



Maximizing Supermarket Refrigeration System Energy Efficiency

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Agenda

Topic	Time
Overview of Refrigeration Team Activities	1:30 to 1:45
Guest Speaker: Dick Lord, Carrier Corporation / Co-Chair ASHRAE SSPC 90.1 <i>Energy Metrics for Building Systems</i>	1:45 to 2:15
Guest Speaker: Jeremy Litow, CLEAResult <i>Leveraging Utility Incentive Programs</i>	2:15 to 2:40
Guest Speaker: John Wallace, Emerson Climate Technologies <i>Purchasing Supermarket Refrigeration as a Service</i>	2:40 to 3:00

Activity Overview—Case Studies

- Hannaford Transcritical CO₂ Case Study (Complete)
 - Turner, ME Store—opened June 2013
 - **~15% reduction in overall climate impacts**
 - See: <http://energy.gov/eere/buildings/downloads/case-study-transcritical-carbon-dioxide-supermarket-refrigeration-systems>
- Whole Foods Market Transcritical CO₂ Case Study (in Progress)
 - Brooklyn, NY Store—opened December 2013
 - WFM's Showcase Project for the Better Buildings Challenge
 - Case study data collection started September 2014
 - Results expected Q4 2015

Activity Overview—Working Group Updates

- **Utility Incentives:**
 - High barriers; weak utility buy-in
 - Issued close-out letter January 2015
- **Integrated Solutions (AKA, Refrigeration as a Service):**
 - Limited access to cost information; long time horizon (and significant risk) to bring to market
 - Issued close-out letter March 2015
- **Energy Metric for Supermarket Refrigeration:**
 - DOE Building Codes program oversees DOE activities related to ASHRAE 90.1
 - Alliance activities should focus on promoting the voluntary uptake of market-ready energy-saving technologies
 - Issued close-out letter May 2015—recommended that DOE Building Codes picks up the metric development effort

Activity Overview—Focus on HITs

- DOE's 2015 analysis of High Impact Technologies (HIT)¹ identifies two priorities for commercial refrigeration:
 - Commercial Refrigeration Controls
 - Retrofit of Open Display Cases

1) See DOE webpage on High Impact Technology Catalyst:
<http://energy.gov/eere/buildings/high-impact-technology-catalyst>

Activity Overview—Focus on HITs

Commercial Refrigeration Controls—Examples

- Adaptive controls (continuously monitor and adjust system parameters such as superheat or evaporator pressure)
- Speed controllers for evaporator and condenser fans
- Timers and dimmers for display-case lighting
- On-demand defrost
- Night-time set back
- Pulsing of anti-sweat heaters
- Wireless communication (enabling technology)
- Refrigerant leak detection

Activity Overview—Focus on HITs

- Refrigeration Controls—Questions to Explore:
 - *What specific barriers are most important to address?*
 - *What activities would be most helpful?*
 - *Manufacturer/supplier challenge?*
 - *Procurement specifications?*
 - *End-user campaign?*
 - *Demonstrations?*
 - *Other?*

Activity Overview—Focus on HITs

Retrofit of Open Display Cases

~10% of display cases (installed base) are medium-temperature, open cases—candidates for retrofit

50% to 80% reduction in system energy consumption

Retrofits often include doors, fans/fan motors, lighting, and controls

Activity Overview—Focus on HITs

- Case Retrofits—Questions to Explore:
 - *We've already done much to support display-case retrofits. Do members need further support? If so, what is needed?*
 - *What information can you share regarding merchandising impacts?*
 - *How can we reach smaller chains and independents?*

**Speaker Presentation—Dick Lord, Carrier
Corporation / Co-Chair ASHRAE SSPC
90.1**



**United
Technologies**

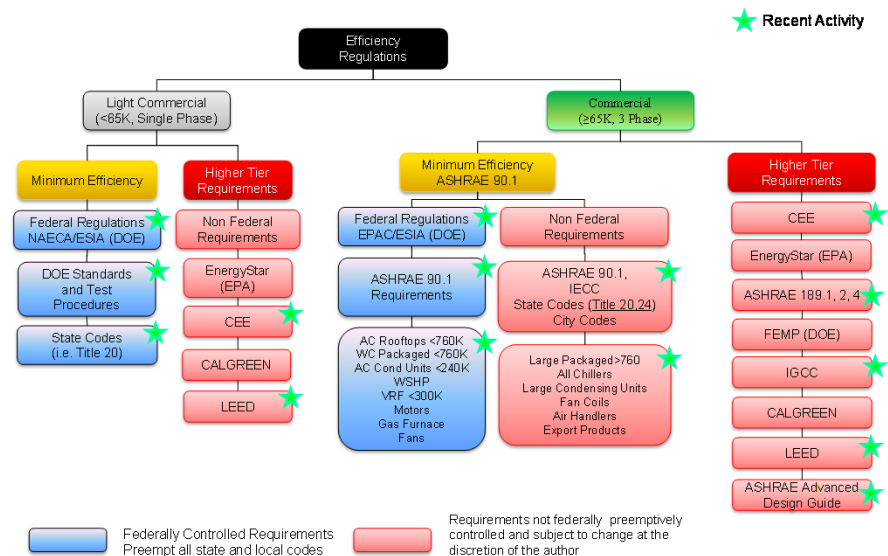
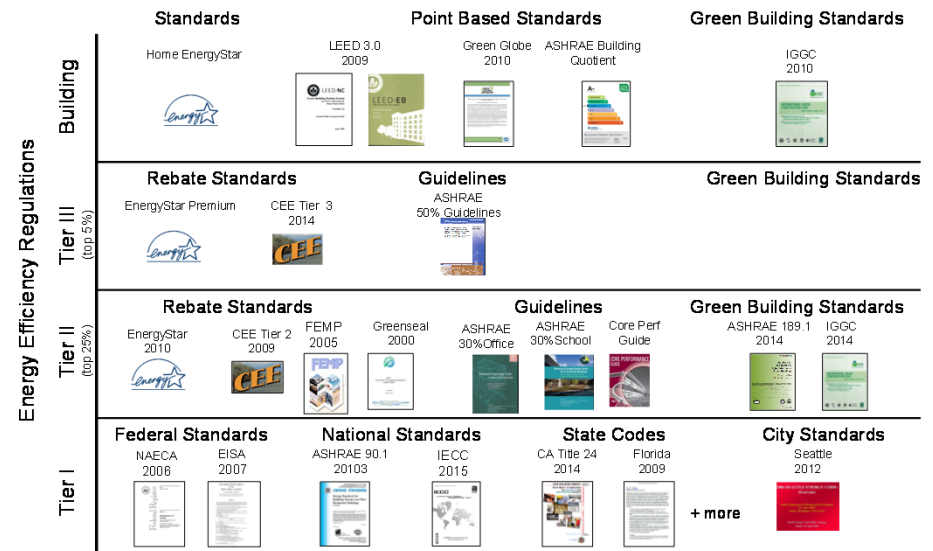
Building & Industrial Systems

HVAC&R Efficiency Improvements
Better Building Summit-2015

Richard Lord

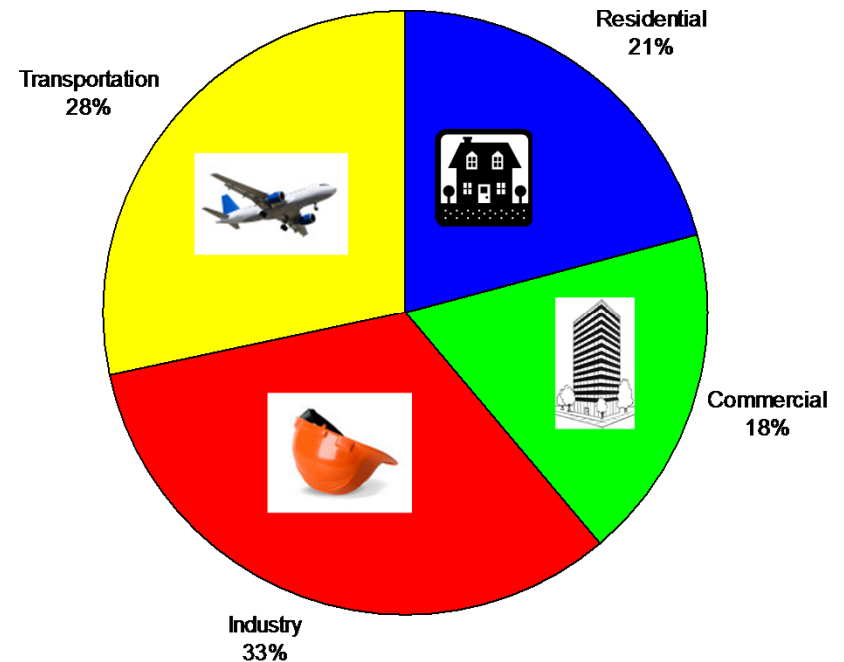
Background

- The focus on HVAC&R and building efficiency is significant and increasing
- There have been significant changes to minimum efficiency regulation like ASHRAE 90.1, IECC, DOE as well as state and city energy standards and many more are in progress
- These standard are also expanding their scope to cover new products like refrigeration, data centers, and processes
- At the same time tier II and III guidelines like CEE, Energy Star, FEMP are changing and expanding
- Globally we are seeing the same trend but often they are not harmonized with the USA approaches
- Most of the focus has been on full load component efficiencies at some industry standard rating conditions, but there has been some new part load metrics



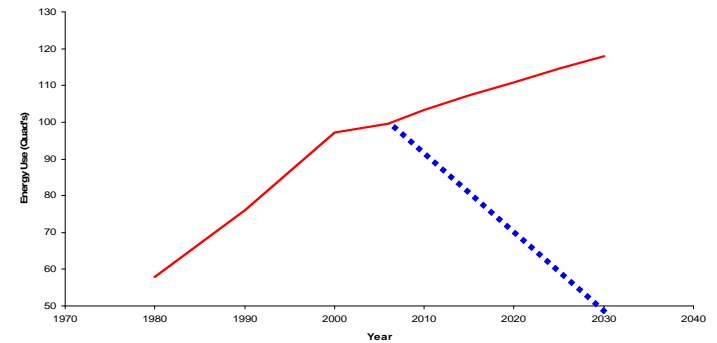
Why the Focus on Building Efficiency

- Use 65% of the nations electricity
- Account for over 36% of total energy usage
- Generate 30% of the greenhouse gas emissions
- Create 136 million tons of construction and demolition waste
- Consume 12% of the potable water



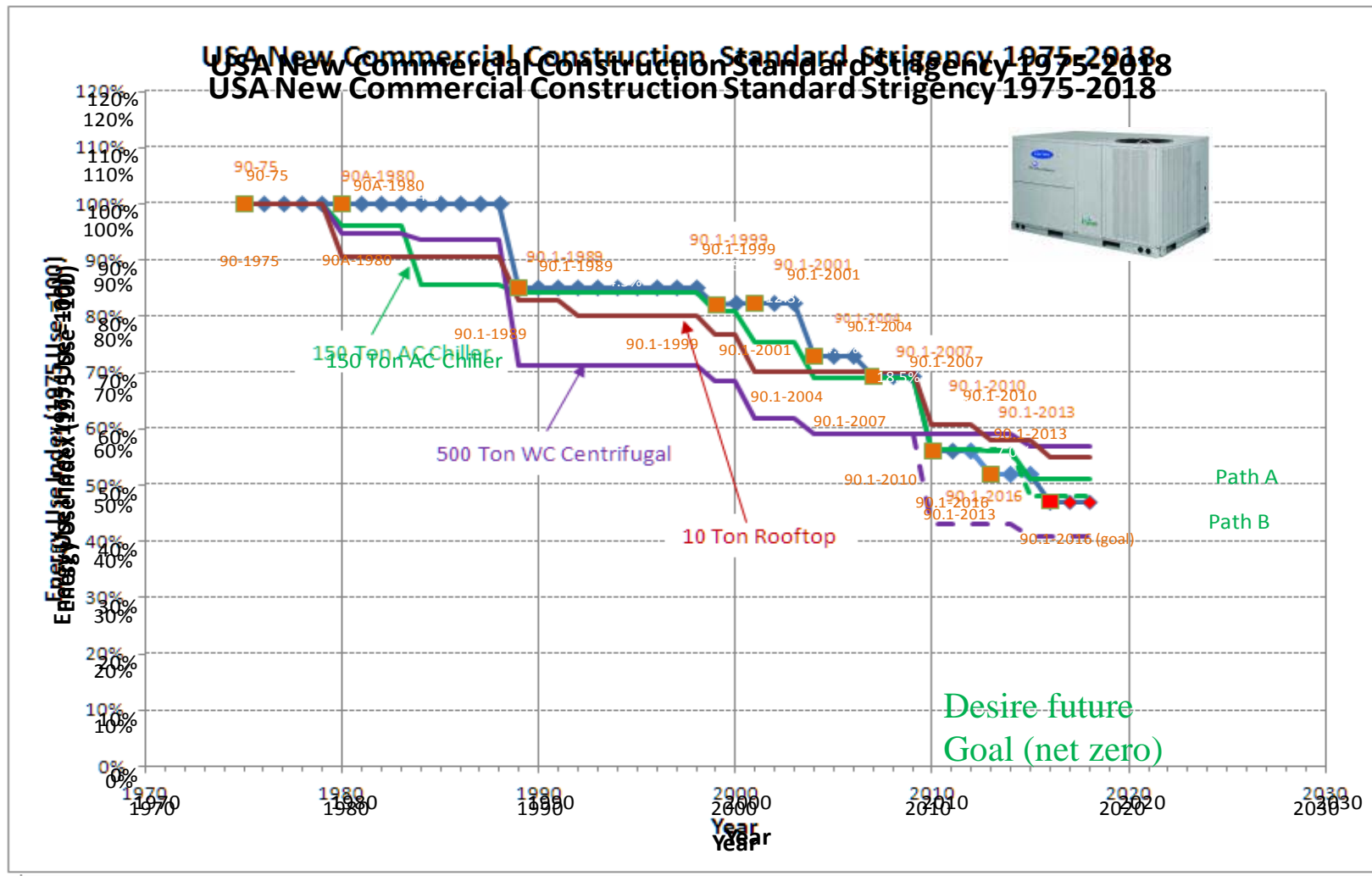
Total Consumption

Year	Quads
1980	57.9
1990	76.1
2000	97.2
2006	99.5
2010	103.3
2015	107.3
2020	110.8
2025	114.5
2030	118.0



