Economic Impacts of Expanding Vermont's Renewable Energy Standards

PRESENTED BY

Dr. Dean Murphy
Dr. Wonjun Chang
Ellie Curtis
Paige Vincent

PRESENTED FOR

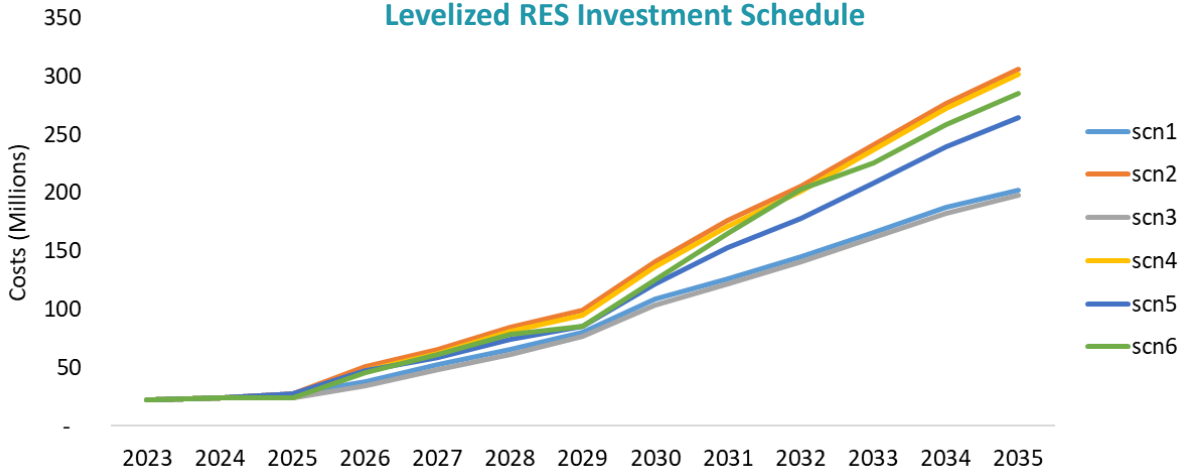
Renewable Energy Standard
Reform Working Group

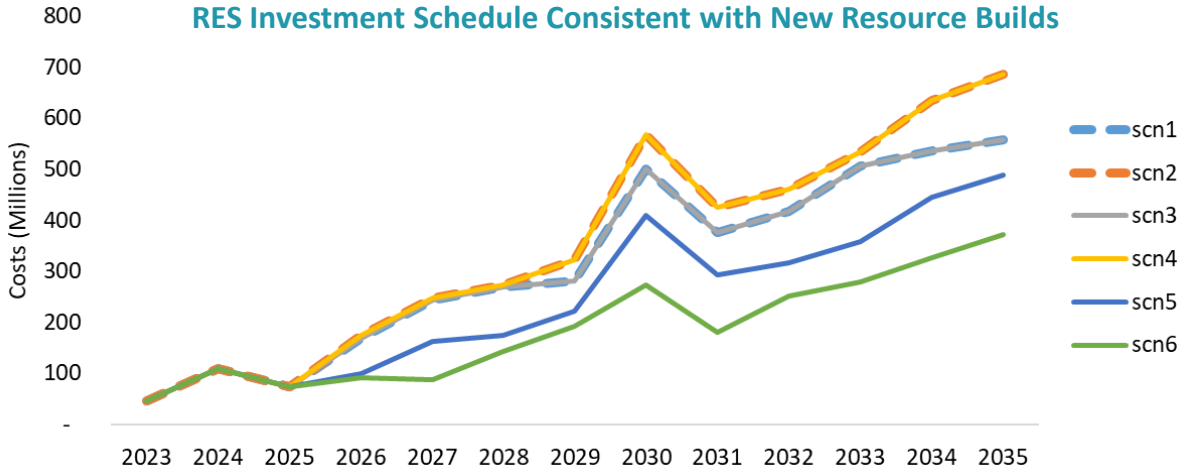
DECEMBER 13TH 2023

Brattle

Changes to the Model

- In the BCA, the costs of renewable energy are levelized:
  - The "lumpiness" of investments involved in building and operating resources are smoothed over the life of resources.
  - Cost smoothing is important in comparing costs and benefits across RES scenarios.
- To capture the economic impacts from investment in *new resources*, Brattle and SEA estimated an "unlevelized" investment schedule that assumes new facility builds occur immediately prior to deployment.
- Costs of *existing resources* are assumed to included in the macroeconomic dataset.





Overview of Scenario Definitions

We model the six core scenarios defined by the Department and Stakeholder Advisory Group.

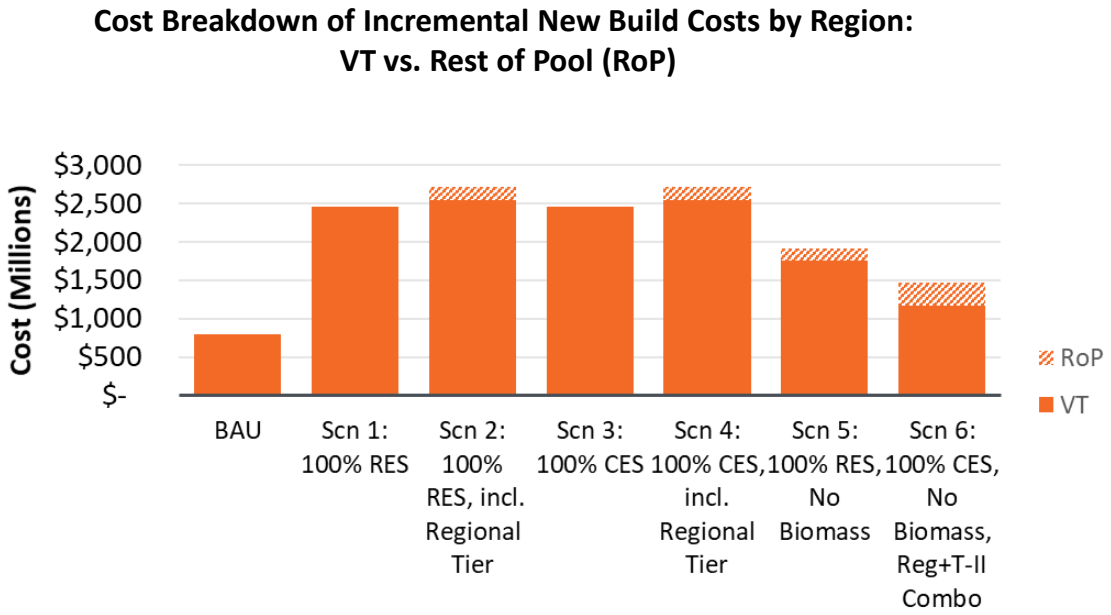
- **Business as Usual (BAU):** 75% by 2032 consisting of 10% Tier I, 65% Tier II.

