Demand-Side Management Strategies for Campus Labs

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CAMPUSENERGY2015

Laboratory Energy Efficiency as a Utility System Asset

Anatomy of Lab Efficiency Retrofit

Lab Retrofit Challenges

Use in Utility Master Planning (UMP) Process

Laboratory Energy Efficiency as a Utility System Asset

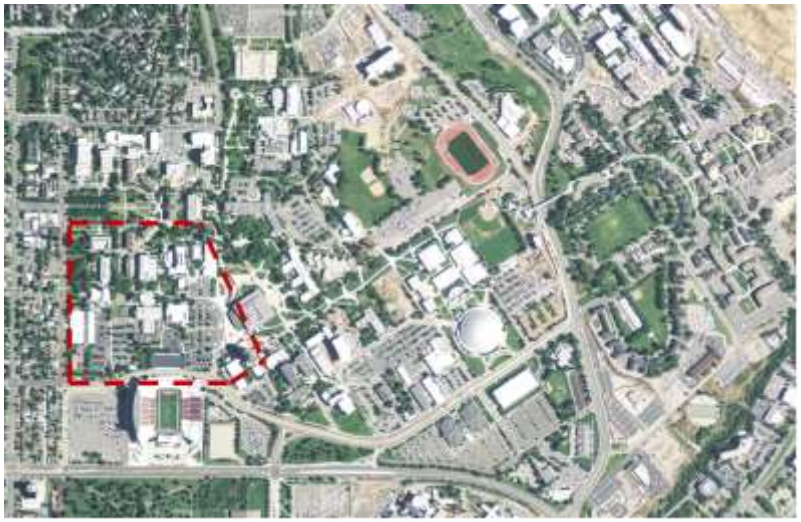
Why Pursue Labs?

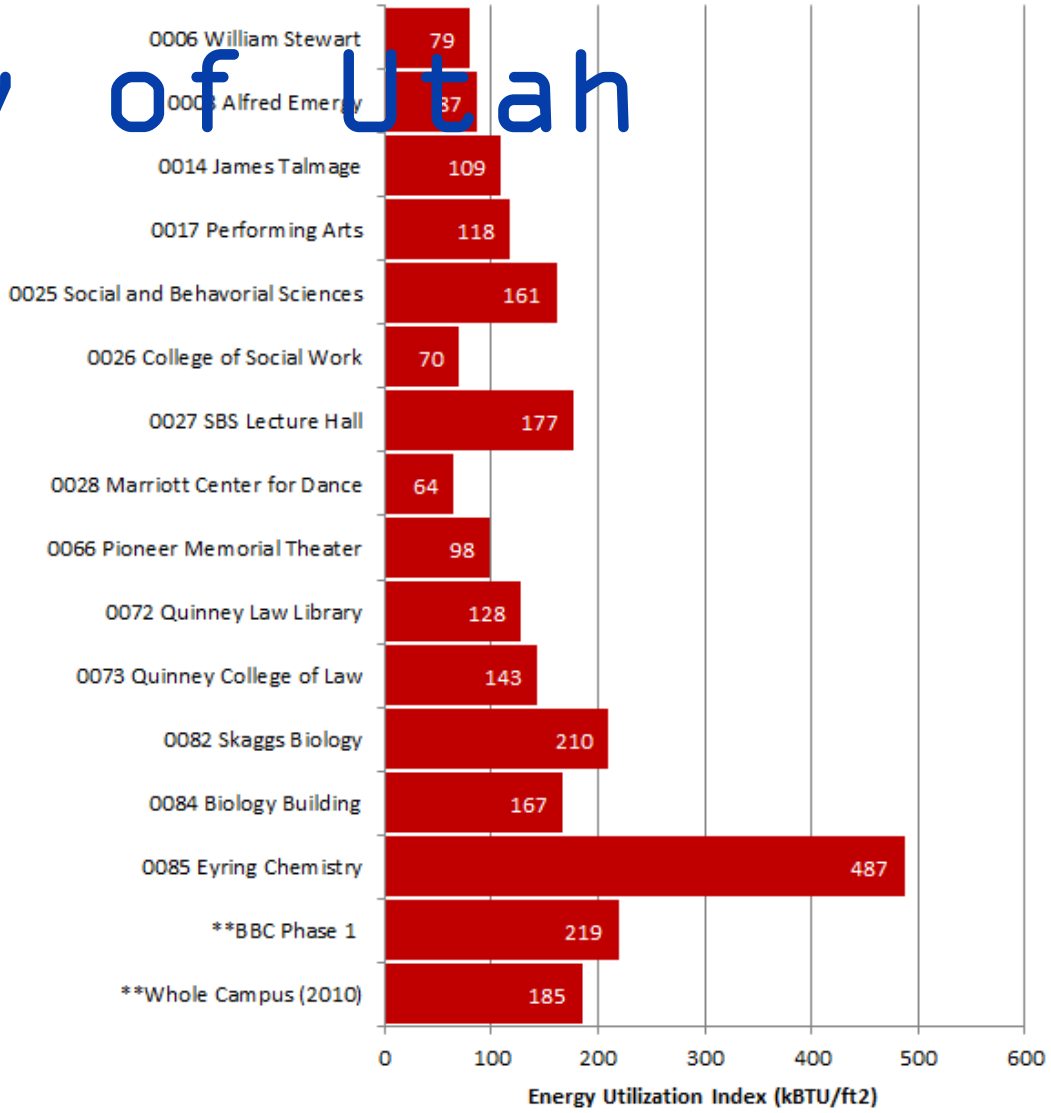
- Energy use is high per square-foot
- Significant area dedicated to laboratories
- Labs have high energy use because:
  - Occupant safety is the #1 priority.
  - High makeup air rates
  - 24/7 operation
- New technologies are now available
- Low hanging fruit has been picked

