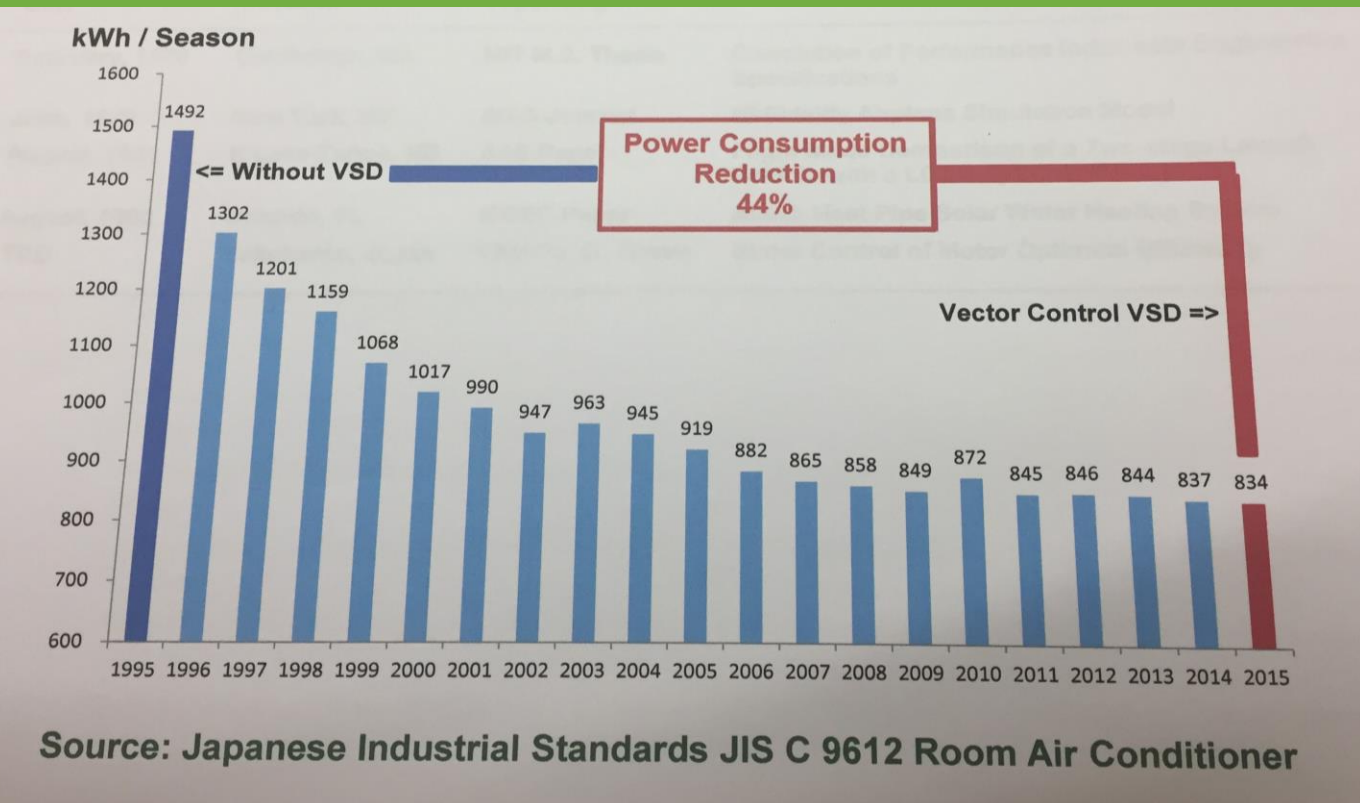


Advanced Air Source Heat Pumps

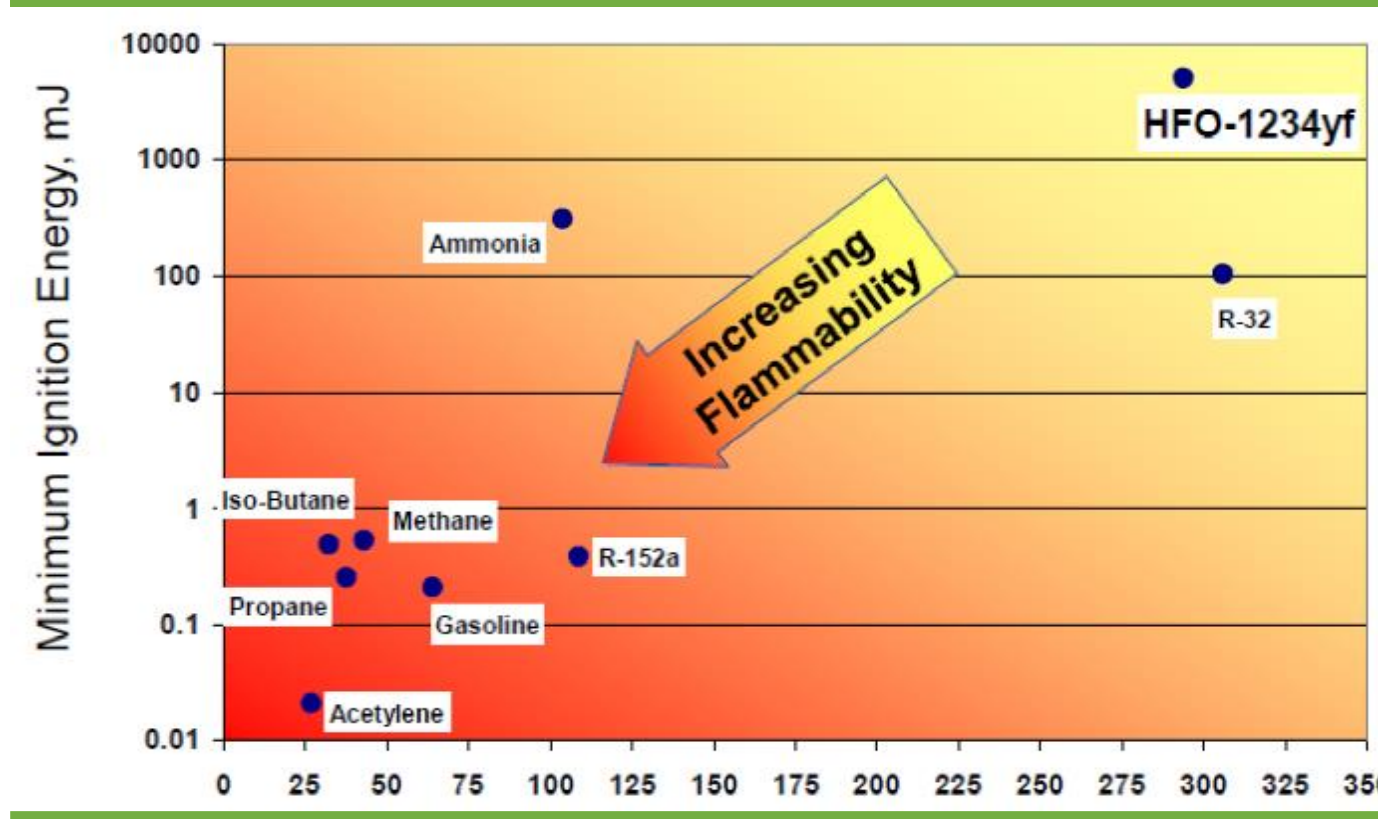
4 Emerging Technology Shifts

Variable Speed Drives



Improved Comfort
Reduced Noise
Cold Climate Heating
Increased Low Load Performance