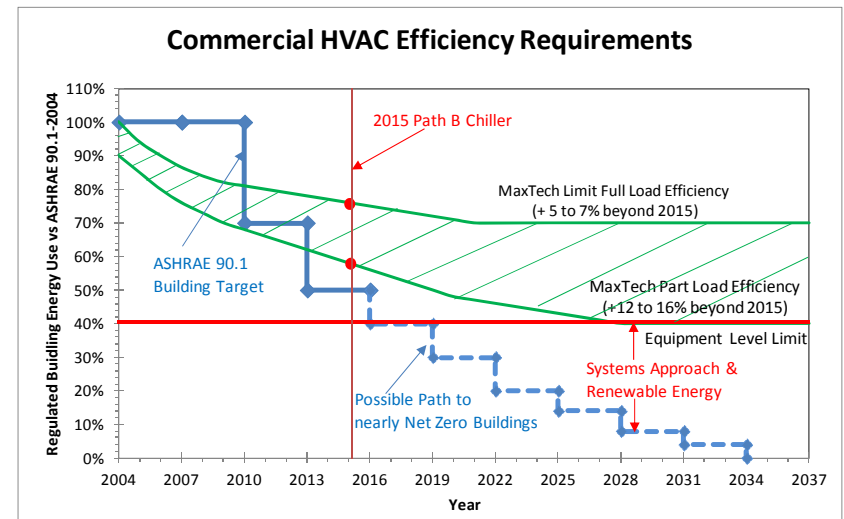
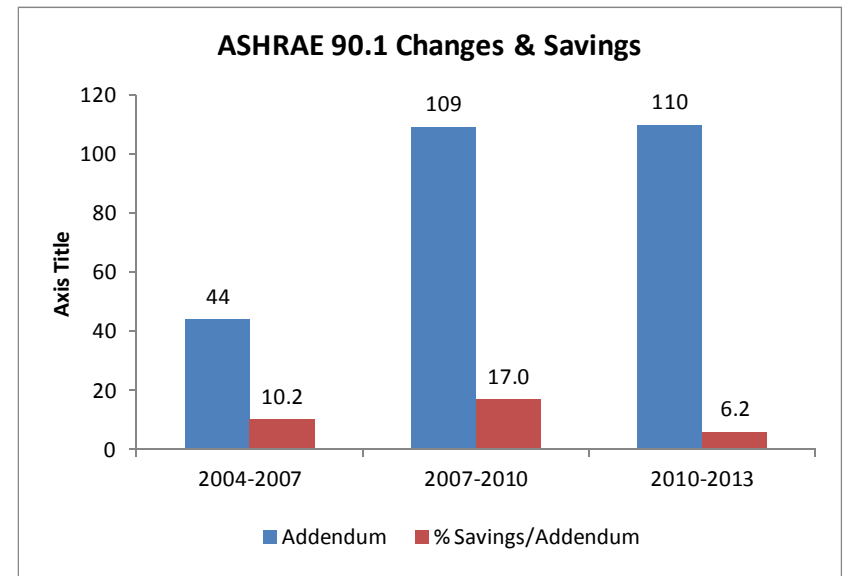
Historical Progress

Great process has been made in building efficiency



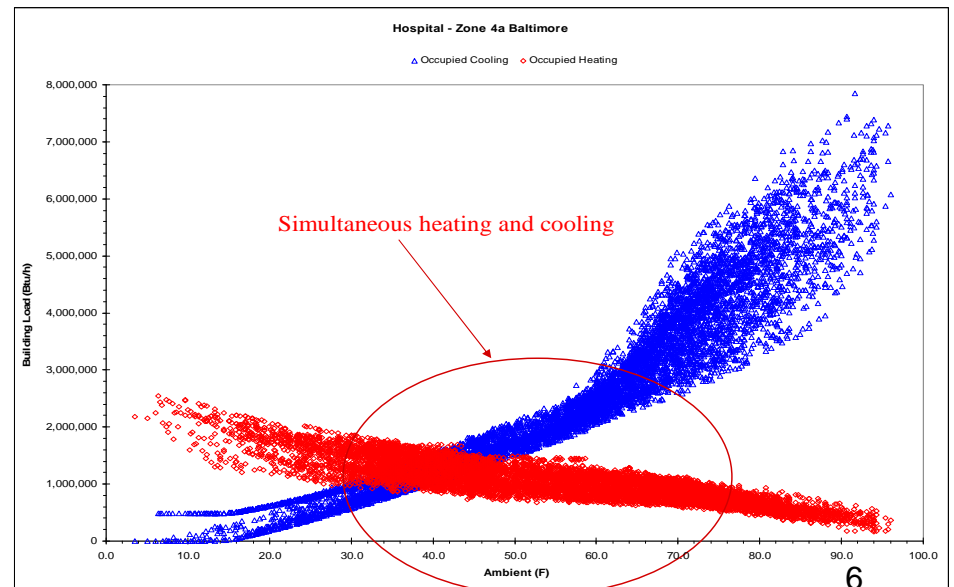
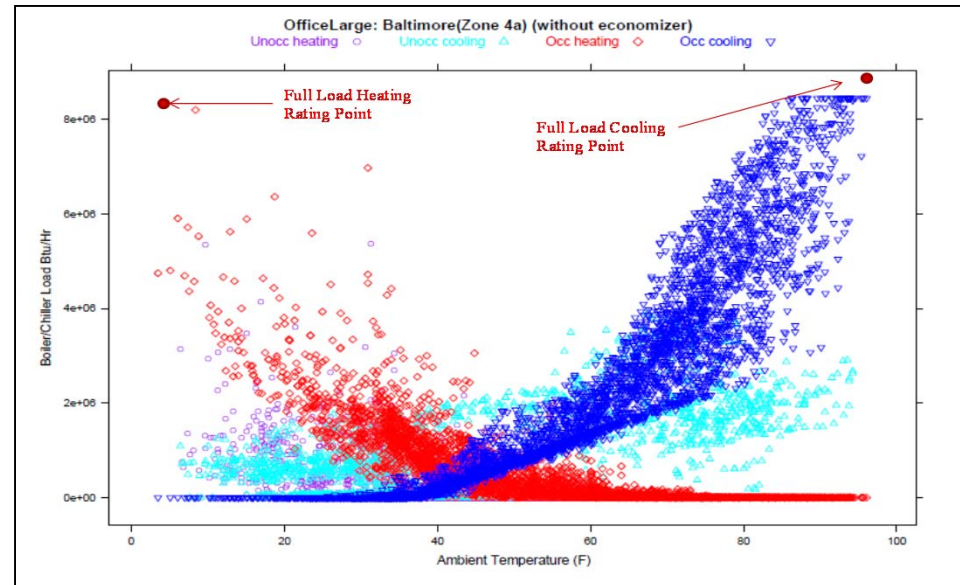
Historical Approach

- But the improvements have not been easy and the efficiency standards are becoming very complexity
- The focus in general has been on component efficiencies and then at full load and industry standard rating condition that may not be representative of the applied conditions in the building
- The focus is also on design of equipment and very little focus on systems and the continued high performance
- Efforts to comply with the standards and related certification programs is significant and occupy a significant part of the industry development time and resources and little time left for creative concepts
- We also are starting to approach “Max Tech” component efficiencies are demonstrated by recent proposals



Understanding Building Energy

- We tend to think of HVAC&R as appliances with a single metric rating at some industry design condition
- But HVAC&R in commercial buildings is complex and Energy use is a function of the ambient, building load, building design, occupancy, ventilation, building controls and many more attributes that when addressed as a system have the potential for significant annualized building energy savings
- Like any Engineering problem it is important to understand the problem we are solving and therefore we need to understand how buildings operate

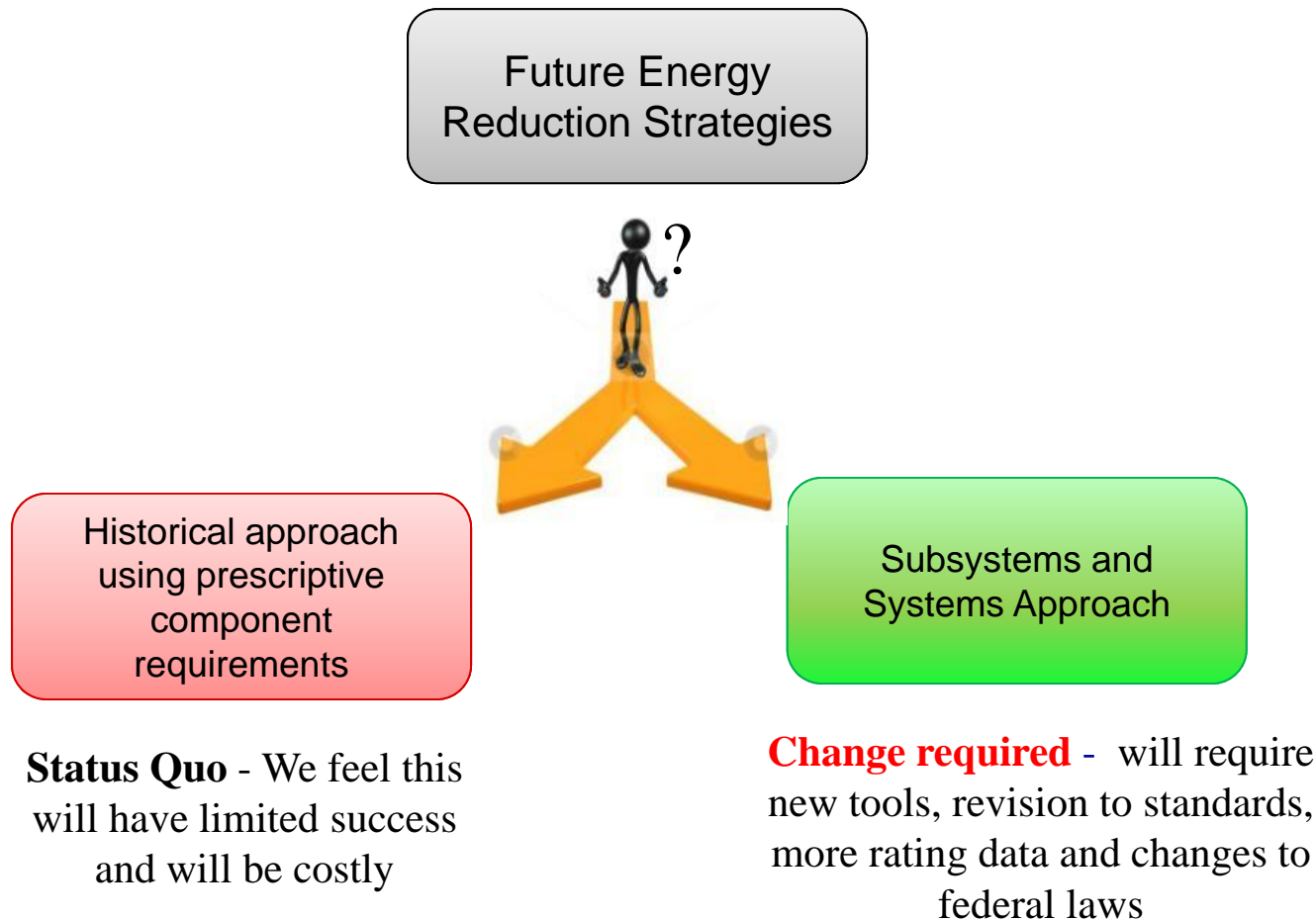


Prescriptive Design vs Goals Standards

- Due to limited options to improve component efficiencies, standards are resorting to very complex prescriptive requirements
- For example for refrigeration condensers ASHRAE 90.1 section 6.5.11 it now has the following;
 - Design requirements for saturated condensing temperature
 - Specific technology for condenser fan motors
 - Defined condenser fan control
 - Defined condenser set point control logic
 - Floating suction pressure control logic
 - Liquid subcooling prescriptive requirements
 - Compressor crankcase heater control
- This may be OK for current technology but as we move to new low GWP refrigerants and new technology the above may actual not be the best options
- Standards should focus more on requirements and not design solutions.

