Energy & Store
Development Conference

E+SC 2015

Reducing Utility Consumption
=
A Better Bottom Line

Ian Crookston, CEM, CMVP, P. Eng.

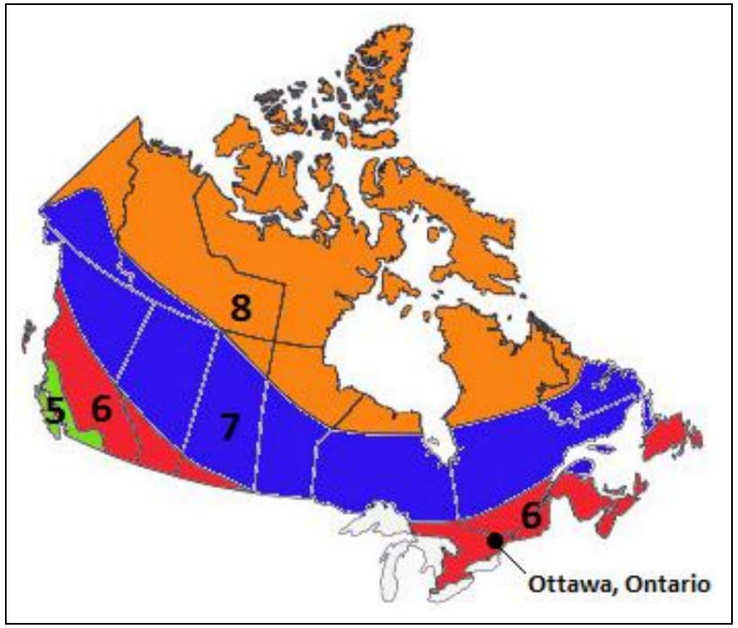
Sobeys Inc.

About Sobeys Inc.

- Established in 1907
- One of Canada's two national grocery retailers
- $21 Billion in annual sales & 125,000 employees and franchise affiliates
- More than 1,500 stores across all 10 provinces, as well as more than 370 retail fuel locations
- Retail banners include Sobeys, Safeway, Thrifty Foods, IGA, Foodland, FreshCo and Lawton's Drugs

Canadian Environment

- **10 Million km² & 36 Million people**
  - 3.4 people/km²
- **ASHRAE Climate Zones**
  - 4 (Vancouver, British Columbia) / 8 (Whitehorse, Yukon Territories)
- **Energy (average cost)**
  - Electricity (at plug): $0.07 to $0.15/kWh
  - Natural Gas (at burner tip): $0.02 to $0.08/kWh ($6 to $23/GJ)



- **CO_2 impact**
  - Electricity: 0.002 (Manitoba) to 0.841 (Alberta) CO_{2e} tonne/kWh → 420:1 ratio
  - Refrigerant: 0.0010 (R744 / CO_2) to 3.3 (R507) CO_{2e} tonne/kg → 3,300:1 ratio
  - Taxes: $0.00/tonne (at present; but significant future risk)
- **Energy usage (Sobeys)**
  - Refrigeration: >60% (we design a refrigeration rich environment)

Cost Saving Vs Cost Avoidance

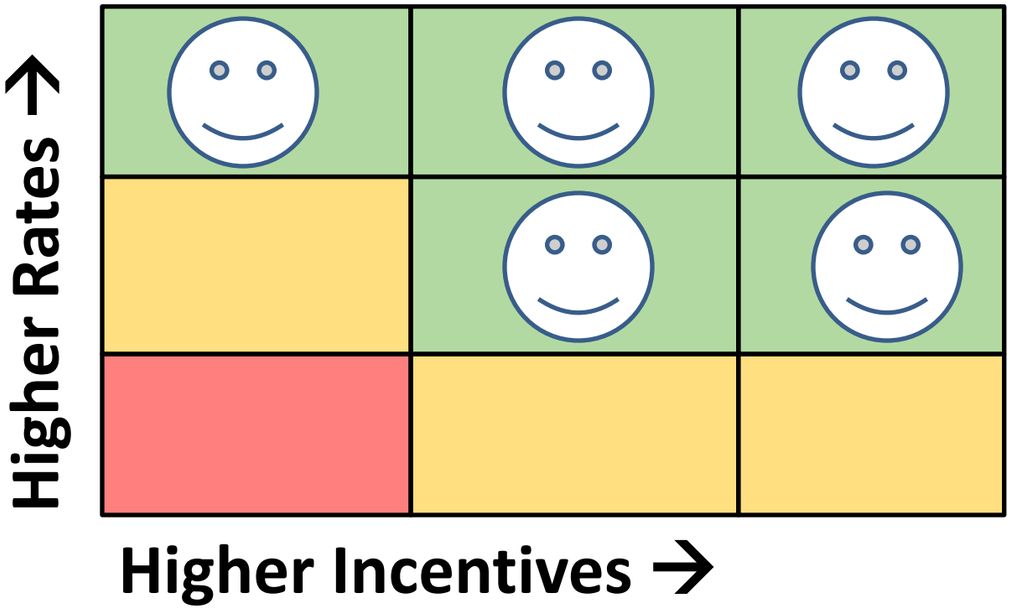
- **Cost Saving: Reduce $/ft²**
  - Not possible if rates ($/kWh) are rising faster than ability to reduce energy intensity (kWh/ft²)
  - Cost Savings ($) = ($/ft²$_{Old}$ – $/ft²$_{New}$)*(ft²$_{New}$)

- **Cost Avoidance: Reduce kWh/ft²**
  - A truer measure of achievement
  - How we track progress for sustainability reporting
  - Cost Avoidance ($) = (kWh/ft²$_{Old}$ – kWh/ft²$_{New}$)*($/kWh$_{New}$) *(ft²$_{New}$)

Energy Conservation

- **Provincial incentives ($/kWh)**
  - Typically reduce Simple Payback by one year
  - One time benefit, which can increase, or decrease
  - Vary by province

- **Rates ($/kWh)**
  - Ongoing cost, which typically only increases
  - Vary by province



Typical Full Service Format Store

- **~50,000 ft²**

- **Electricity**
  - ~$35/hour x 8,760 hours/year = $300,000/year
  - Refrigeration represents ~60% ($180,000)

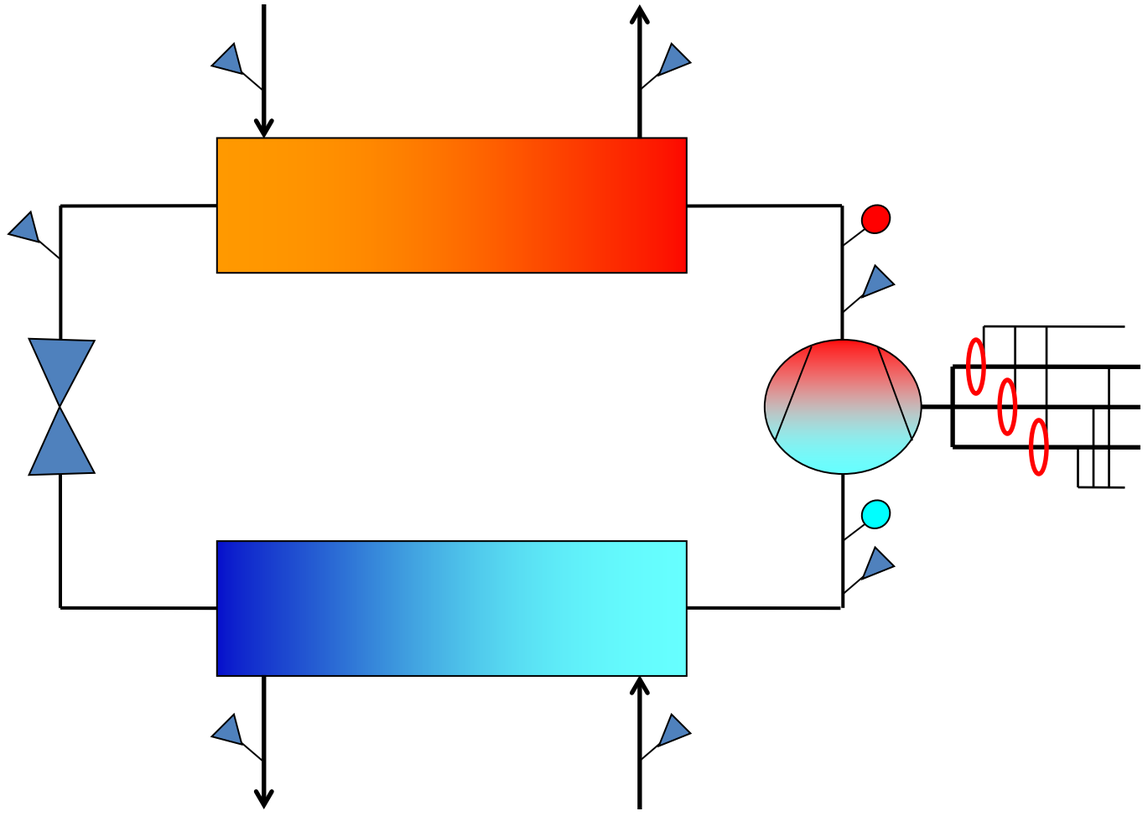
- **Centralized refrigeration racks**
  - Medium temperature: 5 to 7 compressors
  - Low temperature: 5 to 7 compressors

What Did We Do?