Low GWP Refrigerants



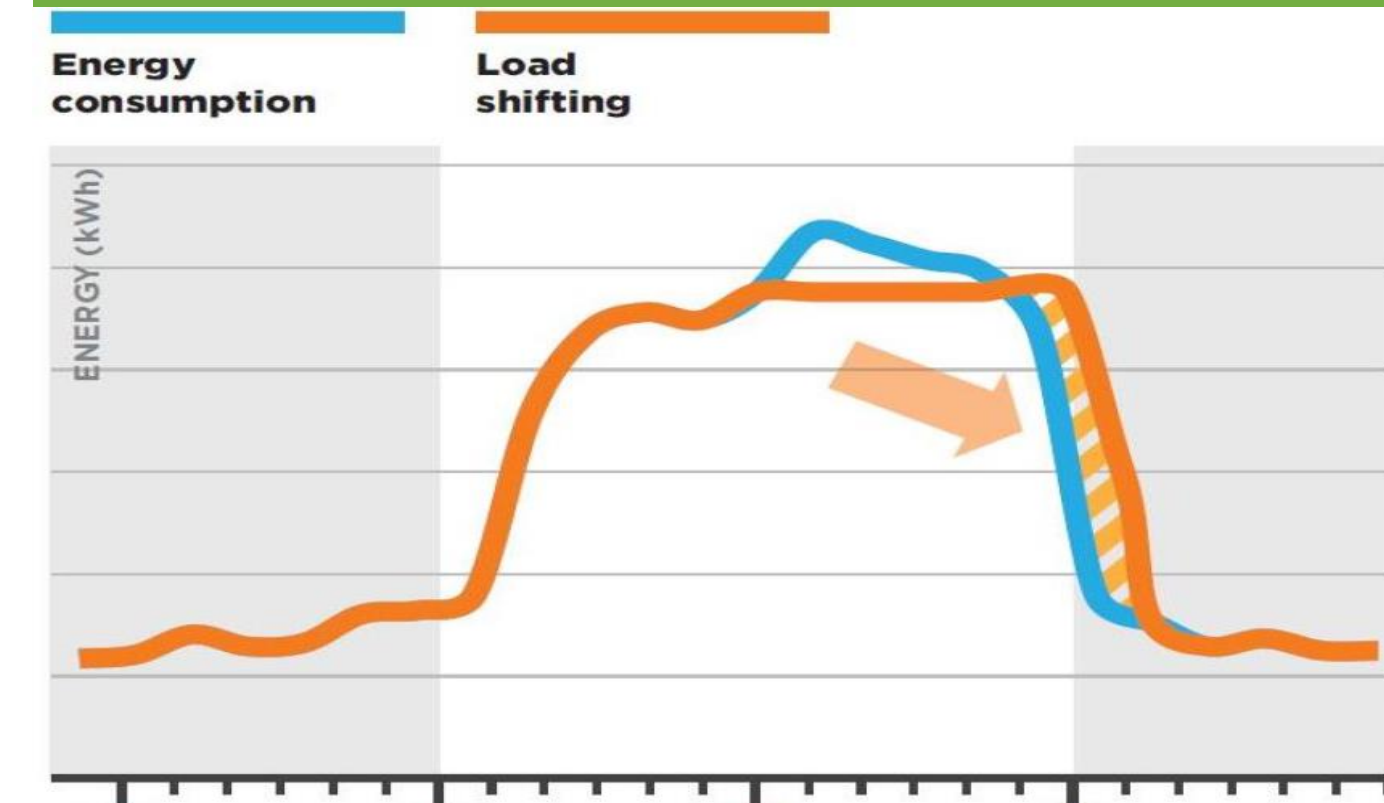
0-10% Increase in Performance
Shift to Hydronic Distribution
Help Reach Climate Goals

Advanced Heat Exchangers



0-20% Increase in Performance
Higher Cost or Decreased Size
Improved Moisture Removal