Scenarios → Design Element ↓		BAU	Scenario 1: 100% RES	Scenario 2: 100% RES, incl. Regional Tier	Scenario 3: 100% CES	Scenario 4: 100% CES, incl. Regional Tier	Scenario 5: 100% RES, no biomass	Scenario 6: 100% CES, no biomass, Reg + T-II combo
Tier I, Net	Target	65%	70%	40%	70%	40%	50%	40%
	Target Date	2032	2035	2035	2035	2035	2035	2035
	Eligibility Changes	N/A	None	None	Add nuclear	Add nuclear	Remove biomass	Add nuclear; remove biomass
Tier II	Target	10%	30%	30%	30%	30%	20%	Combined with Regional Tier
	Target Date	2032	2035	2035	2035	2035	2035	
	Eligibility Changes	N/A	None	None	None	None	None	
Regional Tier	Target	N/A	N/A	30%	N/A	30%	30%	60%
	Target Date	N/A	N/A	2035	N/A	2035	2035	2035
	Eligibility*	N/A	N/A	2010+	N/A	2010+	2010+	2010+

- Six core scenarios varying allocation of tiers and technology eligibility in Tier I:
  - **Tier II:** 10%, 20%, 30%; **Regional Tier:** 0%, 20%, 30%, 40%, 50%; **Tier I:** Fills ‘gap’ to 100%
  - **Tier I eligibility:** with/without Biomass; with/without nuclear

Geographic Distribution of New Resource Investment

- Incremental resources procured within Vermont create economic activity (increased state GDP and employment) predominantly within Vermont.
  - Projects within Vermont will still require some out-of-state and foreign industrial inputs.
- Out-of-state resource procurement projects are assumed to create economic activity in the rest of the pool (RoP).

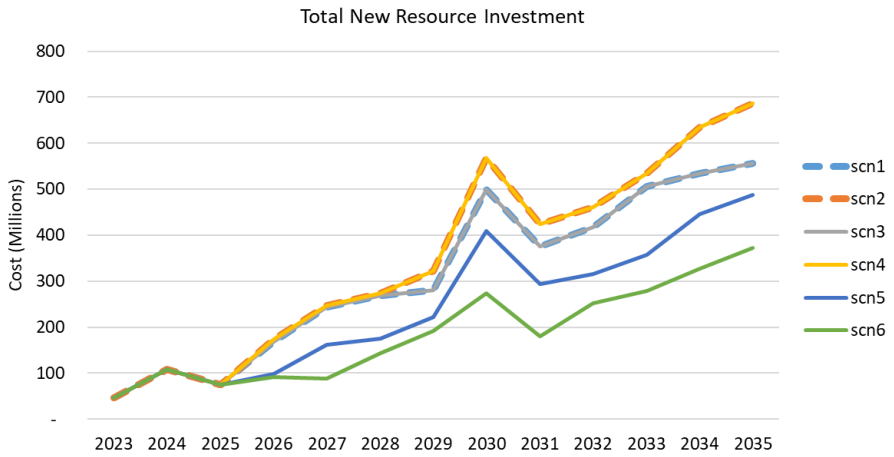


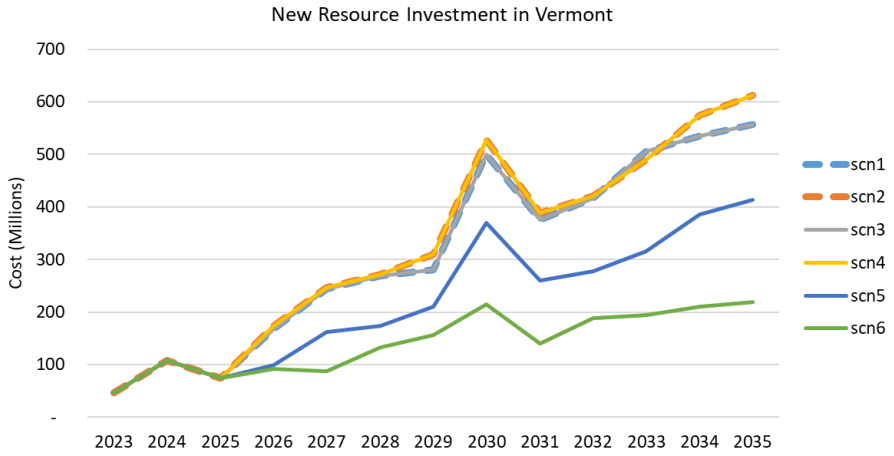
Key Takeaways

Key Drivers of Economic Impacts

Economic impacts in each scenario are driven by:

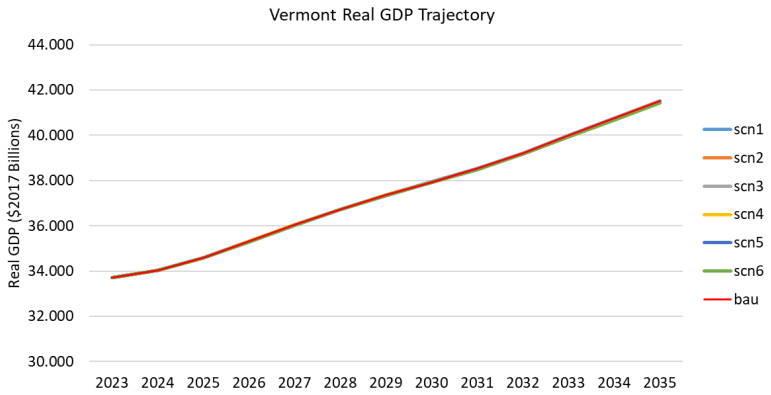
- **Total investment needs to meet Vermont's RES:**
  Total investment costs determine the efficiency in which the RES is satisfied. A more cost-efficient scenario means more production ending up as final consumption and less as industrial inputs used for electricity generation.
- **Amount of investment that takes place in Vermont:**
  Incremental resources built within Vermont create economic activity in non-electricity sectors. Production and employment in the transportation, energy-intensive manufacturing, and services sectors contribute to GDP.
- **Electricity rate changes:**
  Increase in rates results in less disposable income for consumers and producers to spend on non-electricity goods and services.

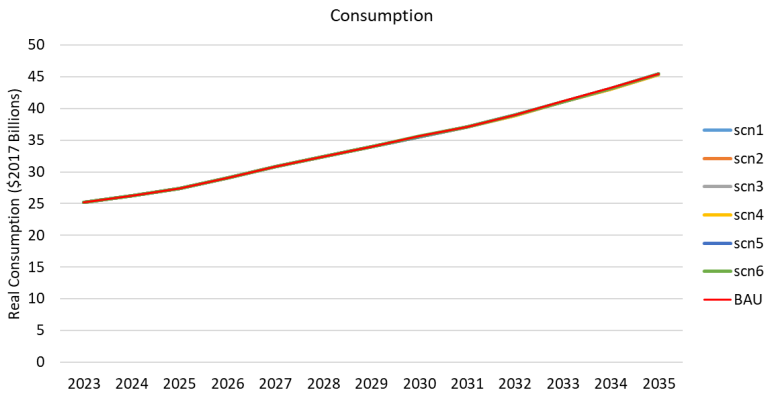


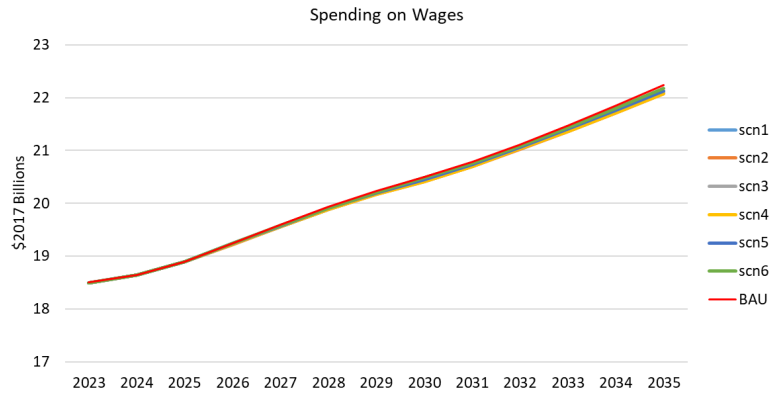


Overview of Economic Impacts

- GDP, Consumption and Employment grows but at a ***slightly*** slower rate relative to BAU
  - There are differences in growth driven by rate impacts and investment needs to satisfy RES, but they are small.