- **Picked a test site**
  - Southern Ontario
  - 42,000 ft^2
  - Built: 1991
- **Contacted Local Distribution Company (LDC)**
  - SaveONenergy incentives
- **Baseline existing system**
- **Developed series of projects**
  - Project #1: Existing Building Commissioning
  - Project #2: Adiabatic cooling (condenser misting)
  - Project #3: Variable flow compressors

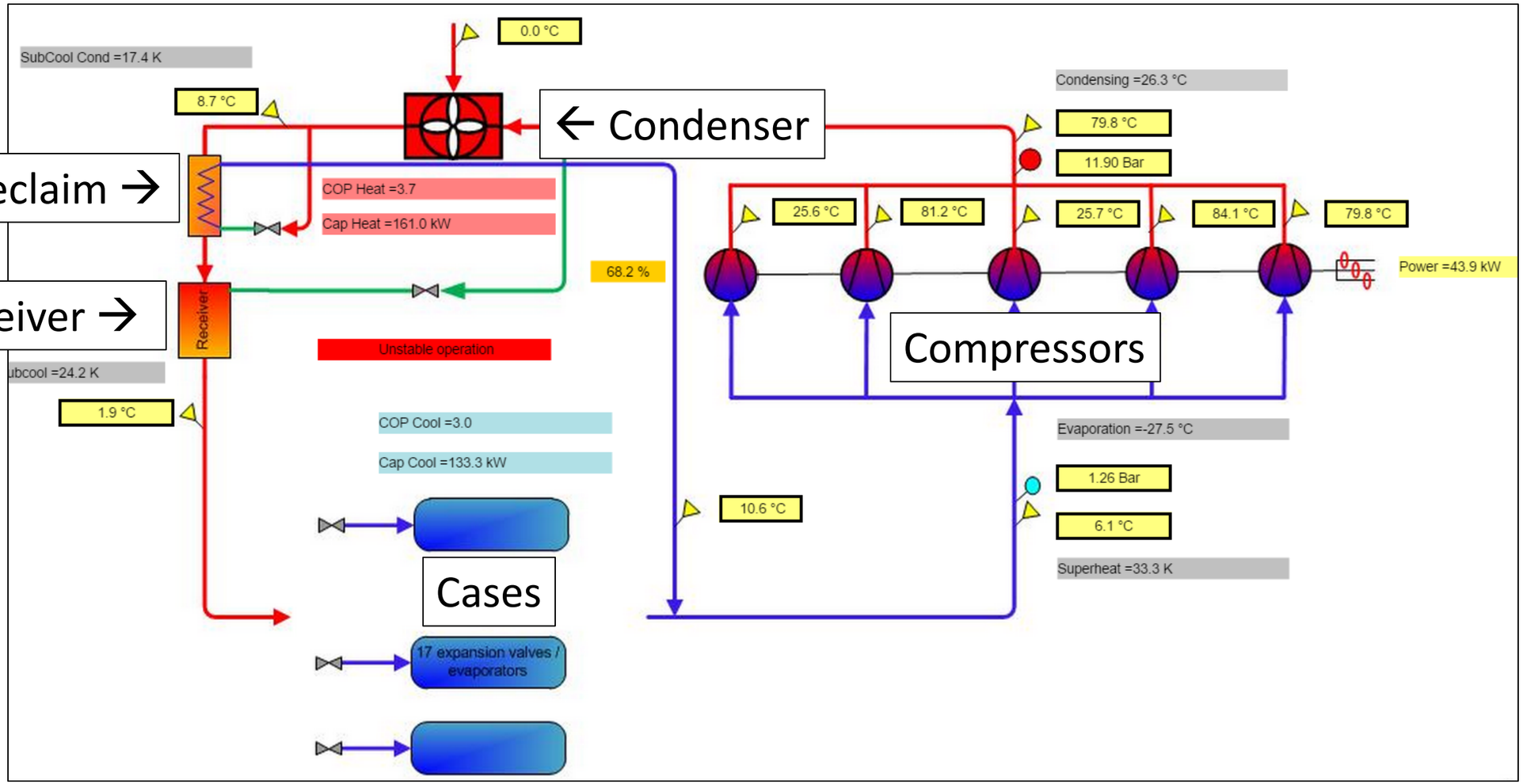
Thermodynamic Model

- **Thermodynamic evaluation = Unbiased system view**
  - ➢ No information about external loads, compressors, etc.
    - Electrical sub-metering, temperatures and pressures



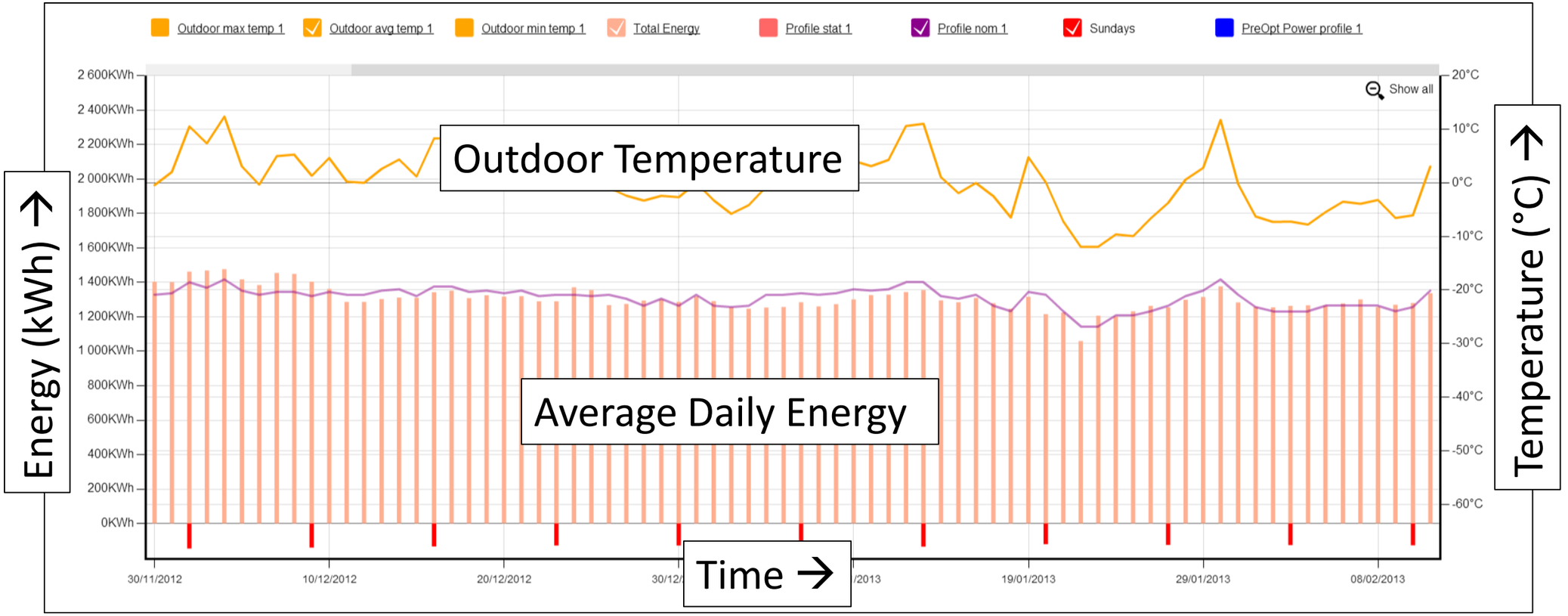
- 2 pressure sensors
- 7 temperature sensors
- 1 power meter

