

Reducing Energy Consumption in New & Existing Buildings

Joint Engineering Society
Conference

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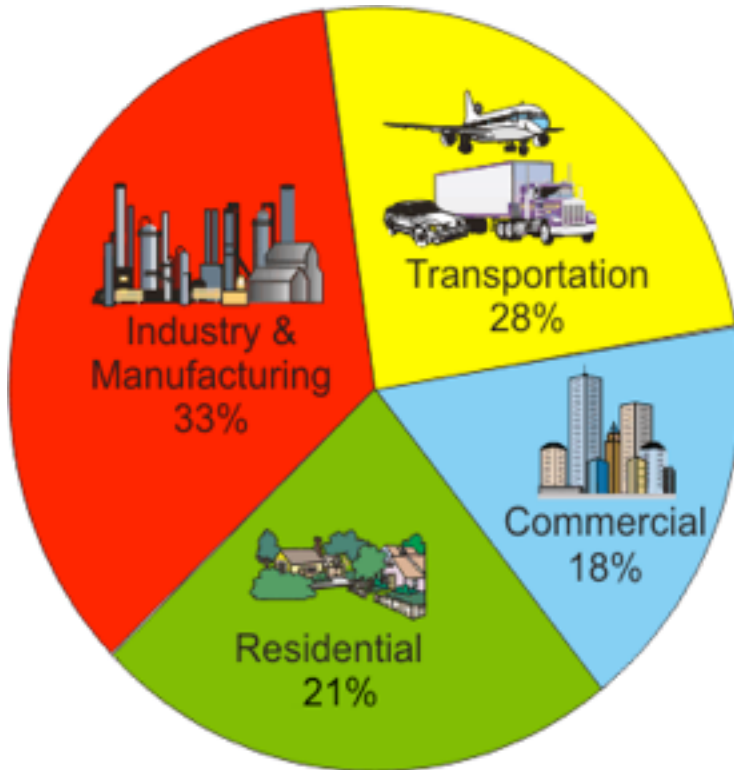
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Questions/Considerations

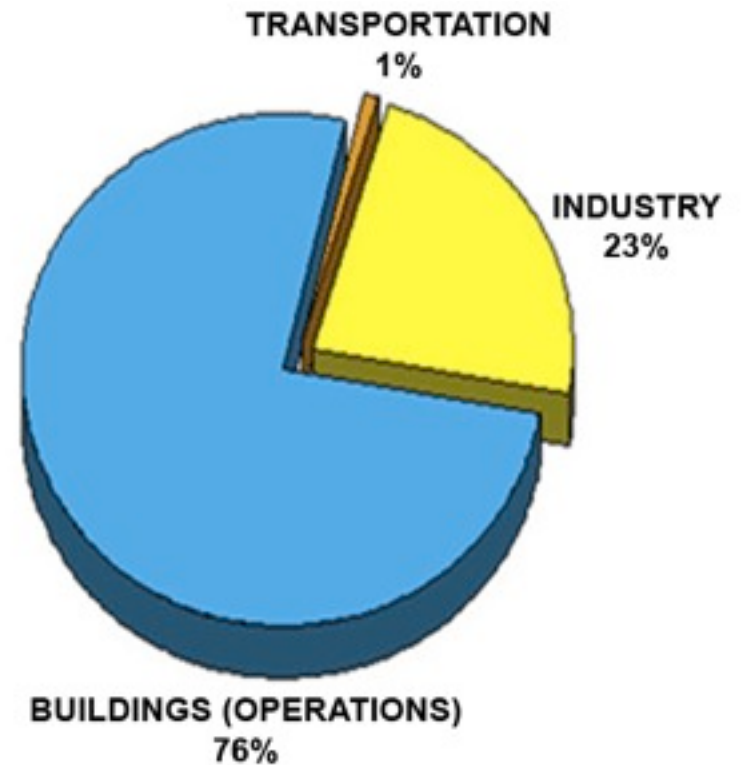
- What are you currently doing to measure energy efficiency of your buildings?
- I know energy efficient construction is THE trend, and I have developed a focused approach for maximizing energy efficiency of my buildings.
- I understand we're consuming more energy than ever, and therefore the need to reduce energy consumption has never been greater.
- What if you could show your customers ways to increase their energy efficiency & reduce waste BEFORE they ever use a kilowatt?

Why Buildings?

