URS

Commissioning, LEED, and Energy Conservation

A Holistic View

August 20, 2014

Agenda

- Introduction of the Presenters
- Why Talk About This?
- Energy Efficient Design: Major Components
    - LEED
    - Energy Conservation
    - Commissioning
- Putting It Into Practice
    - Integrative Design Process
    - Energy Modeling
    - Sustainable Return on Investment (sROI)
- Things To Look Out For
- Questions and Answers

Introduction of the Presenters

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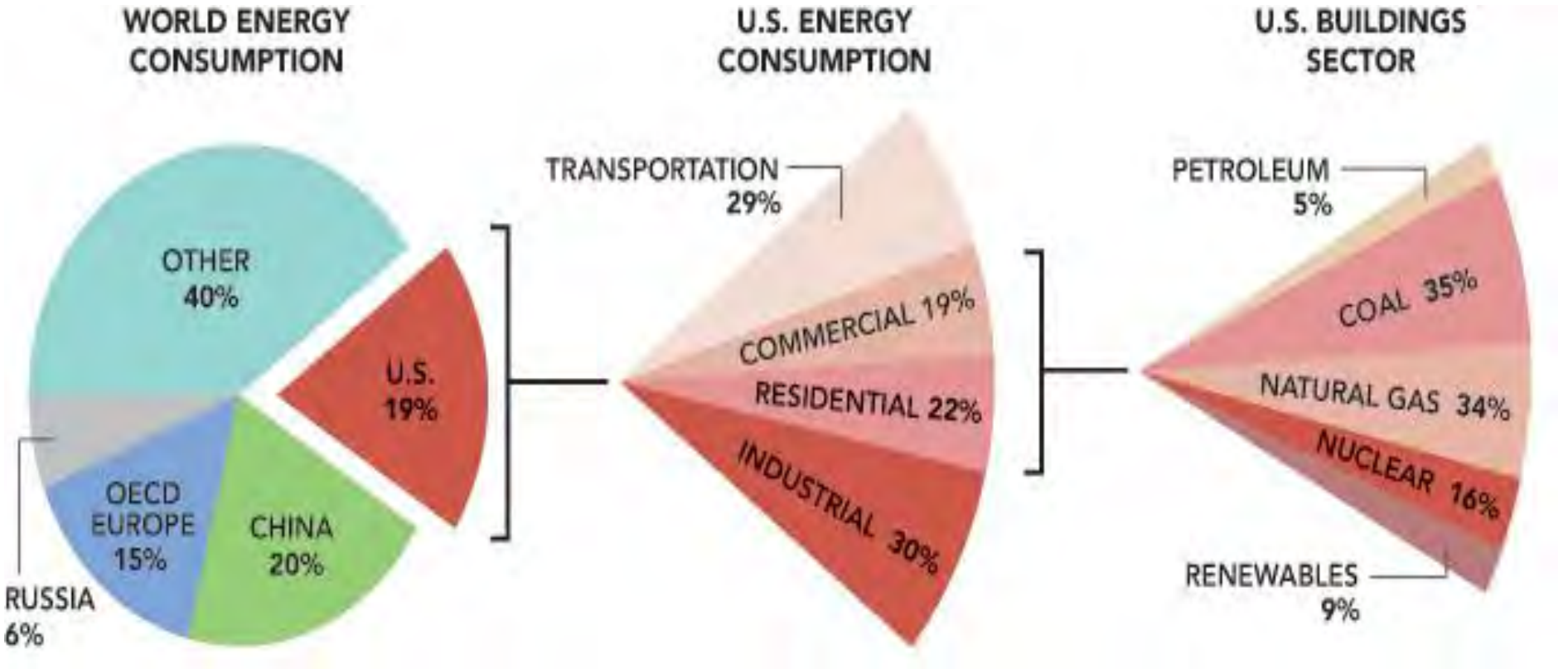
Participant Breakdown

Why Talk About This?

