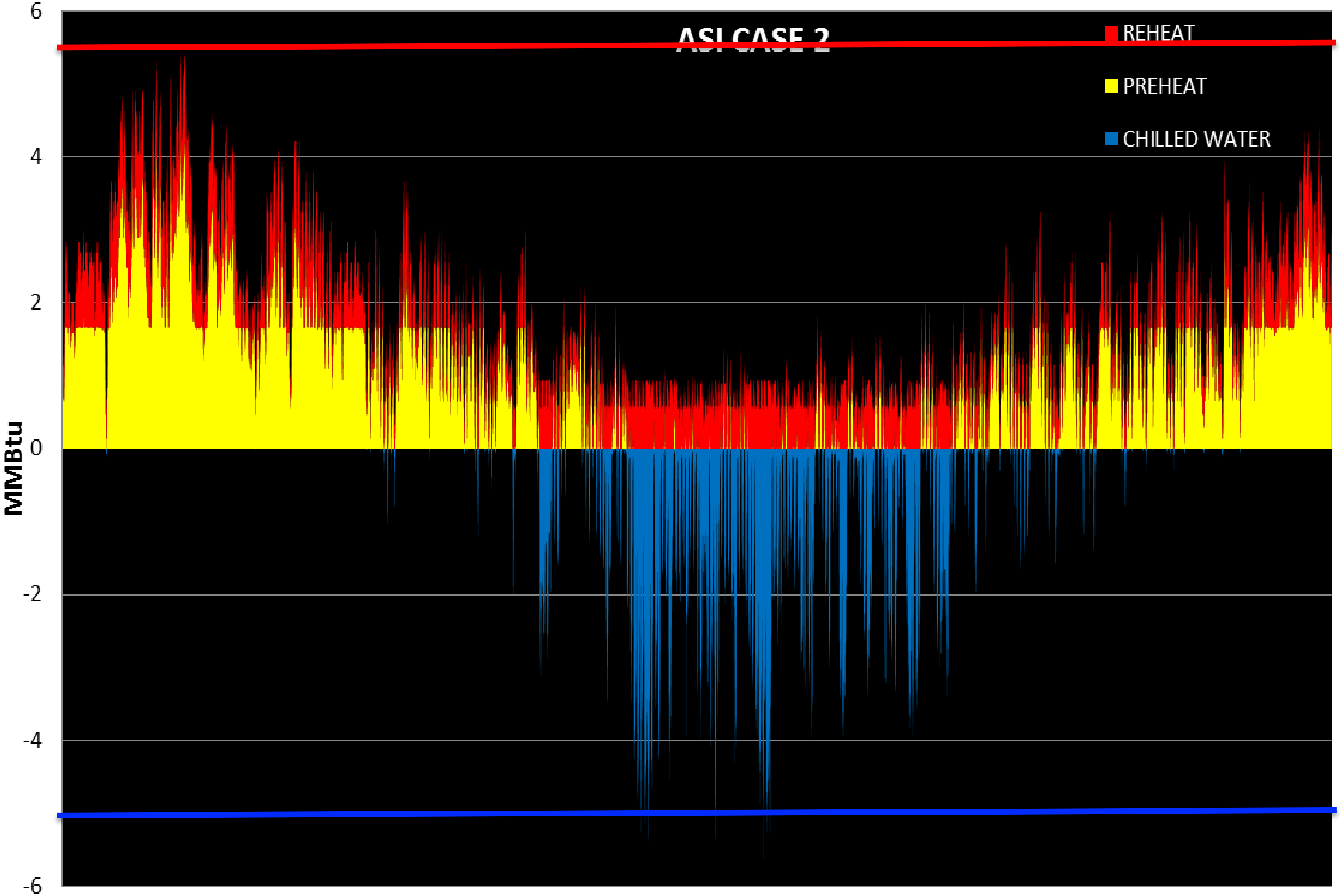
EMP FINDINGS

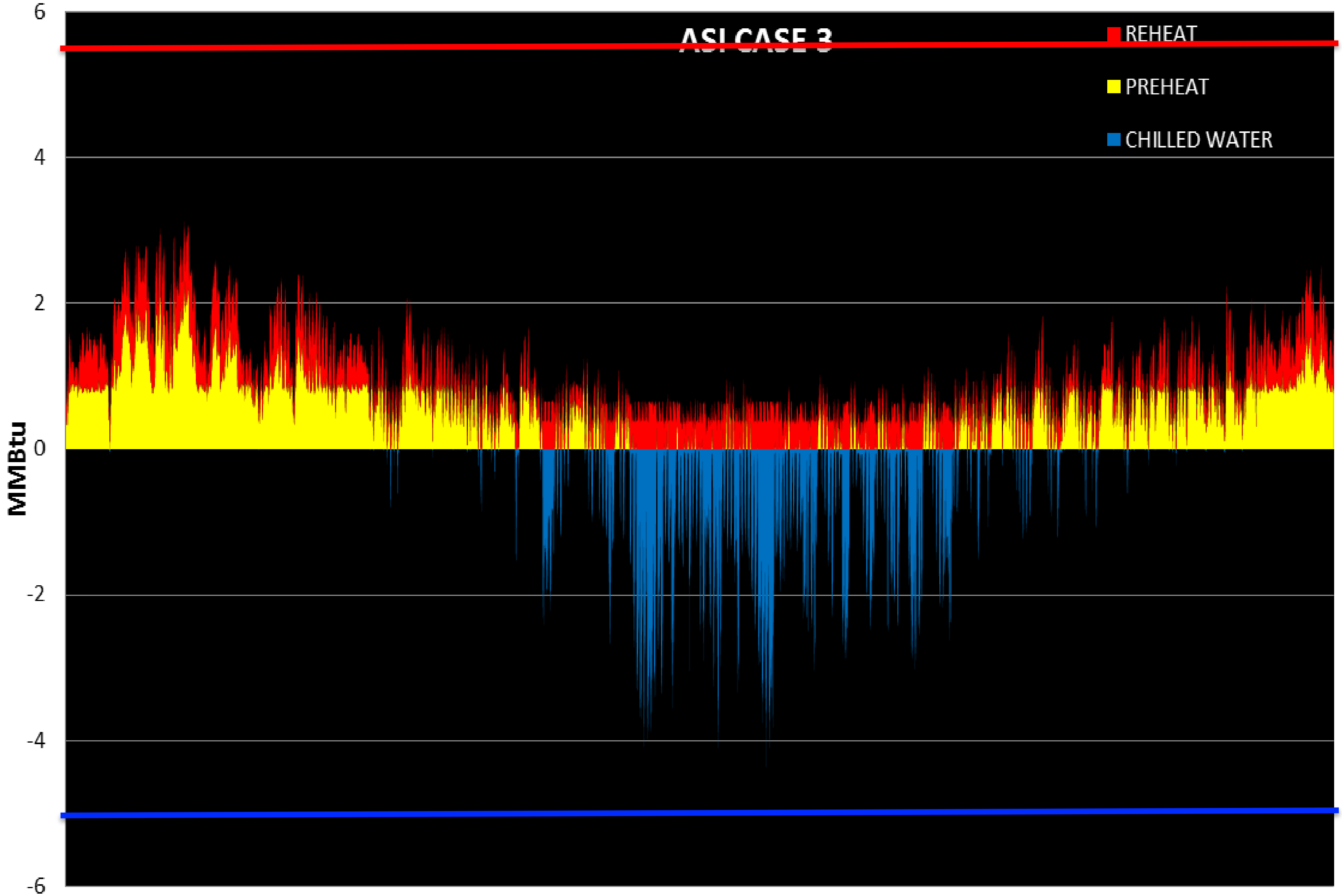
The EMP Program should be a holistic approach that enables new and existing systems to run efficiently and sustain that efficiency without the need of additional maintenance or personnel.

- *Controls Improvements*
  - *Retro-Commissioning*
  - *AHU Scheduling*
  - *Pneumatic Replacements / Fault Detection & Diagnostics*
- *Chilled Water Improvements*
  - *Pressure Independent Control Valves*
  - *Pump and HX Bypasses*
- *Lab HVAC Improvements*
  - *Retro-Commissioning of Existing HVAC*
  - *Replacement of Failed VAV boxes with Lab Grade Controls*
  - *Heat Recovery Optimization*
- *General HVAC*
  - *Evaporative Cooling*
  - *VAV Conversion & Fan Arrays*
  - *Demand-Based Kitchen Exhaust*

