New Construction

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Why do it right the first time?

- Less expensive long term
- Healthier & more comfortable
- More marketable
- It’s required
- It’s the right thing to do
Codes/Standards/Guidelines

- **Required**
  - Based on:
    - 2009 International Energy Conservation Code
    - or
    - ASHRAE 90.1-2007
      - Energy Std. for Bldgs. Except Low-Rise Residential Buildings
  - 2012 IL ECC will use 2012 IECC or ASHRAE 90.1-2010
    - Site energy savings of approximately 18.5%

- **Recommended**
  - ASHRAE 189.1-2009
    - Std. for the Design of High-Perf. Green Bldgs.
  - ASHRAE AEDG 50%
  - LEED-NC® and DCEO grants
    - Exceed current ASHRAE 90.1 + Appendix G
ASHRAE 90.1-2010

- States are required to certify by **Oct. 18, 2013** that they have updated the provisions of their commercial building code regarding energy efficiency to meet or exceed 90.1-2010.

- DOE found 19 positive impacts on energy efficiency
  - Parking garage occupancy sensors
  - Stairwells with bi-level switching
  - Manual-on control sensors in classrooms & offices
  - Supply air temperature reset for non-peak conditions
  - Cool roofs in hot climates
  - Data center efficiency
Roles

- **Owner or Building Operator**
  - Select design team and contractor based on ability to implement energy efficiency.
  - Be willing to pay team for added effort of good design.
  - Require that team follow through on design and implementation.
  - Hold the team accountable.

- **Designers or Contractors**
  - Stay up-to-date on current strategies and technologies
  - Be current on incentives and grants available to client
Design Process & Energy Efficiency

Commissioning

Pre-design
- Energy goals
- Site analysis
- Programming & relationships

Schematic Design
- Charrette
- Envelope & load strategies
- Preliminary HVAC guidelines

Design Development
- Finalize envelope & loads
- HVAC based on envelope & load decisions

Construction Documents
- Final decisions & coordination

SEDAC Energy Design Assistance
- Preliminary building energy model
- Elimination parametrics
- Ongoing building energy modeling to test design decisions

Public Sector/Utility Incentives
- Finalize model
- ASHRAE 90.1
- Appendix G
Top Ten Energy Strategies – New Construction

<table>
<thead>
<tr>
<th>Form &amp; Environment</th>
<th>EXTRA CREDIT: After implementing all of these, consider renewables such as solar and wind.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Orientation &amp; Form</td>
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<tr>
<td>2. Insulation</td>
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<td>3. Air Sealing</td>
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<tr>
<td><strong>Loads</strong></td>
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<td>4. Lighting</td>
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<td>5. Loads</td>
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<tr>
<td><strong>Heating, Ventilating, &amp; Air Conditioning</strong></td>
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<tr>
<td>6. Heating</td>
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<td>7. Cooling</td>
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<td>8. Motors &amp; Pumps</td>
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<td>9. Building Automation</td>
<td></td>
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<tr>
<td>10. Commissioning</td>
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Case Study

- Science, Technology, Engineering, & Math (STEM) magnet school

<table>
<thead>
<tr>
<th></th>
<th>Base Case Annual kWh</th>
<th>Proposed Annual kWh</th>
<th>Savings Annual kWh</th>
<th>% Saved</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>437,167</td>
<td>25,197</td>
<td>411,970</td>
<td>94%</td>
<td>45%</td>
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<tr>
<td>Cooling</td>
<td>74,963</td>
<td>31,606</td>
<td>43,357</td>
<td>58%</td>
<td>5%</td>
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<tr>
<td>Pumps/Fans</td>
<td>72,140</td>
<td>166,560</td>
<td>-94,420</td>
<td>-131%</td>
<td>-10%</td>
</tr>
<tr>
<td>Interior Lighting</td>
<td>123,298</td>
<td>104,357</td>
<td>18,941</td>
<td>15%</td>
<td>2%</td>
</tr>
<tr>
<td>Exterior Lighting</td>
<td>18,505</td>
<td>18,505</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Plug Loads</td>
<td>200,509</td>
<td>200,509</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>926,582</td>
<td>546,734</td>
<td>379,848</td>
<td>41%</td>
<td>41%</td>
</tr>
</tbody>
</table>
1. Orientation / Form

- Orient buildings on the east-west axis (+/- 10°)
- Reduce west facing glass
- Shade south glazing
- Take advantage of, or block, prevailing winds
- Orientation makes a difference in energy use!

