# RGGI Program Review: REMI Modeling Results

Inputs and Draft Results from MRPS Case Run

December
2017

# Modeling Inputs

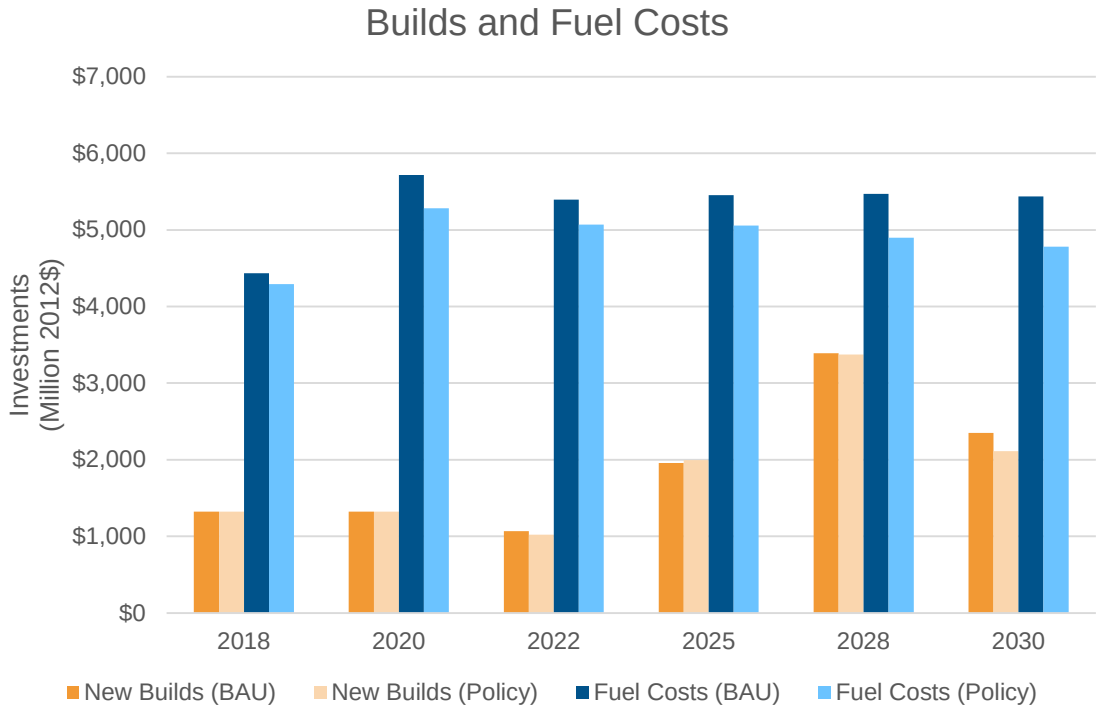
# Overall Modeling Methodology

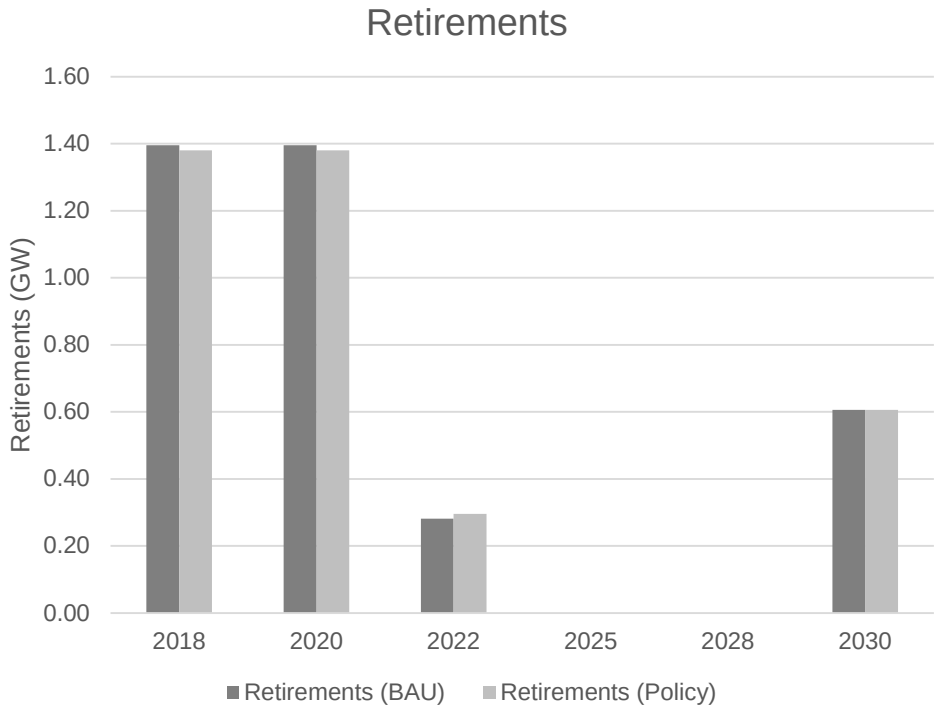
- **Two broad set of inputs used to model the economic impacts of the policy changes**
- **First set of inputs derived directly from relevant IPM runs**
  - Reference Case (No National Program on carbon – No NP)
  - Model Rule Policy Scenario (MRPS) (No NP)
- **Second set comes from the allowance proceeds calculations provided by the RGGI states**
- **Everything modeled at the individual state-level and rest of US**
  - Results discussed here are at the RGGI region level
- **Modeling does not include benefits of avoided carbon emissions**
  - REMI modeling focuses on regional economic impacts, not social benefits of environmental policies