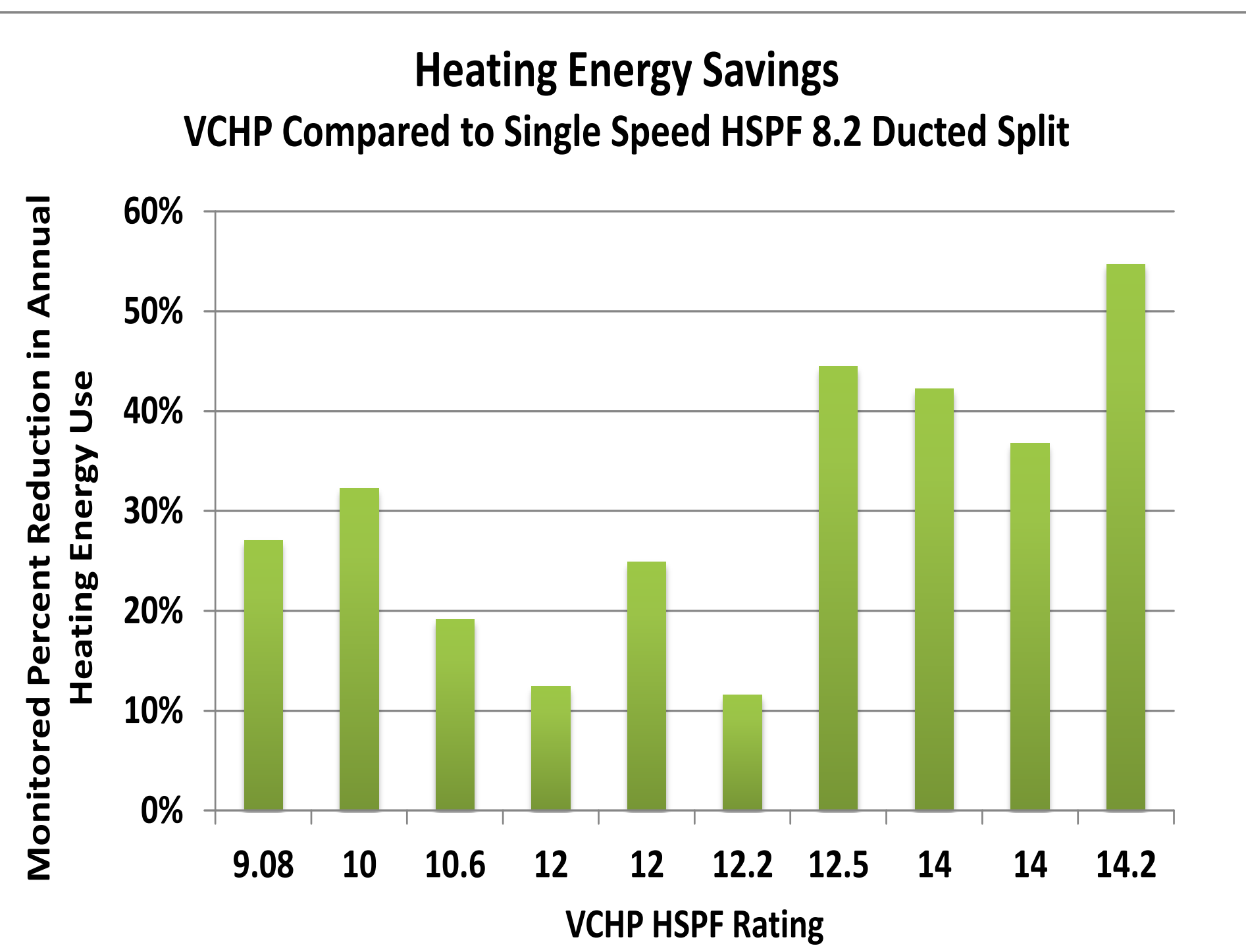
Smart Controls



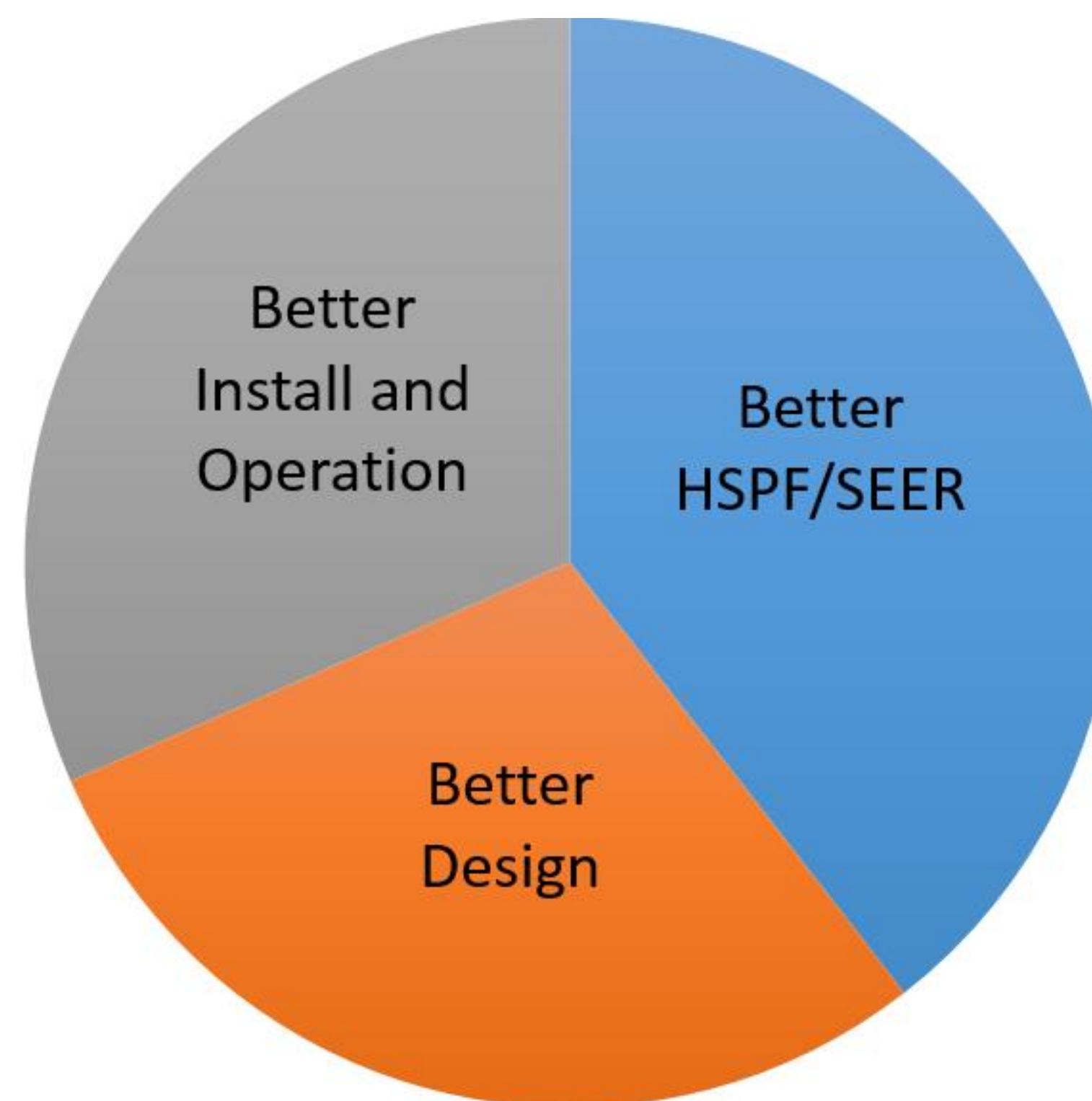
Operational Data
Utility Grid Stability Benefits
Improved Comfort
Installer Information