Buildings use a lot of energy

US Primary Energy Consumption 2010

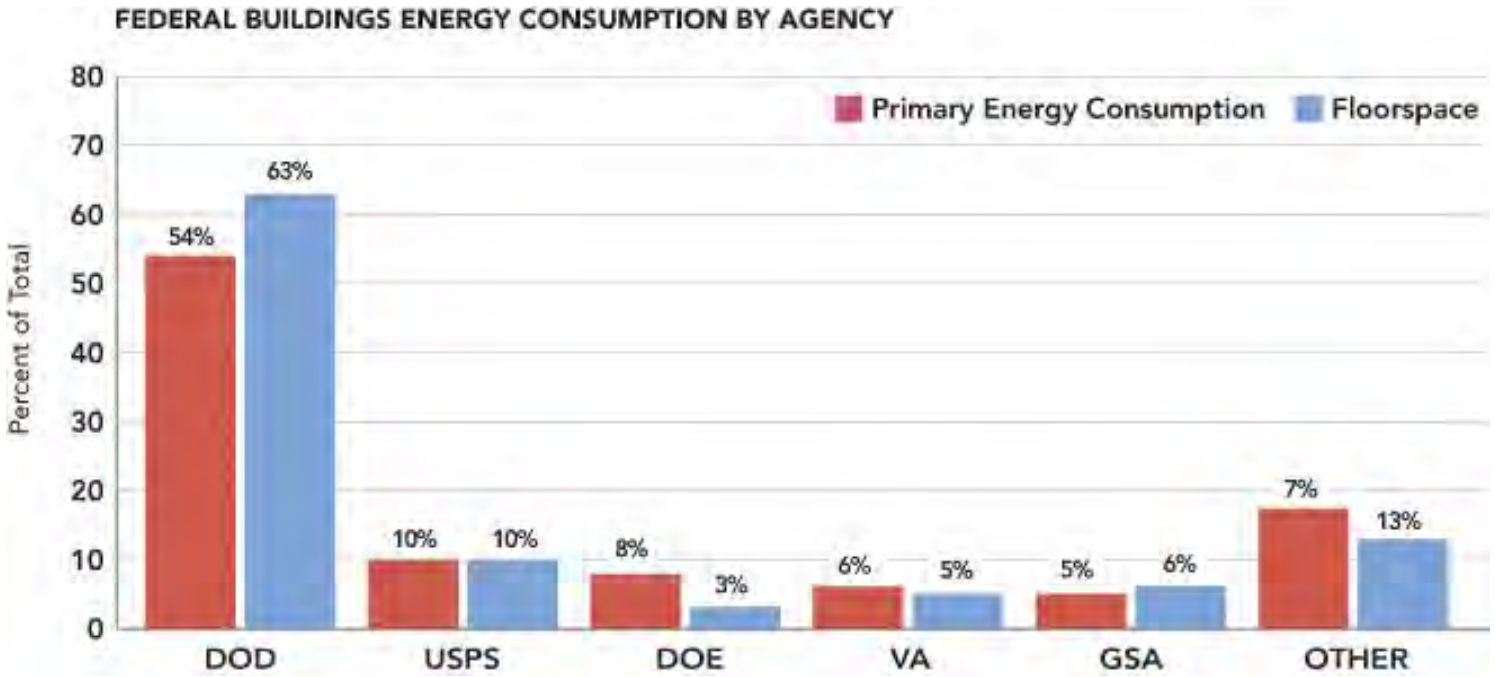


97.8 quadrillion BTU consumed by the U.S. in 2010

Source: US Department of Energy (DOE), Buildings Energy Data Book

Federal Sector

- Federal Buildings (FY 2007) accounted for 2.2% of all building energy consumption and 0.9% of total US energy consumption.
- 0.88 quads of primary energy / $6.0 billion (FY 2007)
- DoD is the biggest Federal energy consumer



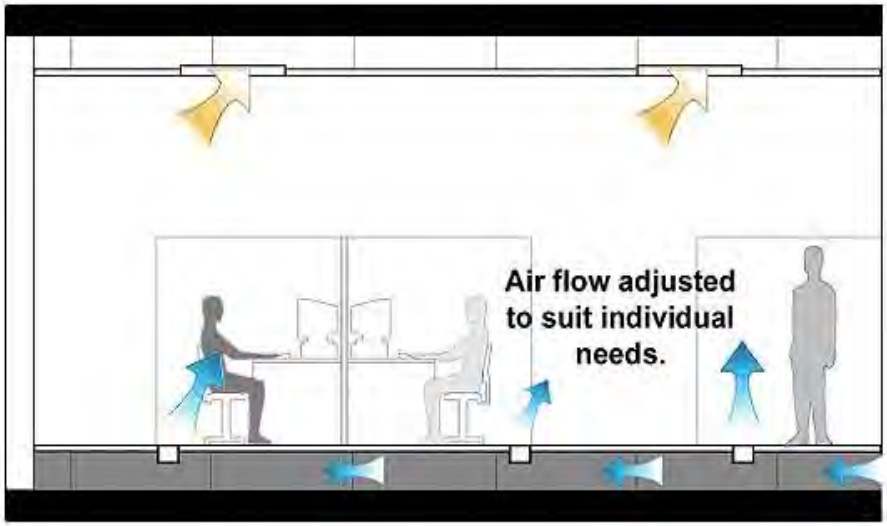
http://buildingsdatabook.eren.doe.gov/

Economics

- Buildings designed and operated efficiently save money!
- Consumption side conservation strategies provide a faster, more predictable return on investment than renewables
  - Focus on efficient envelopes, orientations, and massings that reduce heating and cooling loads to begin with, then move inside the building to examine lighting, HVAC, and other energy consumers.
- Economic simulations provide hard evidence from which owners, designers, and contractors can make decisions
- URS regularly performs these simulations, with in-house economists available for advanced scenarios

Happier people

- Buildings that operate well provide a healthy and comfortable indoor environment for the occupants
- People spend 90% of their time indoors
- Indoor environments can sometimes be worse than outdoor environments (sick buildings)
- Productivity is money: EPA and OSHA estimate US loses tens of billions of dollars each year to lost productivity and medical due to poor IAQ



Federal Mandates

Energy Policy Act of 2005 (EPAct)

- Requires measurement of energy use reduction, without process loads. It requires implementing energy efficiency strategies with financial return on investment with a 25-year payback, within the life of the equipment, or in some cases, within a 40-year payback.

Energy Independence and Security Act of 2007 (EISA)

- Requires usage of renewables and domestic sources of energy and reporting on the management of stormwater on site

Executive Order 13423: Strengthening Federal Environmental, Energy, and Transportation Management

- Agencies are required to report how sustainability is operationalized into business and facility operation practices; including land use, transportation, procurement, and building operations.

Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance

- Calls for integration of Triple Bottom Line (TBL) decision making. Agencies are required to track CO2 Emissions (MTCO2E/Gross SF)

Memo of Understanding for High Performance Sustainable Buildings (MOU HPSB)

- Sets reporting requirements against the high performance building framework the Federal sector expects from building design.

UFC Criteria

UFC 3-400-01: Energy Conservation

- No longer active
- Replaced by UFC 1-200-02

UFC 1-200-02: High Performance and Sustainable Building requirements

- Requires 30% solar thermal water heating if life cycle cost effective
- Requires 30% reduction in energy from the ASHRAE 90.1 baseline
- Makes numerous references to ASHRAE 189.1 for requirements

Energy Efficient Design: Major Components

LEED: Energy Related Credits

Sustainable Sites (SS)

- SSc8: Light Pollution Reduction

Water Efficiency (WE)

- WEc3: Water Use Reduction

Energy and Atmosphere (EA)

- IEQp1: Fundamental Commissioning
- IEQp2: Minimum Energy Performance / IEQc1: Optimize Energy Performance - Overview
- IEQc3: Enhanced Commissioning – Tier 1 sub discussion in light of government RFPs

Materials and Resources (MR)

- MRc1: Building Reuse
- MRc4: Recycled Content
- MRc5: Regional Materials

Indoor Environmental Quality (IEQ)

- IEQp1: Minimum IAQ Performance
- IEQc2: Increased Ventilation – Pitfalls
- IEQc6.1: Controllability of Lighting
- IEQc8.1: Daylight

LEED: Energy Related Credits

SSc8: Light Pollution Reduction

- Sets lighting power density limits
- Requires cut-off fixtures

WHAT TO CONSIDER:

- More light ≠ more safety and usability
- Light only what needs to be illuminated and only when it needs to be lit.
- Energy efficient lighting such as LED