Future Potential Roadmap

Using the historical prescriptive approach will likely not continue to allow the required improvement in overall building efficiency so the industry has been exploring options

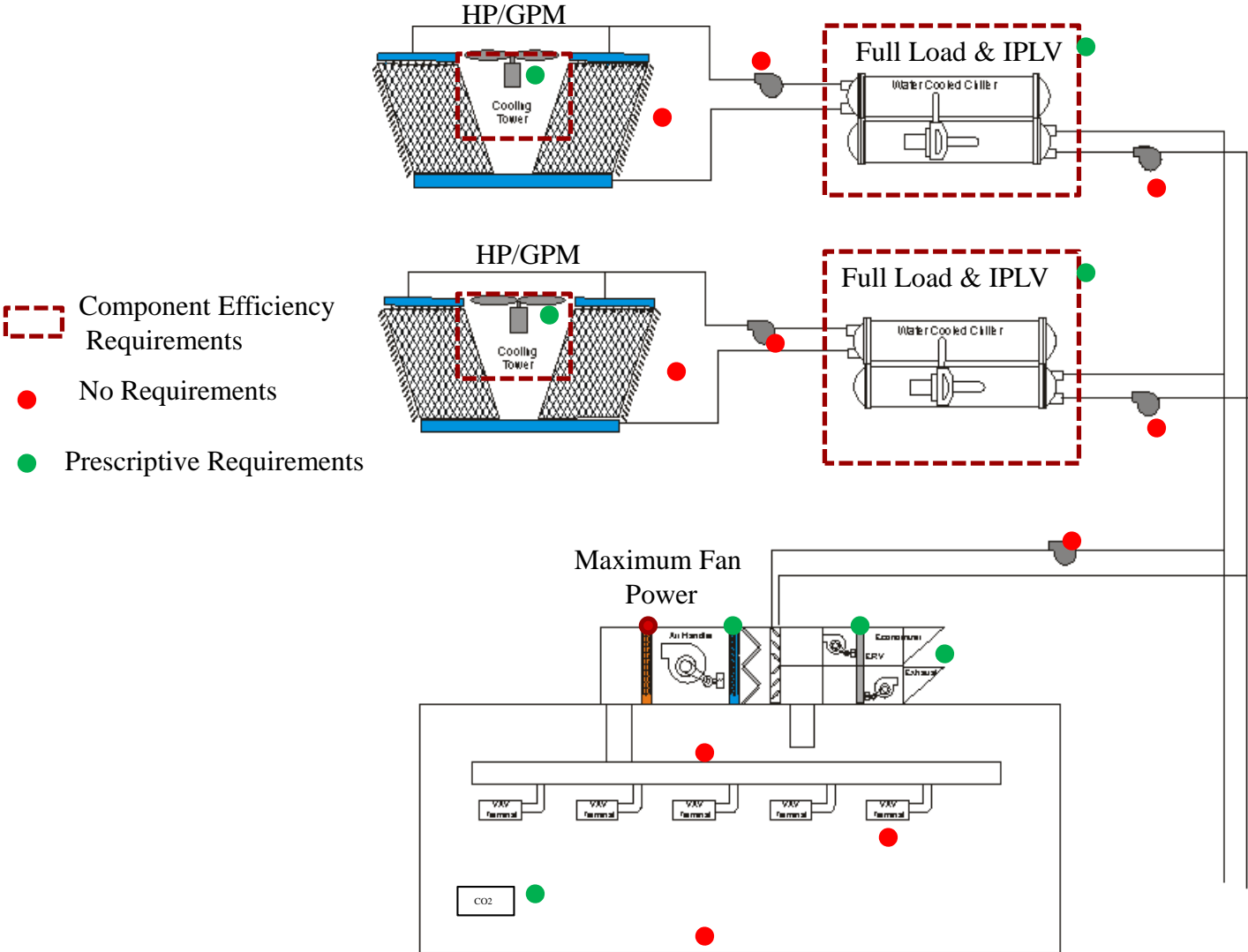


Industry Initiatives

- Several organizations have started initiatives to look at alternate approaches to improving building efficiency thru systems and sub-systems approaches
- **ASHRAE 90.1/ASHRAE 189.1 Advanced Energy Standards Committee (AES)** – A special working committee has been formed to develop strategic plans and to look at where the standards should move in the future
- **AHRI Systems Steering Committee (SSC)** – This group was formed 3 years ago to begin to develop systems and subsystems approaches to efficiency. Recently they have complete strategic plans for each commercial section to begin the work on transition to systems and subsystems
- **Alliance to Save Energy Systems Initiative (ASE)** - This is a new 2 year initiative to look at a systems approach for the HCAC&R, light and overall building with a goal of producing a report on the overall benefits and recommendations to implement new approaches
- **Global Initiatives** – Globally there are systems initiatives underway in Europe (Second European Directive) and Canada (C873)

What is a Systems Approach

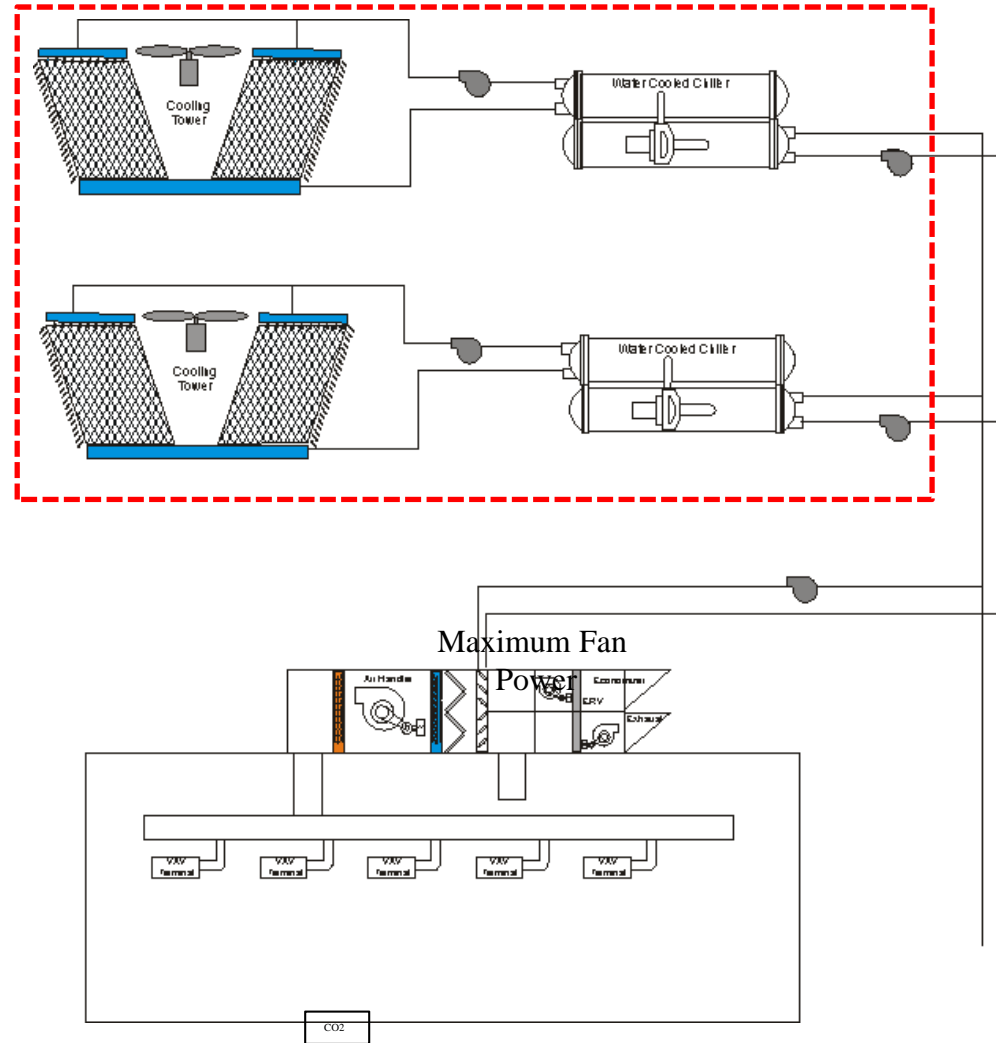
Current ASHRAE 90.1 Chilled Water Regulations (Prescriptive Approach)