3 Market Transformation Challenges

Performance in the **real world** is hard to predict



Savings come from the **total system** not just the hardware



We have **limited leverage** in the market

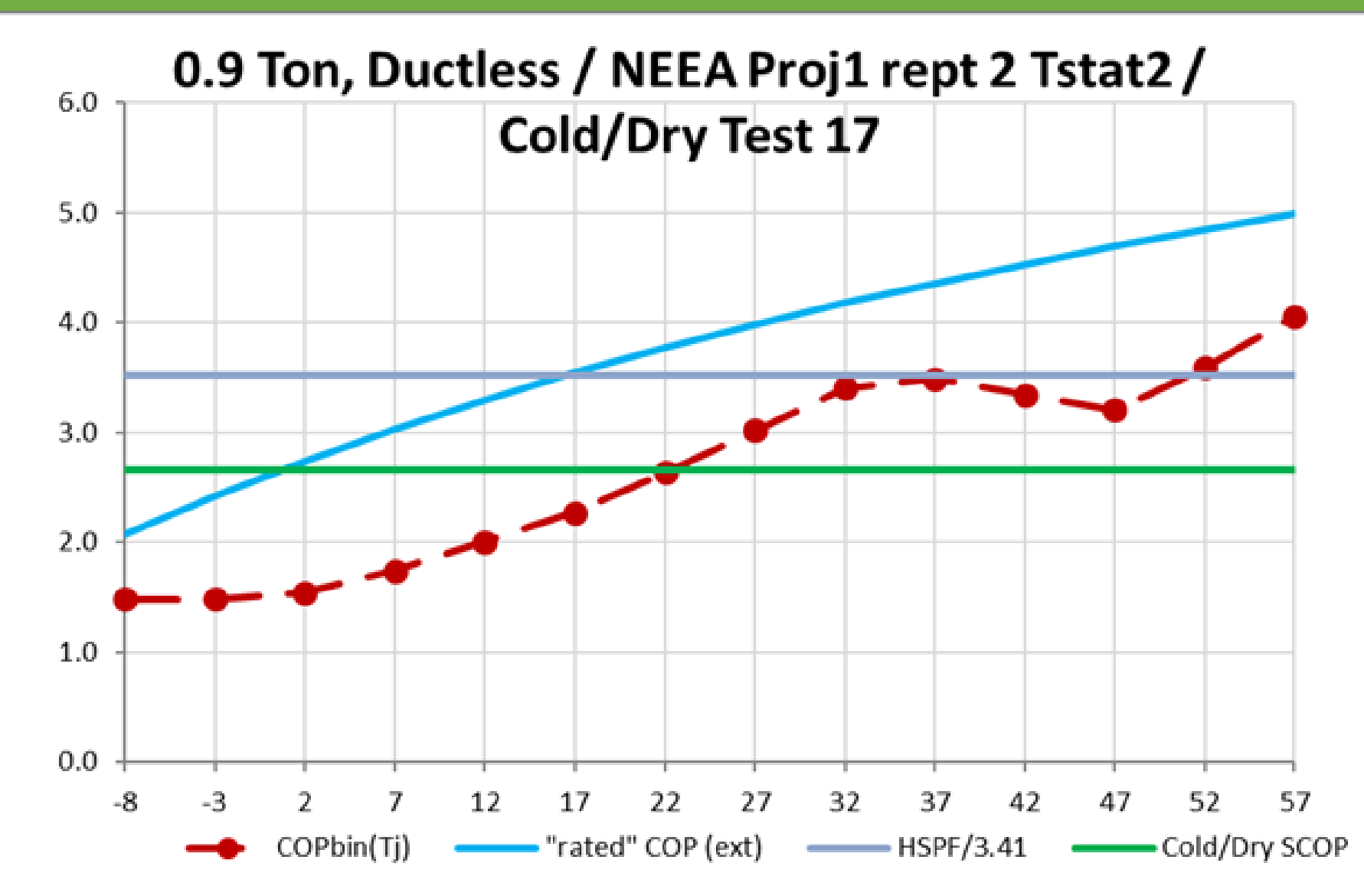
Contractor Wants
#1 Easy Sales
#2 Satisfied Customer
#3 Low Risk

