Rhode Island Energy Efficiency Market Potential Study

Presentation to EERMC

February 27, 2020

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

OVERVIEW

CLIENTS

EXPERTISE

Efficiency — **Renewables** — **Mobility**

SERVICES

Assess Opportunities — **Design** Strategies — **Evaluate** Performance

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Introduction: Study Process

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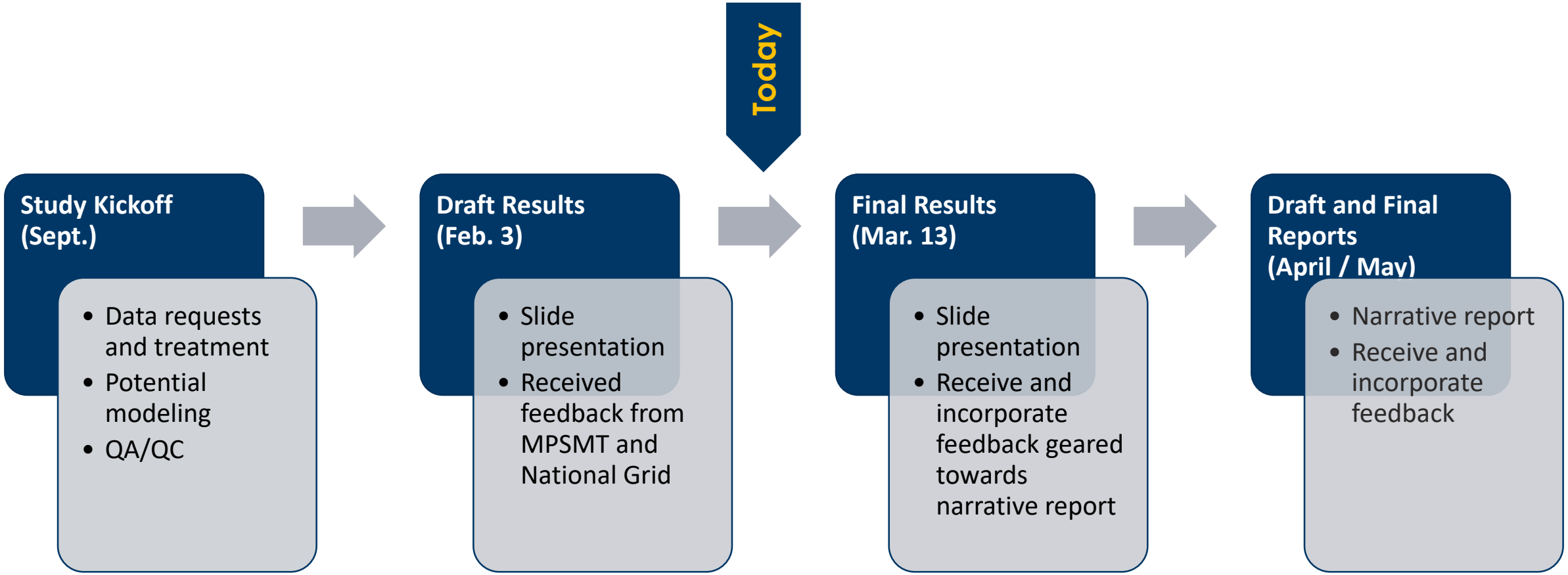
PRELIMINARY RESULTS



Today's Presentation:

- Presents high-level preliminary results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Study Overview

Study Overview: Key Parameters

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PRELIMINARY RESULTS

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

Today's presentation will focus on the first three years of the study (2021 to 2023) and on energy efficiency (electric and natural gas), demand response, and combined heat and power results.

*Savings are estimated based on National Grid's customer territory and will be scaled for Block Island Utility District and Pascoag Utility District

Energy Efficiency (EE)

EE: Achievable Scenarios

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PRELIMINARY RESULTS

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**

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: DEEP Model

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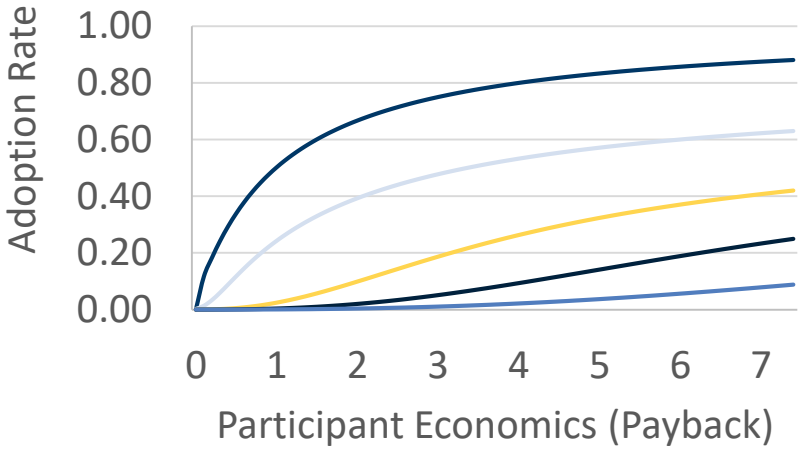
PRELIMINARY RESULTS

	TECHNICAL	ECONOMIC	ACHIEVABLE
MEASURE INTERACTIONS	Chaining		
ECONOMIC SCREENING	n/a	RI Test	Participant Cost Test (PCT)
MARKET BARRIERS	No Barriers	No Barriers	Adoption Curves
COMPETING MEASURES	Winner takes all (most efficient)		Competition Groups
NET SAVINGS	Gross	Gross	Program NTGR, Measure RR

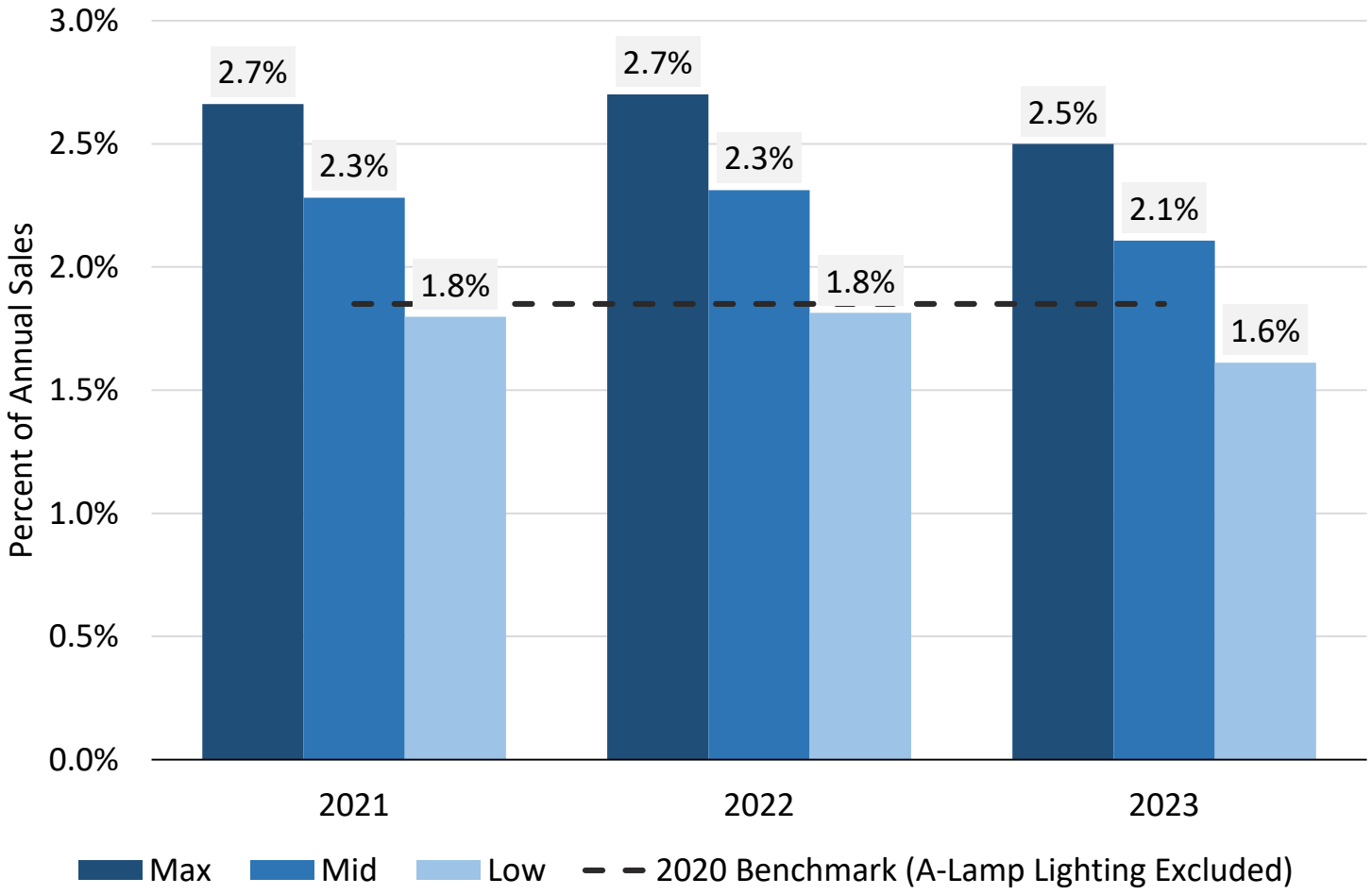


- Achievable adoption is based on U.S. Department of Energy adoption curves, which estimate customer adoption as a function of the customer's economic payback.

EE: Electric Savings Potential

PRELIMINARY RESULTS

Annual Electric Savings as Percentage of Forecasted Electricity Sales*



Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

- Low Scenario aligns with 2020 Plan savings when A-Lamp savings are excluded.
- Max Scenario exceeds 2020 Plan including A-Lamp savings

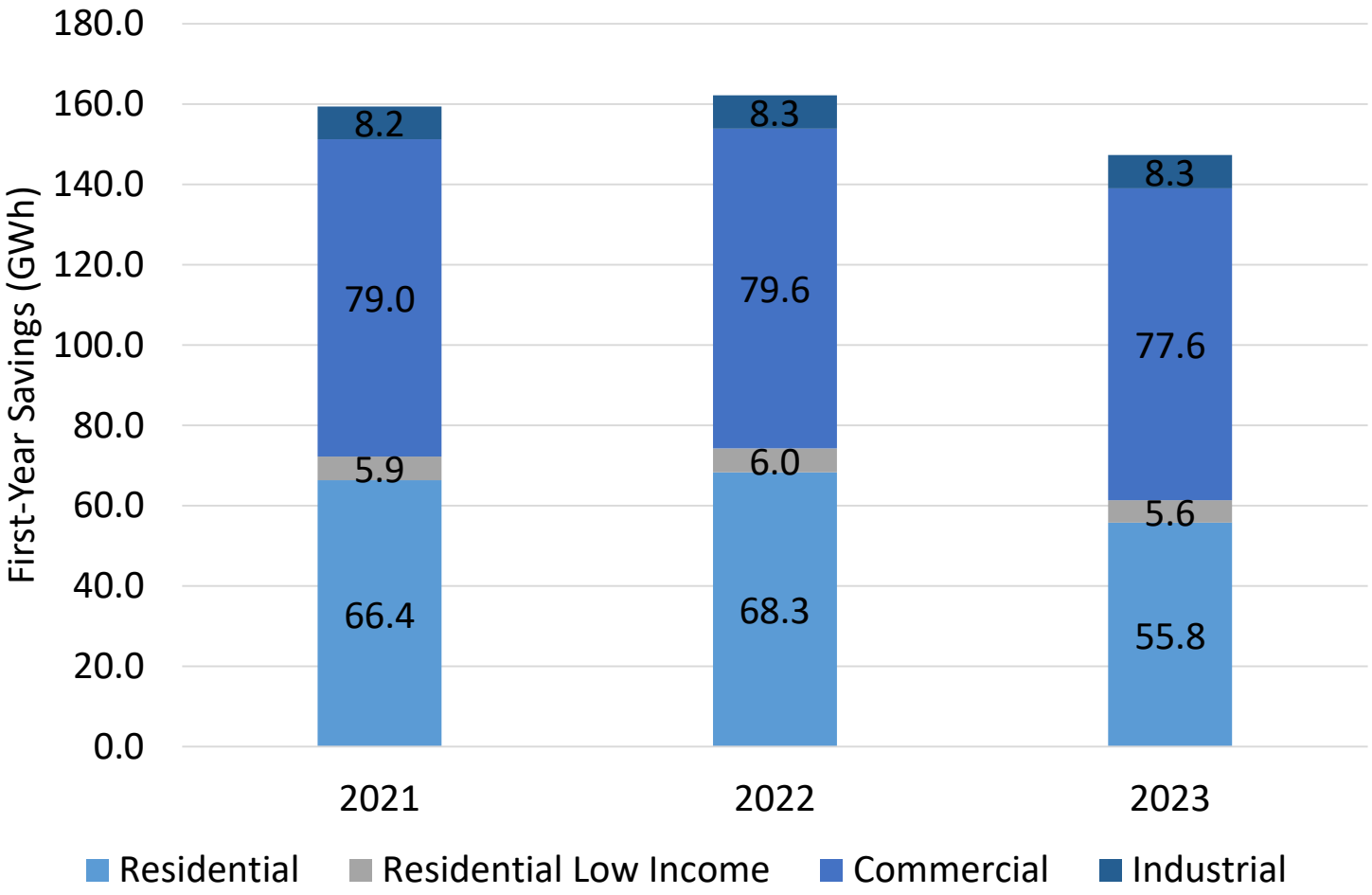
Benchmark	Savings
2019 Program Results	2.8%
2020 RI EE Plan	2.6%
2020 RI EE Plan (w/o A Lamps)	1.8%
2021 Potential National Grid (MA)	
BAU	2.1%
MAX	2.7%

*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

PRELIMINARY RESULTS

Annual First-Year Electric Savings by Sector (Mid)



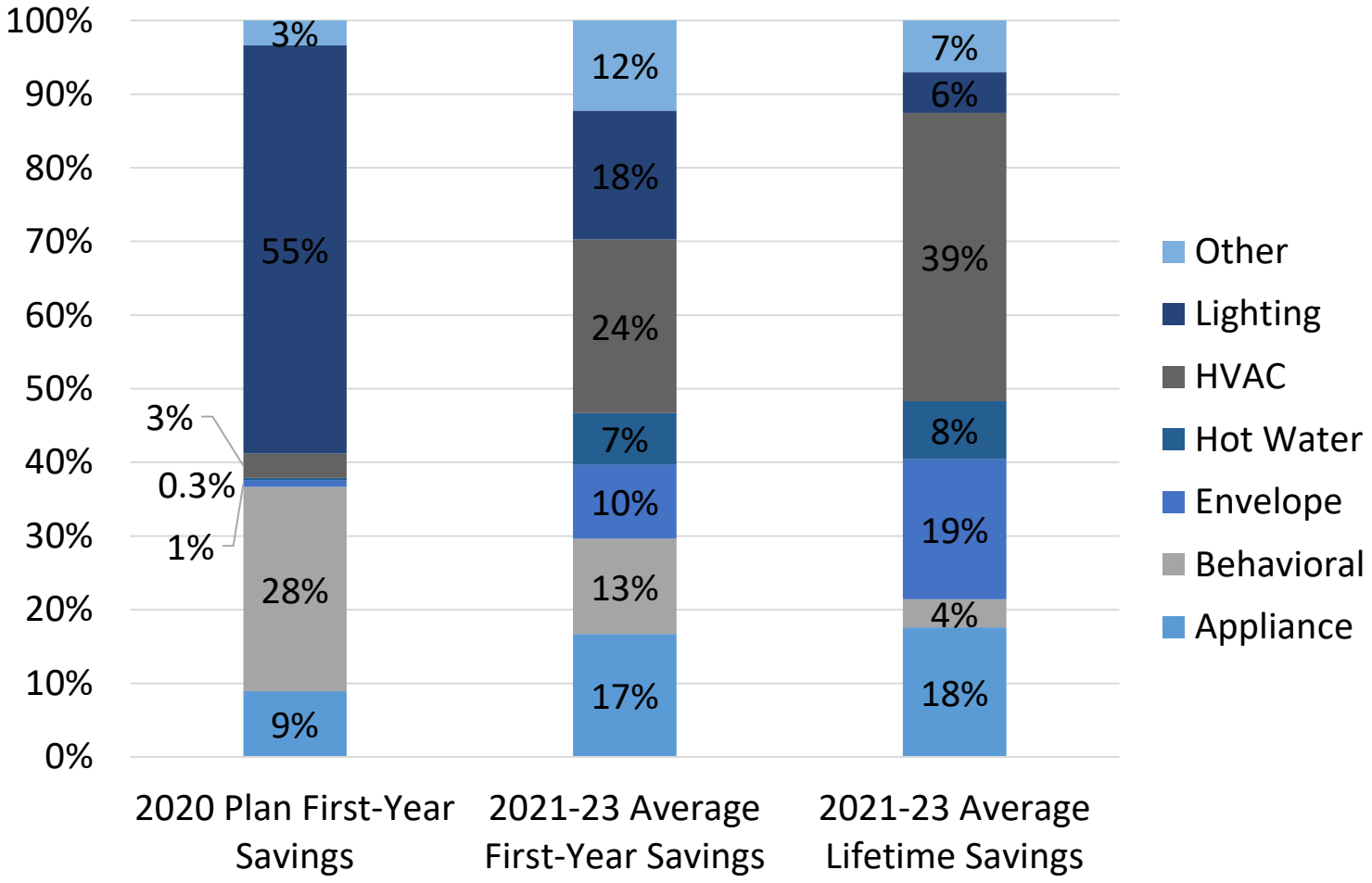
Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

- Bulk of electric savings 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.
- Savings drop in 2023 due to loss of savings from reflectors (lighting)

EE: Electric Savings Potential, Residential

PRELIMINARY RESULTS

Residential Savings by End Use (Mid Scenario)