System Specific Flowchart



Baseline Existing System

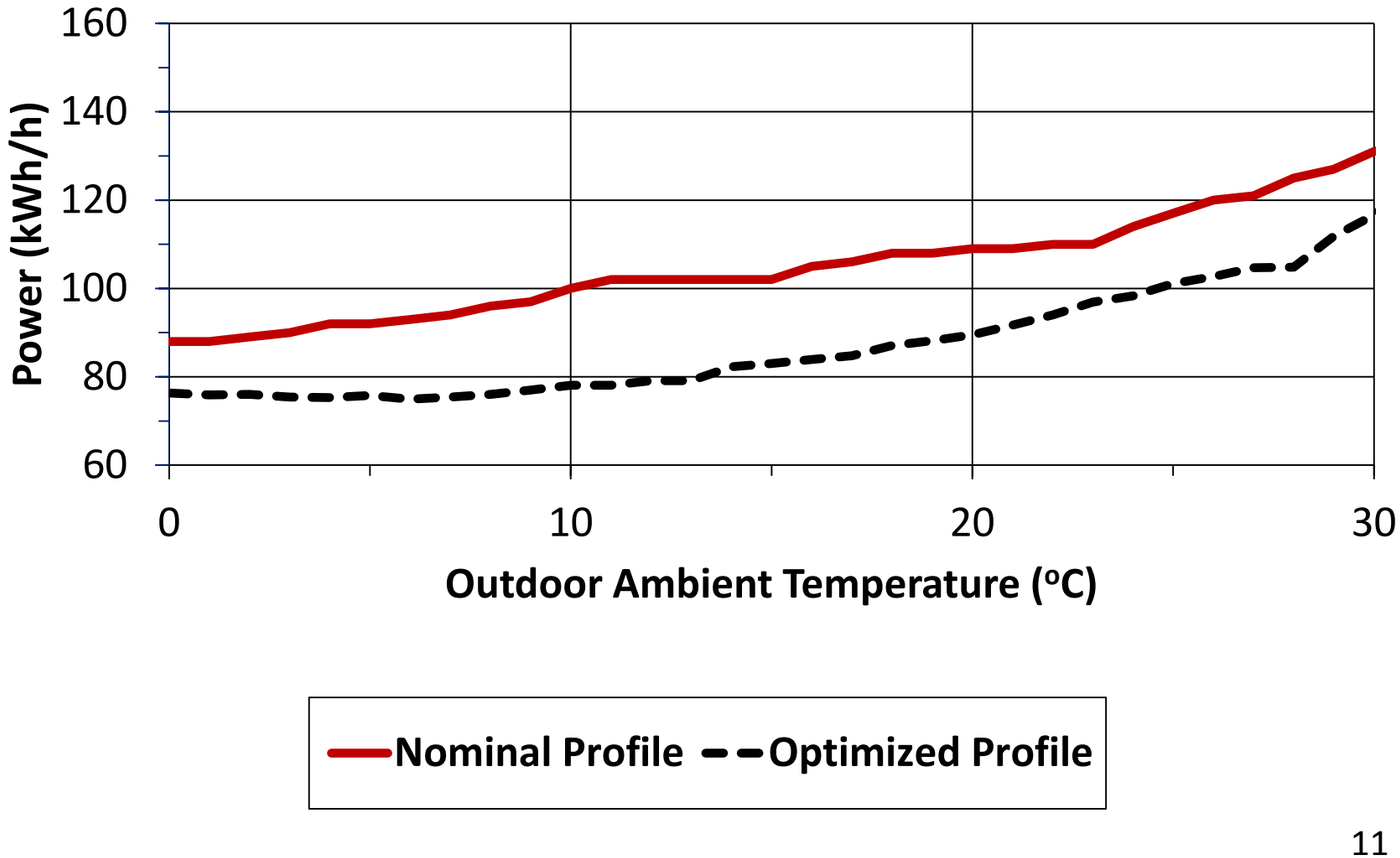
- **Performance monitoring and analyzing system**
  - ➢ Real time data logging
    - Electrical sub-metering, temperatures and pressures at one minute intervals



Power Profile – Measurement & Verification Tool

- **Power Profile**
  - Average kWh at each Outdoor Ambient Temperature (OAT)
  - Averaged over one hour
  - Averaged by additional data points

- **Measurement & Verification (M&V)**
  - Pre and post project Power Profile (kW/°C)
  - Bin Temperature data (°C hours)
  - kWh/year savings

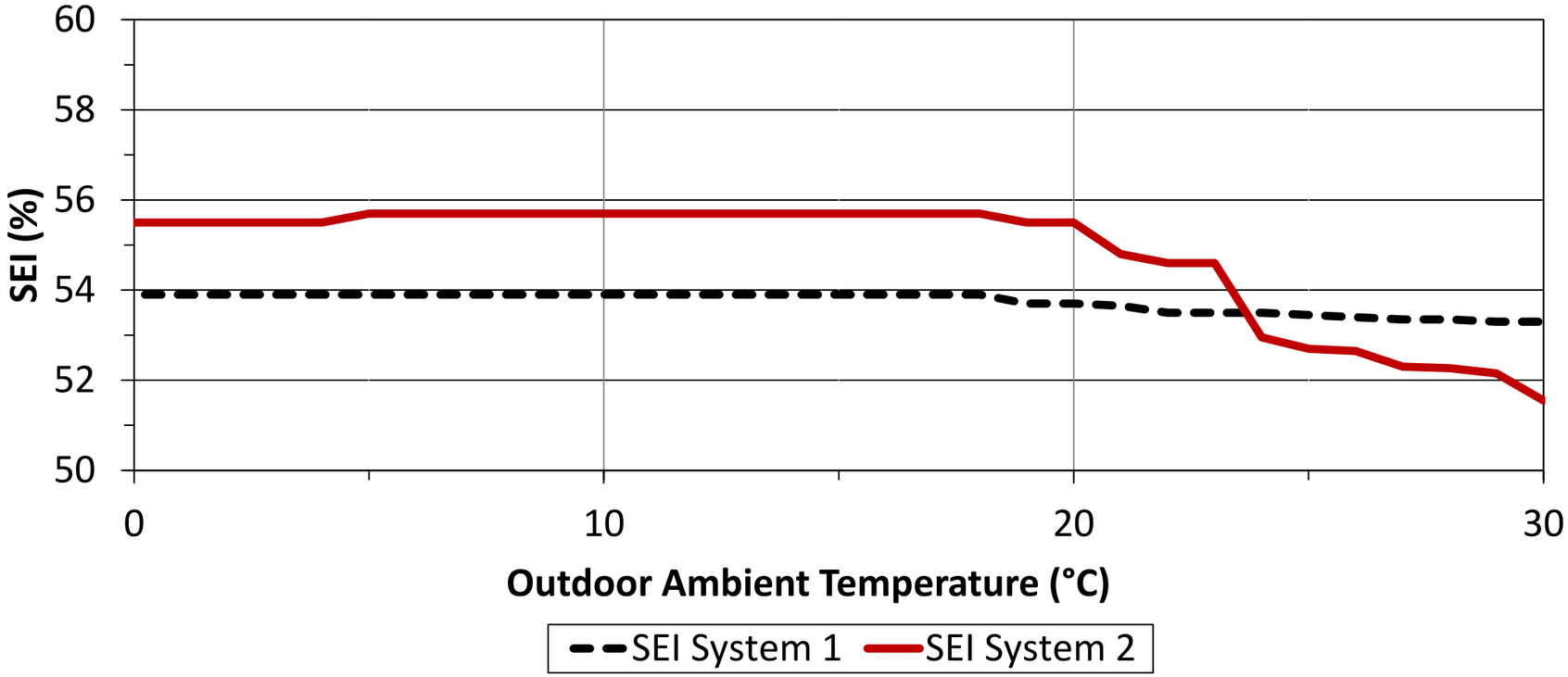


System Efficiency Index (SEI)