Increasing Lab Energy Efficiency = Firm Capacity Reduction

University of Utah

Better Buildings Challenge Phase I Projects





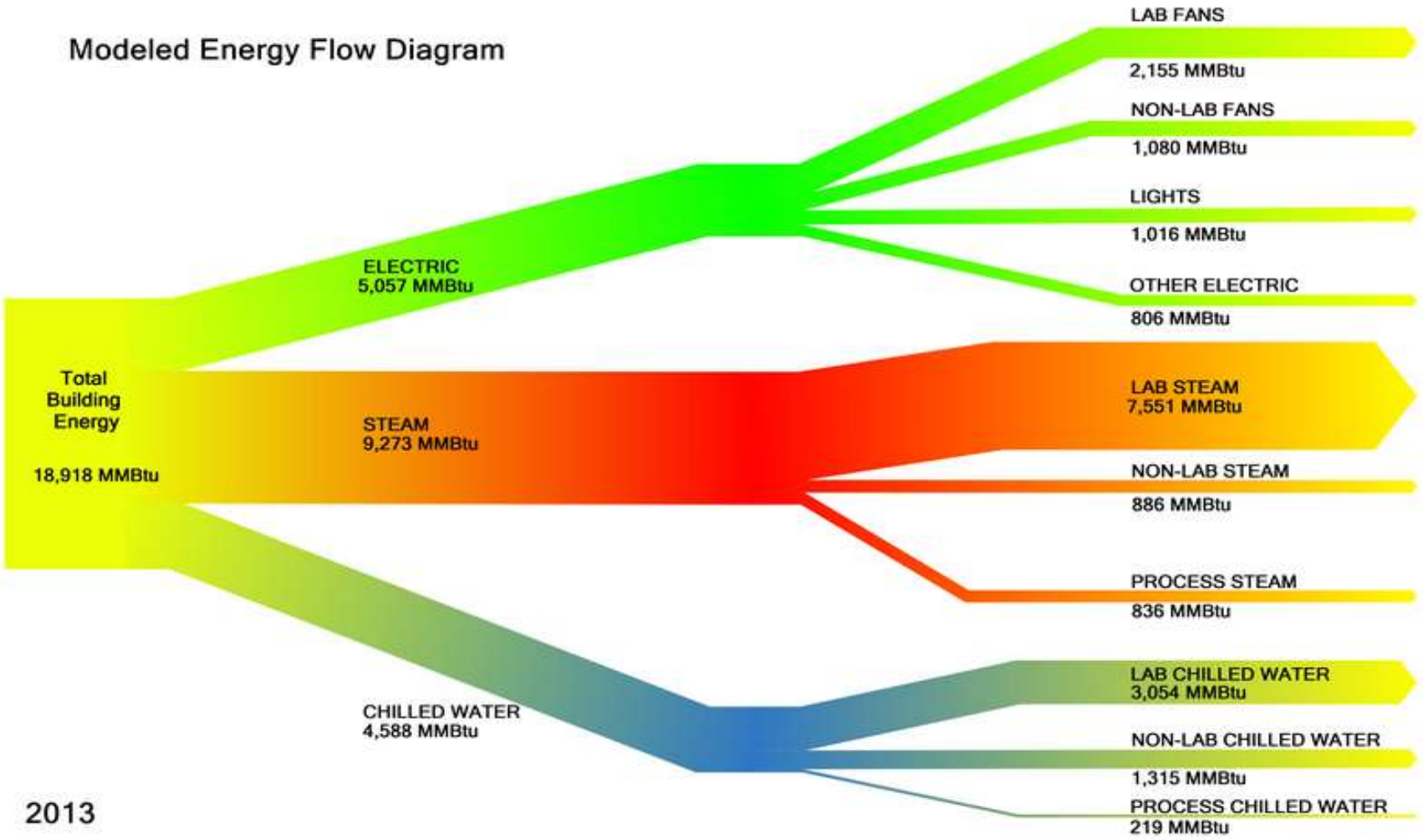
Example Lab Buil

LARGE UNIVERSITY CAMPUS

- Completed in 2006
- 55,000 ft^2
- Mixed Use:
  - Labs
  - Classrooms
  - Offices
- Variable Air Volume (VAV)
  - Lab air handling
  - Non-lab air handling
  - Lab exhaust
- Campus chilled water
  - 10°F ΔT during day
  - 5°F ΔT during night
    (Process likely 5°FΔT, space cooling is likely 10-15°FΔT)
- Campus steam
  - HPS converted to LPS for AHUs
  - HPS converted to HW for reheat

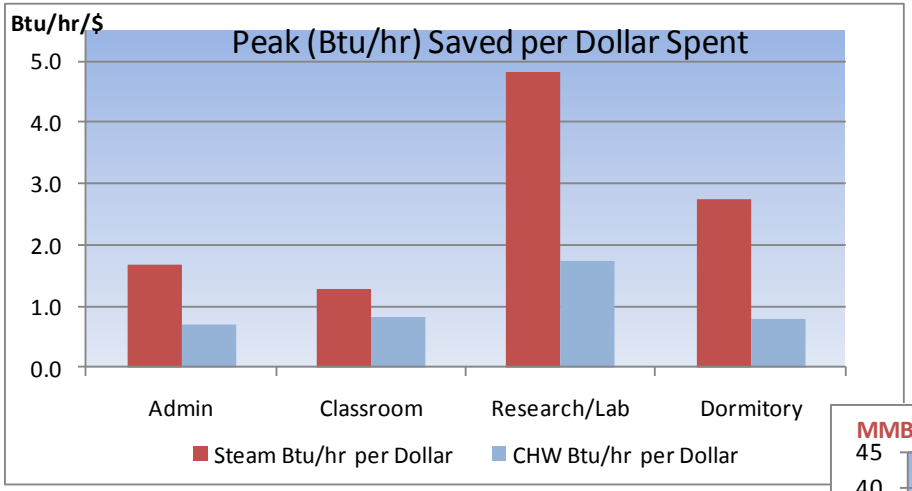
EUI = 345 kBtu / ft^2

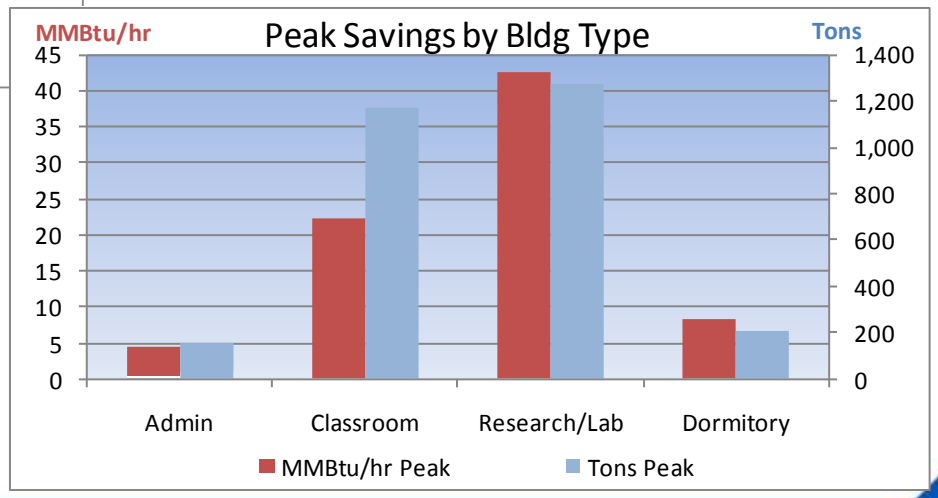
Example Lab Building



Example Research Campus

- Extrapolate data to research intensive campus



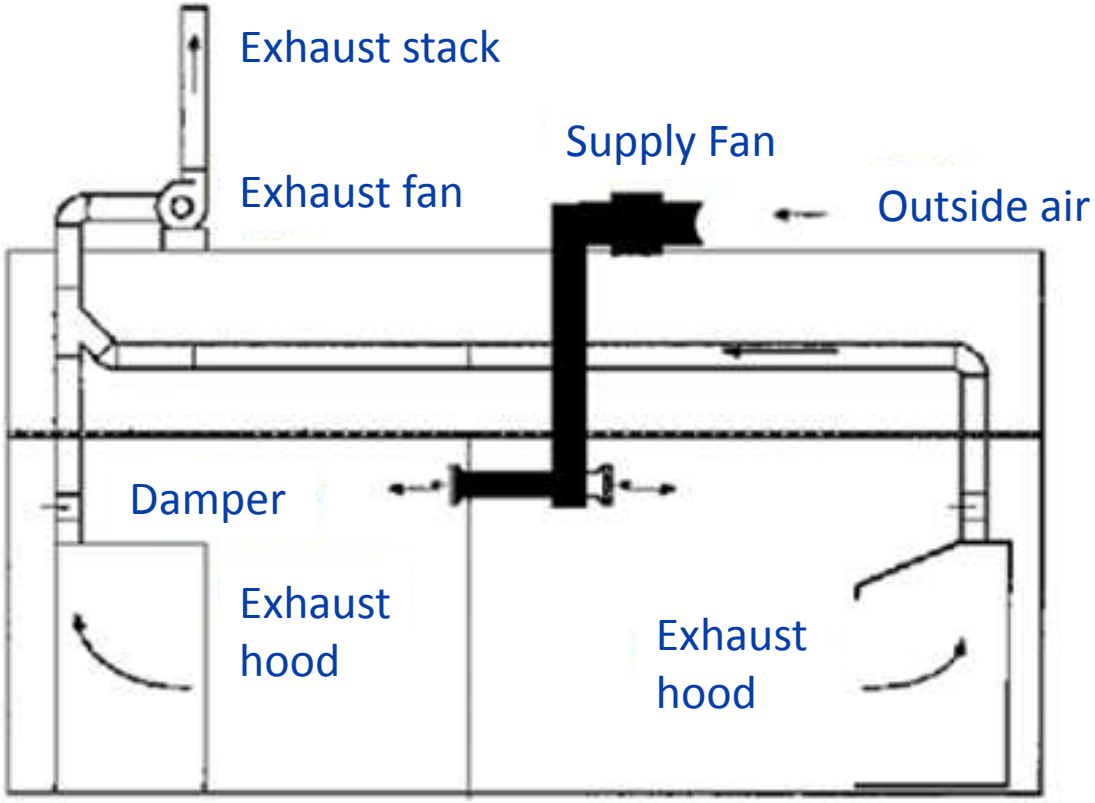


Anatomy of Lab Efficiency Retrofit

Lab Energy Systems

What's In a Lab?

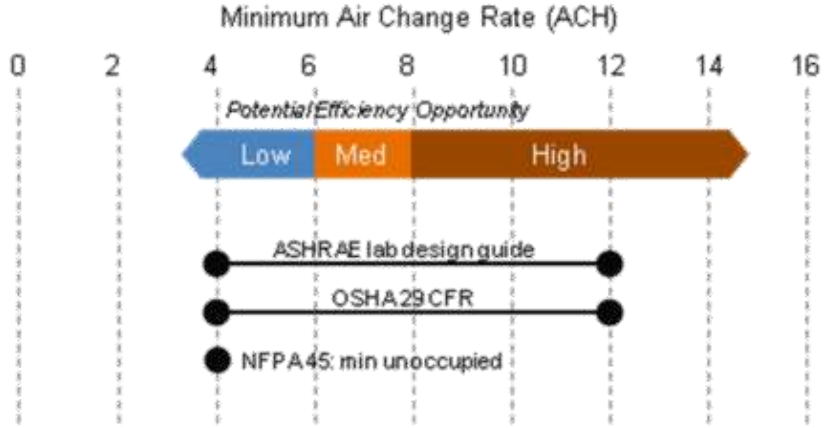
- Exhaust driven airflow
- Fume hoods
- Exhaust systems
  - Individual
  - Manifold
- Makeup air systems
- Internal loads



Lab Energy Systems

What Do We See?