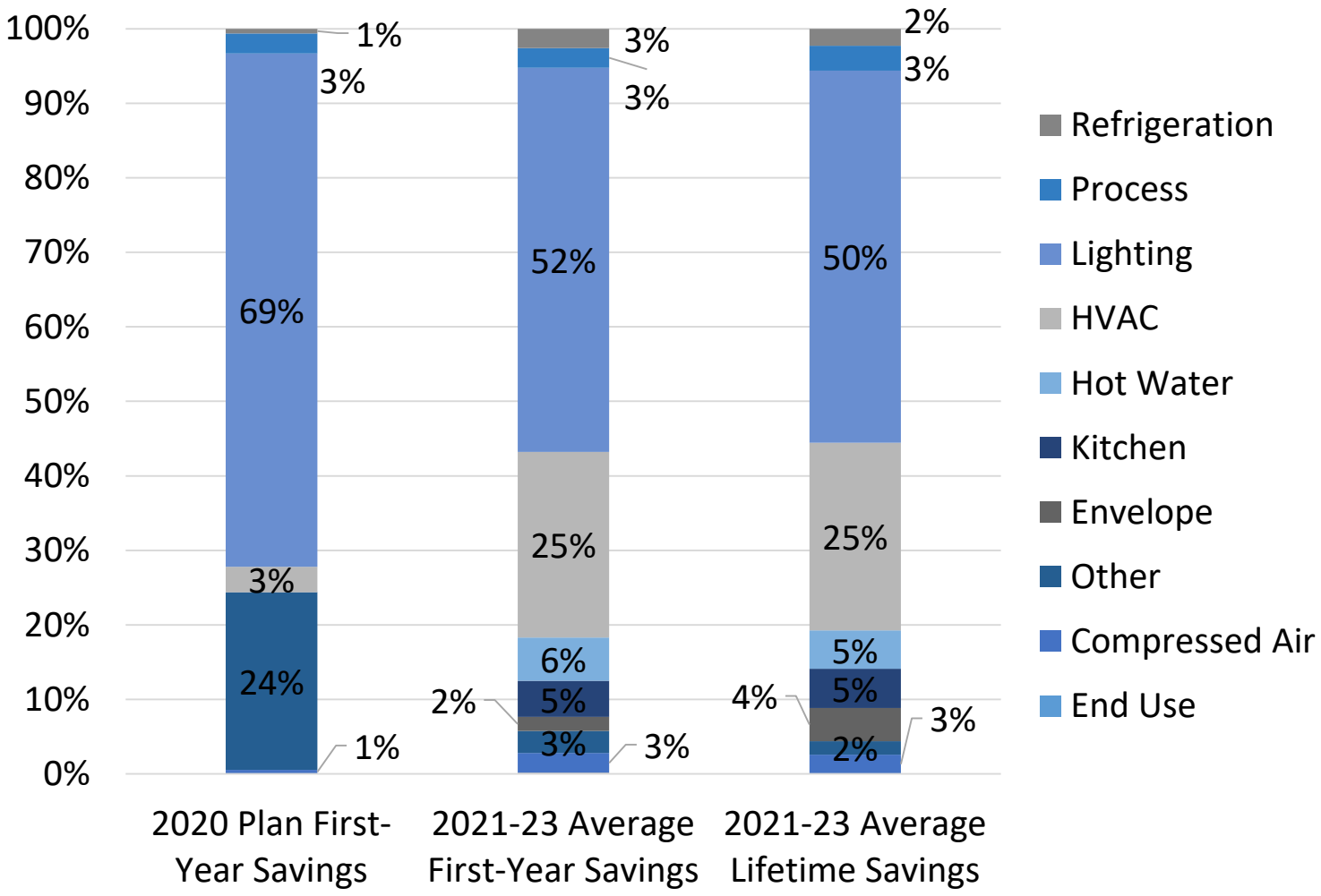
- Savings move quickly away from lighting and towards other end uses
- In terms of initial annual savings, 2021-2023 residential savings are distributed across each end-use
- From a lifetime perspective, the relative impact of HVAC and envelope measures increase significantly – while lighting, behavioral, and other decrease.

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: Electric Savings Potential, Non-Residential

PRELIMINARY RESULTS

Non-Residential Savings by End Use



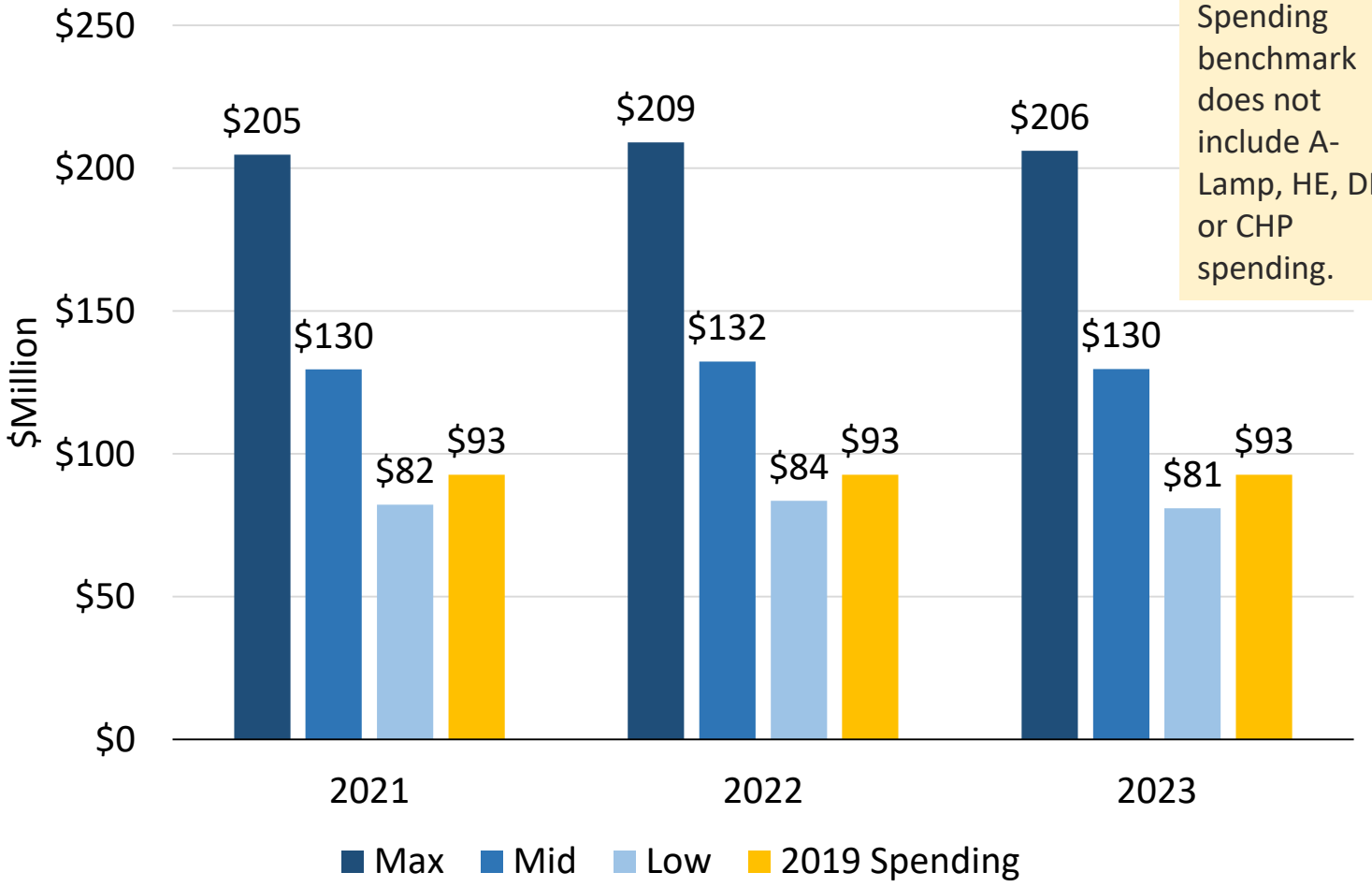
- Lighting savings drop significantly from 2020 EE Plan
- Still, the majority of non-residential savings are driven by lighting (linear) and lighting controls, with HVAC savings representing a growing and significant opportunity
- There is less difference between first-year and lifetime savings compared to residential sector

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: Estimated Electric Program Costs

PRELIMINARY RESULTS

Estimated Annual Electric Program Costs



Note: 2019 Spending benchmark does not include A-Lamp, HE, DR, or CHP spending.

- 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

Scenario	$ per First-year kWh	$ per Lifetime kWh
Max	$1.17	$0.105
Mid	$0.85	$0.081
Low	$0.66	$0.069

Benchmark

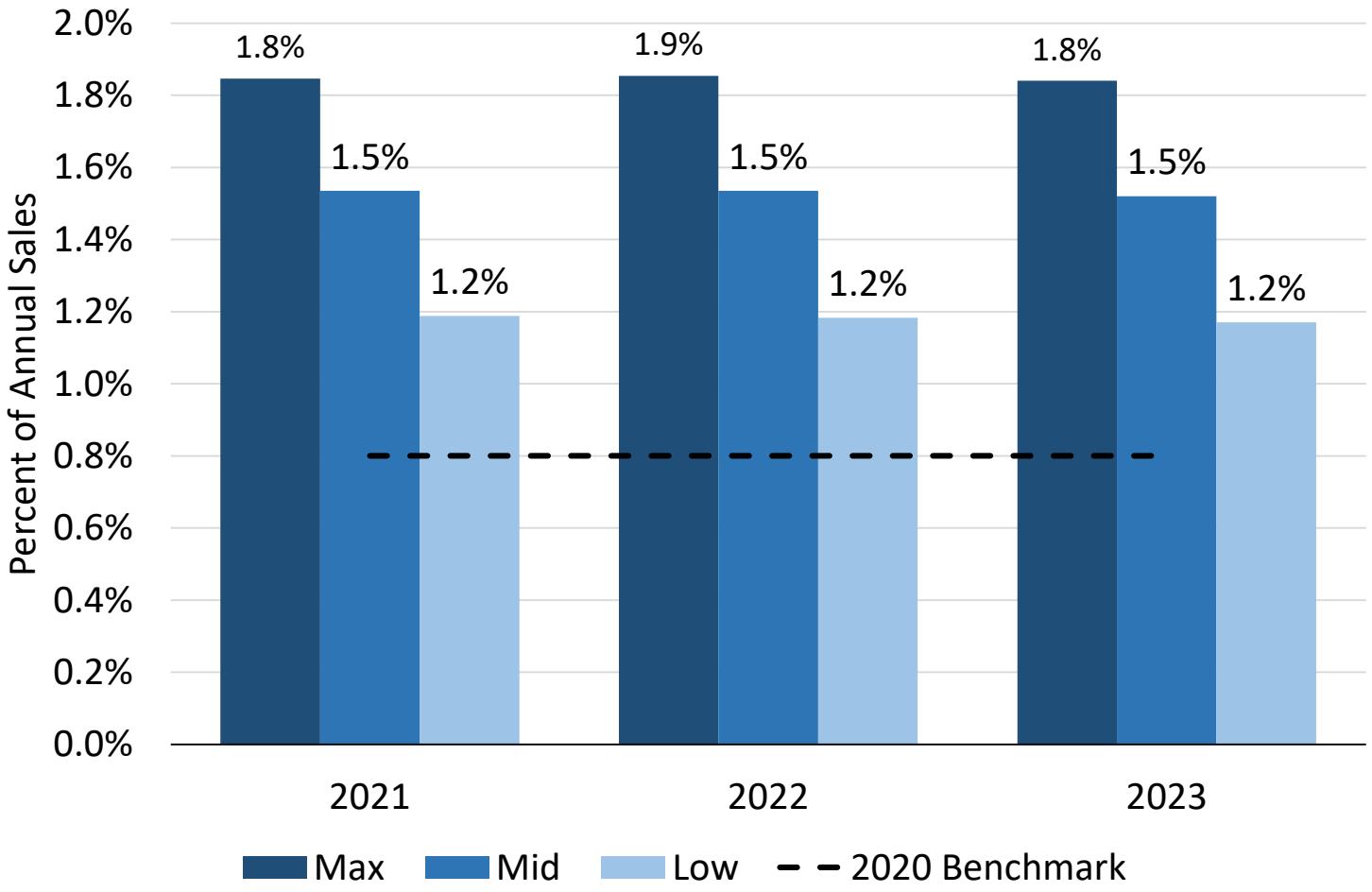
2019 Results: $0.065 per lifetime kWh

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: Natural Gas Savings Potential

PRELIMINARY RESULTS

Annual Gas Savings as Percentage of Forecasted Gas Sales*



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

Benchmark	Savings
2019 Programs	1.1%
2020 RI BCR	0.8%
2021 Potential National Grid (MA)	
Low	0.8%
MAX	1.0%

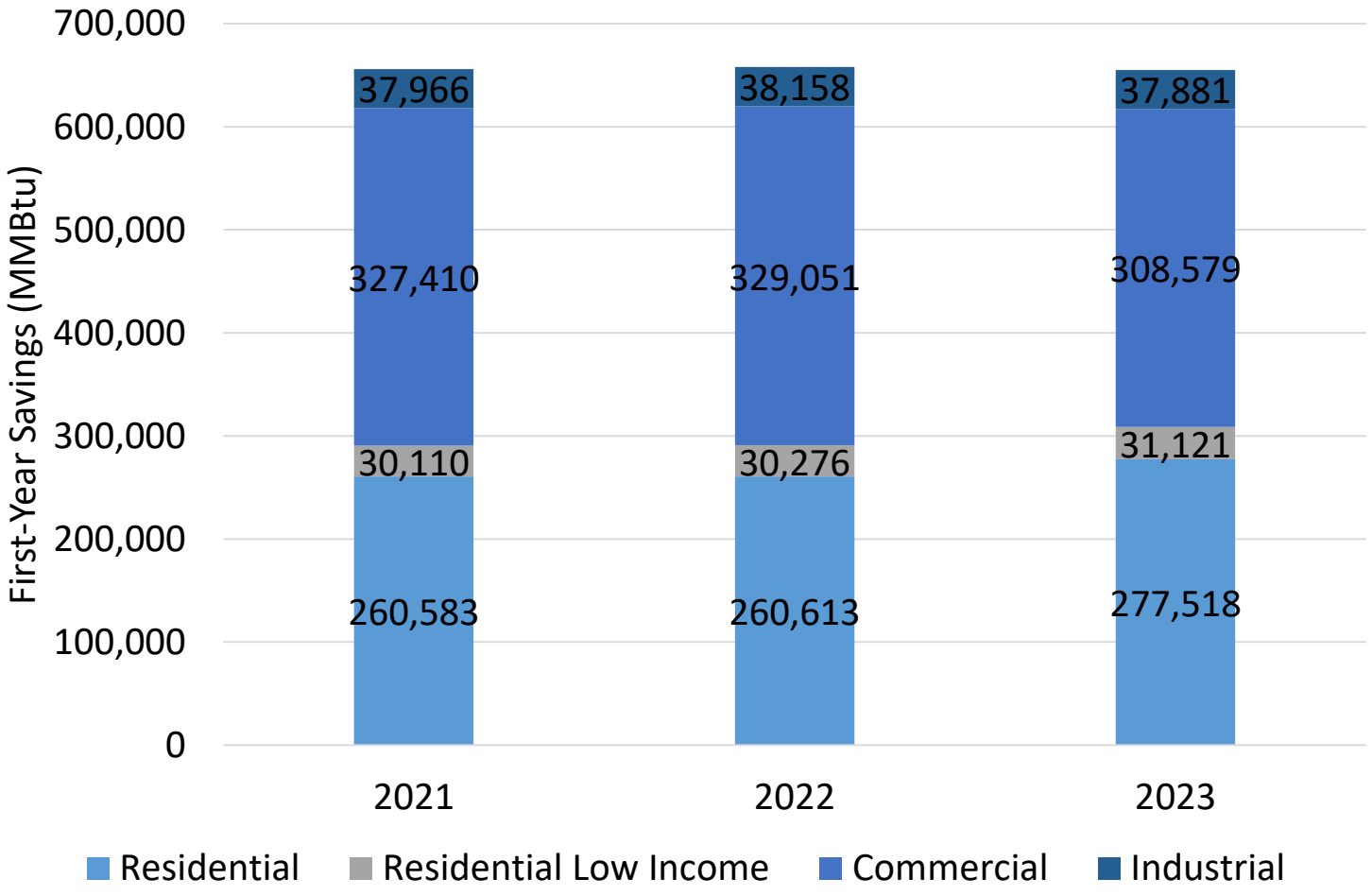
*Dunsky treated National Grid's 2021-2026 forecasted gas sales to remove assumed EE savings to estimate percent savings for each year of the study.

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: Natural Gas Savings Potential

PRELIMINARY RESULTS

Annual First-Year Gas Savings by Sector (Mid)



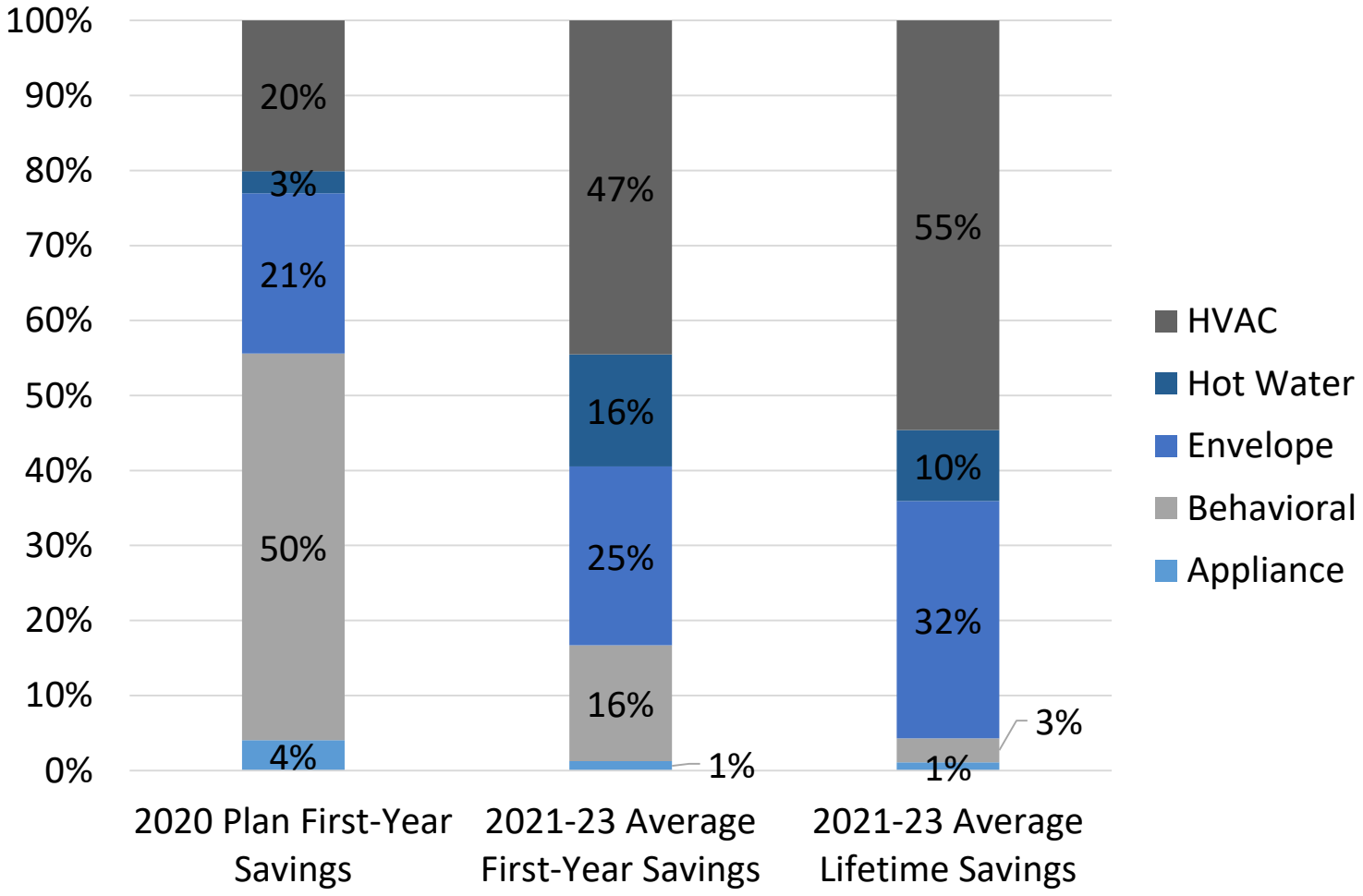
Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

