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Commercial New Construction

Lessons to help you make the tough decisions when under pressure

Energy Design Conference – 2/26/2020

FRANKLIN ENERGY

Job Site Safety

- Always top of mind no matter what
- Plenty of potential hazards on site

Welcome

- What brought you here today?
- What are you hoping to learn?
- How many of you work primarily on residential? commercial?
- Regarding building energy efficiency, what are some of the key trends you've noticed in the past 5 – 10 years?

Presenters

Bruce Stahlberg – Energy Advisor – Franklin Energy

Mark Francis – Energy Engineer – Franklin Energy

- What we do…..
- Consult with teams designing and constructing new commercial buildings including retrofits of existing buildings
- Advise customers for enhanced energy efficiency, building performance, and non-energy benefits (ie, comfort, productivity, etc.)

What will we discuss today?

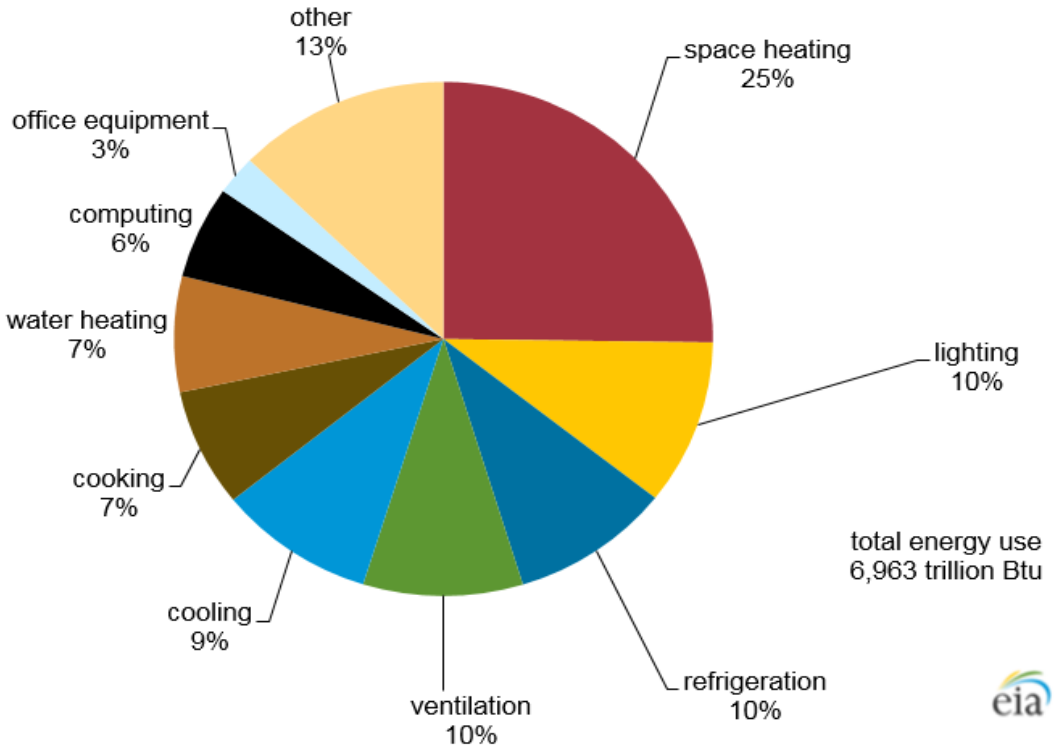
1. Key stats and trends in building energy use
2. Design process for commercial buildings
3. Energy-consuming elements of a commercial building
4. Going beyond typical energy savings
5. What's next?

Projects can be stressful and hard….

- Anyone who has ever done a new build or remodel knows that it can be challenging
- But put in perspective….

Energy use in commercial buildings

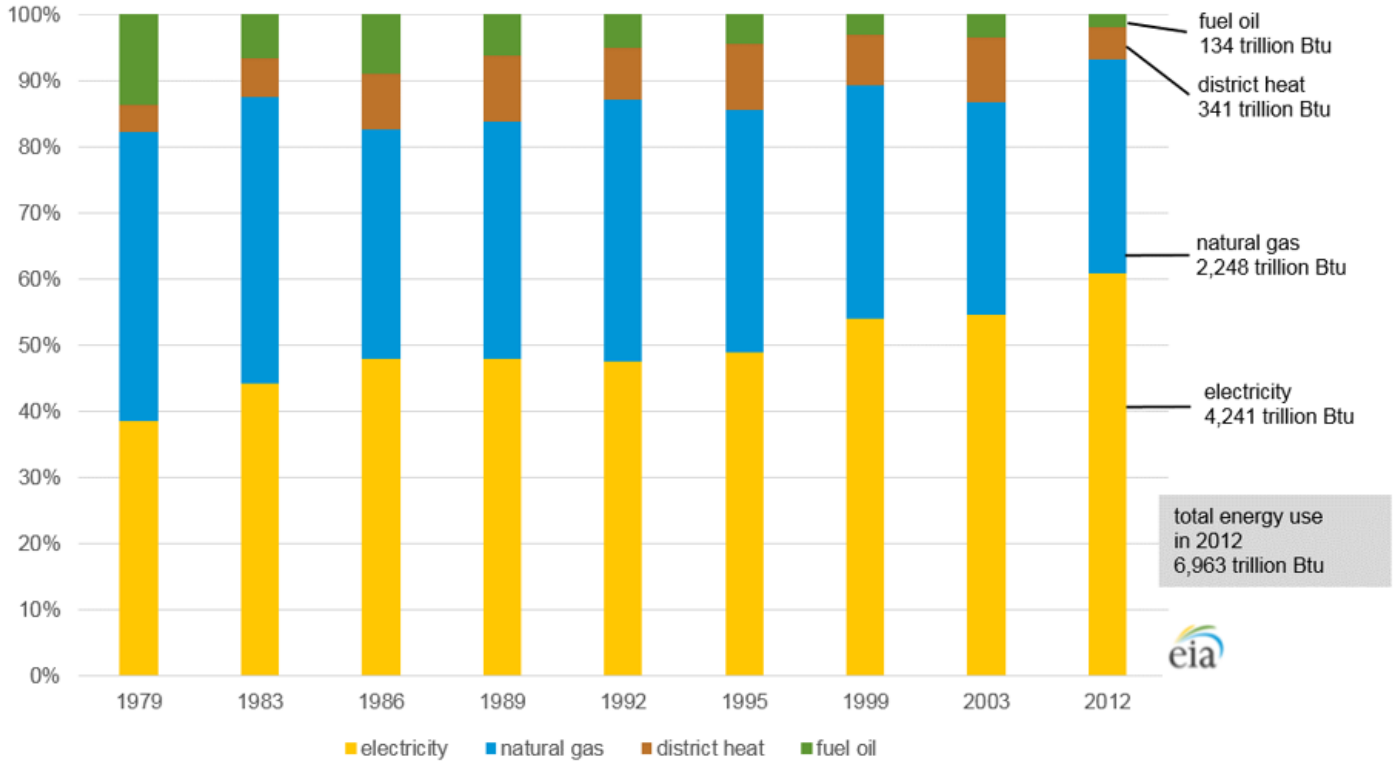
Figure 5. Space heating demanded the most overall energy use in commercial buildings in 2012, followed by other uses



Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey.

Energy use in commercial buildings

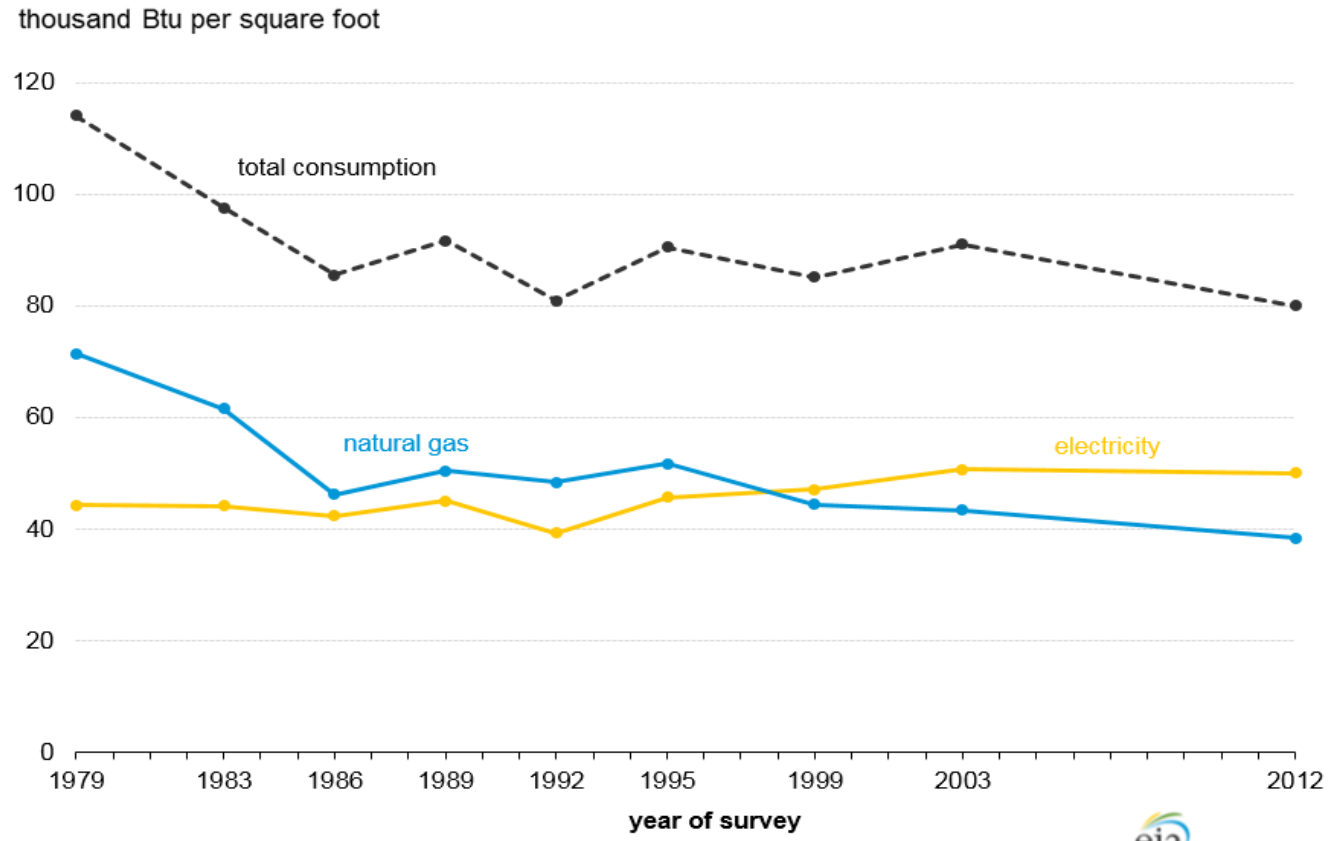
Figure 2. Electricity now accounts for 61% of all energy consumed in commercial buildings