Chilled Water System/Subsystem Example

Proposed Systems Approach

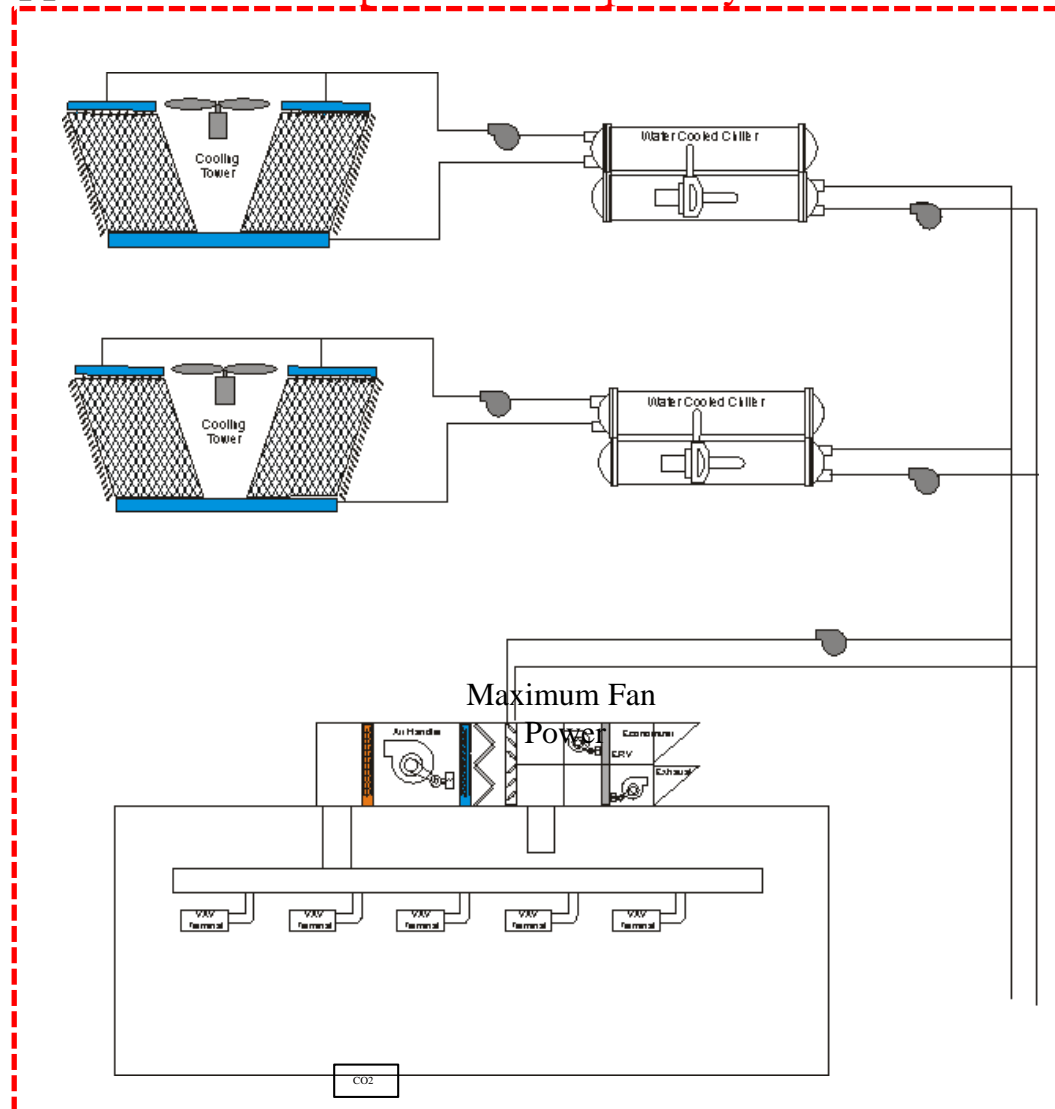
Option 1 – Chilled Water Subsystem



Chilled Water System/Subsystem Example

Proposed Systems Approach

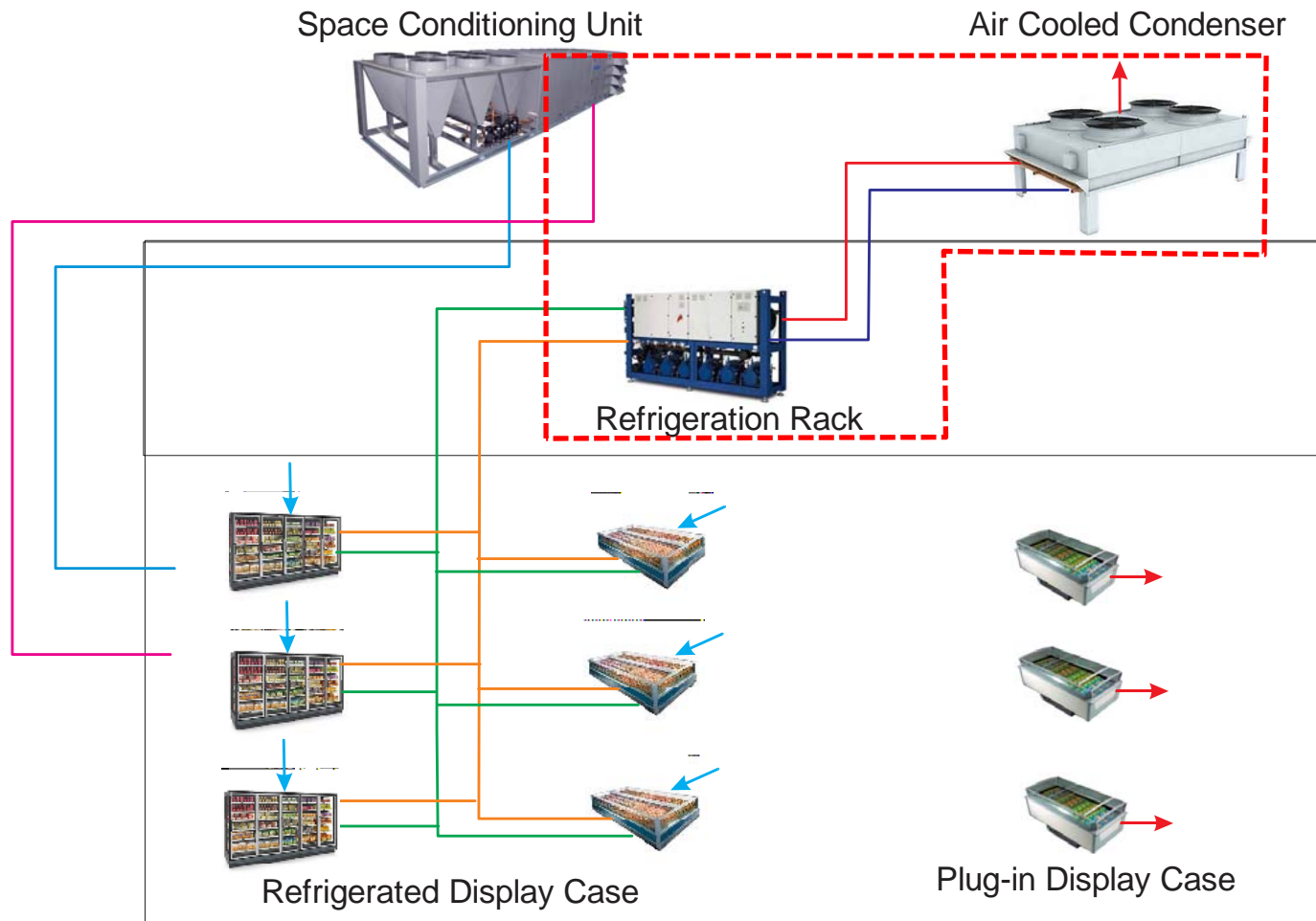
Option 2 – Complete System



Supermarket System Model

Supermarket System Example

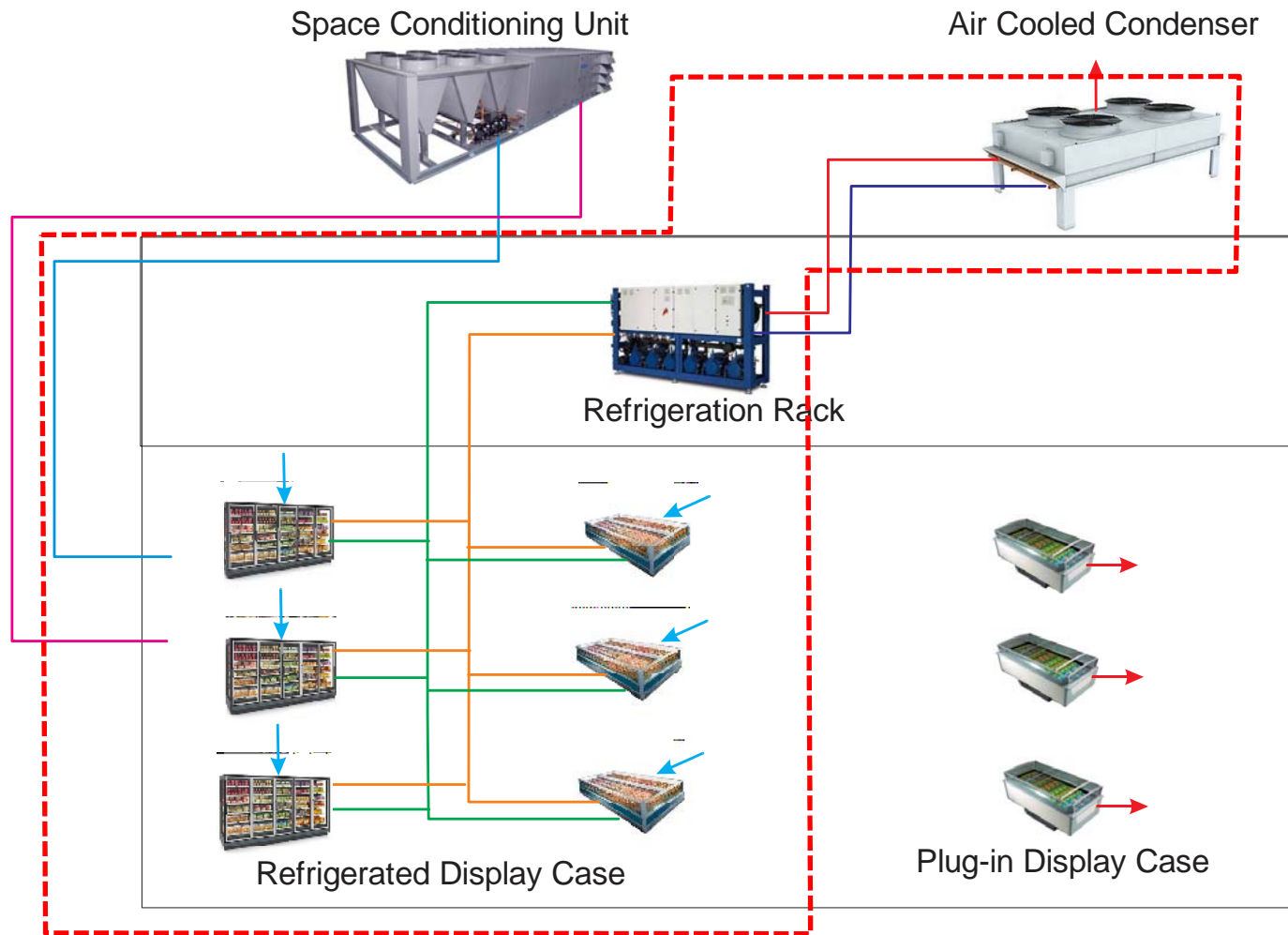
Option 1 Rack Sub-System



Supermarket System Model

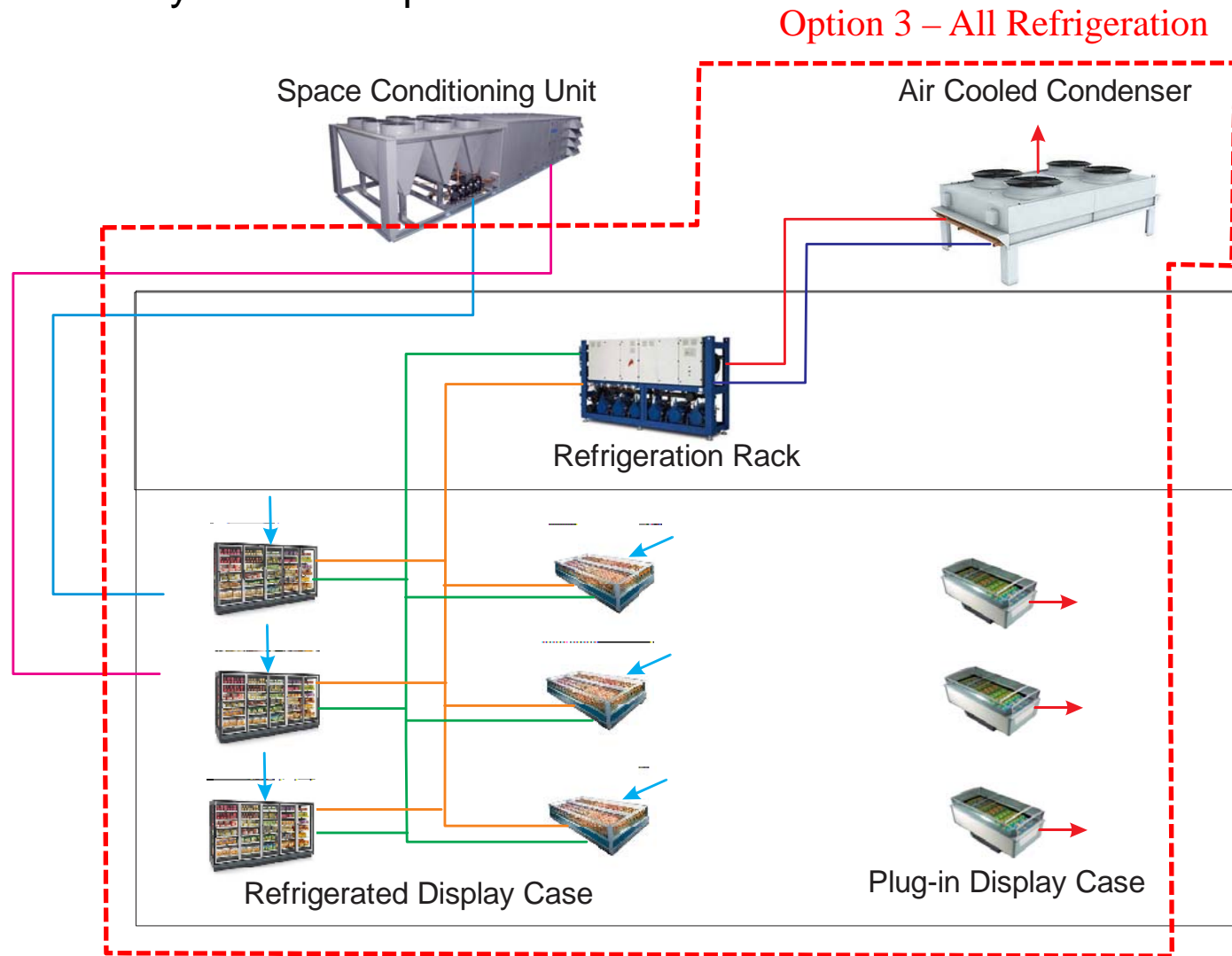
Supermarket System Example

Option 2 – Refrigeration System



Supermarket System Model

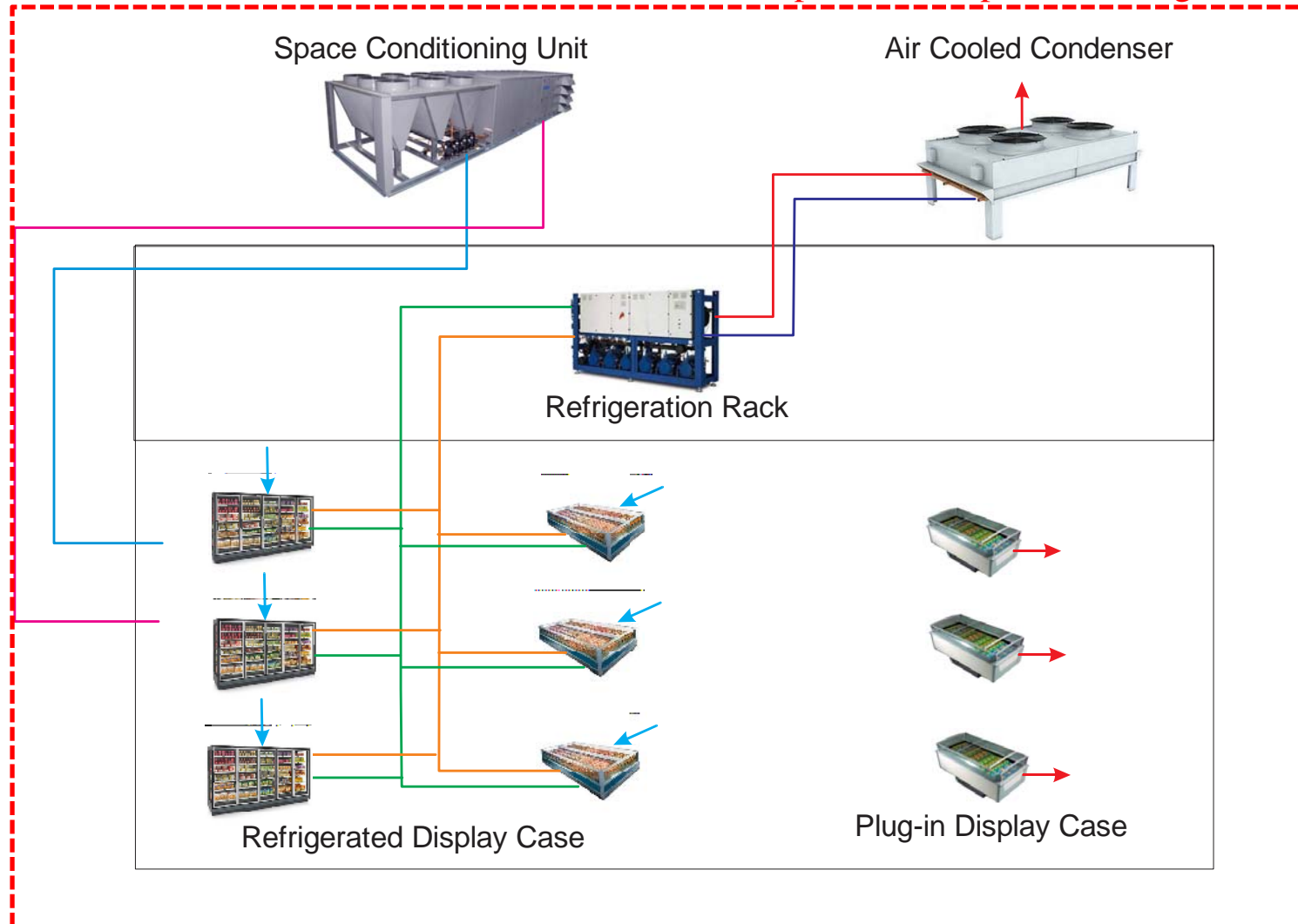
Supermarket System Example



Supermarket System Model

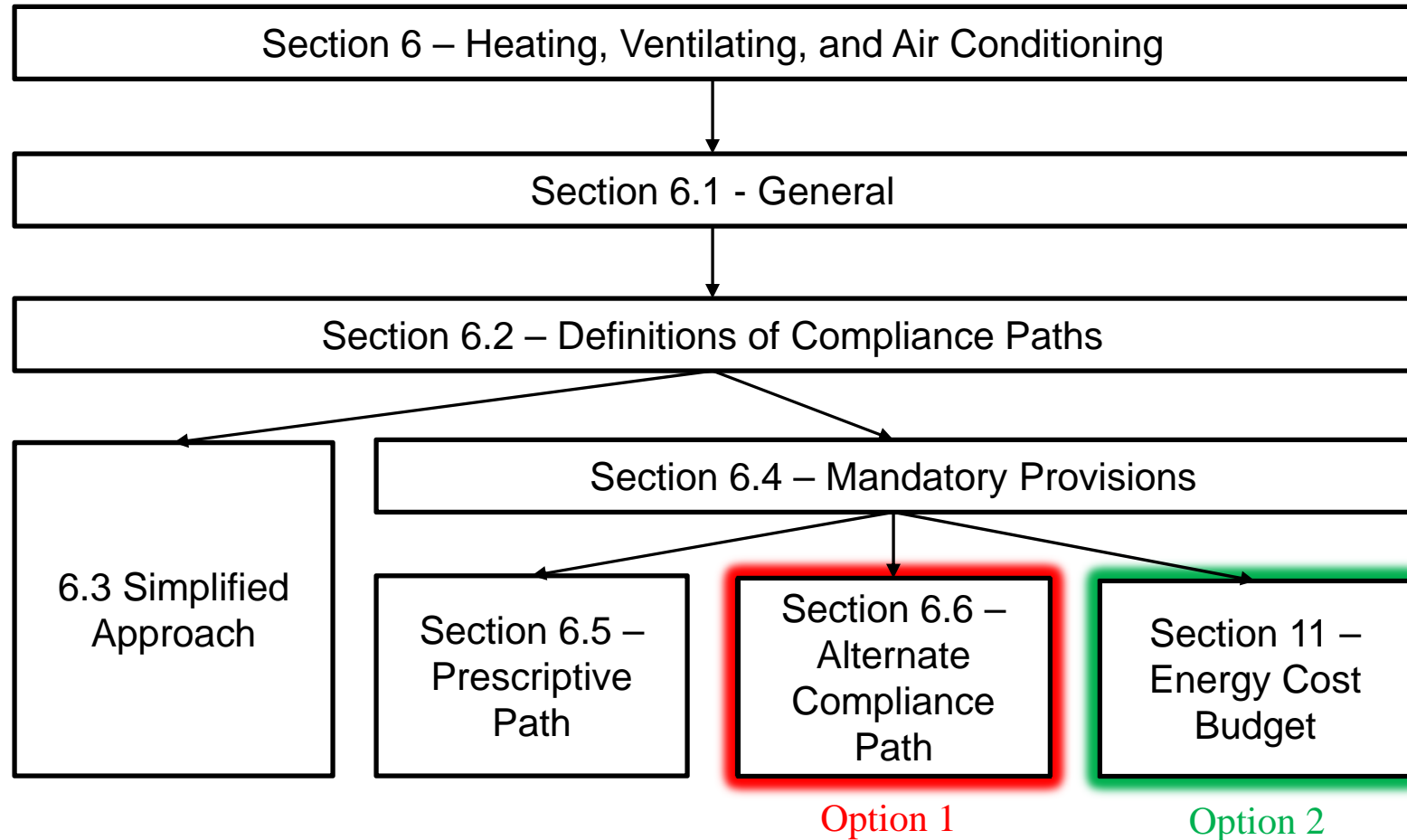
Supermarket System Example

Option 4 Complete Building



Standards Implementation - ASHRAE 90.1

Chapter 6 Compliance Path



Concept would use section 6.6 and Chapter 11

Section 6.6 – Alternate Compliance Path

- Prior to ASHRAE 2013 ASHRAE 90.1 did not use the section 6.6 alternate compliance path