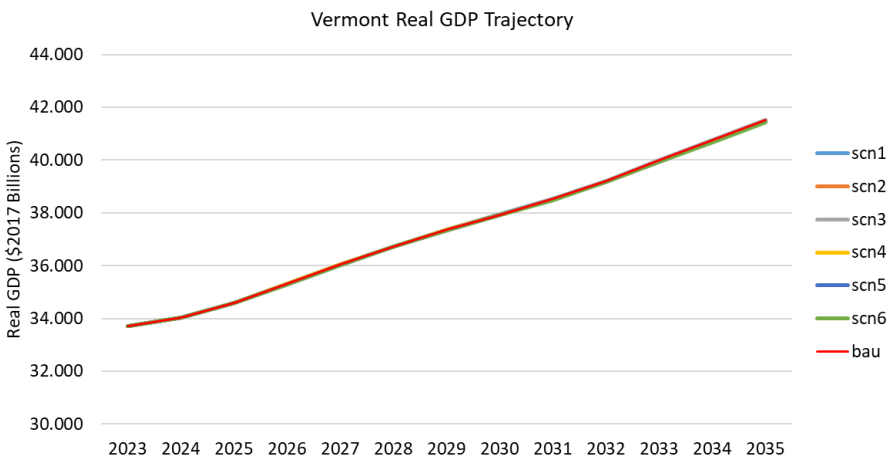


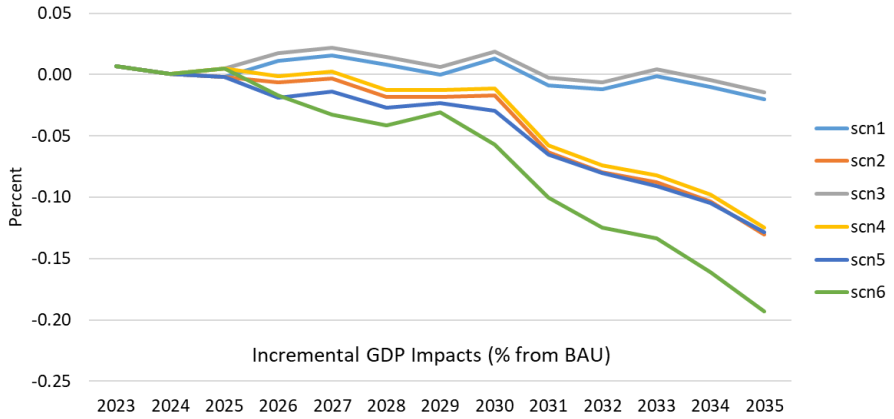




Economic Impacts: GDP Growth

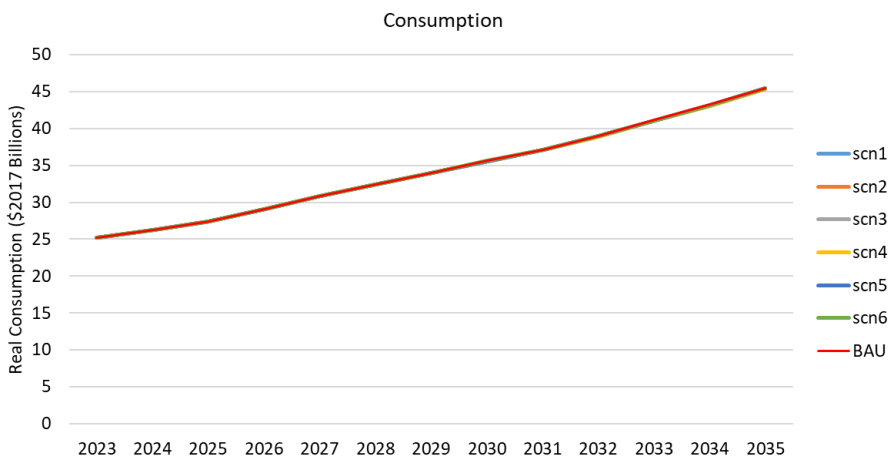
- GDP grows but at a *slightly* slower rate relative to BAU
- 100% RES (Scn1) and CES (Scn3) scenarios result in the highest GDP growth
  - High investment in new renewable resources in Vermont
  - Low rate changes
- 100% CES, No Biomass, Regional+T-II Combo scenario (Scn6) results in the lowest GDP growth
  - Low investment in new renewable resources in Vermont
  - High rate changes
- High VT investment levels and high rates offset each other in the 100% RES (Scn2) and CES (Scn4) scenarios
  - Produces similar GDP impact as in the 100% RES, No Biomass scenario (Scn5) characterized by medium rates and medium VT investment.

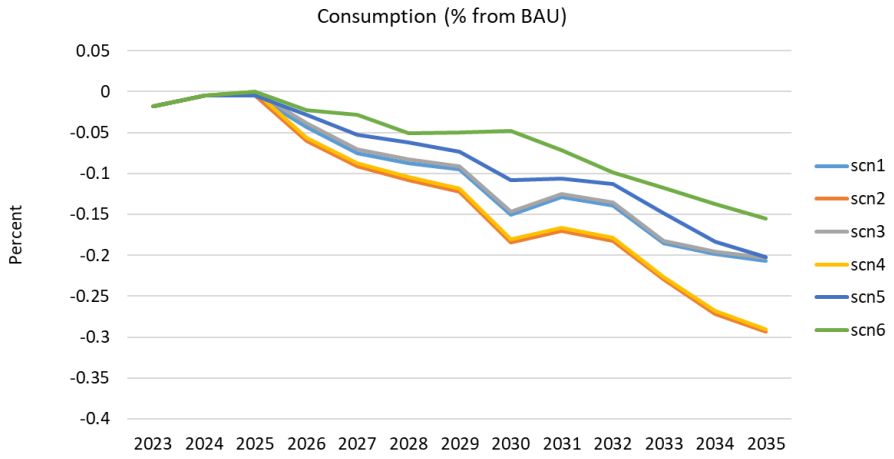




Economic Impacts: Consumption

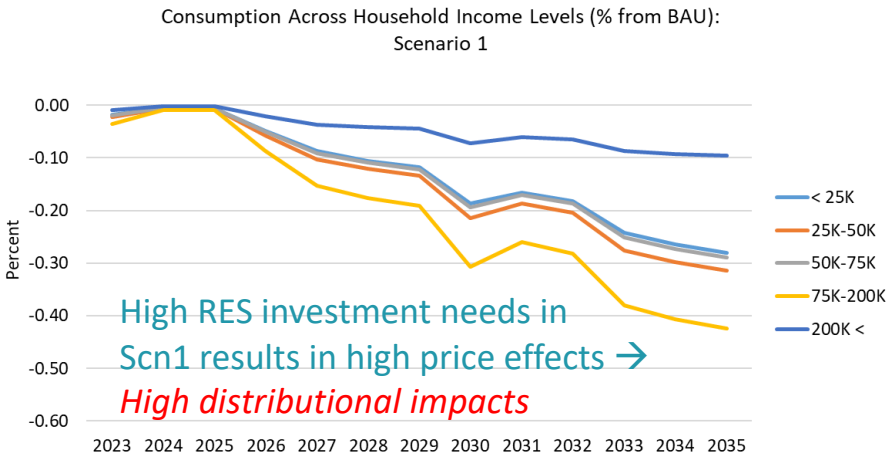
- Similar to GDP, consumption grows at a *slightly* slower rate relative to BAU.
- Consumption impacts are driven largely by the total investment needs to meet RES, and rate impacts.
- The 100% RES and CES w/ Regional Tier scenarios (Scn 2,4) have the slowest consumption growth since:
  - Increased production from high VT investment is consumed by the electricity sector to satisfy RES.
  - Higher demand for industrial inputs due to high-RES investment needs raises prices in non-electricity goods; e.g., services, energy-intensive manufacturing goods.
  - Coupled with higher rates, consumption decreases.
- Scenario 6 has the fastest growth due to low new investment needs. Scn 6 boosts GDP growth in RoP, also contributing to faster consumption growth.

