Agenda

Introduction

Study Overview

Results
- Energy Efficiency
- Demand Response
- Combined Heat and Power
- Heating Electrification
- Cumulative impact on energy sales

Conclusions
TEAM

Dunsky is comprised of 30+ clean energy professionals.

Among them, today’s presenters:

Alex Hill  
Managing Partner

Nick Martin  
Senior Analyst
Study Overview
Study Overview: Key Parameters

Study Period: 2021 to 2026

Study Geography: Rhode Island*

Sectors: Residential ▪ Low-Income Residential ▪ Commercial ▪ Industrial

Savings Streams: Energy Efficiency ▪ Combined Heat & Power ▪ Demand Response ▪ Heating Electrification ▪ Distributed Generation

Fuels: Electricity ▪ Natural Gas ▪ Oil ▪ Propane

DEEP Model: Applies bottom up models, using detailed RI markets and measures

* Savings are estimated based on National Grid’s customer territory and will be scaled for Block Island Utility District and Pascoag Utility District.
Results presented in this slide deck represent savings for National Grid customers only.
Energy Efficiency (EE)
Three program scenarios are explored in this study:

**Low**
Applies incentives and enabling activities in line with National Grid’s 2020 Energy Efficiency Plan to simulate *business as usual*.

**Mid**
Increases incentives and enabling activities *above and beyond* levels within National Grid’s 2020 Energy Efficiency Plan.

**Max**
Completely eliminates customer costs and further reduces customer adoption barriers to estimate *maximum achievable potential*. 
### EE: DEEP Model

<table>
<thead>
<tr>
<th>MEASURE INTERACTIONS</th>
<th>TECHNICAL</th>
<th>ECONOMIC</th>
<th>ACHIEVABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Chaining</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ECONOMIC SCREENING</th>
<th>TECHNICAL</th>
<th>ECONOMIC</th>
<th>ACHIEVABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a</td>
<td>RI Test</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MARKET BARRIERS</th>
<th>TECHNICAL</th>
<th>ECONOMIC</th>
<th>ACHIEVABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Barriers</td>
<td>No Barriers</td>
<td>Adoption Curves</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMPETING MEASURES</th>
<th>TECHNICAL</th>
<th>ECONOMIC</th>
<th>ACHIEVABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winner takes all</td>
<td></td>
<td>Competition Groups</td>
<td></td>
</tr>
<tr>
<td>(most efficient)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NET SAVINGS</th>
<th>TECHNICAL</th>
<th>ECONOMIC</th>
<th>ACHIEVABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross</td>
<td>Gross</td>
<td>Program NTGR, Measure RR</td>
<td></td>
</tr>
</tbody>
</table>

- Achievable adoption is based on U.S. Department of Energy adoption curves, which estimate customer adoption as a function of the customer’s economic payback.
Significant changes since February EERMC Meeting

Additional quality control resulted in the following changes:

- Electric savings **increased** primarily due to model calibration on lighting measures where preliminary results were significantly under estimating savings as compared to current program savings.

- Gas savings **decreased** – particularly in the study’s initial years – due to program ramp rates for measures that have low adoption in existing programs, but that have market data suggesting a larger opportunity exists.
  - Gas savings slightly **increased** in the study’s later years as gas measures ramped up to full potential and savings increased for a small number of measures due to additional refinements.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Lifetime</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric</td>
<td>+8.2%</td>
<td>+6.4%</td>
</tr>
<tr>
<td>Gas</td>
<td>-2.3%</td>
<td>-2.4%</td>
</tr>
</tbody>
</table>

Percent change to 2021-2023 average savings since preliminary results presented to EERMC on February 27, 2020
EE: Electric Savings Potential

Annual Electric Savings as Percentage of Forecasted Electricity Sales*

- Low Scenario aligns with 2020 Plan savings when A-Lamp savings are excluded.
- Savings decline in 2023 as significant lighting measures leave the programs and saturation of other lighting measures.