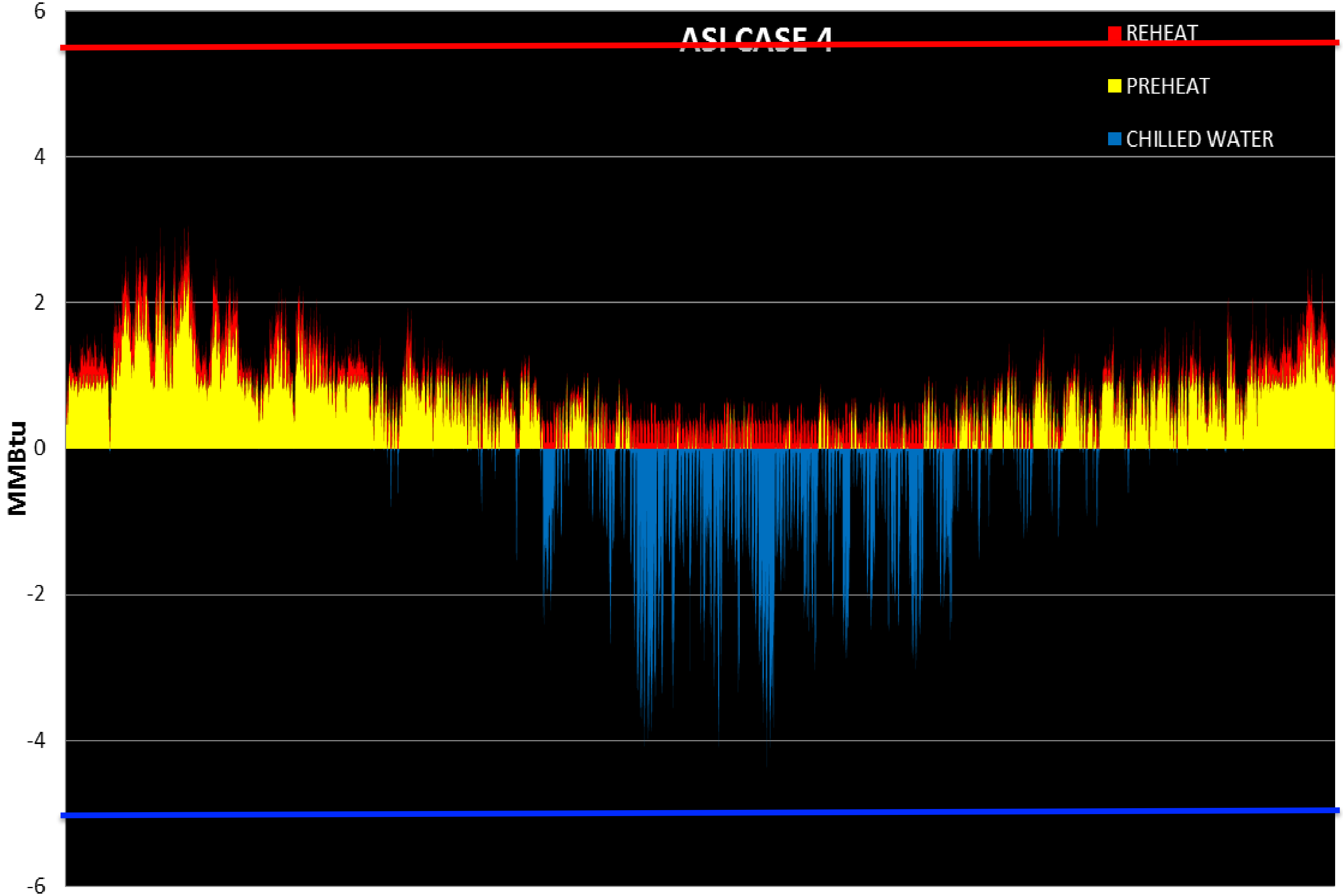


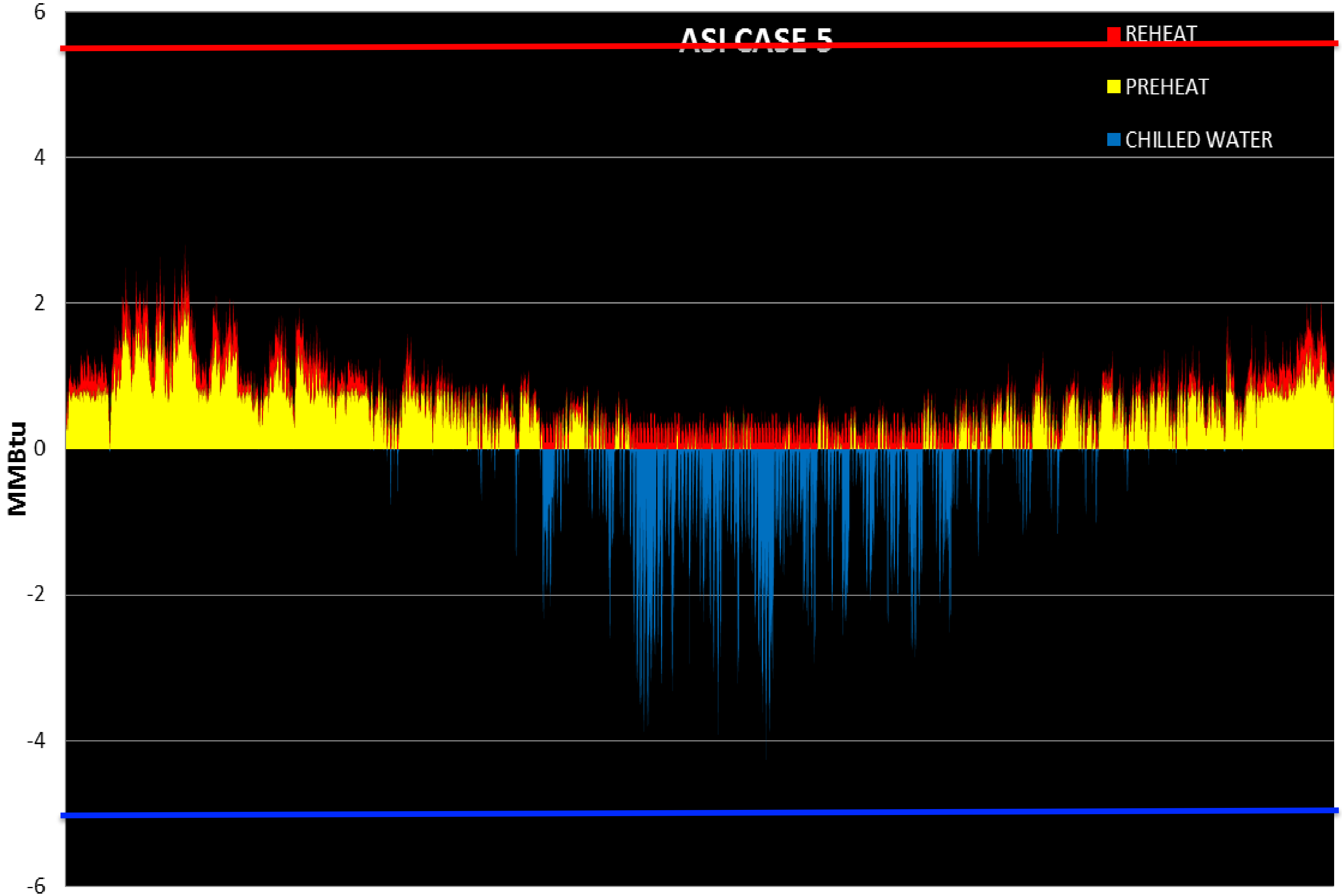
ASI CASE 1
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6