Consumer Wants
#1 Low First Cost
#2 Comfort
#3 Low Risk
#4 Low Bills

Utility Wants
#1 Customer Love
#2 Energy Savings
#3 Demand Savings

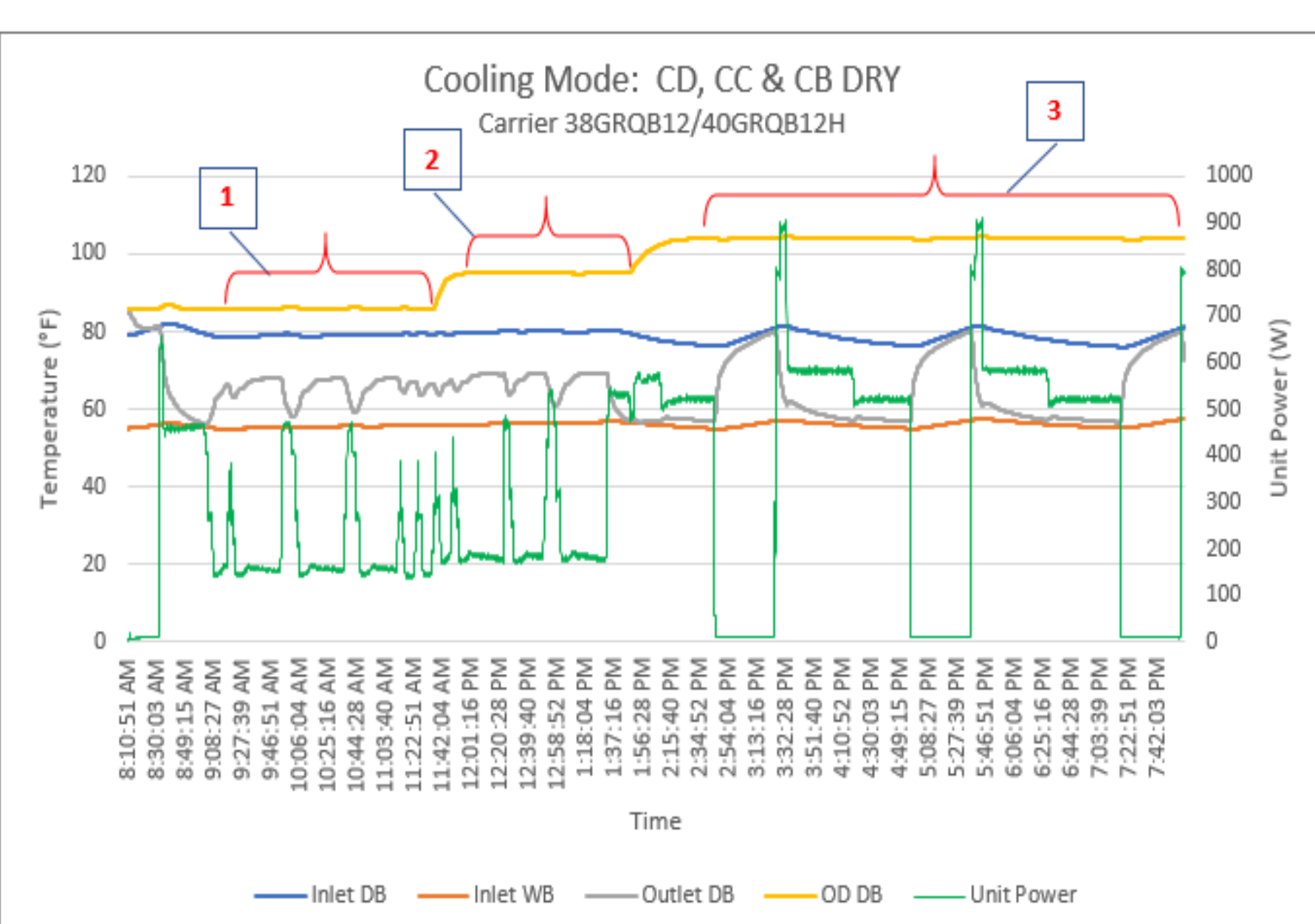
2 Investigations

CSA EXP07 – A Better Test Method?