# REMI Inputs Derived Directly from IPM Runs

- **Extension of the RGGI cap decline to 2031 leads to additional changes in the energy markets, relevant for economic modeling**
- **Changes captured include**
  - Changes in new generation capacity
  - Changes in fuel demand
  - Changes in retirements
  - (Small) changes in retrofit use
  - Impact of allowance prices on electricity ratepayers

# REMI Inputs Derived Directly from IPM Runs




- Relatively small incremental changes under the MRPS Case (over the BAU Reference Case)
  - Decrease in fuel costs mostly due to shift away natural gas in RGGI states
  - Drop in new builds mostly driven by move away from CCs
  - Small shifts in retirements (e.g., less in 2018 and 2020, but more in 2022) mostly driven by coal retirements in some RGGI states

# Allowance Proceeds Reinvestments

- **Second set of REMI inputs derived from different states' plans to reinvest RGGI allowance proceeds**
- **Five different avenues for reinvestments modeled**
  - Electric Energy Efficiency
  - Fossil Fuel Energy Efficiency
  - Clean and Renewable Energy
  - Greenhouse Gas Abatement
  - Direct Bill Assistance
- **REMI modeling reflects different states differing assumptions about the levels of spending on each stream**
  - Net economic impacts of these inputs are positive, though we account for both positive and negative effects, where applicable
  - NOTE: Modeling inputs shown in the slides below are all presented in terms of incremental over the Reference Case

# Proceeds Investments Allocation

- **Table represents current shares for state-level investment by categories used in the REMI modeling**

| State | Electric EE | Fossil Fuel EE | Clean & Renewable Energy | GHG Abatement & Climate Change | Direct Bill Assistance | Admin/ Other | Total |
|---|---|---|---|---|---|---|---|
| **Connecticut** | 4% | 65% | 23% | 6% | -- | 1% | **100%** |
| **Delaware** | 50% | 20% | 5% | 15% | 5% | 5% | **100%** |
| **Maine** | -- | 74%* | -- | -- | 19%* | 7% | **100%** |
| **Maryland** | 25%* | -- | 10% | 10% | 50% | 5% | **100%** |
| **Massachusetts** | 92% | -- | -- | 5% | -- | 3% | **100%** |
| **New Hampshire** | 7%* | 3%* | -- | -- | 88%* | 1% | **100%** |
| **New York** | 35% | 20% | 20% | 13% | -- | 12% | **100%** |
| **Rhode Island** | 50% | -- | 40% | -- | -- | 10% | **100%** |
| **Vermont** | -- | 98% | -- | -- | -- | 2% | **100%** |

*Reflects percentages from the MRPS policy case.