- Constant Air Volume (CAV) or Variable Air Volume (VAV)
- High air change rates (Typical rates of 6-12 ACH)



- High internal loads (ie intense cooling loads)
- High reheat (simultaneous heating & cooling)
- Occupant control is lacking

Common Lab Retrofits

Five Step Evaluation Process

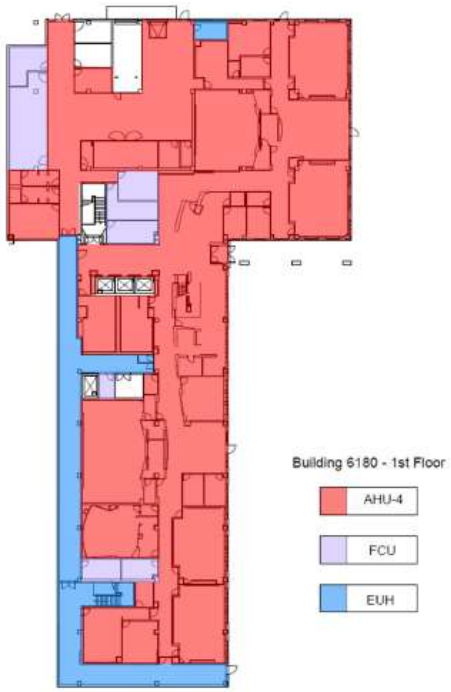
1. Screening based on Building Characterization
   - Building usage
   - Building systems
   - Building energy
2. Prioritize Investigations
3. Confirmation
4. Define execution strategy
   - Retro commissioning
   - Renovation
5. Select & Go

AVIS Preferred | Select & Go℠

Common Lab Retrofits

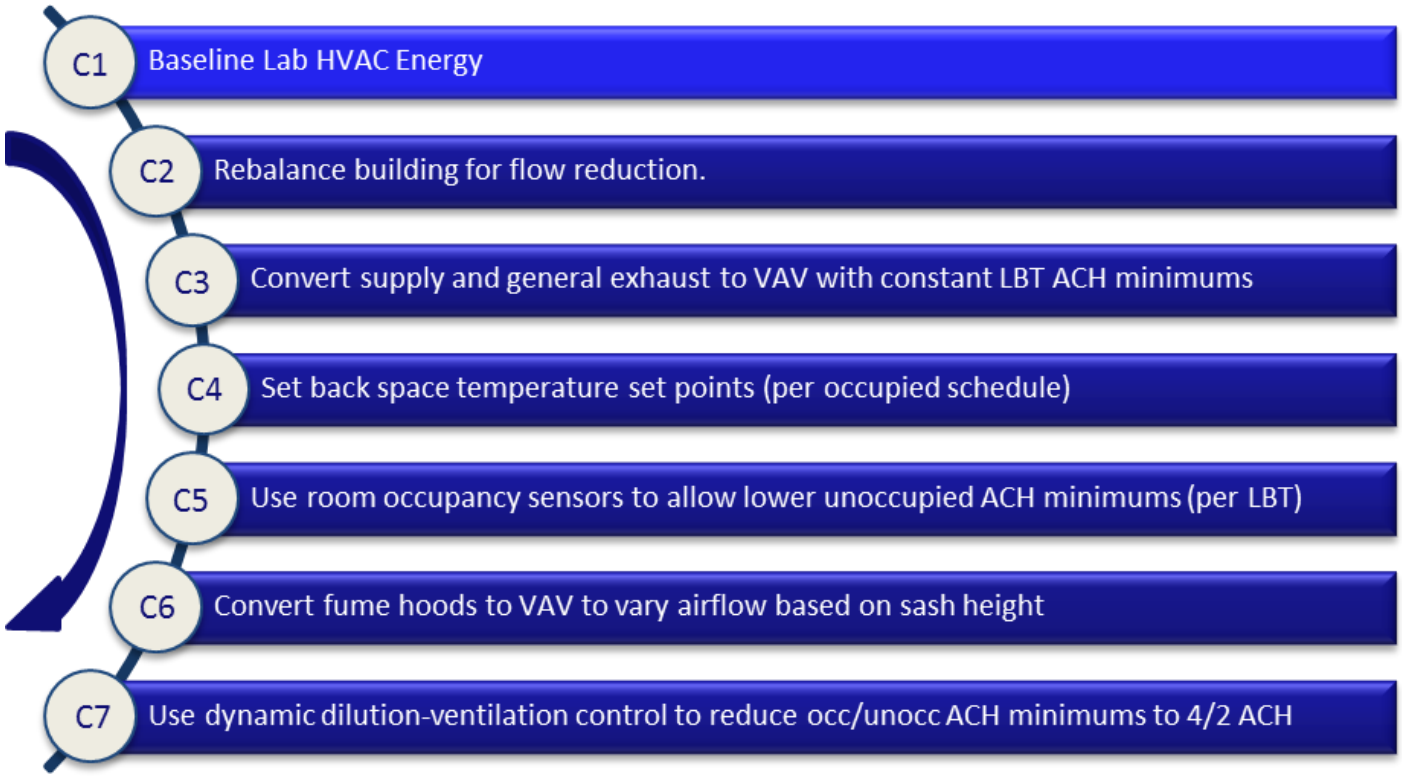
Lab Energy Model Characteristics

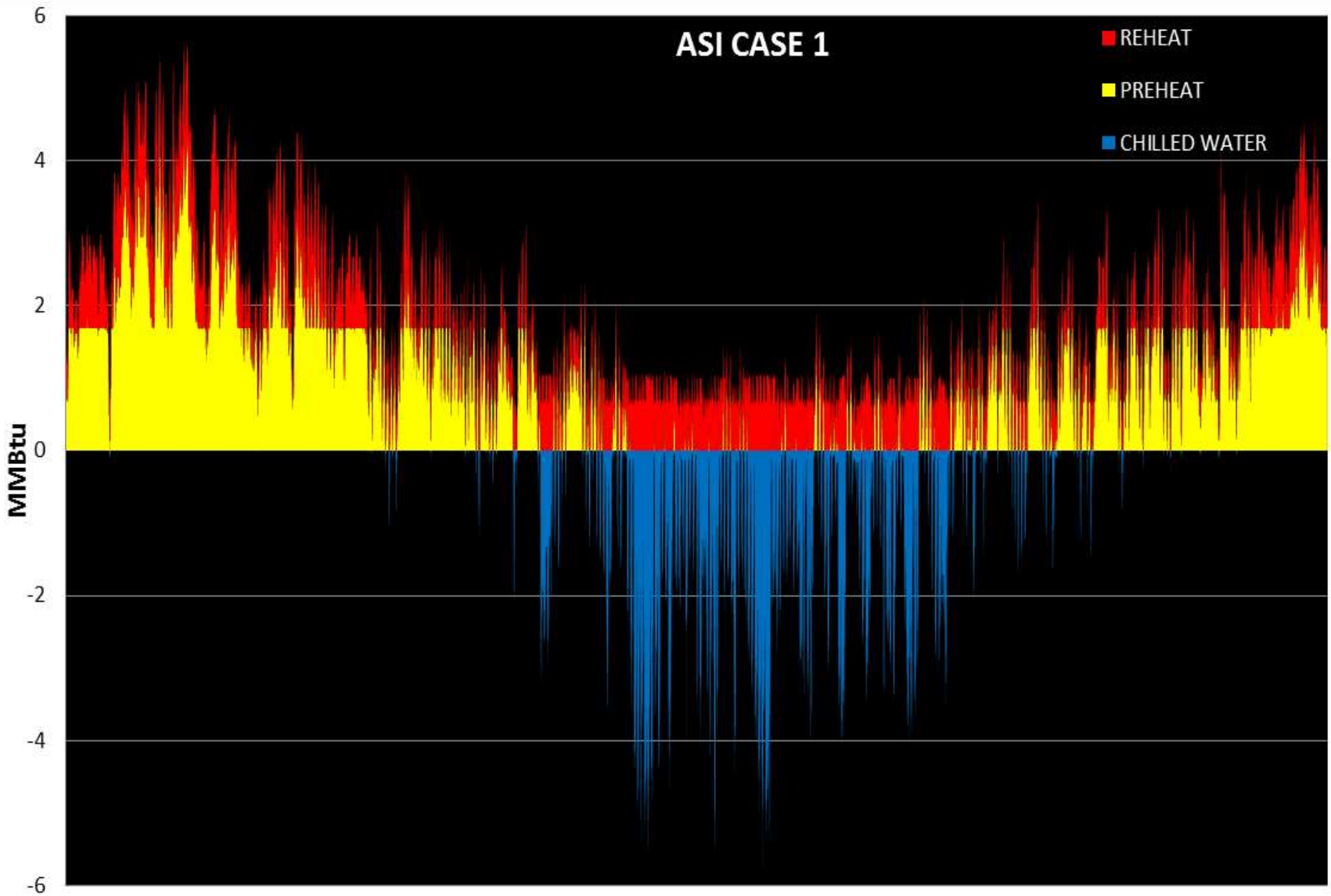
- Hourly Analysis throughout the year (8760 hours)
- Room by Room
- Feeds into Design
- Flexible (multiple uses)
  - Screening Model
  - Detailed Analysis