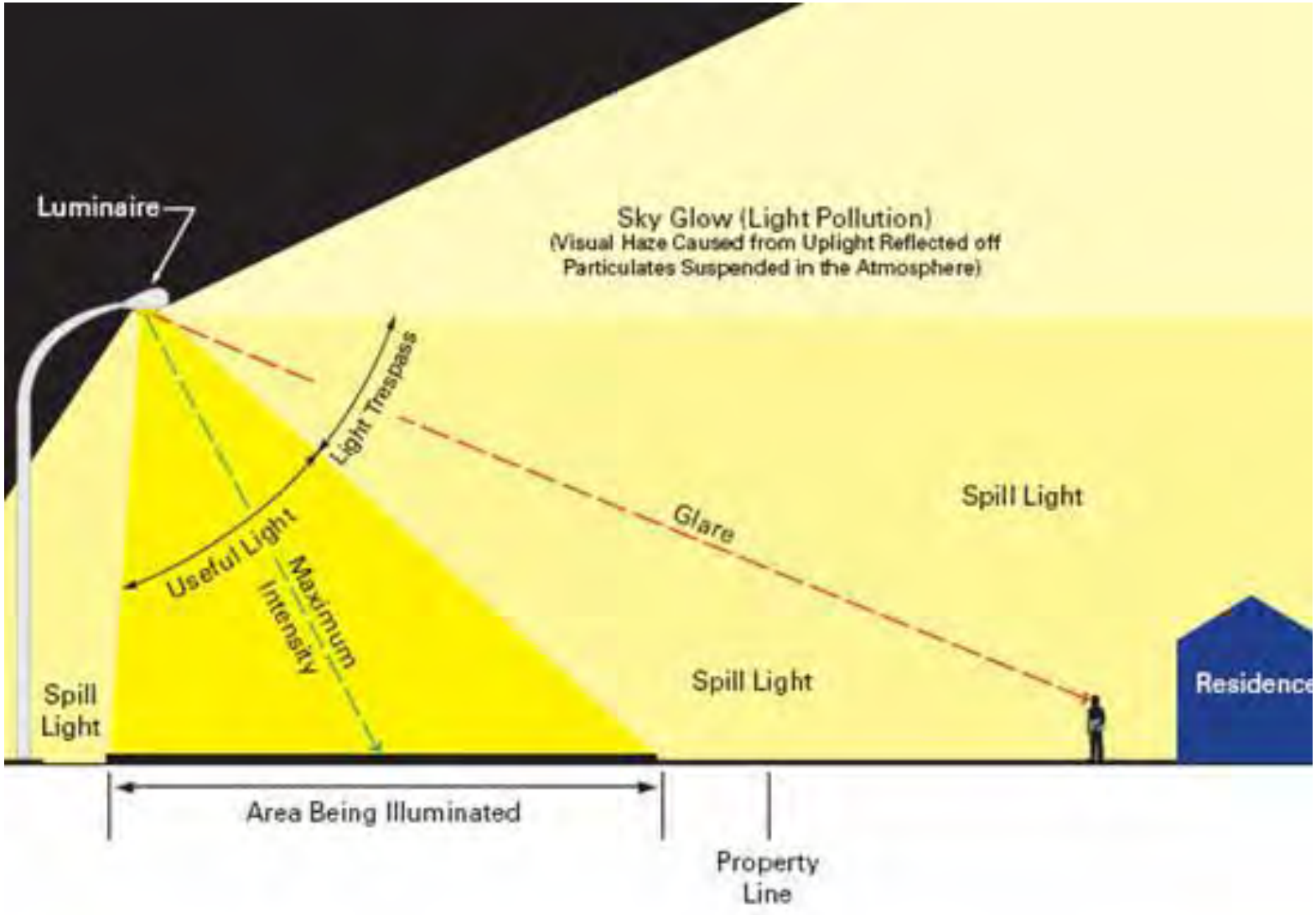
RESULTS:

- More even and comfortable lighting; reduced glare
- Improved way-finding
- Reduction in energy usage

LEED v4:

- Specialized signal, directional, and marker lighting is now exempt from SSc8 requirements

LEED: Energy Related Credits



LEED: Energy Related Credits

WEp1 / WEc3: Water Use Reduction

- Water heating ranges from about 5-15%* of a building's energy consumption
- Thus, reduction in water use = reduction in energy use

WHAT TO CONSIDER:

- Low-flow showerheads and faucets
- Aerators on faucets
- Sensors or meters on showerheads and faucets
- Shutoff button on showerheads

RESULT:

- Through the reduction in water consumption alone, energy savings for water heating can be significant
- LEED Technical Guidance allows energy savings credit to be taken for low-flow fixtures, as less hot water is needed for them.

LEED: Energy Related Credits

EAp1: Fundamental Commissioning of Building Energy Systems

- Fundamental commissioning required for certification
- Includes HVAC, Lighting, Domestic Hot Water, and Renewables
- Does not include building envelope or other systems

EAc3: Enhanced Commissioning

- Includes design reviews by the CxA
- Requires the CxA to get involved with the O&M staff

LEED v4:

- CxA must be involved during design development for Fundamental

LEED: Energy Related Credits

EAp2 / EAc1: Energy Performance

- Comparative Analysis
- Points based on energy COST savings, not energy savings
- Government utility rates can make cost savings difficult
- Savings do not always correlate to overall efficiency
- Don’t be afraid to innovate!

LEED: Energy Related Credits

Materials & Resources

EMBODIED ENERGY = the sum of all energy required to extract, manufacture, and assemble a given material, building component, or whole building. Sometimes this also includes energy to replace and dispose of a product.

- Building construction and materials account for 5.9% of US energy consumption
- Consider the lifecycle of a product; cradle-to-gate vs. cradle-to-cradle
- Using recycled material, regional sources, etc. can reduce the embodied energy of a building
- Consider the embodied energy when making design selections
- Renovating an existing building vs. building a new structure