# Allowance Proceeds Reinvestments: Electric EE

- **Table summarizes total flow of dollars modeled for the entire RGGI region, including**
- **Spending on Equipment**
  - Includes Program and Participant (customer out-of-pocket) spending on electric energy efficiency equipment
- **Residential Consumer Impacts**
  - Consists of customer-out-of-pocket costs (-) and energy savings impacts (+)
  - Consumers have more money to spend on other goods and services when bill savings are larger than customer-out-of-pocket costs
  - Bill savings estimated using retail rates
  - Revenue decoupling adjustment to “make utilities whole”

| | RGGI Region Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $ Millions | 2018 | 2020 | 2022 | 2025 | 2028 | 2030 | 2035 | 2040 | 2045 |
| Spending on Equipment | $182 | $200 | $266 | $327 | $396 | $425 | $0 | $0 | $0 |
| Residential Consumer Impacts | $19 | $88 | $147 | $256 | $393 | $516 | $508 | $388 | $138 |
| Production Cost (C&I)* | $13 | -$83 | -$155 | -$287 | -$452 | -$627 | -$661 | -$505 | -$204 |
| Lost Generator Revenue | -$7 | -$16 | -$21 | -$25 | -$25 | -$31 | -$32 | -$24 | -$9 |
| Total Flow of Dollar Inputs** | $180 | $356 | $546 | $845 | $1,217 | $1,537 | $1,138 | $869 | $333 |

*Negative Production Costs imply decreases in costs that generate positive impacts
**Total Flow = Final Demand + Bill Savings – Production Cost + Lost Generator Revenue

- **Production Cost (C&I)**
  - Same as consumer impacts but for commercial and industrial entities
  - C&I entities have a lower production cost when their bill savings are larger than their out-of-pocket costs
- **Lost Generator Revenue**
  - Output from IPM
  - Lower bills for customers results in generators selling less electricity and getting less revenue

# Allowance Proceeds Reinvestments: Fossil EE

- **Table summarizes total flow of dollars modeled for the entire RGGI region, including**
- **Spending on Equipment**
  - Includes Program and Participant (customer-out-of-pocket) spending on fossil energy efficiency equipment
- **Residential Consumer Impacts**
  - Consists of customer-out-of-pocket costs (-) and bill savings (+)
  - Consumers have more money to spend on other goods and services when bill savings are larger than customer-out-of-pocket costs
  - Bill savings are calculated using EIA Annual Energy Outlook liquid fuel price projections and state specific MMBtu savings

| | RGGI Region Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $ Millions | 2018 | 2020 | 2022 | 2025 | 2028 | 2030 | 2035 | 2040 | 2045 |
| Spending on Equipment | $89 | $97 | $129 | $161 | $193 | $210 | $0 | $0 | $0 |
| Residential Consumer Impacts | -$18 | $0 | $14 | $51 | $107 | $155 | $258 | $199 | $70 |
| Production Cost (C&I)* | $15 | $11 | $10 | $3 | -$10 | -$22 | -$74 | -$57 | -$20 |
| Lost Oil and Gas Revenue | -$11 | -$25 | -$43 | -$77 | -$123 | -$160 | -$175 | -$135 | -$47 |
| Total Flow of Dollar Inputs** | $45 | $61 | $90 | $132 | $186 | $227 | $157 | $121 | $42 |

*Negative Production Costs imply decreases in costs that generate positive impacts
**Total Flow = Final Demand + Bill Savings – Production Cost + Lost Generator Revenue

- **Production Cost (C&I)**
  - Same as consumer impacts but for commercial and industrial entities
  - C&I entities have a lower production cost when their bill savings are larger than their out-of-pocket costs
- **Lost Oil and Gas Revenue**
  - Lower bills for customers results in oil and gas companies selling less fuel and receiving less revenue

# Allowance Proceeds Reinvestments: Clean & Renewable Energy

- **Table summarizes total flow of dollars modeled for the entire RGGI region, including**
- **Spending on Equipment**
  - Includes Program and Participant (customer-out-of-pocket) spending on solar, wind, and other clean and renewable equipment
- **Residential Consumer Impacts**
  - Consists of customer-out-of-pocket costs (-) and bill savings (+)
  - Consumers have less money to spend on other goods of services due to large amount of leveraged consumer expenditures compared to resulting bill savings
  - Bill savings calculated from GWh savings and EIA Annual Energy Outlook electricity price projections

| | RGGI Region Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $ Millions | 2018 | 2020 | 2022 | 2025 | 2028 | 2030 | 2035 | 2040 | 2045 |
| Spending on Equipment | $137 | $149 | $196 | $246 | $295 | $320 | $0 | $0 | $0 |
| Residential Consumer Impacts | -$73 | -$60 | -$71 | -$65 | -$44 | -$26 | $176 | $130 | $44 |
| Production Cost (C&I)* | $23 | $22 | $27 | $30 | $31 | $30 | -$27 | -$18 | -$3 |
| Lost Generator Revenue | -$4 | -$10 | -$16 | -$28 | -$44 | -$55 | -$58 | -$43 | -$15 |
| Total Flow of Dollar Inputs** | $38 | $57 | $83 | $123 | $175 | $209 | $145 | $105 | $32 |