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019 Program Results</td>
<td>2.8%</td>
</tr>
<tr>
<td>2020 RI EE Plan (w/o A Lamps)</td>
<td>1.8%</td>
</tr>
<tr>
<td>2020 RI EE Plan</td>
<td>2.6%</td>
</tr>
<tr>
<td>2021 Potential National Grid (MA)</td>
<td>2.7%</td>
</tr>
<tr>
<td>BAU</td>
<td>2.1%</td>
</tr>
<tr>
<td>MAX</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

*Dunsky treated National Grid’s 2021-2026 forecasted electric sales to remove assumed EE savings to estimate percent savings for each year of the study.
EE: Electric Savings Potential

Lifetime Electric Savings by Sector (Max)

- Bulk of electric savings come from residential and commercial sectors
- Lifetime savings increase slightly year-over-year even while annual savings decline in 2023 (previous slide) as longer-lived measures ramp up and replace reduced lighting savings
Annual Passive Peak Demand Reduction by Sector (Max)

- Similar to energy savings, bulk of passive demand savings come from residential and commercial sectors.
Savings move quickly away from lighting and towards other end uses as lighting market transforms to LEDs.

In terms of annual savings, 2021-2023 residential savings are distributed among end-uses.

From a lifetime perspective, the relative impact of HVAC and envelope measures increase significantly – while lighting, behavioral, and other decrease – when compared to annual savings.
Despite loss of lighting, lifetime residential savings grow

- In the residential sector, increased lifetime savings from long-lived measures (HVAC and appliance) more than make up for reduction of lighting savings in 2023 as the market transforms.

- However, in annual terms, savings drop in 2023 as lighting exits the market.

Residential EE Savings, Max Scenario (MWh)

<table>
<thead>
<tr>
<th></th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual</td>
<td>78,231</td>
<td>84,722</td>
<td>72,917</td>
</tr>
<tr>
<td>Lifetime</td>
<td>594,943</td>
<td>675,705</td>
<td>710,287</td>
</tr>
</tbody>
</table>

*Graph shows combined savings for both residential and low-income residential customers.*
Proportion of Non-Residential Savings by End Use

- Lighting savings drop significantly as compared to 2020 EE Plan as markets transform.
- Still, the majority of non-residential savings are driven by lighting (linear) and lighting controls, with HVAC savings representing a growing and significant opportunity.
- There is less difference between average annual savings and lifetime savings compared to residential sector because the spread in measure lives is less.
Estimated Annual Electric Program Costs

- Total costs and marginal cost per unit savings increase with savings
- Potential study estimated budgets do not account for portfolio optimization and program design improvements

**Estimated 2021 Acquisition Costs**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>$ per First-year kWh</th>
<th>$ per Lifetime kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>$1.09</td>
<td>$0.105</td>
</tr>
<tr>
<td>Mid</td>
<td>$0.80</td>
<td>$0.080</td>
</tr>
<tr>
<td>Low</td>
<td>$0.63</td>
<td>$0.066</td>
</tr>
<tr>
<td>2019 Results</td>
<td>$0.55</td>
<td>$0.065</td>
</tr>
</tbody>
</table>

Note: 2019 Spending benchmark does not include A-Lamp, HE, DR, or CHP spending.
**EE: Natural Gas Savings Potential**

**Annual Gas Savings as Percentage of Forecasted Gas Sales***

- **Low Scenario** exceeds 2020 plan, but is similar to 2019 portfolio results
- **Mid and Max** show notable upside potential

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019 Programs</td>
<td>1.1%</td>
</tr>
<tr>
<td>2020 RI BCR</td>
<td>0.8%</td>
</tr>
<tr>
<td>2021 Potential National Grid (MA)</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>0.8%</td>
</tr>
<tr>
<td>MAX</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

*Dunsky treated National Grid's 2021-2026 forecasted gas sales to remove assumed EE savings to estimate percent savings for each year of the study.
### Lifetime Gas Savings by Sector (Max)

- **Commercial sector** is the slight majority of EE gas savings
  - Residential sector savings driven by single family segment.
  - Commercial sector savings driven by office, retail, education/campus and lodging segments.