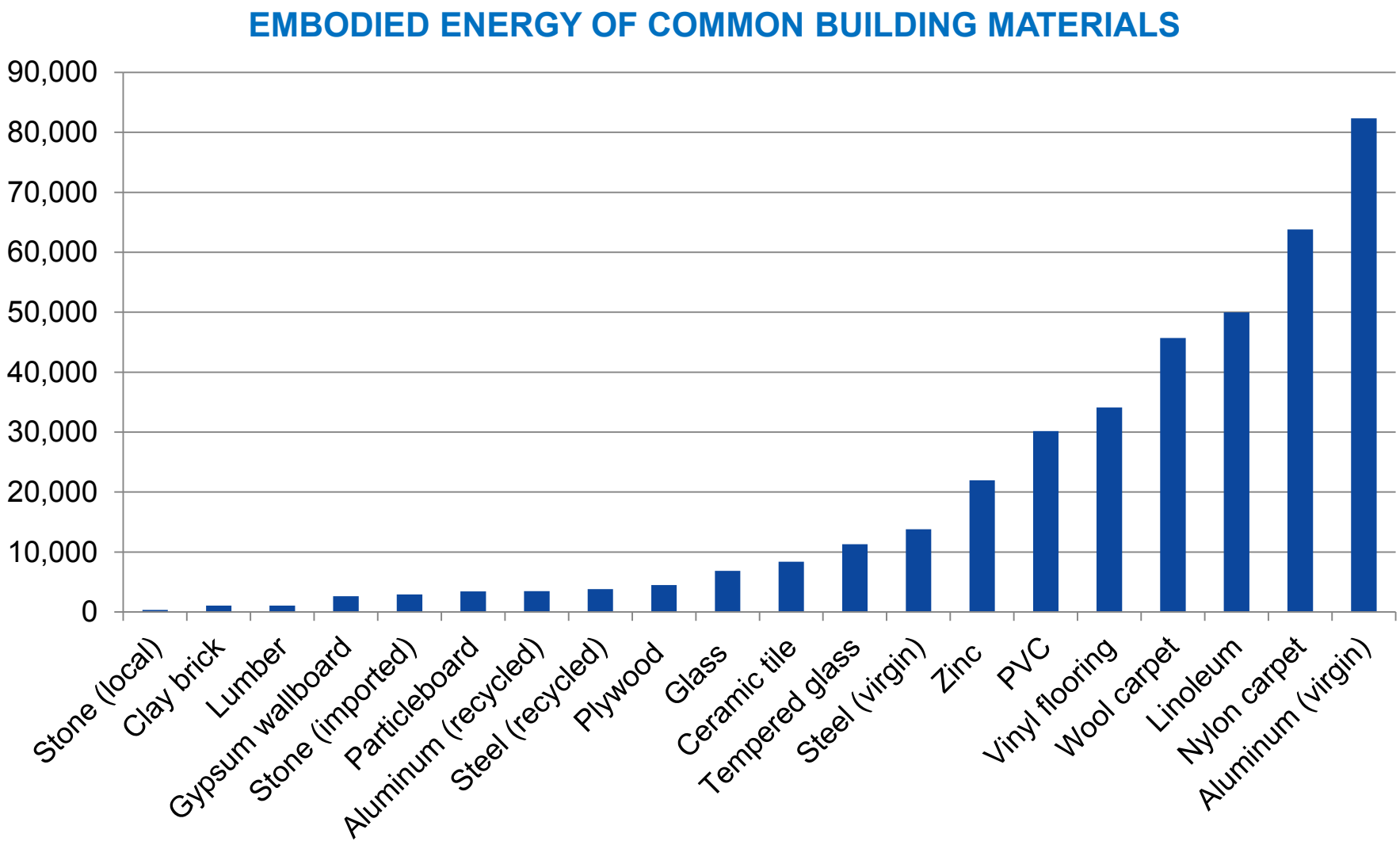
LEED v4 and Life Cycle Analysis

LEED: Energy Related Credits

COMPARISON OF EMBODIED ENERGY TO OPERATING ENERGY

	Heating Energy MMBtu/year (Gj/year)	Embodied Energy MMBtu (Gj)	Embodied Energy Expressed as years of heating energy
Conventional house, Vancouver	101 (107)	948 (1,000)	9.4
Conventional house, Toronto	136 (143)	948 (1,000)	7.0
Energy-efficient version, Vancouver	57 (60)	1,019 (1,075)	17.9
Energy-efficient version, Toronto	78 (82)	1,019 (1,075)	13.1

LEED: Energy Related Credits



LEED: Energy Related Credits

IEQp1: Minimum Indoor Air Quality Performance

- Variable flow minimums can be adjusted
- Consider OA tempering vs heating efficiencies

IEQc2: Increased Ventilation

- May increase savings at the cost of absolute energy usage
- May improve interior conditions and productivity

LEED: Energy Related Credits

IEQc6.1: Controllability of Lighting

- Task lighting is often provided in office and workstations in order to achieve this credit.

WHAT TO CONSIDER:

- Efficient, dimmable tasking lighting
- Occupancy sensors or time controls for task lighting
- Reduce ambient overhead lighting – achieve total required foot candles without double dipping

RESULT:

- Reduced overall lighting loads due to reduced ambient lighting
- Improved occupant comfort and productivity

LEED: Energy Related Credits

IEQc8.1: Daylight

- Successful daylighting strategies can save significant energy on artificial lighting and increase occupant comfort and productivity
- Unsuccessful daylighting can have the opposite effect: too much light intrusion, glare, additional cooling loads, occupants close blinds leading to increased artificial light usage