*Negative Production Costs imply decreases in costs that generate positive impacts
**Total Flow = Final Demand + Bill Savings – Production Cost + Lost Generator Revenue

- **Production Cost (C&I)**
  - Same as consumer impacts but for commercial and industrial entities
  - C&I entities have a higher production cost when their out-of-pocket costs are larger than their bill savings
- **Lost Generator Revenue**
  - Lower bills for customers results in generators selling less electricity and receiving less revenue

# Allowance Proceeds Reinvestments: GHG Abatement and Research

- **Table summarizes total flow of dollars modeled for the entire RGGI region, including**
- **Program Spending**
  - Program spending on research and other investments such as EV charging
- **Residential Consumer Impacts**
  - Consumers have more money to spend on other goods and services because they have bill savings from increases in electric vehicle charging (compared to internal combustion engines)
  - Bill savings calculated from GWh savings and projected electricity prices (currently from EIA's Annual Energy Outlook)

| | RGGI Region Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $ Millions | 2018 | 2020 | 2022 | 2025 | 2028 | 2030 | 2035 | 2040 | 2045 |
| Program Spending | $33 | $35 | $47 | $58 | $70 | $76 | $0 | $0 | $0 |
| Residential Consumer Impacts | $3 | $6 | $12 | $21 | $32 | $42 | $45 | $35 | $12 |
| Production Cost (C&I)* | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Lost Gas Revenue | -$2 | -$5 | -$9 | -$16 | -$26 | -$33 | -$36 | -$28 | -$10 |
| Total Flow of Dollar Inputs** | $18 | $20 | $28 | $36 | $44 | $50 | $9 | $6 | $2 |

*Negative Production Costs imply decreases in costs that generate positive impacts
**Total Flow = Final Demand + Bill Savings – Production Cost + Lost Generator Revenue

- **Production Cost (C&I)**
  - No impacts
- **Lost Gas Revenue**
  - Switching to electric vehicle charging results in gas companies selling less fuel

# Allowance Proceeds Reinvestments: Bill Assistance and Other Spending

- **Table summarizes total flow of dollars modeled for the entire RGGI region, including**
- **Government Spending (Admin costs)**
  - Payments to RGGI, Inc., salaries, and other expenditures
- **Direct Bill Assistance/Consumer Impacts**
  - Direct bill assistance gives residential consumers more money to spend on other goods and services
- **Production Cost (C&I)**
  - None
- **Lost Generator Revenue**
  - None

| | RGGI Region Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $ Millions | 2018 | 2020 | 2022 | 2025 | 2028 | 2030 | 2035 | 2040 | 2045 |
| Government Spending | $21 | $23 | $30 | $38 | $45 | $49 | $0 | $0 | $0 |
| Direct Bill Assistance (R) | $35 | $38 | $50 | $63 | $75 | $82 | $0 | $0 | $0 |
| Production Cost (C&I)* | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Lost Generator Revenue | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total Flow of Dollar Inputs** | $56 | $60 | $80 | $100 | $120 | $131 | $0 | $0 | $0 |

*Negative Production Costs imply decreases in costs that generate positive impacts
**Total Flow = Final Demand + Bill Savings – Production Cost + Lost Generator Revenue

# Results

# Reference Case: Business as Usual

| Regional BAU Levels | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Economic Indicator | Region | 2018 | 2020 | 2022 | 2025 | 2028 | 2030 | 2035 | 2040 | 2045 |
| Total Employment (000' Jobs) | RGGI | 26,335 | 26,437 | 26,525 | 26,571 | 26,595 | 26,628 | 27,409 | 28,211 | 28,964 |
| | Rest-of-U.S. | 167,186 | 167,353 | 167,835 | 167,866 | 167,804 | 167,758 | 171,977 | 176,367 | 180,351 |
| Gross State Product (Billion Fixed 2015$) | RGGI | $2,927 | $3,050 | $3,176 | $3,370 | $3,569 | $3,712 | $4,033 | $4,372 | $4,738 |
| | Rest-of-U.S. | $16,928 | $17,585 | $18,316 | $19,410 | $20,544 | $21,340 | $23,136 | $25,032 | $27,063 |
| Disposable Personal Income (Billion Fixed 2015$) | RGGI | $2,192 | $2,305 | $2,428 | $2,606 | $2,794 | $2,914 | $3,127 | $3,341 | $3,579 |
| | Rest-of-U.S. | $12,678 | $13,301 | $14,023 | $15,015 | $16,076 | $16,733 | $17,877 | $19,067 | $20,388 |