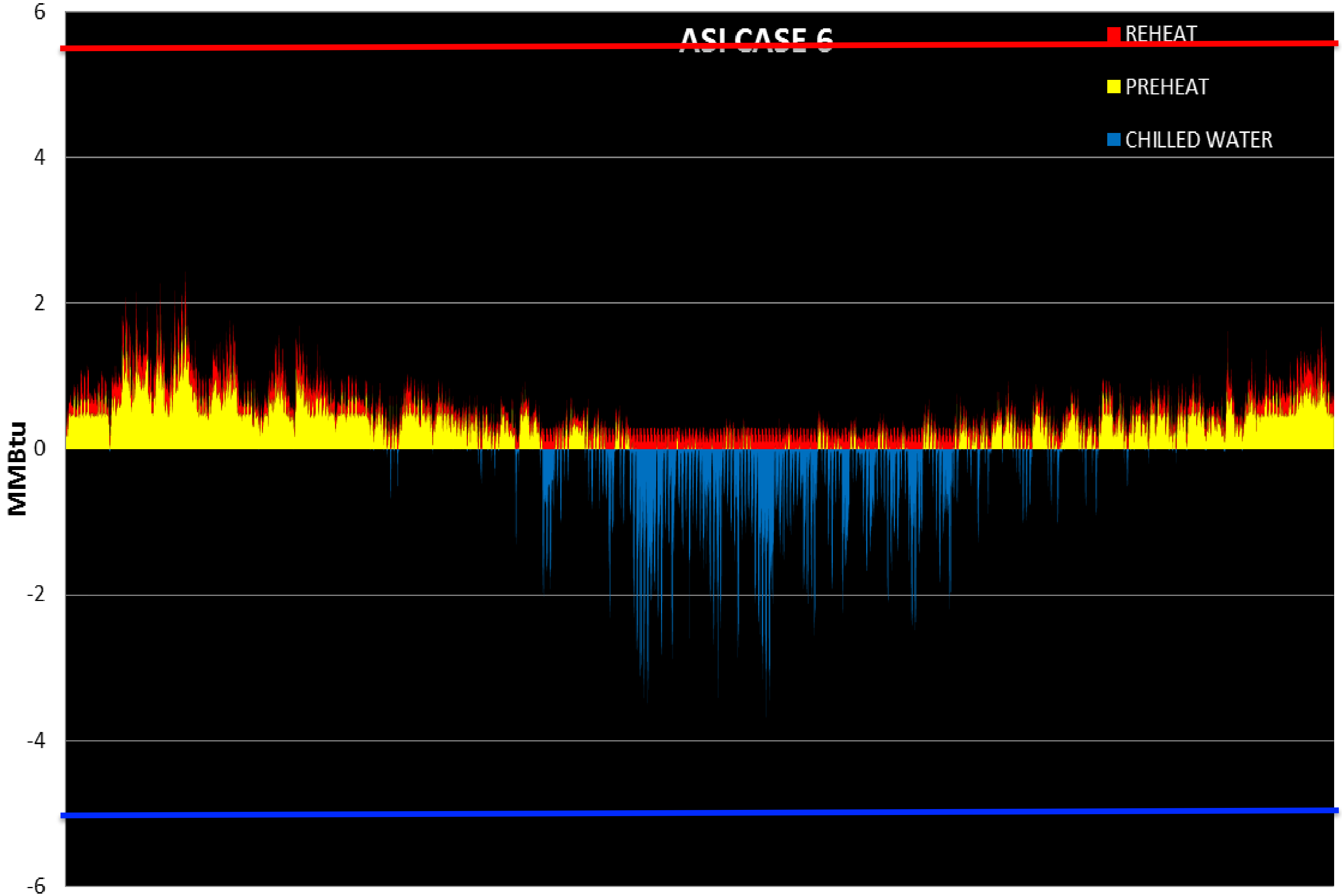

ASI CASE 2
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6

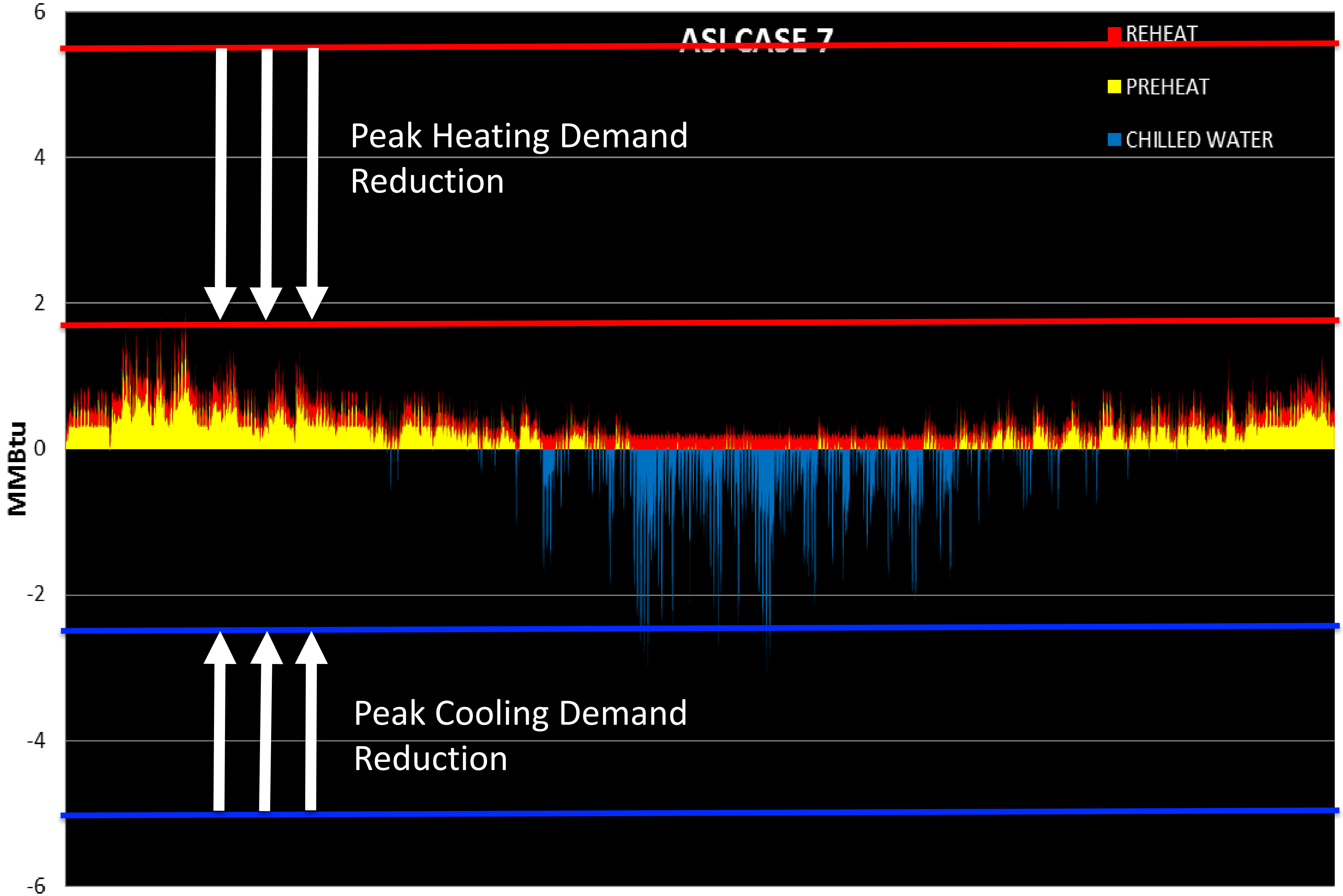


ASI CASE 3
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6


ASI CASE 4
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6

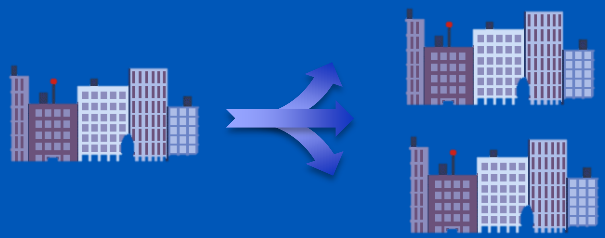

ASI CASE 5
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6


ASI CASE 6
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6


ASI CASE 7
REHEAT
PREHEAT
CHILLED WATER
Peak Heating Demand
Reduction
Peak Cooling Demand
Reduction
MMBtu
6
4
2
0
-2
-4
-6