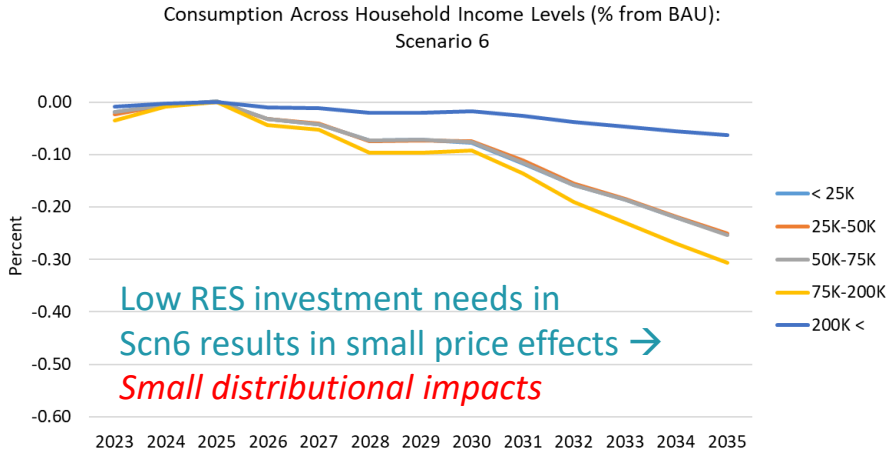




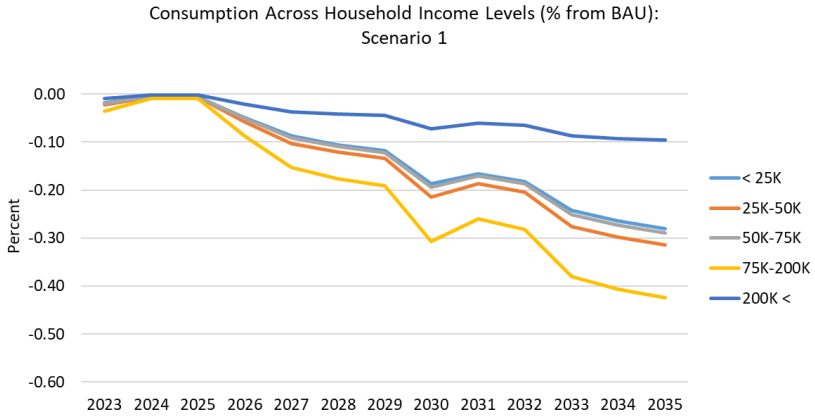
Economic Impacts: Consumption Across Income Levels

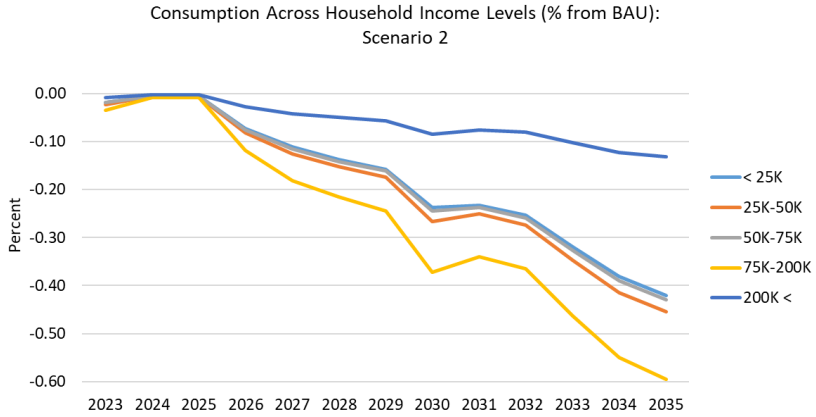
- Model uses input-data from the peer-reviewed work of the Wisconsin National Data Consortium (WiNDC).
  - Representative households by income group, used to characterize the economic behavior of an average consumer in their respective income levels, are modeled based on the Statistics of Income (SOI) data from the IRS.
- Consumption impacts across income groups are driven by the income share spent on consumption goods.
  - Lowest income households spend highest share of income on electricity.
  - But all income groups spend far more on services and energy-intensive manufacturing goods, goods that experience the highest price increase due to RES.
  - Among the sub-200K income groups, 75K-200K income group spends the most on these goods.