- 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%

EE: Natural Gas Savings Potential, Residential

PRELIMINARY RESULTS

Residential Savings by End Use (Mid Scenario)



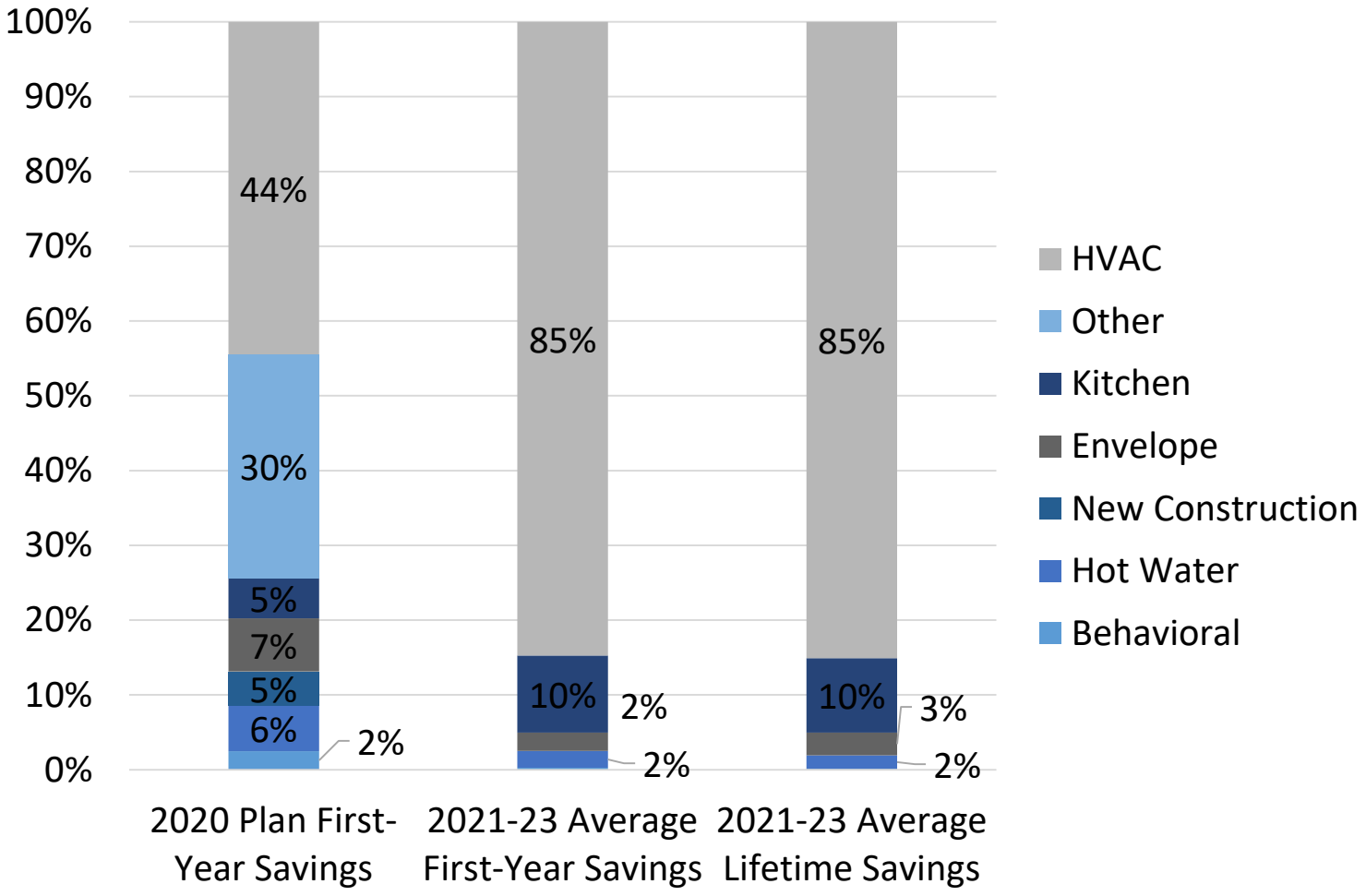
- On an annual basis, nearly half of residential savings come from HVAC measures
- The impact of HVAC and envelope measures increases when viewed from a lifetime savings perspective

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: Natural Gas Savings Potential, Non-Residential

PRELIMINARY RESULTS

Non-Residential Savings by End Use (Mid Scenario)



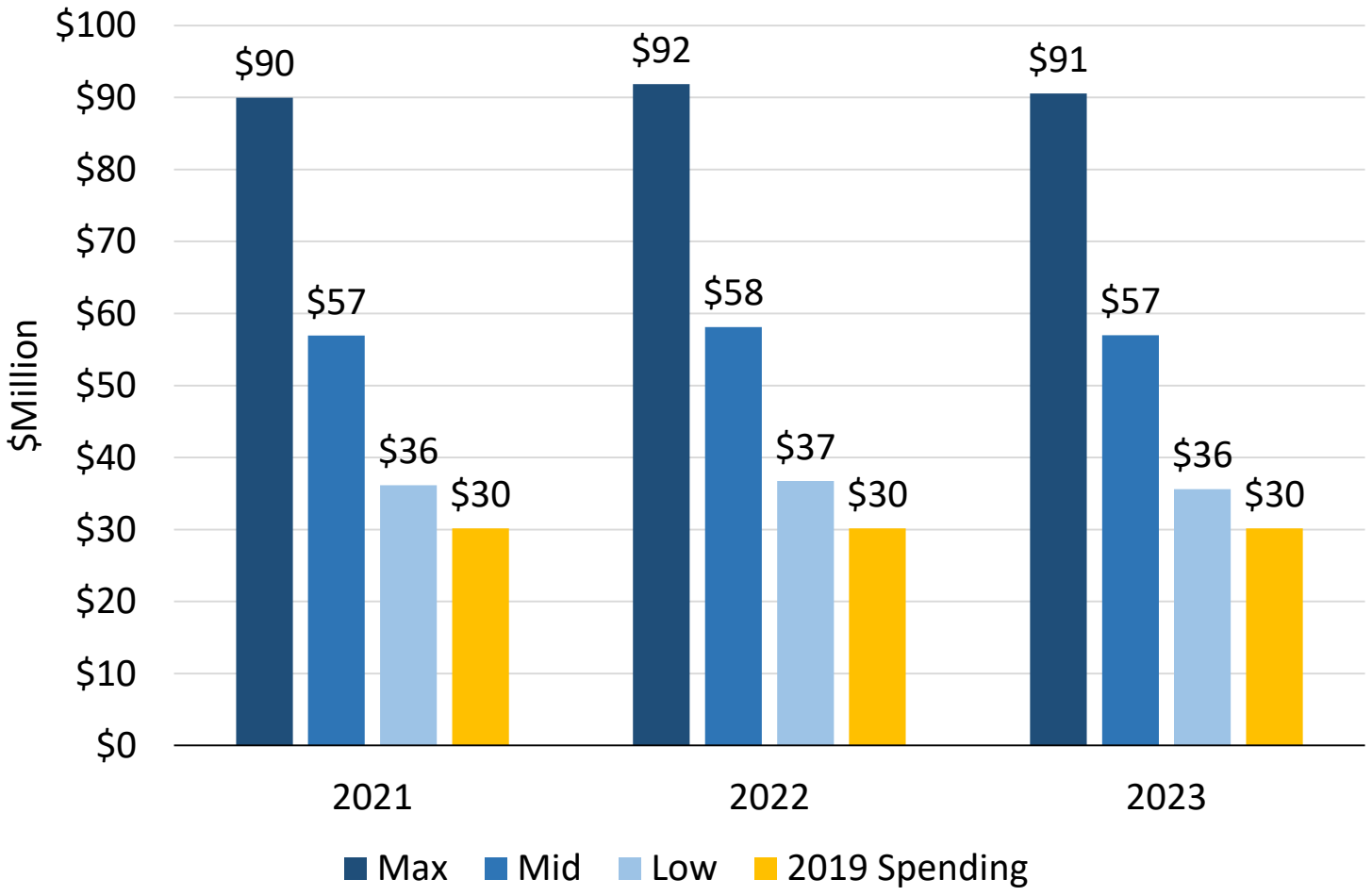
- Majority of gas savings are found in HVAC measures
- There is not a significant difference in proportional savings when viewed from annual and lifetime basis

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: Estimated Gas Program Costs

PRELIMINARY RESULTS

Estimated Annual Gas Program Expenditures



Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

- 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 2021 Acquisition Costs

Scenario	$ per First-year MMBtu	$ per Lifetime MMBtu
Max	$457	$8.87
Mid	$373	$7.17
Low	$365	$6.46

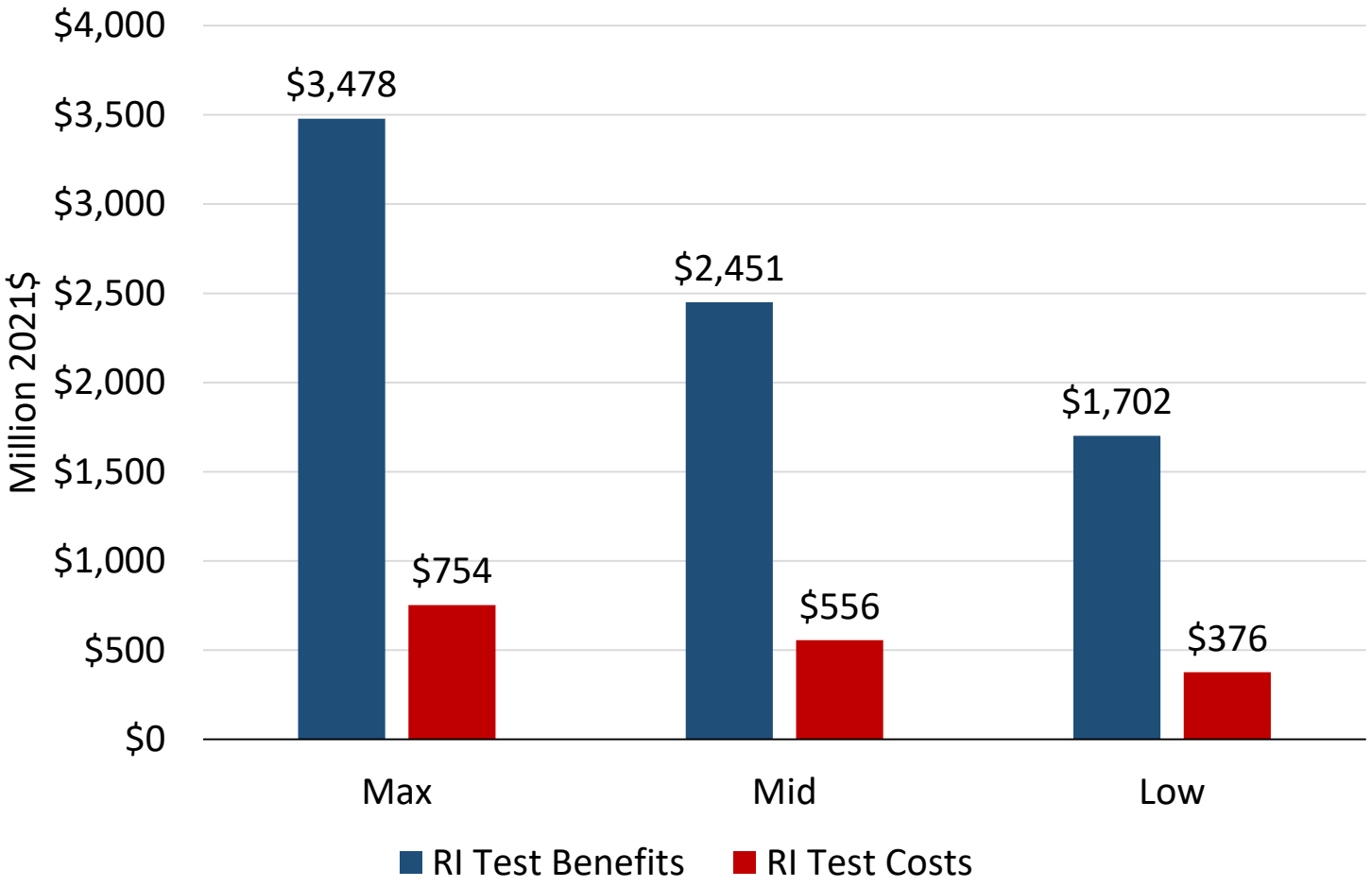
Benchmark

2019 Results: $6.66 per lifetime MMBtu

EE: Rhode Island Test

PRELIMINARY RESULTS

Total Rhode Island Test Benefits and Costs by 2023



- 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 $1.3B to $2.7B

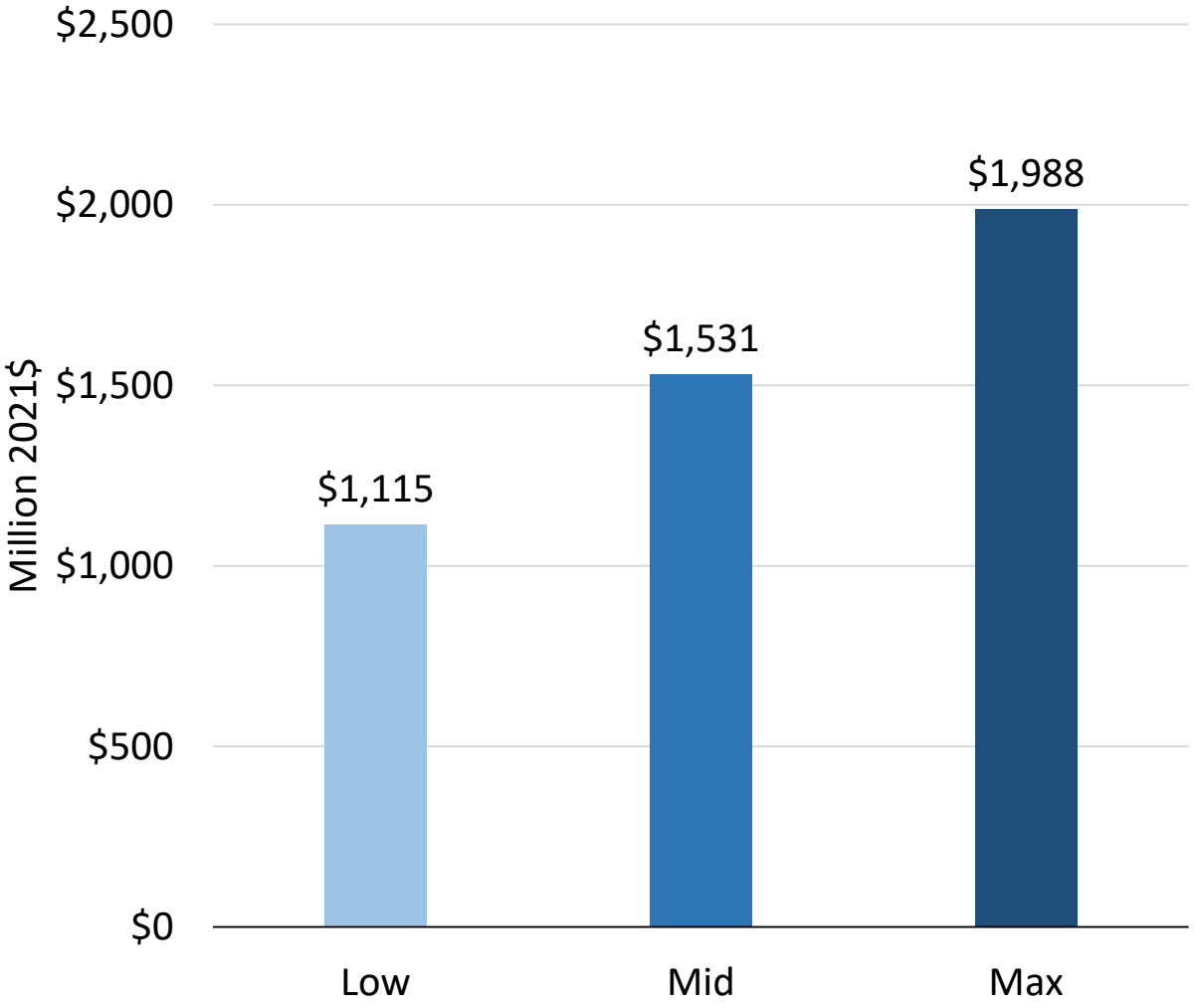
Scenario	Net Benefits	RI Test Ratio	2020 Plan RI Test Ratio
Max	$2,725	4.62	4.32
Mid	$1,895	4.41	
Low	$1,326	4.52	

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: Customer Benefits

PRELIMINARY RESULTS

Total Lifetime Customer Net Benefits by 2023



Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

- Efficiency programs create significant customer savings

Low Income Customer Benefits by 2023 (Mid Scenario)

Savings	Mid Scenario
Electric Savings	24.52 GWh
Gas Savings	72,566 MMBtu
Delivered Fuel Savings	22,705 MMBtu
Customer Savings	$53.2M

EE: Key Takeaways

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PRELIMINARY RESULTS

1. Electric savings likely to drop as lighting markets become increasingly transformed… *however*, new opportunities exist and can be exploited in a cost-effective manner.

2. Gas savings appear to be growing in importance in the EE portfolio. In the future, optimizing to GHG reductions could be a valid focus.

3. Program costs to capture non-lighting savings could be somewhat higher that historical program results… *however*, the 3-year portfolio can offer up to $2.7Bn in net benefits to Rhode Islanders.

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

Demand Response

DR: Achievable Scenarios

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PRELIMINARY RESULTS

Three program scenarios are explored in this study:

Low — Current DR programs and incentives, expanded to full market.