Source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey.

Energy use in commercial buildings

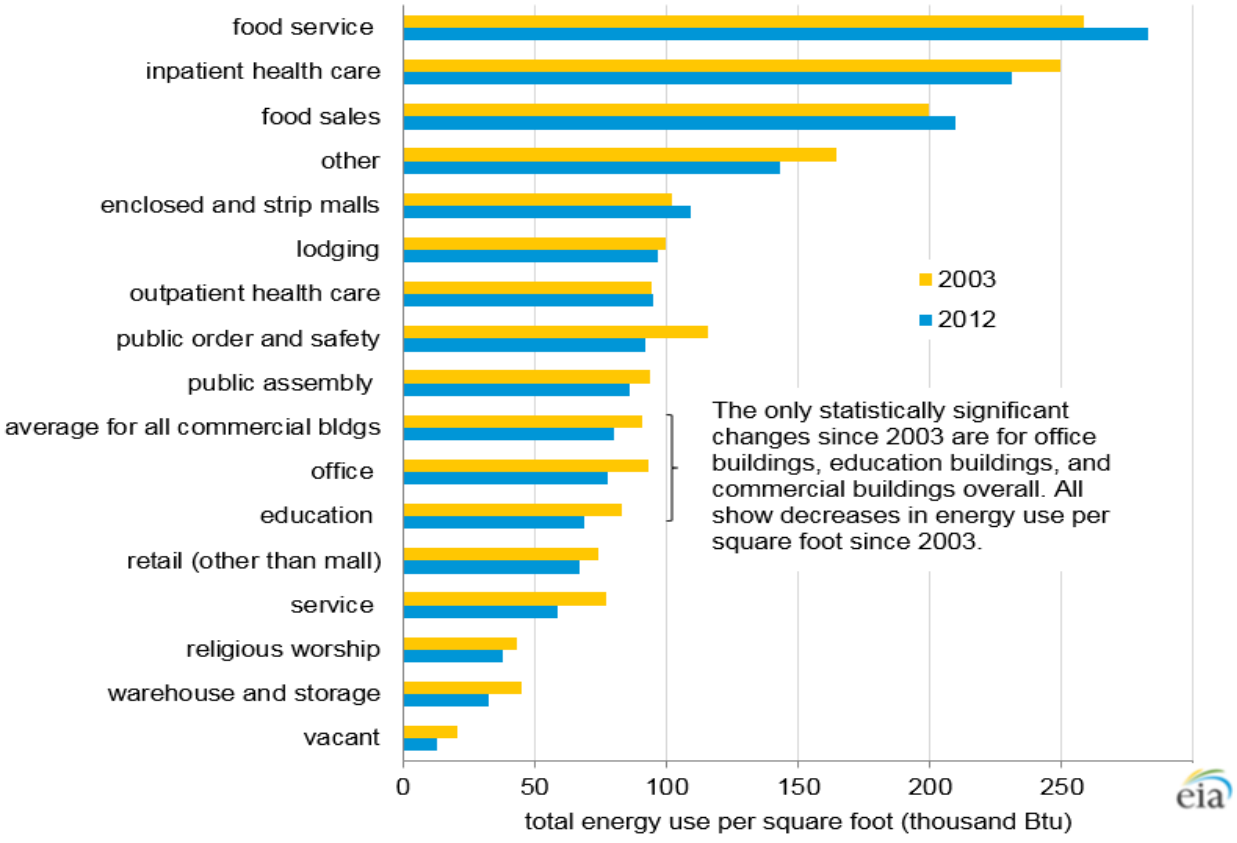
Figure 3. Total energy used per square foot in commercial buildings has decreased since 2003



Source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey.

Energy use in commercial buildings

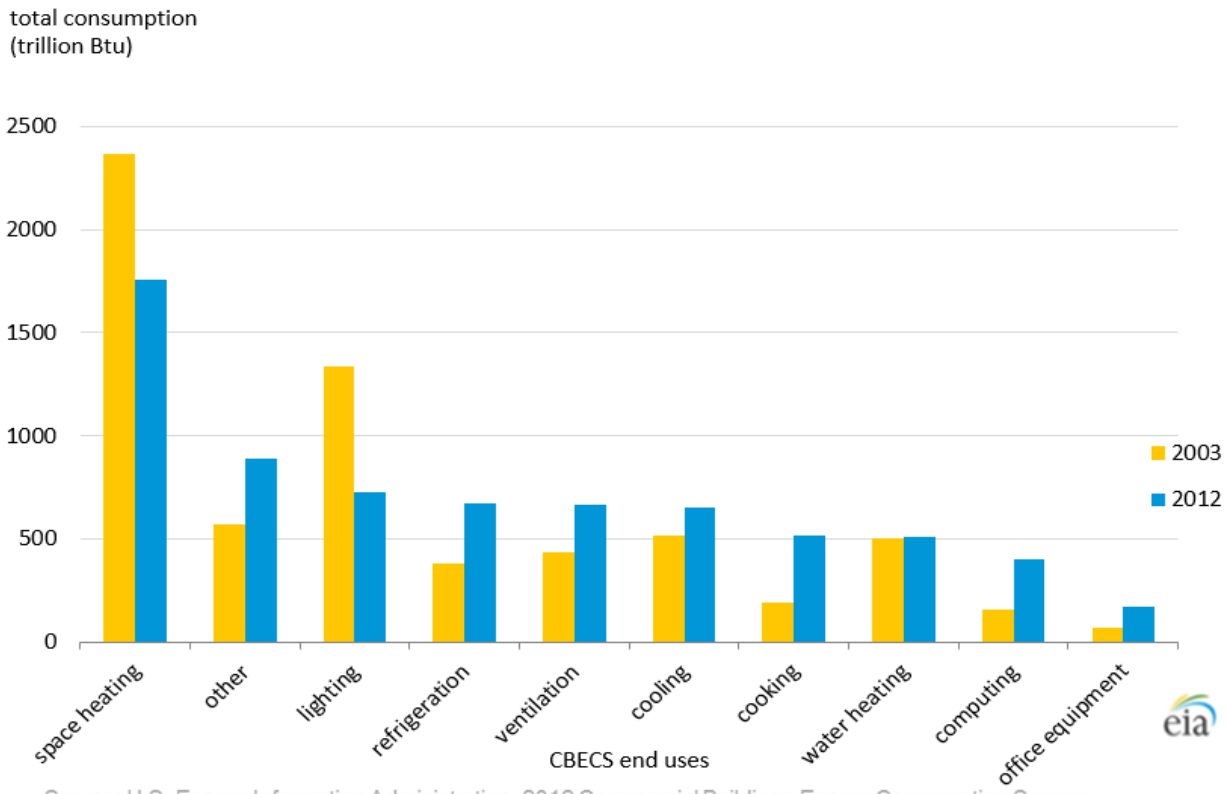
Figure 4. Food service buildings and hospitals are the most intensive users of energy overall



Source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey.