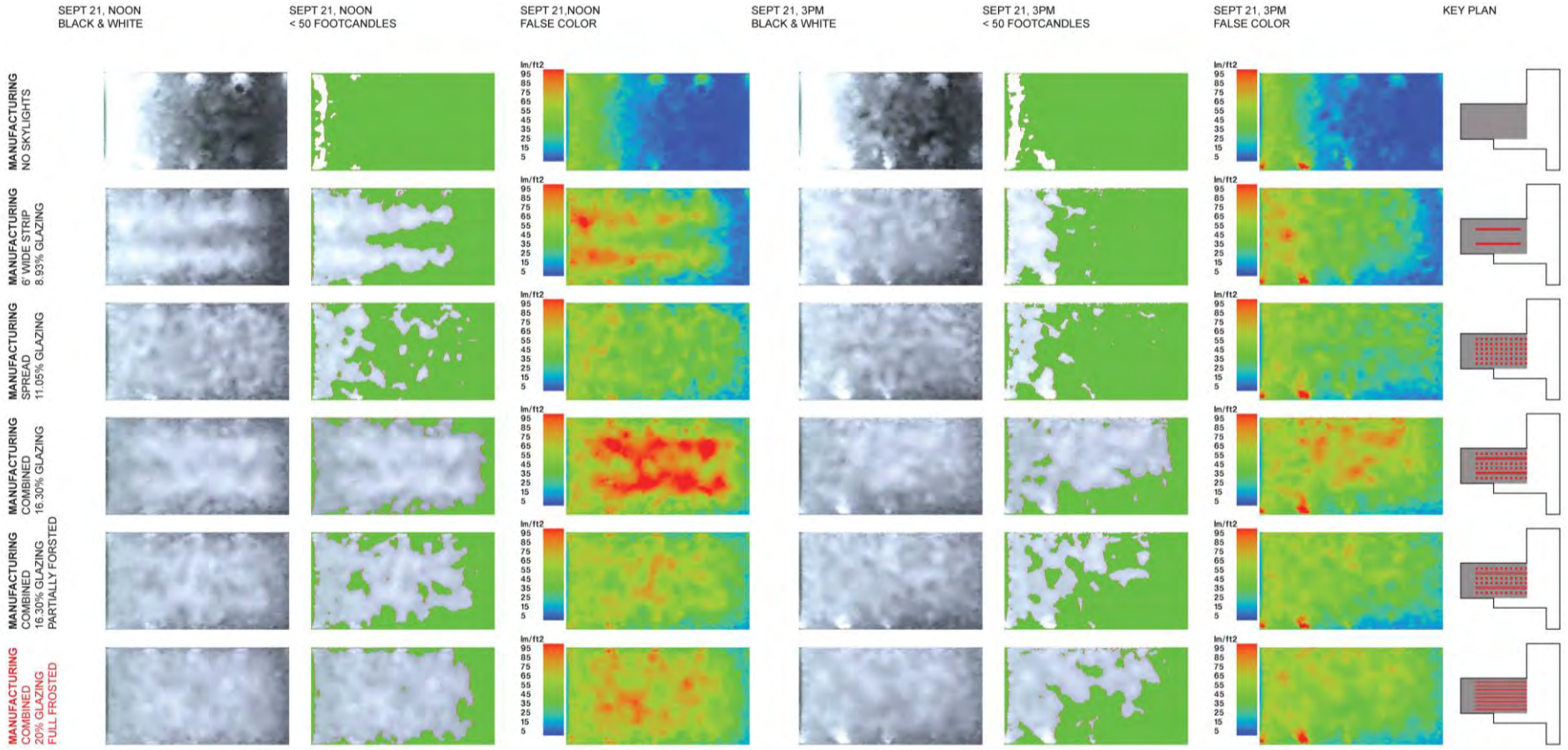
What To Consider – First Steps

- No more slab to slab glazing!
- Differentiate vision glazing vs glazing for daylighting
- Zoned perimeter lighting with photosensor dimming controls
- Automated shades
- External shading from louvers, perforated panels, vegetation, etc.
- “Tune” glazing for each façade orientation and type of desired light
- Commission lighting controls

LEED: Energy Related Credits

OTHER THINGS TO CONSIDER

- Daylight simulation
  - Example – Rolls Royce manufacturing facility, Crosspointe, VA
    - Used IES-VE for simulation

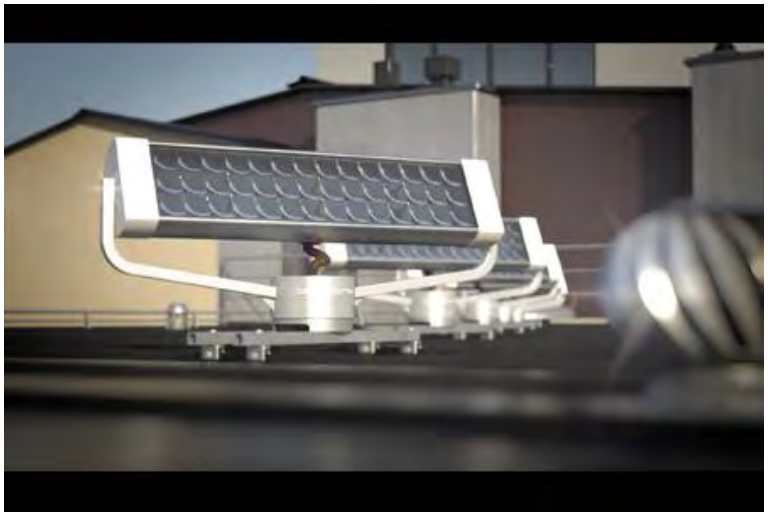


LEED: Energy Related Credits

Alternative ways to bring light in:

- Solar tubes
- Fiber optic daylighting
- Light shelves/reflectors (internal & external)

Don't forget lighting controls for these technologies!



Energy Conservation

Energy use Intensity (EUI)

- A measure of the total energy consumed by a building
- Typically measured in KBTU per square foot per year (KBTU/SQ FT/YR)

Why Energy Conservation

- Conserve resources to reduce pollution and carbon emissions
- Stabilize energy prices
- Reduce operating costs

Major sources of energy consumption

- Lighting
- HVAC
- Plug Loads (IT Equipment)
- Process Loads

Energy Conservation

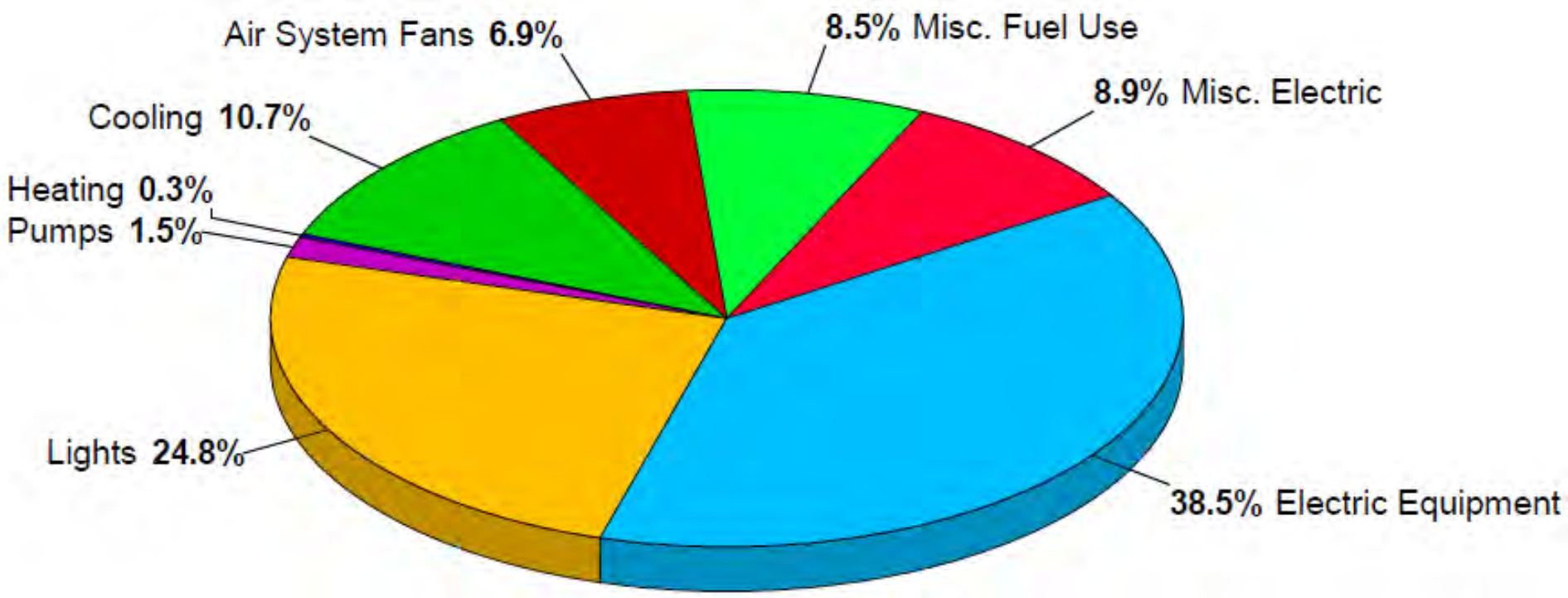
Step 1: Reduce Consumption

- Right-sizing HVAC equipment
- Right-sizing IT equipment

Step 2: Introduce Renewables

- Photovoltaic Arrays (PV)
- Solar Thermal Water Heating
- Solar Air Heating
- Wind Turbines
- Geothermal