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

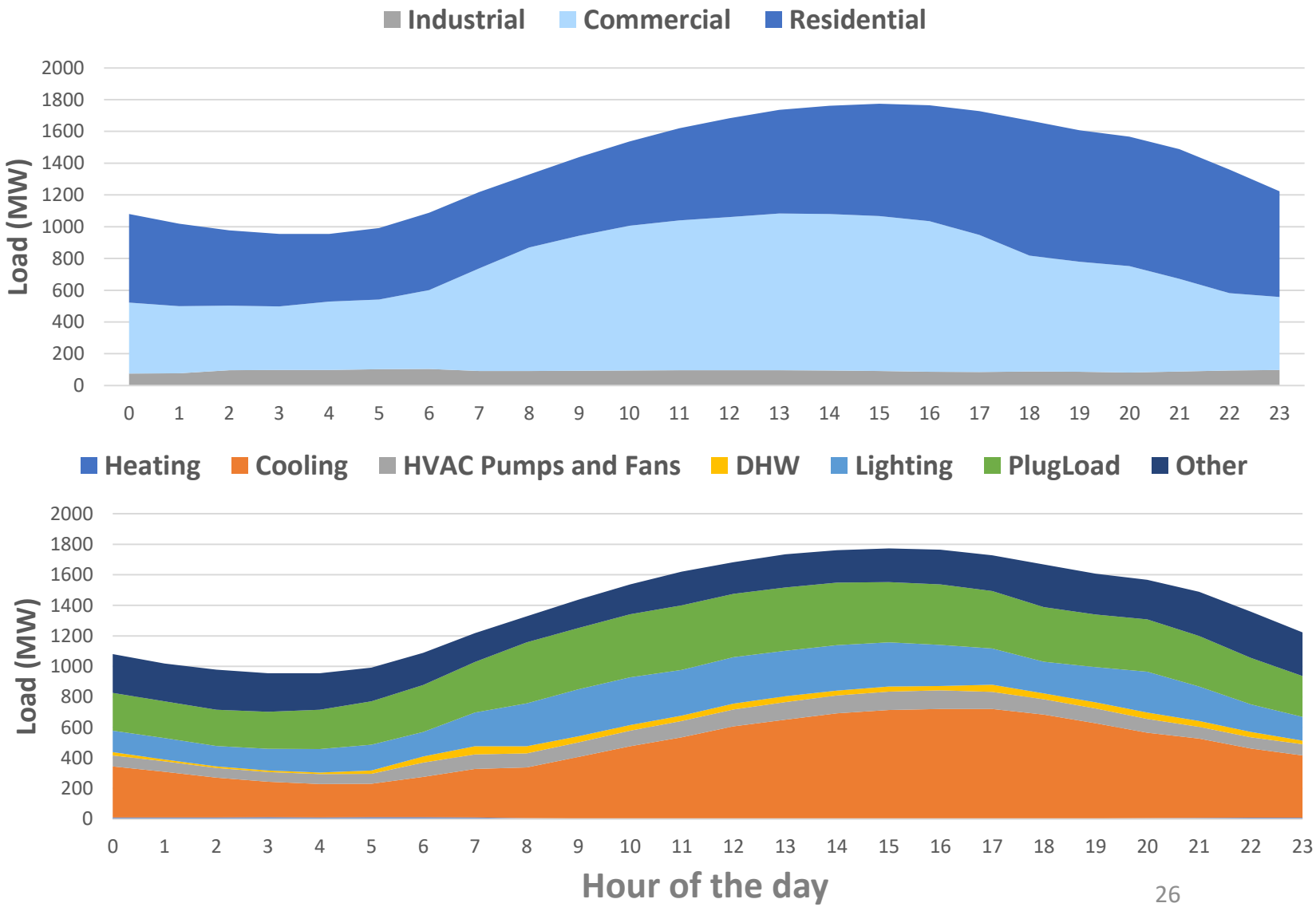
Max — Expanded DR programs with maximum cost-effective incentives

DR: Peak Load Breakdown

PRELIMINARY RESULTS

- Peak hours: 12:00 - 18:00
- Peak driven by cooling
- Limited industrial load relative to peak

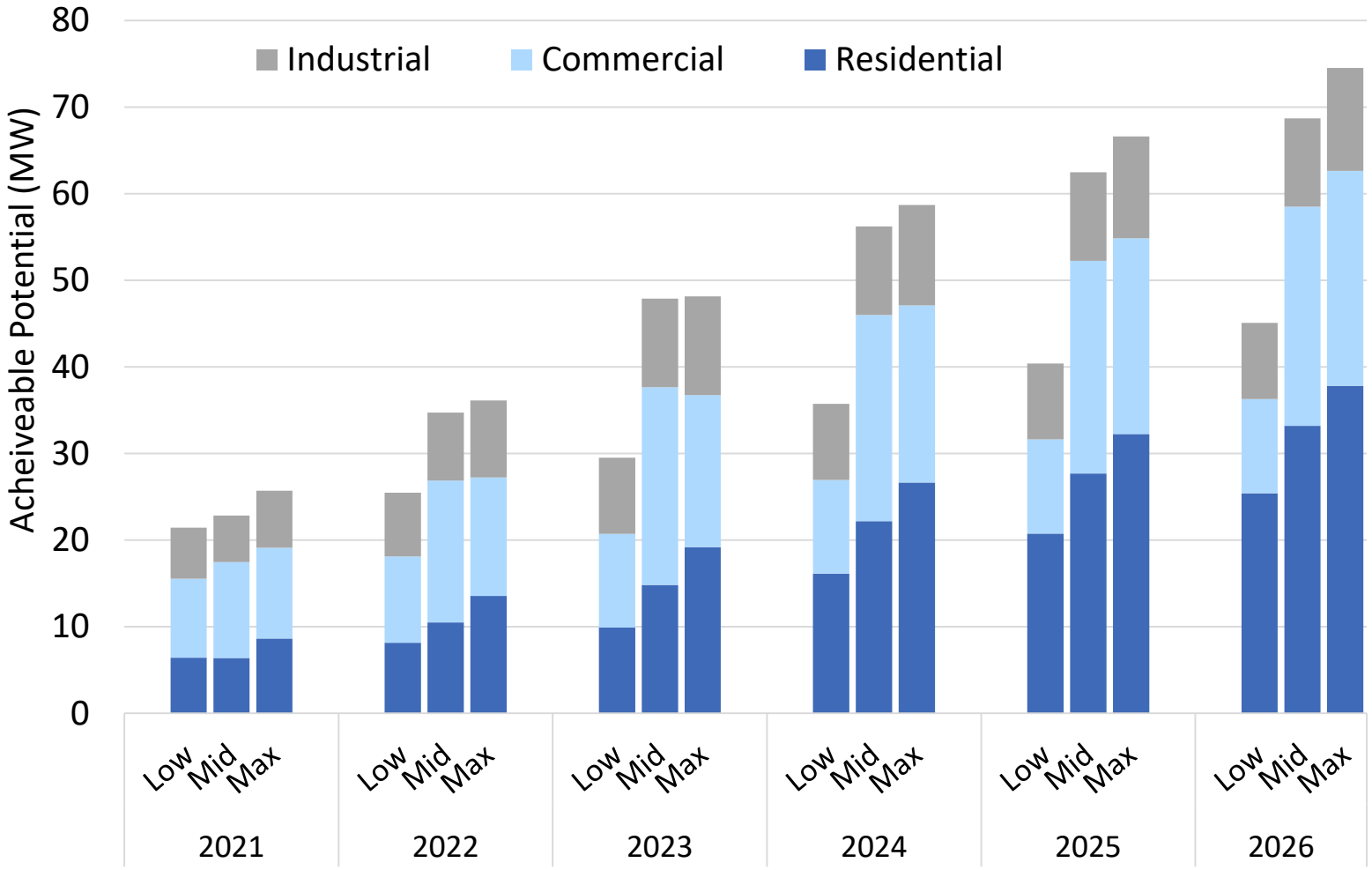
Year	Peak (MW)
2021	1773
2022	1795
2023	1816
2024	1836
2025	1854
2026	1873



DR: Overview

PRELIMINARY RESULTS

Achievable Potential (MW) by scenario



- Economic potential assessed at: 118 MW*
- Residential DR has lots of room to grow
- Expanding programs has bigger effect than simply raising incentives
- Budgets range from $2M to $20M per year. Mid scenario appears to offer best savings/cost balance.

Note: Results are **preliminary**, changes are possible as we complete revisions

DR: Key Takeaways

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PRELIMINARY RESULTS

1. Residential programs offer steady potential for growth over full study period.

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

3. Overall, estimated potential aligns with other recent DR studies:

	Rhode Island (2020)	Massachusetts (2018)	Michigan (2017)	Northwest Power (2014)
Portion of Peak Load	2.7% (2023) 4.0 % (2026)	3.5% - 4.0% (summer peak)	4.4%-7.7% (summer peak)	8.2% (summer peak)
Avoided Costs	$200 / kW	$290 / kW	$140 / kW	n/a

Combined Heat and Power (CHP)

CHP: Achievable Scenarios

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PRELIMINARY RESULTS

Three program scenarios are explored in this study:

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

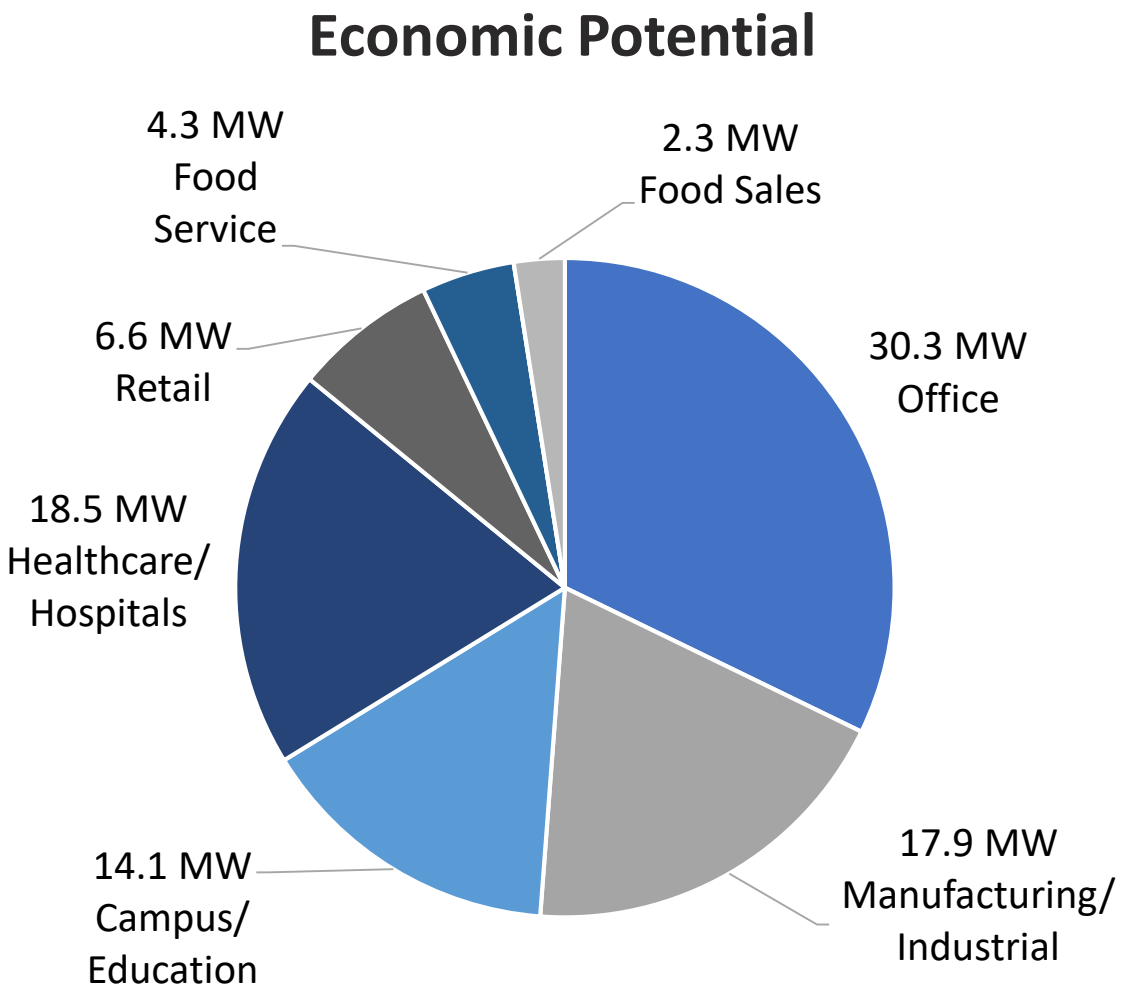
Mid — Incentive levels set at maximum allowable incentive (70%) with **additional barrier level decrease**

Max — Incentive levels set at **100%** with same barrier level decrease as mid scenario

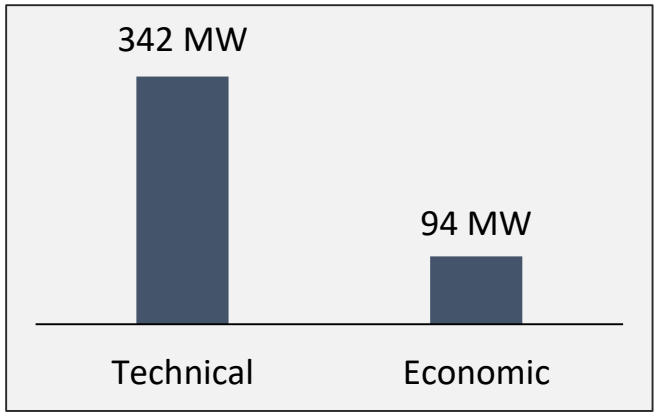
CHP: Economic Potential

PRELIMINARY RESULTS

CHP Economic Potential Installed Capacity Potential by Segment (MW)



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



CHP: Installed Capacity

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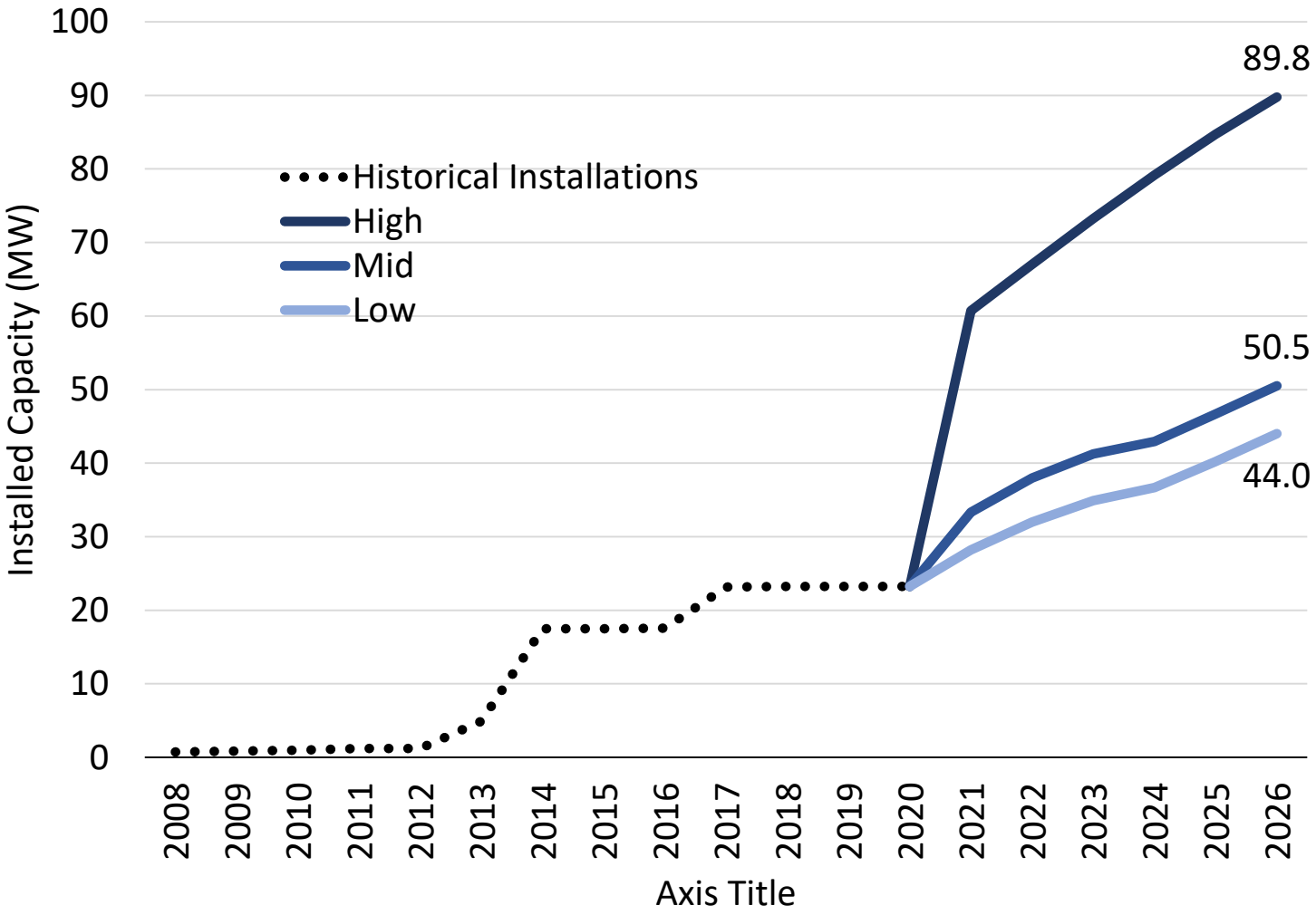
PRELIMINARY RESULTS

Historical Installed Capacity and Achievable Adoption Projections



Average annual impacts

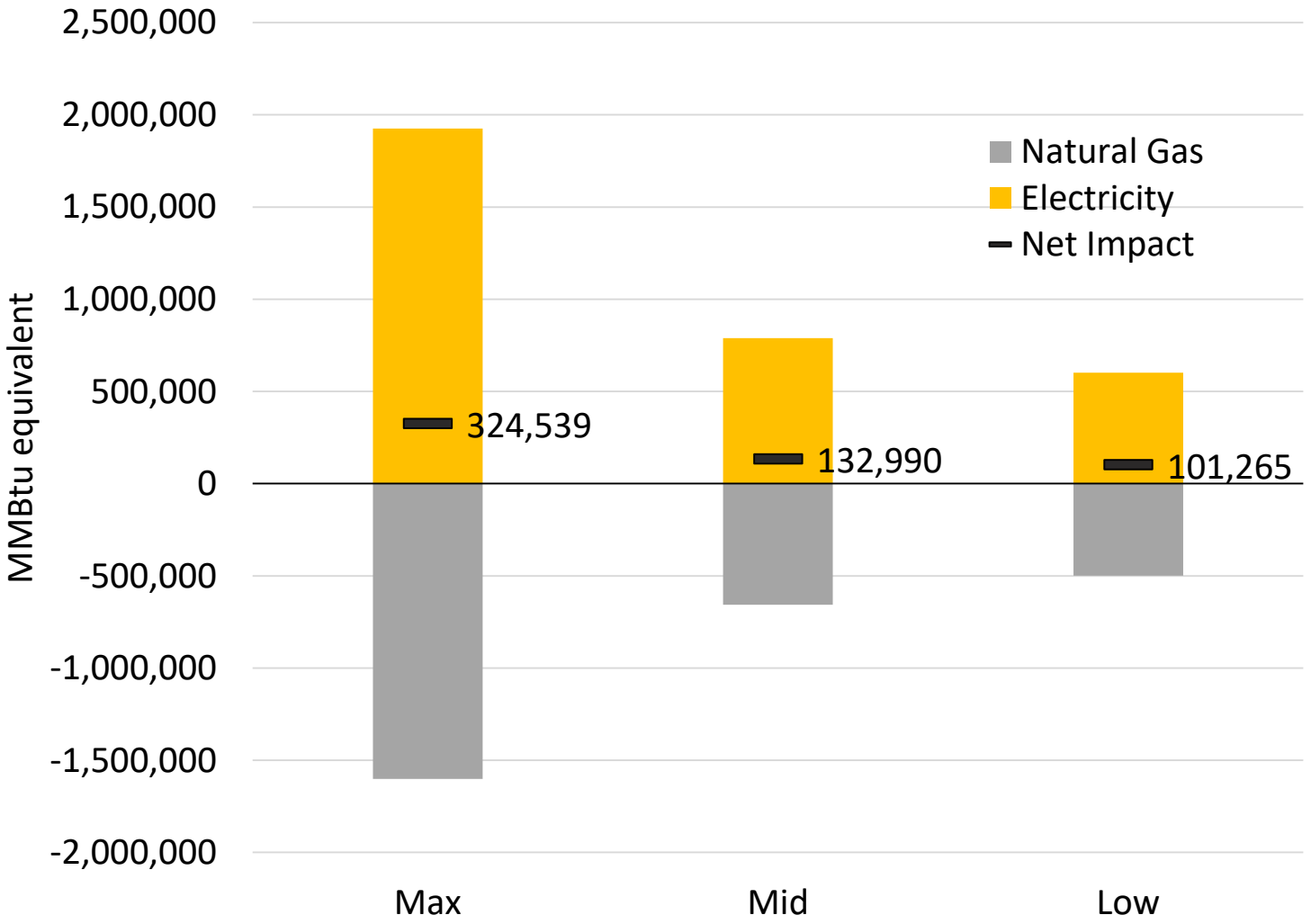
Scenario	Capacity Additions (MW)	Savings (GWh)	Annual Program Spending (2021$)
Max	11.1	90.4	$29.6M
Mid	4.5	37.1	$9.0M
Low	3.5	28.2	$6.7M

- Adoption estimates are best interpreted by study period averages
- **Benchmark:** 3.6MW installed annually between 2014 and 2018

CHP: Net Savings

PRELIMINARY RESULTS

Total Net Annual Energy Savings Including Grid Electricity Embedded Energy by 2026



- 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)

CHP: Key Takeaways

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PRELIMINARY RESULTS

1. Additional CHP potential exists and current incentive levels can encourage additional adoption commensurate with recent years.