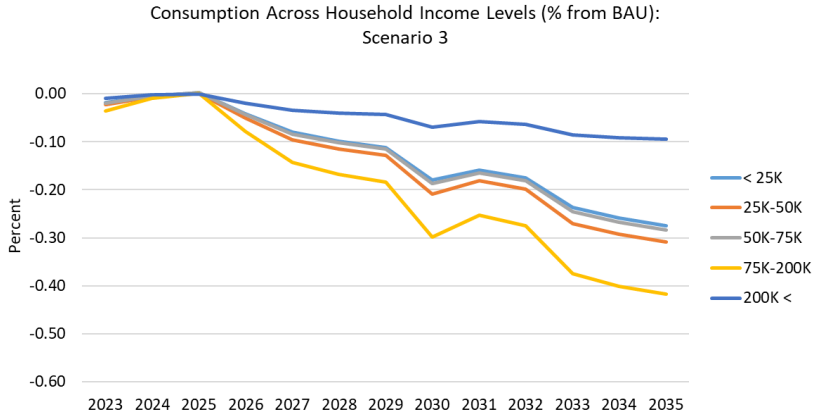


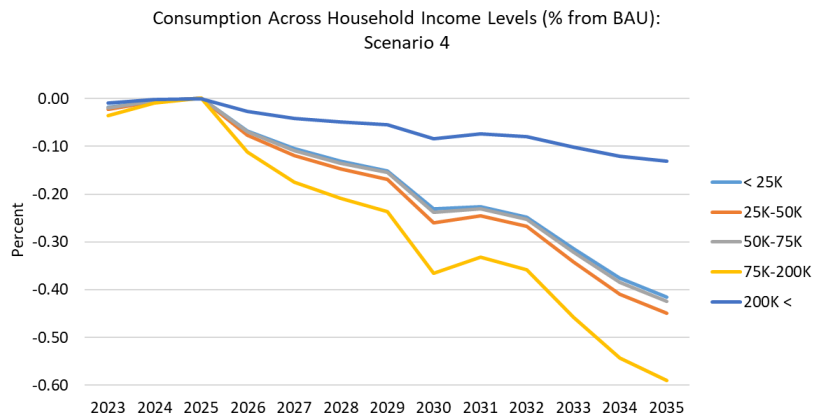


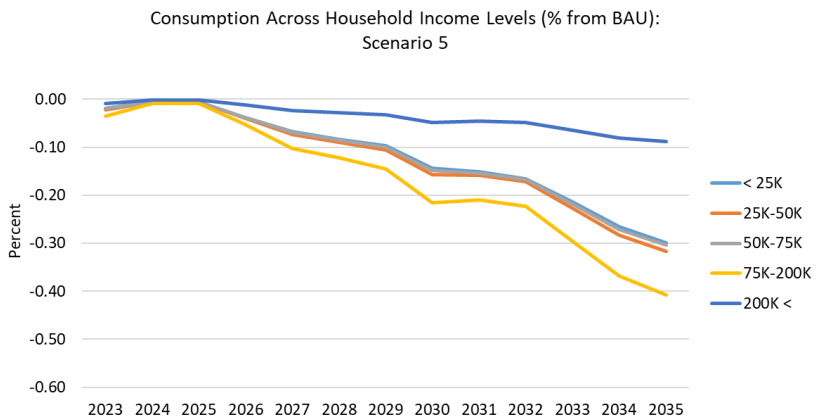
Economic Impacts: Consumption Across Income Levels