- **Residential sector** shows significant upside between Low and Mid scenarios – increasing by 50%

<table>
<thead>
<tr>
<th>Year</th>
<th>Residential Low Income</th>
<th>Residential</th>
<th>Commercial</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>384,995</td>
<td>4,778,819</td>
<td>4,003,05</td>
<td>387,821</td>
</tr>
<tr>
<td>2022</td>
<td>387,821</td>
<td>4,812,614</td>
<td>4,308,576</td>
<td>392,987</td>
</tr>
<tr>
<td>2023</td>
<td>392,987</td>
<td>4,902,991</td>
<td>4,226,126</td>
<td>436,023</td>
</tr>
</tbody>
</table>

**Lifetime Gas Savings**

- **Residential Low Income**
- **Residential**
- **Commercial**
- **Industrial
On an annual basis, nearly half of residential savings come from HVAC measures.

The impact of HVAC and envelope measures increases when viewed from a lifetime savings perspective, while the behavioral savings portion drops.
**Proportion of Non-Residential Savings by End Use**

<table>
<thead>
<tr>
<th>End Use</th>
<th>2020 Plan First-Year Savings</th>
<th>2021-23 Average Annual Savings</th>
<th>2021-23 Average Lifetime Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC</td>
<td>44%</td>
<td>86%</td>
<td>86%</td>
</tr>
<tr>
<td>Other</td>
<td>30%</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Kitchen</td>
<td>5%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Envelope</td>
<td>7%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>New Construction</td>
<td>5%</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Hot Water</td>
<td>6%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Behavioral</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
</tbody>
</table>

- Majority of non-residential gas savings are found in HVAC measures.
- There is not a significant difference in proportional savings when viewed from annual and lifetime basis.
• Estimated total costs and marginal cost per unit savings increase with savings.

• Potential study estimated budgets do not account for portfolio optimization and program design improvements.

### Estimated Annual Gas Program Expenditures

<table>
<thead>
<tr>
<th>Year</th>
<th>Max</th>
<th>Mid</th>
<th>Low</th>
<th>2019 Spending</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>$90</td>
<td>$57</td>
<td>$36</td>
<td>$66.79</td>
</tr>
<tr>
<td>2022</td>
<td>$93</td>
<td>$59</td>
<td>$37</td>
<td>$69.36</td>
</tr>
<tr>
<td>2023</td>
<td>$92</td>
<td>$58</td>
<td>$36</td>
<td>$66.79</td>
</tr>
</tbody>
</table>

### Estimated 2021 Acquisition Costs

<table>
<thead>
<tr>
<th>Scenario</th>
<th>$ per Annual MMBtu</th>
<th>$ per Lifetime MMBtu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>$120.09</td>
<td>$9.38</td>
</tr>
<tr>
<td>Mid</td>
<td>$91.92</td>
<td>$7.65</td>
</tr>
<tr>
<td>Low</td>
<td>$75.62</td>
<td>$6.95</td>
</tr>
<tr>
<td>2019 Results</td>
<td>$66.79</td>
<td>$6.66</td>
</tr>
</tbody>
</table>
EE: Delivered Fuel Savings Potential

The bulk of delivered fuel savings come from the single-family residential customers.

Oil measures account for approximately 94% of delivered fuel savings.
Regardless of program scenario, efficiency programs create significant net benefits under the Rhode Island Test.

- BCR ratio decreases slightly under Mid and Max program scenarios, however each scenario is highly cost-effective.
- For the first 3 program years, net benefits range from $1.4B to $2.8B.