- **Default REMI Baseline was calibrated to be consistent with IPM's Reference Case (No NP)**
  - Existing RGGI program cap till 2020
  - IPM outputs extend to 2031; flat lined beyond to extend REMI modeling to 2046
  - No National Program on carbon (No NP)
- **Modeling is annual but we present a subset of years**
- **Three economic indicators are reported for the RGGI region as a whole and the rest of the U.S.**
  - Employment, GSP, Disposable Personal Income

# MRPS Case Modeling: Cumulative Impacts

| Cumulative RGGI Results (2017-2031) | |
|---|---|
| **Economic Indicator** | **3% Discount Rate*** |
| Total Employment (Job-Years) | 34,397 |
| % Change from BAU | 0.009% |
| BAU Level | 400,000,000 |
| Gross State Product (Billion Fixed 2015$) | $2.79 |
| % Change from BAU | 0.007% |
| BAU Level | $39,000 |
| Disposable Personal Income (Billion Fixed 2015$) | $1.45 |
| % Change from BAU | 0.005% |
| BAU Level | $30,000 |

*Employment numbers are undiscounted

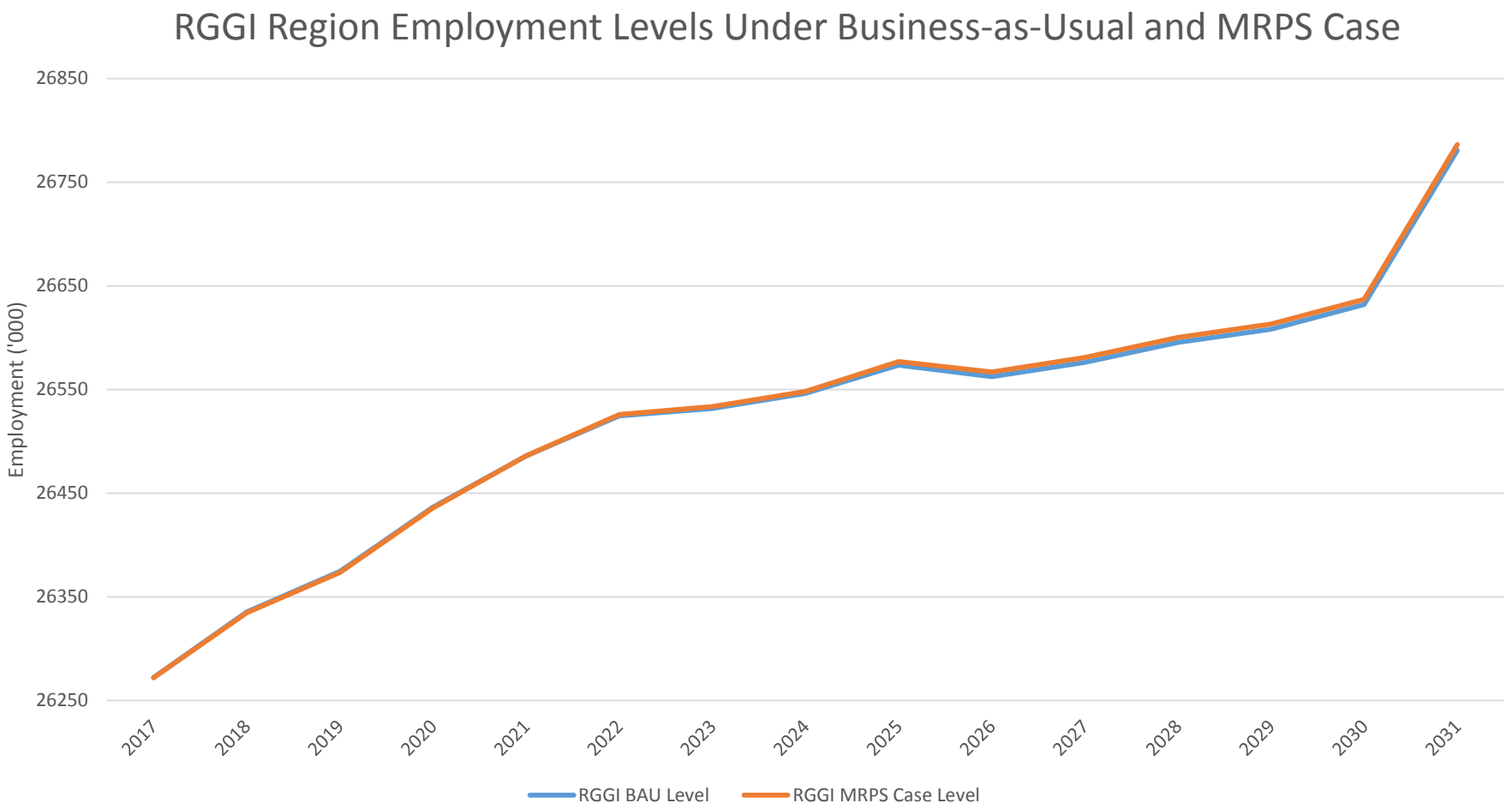
| Cumulative RGGI Results (2017-2046) | |
|---|---|
| **Economic Indicator** | **3% Discount Rate*** |
| Total Employment (Job-Years) | 130,119 |
| % Change from BAU | 0.016% |
| BAU Level | 820,000,000 |
| Gross State Product (Billion Fixed 2015$) | $9.50 |
| % Change from BAU | 0.013% |
| BAU Level | $72,000 |
| Disposable Personal Income (Billion Fixed 2015$) | $6.21 |
| % Change from BAU | 0.011% |
| BAU Level | $55,000 |