- **Normalized unit of absolute efficiency**
- **Introduced by VDMA (Germany) and IOR (UK)**
- **100% SEI: System operating at ideal theoretical efficiency (Carnot Cycle)**
- **Independent of operating conditions**
  - Coefficient of Performance (COP), Energy Efficiency Ratio (EER), Etc. based on design/standard conditions
    - Saturated Suction Temperature
    - Condensing Temperature
- **Evaluation of sub-system performance**
  - Compressor (Isentropic efficiency)
  - Evaporator
  - Condenser
  - Auxiliary loads

System Efficiency Index (SEI)

- **SEI independent of outdoor ambient temperature**
  - Should be consistent across wide range of temperatures
  - Changes Vs temperature represent issues with sub-system performance
    - Doesn't always show up on the Power Profile
  - Differences between systems represent overall efficiency differences

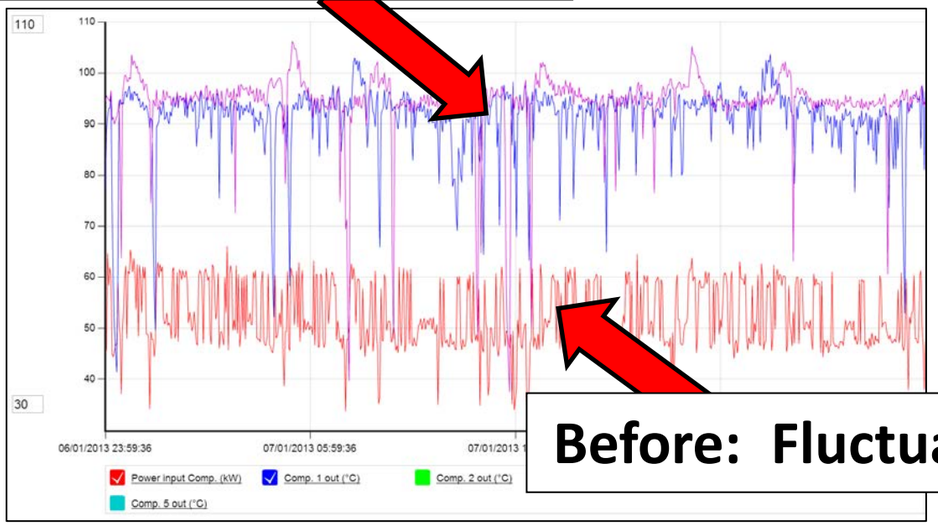


Project #1: Existing Building Commissioning (EBCx)

- **Low / No cost optimization**
- **Opportunities based on reviewing baseline data**
  - Setpoints
  - Sequencing
  - Condenser fan control