39% Total U.S. Energy Use



Source: U.S. Energy Information Administration



US ELECTRICITY CONSUMPTION

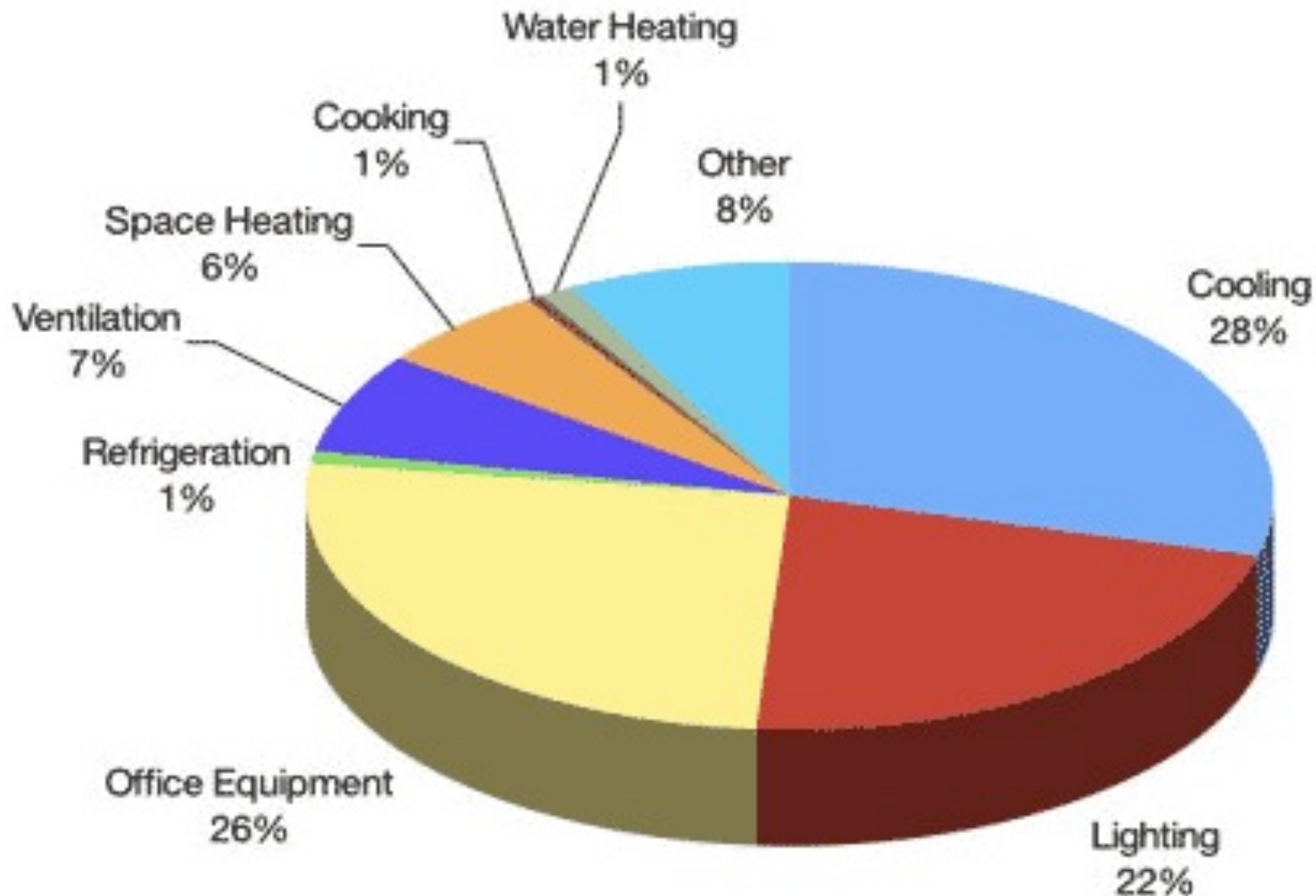
Annual Utility Cost = \$400 billion

Any Room To Improve?

“If you built to the minimum standards of the Code, then you would only have achieved the worst building that the law will allow.”