### Total Rhode Island Test Benefits and Costs by 2023

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Net Benefits</th>
<th>RI Test Ratio</th>
<th>2020 Plan RI Test Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>$2,758M</td>
<td>4.63</td>
<td></td>
</tr>
<tr>
<td>Mid</td>
<td>$1,928M</td>
<td>4.42</td>
<td>4.32</td>
</tr>
<tr>
<td>Low</td>
<td>$1,361M</td>
<td>4.56</td>
<td></td>
</tr>
</tbody>
</table>
Total Lifetime Customer Net Benefits by 2023

- Efficiency programs create significant customer savings

### Low Income Customer Benefits by 2023 (Max Scenario)

<table>
<thead>
<tr>
<th>Savings</th>
<th>Max Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Savings</td>
<td>25.28 GWh</td>
</tr>
<tr>
<td>Gas Savings</td>
<td>80,339 MMBtu</td>
</tr>
<tr>
<td>Delivered Fuel Savings</td>
<td>24,262 MMBtu</td>
</tr>
<tr>
<td>Customer Savings</td>
<td>$54.3M</td>
</tr>
</tbody>
</table>
Electric annual savings are likely to drop as lighting markets become increasingly transformed... however, new opportunities exist and can be exploited in a cost-effective manner and savings can continue to increase when considered from a lifetime perspective.

Gas savings appear to be growing in importance in the EE portfolio, and the residential sector may offer significant upside potential through higher investments.

Program costs to capture non-lighting savings could be somewhat higher that historical program results... however, the 3-year portfolio can offer up to $2.8Bn in net benefits to Rhode Islanders.
Demand Response
Three program scenarios are explored in this study:

**Low**
Current DR programs and incentives, expanded across the full possible market.

**Mid**
Expanded DR programs with mid-point incentives (relative to maximum and benchmarked to other jurisdictions)

**Max**
Expanded DR programs with maximum cost-effective incentives.
Integration of other studies:
  • Energy efficiency, heating electrification, distributed generation, and EV adoption impacts were integrated into the utility load curve, and the changes to the utility load shape and peak result in an increase in DR potential.

Apply National Grid Feedback:
  • Updated assumptions for battery energy storage and commercial curtailment leading to increased potential

Model Refinement:
  • Changes in adoption for large commercial and industrial to better reflect existing programs resulting is a small decrease in potential (smaller impact than the changes made by the feedback above)
- Cooling driven peak from 12:00 - 18:00
- Limited industrial load relative to peak

### Peak Load Breakdown

<table>
<thead>
<tr>
<th>Year</th>
<th>Peak Forecast (MW) (accounting for EE, DG, EVs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>1,753</td>
</tr>
<tr>
<td>2022</td>
<td>1,748</td>
</tr>
<tr>
<td>2023</td>
<td>1,752</td>
</tr>
<tr>
<td>2024</td>
<td>1,750</td>
</tr>
<tr>
<td>2025</td>
<td>1,744</td>
</tr>
<tr>
<td>2026</td>
<td>1,746</td>
</tr>
</tbody>
</table>
Achievable Annual Peak Demand Reduction from DR (MW) by Scenario

- Economic potential assessed at: 125 MW*
- Both Residential and Commercial DR have lots of room to grow
- Expanding programs has bigger effect than simply raising incentives
- Budgets range from $2M to $22M per year. Mid scenario appears to offer best savings/cost balance.
• Increasing impact come at significantly increased cost

• Mid and Max scenarios involve notable investment in early years to install equipment (controls, battery storage, etc)

• The Max scenario is more focused on high curtailment incentives, which need to be paid each year to drive peak reductions.

• Keep in mind: DR savings only persist for as long as the programs are active (study assumed that measures deliver savings for a 10 year program life)
• Assessed net commercial impacts are lower than what is measured on an hourly basis
• Interactions among measures can further deteriorate net impact
• 3-hour window is limiting: Expanding the duration of DR measures could improve potential for new measures
• DR potential is evaluated using RI load curve. DR potential on the NE ISO peak will be in the main report appendices.