Energy Conservation



2013 Administrative Building
56.70 KBTU / SQ Ft / Year

Energy Conservation

Absolute Energy Consumption vs Comparative Savings

Energy Cost and Consumption by Energy Type - Performance Rating Method Compliance

	Proposed Design		Baseline Design	
Energy Type	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost ($)**
Electric	496,849 kWh	31,808	627,117 kWh	40,148
Natural Gas	3,159 Therm	3,045	5,470 Therm	5,288
Subtotal (Model Outputs)	**2,011,100 kBTU**	**34,853**	**2,686,675 kBTU**	**45,436**
	Energy Generated	**Renewable Energy Cost Savings ($)**		
Total On Site Renewable Energy				
	Energy Savings	**Cost Savings ($)**		
Exceptional Calculation Totals				
	Energy Use	**Cost ($)**		
Net Proposed Design Total	**2,011,100 kBTU**	**34,853**		

	Percent Savings		Energy Use Intensity	
	Energy	**Cost**	**Proposed Design (kBTU/ft²)**	**Baseline Design (kBTU/ft²)**
Summary Data	25.1 %	23.3 %	56.70	75.74

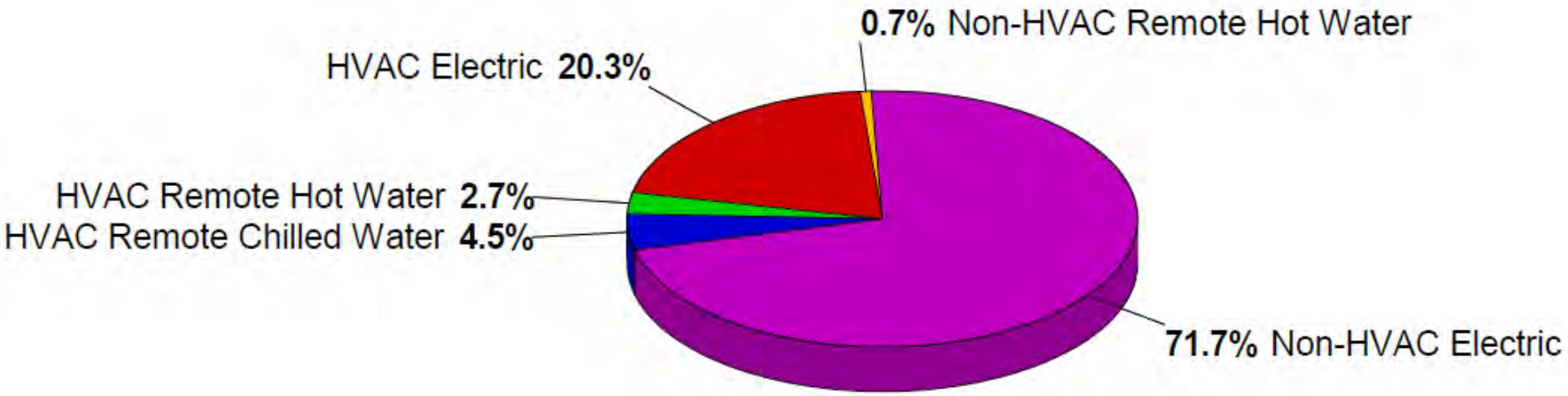
Energy Conservation

Absolute Energy Consumption vs Comparative Savings

Energy Cost and Consumption by Energy Type - Performance Rating Method Compliance

	Proposed Design		Baseline Design	
Energy Type	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost ($)**
Electric	11,896,745 kWh	1,201,571	12,264,944 kWh	1,238,759
Remote HW	46,850 Therm	45,117	101,128 Therm	97,386
Remote CW	54,010 Therm	59,033	114,227 Therm	124,850
Subtotal (Model Outputs)	**50,677,701 kBTU**	**1,305,721**	**63,383,443 kBTU**	**1,460,995**
	Energy Generated	**Renewable Energy Cost Savings ($)**		
Total On Site Renewable Energy				
	Energy Savings	**Cost Savings ($)**		
Exceptional Calculation Totals				
	Energy Use	**Cost ($)**		
Net Proposed Design Total	**50,677,701 kBTU**	**1,305,721**		
	Percent Savings		**Energy Use Intensity**	
	Energy	**Cost**	**Proposed Design (kBTU/ft²)**	**Baseline Design (kBTU/ft²)**
Summary Data	**20.0 %**	**10.6 %**	**258.41**	**323.20**

Energy Conservation



2014 Mixed Use Office Building
258.41 KBTU / SQ Ft / Year

Commissioning

The process of facilitating communication, coordination, testing, and verification of building systems, resulting in systems which perform as intended.

Types of Commissioning

- Commissioning
- Retro-Commissioning
- Re-Commissioning

Benefits of Commissioning

- Reduced energy costs
- Reduced operational costs
- Better operation, maintenance and reliability.
- Improved indoor air quality and occupant productivity

Commissioning

Startup vs Commissioning

- Startup ensures that each piece of equipment is functional and safe
- Commissioning ensures that all systems work together

When To Get Involved

- As early as possible
- Enhanced Commissioning requires early participation

Commissioning

How Commissioning Saves Energy and Money

Item #	Date	Reference Document	Equip. ID	Issue	Location	Party to Address Issue	Party's Response/Action	Disposition After Re-Testing	Status	Date Verified
4	12/26/11	FR	RTU-2	Outdoor air and return air dampers are not modulating to provide minimum outdoor air.	Annex Roof	MC	Bad damper actuator. Damper actuator has been replaced.	Dampers now modulate to maintain minimum outdoor air.	P	2/9/12
8	12/30/11	FR	RTU-2	The location where the supply air static pressure is being measured is too close to the unit. The sensing location is on the 2nd floor is roughly 10 feet from the unit discharge. The contract documents require that the supply air static pressure be measured at 2/3 of the way down the longest branch duct. The sensing location will need to be relocated to a branch duct on the 1st floor	Annex Roof	MC/CC	Supply air static pressure sensing port relocated to a better location on the second floor in a branch duct.	New static pressure sensing location has been confirmed and is acceptable to the CxA.	P	2/9/12