- In the update for 2013 standard the alternate compliance path for Data Centers
 - The computer room PUE₁ shall be less than or equal to the values listed in Table 6.6.1. Hourly simulation of the proposed design, for purposes of calculating PUE₁, shall be based on the ASHRAE Standard 90.1 Appendix G simulation methodology.
 - The computer room PUE₀ is less than or equal to the values listed in Table 6.6.1, shall be the highest value determined at outdoor cooling design temperatures, and shall be limited to systems only utilizing electricity for an energy source. PUE₀ shall be calculated for two conditions: 100% design IT equipment energy and 50% design IT equipment energy.

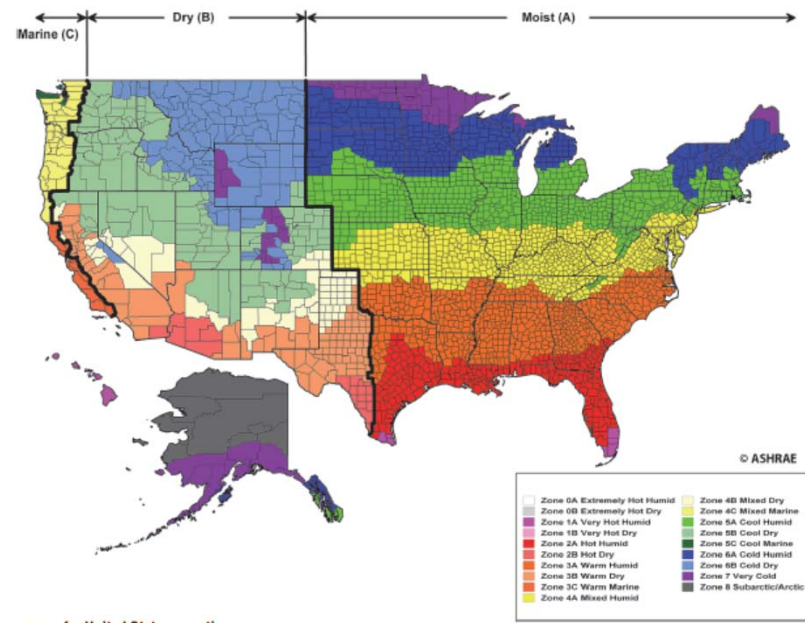
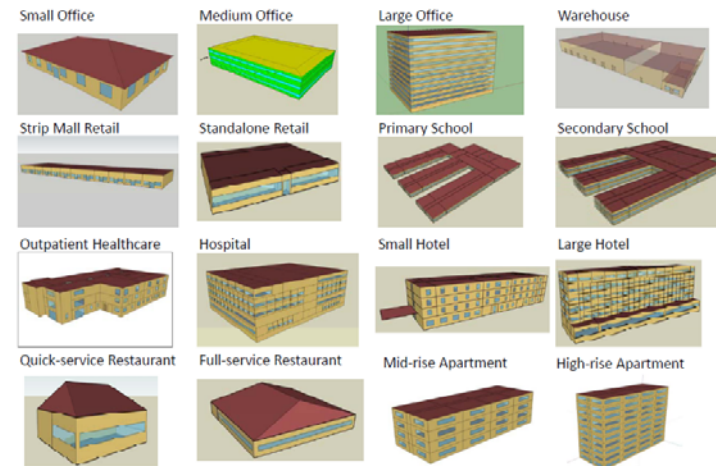
TABLE 6.6.1 Power Usage Effectiveness (PUE) Maximum

Climate Zone	PUE ^a
1A	1.61
2A	1.49
3A	1.41
4A	1.36
5A	1.36
6A	1.34
1B	1.53
2B	1.45
3B	1.42
4B	1.38
5B	1.33
6B	1.33
3C	1.39
4C	1.38
5C	1.36
7	1.32
8	1.30

a. PUE₀ and PUE₁ shall not include energy for battery charging.