Energy use in commercial buildings

Figure 6. Space heating and lighting energy use in 2012 substantially lower than in 2003

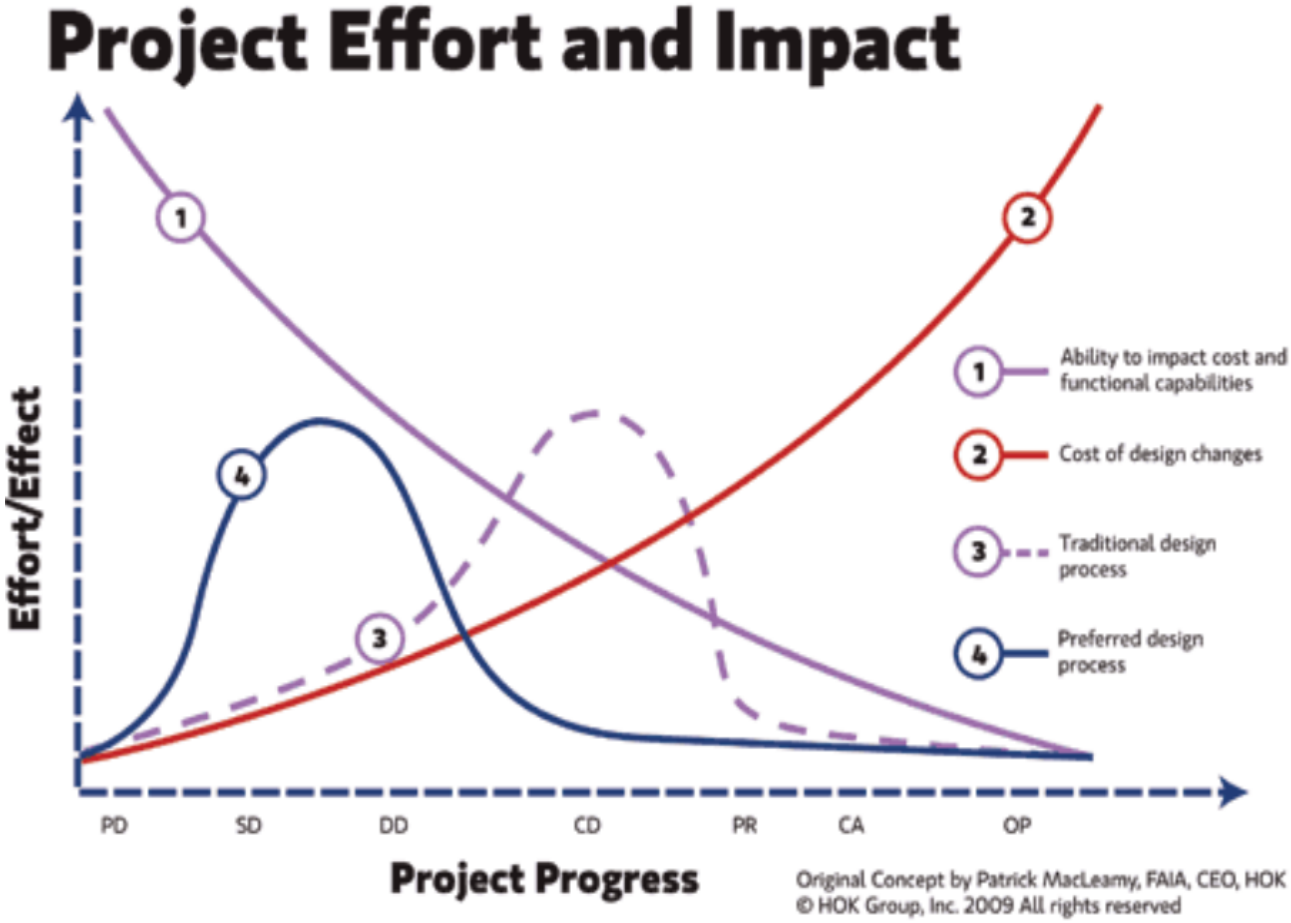


Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey.

Project Timeline / Project Pressures

- There is always stress and pressure: Time, cost, etc.
- You CAN start too late, but you can NEVER start too early with initial concepts, narratives, overall goals.
- Starting too late will generally hurt your effort
- New construction represents a great opportunity to take advantage of a “blank slate”. Think “blue sky” early on – on paper there is no risk.
- Retrofits after initial build: places many restrictions on potential options, and energy efficiency improvements can be expensive.

Project Timeline



Integrated Project Delivery (IPD)

Avoid the “silo” team structure….

Integrated Project Delivery (IPD)

- What is IPD?
  - A structure that gets the owner, designers, and builders together early on and fosters collaboration throughout the entire design and build process.

- What are the benefits?
  - Catch issues earlier in the process before they become costly
  - “Building as a system” mindset
  - Better optimization

- Methods/Tools
  - Setting up routine team meetings
  - Document share sites such as Procore
  - Take advantage of energy modeling if possible (many different choices)

Example of (IPD) Office Building

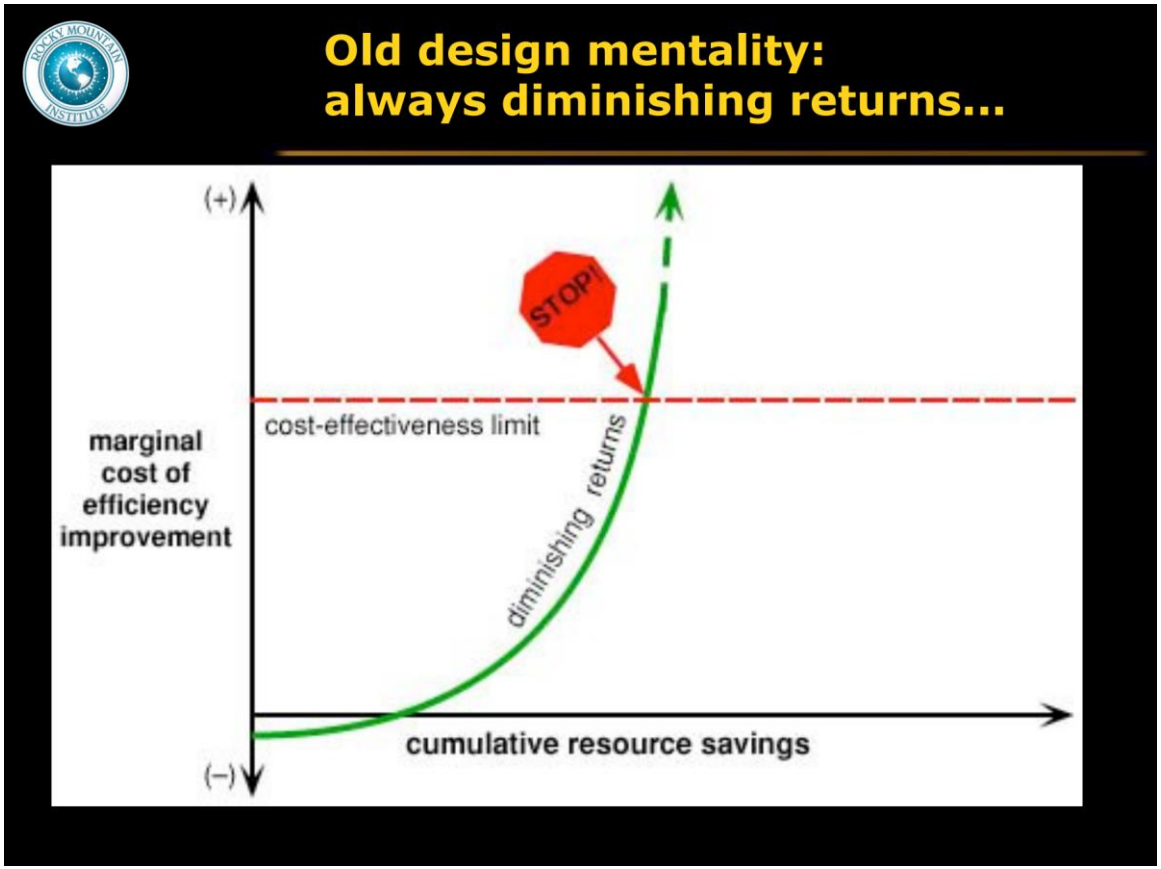
Using IPD to design and build a new Office Building

- Lower heating and cooling loads
- Downsized HVAC equipment
  - Less electricity use = less cooling load
  - Better building shell = less heating and cooling load
- Fewer lighting fixtures

- What are the benefits?
  - Less utility costs to operate
  - More comfort – happier occupants
  - Better control

Source: Advanced Energy Design Guide for Small to Medium Office Buildings – American Society of Heating, Refrigerating, and Air-Conditioning Engineers - 2014

Tunneling through the cost barrier



Source: Advanced Design Integration for Radical Energy Efficiency – Stanford design course for Steve Bishop (IDEO), 30 May 2007 – Amory B. Lovins, Rocky Mountain Institute