CSA EXP-07 Test Procedure

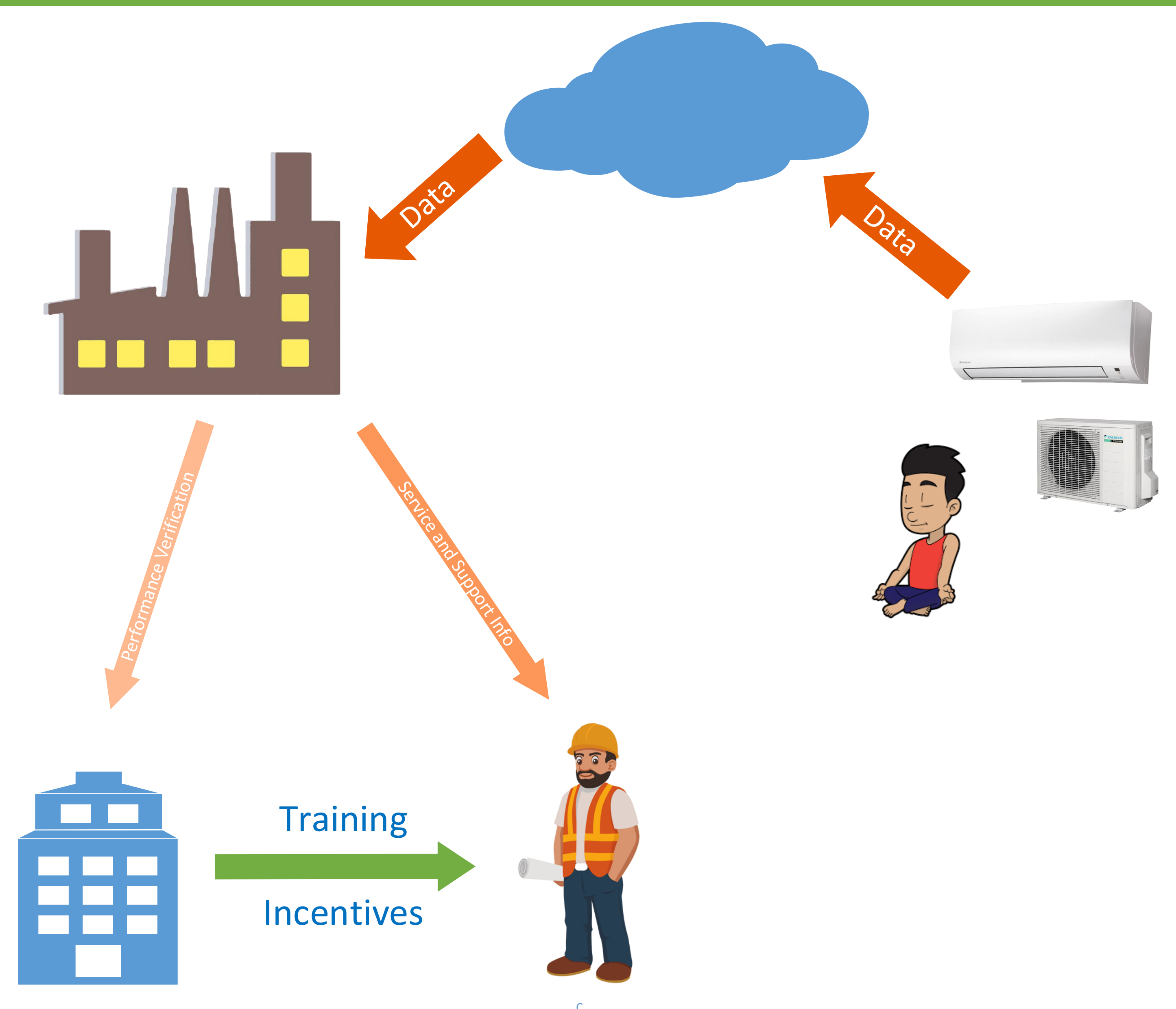
- Dynamic Loads Based Test
- Indoor room load changes with outdoor temp
- Equipment operates under its own controls



Early Observations

- (various machines)
- Slow Cooling Convergence
- Odd Defrost
- Short Cycling
- Not truly variable speed

Post Installation Data



1 Ton of Savings