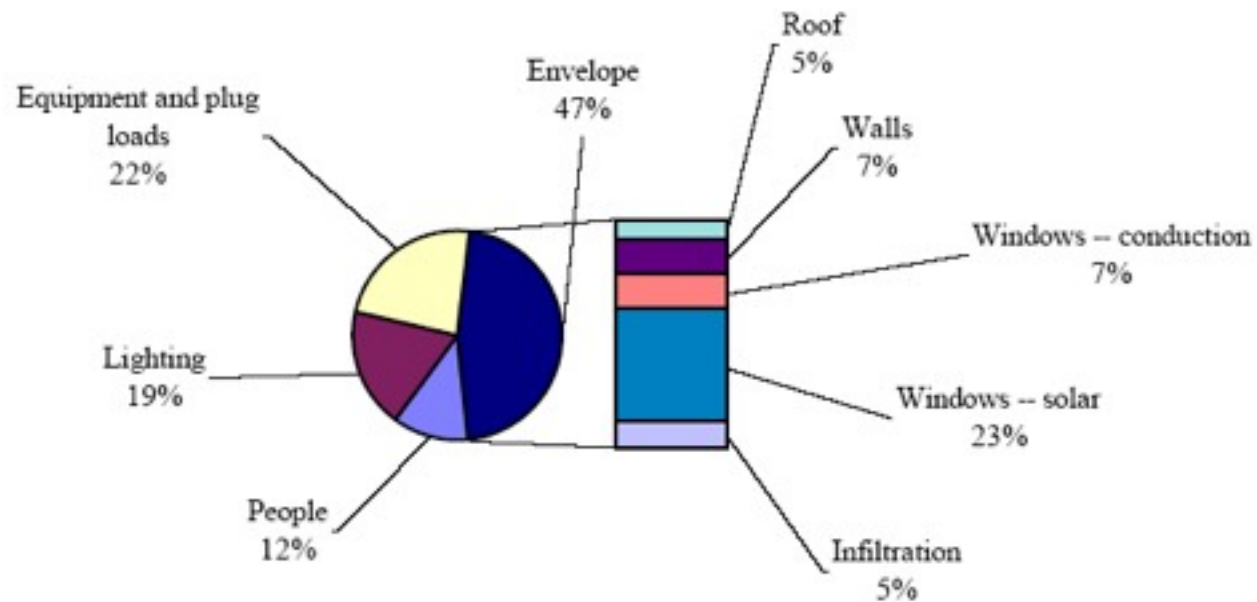
Tony Gibbs

Building Energy Consumption



Cooling Load Source

**Cooling Load Components for a Typical
10,000 Square Foot Office Building**



How to Reduce Energy Use

- Energy efficient equipment
- Lighting design
- Low-e windows
- Efficient HVAC equipment
- Improve building envelope
- Insulation
- Reduce duct leakage

Duct Leakage Leaks Money

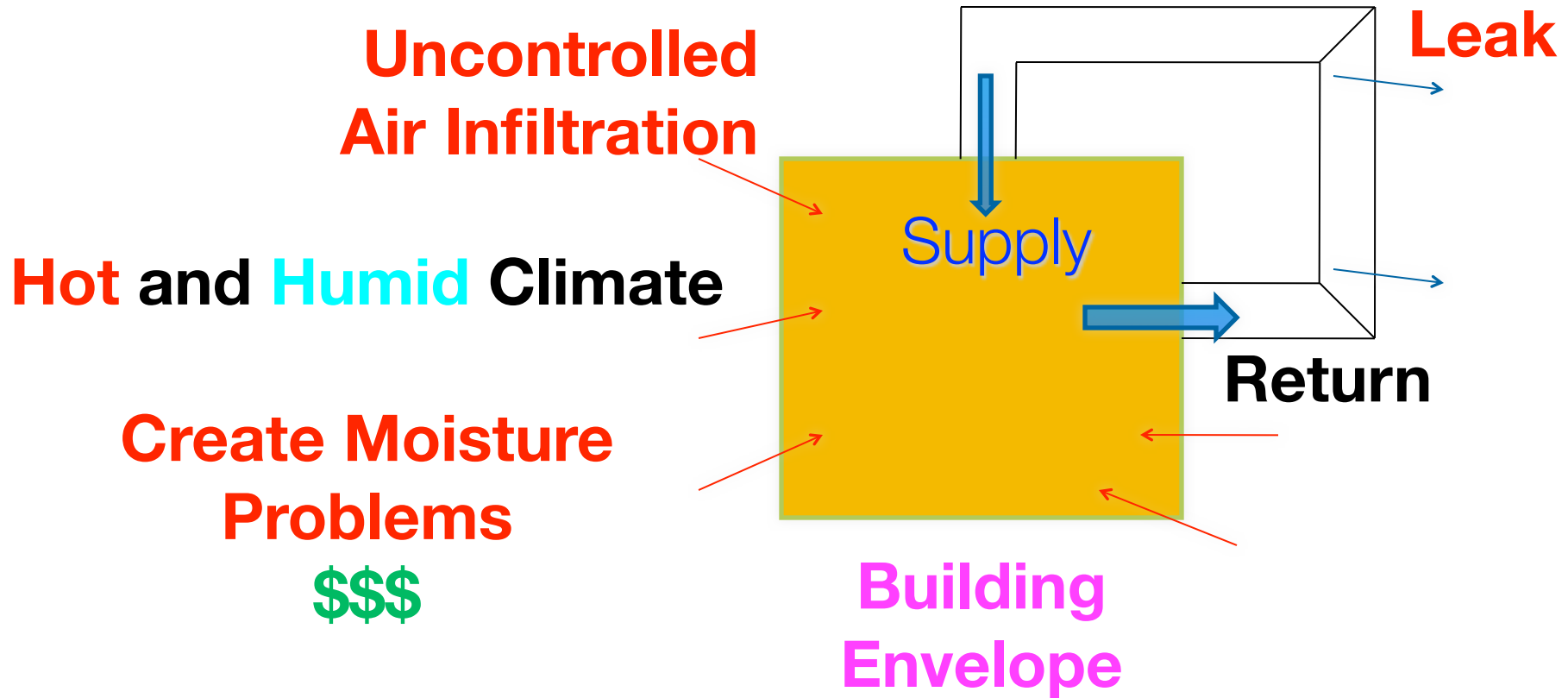
Expensive!