Tunneling through the cost barrier

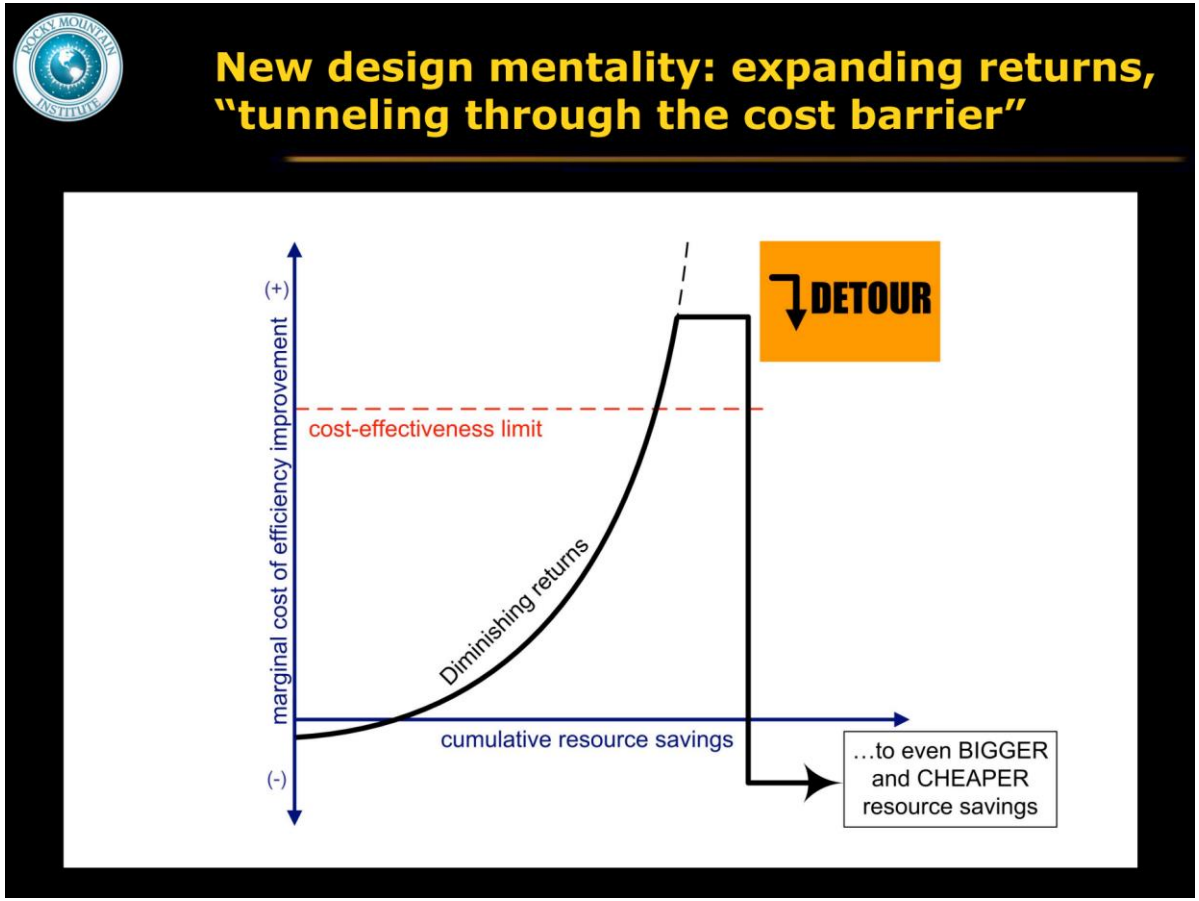
- Two methods of achieving this result. The methods can be combined

  1. Piggyback on improvements made anyway for other reasons, such as renovation of aging equipment, renewal of deteriorating building facades, or removal of such hazards as CFCs, asbestos, and PCBs.

  2. Integrate the design of an entire package of measures, so that each measure achieves multiple benefits, such as savings on both energy AND equipment costs.

Source: Natural Capitalism – Creating the Next Industrial Revolution - Paul Hawken, Amory B Lovins, L Hunter Lovins, 1999

Tunneling through the cost barrier



Source: Advanced Design Integration for Radical Energy Efficiency – Stanford design course for Steve Bishop (IDEO), 30 May 2007 – Amory B. Lovins, Rocky Mountain Institute

Tunneling through the cost barrier

1. Piggybacking onto renovations already planned…

- Original plan = replace leaky windows and renovate large AC system

- Instead, piggyback the following measures...
  - Highly efficient windows, deep daylighting, and efficient lights and office equipment to reduce the cooling load by 85%
  - Reduced cooling load means new cooling equipment can be sized much smaller
  - Additionally, buying high efficiency cooling = downsized even further
  - Resulting energy bill is much lower

Source: Natural Capitalism – Creating the Next Industrial Revolution - Paul Hawken, Amory B Lovins, L Hunter Lovins, 1999

Tunneling through the cost barrier

2. Capturing multiple benefits from each measure…

- Example: Fluid pumping - minimize friction and flow to reduce pumping HP
  - Design for fatter pipes, small pumps
  - Smooth piping design (avoid 90 degree turns)

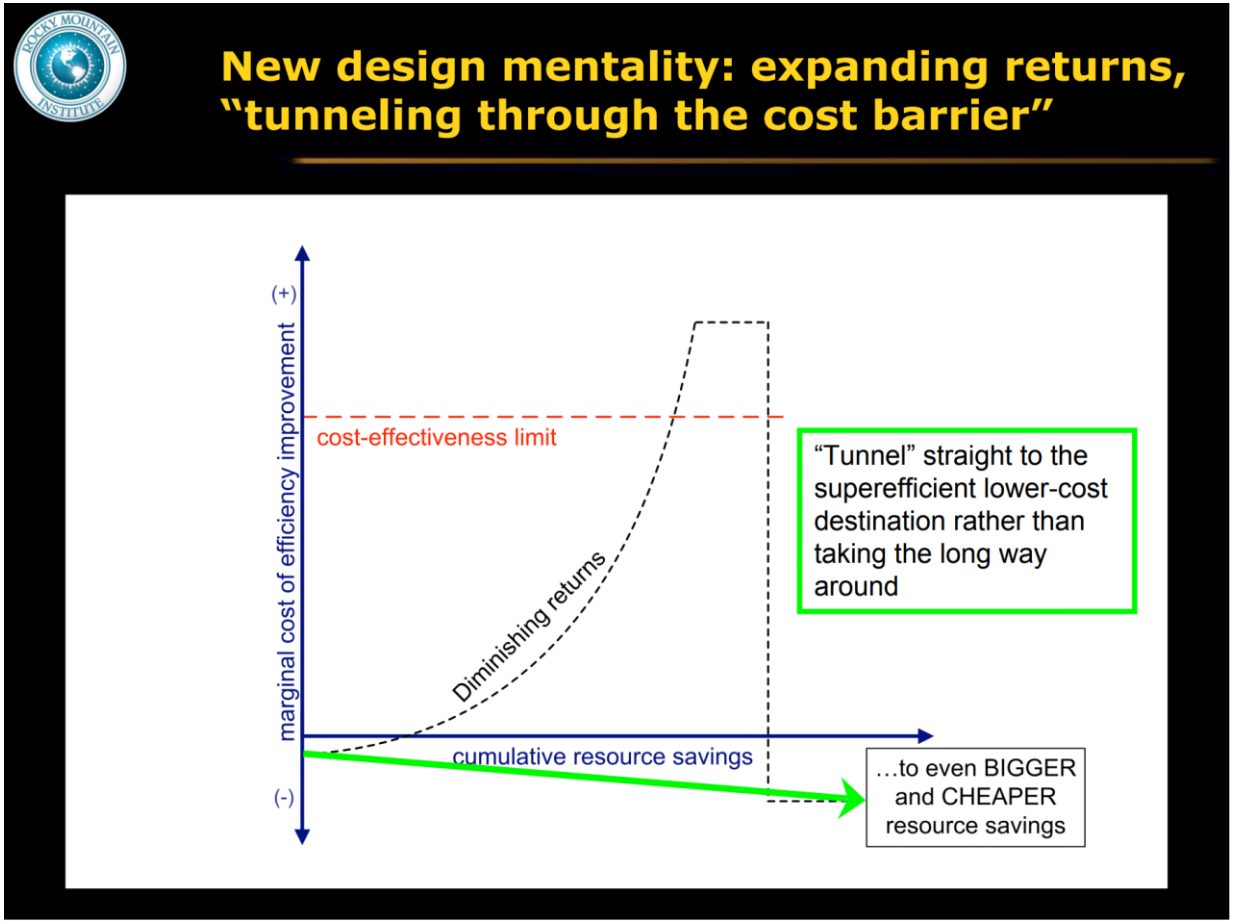
- Resulting multiple benefits
  - Lower capital cost for pumps and motors
  - Less pumping energy, more reliable operation, longer equipment life

- The same analogy applies to ductwork for air flow, fans and fan motors

- Especially important to savings given the "fan laws"
  - $Power_{new} = Power_{old} (RPM_{new}/RPM_{old})^{**}3$

Source: Natural Capitalism – Creating the Next Industrial Revolution - Paul Hawken, Amory B Lovins, L Hunter Lovins, 1999

Tunneling through the cost barrier



Source: Advanced Design Integration for Radical Energy Efficiency – Stanford design course for Steve Bishop (IDEO), 30 May 2007 – Amory B. Lovins, Rocky Mountain Institute

Utilities

- Seek information and assistance from both electric and gas utilities early on
- If you have an assigned account rep, contact them as soon as you embark on early design
- Rebates exist to help you to offset the costs of higher efficiency items which will lead to continued annual energy savings
- Don’t forget about water and sewer savings

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MMUA
Minnesota Municipal Utilities Association