<table>
<thead>
<tr>
<th>Programs</th>
<th>Current Program</th>
<th>Potential (NE ISO)</th>
<th>Potential (RI load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>5.5</td>
<td>5.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Commercial and Industrial</td>
<td>29.3</td>
<td>28.6</td>
<td>13.6</td>
</tr>
<tr>
<td>Curtailment</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Slide updated June 9th, 2020
DR: Low Scenario

Top 10 Measures: 2023 Achievable Potential (MW)

- Central AC and C&I Curtailment show notable potential for current program expansion, could integrate with efficient AC incentives
- Did not apply any growth to Behavioral DR

<table>
<thead>
<tr>
<th>Program (2023)</th>
<th>RI Test</th>
<th>Savings (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential BYOD</td>
<td>1.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Medium &amp; Large Commercial Curtailment</td>
<td>7.3</td>
<td>17.4</td>
</tr>
<tr>
<td>Medium &amp; Large Industrial Curtailment</td>
<td>7.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Res. Behavioral DR</td>
<td>41.7</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Slide updated June 9th, 2020
Top Measures: 2023 Achievable Potential (MW)

- Commercial curtailment and residential program expansion are driving the savings.
- Commercial energy storage plays a key role in this scenario.
  - Note: Commercial energy storage is excluded from the Low Scenario as this technology is not currently participating in existing programs.

<table>
<thead>
<tr>
<th>Program (2023)</th>
<th>RI Test</th>
<th>Savings (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Res. DLC</td>
<td>2.0</td>
<td>14.4</td>
</tr>
<tr>
<td>Res. BYOD</td>
<td>1.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Small Comm. BYOD</td>
<td>3.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Small Comm. DLC</td>
<td>1.3</td>
<td>10.1</td>
</tr>
<tr>
<td>Med. &amp; Large Comm. Curtailment</td>
<td>4.1</td>
<td>25.5</td>
</tr>
<tr>
<td>Med. &amp; Large Industrial Curtailment</td>
<td>4.5</td>
<td>7.4</td>
</tr>
<tr>
<td>Res. Behavioral DR</td>
<td>41.7</td>
<td>2.0</td>
</tr>
</tbody>
</table>
DR: Max Scenario

Top Measures: 2023 Achievable Potential (MW)

- Results in a notable change in top measure mix to be more focused on C&I curtailment, compared to Mid scenario

<table>
<thead>
<tr>
<th>Program (2023)</th>
<th>RI Test</th>
<th>Savings (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Res. DLC</td>
<td>0.8</td>
<td>5.4</td>
</tr>
<tr>
<td>Res. BYOD</td>
<td>0.8</td>
<td>18.4</td>
</tr>
<tr>
<td>Small Comm. BYOD</td>
<td>0.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Small Comm. DLC</td>
<td>1.0</td>
<td>11.5</td>
</tr>
<tr>
<td>Med. &amp; Large Comm. Curtailment</td>
<td>5.3</td>
<td>36.6</td>
</tr>
<tr>
<td>Med. &amp; Large Industrial Curtailment</td>
<td>3.4</td>
<td>9.3</td>
</tr>
<tr>
<td>Res. Behavioral DR</td>
<td>41.7</td>
<td>2.0</td>
</tr>
</tbody>
</table>
There is significant opportunity to expand DR programs in RI in a cost-effective manner, both through growing the market for existing programs, and introducing new programs and measures.

Expanding programs to new measures (low to mid) has bigger effect than raising incentives (mid to max)

Overall, estimated potential aligns with other recent DR studies:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Portion of Peak Load</td>
<td>3.6% - 4.4% (2026)</td>
<td>3.5% - 4.0% (10-year outlook)</td>
<td>4.4%-7.7% (3-year outlook)</td>
<td>8.2% (15-year outlook)</td>
</tr>
<tr>
<td>Avoided Costs</td>
<td>$200 / kW</td>
<td>$290 / kW</td>
<td>$140 / kW</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Combined Heat and Power (CHP)
Three program scenarios are explored in this study:

**Low**
Incentive levels set at maximum allowable incentive (70%)

**Mid**
Incentive levels set at maximum allowable incentive (70%) with additional barrier level decrease

**Max**
Incentive levels set at 100% with same barrier level decrease as mid scenario
CHP Economic Potential Installed Capacity Potential by Segment (MW)

- 30.3 MW Office
- 18.5 MW Healthcare/Hospitals
- 17.9 MW Manufacturing/Industrial
- 14.1 MW Campus/Education
- 6.6 MW Retail
- 4.3 MW Food Service
- 2.3 MW Food Sales

Economic Potential

- Significant technical potential exists, but the majority does not pass economic screening
- Office, Healthcare, Campus/Education and Industrial segments have greatest potential

Technically potential: 342 MW
Economically potential: 94 MW
Historical Installed Capacity and Achievable Adoption Projections

Average impacts (2021-2026)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Max</th>
<th>Mid</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Capacity Additions (MW)</td>
<td>11.1</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Annual Electric Savings (MWh)</td>
<td>45,209</td>
<td>18,526</td>
<td>14,106</td>
</tr>
<tr>
<td>Lifetime Electric Savings (MWh)</td>
<td>723,337</td>
<td>296,409</td>
<td>225,700</td>
</tr>
<tr>
<td>Peak Demand Reduction (MW)</td>
<td>4.12</td>
<td>1.69</td>
<td>1.28</td>
</tr>
<tr>
<td>Annual Gas Consumption Increase (MMBtu)</td>
<td>266,891</td>
<td>109,366</td>
<td>83,277</td>
</tr>
<tr>
<td>Annual Program Spending (Million $2021)</td>
<td>$29.6M</td>
<td>$9.0M</td>
<td>$6.7M</td>
</tr>
</tbody>
</table>

- Adoption estimates are best interpreted by study period averages
- **Benchmark**: 3.6MW installed annually between 2014 and 2018
• When the embedded energy of grid electricity production is considered, CHP adoption results in net energy savings

• Note: Analysis assumes marginal heat rate of 7,100 Btu/kWh (AESC 2018)
Additional CHP potential exists and current incentive levels can encourage additional adoption commensurate with recent years.

The biggest opportunities are in the Office, Healthcare, Education & Campus, and Industrial segments.

Reducing non-financial barriers through enabling activities may move the market a little, but overall impact is small compared to increasing customer payback (e.g. increased incentives).
Heating Electrification (HE)
Three program scenarios are explored in this study:

**Low**
Applies 25% incentives and enabling activities (half-step barrier reduction) in line with National Grid’s 2020 Energy Efficiency Plan

**Mid**
Applies 50% incentives and additional enabling strategies (full-step barrier reduction)

**Max**
Incentives set at 100% to completely eliminates customer costs and applies enabling strategies (full-step barrier reduction)
• There is significant technical potential for heating electrification in Rhode Island – particularly when natural gas is included.
• Propane and oil fuel switching are largely cost-effective, but most natural gas electrification does not pass the RI Test
• Increasing incentives and reducing barriers drives significantly more adoption compared to the Low Scenario (mostly oil savings)
Heating electrification has the potential to significantly increase electricity consumption.

The majority of potential is in the residential sector.

The commercial sector is constrained by economics (high cost, and limited sizing).

Space heating dominates fuel-switching savings when compared to hot water savings.
Total Rhode Island Test Benefits and Costs by 2023

- Annual estimated costs range from $6.4M (Low) to $115M (Max) per year
  - National Grid’s 2019 HE spending totaled $1.8M
- Lifetime customer net benefits are significant.
  - $35.2M customer lifetime benefits by 2023 under Low Scenario over a third accruing to the residential low income sector.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Net Benefits</th>
<th>BCR Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>$650M</td>
<td>3.33</td>
</tr>
<tr>
<td>Mid</td>
<td>$112M</td>
<td>3.36</td>
</tr>
<tr>
<td>Low</td>
<td>$42M</td>
<td>3.36</td>
</tr>
</tbody>
</table>

- RI Test Benefits and Costs
  - Annual estimated costs range from $6.4M (Low) to $115M (Max) per year
  - National Grid’s 2019 HE spending totaled $1.8M
  - Lifetime customer net benefits are significant.
    - $35.2M customer lifetime benefits by 2023 under Low Scenario over a third accruing to the residential low income sector.
HE: Key Takeaways

1. There is significant potential for heating electrification in Rhode Island that can create significant net benefits for the state.