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

3. 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)

HE: Achievable Scenarios

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PRELIMINARY RESULTS

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

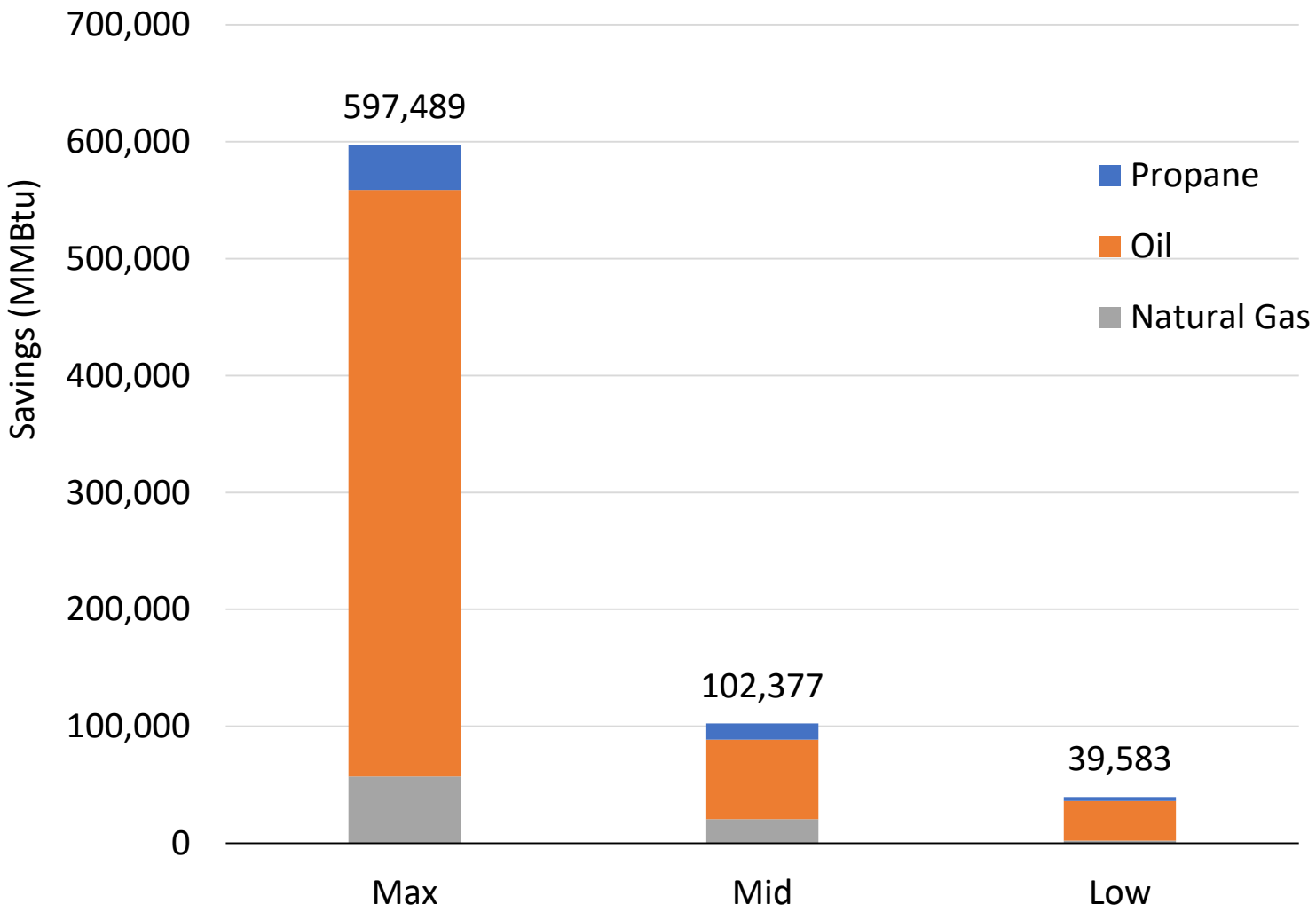
Mid — Applies **50%** incentives and additional enabling strategies (full-step barrier reduction)

Max — Incentives set at **100%** to completely eliminates customer costs and applies enabling strategies (full-step barrier reduction)

HE: Fuel Savings

PRELIMINARY RESULTS

Average Annual Combustible Fuel First-Year Savings (2021-2023)

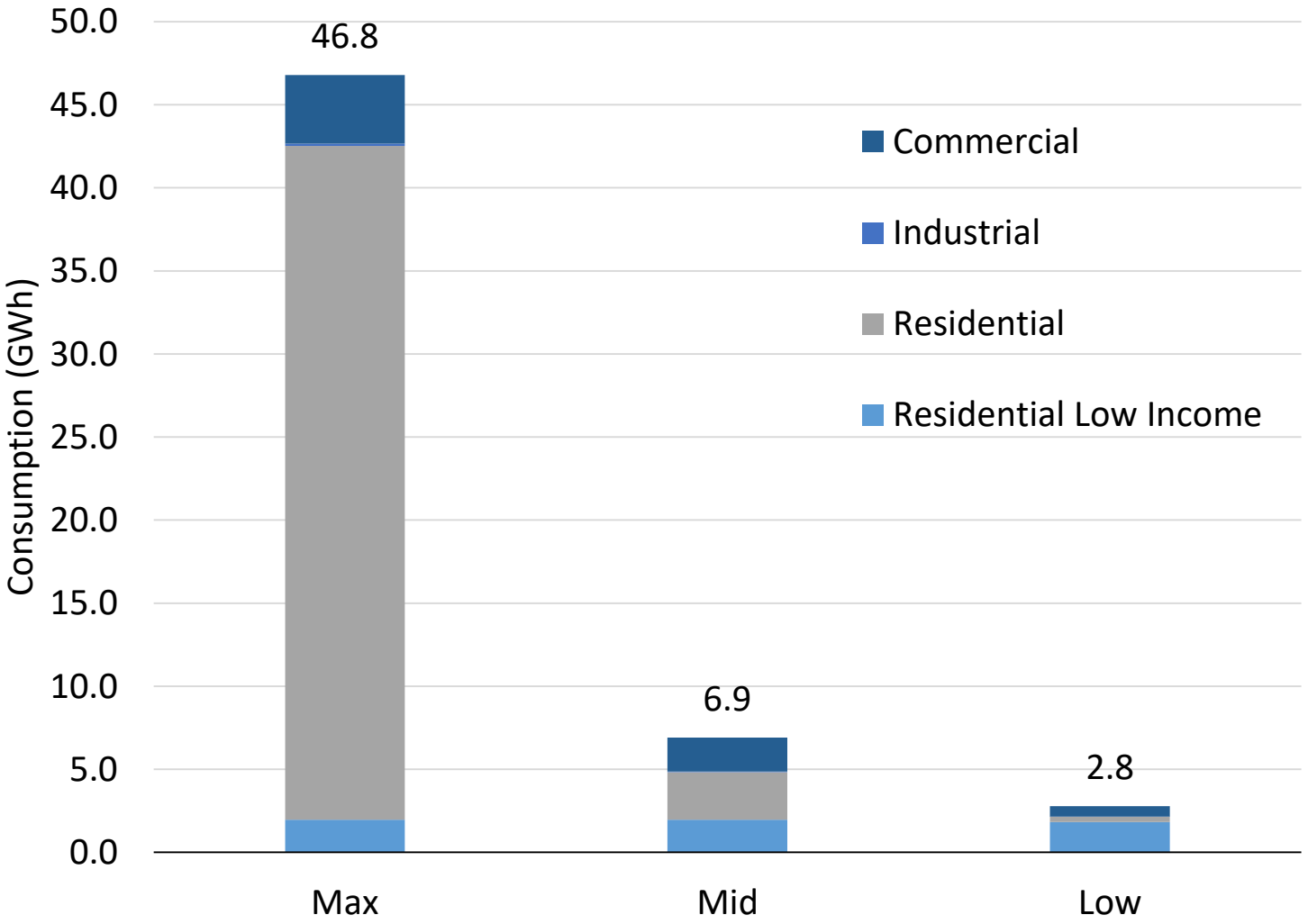


- There is significant technical potential for heating electrification in Rhode Island – particularly when natural gas is included.
- Propane and oil fuel switching are largely cost-effective, but most natural gas electrification does not pass the RI Test
- Increasing incentives and reducing barriers drives significantly more adoption compared to the Low Scenario (mostly oil savings)

HE: Electricity Consumption

PRELIMINARY RESULTS

Average Annual Electricity Consumption Increase (2021-2023)

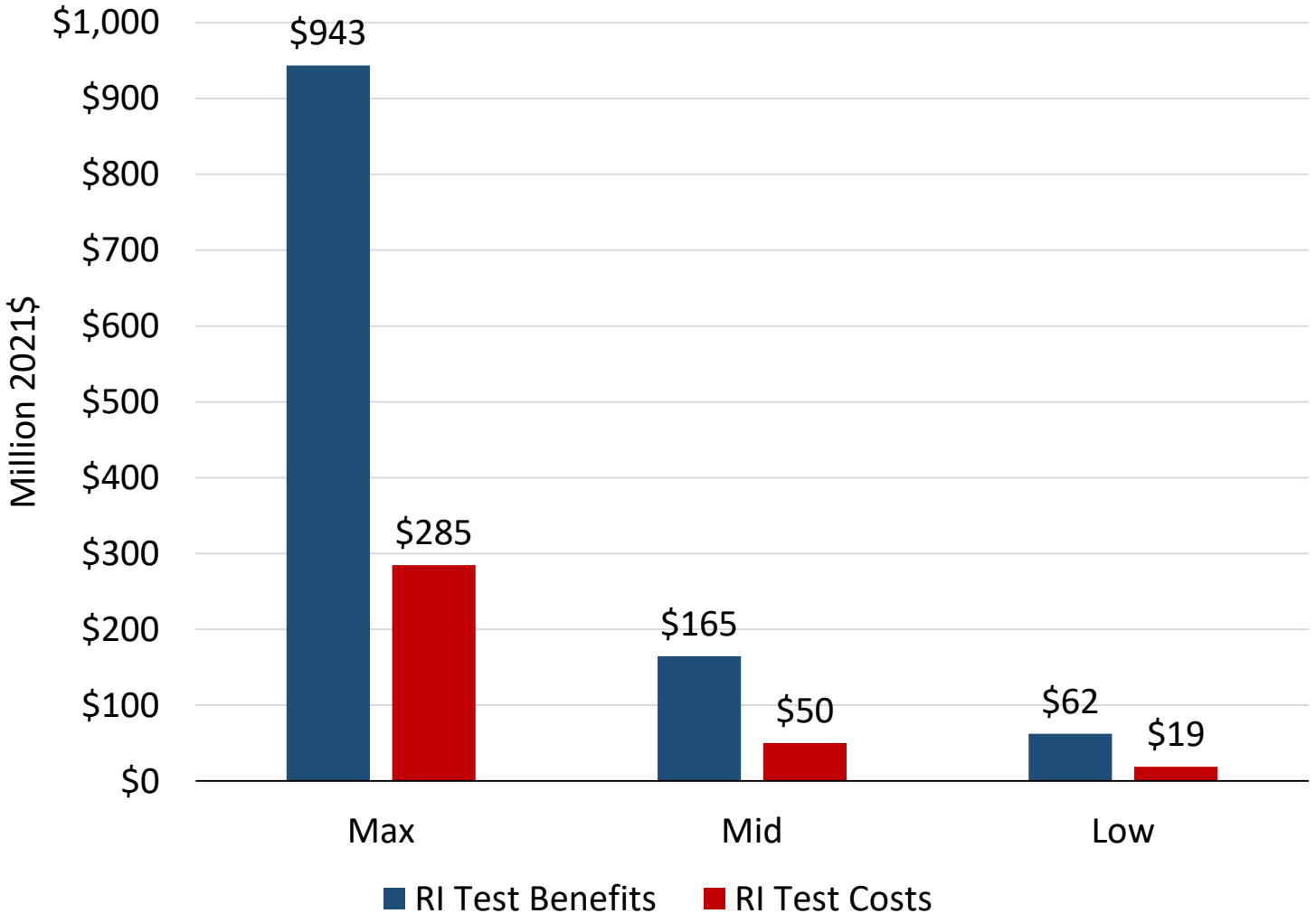


- Heating electrification has the potential to significantly increase electricity consumption
- The majority of potential is in the residential sector
- The commercial sector is constrained by economics (high cost, and limited sizing)
- Space heating dominates fuel-switching savings when compared to hot water savings

HE: Rhode Island Test

PRELIMINARY RESULTS

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.

Scenario	Net Benefits	BCR Ratio
Max	$659	3.32
Mid	$115	3.29
Low	$43	3.30

HE: Key Takeaways

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PRELIMINARY RESULTS

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.

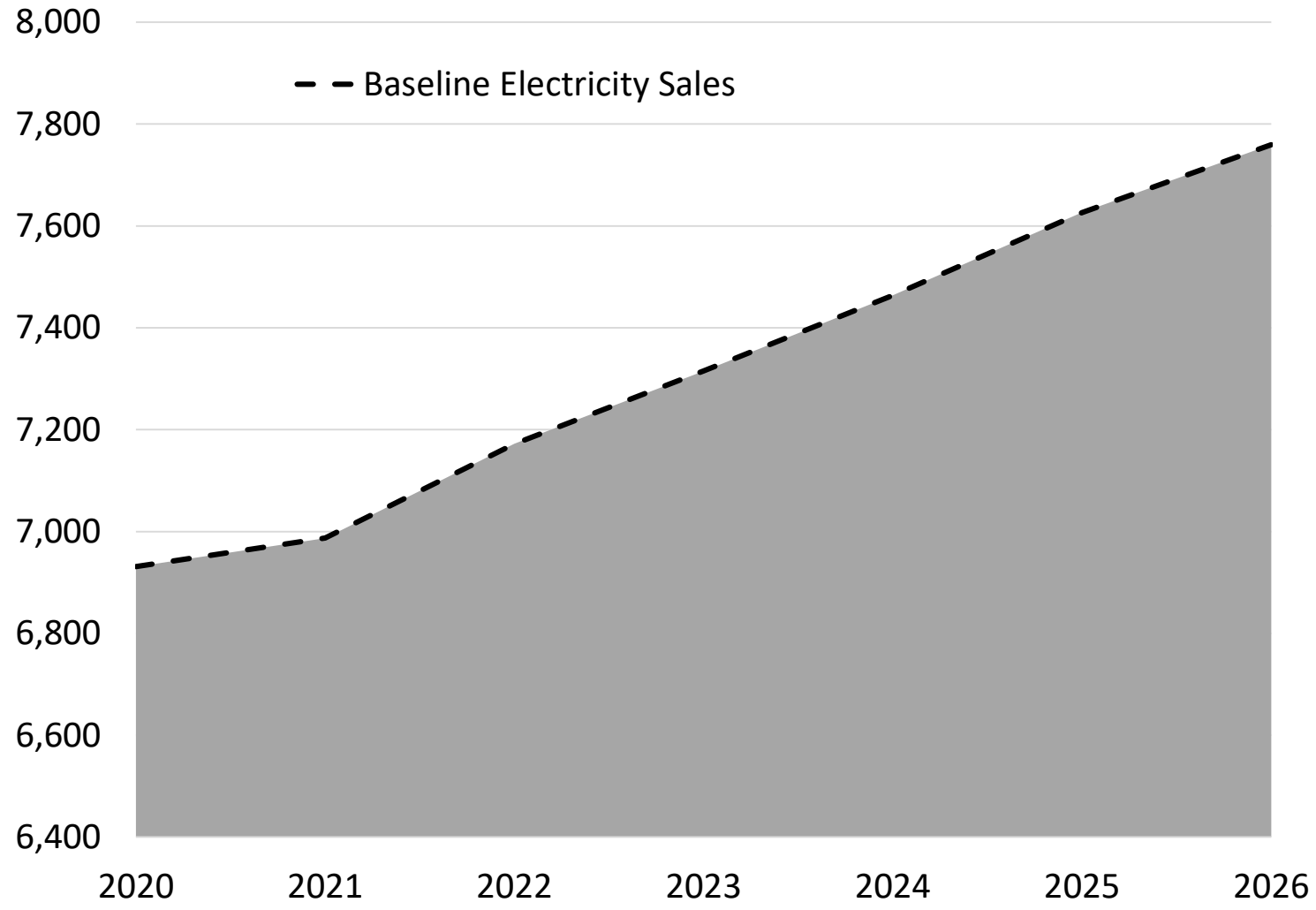
3. Increasing incentives drives significantly more heating electrification, particularly between the Mid and Max scenarios.