Costs:

- **Fan Power \$**
- **Cooling \$\$**
- **Heating \$\$**
- **Ductwork \$**



Duct leakage causes **problems**



How to reduce the leakage

- Tapes and mastics to seal ductwork.
- Pressure Test the Duct Work **BEFORE** closing up.
- Set acceptable duct leakage criteria and stick to it (factor of safety).
- **Trust but verify - valid TAB.**

What will design & construction professionals have to do?

- **Look at the current political climate.**
- **How long before we're legislatively boxed into energy efficient design & construction?**
- **We also have to help the Owner post construction.**

2 Helpful Processes

- **Energy Simulation**
- **Commissioning**

Energy Simulation

- **Why model - can “what if” different components/scenarios**
- **When to begin simulations**
- **What to include**
- **What to make of the data**

What is Energy Simulation?

Using software to simulate the energy use of a building throughout an entire year of operation. This is commonly referred to as “annual energy use simulation.”

Energy Simulation

- **LEED** requires energy modeling to assess the energy use of a building and to quantify the savings attributable to the proposed design
- Can help optimize the building design & allow the design team to determine strategies that will have the greatest effect on the building's energy use

Conceptual Design - 30,000'

- begin here
- test site location
- test building size/stories
- test building orientation

Schematic Design - 10,000'

- focus on major drivers of energy use
- focus can shift to cooling and lighting

Reduce Cooling & Lighting Loads in Schematic Phase

- reduce fan & pump energy.
- find overall reduction since cooling required to remove lighting energy.
- examine solar gain through windows and skylights & heat gain from lighting.
- examine building orientation, daylighting, more efficient lighting, more appropriate lighting levels, better lighting controls, glazing with a lower solar heat gain coefficient, and shading for glazing.

Design Development - 1,000'

- better understanding of components.
- shading, glazing type, & glazing quantity.
- examine lighting options/controls.
- trade-off between daylighting/glazing?
- enclosure/HVAC interaction due to unwanted infiltration.

Modeling Inputs - 1

Location

- Climate data
- Interior conditions & setpoints

Envelope

- Area, orientation and solar absorptance of all opaque building surfaces
- Mass of building components
- Infiltration rates

Modeling Inputs - 2

Schedules:

- Lighting & plug load schedules
- Occupancy schedules.

Internal Gains:

- Lighting & plug loads (watts/sq. ft)
- Sensible and latent moisture loads from people

Modeling Inputs - 3

Systems:

- Heating system type, source, distribution, and terminal units
- Cooling system type, source, distribution, and terminal units
- Ventilation system type
- Fan and pump inputs

Modeling Inputs - 4

Systems:

- Economizers and/or heat recovery systems
- Domestic hot-water system
- Specialty systems (commercial kitchens)
- Renewable-energy systems.

Where do I get all that stuff?

- weather station data
- local topography, site features
- expected loads vs. assumed loads
- anticipated facility use
- equipment manufacturer data

Common Errors

- assumed worst condition actually only occurs for a short duration.
- incorrect occupant density.
- incorrect plug & equipment load/placement.
- incorrect glazing characteristics.
- disingenuous look at infiltration - just oversize to reduce effects.
- factor of safety - (according to some).
- result: oversized systems.