*Employment numbers are undiscounted

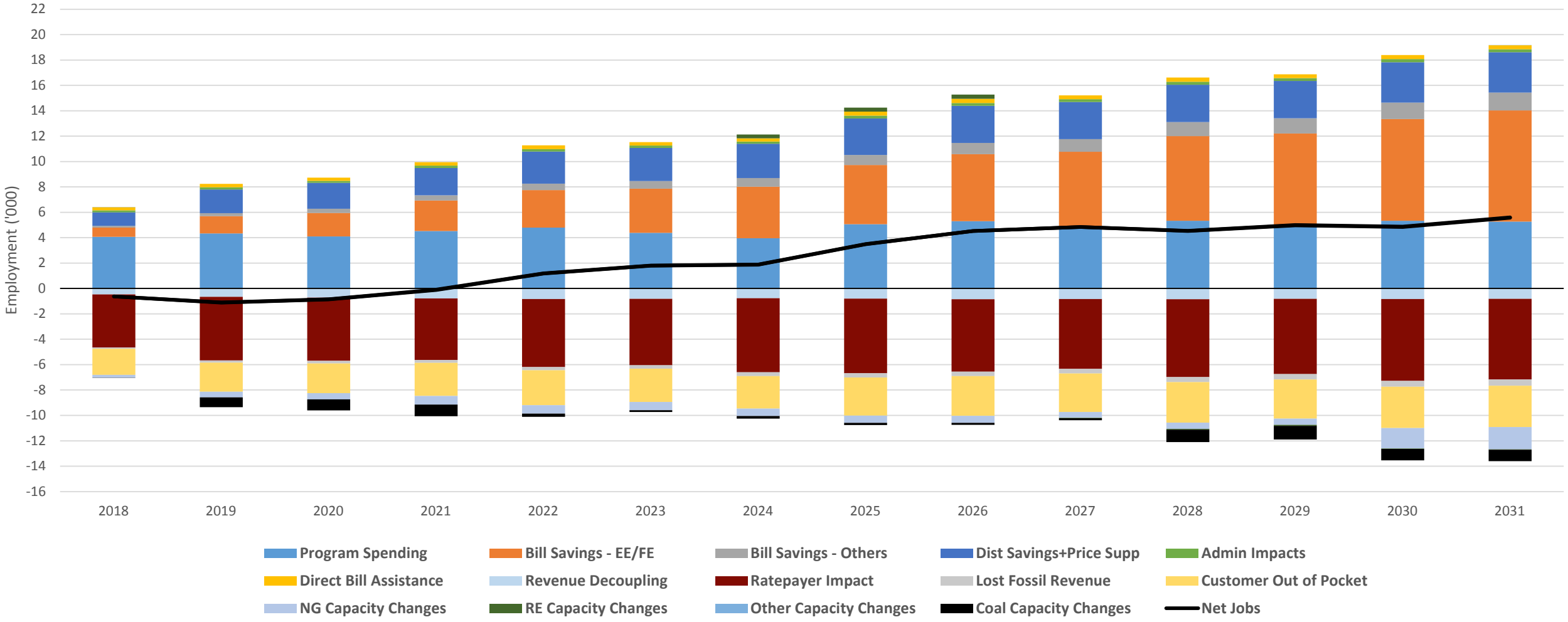
- **First table shows the aggregated economic impacts of the MRPS Case only during the IPM modeled RGGI cap years (2017-2031)**
  - Cumulatively, RGGI is estimated to support around 35,000 job-years during 2017-2031 (the IPM modeled period).
- **Second table shows aggregate economic impacts of the MRPS Case for the entire REMI modeling period (2017-2046) which captures the lifetime impacts of investments made during the IPM modeled period (e.g., bill savings from energy efficiency)**
  - Cumulatively, RGGI is estimated to support around 130,000 job-years during 2017-2046 (the REMI modeled period).
  - Changes are small, on the order of 0.011% to 0.016% of BAU levels.