Impacts on Sales

Cumulative Savings: Electricity Sales

PRELIMINARY RESULTS

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

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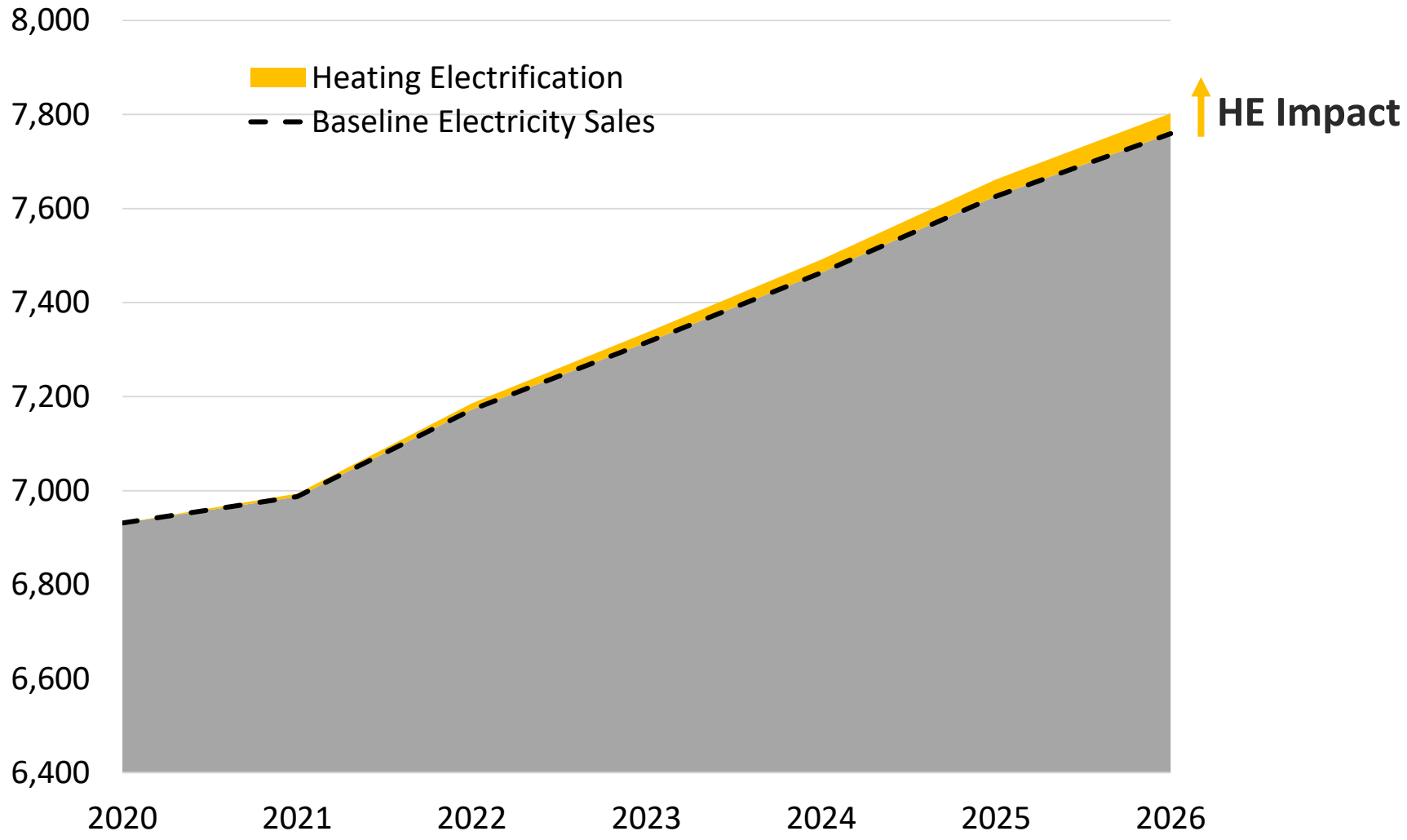
PRELIMINARY RESULTS

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	
HE	+0.6%

Cumulative Savings: Electricity Sales

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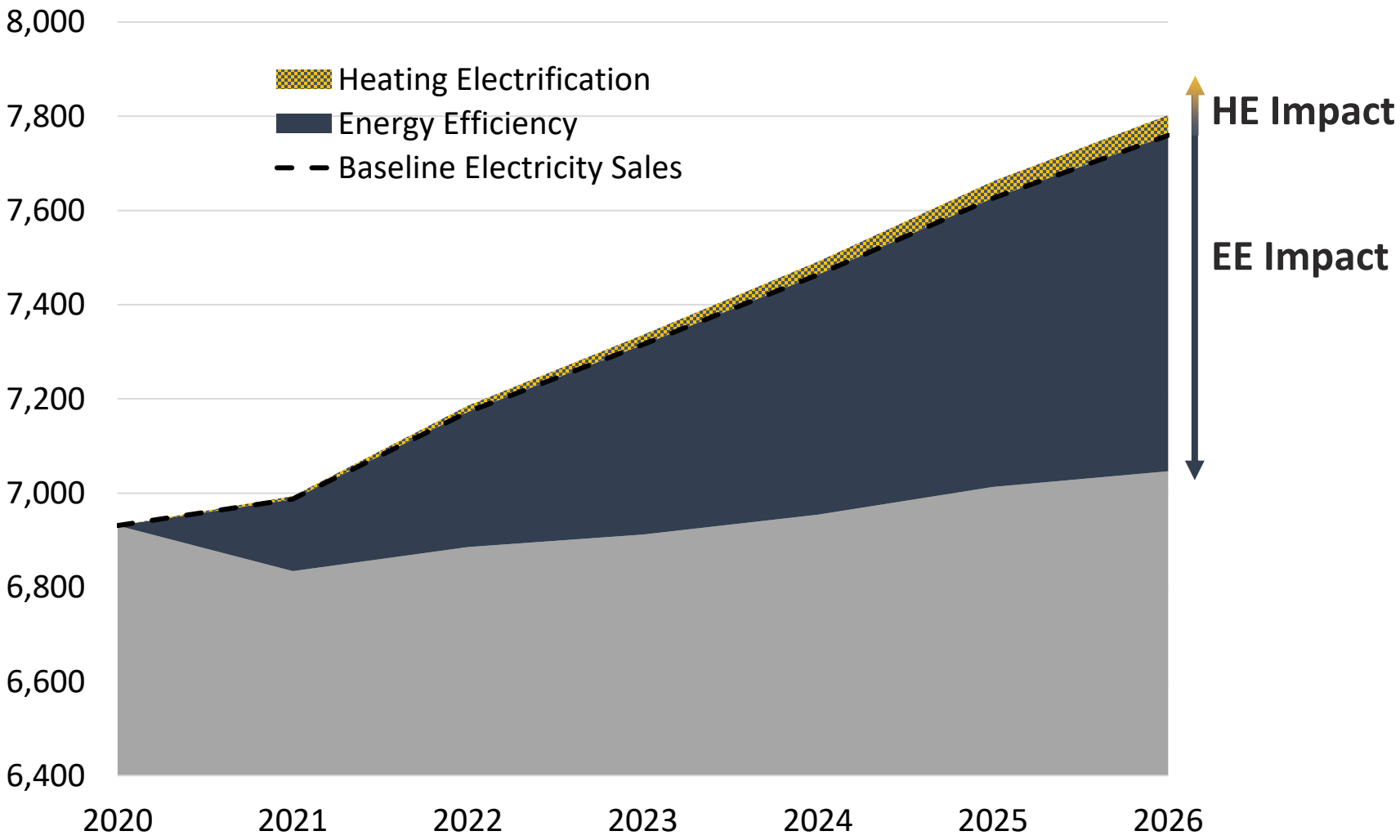
PRELIMINARY RESULTS

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



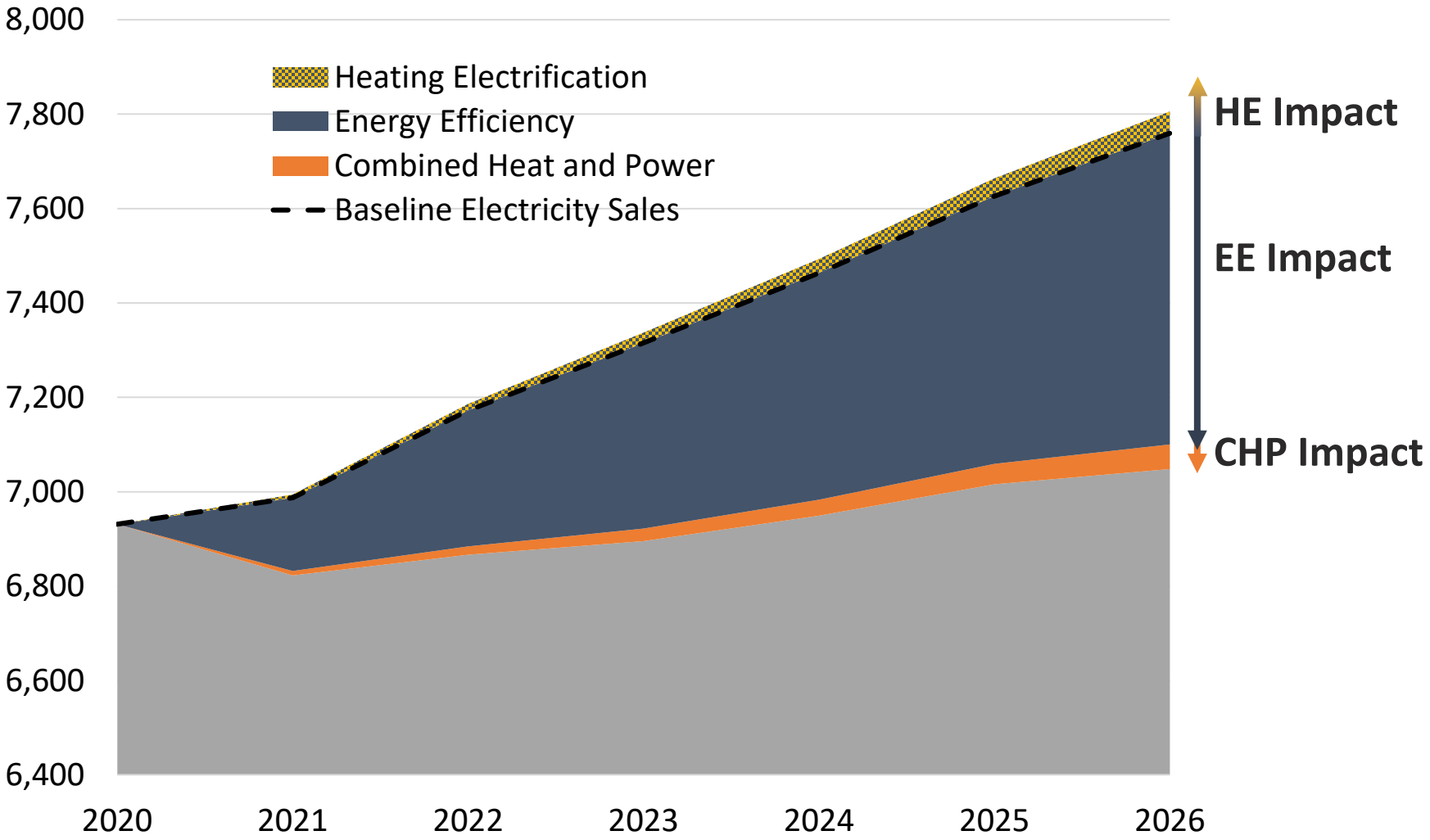
- **Energy efficiency** mitigates heating electrification impact and delivers substantial sales curtailment.

Cumulative Impact on 2026 Baseline	
HE	+0.6%
EE	-9.70%

Cumulative Savings: Electricity Sales

PRELIMINARY RESULTS

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



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

Cumulative Impact on 2026 Baseline	
HE	+0.6%
EE	-9.7%
CHP	-0.7%

Cumulative Savings: Electricity Sales

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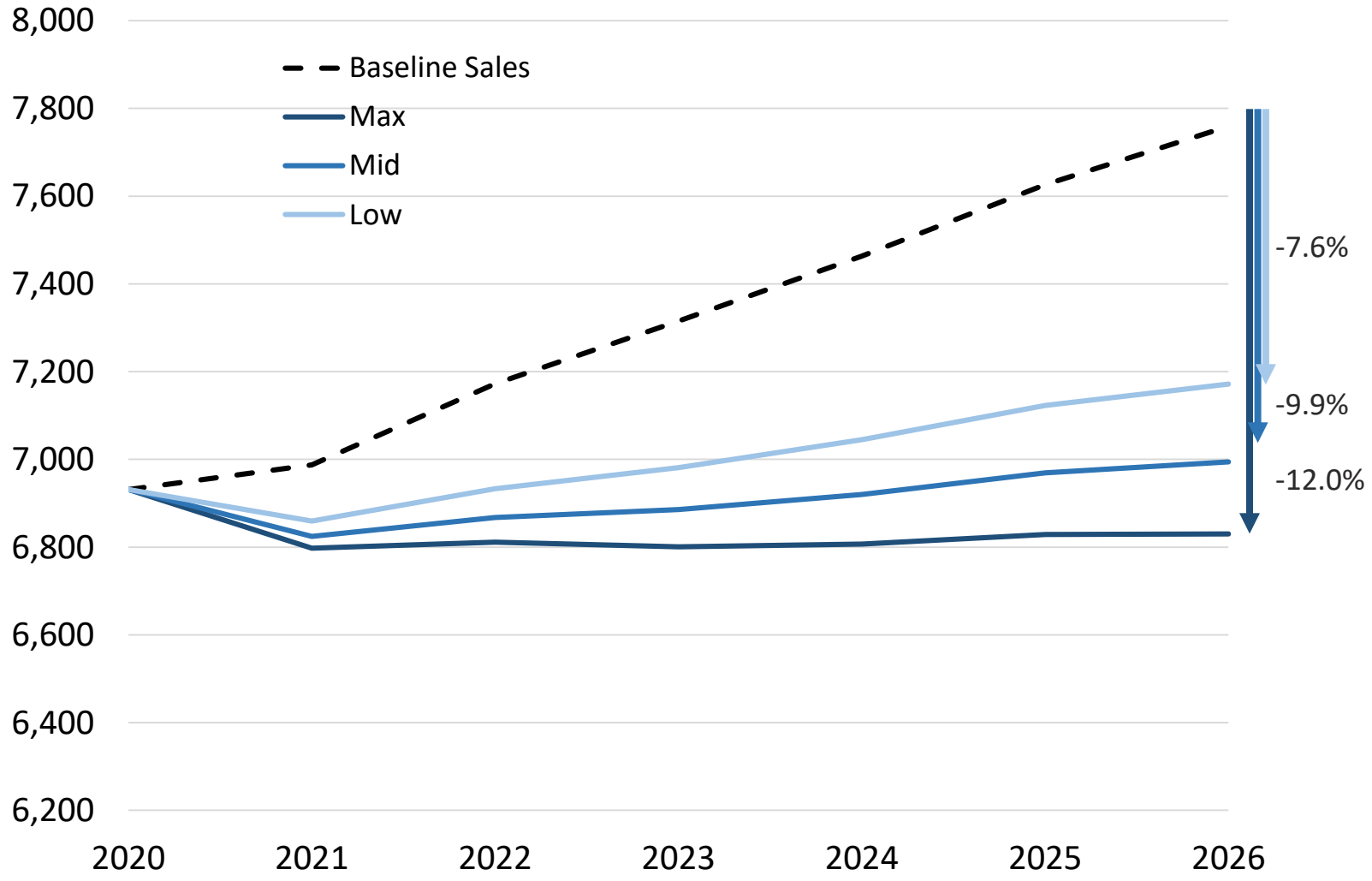
PRELIMINARY RESULTS

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

Cumulative Savings : Electric Demand

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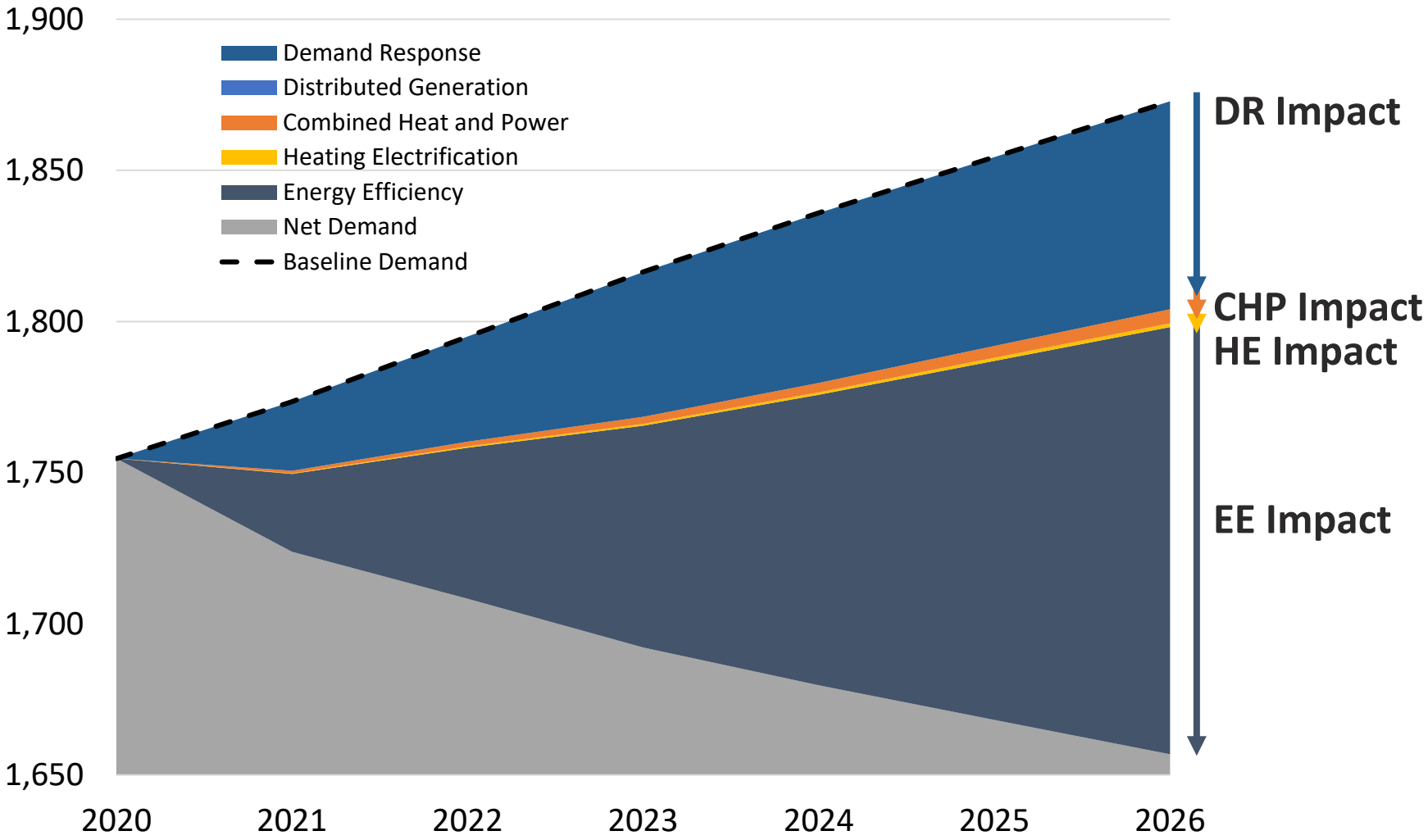
PRELIMINARY RESULTS