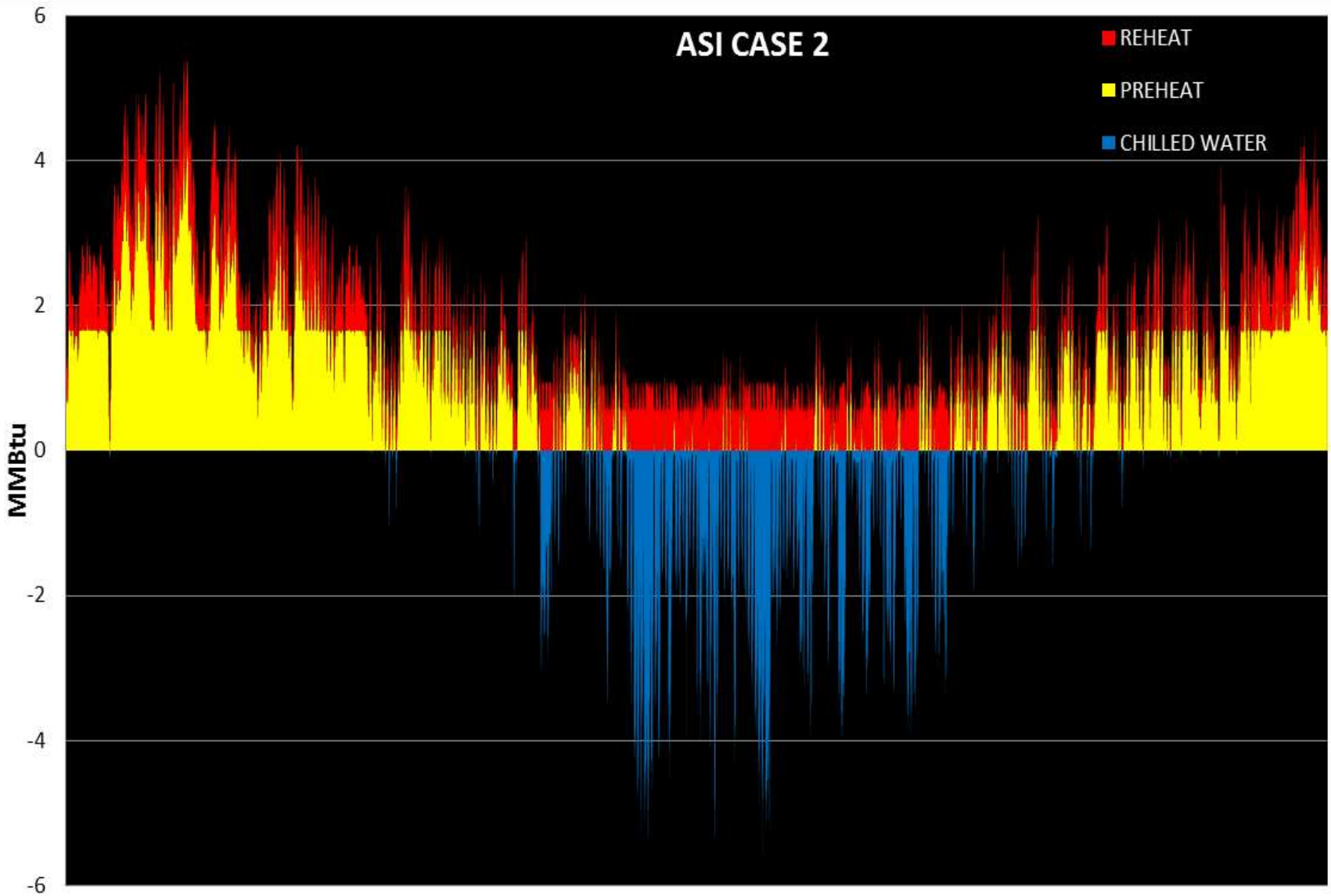


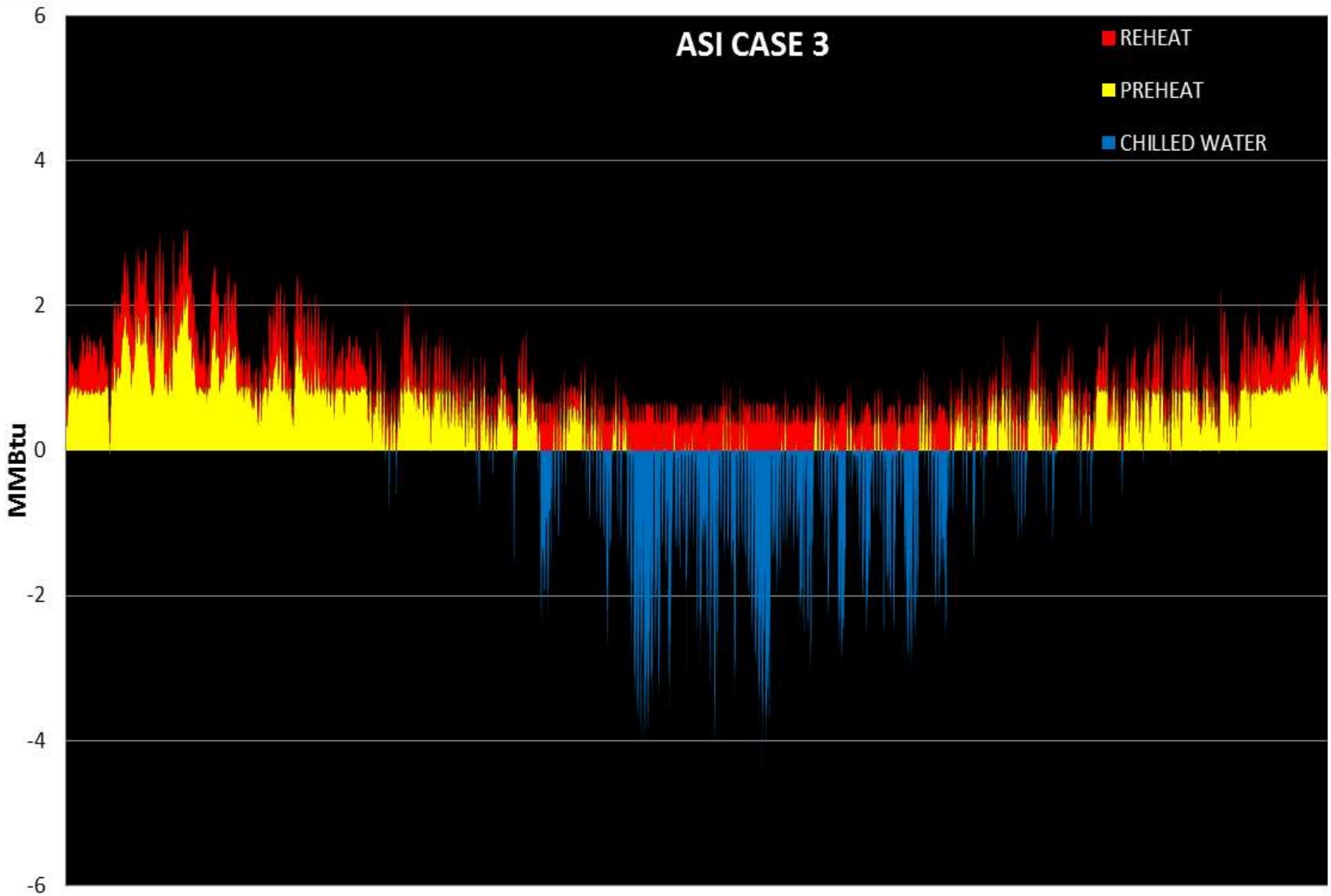
Laboratory Energy Efficiency

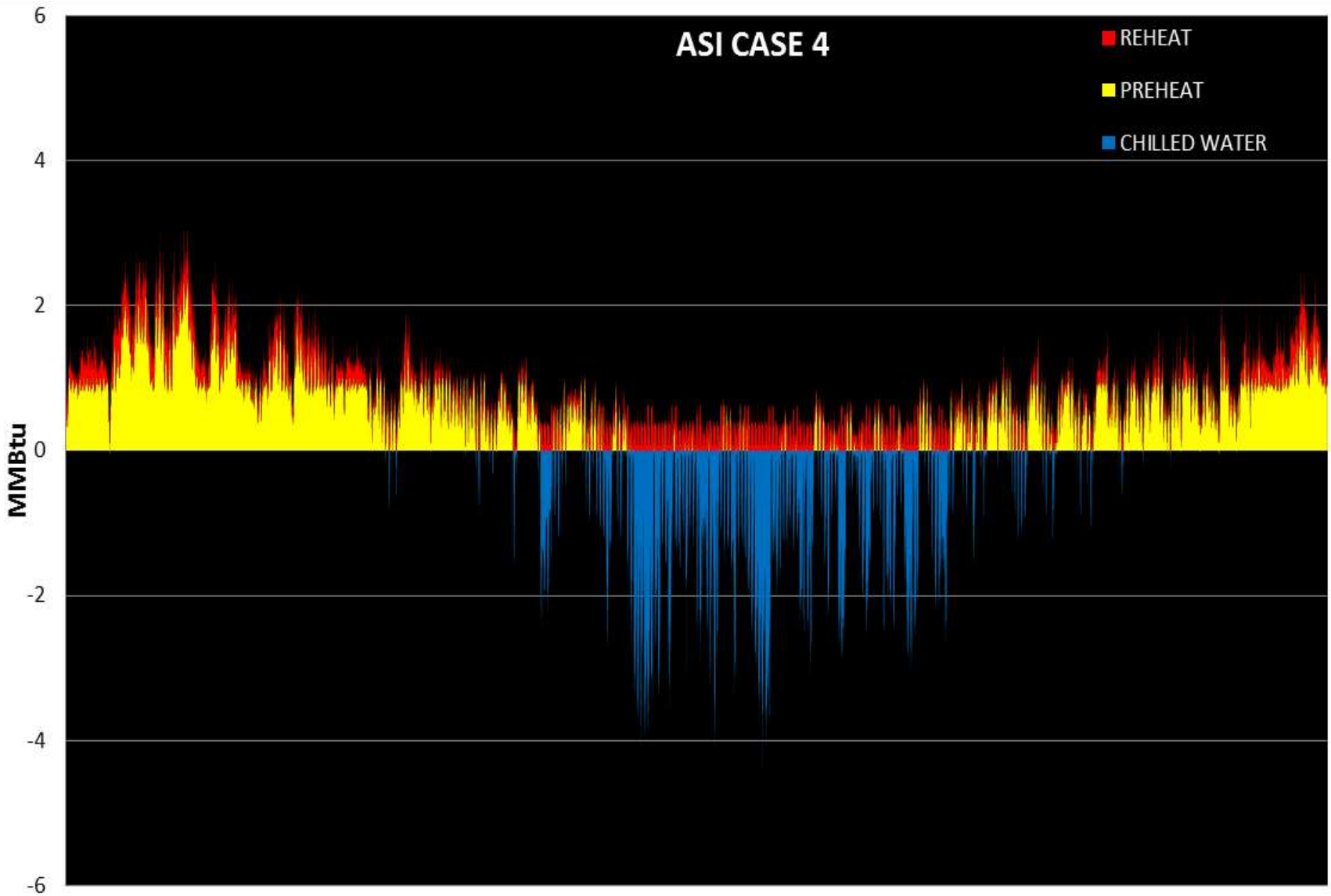
Investment Steps

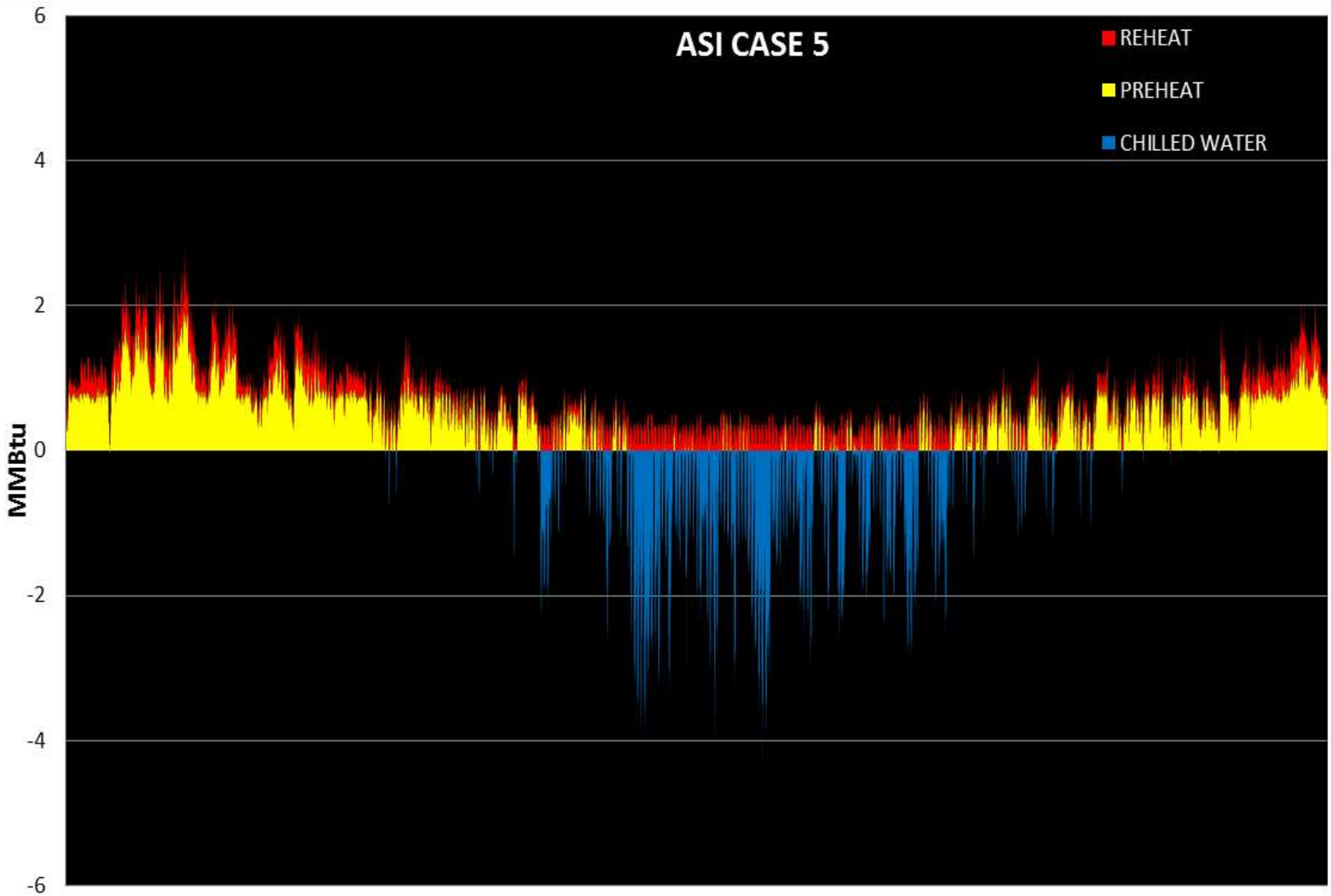


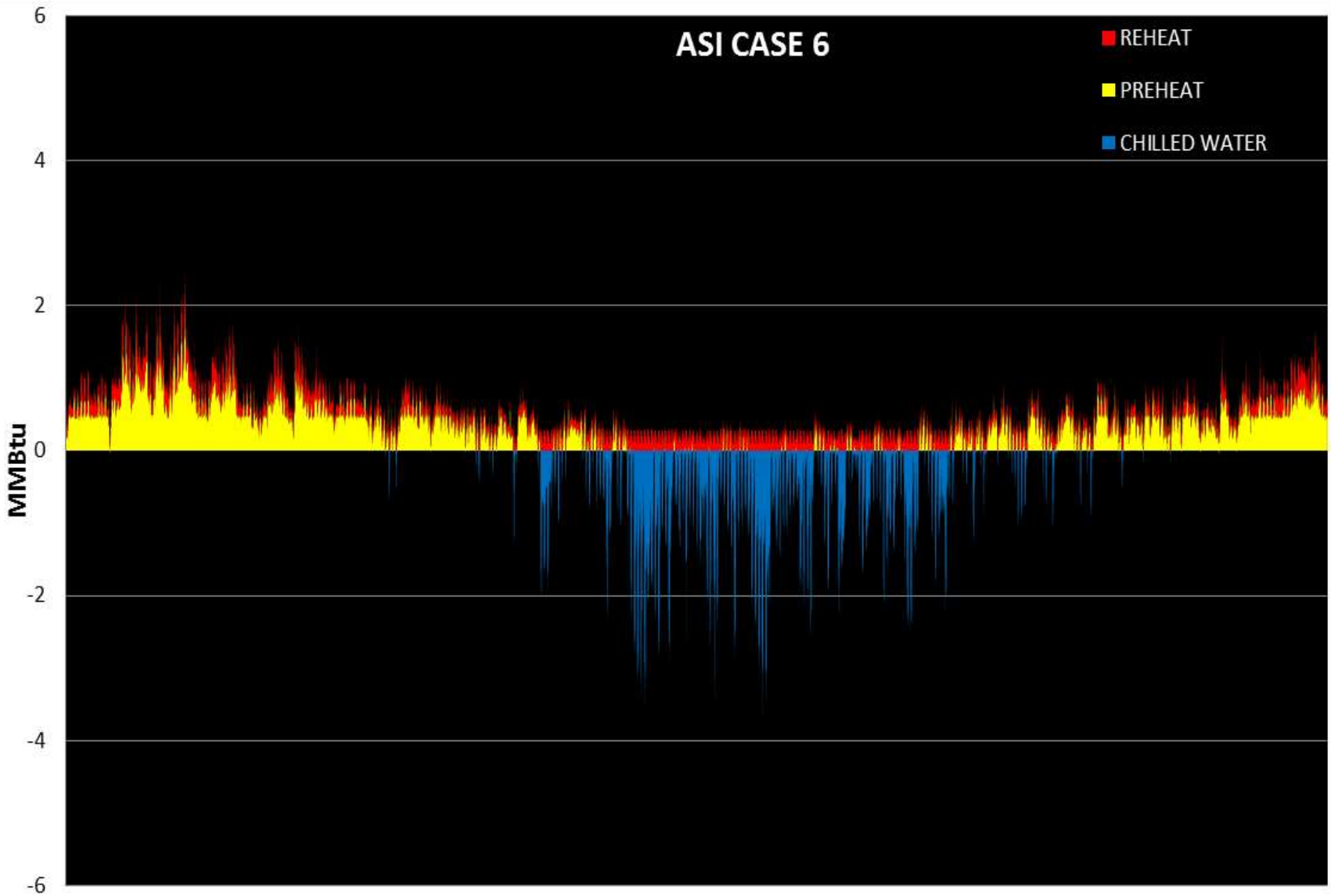

ASI CASE 1
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6

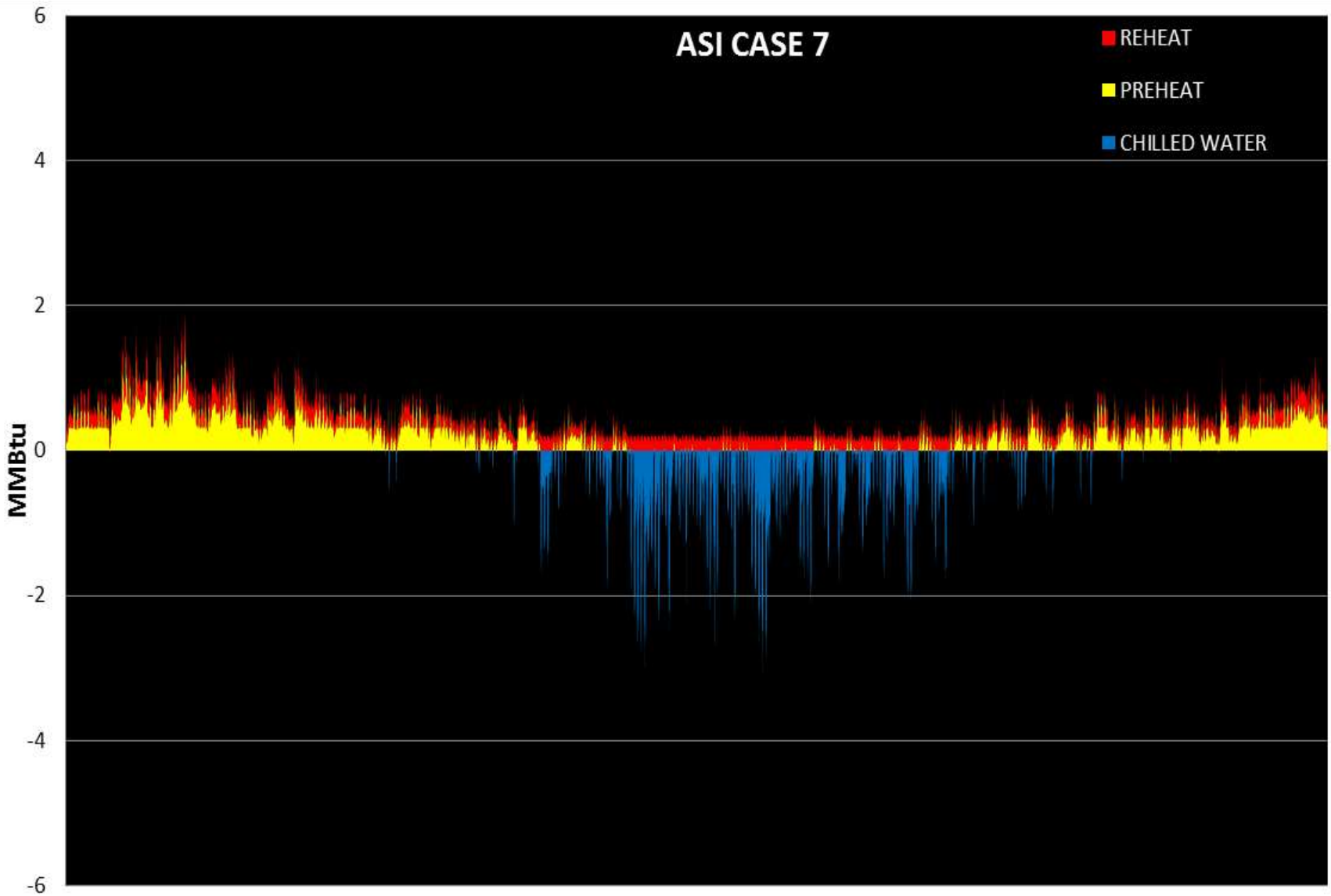

ASI CASE 2
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6


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

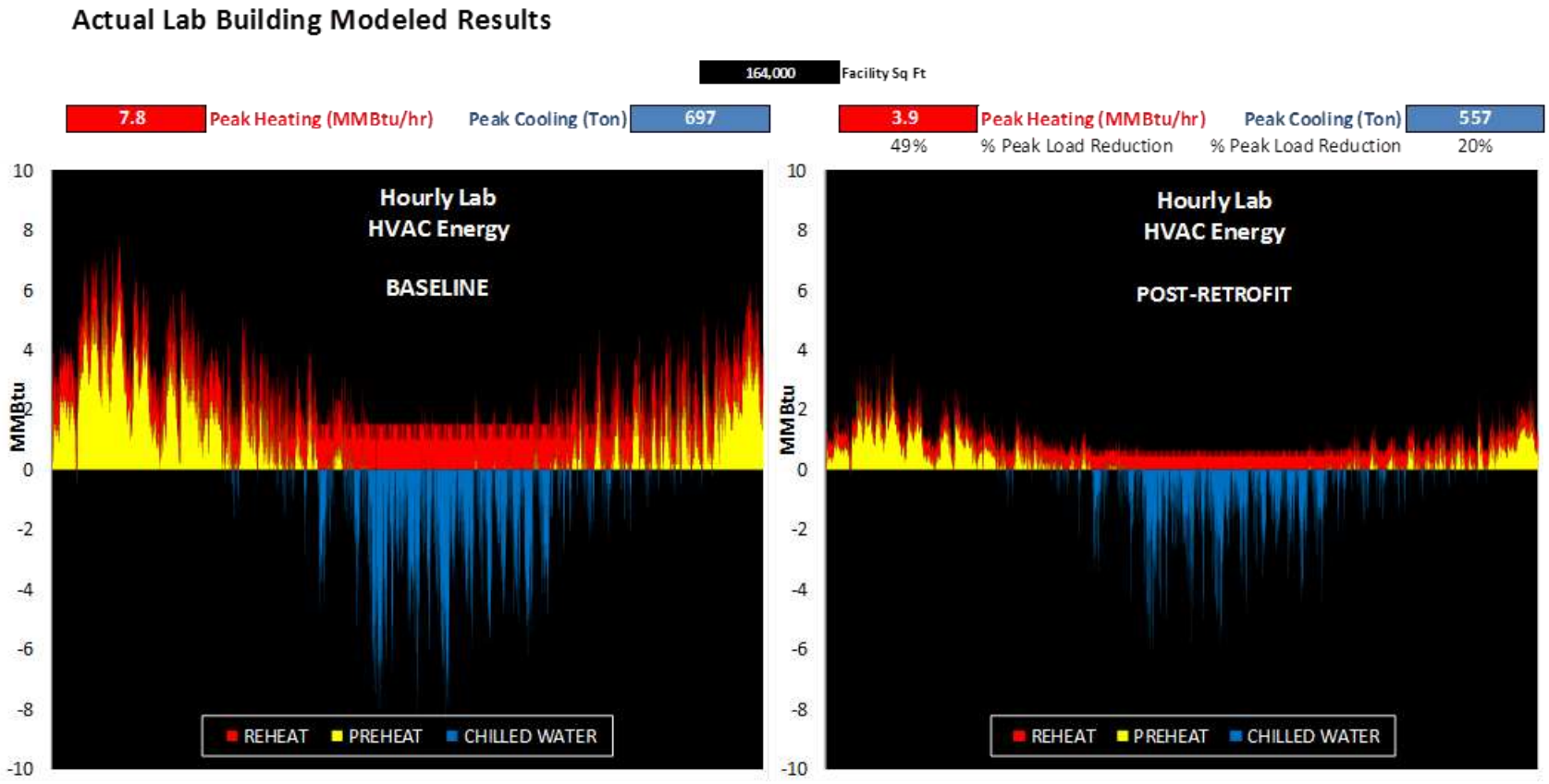

ASI CASE 4
REHEAT
PREHEAT
CHILLED WATER
MMBtu
6
4
2
0
-2
-4
-6


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
MMBtu
6
4
2
0