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Putting It Into Practice

INTEGRATIVE DESIGN PROCESS

Conventional Design Process:

Linear process

Owner
▼
Architect
▼
Engineers
▼
Contractor
▼
Occupants

- Building elements are designed independently
- Stakeholders are left out of planning process
- Design issues are not discovered until late in the process, when it is more difficult and expensive to make changes

VS

Integrative Design Process

Collaborative process

- Non-sequential, iterative process
- Multidisciplinary team collaborates early in the design
- Shared expertise, shared goals, shared understanding of design implications
- Shared project vision & shared buy-in

- Building designed as a whole
- Continual assessment an evaluation of design (coordination, energy modeling, commissioning, etc.)
- Cost effective solutions that yield multiple benefits

(New credit for LEED v4)

INTEGRATIVE DESIGN PROCESS

Buildings as organisms vs. discrete sets of parts

- Joint decision-making and problem-solving
- Early analysis and testing of assumptions
- Multiple design charrettes
- Higher performance buildings at lower cost

Why is Integrative Design difficult to implement?

- Architects want control of the “vision”
- Engineers stick to what they know
- Requires a skilled manager to boost collaboration
- Design fees and schedule do not account for cost and time

Energy Modeling

Things to look for:

- Smaller equipment sometimes ignored: fans, unit heaters
- Focus on EUI in addition to savings %
- Be thorough with Appendix G requirements
- Don’t discount new technology just because it can’t be modeled

Initial Estimates:

- Be conservative with initial savings forecasts
- May be difficult/costly to make up LEED points elsewhere

Sustainable Return on Investment (sROI)

Financial Return on Investment

PROBLEM:

- Only evaluates internal cash costs and benefits
- Government pays reduced rates

SOLUTION: sustainable Return on Investment (sROI)

- **"Triple-bottom-line" approach**: evaluates **economic, social, and environmental** costs and benefits
- Puts $ value on often hidden effects
- Complies with Executive Order 13514

Three Spheres of Sustainability

Sustainable Return on Investment (sROI)

- Capital Cost
- Operations & Maintenance

- Improved Health & Safety
- Productivity
- Sense of Security

- GHG Emission
- Ecosystem Services
- Water Quality

Cash | Internal Non-cash | External Non-cash

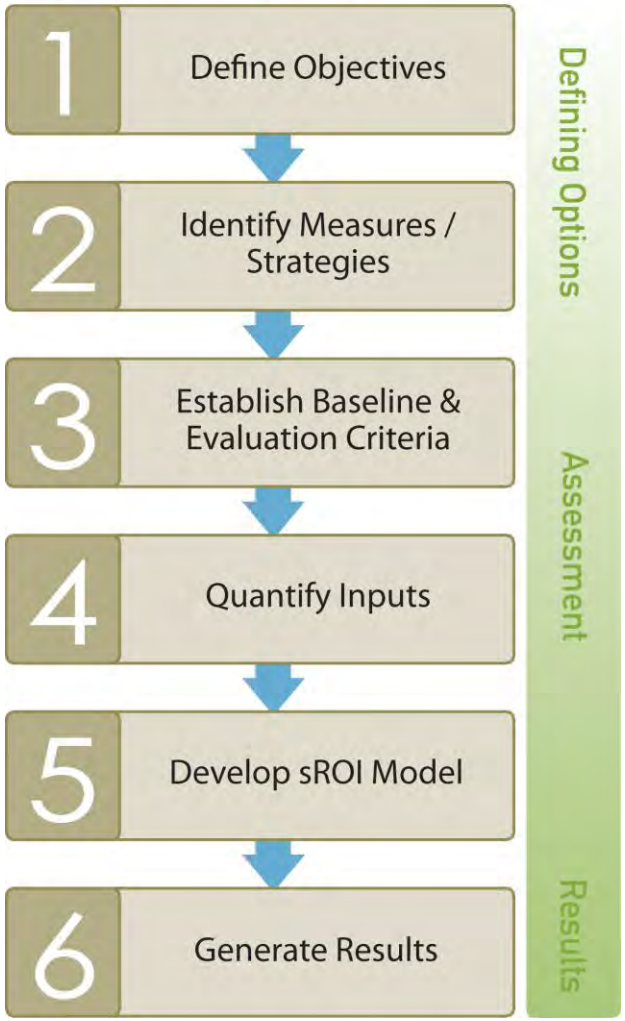
sROI Framework

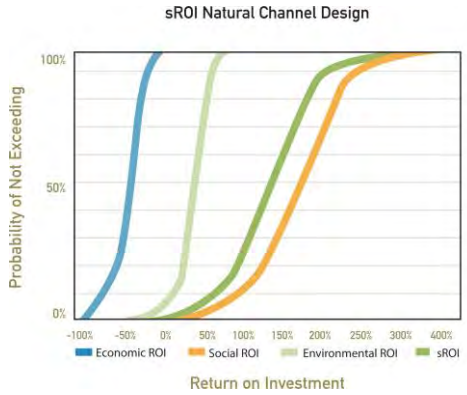
Full cost accounting of economic, social & environmental returns.

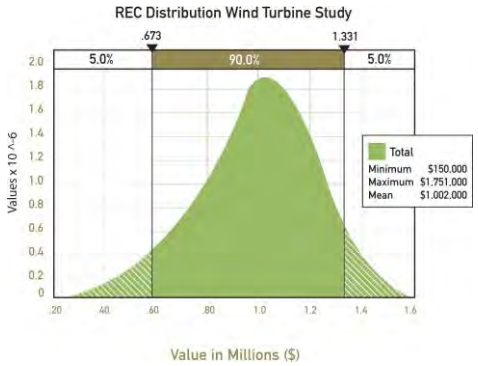
Sustainable Return on Investment (sROI)

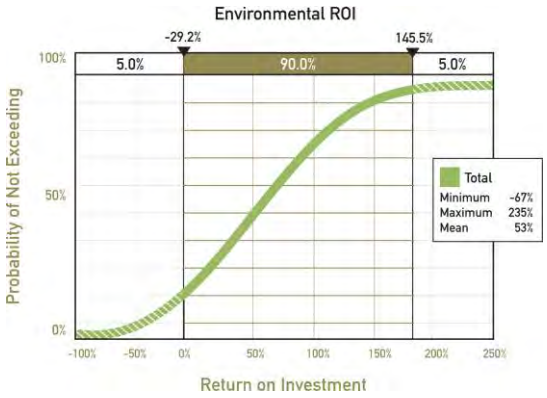
Society of SAME American Military Engineers