EMP LIFECYCLE BENEFITS

10 of the 25 buildings were evaluated. Results were extrapolated to the 25-building campus.



RESULTS

- ***Reduce Heating & Cooling Usage by ~20%***
- ***Reduce Heating & Cooling Demand by ~10%***
- ***Increase CHW delta-T from 8°F to 14°F***
- ***EMP Program Cost of $30 Million***
- ***Positive Cash Flow in 15 years***
- ***Cumulative Net Cash Flow of $56 Million***

The University of Utah HSC buildings can save an estimated $2 Million annually on metered building energy costs while improving laboratory life safety and system reliability.

The implementation of energy reduction plans at the Building Level became the Base Case Assumption for a variety of reasons, financial to building O&M improvements.

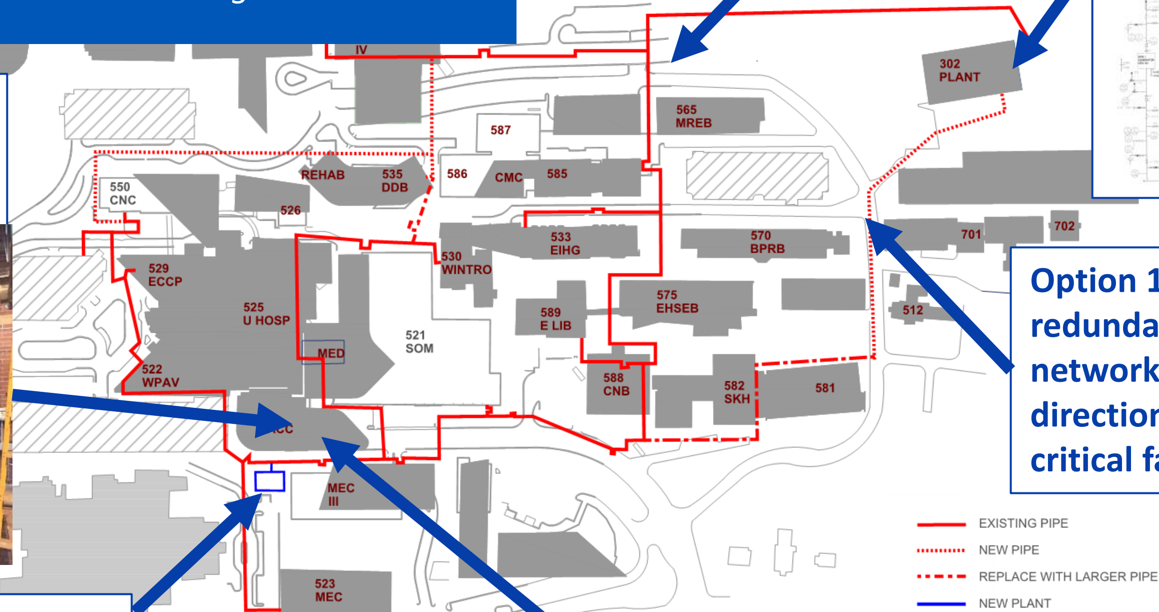
THERMAL UTILITY: HEATING

The existing thermal heating utility is served by the East Plant High Temperature Hot Water system. Steam boilers are located throughout the HSC to provide redundant backup at each critical building.

Option 1: Provide a looped system to provide bi-directional flow to all critical facilities.

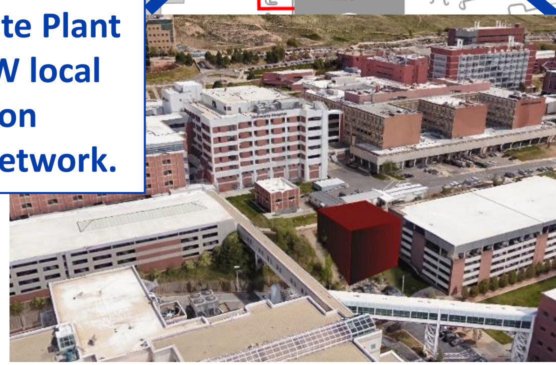
Option 1: Provide primary HTHW from the East Plant with redundant boilers for backup

Base Case: Provide Steam Boilers at all critical loads throughout the campus.