Project #1: Before & After

Before: Short cycling

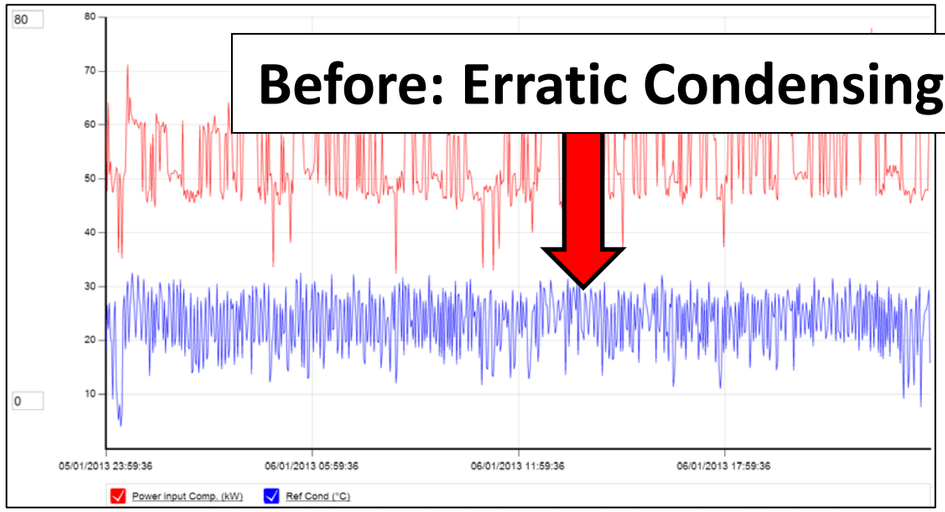


Before: Fluctuating Power

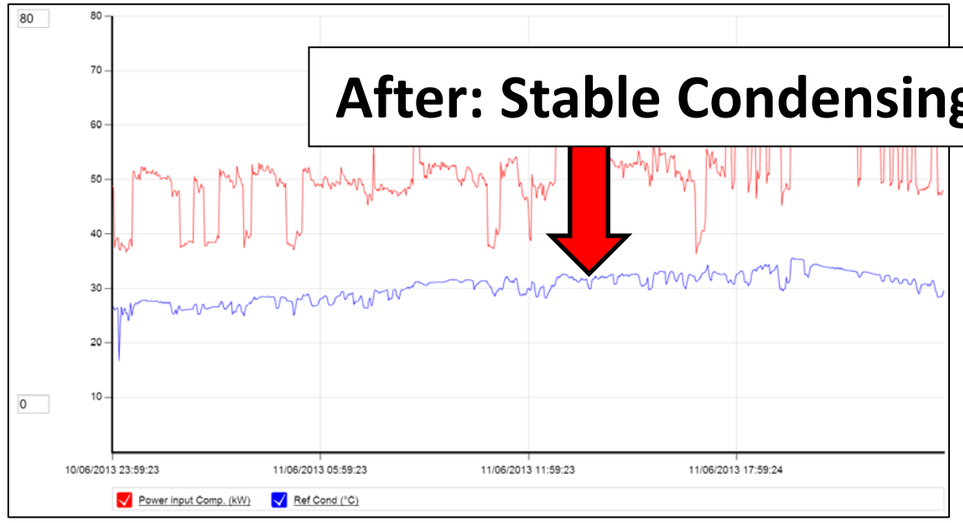
After: Reduced Cycling

After: Stable Power

Before: Erratic Condensing

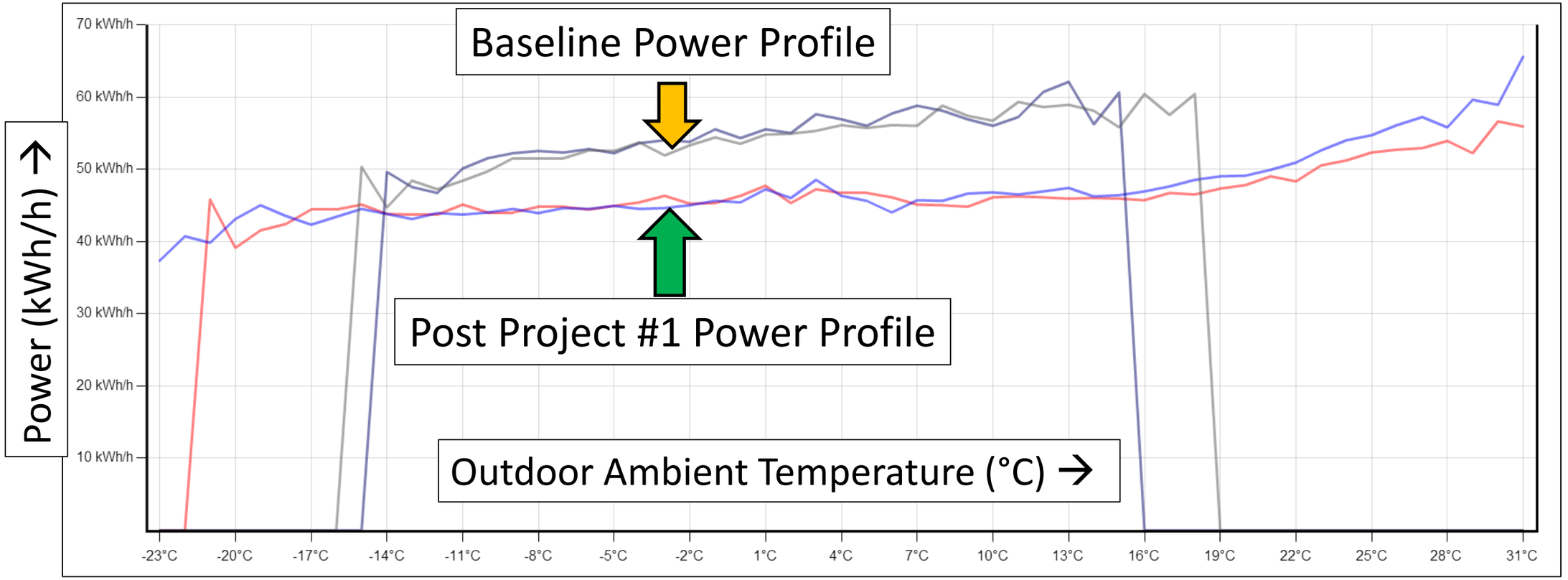


After: Stable Condensing



Project #1: Extended Energy Data

- **Existing Building Commissioning complete March 2014**
  - Annual Savings: 173,000 kWh/year
  - Simple Payback (after incentives): 1.2 years



Project #2: Adiabatic Cooling

- **Many air cooled condensers are marginally sized when new**
- **20 year old condenser often ~20% degraded from new**
- **Garden sprinkler often used to wet condenser on hot days**
  - Evaporative cooling: dry bulb versus wet bulb temperature
- **Key issues**
  - Uneven condensing due to uneven wet/dry area
  - Excessive water usage
- **Solution**
  - Install “misting” system
    - Even condensing
    - Significant reduction in water usage

Project #2: Existing Sprinkler

Project #2: New Misting

- Nozzles installed under the condenser
- Water is forced into a fine mist and quickly evaporates
- Air temperature drops from dry bulb to wet bulb

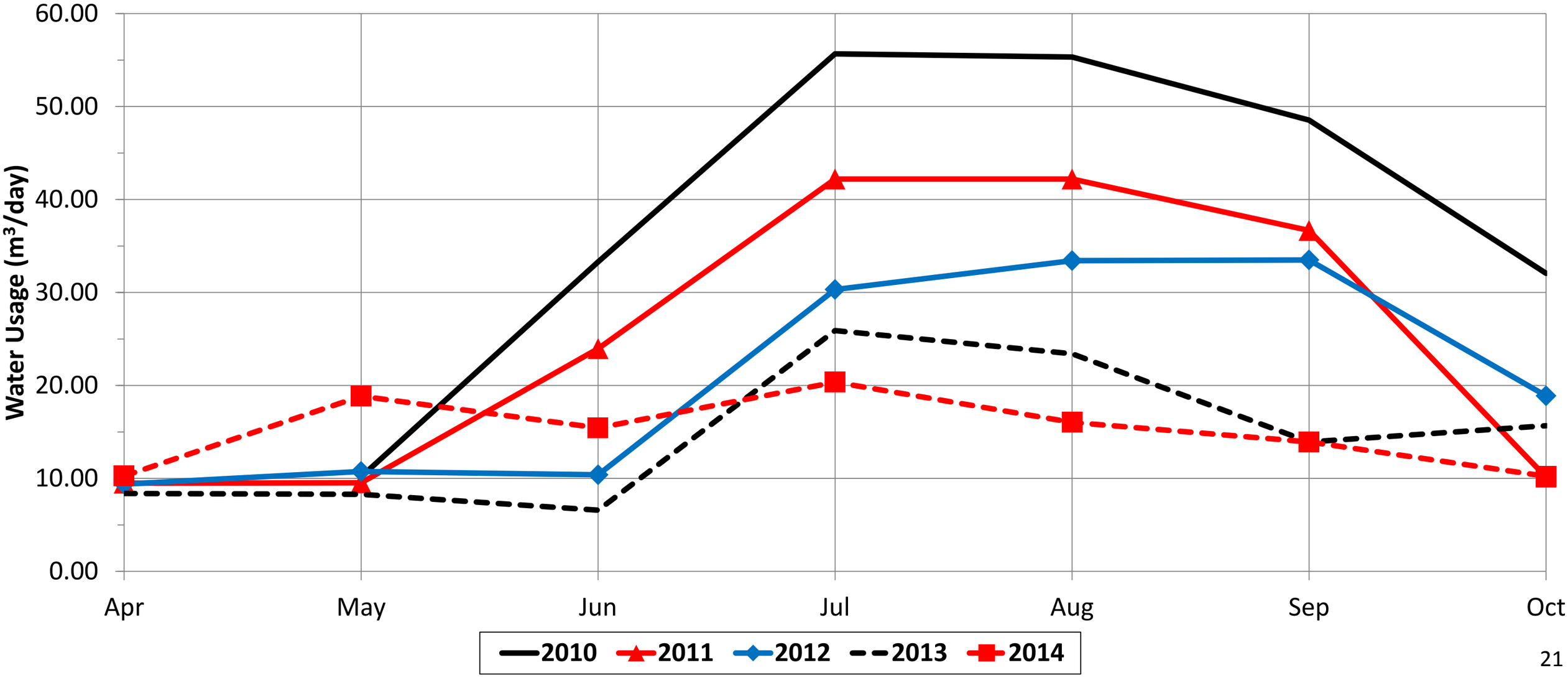
Project #2: Utility Savings

- **Sprinklers operate from June to September**
- **Electricity and water / sewage charge savings**
- **2,500m^3 = Olympic swimming pool of water**

Table 2: Pre and Post Implementation Values

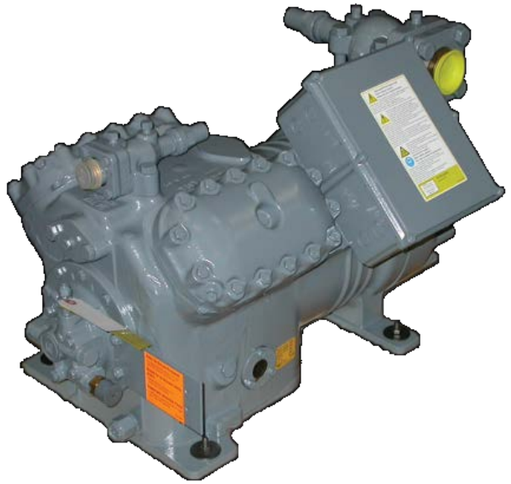
Utility	**Pre-Implementation†** **Previous 3 year average**	**Post-Implementation†** **2 year average**	**Savings**	**Annual Savings ($)**
Water (Annual Data)	5,618 m^3	2,879 m3	***2,739 m^3***	***$5,800.00***
Electricity (Weekly Data)	17,684 kWh	15,997 kWh	***1,687kWh/week*** ***25,305kWh/year***	***$2,500.00***

Project #2: Water Savings



Project #3: Variable Flow Compressor

- **Project #3: Variable flow compressor**
  - Both existing Refrigeration Racks had one weak Compressor
  - Opportunity to upgrade from Constant Flow to Variable Flow Compressor
    - Variable Flow Compressors allow for better load control



Energy Efficient Replacement

Project #3: Pre and Post Energy Data

TABLE 5: PRE- IMPLEMENTATION PERIOD

System	Pre-Implementation Period Energy Consumption*	Pre- Implementation Yearly kWh Consumption Estimate	Pre- Implementation Peak kW Demand
LT Rack	263,330	433,441	**64.5**
MT Rack	181,330	343,274	**62.6**
Total	444,660	776,715	

*Pre-Optimization Period is September 1st 2013 to April 22nd 2014 (223 days)

TABLE 6: POST- IMPLIMENTATION PERIOD

System	Post- Implementation Period Energy Consumption*	Post- Implementation Yearly kWh Consumption Estimate	Post- Implementation Peak kW Demand
LT Rack	74,988	386,051	**62.6**
MT Rack	55,344	267,699	**59.6**
Total	130,332	653,750	