2. Savings come primarily from switching away from oil and propane heating. Most natural gas heating electrification does not pass economic screening.

3. Increasing incentives drives significantly more heating electrification, particularly between the Mid and Max scenarios.
Impacts on Sales
Baseline Electricity Sales (GWh)

- Without additional energy efficiency programming, electricity sales are forecasted to increase by approximately **12%** during the study period.
Cumulative Savings: Electricity Sales

Mid Scenario: Electricity Sales + HE (GWh)

• Heating electrification will slightly increase annual consumption (net of reduction for more efficiency air conditioning)

Cumulative Impact on 2026 Baseline

<table>
<thead>
<tr>
<th>HE</th>
<th>+0.6%</th>
</tr>
</thead>
</table>

**Cumulative Savings : Electricity Sales**
Cumulative Savings: Electricity Sales

Mid Scenario: Electricity Sales + HE + EE (GWh)

- Energy efficiency mitigates heating electrification impact and delivers substantial sales curtailment.

<table>
<thead>
<tr>
<th>Year</th>
<th>HE Impact</th>
<th>EE Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>2026</td>
<td>+0.6%</td>
<td>-10.1%</td>
</tr>
</tbody>
</table>

Cumulative Impact on 2026 Baseline
Cumulative Savings: Electricity Sales

Mid Scenario: Electricity Sales + HE + EE + CHP (GWh)

- **Combined heat and power** then further reduced electricity consumption (from the grid)

<table>
<thead>
<tr>
<th>Cumulative Impact on 2026 Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>HE</td>
</tr>
<tr>
<td>EE</td>
</tr>
<tr>
<td>CHP</td>
</tr>
</tbody>
</table>
Cumulative Savings: Electricity Sales

Cumulative Impact on Electric Sales (GWh)

- All scenarios are successful in curtailing RI electric consumption growth
- Max scenario leads to a slight reduction in overall consumption
- Solar PV (DG) when added will further reduce overall electricity consumption
• Efficiency offers the greatest peak load reduction
• DR programs offer second-most, if expanded significantly (new measures, higher incentives)

**Cumulative Impact on 2026 Baseline**

<table>
<thead>
<tr>
<th></th>
<th>DR</th>
<th>CHP</th>
<th>HE</th>
<th>EE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR</td>
<td>-3.7%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHP</td>
<td>-0.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HE</td>
<td>-0.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>-7.8%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cumulative Impact on Peak Demand (MW)

- Low Scenario nearly avoids any growth in peak demand over the study period.
- Increase in DR is most significant jump in peak load reduction between Low to Mid scenarios.
- Solar PV (DG) will further reduce peak load when added.
Cumulative Savings: Natural Gas Sales

Mid Scenario Natural Gas Sales + CHP + EE + HE (MMBtu)

- CHP will increase on-site consumption of natural gas
- EE offers greatest opportunity to reduce natural gas sales

<table>
<thead>
<tr>
<th>Cumulative Impact on 2026 Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHP</td>
</tr>
<tr>
<td>EE</td>
</tr>
<tr>
<td>HE</td>
</tr>
</tbody>
</table>

• CHP will increase on-site consumption of natural gas
• EE offers greatest opportunity to reduce natural gas sales
Cumulative Savings: Natural Gas Sales

Cumulative Impact on Natural Gas Sales (MMBtu)

- Under all scenarios, an increase in gas consumption is projected to increase over the study period.
- Max scenario comes near to keeping gas consumption flat over study period.
Conclusions
Efficiency continues to have the largest overall impact:
- Electric savings lower than in past, but still substantial
- Gas savings growing in importance

CHP contributes to a slight increase in total site energy use:

HE could have notable impact, with further investments:

DR (not shown) shows room to grow with increased budgets:

Overall, the results show great potential for GHG reductions via all savings streams. In the future, GHGs may provide a useful basis for combined target setting.