Now look at the data

- does the model match real experience?
- does cooling go up in winter?
- if comfortable with model, start what-ifs.
- get down to the 50 ft level.

Energy Modeling Costs

- R.S. Means estimates commissioning costs between \$0.05-\$0.45 per square foot, depending on project size.
- Natural Logic estimates \$15-\$30k/project.
- Related to construction costs, NEMC found that energy modeling adds about 0.1% to total construction cost.

Commissioning - what is it?

- systematic process of ensuring that a building performs in accordance with the design intent, contract documents, and the Owner's operational needs.
- critical for ensuring that the design is successfully constructed and operated.
- whether going for LEED or not, we ought to do it

Commissioning includes:

- Systematically evaluating all equipment to ensure function according to specifications.
- Reviewing the operations sequence to verify controls are providing the correct interaction between equipment.

Commissioning is **NOT**:

- Construction observation
- Start-up
- Testing, adjusting, and balancing (TAB)
- Punch list development
- These are part of the process, but they don't comprise all of the process.

Commissioning Activities

- Engaging commissioning authority and team
- Documentation
- Verification procedures, functional performance tests, and validation
- Training

Commissioning - of note:

- more important in energy-efficient buildings because oversized equipment less likely
- HVAC must run as intended to maintain comfort
- advanced HVAC control strategies in performing buildings
- envelope many times used to ensure comfort

Commissioning benefits

- Energy savings
- Improved thermal comfort through proper environmental control
- Improved indoor air quality (IAQ)
- Improved operation and maintenance with documentation
- Improved system function that eases building hand-off

Relevant documentation:

- Quality assurance of project plans
- Construction management plans
- Test and inspection plans
- Acceptance test procedures
- Operation and maintenance manuals
- Training documentation
- Commissioning report

Commissioning Process

- Begins early in design.
- May involve design peer review.
- Special bidding requirements.
- Close coordination during design and construction.
- Controls systems testing/acceptance.
- Staff training & warranty monitoring.

Commissioned Systems

- Building enclosure and interior finish materials (wait, that's a system?!)
- HVAC/mechanical
- Electrical
- Lighting
- Life safety
- Plumbing

Commissioning

- ideally occurs through all project phases.
- third party commissioning authority (CA) beneficial, involved ASAP.
- objective CA as Owner's advocate, presents final recommendations to Owner regarding the performance of commissioned building systems.
- CA verifies Owner's requirements are met by construction documents.
- CA verifies that construction meets minimum targets.
- CA can provide guidance on how to operate systems at peak efficiency.

Commissioning Activities & Documentation - 1

- Owner's requirements—list and describe along with basis of design intent and performance criteria.
- Commissioning plan—create as early in the design phase as possible & include strategy with list of all features and systems to commission.

Commissioning Activities & Documentation - 2

- Bid document integration—CSI Section 01810 for general commissioning, & 01811 - 01819 for individual systems. Mechanical and electrical commissioning requirements in Sections 15995 and 16995.
- Bid documents - indicate Owner's agents (TAB consultant?)
- Develop functional performance test procedures or performance criteria verification checklists.

Commissioning Activities & Documentation - 3

- Commissioning report— for each identified component, equipment, system, or feature with results of installation observation, start-up, performance testing, and performance criteria verification.
- Training—written verification that training was conducted for appropriate personnel on all commissioned features and systems.

Commissioning Activities & Documentation - 4

- Operation and Maintenance manuals—installation instructions, maintenance, replacement, and start-up; replacement sources; parts list; special tools; performance data; and warranty details.
- Recommissioning management manual—indexed with whole building energy use and equipment efficiency benchmarks; sensor recalibration frequency; list of all user adjustable set-points and reset schedules; and list of diagnostic tools.

Commissioning Costs

Scope	Cost
Entire building(HVAC, controls, electrical, mechanical)	0.5-1.5% of total construction
HVAC and automated control system	1.5-2.5% of mechanical system
Electrical systems	1.0-1.5% of electrical system
Energy efficiency measures	\$0.23-0.28/sq. ft

Source: Mills E et al. 2004. The cost-effectiveness of commercial buildings commissioning. Lawrence Berkeley National Laboratory. LBNL report #56637

What to look for when selecting Green Consultant

- Registered Professional Engineers on staff.
- LEED Accredited Professionals on staff.
- Building Envelope experts on staff.
- Building Science experts on staff.
- Energy simulation experts on staff.

Leave a lasting legacy

We use simple science to solve complex problems.

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