-2
-4
-6

Before and After



Lab Retrofit Challenges

Lab Retrofit Challenges

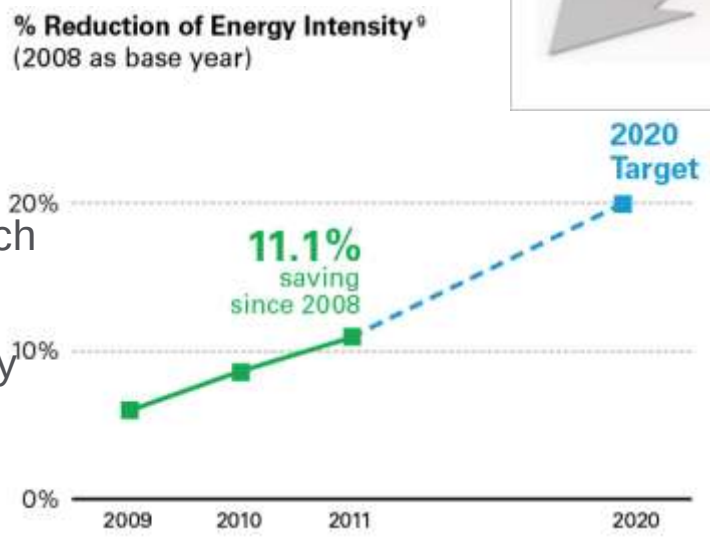
- Life Safety / Industrial Hygiene
- Capturing Room Specific Requirements
  - Functional
  - Operational
  - Usage
- Analyzing value proposition
- Translation to usable utility system impacts
- Execution of the work
  - System shutdowns
  - Lab moves

Use in the Utility Master Planning (UMP) Process

Purpose of a UMP

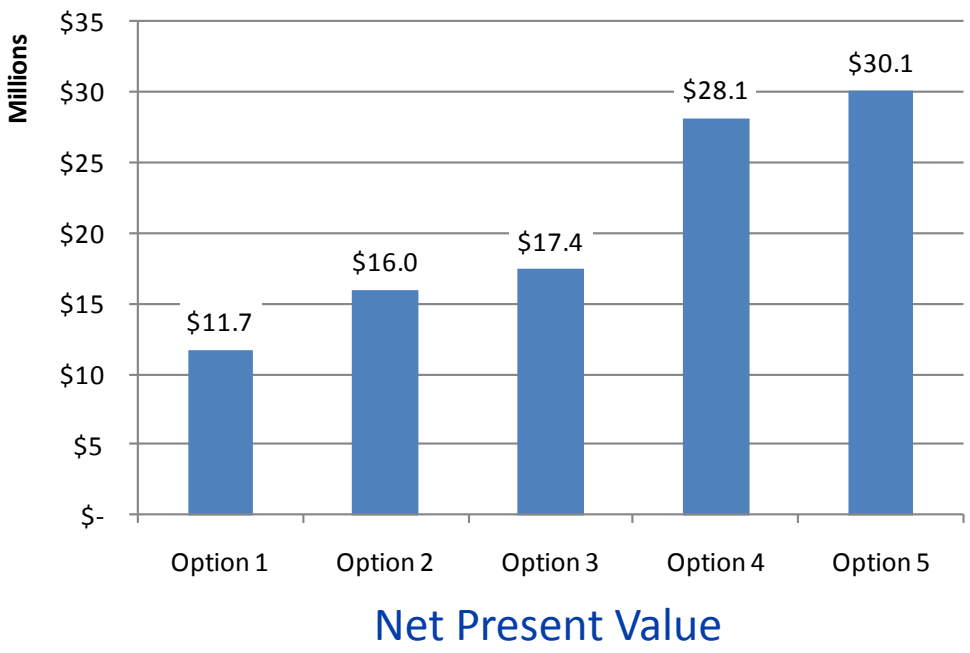
- Define the optimal investment to meet long term needs
  - Historically, interdependence between energy demand and supply was missing
  - Production and Demand models were not integrated

