A Portfolio Impact Analysis Tool for Building Energy Efficiency Technologies

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The problem: Many ways to reduce energy use in buildings, and multiple perspectives

- Technologies span multiple end uses and operating contexts
- Range of stakeholder goals/assessment criteria for technology development
Scout establishes a level playing field for stock-wide EE impact assessment

- Technologies evaluated at a consistent scale, using a common methodology
- Technology impacts communicated using common variables and metrics
Starting point: EIA Annual Energy Outlook (AEO) U.S. primary energy use baselines

- AEO baselines represent “business-as-usual” projections
- EIA updates AEO projections annually
- Baselines split by climate, building type/vintage, fuel, end use, technology
- Energy use baselines can be translated to other variables (CO₂, cost)
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U.S. primary energy use baselines

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**HVAC&R – All Buildings**

- Initial baseline: $180.6 billion
- Projected cost: $210 billion by 2040

**Lighting – All Buildings**

- Initial baseline: $34.4 billion
- Projected cost: $40 billion by 2040

**Water Heating – All Buildings**

- Initial baseline: $45.5 billion
- Projected cost: $50 billion by 2040

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**U.S. DEPARTMENT OF ENERGY**

Energy Efficiency & Renewable Energy
Energy conservation measures (ECMs) are applied to AEO baseline energy use totals

- ECMs improve upon comparable baseline technology’s energy performance
- Defined by applicable market/market entry, cost, performance, and lifetime
- Uncertainty may be added to cost, performance, and lifetime inputs

Scout ECM definitions and results are in JSON format
Multiple adoption scenarios determine ECM diffusion into AEO baseline markets

- Adoption scenarios distinguished by the competed market *available to ECMs*
- Technical potential: ECMs compete for total market in market entry year, new fraction of market in subsequent years
- Max. adoption potential: ECMs compete for new/replacement/retrofit fractions of total market annually

<table>
<thead>
<tr>
<th>Year</th>
<th>Technical Potential</th>
<th>Maximum Adoption Potential</th>
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<tbody>
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<td><img src="chart2" alt="Maximum Adoption Potential" /></td>
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<td><img src="chart2" alt="Maximum Adoption Potential" /></td>
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</table>

- **Competed baseline**
- **Uncompeted baseline**
- **Captured by an efficient measure**
Multiple adoption scenarios determine ECM diffusion into AEO baseline markets

Technical potential

Maximun adoption potential

End Uses: Multiple

Primary Energy Use (Quads)

Year

2015 2020 2025 2030 2035 2040

HVAC&R ECM 1

14.1 Quads

10.0 Quads

AEO Baseline

Efficient

Year

2015 2020 2025 2030 2035 2040

HVAC&R ECM 1

14.1 Quads

11.1 Quads

AEO Baseline

Efficient
Multiple adoption scenarios determine ECM diffusion into AEO baseline markets
ECMs affecting the same baseline market are competed to remove savings overlaps

- ECM capital and operating costs determine their competed market shares
- Competition allows aggregation of savings impacts across ECM portfolio

1. Determine competing ECM incremental unit capital/operating costs

1. Determine size of competed market (total primary energy)

1. Apportion competed market across ECMs using logit model (residential) and cost model (commercial)
ECMs affecting the same baseline market are competed to remove savings overlaps

- Competed Baseline and Efficient results are summed across all ECMs

<table>
<thead>
<tr>
<th>Year</th>
<th>Primary Energy Use (Quads)</th>
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<tbody>
<tr>
<td>2015</td>
<td>16</td>
</tr>
<tr>
<td>2020</td>
<td>15</td>
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<tr>
<td>2025</td>
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<tr>
<td>2035</td>
<td>12</td>
</tr>
<tr>
<td>2040</td>
<td>11</td>
</tr>
</tbody>
</table>

AEO Baseline (Uncompeted)  
AEO Baseline (Competed)  
Efficient (Uncompeted)  
Efficient (Competed)  

- Competed Baseline and Efficient results are summed across all ECMs
ECMs affecting the same baseline market are competed to remove savings overlaps

- Competed Baseline and Efficient results are summed across all ECMs

Accounting trick: baseline market apportioned among ECMs
- ECM1 baseline increases because ECM2 captures small fraction
- ECM2 baseline decreases because ECM1 captures large fraction
- Look strange individually, but competed numbers should add up
ECMs affecting the same baseline market are competed to remove savings overlaps