Case Study
- East-west axis (see savings below)
- South overhangs
- Northern and southern windows
- Gardens based on location (i.e. Shade gardens and vegetable gardens)
2. & 3. Envelope

- **Exceed Code**
  - Insulation levels
  - Windows
  - Air sealing
    - Specifications
    - Vestibules
    - Site Observation
  - Envelope Commissioning

**Case Study**
- R-18 to R-24 walls
- Double wall construction
- Similar to PassiveHaus
- R-37 roof
- Windows U-0.27, SHGC-0.31
- Vestibules
- Planned for Heat Exchanger to make up for reduced air infiltration
4. Lighting

- Lighting power usage
  - Reduce ASHRAE numbers to 0.9 W/sf
- Occupancy & Vacancy Sensors
  - Manual On / Auto OFF (after < 30 min)
  - Multi-level switching or dimming
  - Now required in many areas
- Daylighting Controls
  - Light Tubes
- Outdoor Lighting:
  - Reduce 50% after closing
  - Turn off 30 minutes after sunrise

Case Study
- LPD = .9 W/sf
- Daylighting controls on perimeter windows
- Vacancy sensors or occupancy sensors throughout
- Controllable light tubes
5. Plug Loads

- Use design to reduce loads
- Data Centers
  - Cold Aisle
  - Server Virtualization
  - Thin Client
  - Economizers
- General Plug Loads
  - Smart strips
- Process
  - Equipment efficiency
  - Equipment interaction (i.e. reclaim heat)
- ENERGY STAR equipment.

Case Study
- Data Center houses thin client servers for district
- ENERGY STAR equipment
- Elevator only usable as needed
- Computer energy management district wide
- Vending energy management contractually obligated by vendors.
6. – 8. HVAC

- Minimize loads first, then think about equipment.
- Adding quality to envelope and loads reduces final HVAC cost
- High Efficiency equipment
  - Air source heat pump
  - Condensing boiler
  - Chilled beams
  - Variable refrigerant flow (VRF)
- Modular equipment

Case Study
- Ground Source Heat Pumps
  - EER 13.5
  - COP 4.5
- Server Room cooling tied to heat pump loop
- Dedicated outside air VAV w/ GSHP & heat recovery
- Demand control ventilation
- Economizer
- User control thermostats w/ +/- 2° adjustment.
- VFDs on water pumps
9. Building Automation

- Ability to control and document systems and settings.
- Design to the level of ability of operating personnel.
- Assure adequate training and ability to manipulate.
- Systems should:
  - Allow owner to set schedules for equipment and lighting.
  - Optimal equipment start with adaptive learning.
  - Trim and respond capabilities based on demand in zones.
  - Monitor and meter energy usage.
  - Trend data.
  - Reset schedules for systems.
  - Send alarms.

Case Study
- Full Building Automation System (BAS)
- Allows minimal control at each space. +/- 2 degrees.
- Provide district wide control from central office.
10. Commissioning

- A quality assurance process (design phase through occupancy)
- Ensures that the building operates as intended
- Building staff are prepared to operate and maintain
- Why needed?
  - Increasing complexity of building control systems
  - Lack of **contractual** coordination between trades
  - Technical staff in the field who looks out for the owner.

Case Study
- Commissioning agent brought onto project during schematic design.
- On-site commissioning of all equipment
- Training of staff on equipment and control operation
Extra Credit

- After implementing all of the previous ideas. Only then look at renewables.
- The cost per unit of energy saved of high efficient equipment and improved design is less than the cost per unit of energy of wind or solar.
- Nevertheless, renewables make great marketing and educational opportunities and can be more affordable when incentives are available.

Case Study
- Not included in savings noted
- 3 kW solar array funded through ICECF
- Program to put panels on all schools
- This site does not have sufficient wind resources to consider educational level turbine
# Case Study Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Incremental Cost</td>
<td>$546,120</td>
</tr>
<tr>
<td>Incentives</td>
<td>$340,508</td>
</tr>
<tr>
<td>Final Incremental Cost</td>
<td>$205,612</td>
</tr>
<tr>
<td>Annual Utility Savings w/o solar</td>
<td>$33,037</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>6.2 years</td>
</tr>
<tr>
<td>Internal Rate of Return (5% acceptable)</td>
<td>10.3%</td>
</tr>
<tr>
<td>Net Present Value (10 yr, 5%)</td>
<td>$53,952</td>
</tr>
</tbody>
</table>
How SEDAC can help

- Design Assistance
  - Public & private sector
  - Predesign through Construction Documents
  - Identify possible incentive funding
    - DCEO
    - Utilities
    - ICECF
    - Other

- Incentive Review
  - Public Sector

- Services are funded by DCEO or Utility at no charge to the project or owner
Presentations will be available at:
presentations.sedac.org

Web site: www.sedac.org
Contact: info@sedac.org
1-800-214-7954