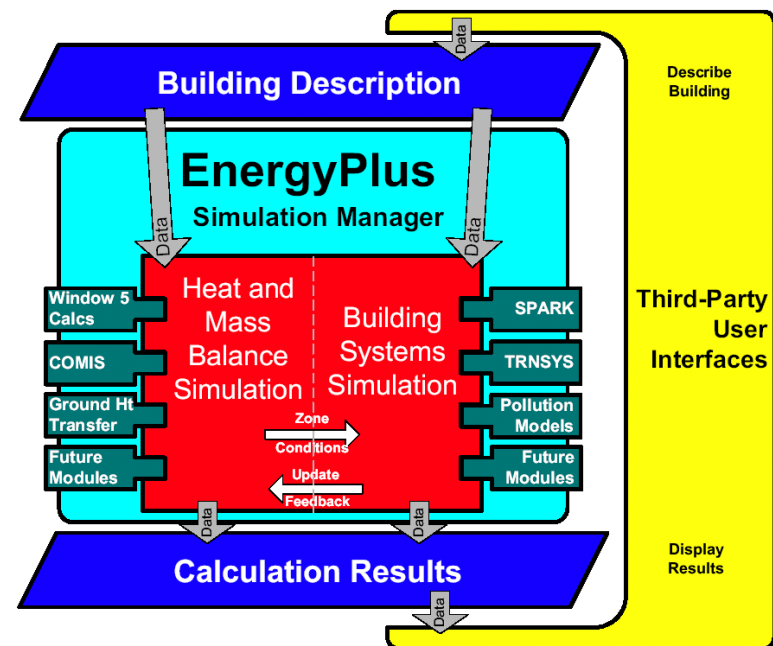
System Approach Option 1

- The use option 1 we would use industry defined benchmark building models developed by ASHRAE 90.1 AES and PNNL to determine the HVAC&R load profiles
- Along with this we would use the new ASHRAE 169 19 climate zones and benchmark cities to define the ambient profiles
- Calculations for the proposed system would be compared to the common industry defined benchmark system and if the annual energy is less then it would be an acceptable system



Option 2 – Full System Analysis

- For this option a full Energy Plus software or other qualified model for the proposed building would be used
- This model would then be compared to a baseline building using the procedures of appendix G of ASHRAE 90.1
- Again compliance would be determined if the proposed building energy was less than the baseline building
- Could also factor in the new ASHRAE addendum BM which is fixing the baseline building to 2004 and then the compliance would be a percentage improvement in energy use

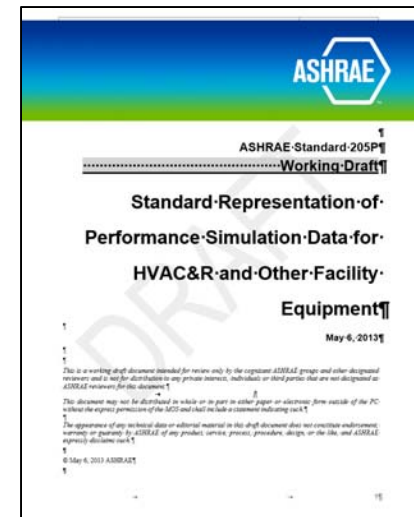


Enabling Technology

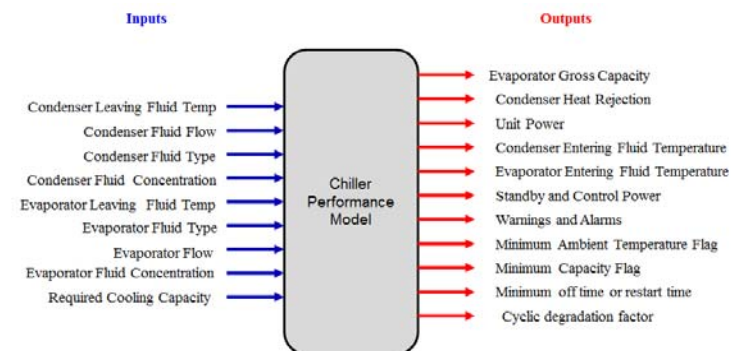
- Today only about 20% of the buildings are modeled due to the cost and complexity.
- Typically this is done for large high end buildings and the average small building is not typically modeled and the prescriptive approach is used for compliance
- The industry is undertaking work to enabling greater use of modeling thru the following work;
 - Rating and certification of the complete operating map for the HVAC&R product – AHRI
 - Development of standards for standard representation of product performance and the electronic transfer of the data to simulation tools – ASHRAE 205P
 - Development of new tools that allow for easy use of option 1 and option 2 compliance methods – Carrier and AHRI

ASHRAE 205P Standard

- The purpose of the standard is to facilitate sharing of equipment characteristics for performance simulation by defining standard representations such as data models, data formats, and automation interfaces.
- The scope of this standard applies to data used in the performance simulation of any HVAC&R or other facility system, equipment, or component
- The committee has chosen to represent data in an xml tabular format vs defining correlation equations that can be used directly in models
- The standard is expected to be released for advisory public review in late summer 2015



Example I/O Diagram

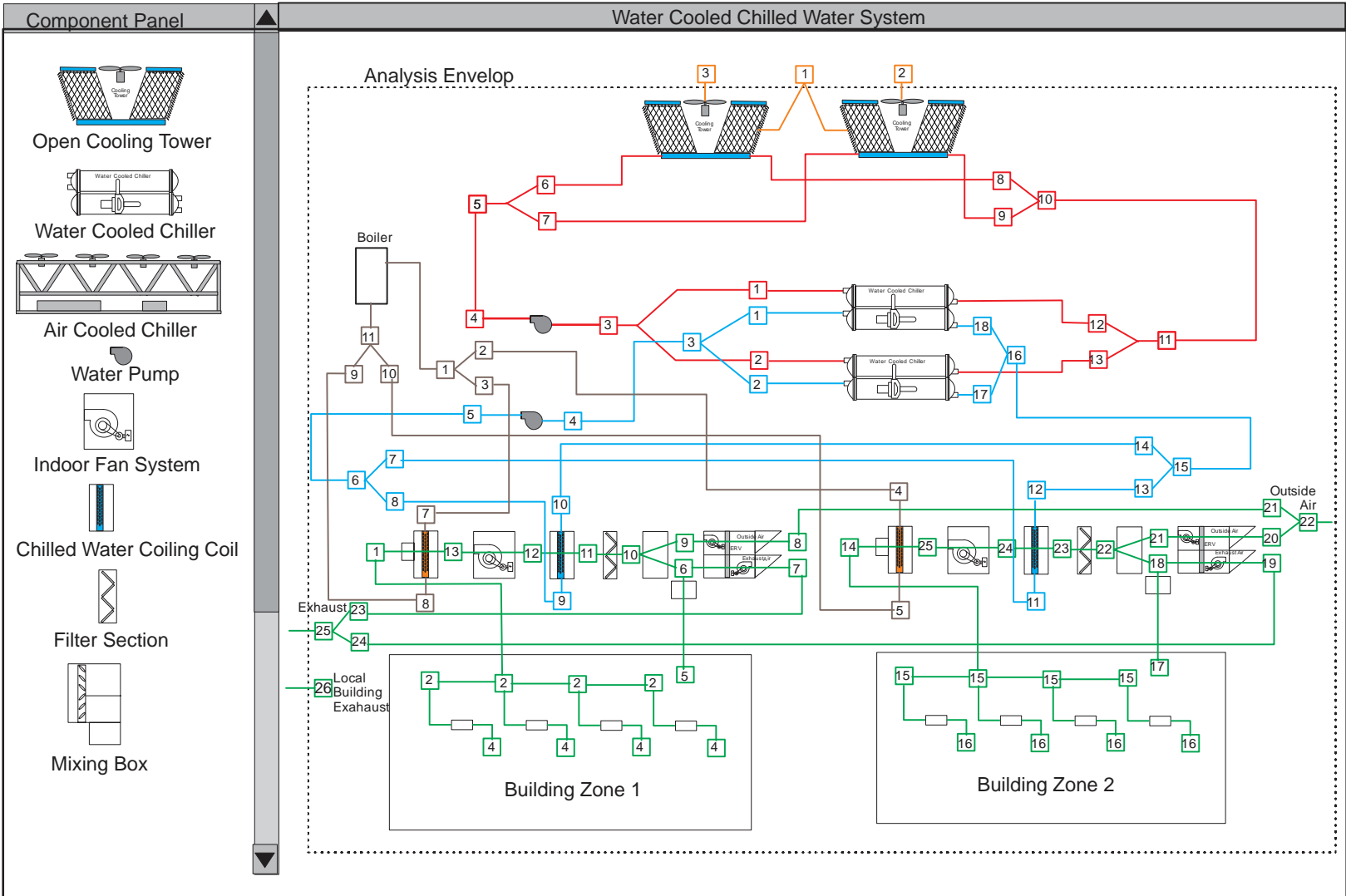


System and Subsystem Modeling Tool

- At Carrier we have started to develop a tool that will be given to the industry to allow for quick modeling and use of the systems and subsystems approach for compliance with energy standards
- Concept is to use a flexible visual Icon based system to allow for visual drawing of the systems and flow paths for air, chilled water, condenser water, hot water, etc.
- Each component in the model would have a performance correlation based on the new ASHRAE 205 Standard (Representation of Performance Simulation Data for HVAC&R and Other Facility Equipment)
- Concept is to allow for two system modeling approaches
 - Option 1 – Use default models and cities to allow for proof of compliance at a subsystem or system level with default equipment typical for the building
 - Option 2 – Use the tool to interface with Energy Plus to allow for a full building evaluation compliant with Chapter 11 or Appendix G relative to the based building requirements

Example Modeling Tool Input Screen

The following is an example of a chilled water system for a commercial building



Questions

**Speaker Presentation—Jeremy Litow,
CLEAResult**

CLEAResult

Leveraging utility incentives for food retailers

Jeremy Litow
Grocery Practice Leader
May 27, 2015

We change the way
people use energy™

About CLEAResult

- Founded - 2003
- Headquartered - Austin, TX
- Regional offices - 47
- Employees - 1,800+
- Utility programs - 700+
- Utility clients - 200+
- Contractors - 20,000+
- Incentives paid - \$500MM+

Topics

- Program offers – challenges of variation
- Program participation – barriers
- Mitigation – planning and execution
- Resources – utility, governmental, private party
- Future trends – awareness and action

Program offers

- Prescriptive and custom
- Retrofit, new construction, retrocommissioning
- Efficiency, demand response, self generation



Variations and barriers to participation – why

- No national, utility style program
- Driven by regulation, which is local
- Budget mismatches
- Design intention to reduce risk
- Avoiding free ridership
- Subject matter limitations
- Negative business impacts
- Programs as rate case support



Mitigation

- Internal alignment – supports utility engagement
- Objectives – 1 measure at 1000 sites, or 10 measures and 100 sites?
- Technical approaches – well defined package
- Aggregate data – how to target

Data

Measures	Number of sites w/ potential	% of sites with opportunity	kWh potential
Air Cooled to Evap-Cooled Condenser-Multiplex	2	1%	571,339
Anti-Sweat Heat (ASH) Controls - Low Temp	64	39%	3,143,213
Anti-Sweat Heat (ASH) Controls - Medium Temp	21	13%	146,971
Evaporated Fan - Walk-In ECM Controller - Low Temp	62	38%	140,847
Evaporated Fan - Walk-In ECM Controller - Med Temp	110	67%	506,260
LED refrigerated display case lighting retrofit	138	84%	12,405,510
Shaded Pole to ECM in Display Cases	81	49%	3,095,040
Shaded Pole to ECM in Walk-in	105	64%	1,683,716
Floating Head Pressure Control - Air Cooled	77	47%	4,684,276
Floating Suction Pressure – Multiplex Air or Evap Cooled	99	60%	891,444
Low Temp Coffin to High Efficiency Reach-in	13	8%	226,991
Low Temp Open to Reach-in	28	17%	571,212
Low Temp Reach-in to High Efficiency Reach-in	8	5%	382,721
Medium Temp Open to Reach-in	99	60%	13,704,834
Night Covers – Horizontal	3	2%	84,677
Night Covers – Vertical	128	78%	964,796
Shaded Pole to PSC in Display Cases	3	2%	183,323
Shaded Pole to PSC in Walk-in	3	2%	47,938
Special Doors with Low/No ASH for Low Temp Reach-in	133	81%	17,895,296
Cases-No doors to French or 3' doors, low LED power	138	84%	8,307,755
Strip Curtains for Walk-in Boxes	145	88%	2,685,788
VFD - Condenser Fan Motors - Air Cooled	138	84%	3,078,953