- Competed Baseline and Efficient results are summed across all ECMs

Uncompeted/competed savings impacts
- Uncompeted savings add up to more than total
- Competed savings add up to total savings
ECMs affecting the same baseline market are competed to remove savings overlaps

- Uncertainty assigned to ECM inputs propagates through to competed outputs
ECM portfolio impacts can be examined by climate zone, building class, and end use

- **Example finding:** Savings are generally even across climates, but lower in AIA CZ1 (North), owing to a lower population.

*Results based on prospective ECM portfolio with 2020 market entry years*
ECM portfolio impacts can be examined by climate zone, building class, and end use

- **Example finding:** Savings are largest in residential existing buildings; savings in existing buildings decline as more new buildings accumulate.

*Results based on prospective ECM portfolio with 2020 market entry years.*
ECM portfolio impacts can be examined by climate zone, building class, and end use

- **Example finding:** Water heating and envelope/HVAC show largest savings; lighting savings spike early due to quick turnover in baseline technologies.

*Results based on prospective ECM portfolio with 2020 market entry years*
ECM impacts can be compared against multiple cost effectiveness metrics

- **Example finding:** Under a consumer-focused cost effectiveness threshold (IRR > 0), 4.4 quads savings in 2030 are cost-effective; most top 5 ECMs are residential

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* Results based on prospective ECM portfolio with 2020 market entry years
ECM impacts can be compared against multiple cost effectiveness metrics

- **Example finding:** Under a consumer-focused cost effectiveness threshold (IRR > 0), 4.4 quads savings in 2030 are cost-effective; most top 5 ECMs are residential.

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Cost effective impact: 4.4 Quads
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* Results based on prospective ECM portfolio with 2020 market entry years
ECM impacts can be compared against multiple cost effectiveness metrics

- **Example finding:** Under a consumer-focused cost effectiveness threshold (IRR > 0), 4.4 quads savings in 2030 are cost-effective; most top 5 ECMs are residential.
ECM impacts can be compared against multiple cost effectiveness metrics

- **Example finding:** Under a portfolio-focused cost effectiveness threshold (CCE < energy cost), 2.3 quads savings in 2030 are cost-effective; lighting ECMs move into top 5

![Cost of Conserved Energy (CCE)](image)

* Results based on prospective ECM portfolio with 2020 market entry years
Scout beta testing release is out; subsequent testing depends on results

- Follows round of internal alpha testing at BTO to identify bugs, streamline workflow

- Beta testing goals
  - Familiarize testers with Scout
  - Determine Scout’s value across multiple organization types
  - Evaluate aspects of the Scout user experience

Let us know you’d like to participate in future testing:
https://goo.gl/forms/1a7t6Z4Mg7r33S7N2

BTO recently distributed a beta release of Scout to a targeted mix of stakeholders (N=57).
Extensive user documentation and tutorials have been developed

Access the documentation and find out how to contribute:
https://github.com/trynthink/scout#scout-
Web interface is under development; results visualizations prototype complete.
Technical improvements can be integrated into existing Scout codebase

- Consumer adoption modeling
  - Improve understanding of EE uptake vs. conventional options

- OpenStudio integration
  - Streamline transfer of OS results to Scout ECM inputs, add residential OS stock models

- Peak demand/demand-response ECMs
  - Incorporate marginal emissions rates, time of use

- Update thermal load components
  - Existing data from 1999 studies

- Benchmark savings against TRMs
  - Verify consistency in ECM definitions
Icon attributions

Slide 2: LED (Nikita Kozin); Water heater (Michael Thompson); Air conditioning unit (Arthur Shlain); Fan (Edward Boatman); Refrigerator (shashank singh); Washing machine (Ed Harrison); Window (Arthur Shlain); Utility tower (Maurizio Fusillo); Lab scientist (Edward Boatman); Business team (lastpark); Energy dollar (Nicholas Menghini); United States (Bohdan Burmich)

Slide 6: Calendar (Khomsun Chaiwong); Gauge (Nicolas Vicent); US Dollar (Christopher Beach); Clock (Nadya Bratt)

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