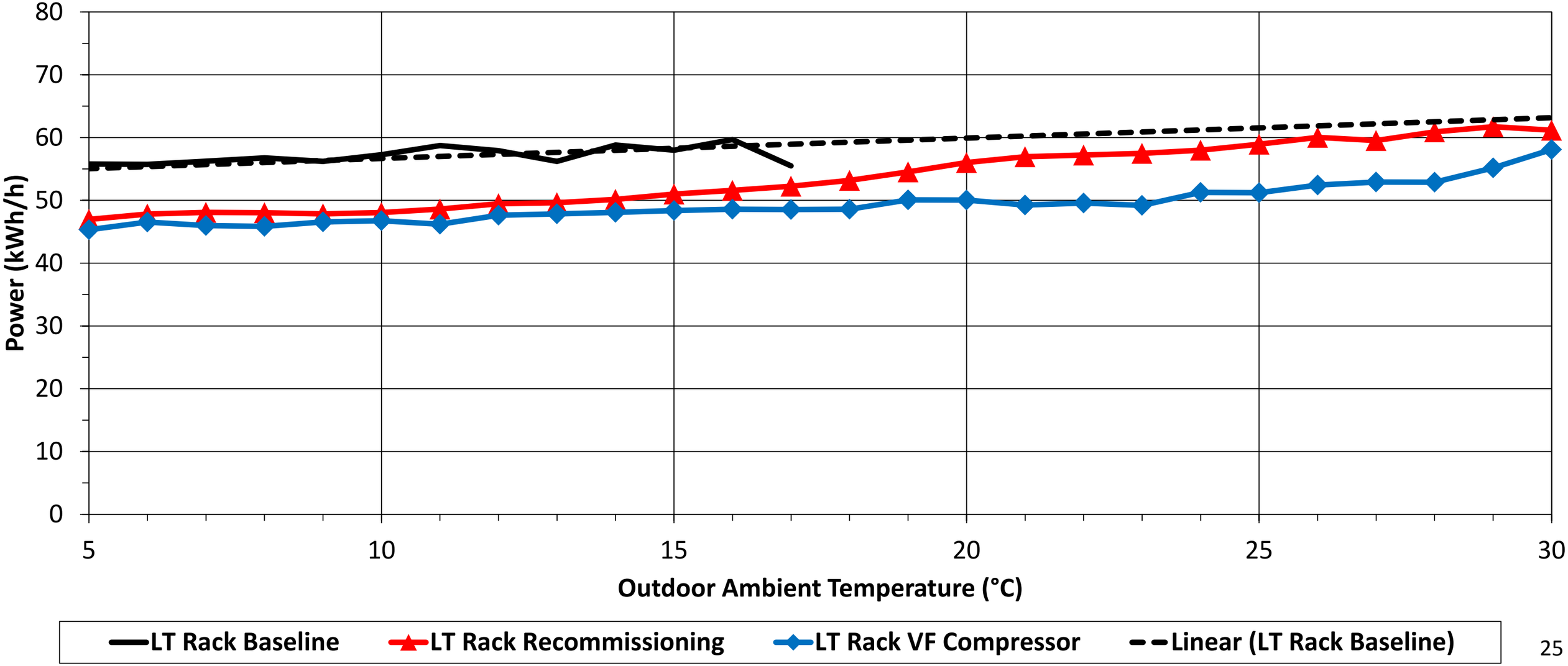
*Post Optimization Period is April 23rd 2014 to June 30th 2014 (69 days)

Project #3: Business Case

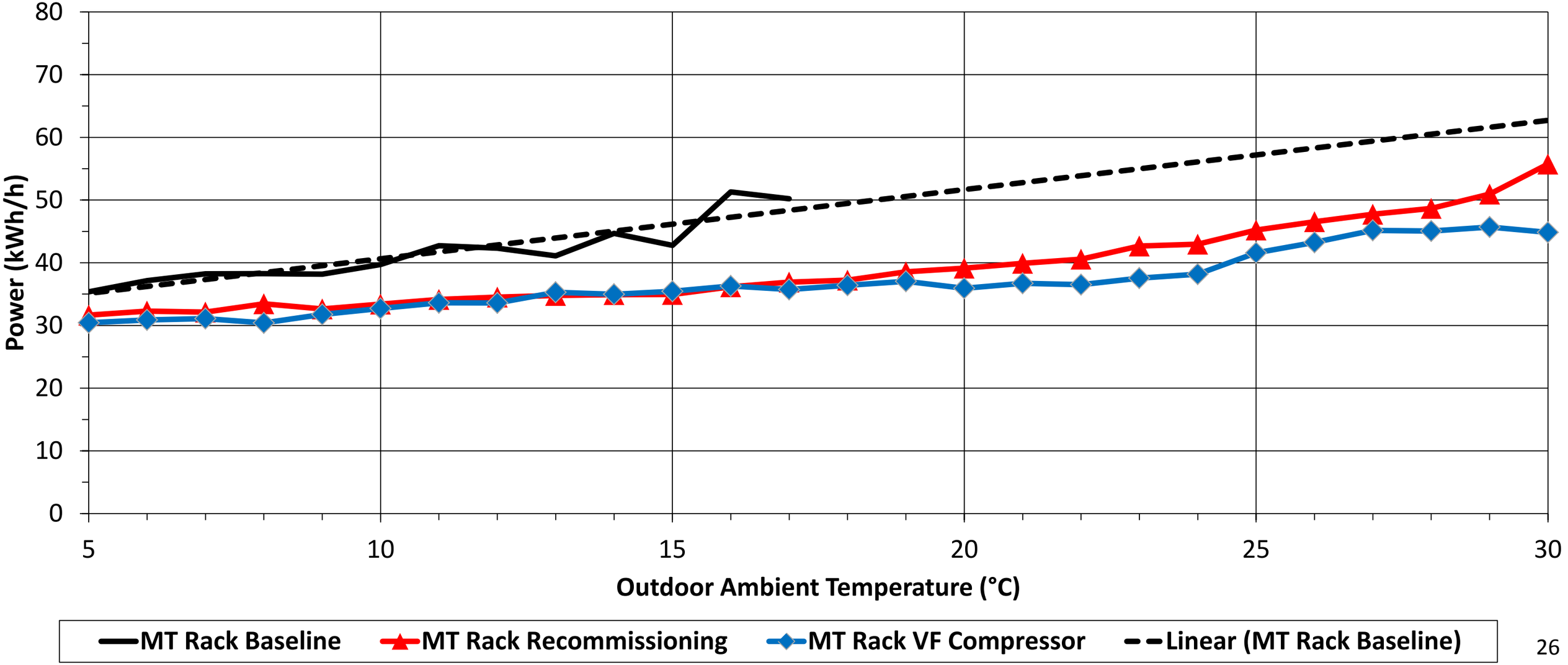
TABLE 14: SUMMARY OF SIMPLE PROJECT COSTS, OPA INCENTIVES, ANNUAL OPERATIONAL SAVINGS AND SIMPLE PAYBACK CALCULATIONS

Total Project Cost	$ 14,100
OPA Incentives (Max 50% of costs)	$ 7,050
Net Project Cost	$ 7,050
Estimated Annual savings	$ 12,740
Simple payback with Incentives	**0.6 years**
Simple payback without Incentives	**1.1 years**