# Trends Over Time

- **Graph shows the employment growth trends over time under Reference (BAU) and MRPS Policy cases**
- **Employment impacts from previous graph are the heights between orange and blue lines**
- **Very small impacts under the scenario**



# MRPS Case Modeling: Employment Impacts by Components



# Results Summary

- **RGGI region sees initial slight negative economic impacts from the MRPS case cap reduction but quickly grow to small but consistent economic benefits**
  - Impacts exclude health, environmental, and climate related benefits due to emission reductions
- **While the effect of the RGGI cap decline (i.e., the other IPM-based inputs) is generally negative, the cumulative effect is positive due to the positive benefits of the allowance proceeds reinvestments**
  - See results by individual components in the Appendix section of presentation
- **MRPS Case results show that changes are very small**
  - Largest annual delta (MRPS compared to BAU case) is 3 hundredths of a percent
  - Results are consistent with the general consensus in the economics literature – properly designed cap-and-trade programs are likely to produce small but positive economic impacts over the long run

# Appendix

# Appendix

- **Appendix provides additional results from the MRPS Case REMI run**
  - Undiscounted results

# MRPS Case Modeling: Cumulative Impacts

| Cumulative RGGI Results (2017-2031) | |
|---|---|
| **Economic Indicator** | **Undiscounted** |
| Total Employment (Job-Years) | 34,397 |
| % Change from BAU | 0.009% |
| BAU Level | 400,000,000 |
| Gross State Product (Billion Fixed 2015$) | $3.95 |
| % Change from BAU | 0.008% |
| BAU Level | $50,000 |
| Disposable Personal Income (Billion Fixed 2015$) | $2.11 |
| % Change from BAU | 0.006% |
| BAU Level | $38,000 |

| Cumulative RGGI Results (2017-2046) | |
|---|---|
| **Economic Indicator** | **Undiscounted** |
| Total Employment (Job-Years) | 130,119 |
| % Change from BAU | 0.016% |
| BAU Level | 820,000,000 |
| Gross State Product (Billion Fixed 2015$) | $16.57 |
| % Change from BAU | 0.014% |
| BAU Level | $114,000 |
| Disposable Personal Income (Billion Fixed 2015$) | $11.17 |
| % Change from BAU | 0.013% |
| BAU Level | $88,000 |

- **First table shows the aggregated economic impacts of the MRPS Case only during the IPM modeled RGGI cap years (2017-2031)**
  - Cumulatively, RGGI is estimated to support around 35,000 job-years during 2017-2031 (the IPM modeled period).
- **Second table shows aggregate economic impacts of the MRPS Case for the entire REMI modeling period (2017-2046) which captures the lifetime impacts of investments made during the IPM modeled period (e.g., bill savings from energy efficiency)**
  - Cumulatively, RGGI is estimated to support around 130,000 job-years during 2017-2046 (the REMI modeled period).
  - Changes are small, on the order of 0.013% to 0.016% of BAU levels.