Option 1: Provide redundant feed to the network to provide bi-directional flow to all critical facilities.

Option 2: Satellite Plant to provide HTHW local to critical loads on looped HTHW network.

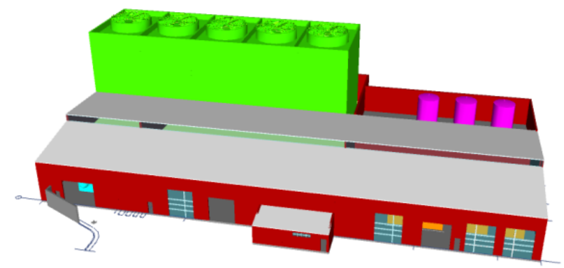


Option 3: Provide High Efficiency Low Temperature Hot water boilers at all new buildings.

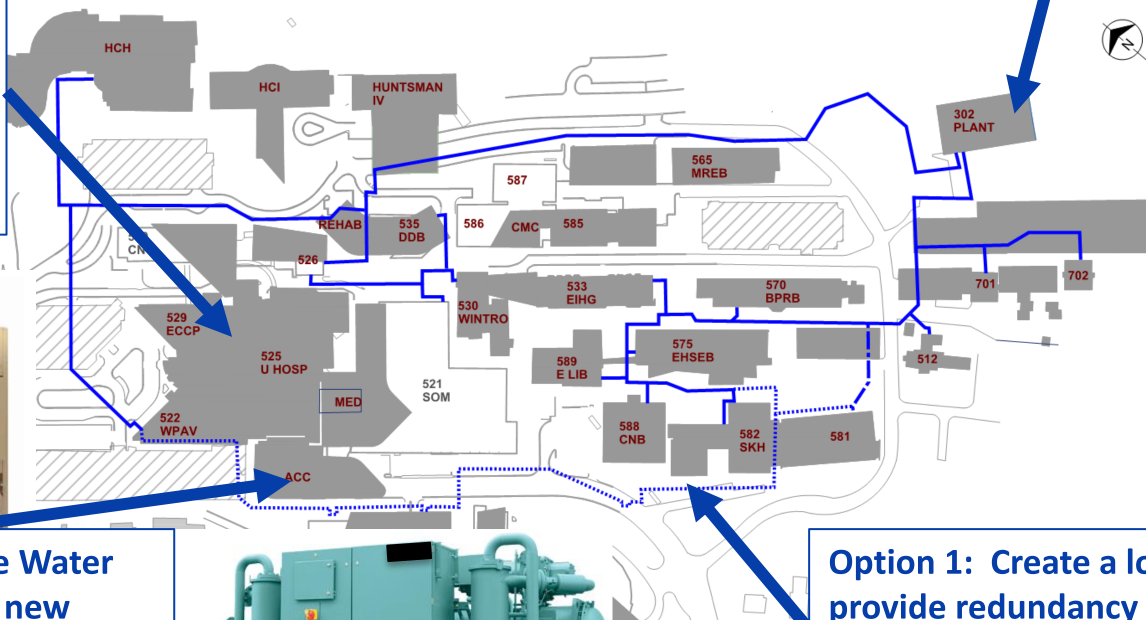
THERMAL UTILITY: COOLING

The existing cooling load is served by the East Plant. The current operating limitations at the East Plant de-rate the system to only 9,380 tons available of the installed 12,164 tons.
There is currently no redundant chillers local to the buildings. Two of the options selected provide single mode of failure redundancy beyond what is provided in the Base Case.

Base Case: Expand Current Plant with 4,500 Ton Chillers to meet Load



Option 2: Provide Air Cooled peaking chillers at buildings which require redundancy.

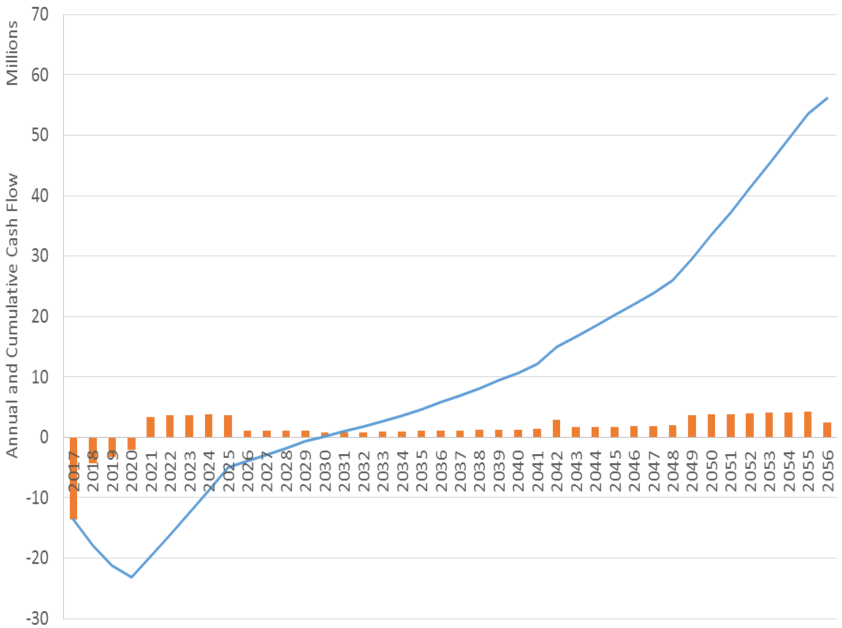


Option 3: Provide Water Cooled chillers at new buildings without a connection to the central plant.