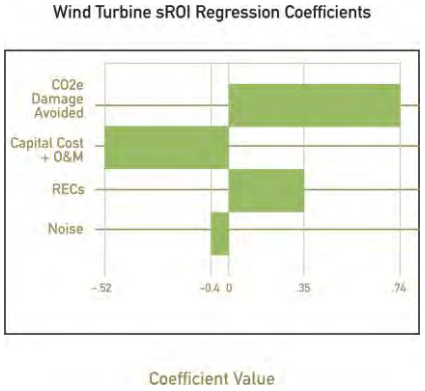
sROI Methodology Process



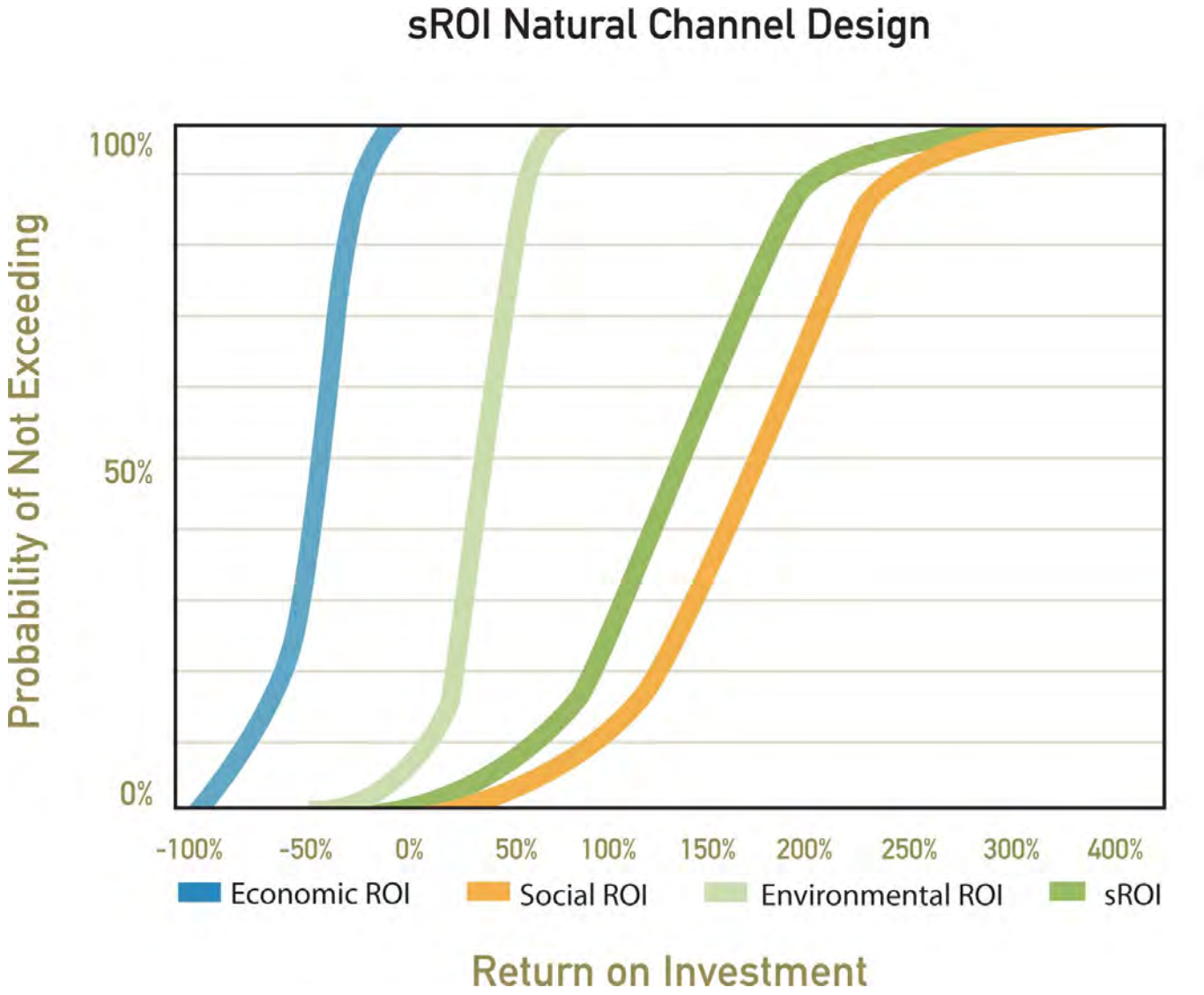








Sustainable Return on Investment (sROI)



Things To Look Out For

RFP Requirements and Response

Conflicting Language with Commissioning, LEED, and Energy Conservation Goals

- Enhanced commissioning – CxA cannot be hired by the construction contractor, but can be contracted by the design firm: important for design-build projects
- Government often requires Enhanced Commissioning to be met in practice, even though LEED points cannot be obtained

Latest Version of Standards

- ASHRAE 90.1: Many RFPs require the designer to use the latest standard, while also requiring a version of LEED that uses a previous standard, creating duplication in energy modeling and confusing the design

What to Achieve vs How to Achieve It

- Building envelope performance requirements above and beyond ASHRAE or other recognized baselines, regardless of building type, location, and use
- Dictating exact equipment types (ex: air vs water cooled chillers)

During the Design

Getting the Commissioning Agent on Board

- Often come in far too late into the design, reducing efficacy
- Enhanced commissioning requires design reviews, forcing the CxA to be introduced early

Value Engineering

- Photocells on daylight harvesting systems
- CO2 sensors and Demand Controlled Ventilation
- Insulation above ASHRAE requirements
- Glazing performance
- Shade louvers

Renewable Requirements

- Government utility rates often make payback periods untenable

During Construction

Conflicts

- Use Building Information Modeling (BIM) to reduce changes during construction!
  - Revit, Navisworks, Microstation 3D.
  - Changes in duct routing to clear obstructions can result in significant static pressure increases, which chews up fan energy.
- Change requests to UFGS specifications by the contractor. Require the contractor submit RFIs to the government to obtain approval.

Post Occupancy

The Role of Facilities Management

- Once commissioning is completed, FM is crucial to successful building operation
- Educate the owner on the importance of FM personnel training on building-specific equipment
- Timely inspection, maintenance, and repair of equipment reduces energy consumption
- FM personnel must understand building controls to keep equipment operating efficiently

Measurement and Verification (M&V)

- Valuable teaching tool for owners and designers
- Aids FM personnel in diagnosing building inefficiencies

Questions and Answers