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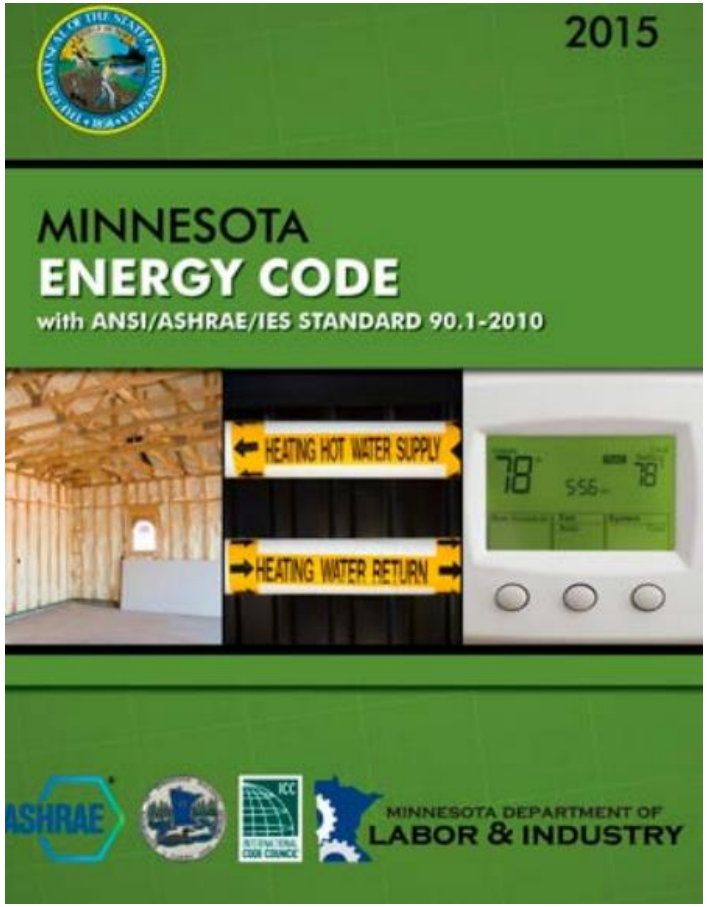
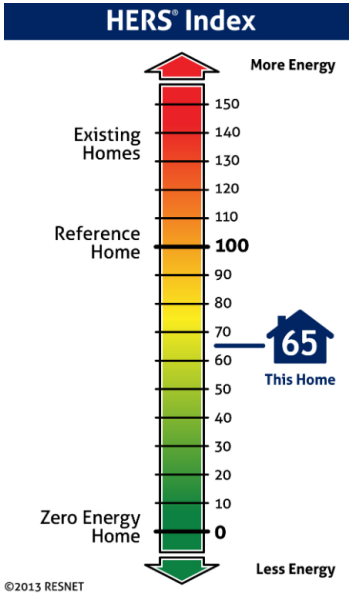
MINNESOTA ENERGY RESOURCES

MN Building Energy Code



Certifications – Pluses / Minuses

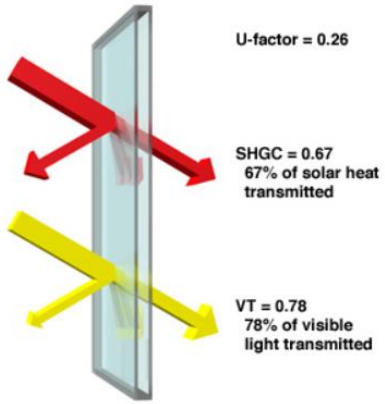


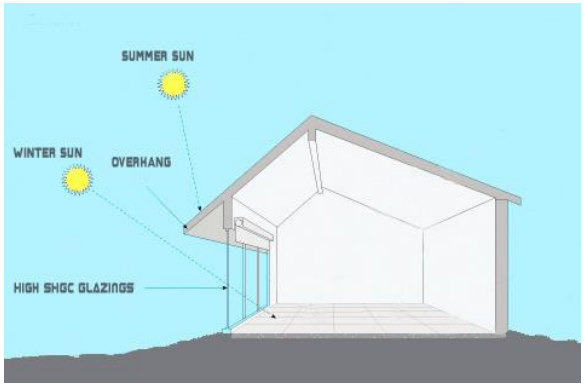
Plan, Plan, Plan.

- Start Early, even before plans
- Dream Big – shoot for the moon
- Get ***all*** parties involved
- Plan for the future
- Check and verify installations

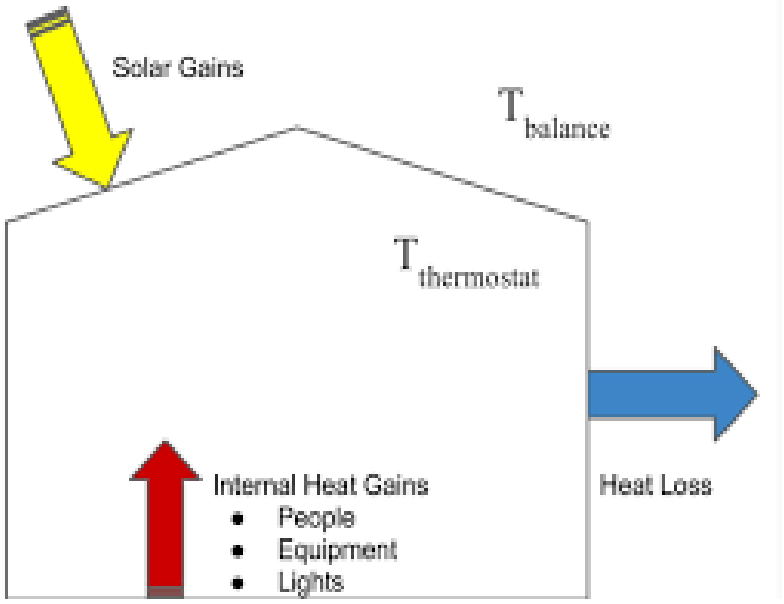
Passive elements – building envelope

- Insulation and air sealing
- Glazing
  - U-value and SHGC can have a significant impact on heating/cooling load
- Roof materials
  - White roof?
  - Shading / overhang
  - Structural able to support solar





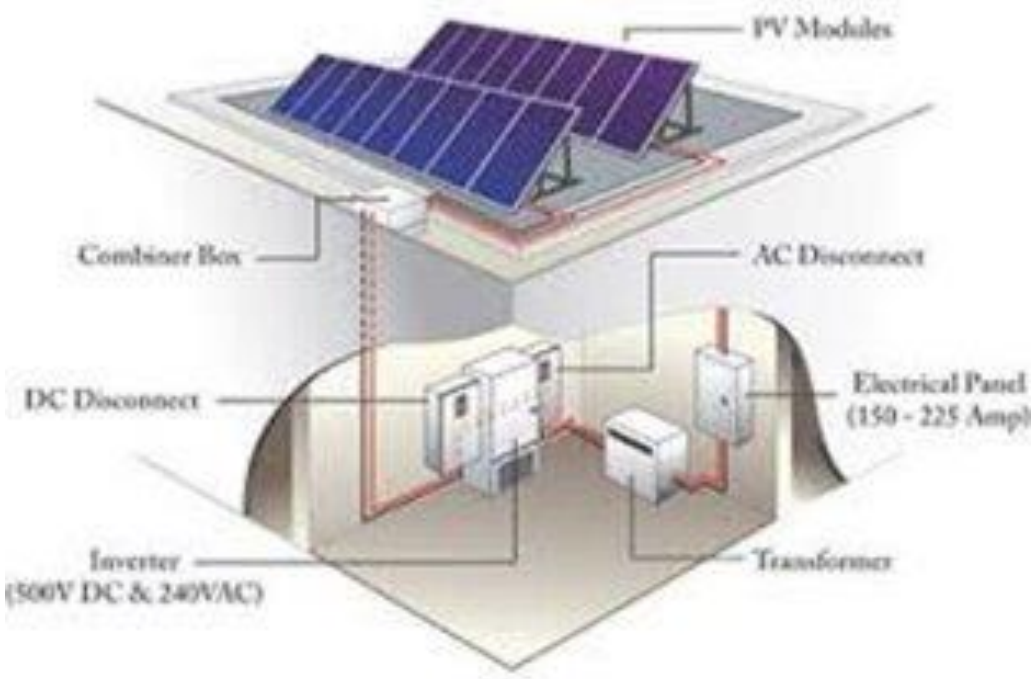
Accurate Load calculations / Staged Systems



- Save on HVAC equipment cost
- Better efficiencies
- Follow actual calculated load = more accuracy
- Redundancy = staged systems
- *Most systems oversized

Start Early! Passive Elements

- These decisions must be made *very early* in the conceptual stage
- Bldg orientation - Elongated south and north exposures - maximize daylighting
- Site shading / solar gain / "solar-ready"



You can pay me now…

"*You can use an eraser on the drafting table or a sledgehammer on the construction site*."

– Frank Lloyd Wright

Old School Lighting Design

- Ceiling fixtures
- Used for work *and* ambient light
- Harsher lighting
- Glare, reduces production
- Consumes more energy

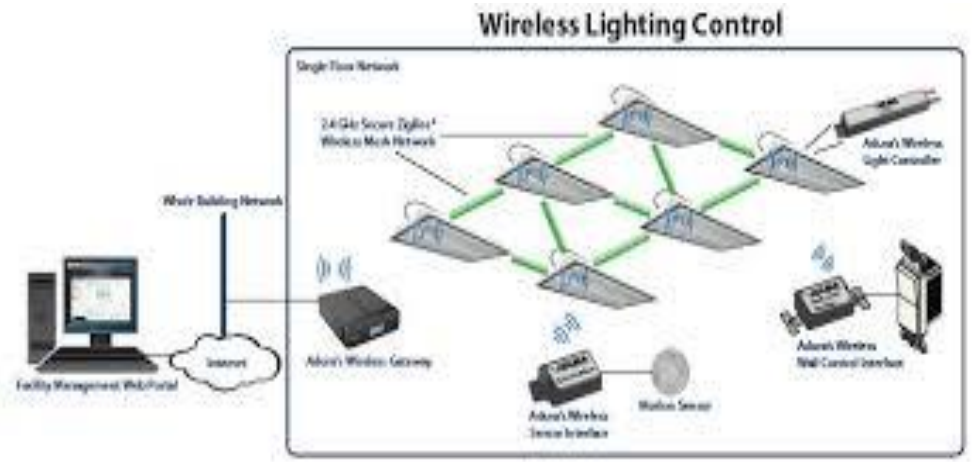
New School Lighting Design

- Lighting technology
  - LED has become “the standard” for new construction
- Paint color selection to “bounce” light around the room while reducing glare
- Office layout to maximize light penetration, utilization

New School Lighting Design

- Put the light where you want it
- Combine with task lighting
- Daylight harvesting