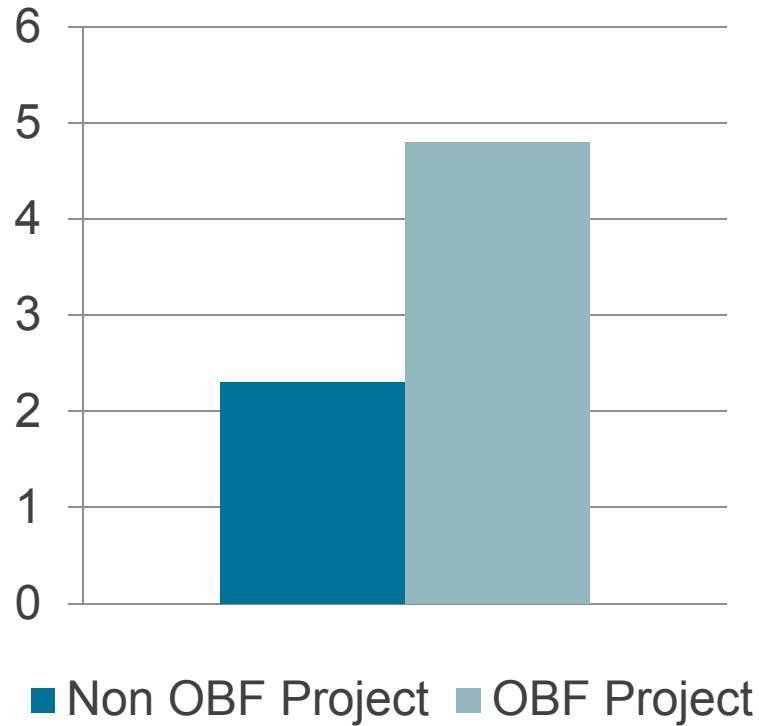
Lights and motors

Controls

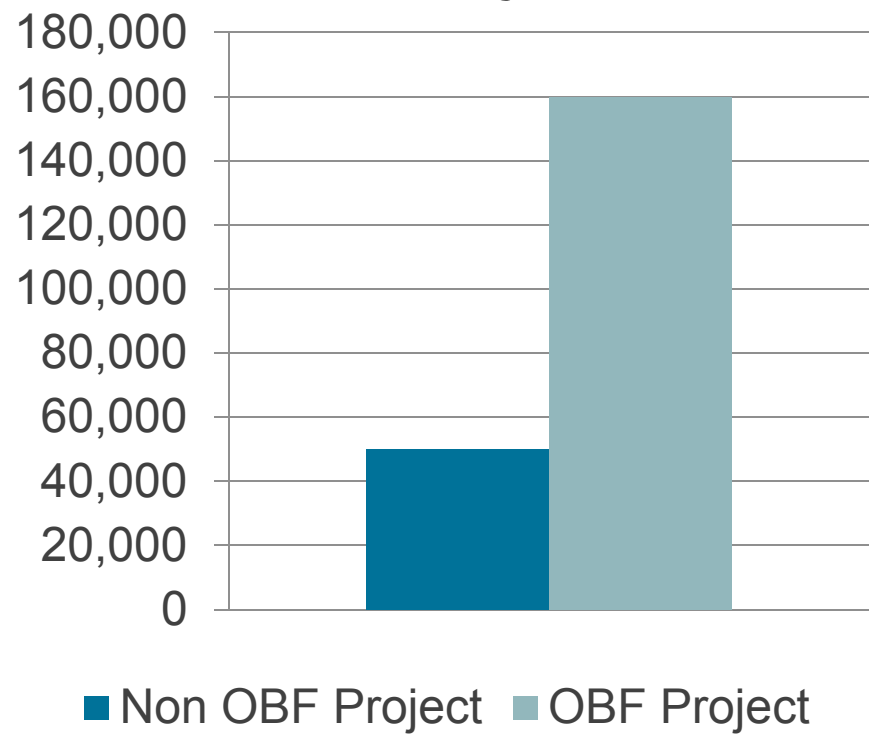
Case Doors

Project rethink?

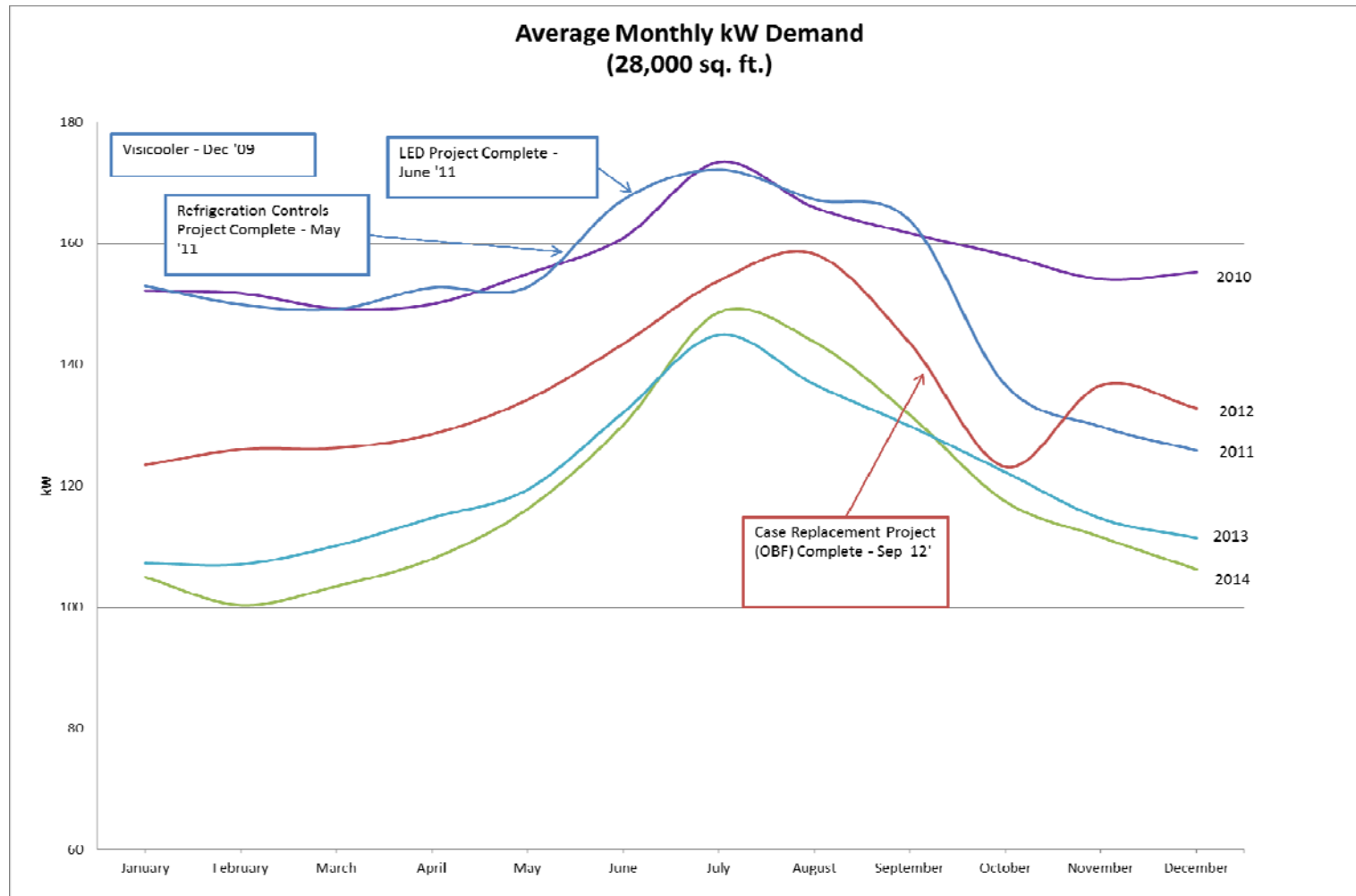
Avg. Measures per Project



Avg. kWh per Project



Measuring success



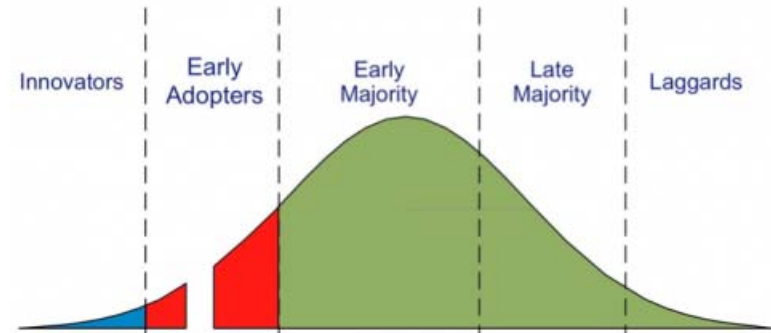
15% load reduction, engaged, repeat customer, comprehensive savings

Resources

- Benchmarking – EPA’s Portfolio manager
- Building analytics – private party tools
- Utility programs
 - Facility assessments
- Third party service providers

Trends

- Awareness
 - Legislative action and spend
 - Codes and technology evolution
 - Rate pressure and competition business model impacts
 - Resiliency and infrastructure
- Action
 - Be ready for more complexity
 - What do you know about your buildings
 - New business models opportunities your benefit