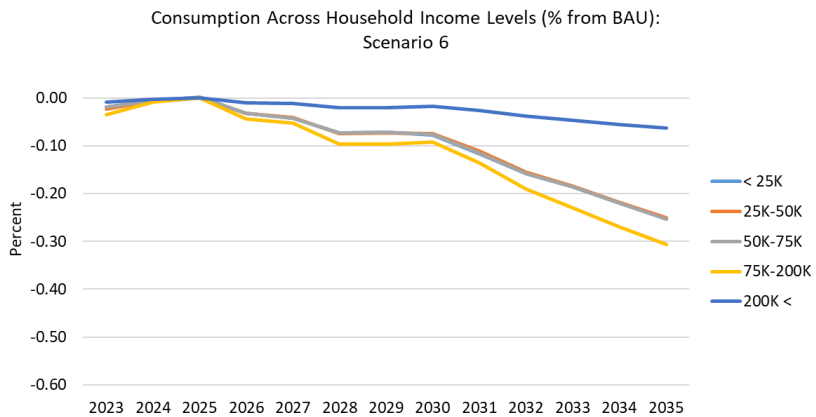






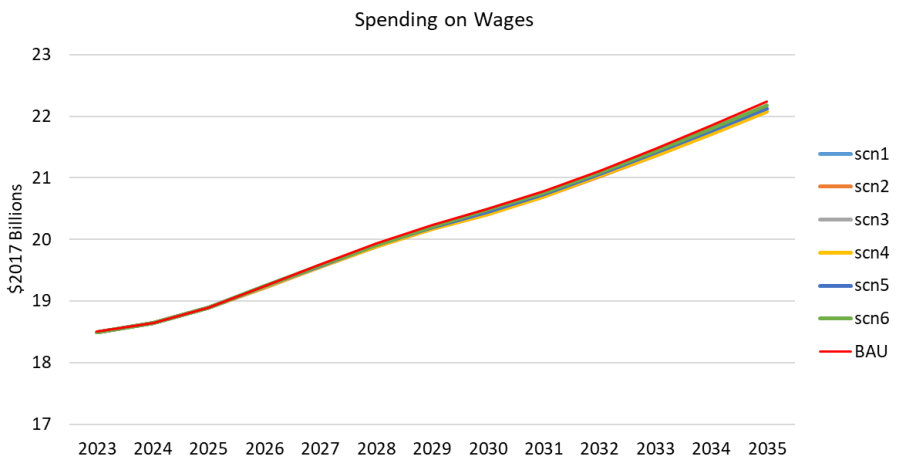


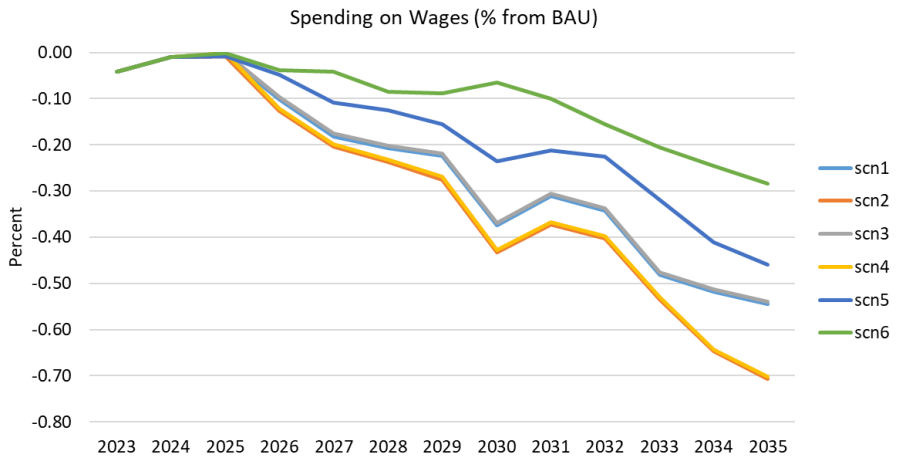




Economic Impacts: Employment

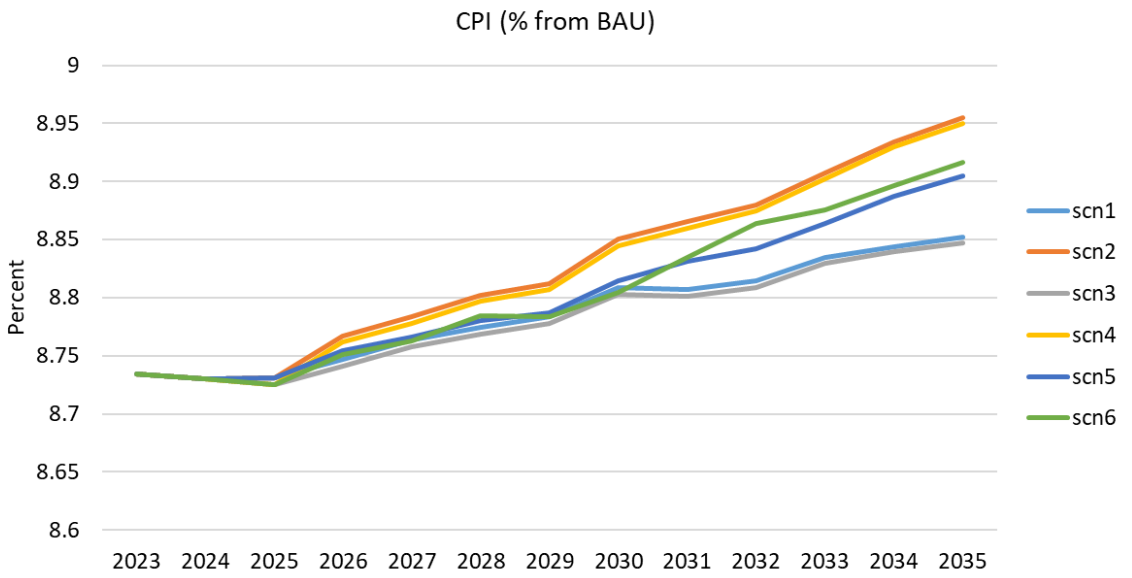
- Similar to GDP and consumption, spending on wages grows at a *slightly* slower rate relative to BAU.
- Employment follows a similar trajectory to consumption as both are driven largely by the total investment needed to meet Vermont's RES.
- Low RES investment needs means less employment needed to build and operate new facilities to satisfy RES. This contributes to higher marginal productivity of labor; i.e., higher wages.
- Faster growth in scenario 6 is attributed to the lower total resource builds.
  - Scenario 6 also has highest investment in RoP, contributing to an increase in GDP for the rest of New England, and hence employment in Vermont.





Economic Impacts: Consumer Price Index (CPI) in Vermont

- Similar to consumption, growth in the Consumer Price Index (CPI) is largely driven by total investment needs to meet RES, and rate impacts.
- The 100% RES and CES scenarios w/ Regional Tier (Scn 2,4) result in the highest increase in the CPI due to high rate impacts and high-investment needs.
  - High-investment needs create competition for resources in the economy, raising their prices.
- The 100% RES and CES scenarios (Scn 1,3) result in the lowest CPI increase due to low rate impacts.