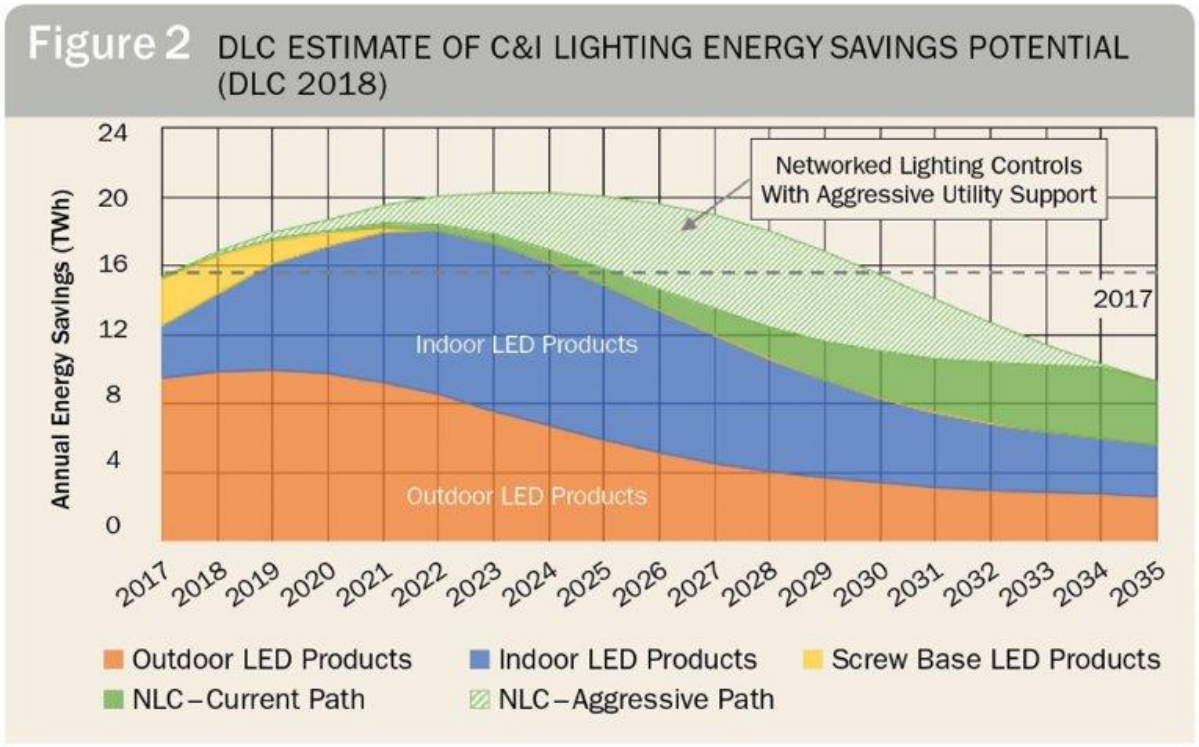
Networked Lighting Controls – wired and wireless



- Lighting Controls
  - Occupancy Sensors
  - Vacancy Sensors (must turn on)
  - High End Trim
  - Daylight Harvesting
  - Scheduling
  - Plug load scheduling

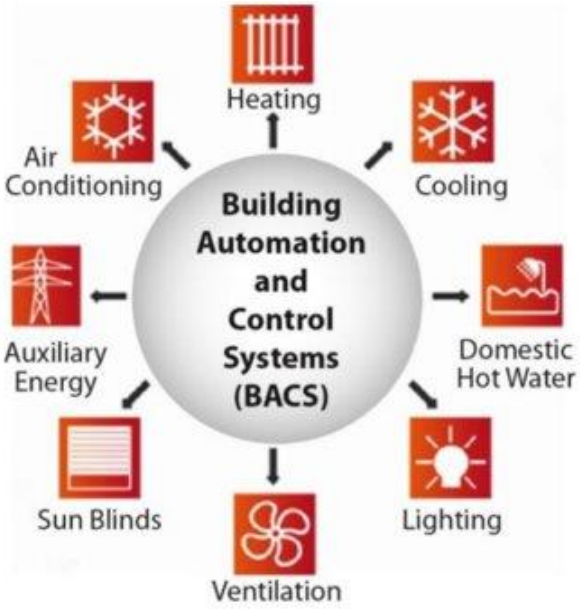
Networked Lighting Controls

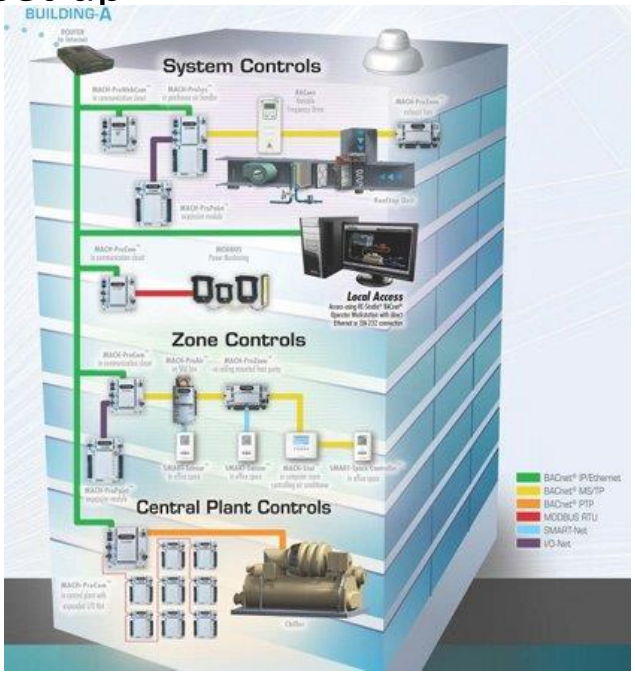
- Connected, intelligent network of luminaire and control devices
  - Energy Savings: ranges from 23% to 82%
  - Energy Savings: Average of 47%



Building Controls

- Controls – simple to complex
- Energy Savings – 10% to 30%
  - Simple programmable thermostat per zone
  - High complexity – full blown BAS/EMS including lighting control system
  - Important to verify the installation / set up





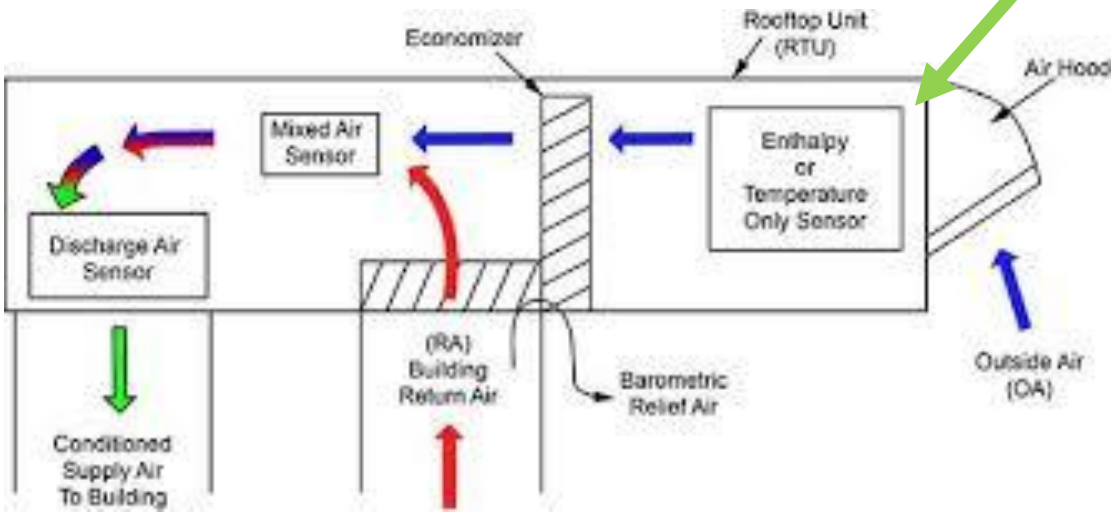
Operating and Maintaining the Building

- Initial and continuous commissioning
- *Ongoing Data collection and trending – important*
- Metrics - BTU/sq. ft, $ / sq. ft

Economizer – Demand Controlled Ventilation

- Economizing
  - Free cooling
  - Full, mixed, or no outdoor air depending on outdoor conditions