Mid Scenario: Electric Demand (MW)



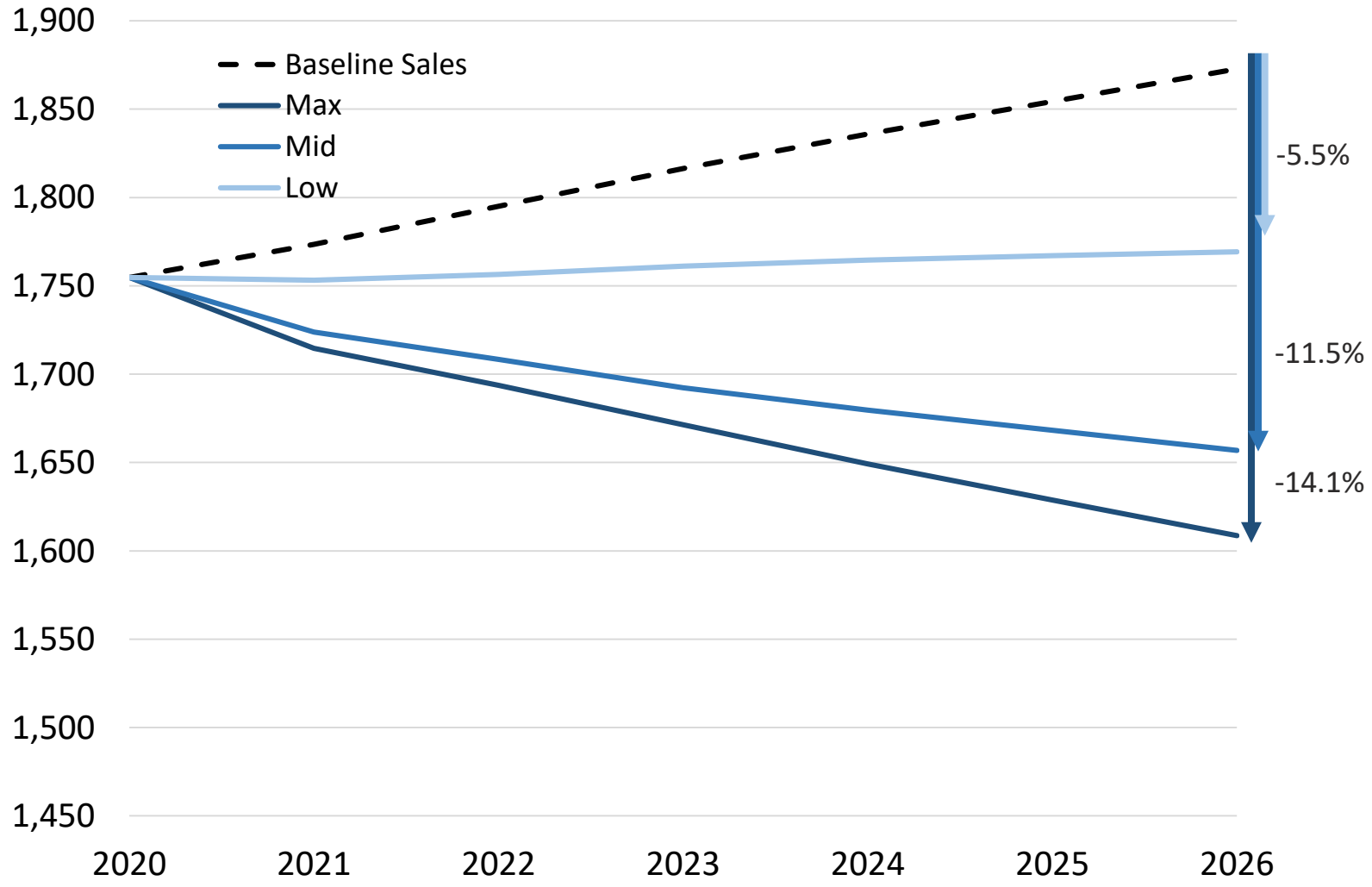
- Efficiency offers the greatest peak load reduction
- DR programs offer second-most, if expanded significantly (new measures, higher incentives)

Cumulative Impact on 2026 Baseline	
DR	-3.7%
CHP	-0.3%
HE	-0.1%
EE	-7.5%

Cumulative Savings : Electric Demand

PRELIMINARY RESULTS

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

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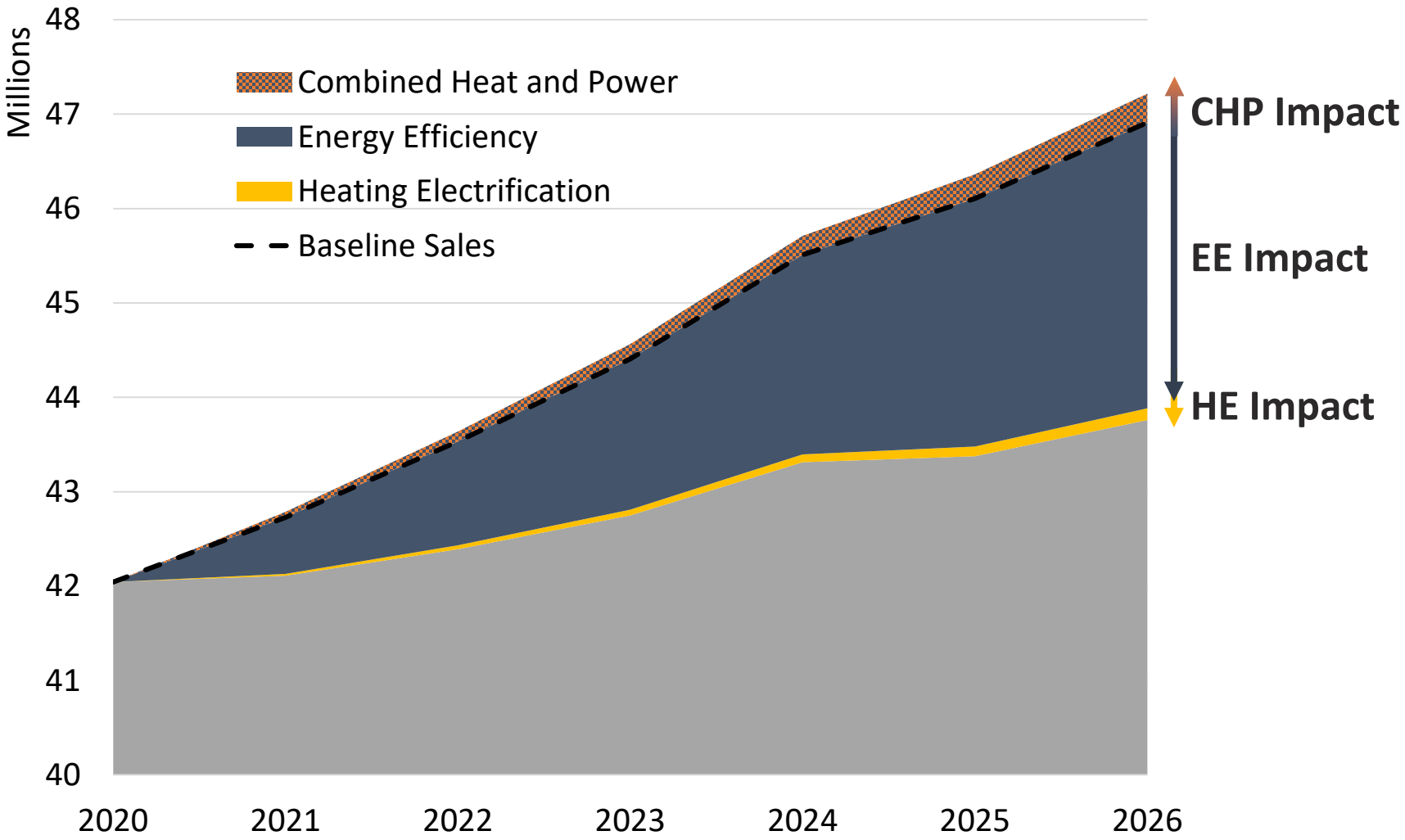
PRELIMINARY RESULTS

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

Cumulative Impact on 2026 Baseline	
CHP	+0.7%
EE	-7.1%
HE	-0.3%

Cumulative Savings : Natural Gas Sales

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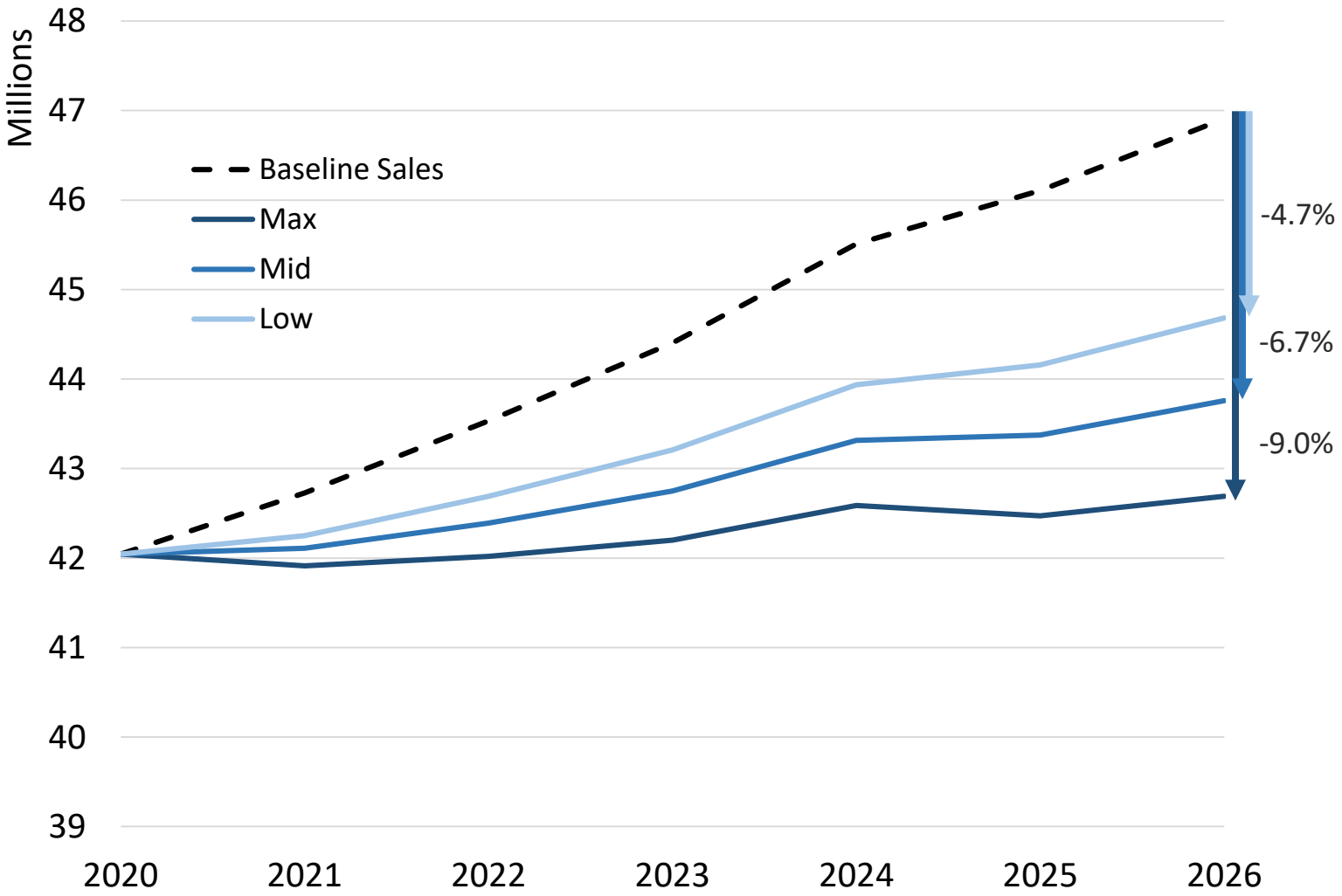
PRELIMINARY RESULTS

Cumulative Impact on Natural Gas Sales (MMBtu)



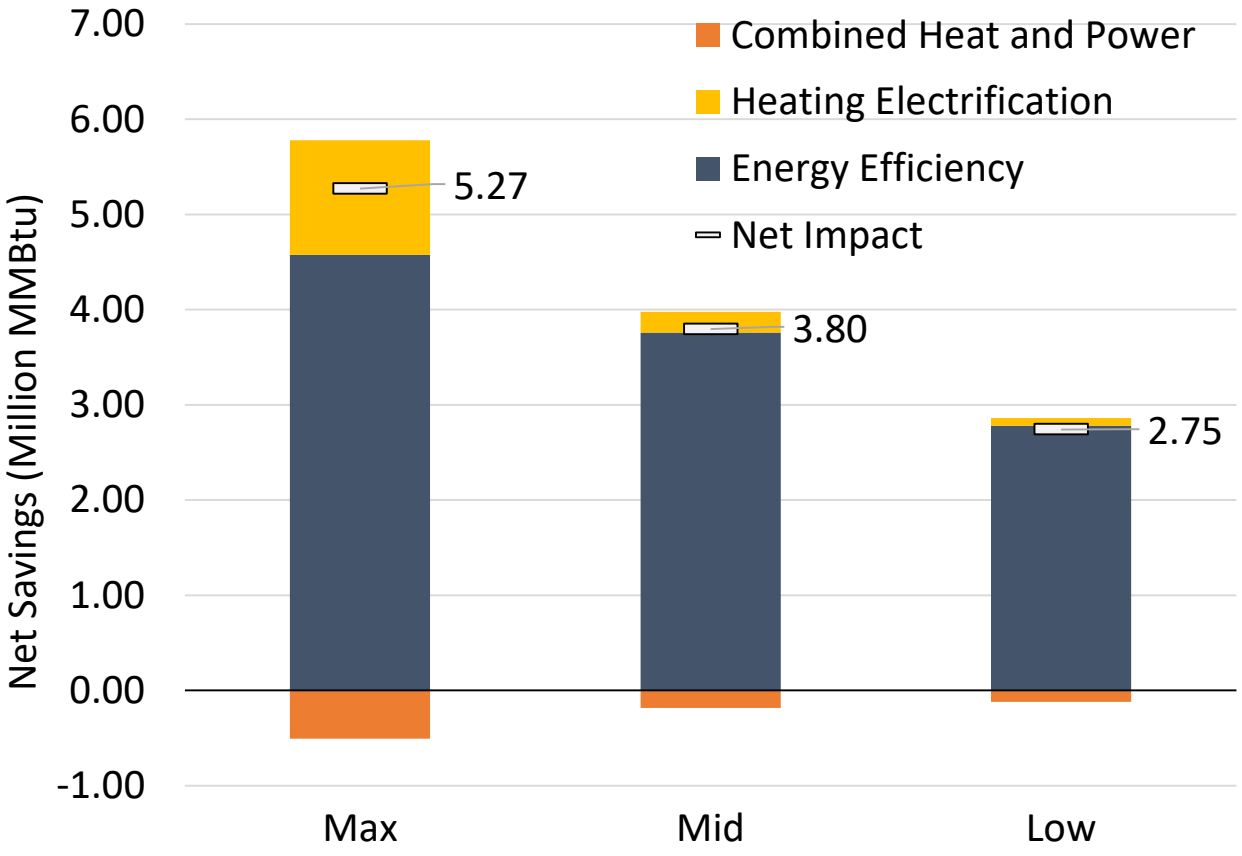
- Under all scenarios, an increase in gas consumption is projected to increase over the study period
- Max scenario comes near to keeping gas consumption flat over study period

Conclusions

Cumulative Savings: Overall Energy Impacts

PRELIMINARY RESULTS

Total Net Customer Energy Savings by 2023

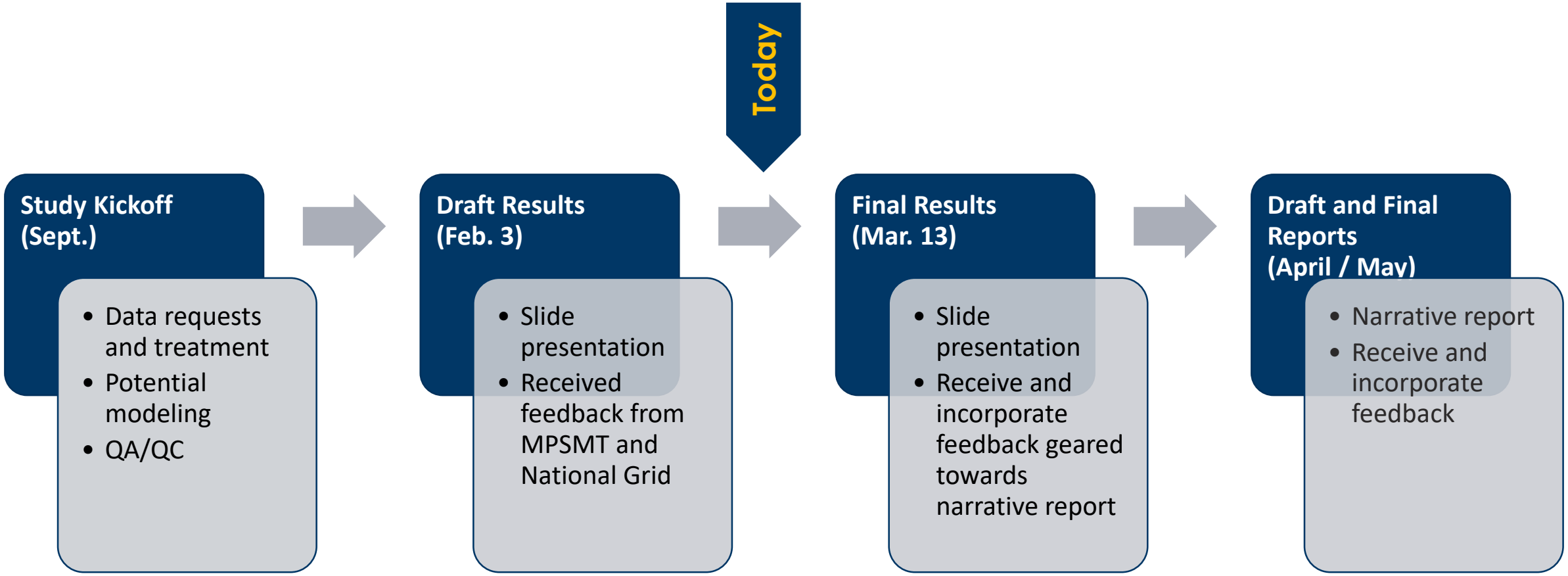


- Efficiency continues to have the largest overall impact
  - Electric savings lower than in past, but still substantial
  - Gas savings growing in importance
- CHP contributes to a slight increase in total site energy use
- HE could have notable impact, with further investments
- DR (not shown) shows room to grow with increased budgets (up to $20M)
- 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.