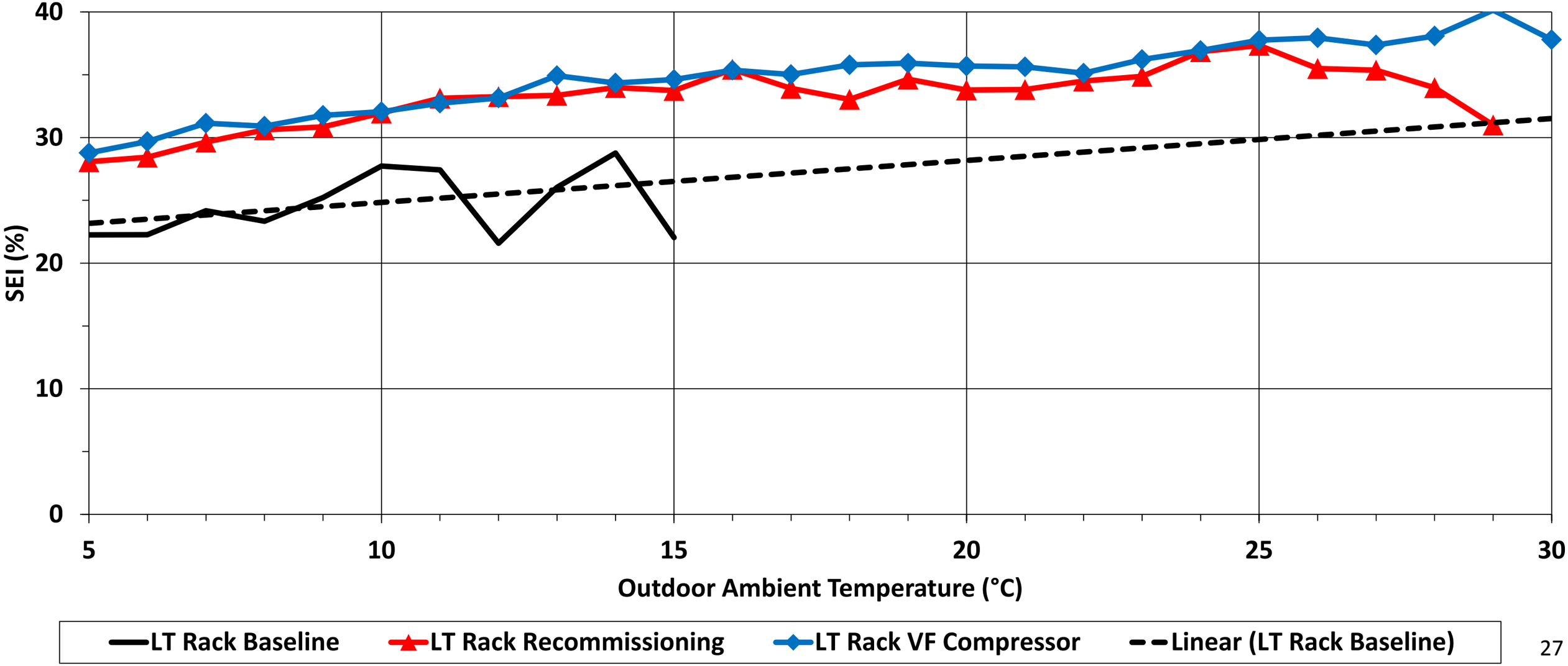
Power Profile: LT System (Baseline, Post Project #1 & 3)



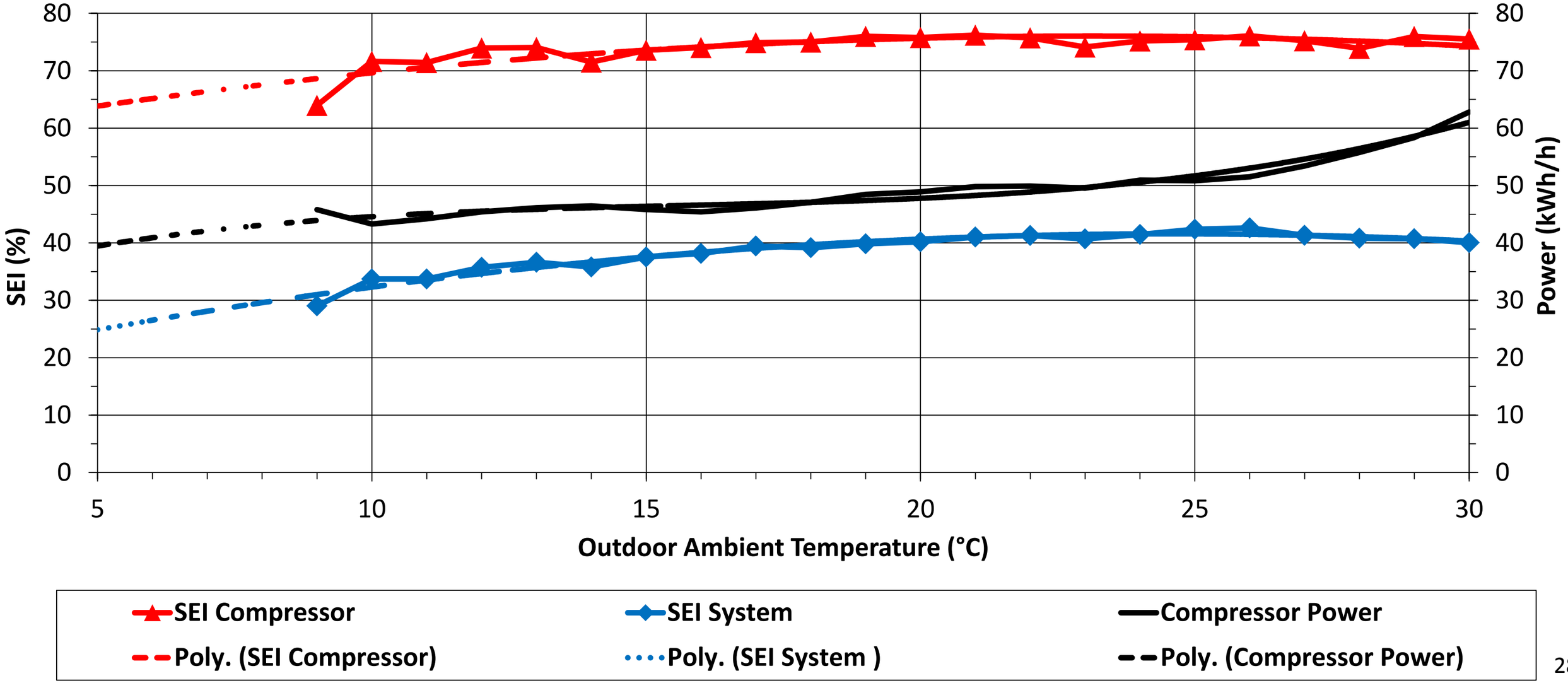
Power Profile: MT System (Baseline, Post Project #1 & 3)



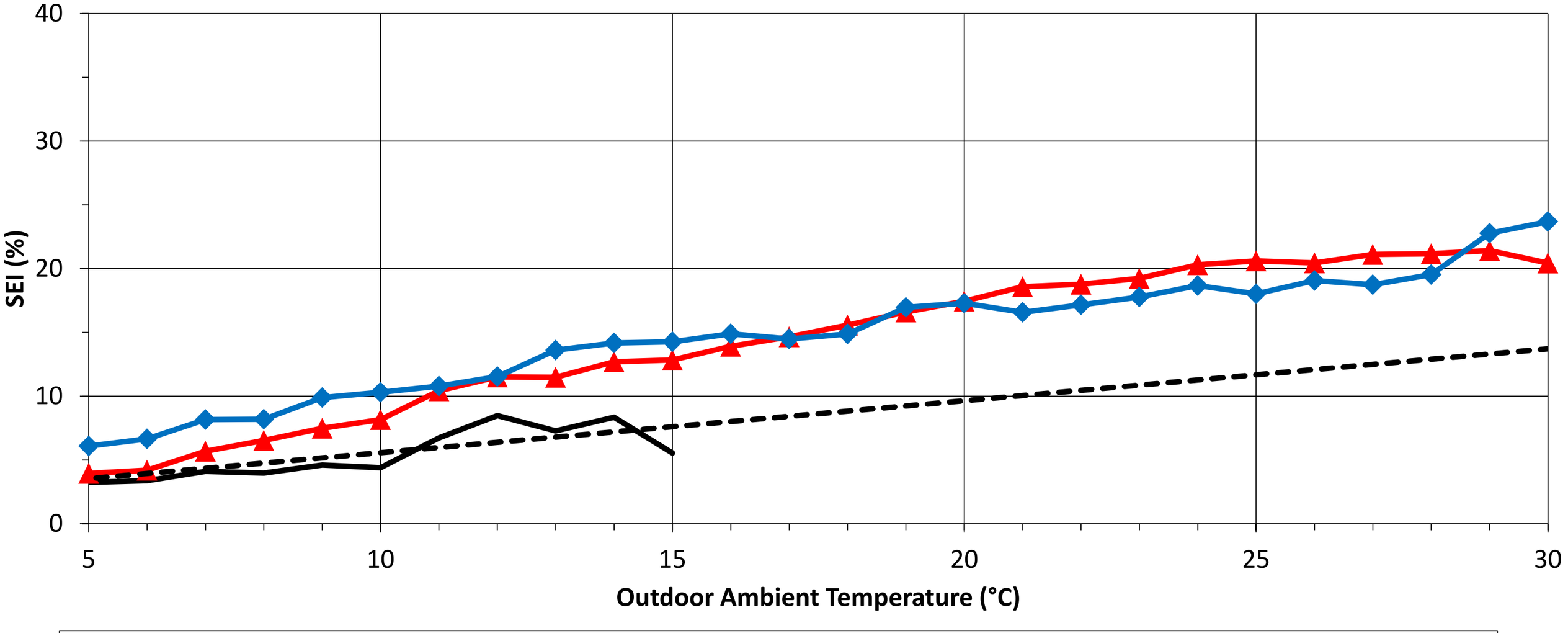
SEI: LT System (Baseline & Post Project #1 & 3)