Temperature *and* Enthalpy Sensing

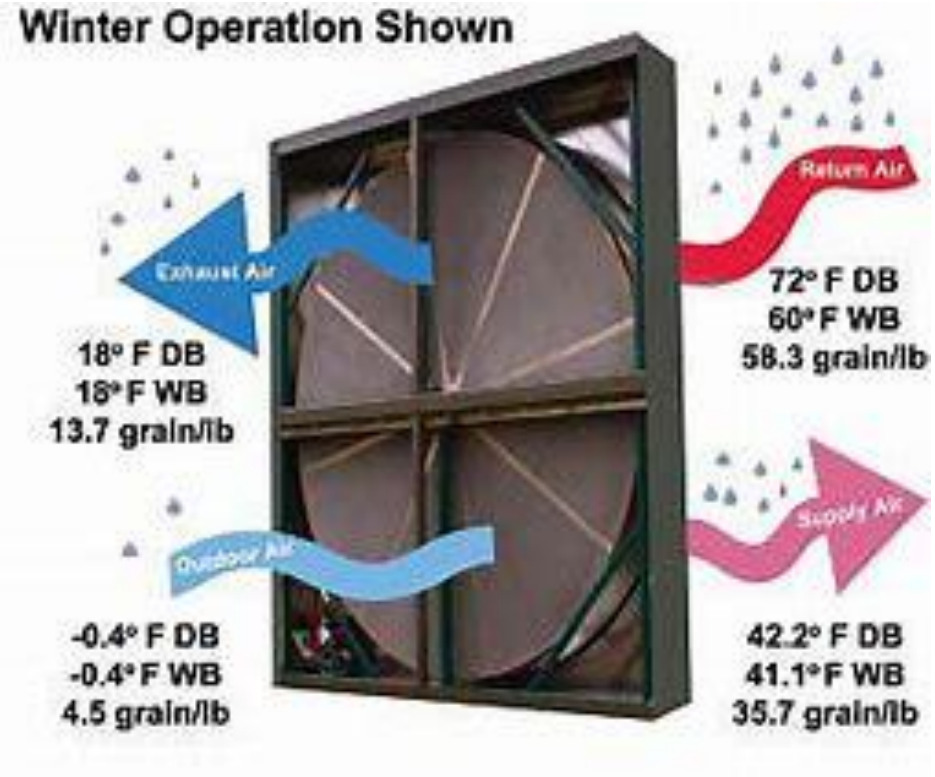


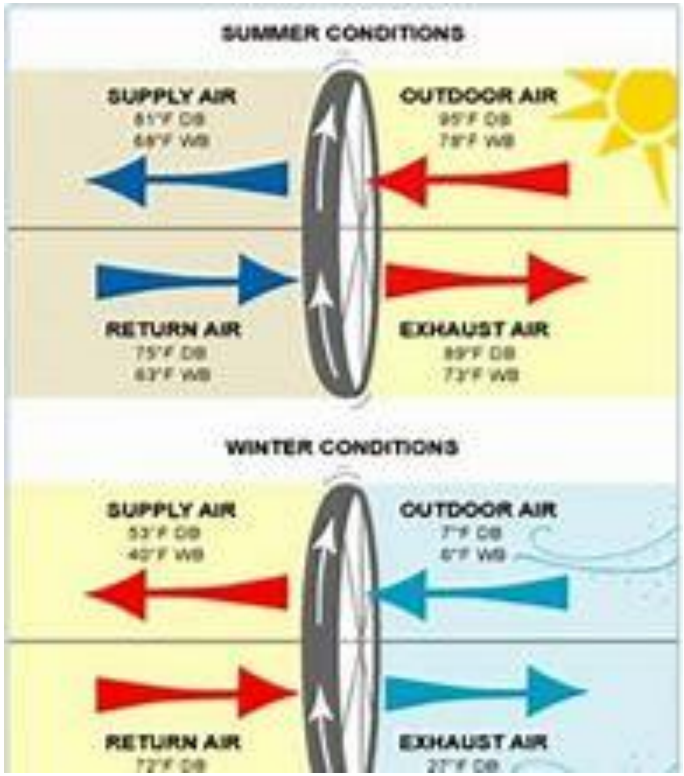
CO2 Sensors = People

Economizer

- Fresh air intake
- Humidity and temp
- “Free” cooling
- Adjustable per occupancy
- Demand Controlled Ventilation (DCV)

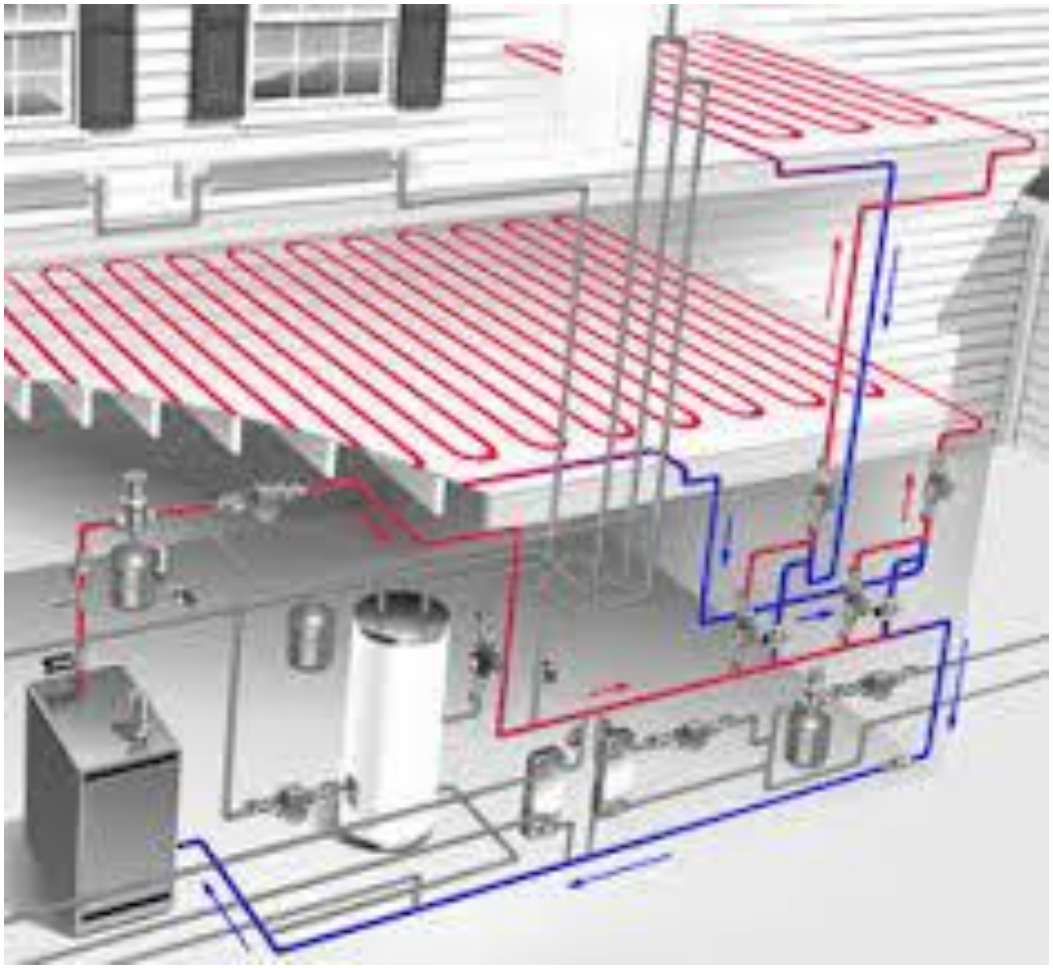
Heat Recovery/Enthalpy Wheel





Types of heating and distribution choices

- In-floor heat
- Forced Air
- Boiler Radiation
- Solar thermal
- Wood fired
- Other



Types of heating and distribution choices

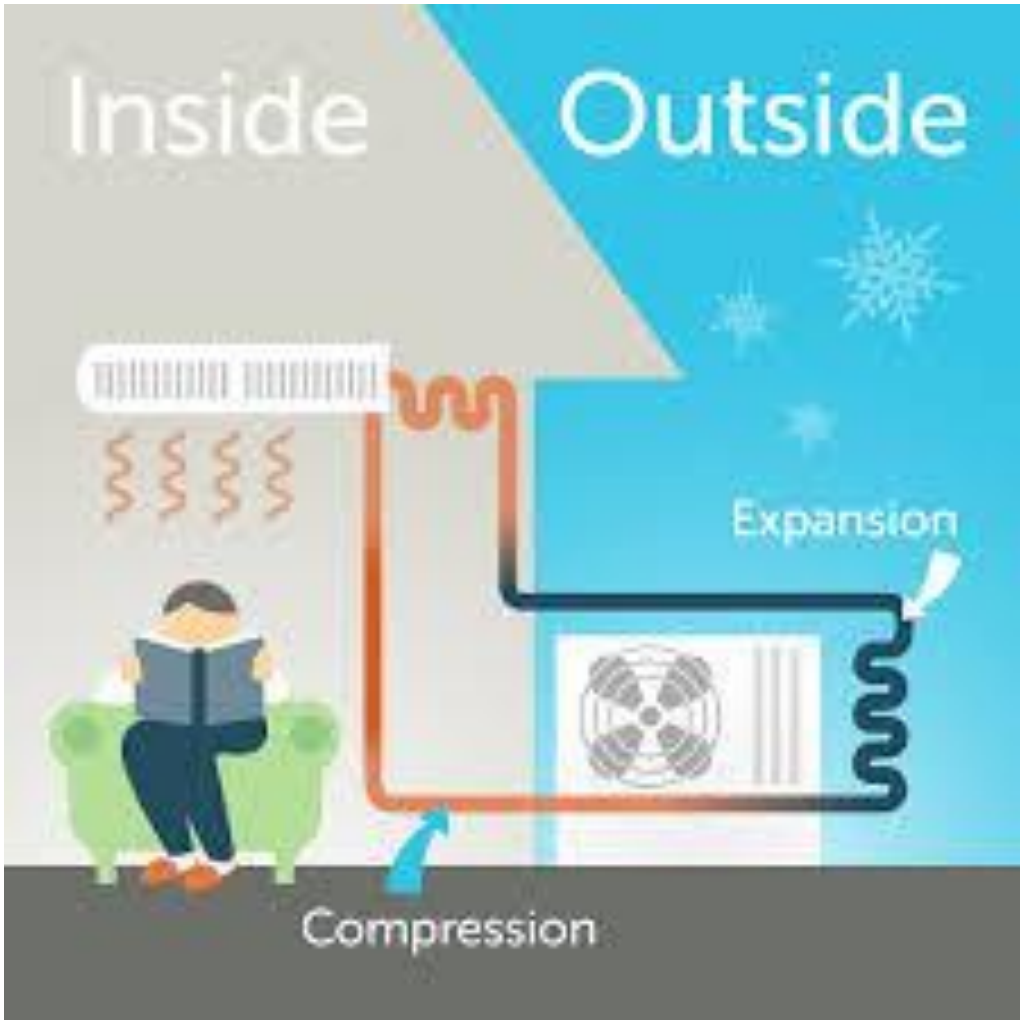
- Thermal storage
- Electric off-peak

Old School

New School

Cold Climate Heat Pumps

- Becoming more common
- CCHP – Cold Climate Heat Pump systems
- Efficiency 150% to 300%
- Low as -13 F
- Can do both heating and cooling