- Jeremy Litow
jeremy.litow@clearResult.com
503.467.0923

Thank you

**Speaker Presentation—John Wallace,
Emerson Climate Technologies**



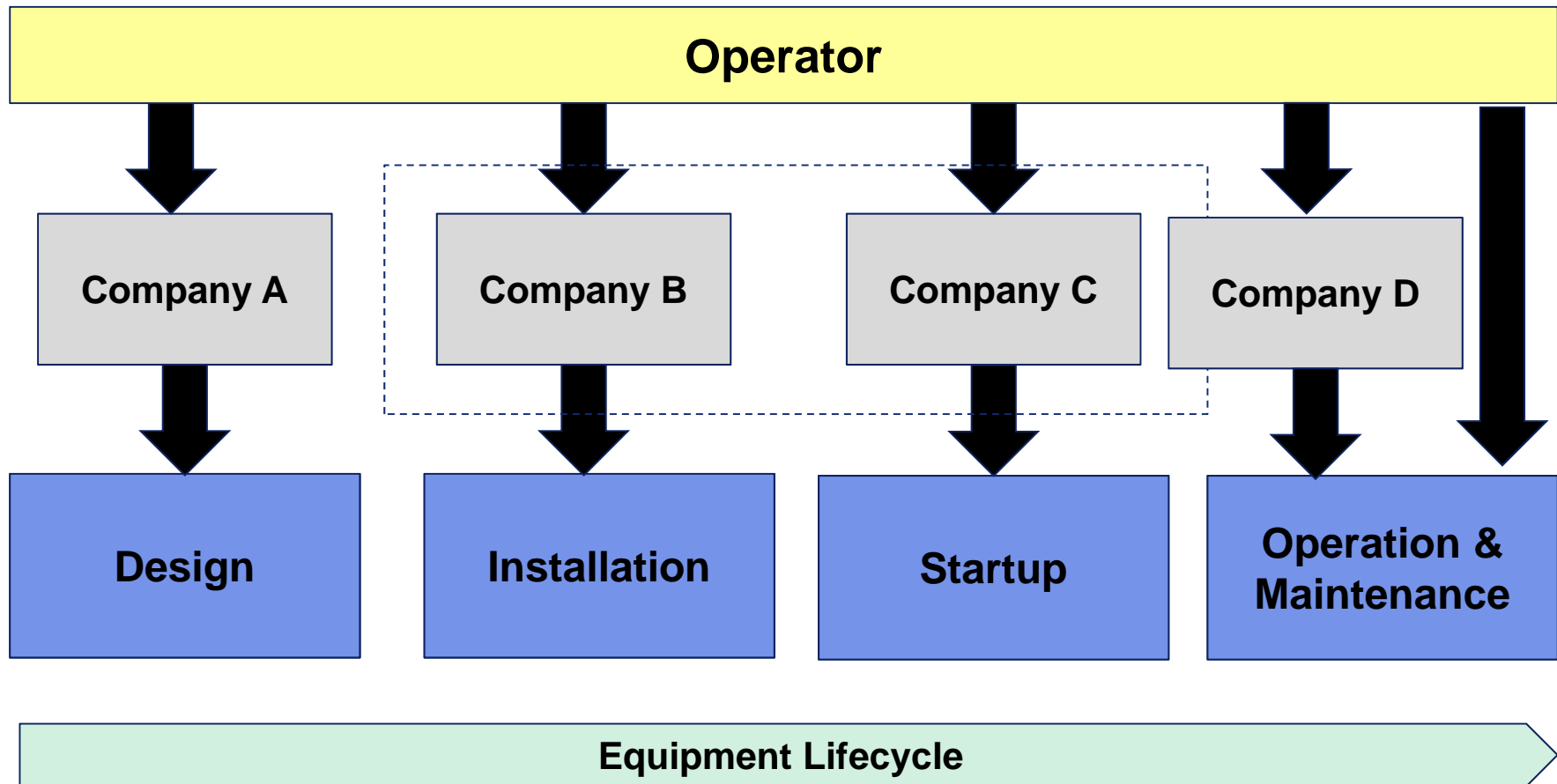
Integrated Supermarket Refrigeration

*Presented To Better Buildings
Alliance*

*John Wallace
Director Innovation
Emerson Climate Technologies
Retail Solutions*



Lots Of “Moving Parts” In Refrigeration Design, Startup & Operations Management

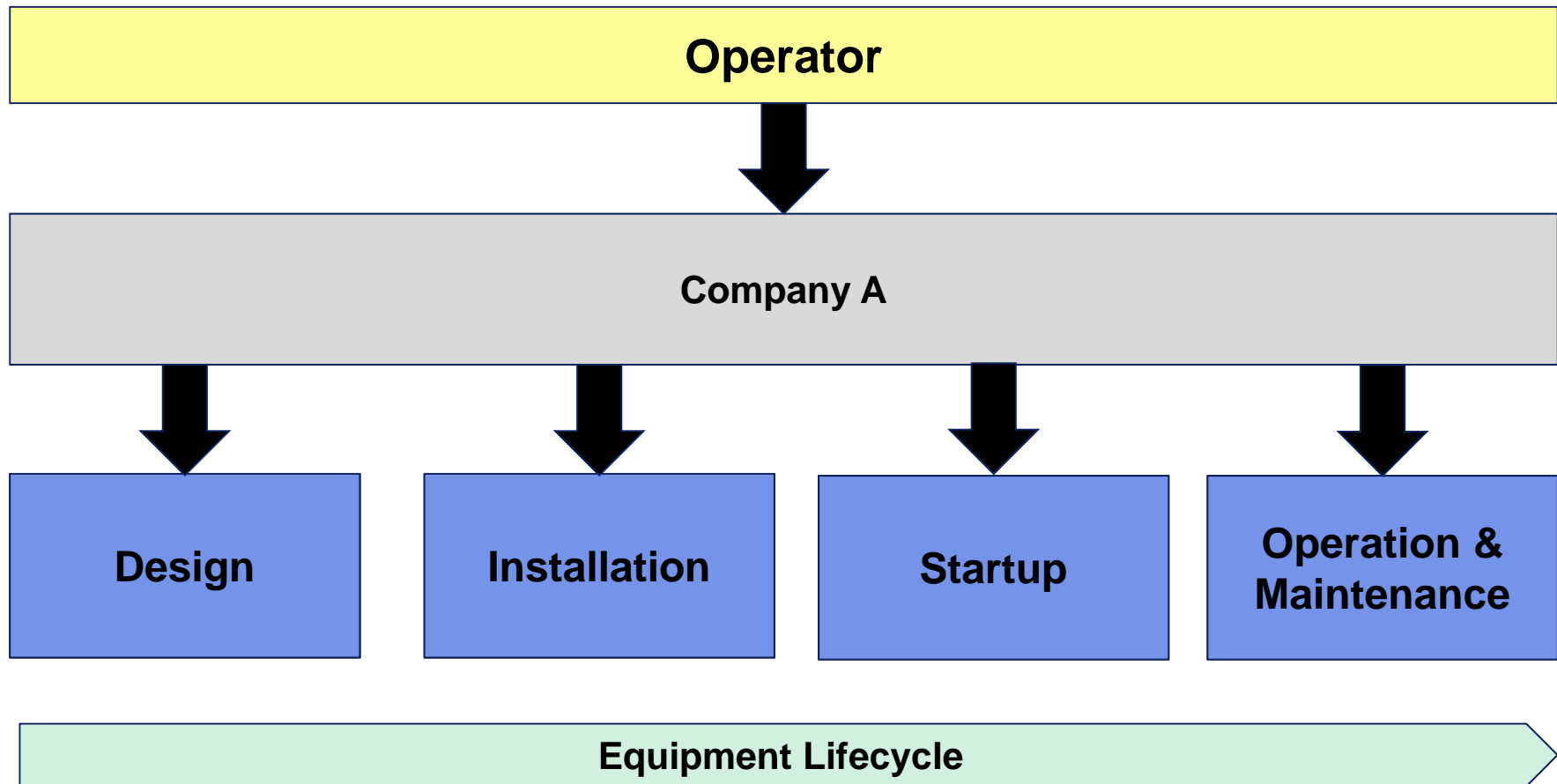


Integrated Solution Concept

Could we bring together all phases – and all parties – in the refrigeration system life cycle, to increase operational efficiency?

- **Could streamlining and integrating the elements of refrigeration service result in cost savings, lowered downtime, or other benefits?**
- **Would having a “go to” source for all refrigeration needs allow retailers to refocus on their core business?**
- **Would retailers be willing or interested in purchasing refrigeration as a service – “paying for cold space”?**

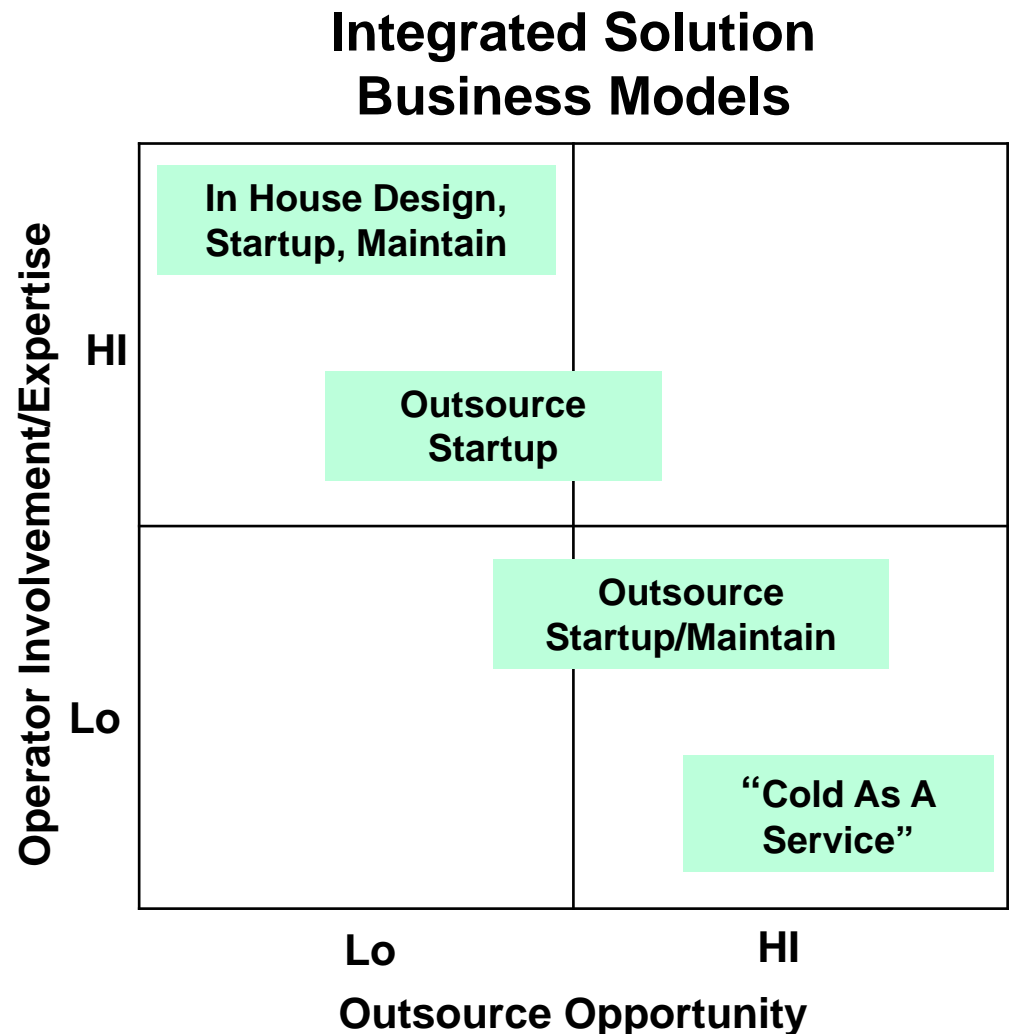
Integrated Solution Would Streamline & Consolidate Lifecycle Management



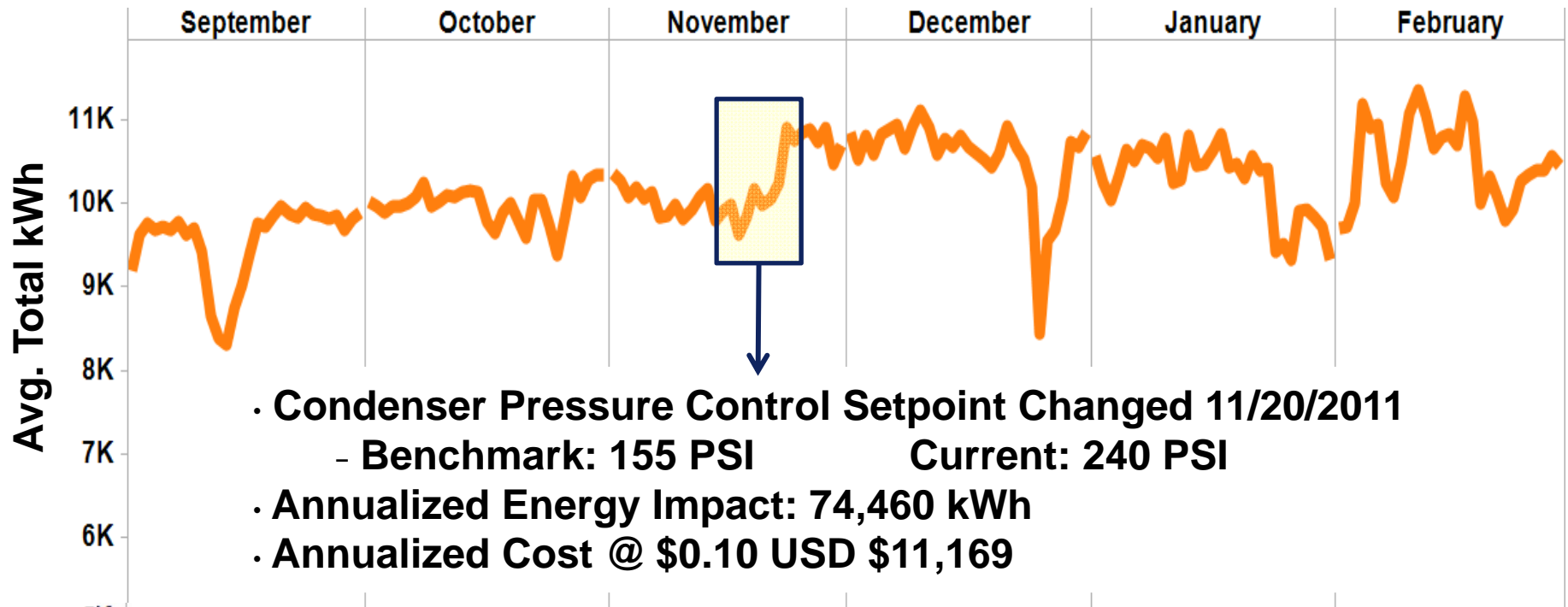
Characteristics Of An Integrated Refrigeration Solution

Potential Benefits

- “One Stop Shop” For Operator
- Tighter Collaboration Between Design & Operation
- No “Finger Pointing”
- Faster Startups
- More Efficient Operation
- Remote Monitoring Provides Energy Savings
- Reduced Up Front Costs
- Fewer Hassles For Operator
- Allows Focus On Selling Versus Operations



Advantages Of Remote Monitoring As Part Of Integrated Approach



Technicians Assess Of Change. Revert Changes When Necessary



Reporting & Evidence

Case Study: Retailer Outsources All Phases Of Refrigeration Lifecycle Management

- Several Aspects Of Integrated Solutions Employed Cold Technology For Their Customers
- Design, Supply, Install, Perform Ongoing Monitoring & Maintenance
- Works With Operations & Merchandising Departments To Understand Key Requirements
- Established Partnerships With OEM's To Insure Equipment Meets Their Standards And Has Features That Enable Easy Installation, Startup & Operation
- Ongoing Monitoring Maximizes Energy Efficiency And Provides Maintenance Optimization

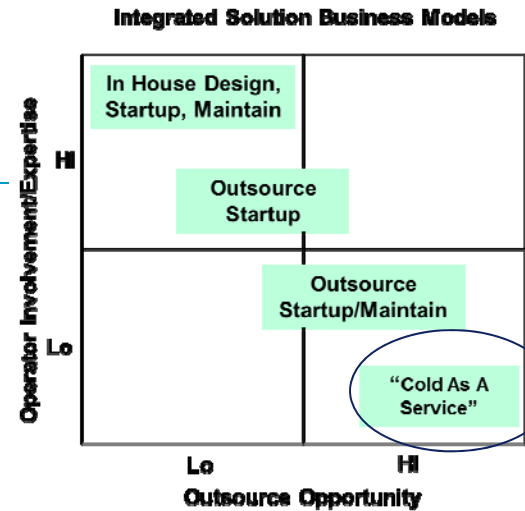
COLD TECHNOLOGY



Integrated Design Employed For Refrigeration, HVAC & Lightings Systems; Tailored To Achieve Operators Merchandising & Operational Objectives

Summary

- Integrating Refrigeration Lifecycle Management Can Simplify All Phases
- Many Potential Benefits To Operator
- Business Model Exists; Examples From Other Industries Include PV, ESCO's, etc.
- Connectivity & Monitoring Technologies Make Overall Management Easier
- "Market" Will Adopt Based On Realized Benefits



A more common sight. (Photo credit: Wikipedia)

Solar upstarts like Sunnova will lease you a roof-full of panels for about the same price you pay your old-fashioned electric utility. This has the makings of a solar boom.

<http://www.forbes.com/sites/christopherhelman/2013/09/25/welcome-to-the-residential-solar-revolution/>