Note: This graph does not consider savings at the generator, which would show CHP as a net positive energy savings.
Appendix
EE: Electric Savings Potential

Lifetime Electric Savings by Sector (Mid)

- Bulk of electric savings come from residential and commercial sectors
  - Within residential sector, savings are driven by the single family segment
  - Within commercial sector, savings are driven by office, retail, and education/campus segments.
Annual Passive Peak Demand Reduction by Sector (Mid)

- Similar to energy savings, bulk of passive demand savings come from residential and commercial sectors.

<table>
<thead>
<tr>
<th>Year</th>
<th>Residential</th>
<th>Residential Low Income</th>
<th>Commercial</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>26.2 MW</td>
<td>0.8</td>
<td>12.7</td>
<td>11.1</td>
</tr>
<tr>
<td>2022</td>
<td>28.1 MW</td>
<td>0.9</td>
<td>12.8</td>
<td>12.8</td>
</tr>
<tr>
<td>2023</td>
<td>27.9 MW</td>
<td>1.0</td>
<td>13.0</td>
<td>12.2</td>
</tr>
</tbody>
</table>

Annual Savings (MW)
EE: Natural Gas Savings Potential

Lifetime Gas Savings by Sector (Mid)

- Commercial sector is the slight majority of EE gas savings under mid scenario
  - Residential sector savings driven by single family segment.
  - Commercial sector savings driven office, retail, education/campus and lodging segments.
- Residential sector shows significant upside between Low and Mid scenarios – increasing by nearly 50%
The bulk of delivered fuel savings come from the single-family residential customers.

Oil measures account for approximately 94% of delivered fuel savings.
Annual Savings: The amount of energy savings achieved in the first-year of the measure’s installation.

Lifetime Savings: The amount of energy savings achieved over the entire measure’s lifetime.

Note: 2020 Plan Benchmark savings do not include A-Lamp savings.
**Annual Gas Program Savings**

- **2021**: Max = 0.75, Mid = 0.62, Low = 0.48
- **2022**: Max = 0.77, Mid = 0.64, Low = 0.50
- **2023**: Max = 0.79, Mid = 0.66, Low = 0.51

**Lifetime Gas Program Savings**

- **2021**: Max = 9.60, Mid = 7.48, Low = 5.23
- **2022**: Max = 9.95, Mid = 7.79, Low = 5.49
- **2023**: Max = 9.96, Mid = 7.81, Low = 5.52

**Annual Savings**: The amount of energy savings achieved in the first year of the measure’s installation.

**Lifetime Savings**: The amount of energy savings achieved over the entire measure’s lifetime.
Measure Example: Ductless Mini-split Heat Pumps (DMSHP) for Electric Resistance Heating

- Under the Mid Scenario, over 2,000 customers adopt mini-split heat pumps to displace electric resistance heating – including 450 Low Income customers – by 2023.

- Benchmarks:
  - 2019 results: 181 heat pumps
  - 2020 plan: 325 heat pumps

### Average Annual GWh Savings (2021-2023)

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th>Mid</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>5.4</td>
<td>3.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Residential Low-Income</td>
<td>0.9</td>
<td>0.9</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6.2</strong></td>
<td><strong>4.5</strong></td>
<td><strong>1.8</strong></td>
</tr>
</tbody>
</table>
Estimated Combined Costs (EE, CHP, and DR only)

Max Scenario

2021: $341
2022: $359
2023: $365

Mid Scenario

2021: $204
2022: $214
2023: $214

Low Scenario

2021: $128
2022: $131
2023: $128

Note: 2019 Benchmark does not include Heating Electrification or A-Lamp spending.