System Retrofits in Efficiency Programs: Track Record and Outlook

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Please enter questions via chat

Please make sure to keep your line muted
Challenge

The opportunity:
System retrofits can provide 50%+ additional whole building energy savings in existing buildings over ‘widget’ retrofits.

However, barriers exist:

• Systems are inherently more complex and disruptive; need simplified approaches to access savings, understand interactions
• Lack of industry awareness of how systems provide deeper savings, about the state of systems deployment in industry, and the R&D needed to increase uptake

Figure – Regnier et al, Energy and Buildings, 2017 (Regnier et al, 2017)
What is a System?

“A building system is a combination of equipment, operations, controls, accessories and means of interconnection that use energy to perform a specific function.“ (ASE, 2016, 2017)
Industry System Retrofit Study – System Definitions

1. **End Use Systems:**
   Consist of equipment, supporting devices, distribution, termination and sensors/controls
   - e.g. HVAC, lighting, DHW etc.

2. **Interactive Systems:**
   - No physical communications link between end use systems
   - One system responds to behavior of another via impacts to the space
     - e.g. Lighting dimming systems responding to lower daylighting due to shade operation

3. **Integrated Systems:**
   - Active controls communications between end use systems
     - e.g. Automated shading controlled to reduce HVAC energy use while optimizing daylight availability (communicates with HVAC system to determine mode of operation, cooling or heating)
End Use System Retrofit Examples

- e.g. Air Source Heat Pump with Demand Control Ventilation
- e.g. ASHP with hydronic storage and Time Of Use controls
- e.g. Thermal storage and Time Of Use controls
- e.g. ASHP with Heat Recovery on Relief Air
- e.g. Hydronic fan coil with occupancy controls
Motivating questions

◆ What is the extent of systems retrofits compared to component retrofits?

◆ Do systems retrofits save more energy than component retrofits?

◆ What types of measures are used in systems retrofits?
Data and Approach

12,255 projects
10 building types | 7 climate zones

Cohort Analysis

<table>
<thead>
<tr>
<th>Cohort Attribute</th>
<th>Attribute Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrofit Type</td>
<td>Non-System retrofits&lt;br&gt;End-Use System retrofits&lt;br&gt;Interactive System retrofits&lt;br&gt;Integrated System retrofits</td>
</tr>
<tr>
<td>Project Savings</td>
<td>Low Energy Savings projects&lt;br&gt;High Energy Savings projects</td>
</tr>
<tr>
<td>Program Type</td>
<td>Federal&lt;br&gt;NAESCO&lt;br&gt;Utility&lt;br&gt;Other</td>
</tr>
</tbody>
</table>
What is the extent of systems retrofits compared to component retrofits?
Systems retrofits relatively uncommon
Systems retrofits less prevalent in utility programs

![Distribution of System Retrofits in Different Program Types](chart.png)
Do systems retrofits save more energy than component retrofits?
Systems more prevalent in high savings projects

All Programs > High and Low Energy Savings by Retrofit Type

- Non-System Retrofits
- End Use System Retrofits
- Interactive System Retrofits

Low Energy Savings Projects:
- Non-System Retrofits: 86%
- End Use System Retrofits: 13%
- Interactive System Retrofits: 3%

High Energy Savings Projects:
- Non-System Retrofits: 65%
- End Use System Retrofits: 32%
- Interactive System Retrofits: 18%
ESCOs have more high savings system projects

ESCO Projects

Federal Projects

Utility Projects
What types of measures are used in system retrofits?
Non-system projects highly dominated by lighting

Non-System Retrofits > EEM End Use Categories for High and Low Energy Savings Projects

- Lighting: 58% (Low) vs 59% (High)
- Cooling: 18% (Low) vs 18% (High)
- Heating: 15% (Low) vs 18% (High)
- Ventilation: 7% (Low) vs 4% (High)
- Envelope: 1% (Low) vs 1% (High)
- Plug Loads: 0% (Low) vs 0% (High)
- DHW: 0% (Low) vs 0% (High)
- Refrigeration: 0% (Low) vs 0% (High)
End-use system retrofits dominated by lighting and HVAC

End Use System Retrofits > End Use Categories for High and Low Energy Savings Projects

- Lighting
- HVAC - Cooling
- HVAC - Heating
- HVAC - Ventilation
- Envelope
- Plug Loads
- DHW
- Refrigeration

Low Energy Savings Projects
High Energy Savings Projects
Waterside HVAC measures (Airside HVAC measures shown as solid)
Interactive system retrofits include lighting, HVAC and envelope.
Federal Retrofit Program System Retrofit Distribution by Type – High Energy Saving Projects
<table>
<thead>
<tr>
<th>End Use System Retrofits</th>
<th>ESCO</th>
<th>High Energy Saving Projects</th>
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</thead>
<tbody>
<tr>
<td>Pumps &amp; Priming Systems, Energy Mgmt System</td>
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<tr>
<td>Lighting Retrofit, Controls/Motion Sensors</td>
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<tr>
<td>Air Handling Unit Retrofit, Energy Mgmt System</td>
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<tr>
<td>HVAC General, Energy Mgmt System</td>
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<tr>
<td>New/Replacement Boiler, VFD</td>
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<td>Air Handling Unit Retrofit, Equipment Scheduling</td>
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Stakeholder Insights

- Less than 10% of implementers/programs currently address systems
- Lighting most common retrofit due to ease and cost
- Larger buildings more likely to do system retrofits
- Key sectors: offices, schools, healthcare, datacenters, biotech

- Barriers real and perceived:
  - Systems are too complex
  - Systems have poor cost effectiveness
  - Utility programs still highly "widget" oriented
  - Lack of training for vendors and service providers
Recommendations

**Technology**
- Bundle with low-cost measures for cost-effectiveness.
- Systems that "work right out of the box"
- Reduce complexity and cost of design and implementation
- Ease controls integration with standards, plug and play.

**Policy and Programs**
- Lower touch “deemed”-style programs
- Expanding financing options
- Incentivize based on lifetime savings
- Flexibility in existing building baselines

**Education**
- Case studies comparing systems vs. component approaches
- Awareness through professional and trade associations
Takeaways

◆ **Systems are an underutilized EE strategy**, that can provide substantial energy savings over individual widgets.

◆ **Utilities remain a largely untapped resource for systems** and they are motivated to deploy them.

◆ **Systems can be cost effective**, but demand assistance to reduce complexity, increase ease in deployment. **Need R&D** in technology development and methods to reduce transaction cost.
Systems Resources – Beyond Widgets Program

3 Systems: *Simplified, validated assessment tools* (excel based) available for all three systems, including *system specifications and test results*: cbs.lbl.gov/beyond-widgets-for-utilities