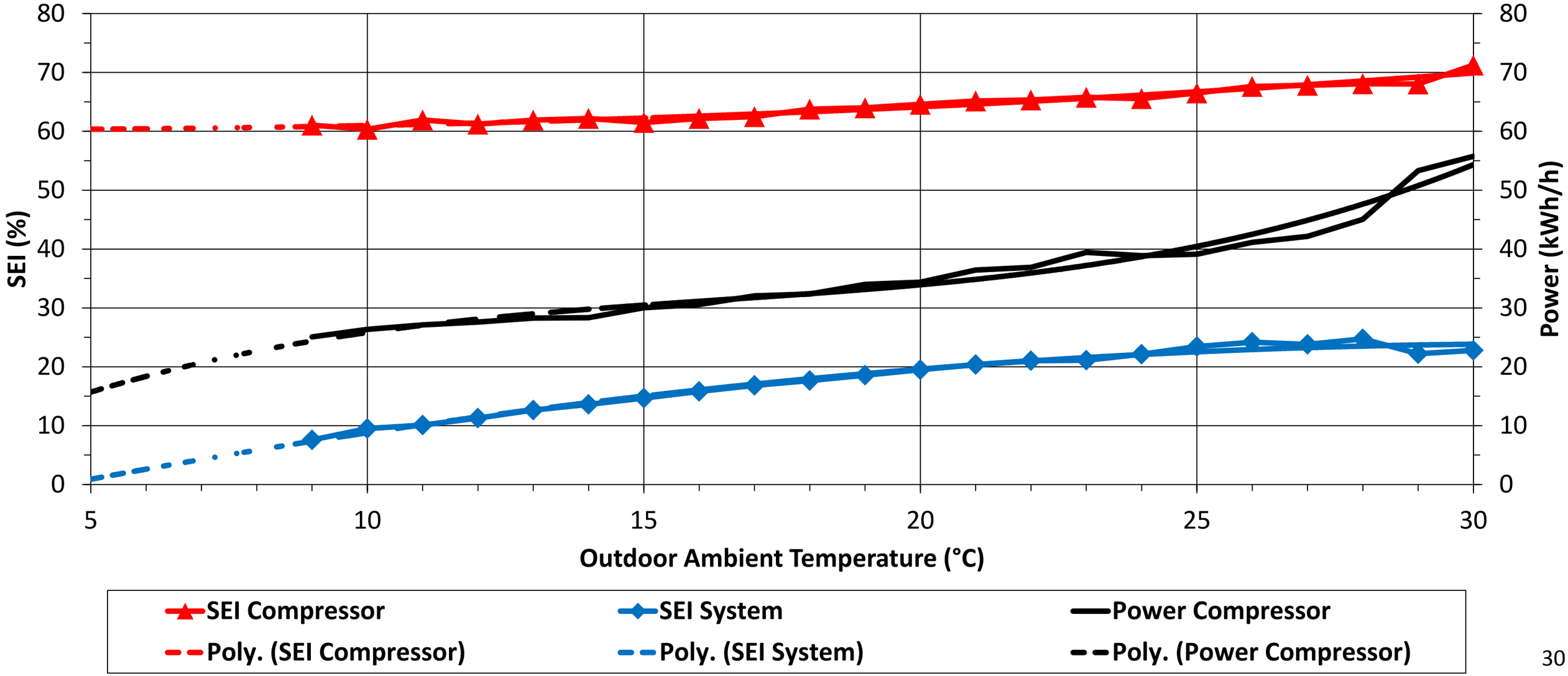
SEI: LT Sub-Systems (Post Project #3)



SEI: MT System (Baseline & Post Project #1 & 3)

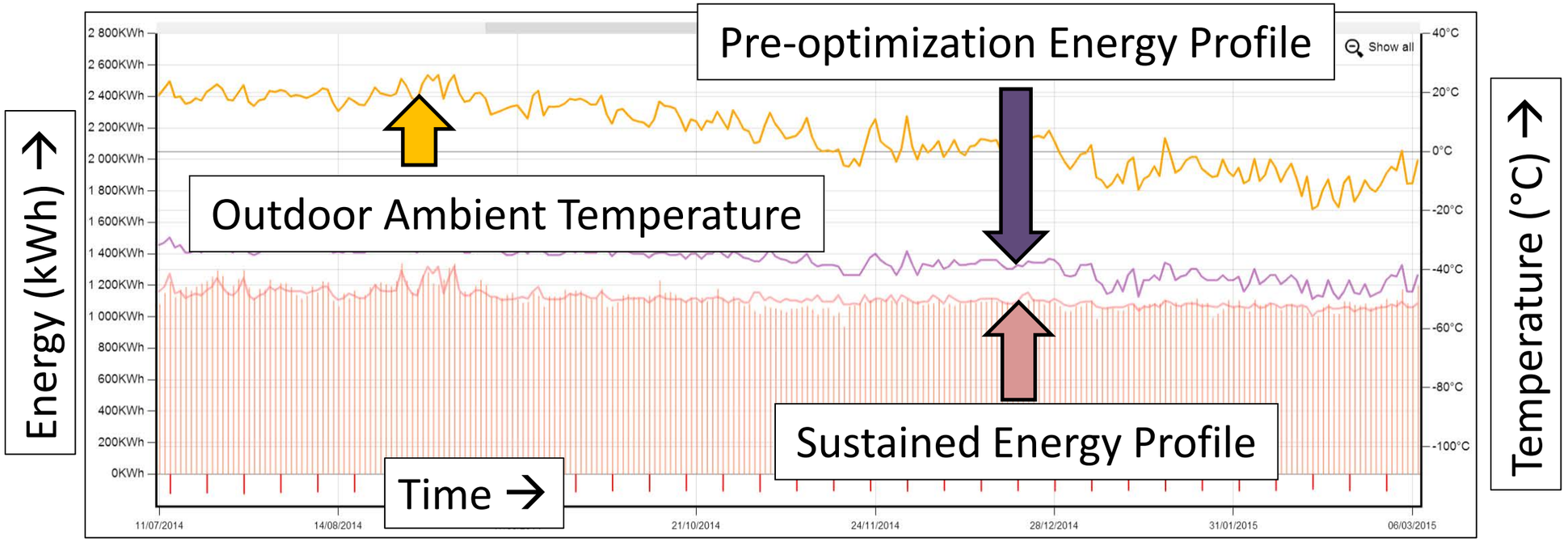


SEI: MT Sub-Systems (Post Project #3)



Sustained Savings

- **No degradation in energy use over 18 months**
  - System issues identified through monitoring energy change are corrected:
    - Helps prevent catastrophic shut-down
    - Reduces Store Based Alarms (down ~66%)
    - Sustains cost savings



Opportunities

- **Enclosing medium temperature multi-deck cases**
  - ~$100/year/linear foot savings
  - New construction: first cost neutral
  - Replacements: <5 year simple payback (>20% ROI)

- **100% LED Vs Linear Fluorescent Lighting**
  - New construction: <4 year simple payback (>25% ROI)
  - Replacement: <6 year simple payback (>15% ROI)

- **Replacing Primary Roof Top Unit (RTU) > 15 years old**
  - <4 year simple payback (>25% ROI)

Questions?

Thank You