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

Wrap Up: Next Steps



- Prepare Final Results: integrate all feedback and final QC, add solar PV analysis, integrate load curves, update slide deck of results and excel workbooks
- Prepare Draft and Final narrative reports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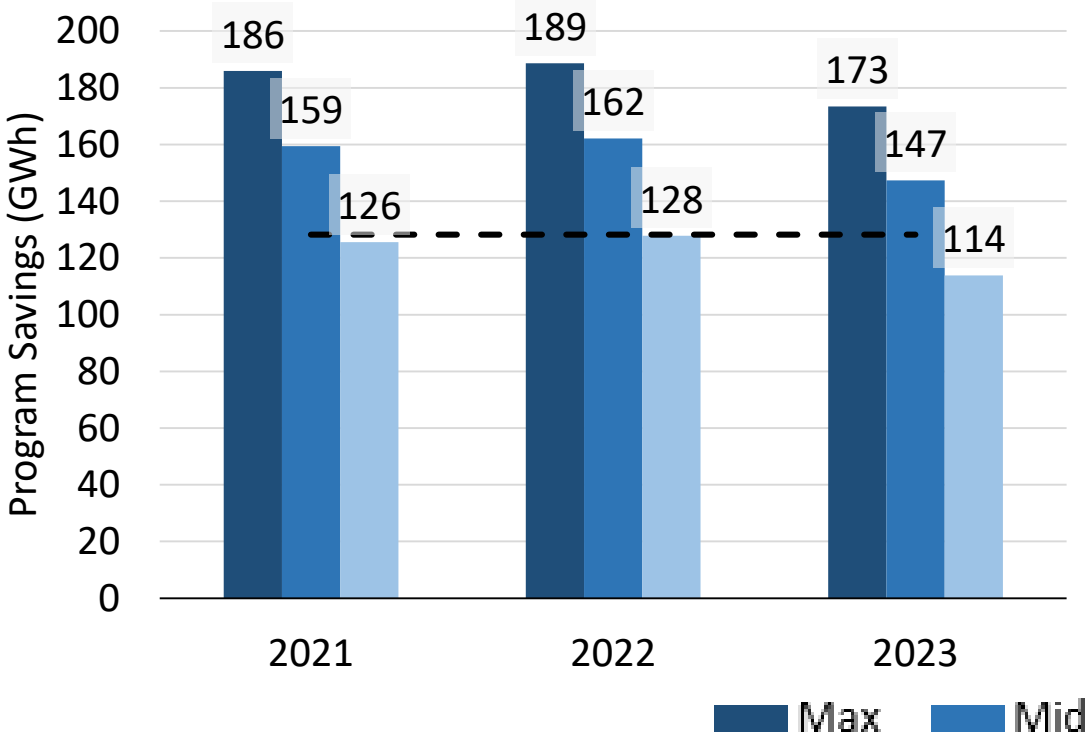
Appendix

EE: Electric Savings Potential

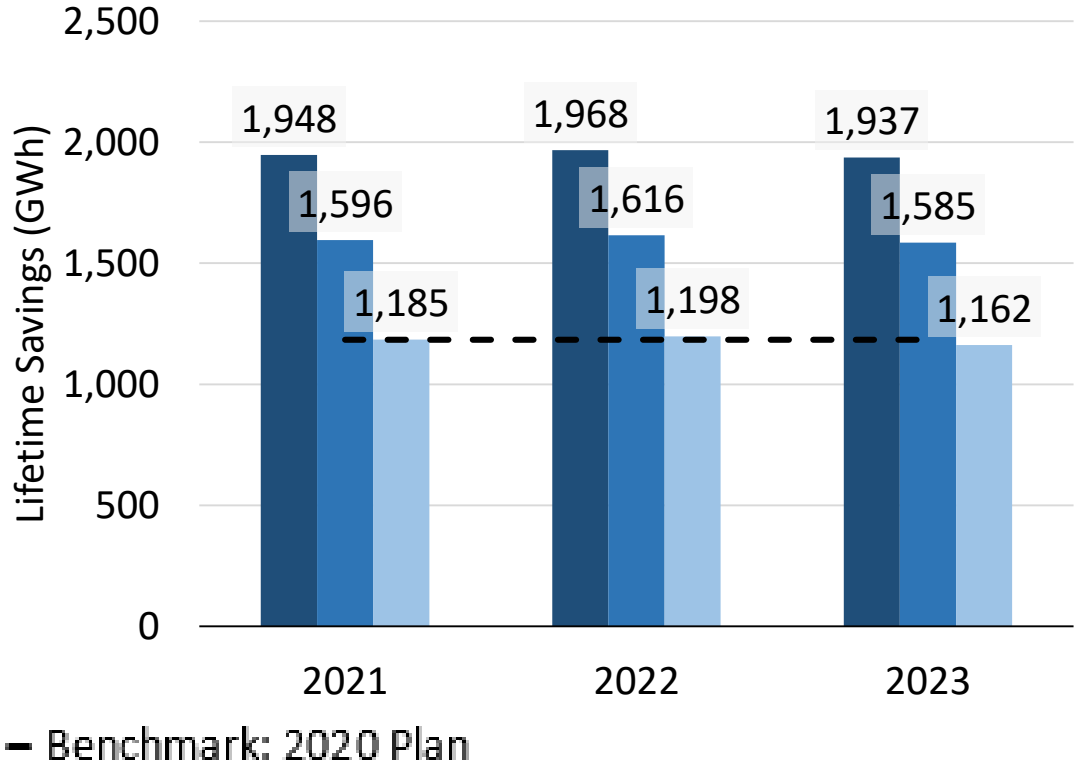
PRELIMINARY RESULTS

Annual First-Year Electric Program Savings



Note: 2020 Plan Benchmark savings do not include A-Lamp savings.

Annual Lifetime Electric Program Savings



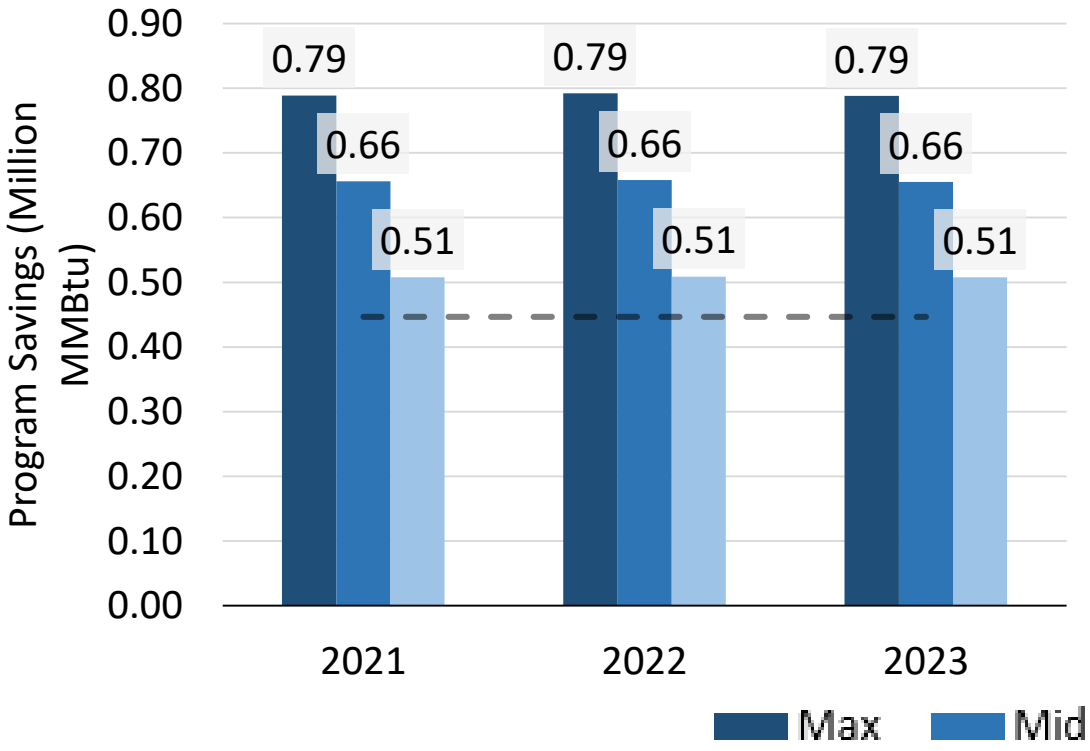
First-Year Savings: The amount of energy savings achieved in the first-year of the measure's installation.
Lifetime Savings: The amount of energy savings achieved over the entire measure's lifetime.

Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

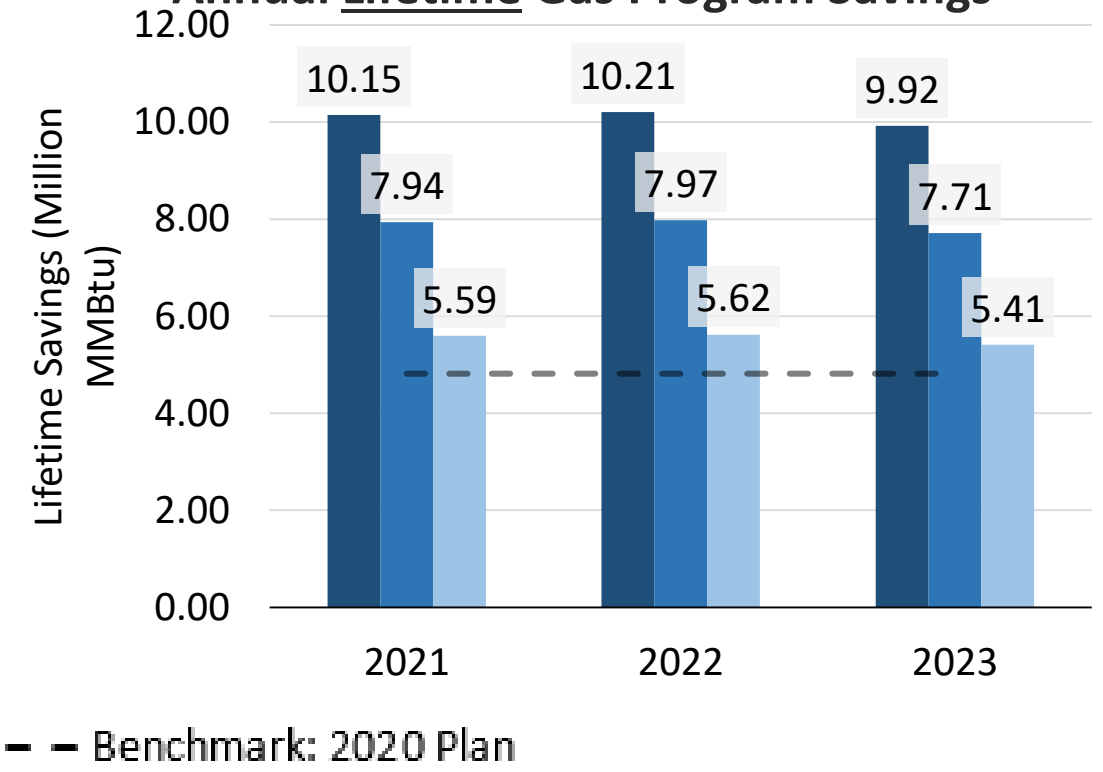
EE: Gas Savings Potential

PRELIMINARY RESULTS

Annual First-Year Gas Program Savings



Annual Lifetime Gas Program Savings



Max Mid Low Benchmark: 2020 Plan

First-Year 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.

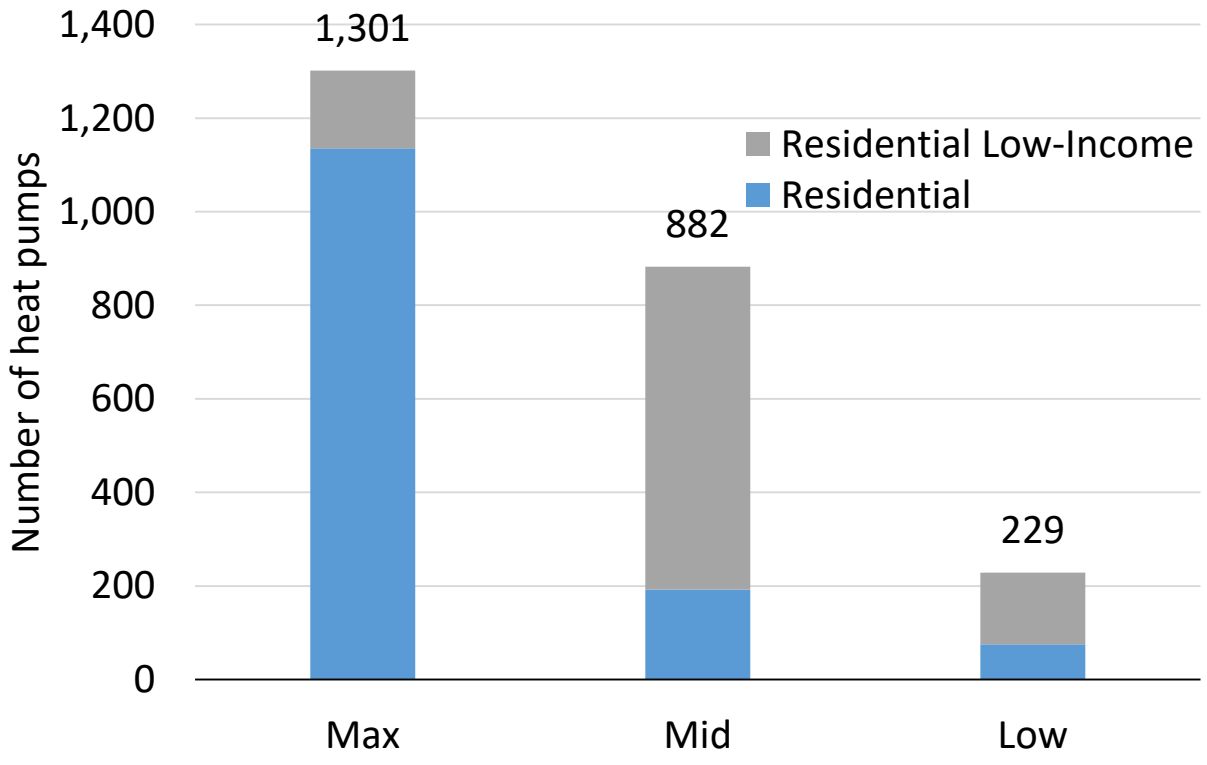
Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

EE: Electric Savings Potential, Residential

PRELIMINARY RESULTS

Measure Example: Ductless Mini-split Heat Pumps (DMSHP) for Electric Resistance Heating

Average Number of DMSHP adopted by residential customers per year (2021-2023)



- 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)

	Max	Mid	Low
Residential	7.1	4.7	1.5
Residential Low-Income	1.1	1.1	1.0
Total	**8.2**	**5.8**	**2.5**

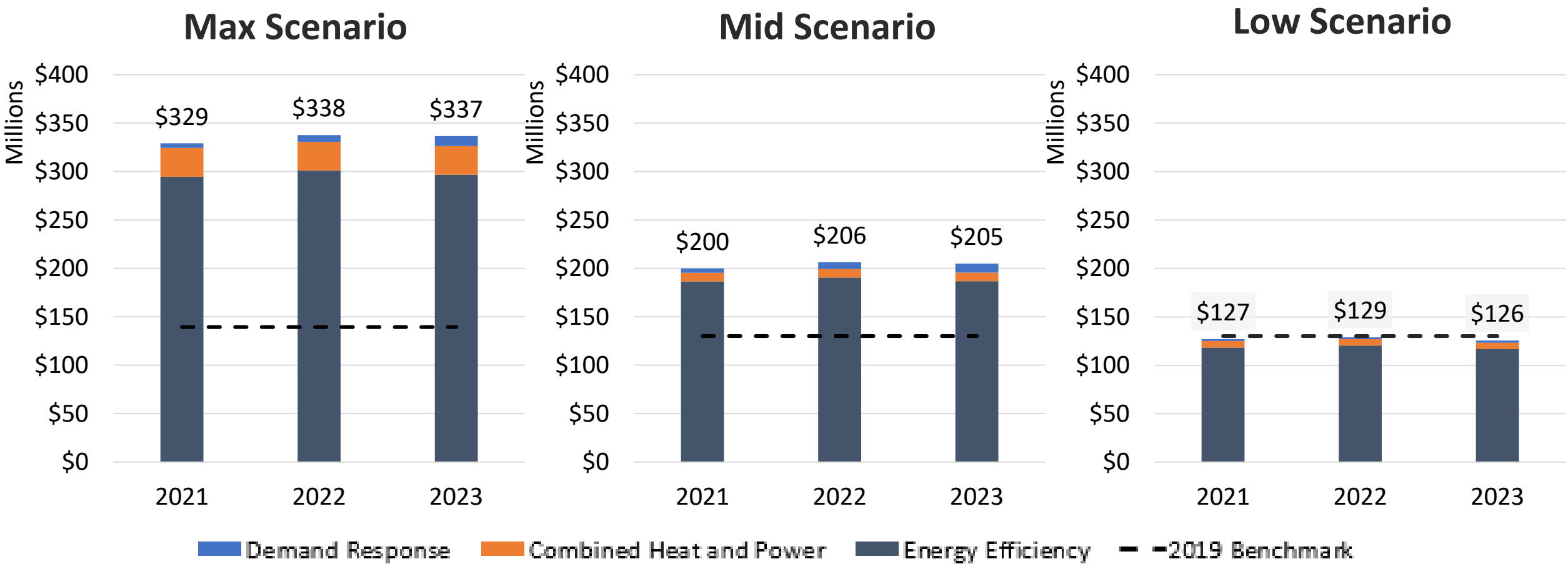
Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions

All Saving Streams: Estimated Combined Costs

PRELIMINARY RESULTS

Estimated Combined Costs (EE, CHP, and DR only)

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



Note: Results are **preliminary**, changes are possible (+/- 10%) as we complete revisions