- What can an integrated model provide?
  - Balance peak load reduction with new capacity additions
  - Increase investment efficiency
  - Reduce or eliminate the need to dispatch high marginal cost equipment
  - Reduce overall campus energy intensity



Purdue University

Master planning should include all energy systems across the entire campus



- Options Analyzed
  1. Thermal Energy Storage (TES)
  2. TES & CHP
  3. Demand Side Management (DSM)
  4. DSM & TES
  5. DSM, TES & CHP

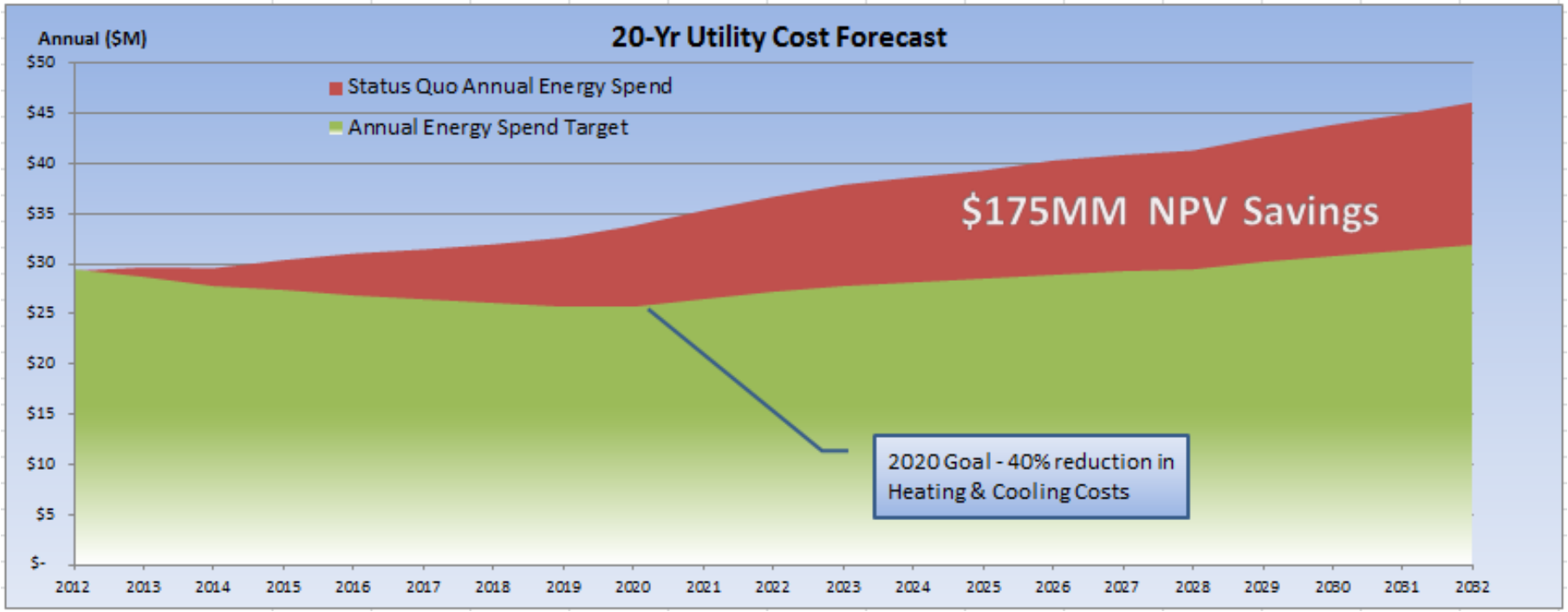
Integrated Plan – Capital Projects Planning

Buildings | Distribution | Production

Project	Actual/ Estimated Construction Cost	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Comprehensive Program Analysis	n/a										
Loop Line Design & Construction	$5.6M										
Lateral Line Design & Construction	$3.0M										
Controls Master Plan Study	n/a										
Utility Metering Design & Construction	$0.6M										
Central Plant & Utilities Master Plan	n/a										
Rec Building Retro-Commissioning	n/a										
Campus CHW Upgrades - Buildings	$1.0M										
Central Utility Plant Upgrades	$9.0M										
Building Retrofits Phase 4A	$2.0M										
Building Retrofits Phase 4B	$2.0M										
Building Retrofits Phase 4C	$2.0M										
Building Retrofits Phase 4D	$2.0M										