Ground Source - Geothermal

- The largest energy storage device ever
- Stable year-round temperature ~50 degree F
- Pumping only
- Easily adaptable to simultaneous heating and cooling modular systems

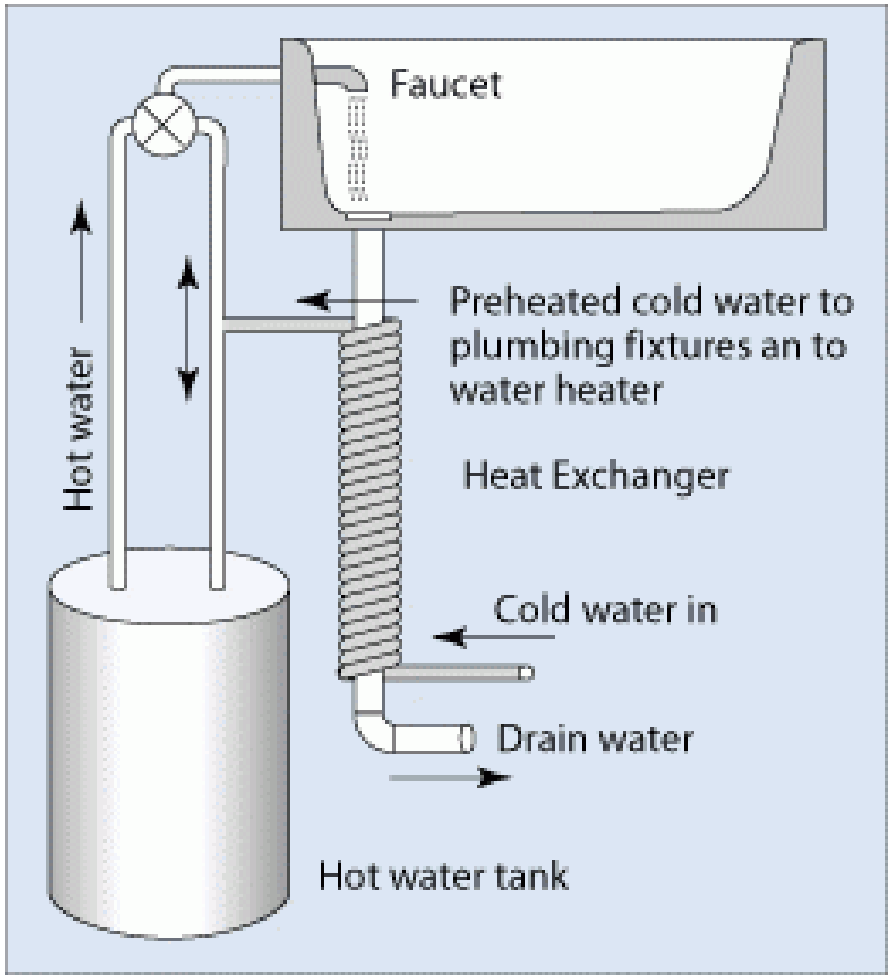
Piping – Old School

- 90 degree turns the norm
- Higher pressure
- More pumping power needed
- Used 90 degree turns

Change Mentality – Piping Design

- Big Pipes, small pumps (not the opposite)
- Lay out the piping first, then the equipment (not the reverse)
- Fat, short and straight
- 45 degree turns and Ys
- Think drain pipes

Heat Recovery - Water



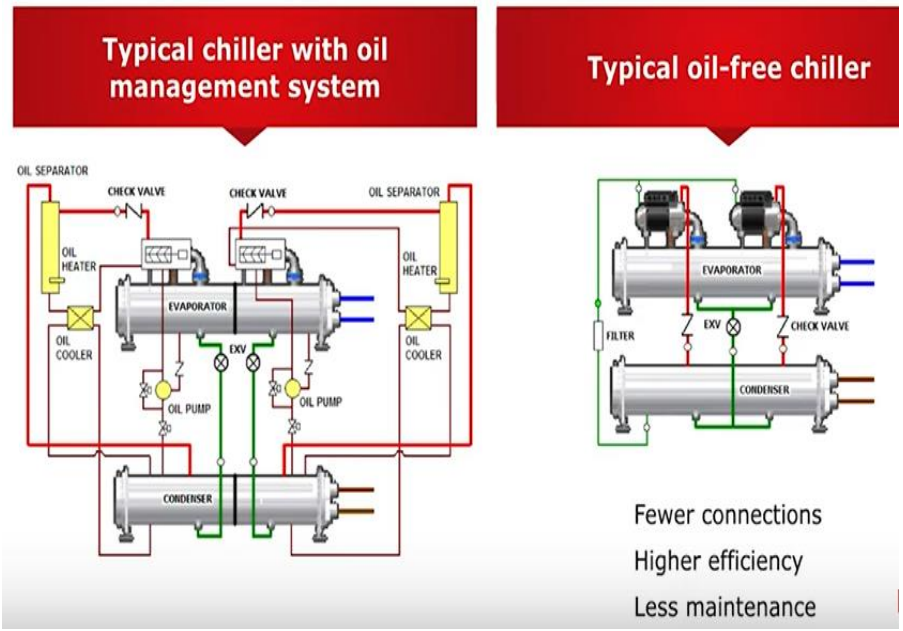
- Capture heat off drain
- Larger users
  - –Hospitals
  - –Gymnasiums
  - –Universities

Commercial Heat Recovery application

Modulating Chillers

- Independent refrigeration systems
- Redundancy
- Coupled together to form a chiller system
- Master controller oversees operation
- EASY to stage

Oil Free Magnetic Bearing Chillers



- Eliminates complexity
- Reduces Maintenance
- Increases Efficiency

What's Next?

"It's tough to make predictions – especially about the future" - Yogi Berra

Plan for the future

Solar Panels – Now or later?

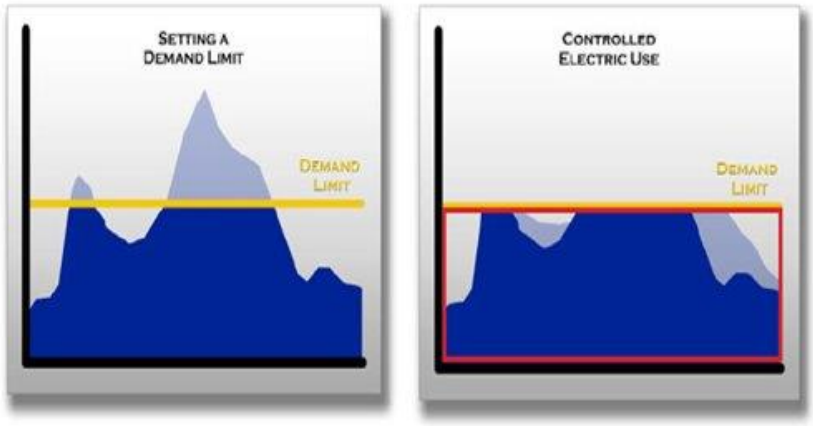
- Plan for solar
- Even if not installing
- Plan for future installation
- “Solar ready”
- Roof –
  - Structure
  - Electrical
  - Metering

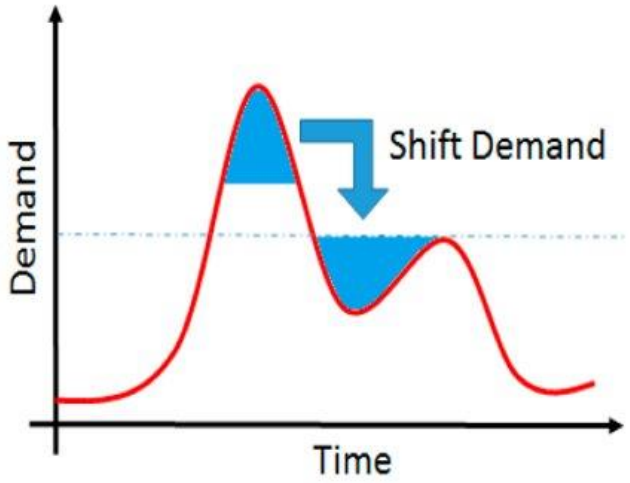
EV Charging


ELECTRIC
VEHICLE
CHARGING
STATION


ELECTRIC
VEHICLE
PARKING
ONLY
ELECTRIC
VEHICLE
PARKING
ONLY

Demand Response / Demand Shift





- Utility programs and benefits
- More important moving forward
- Incorporate into design
- Able to shift loads at *specific* times
- Shift loads is valuable to utilities

Modulating Chillers

- Independent refrigeration systems
- Connected in parallel
- Coupled together to form a chiller system
- Master controller oversees operation
- EASY to stage

In Summary

- Start Early, even before plans
- Dream Big – shoot for the moon
- Get ***all*** parties involved
- Plan for the future
- Check and verify installation

And remember….things don't always go as planned

Questions?

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