Option 1: Create a looped feed to provide redundancy to the network.

Program Results- Building Efficiency

- Building efficiency investments provide 10% peak demand reduction in heating/cooling while delivering $56 Million in net positive cash flow to the University over the planning period.
- Eliminates near term heating/cooling capacity shortfalls against N+1 requirement, deferring need to add utility system capacity
- Supports University's campus energy reduction goals
- Improves building system function, performance and monitoring capability (Life Safety)
- Base Case to incorporate building efficiency work



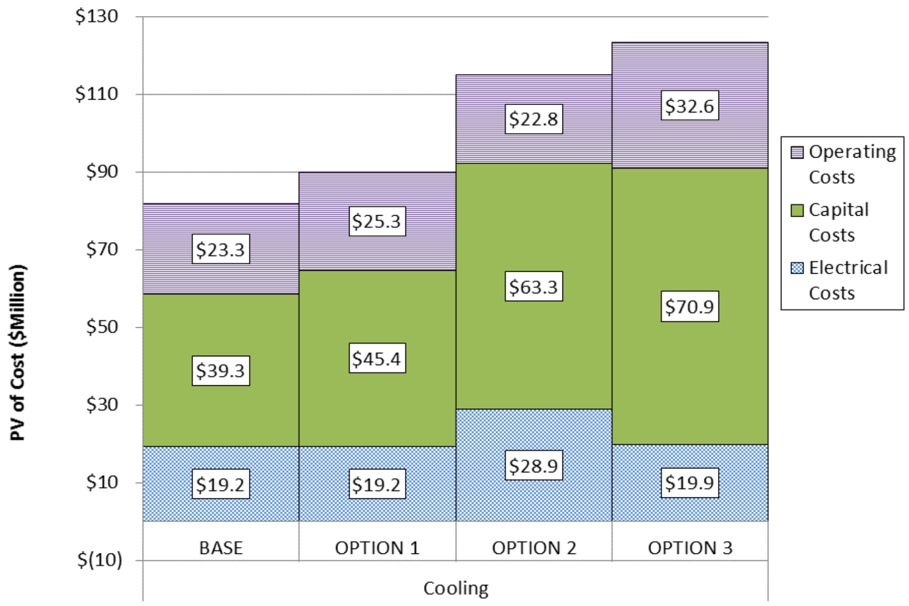
Program Results- Heating

- Distributed heating option (Option 3) provides the lowest overall lifecycle cost
- Distribution system redundancy requirements drive capital cost for fully centralized heating options (Options 1 and 2)
- Distributed heating option results in best energy consumption profile (maximizes system fuel efficiency)
- Distributed heating option places production closest to load (minimize concerns over catastrophic distribution system failure)

VALUE-DRIVER COMPARISON

	Base	Option 1	Option 2	Option 3
Satisfy Heating and Cooling Loads	●	●	●	●
Satisfy Production Redundancy Requirements	●	●	●	●
Satisfy Distribution Resilience Requirements	▲	◆	◆	●
Overall Lifecycle Cost	◆	●	▲	●
Satisfy Energy Efficiency Goals	◆	◆	◆	●
Implementation Difficulty	▲	◆	◆	●

Program Results- Cooling



- Significant cost premium to increase chilled water system resilience as desired by Hospital personnel
- Distributed options provide no efficiency gain to offset additional capital and O&M cost requirements

VALUE-DRIVER COMPARISON

	Base	Option 1	Option 2	Option 3
Satisfy Heating and Cooling Loads	●	●	●	●
Satisfy Production Redundancy Requirements	●	●	●	●
Satisfy Distribution Resilience Requirements	◆	▲	▲	●
Overall Lifecycle Cost	●	▲	▲	◆
Satisfy Energy Efficiency Goals	●	●	●	●
Implementation Difficulty	●	◆	◆	▲

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Summary

- Building efficiency investments via EMP positively contribute to all major University value-drivers
- Utilizing building efficiency as a utility system asset provides the University with other value-added alternatives in the management and planning of utility infrastructure. Must be done correctly.
- University of Utah will best meet it's energy needs and goals through an integrated energy approach, managing investments across reducing demand /consumption and upgrading / expanding utility systems.

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