Integrated Plan – Campus Wide View

Buildings | Distribution | Production



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BURNS McDONNELL SM

APPENDIX // EXAMPLES

Assignment #2 – Detailed Review of Two Facilities

AHU IR – HTG Coil

Burns & McDonnell
SINCE 1898

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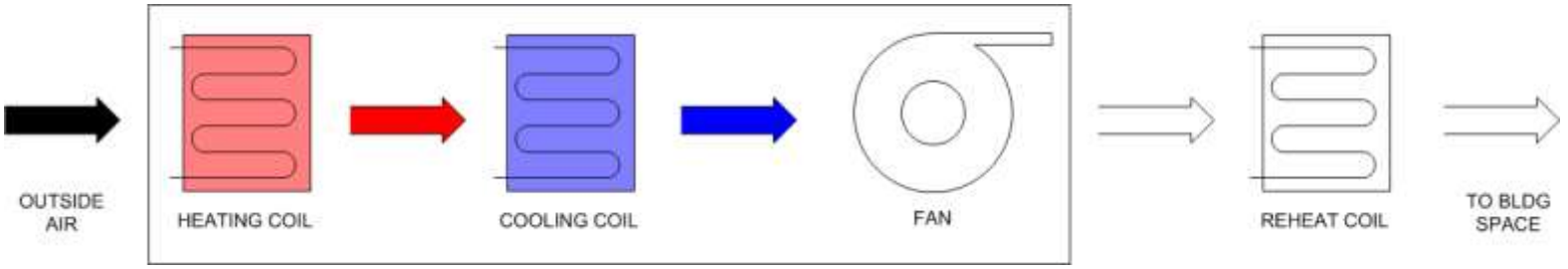

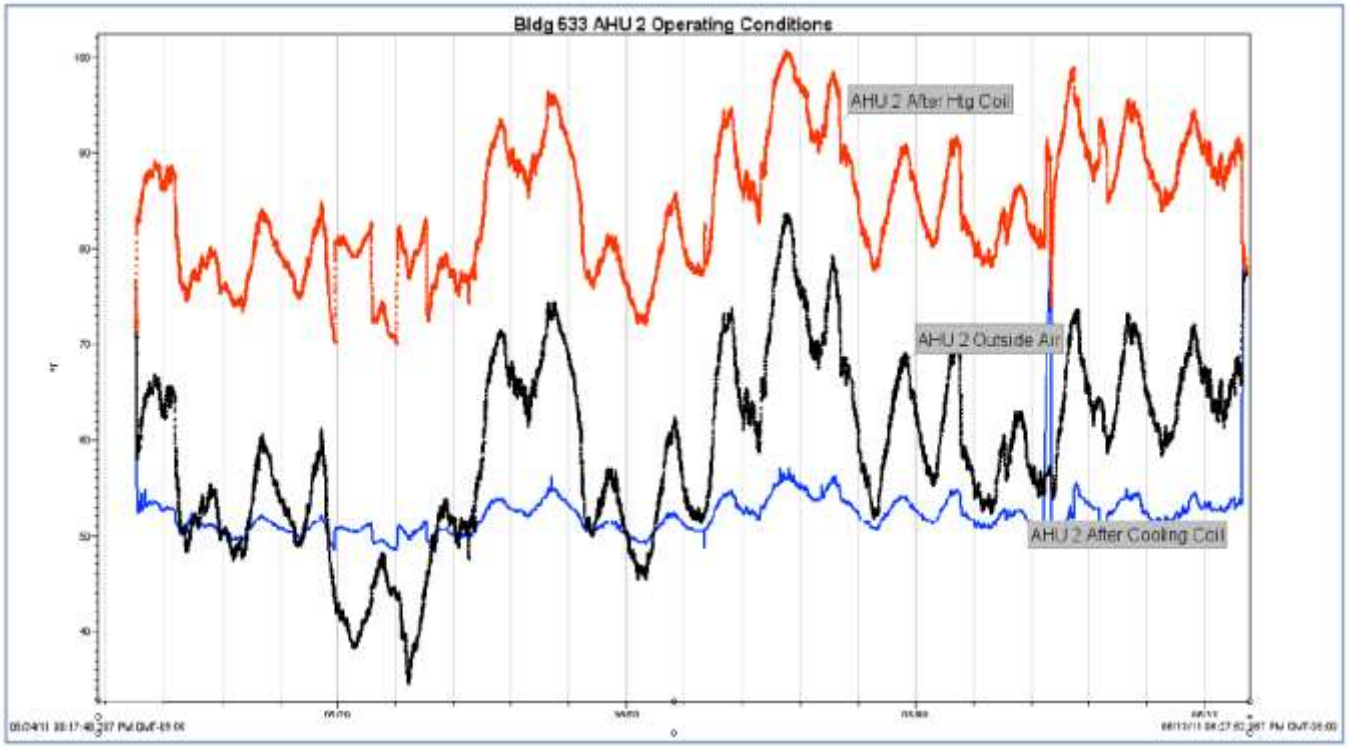

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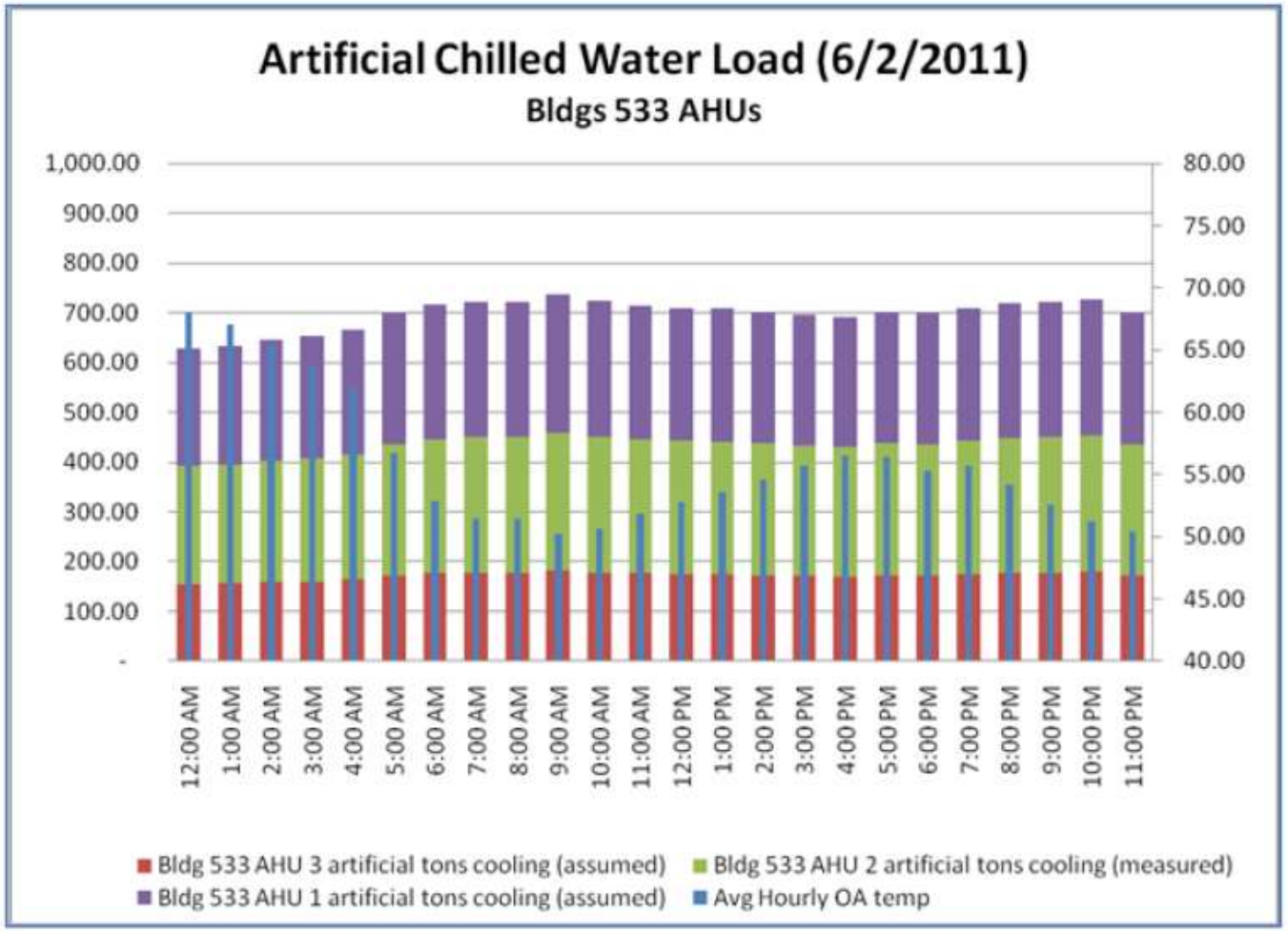

Burns & McDonnell
SINCE 1898