Full Report

Objective and Approach

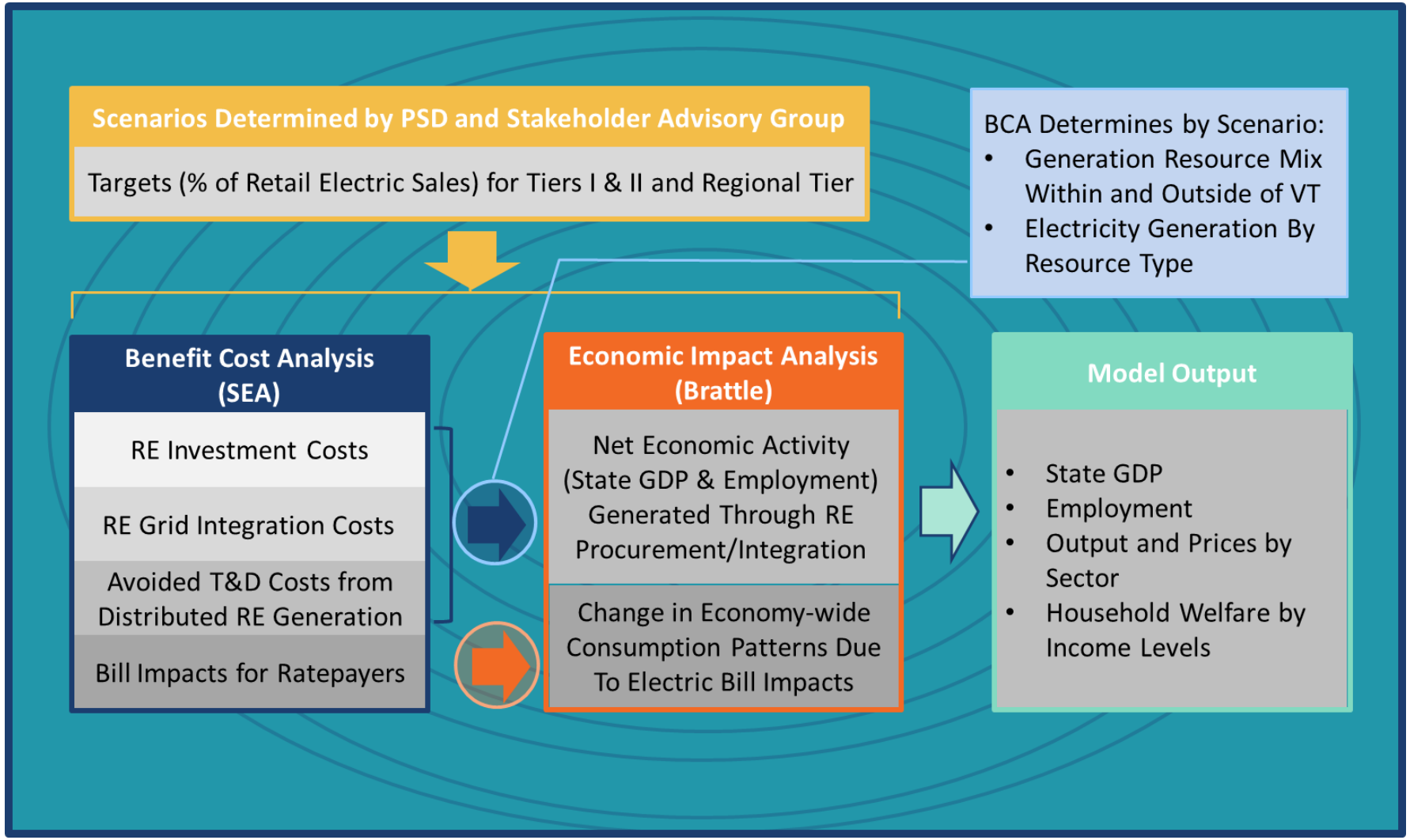
Project Objective

- Assess the macroeconomic impacts to Vermont under various scenarios of Vermont's Renewable or Clean Energy Standard (RES), including impacts to gross domestic product and employment.

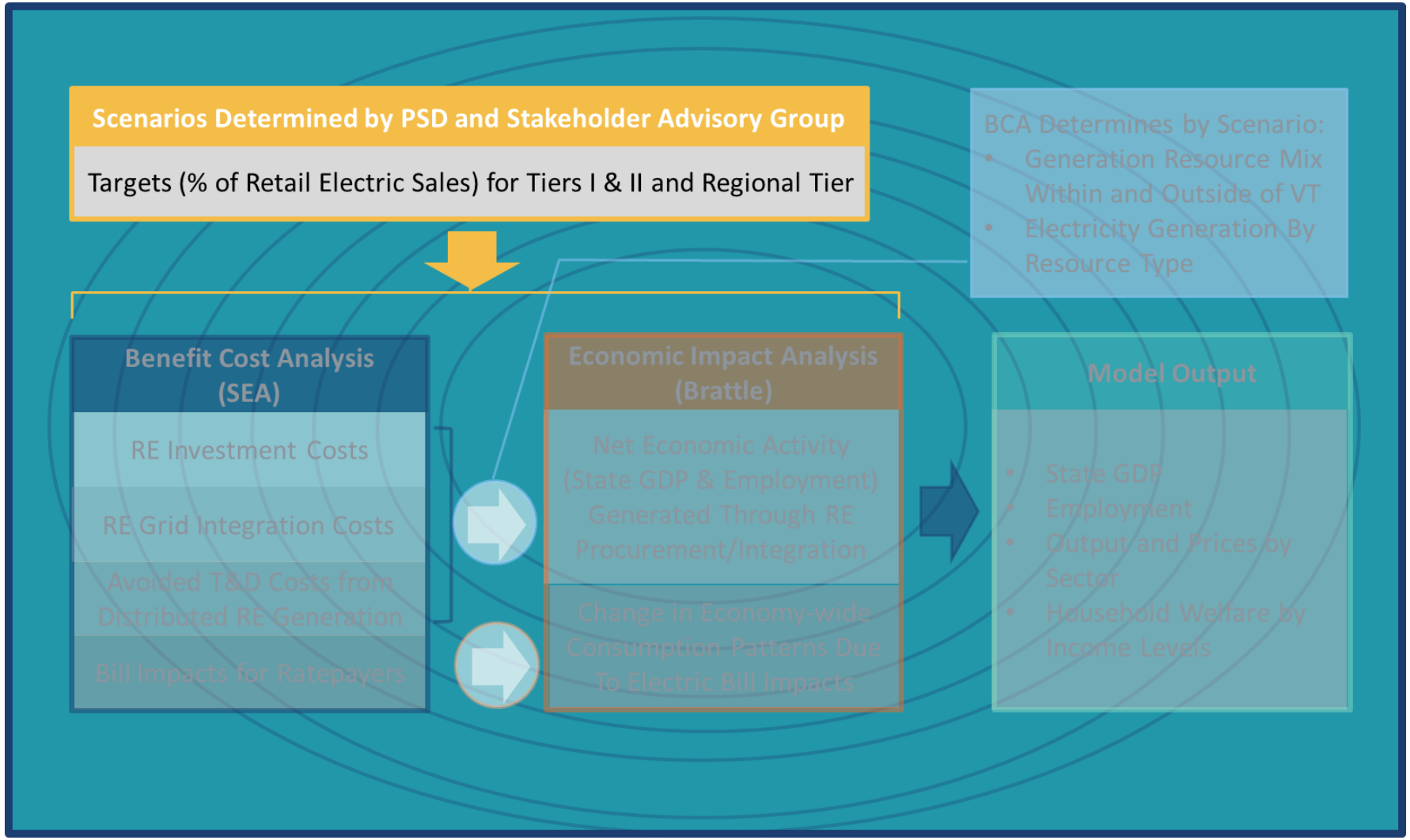
Approach

- Provide economic impact analysis (EIA) for six core scenarios regarding how to expand Vermont's RES. Scenarios were designed jointly by the Department of Public Service and Stakeholder Advisory Group.
- Maintain consistency with the Benefit-Cost Analysis (BCA) conducted by *Sustainable Energy Advantage, LLC* (SEA). BCA output such as rate impacts, incremental generating resource additions and incremental costs of renewable energy are used as inputs in the economic impact analysis.

Benefit-Cost & Economic Impact Analysis Overview



Overview of Scenario Definitions



Overview of Scenario Definitions

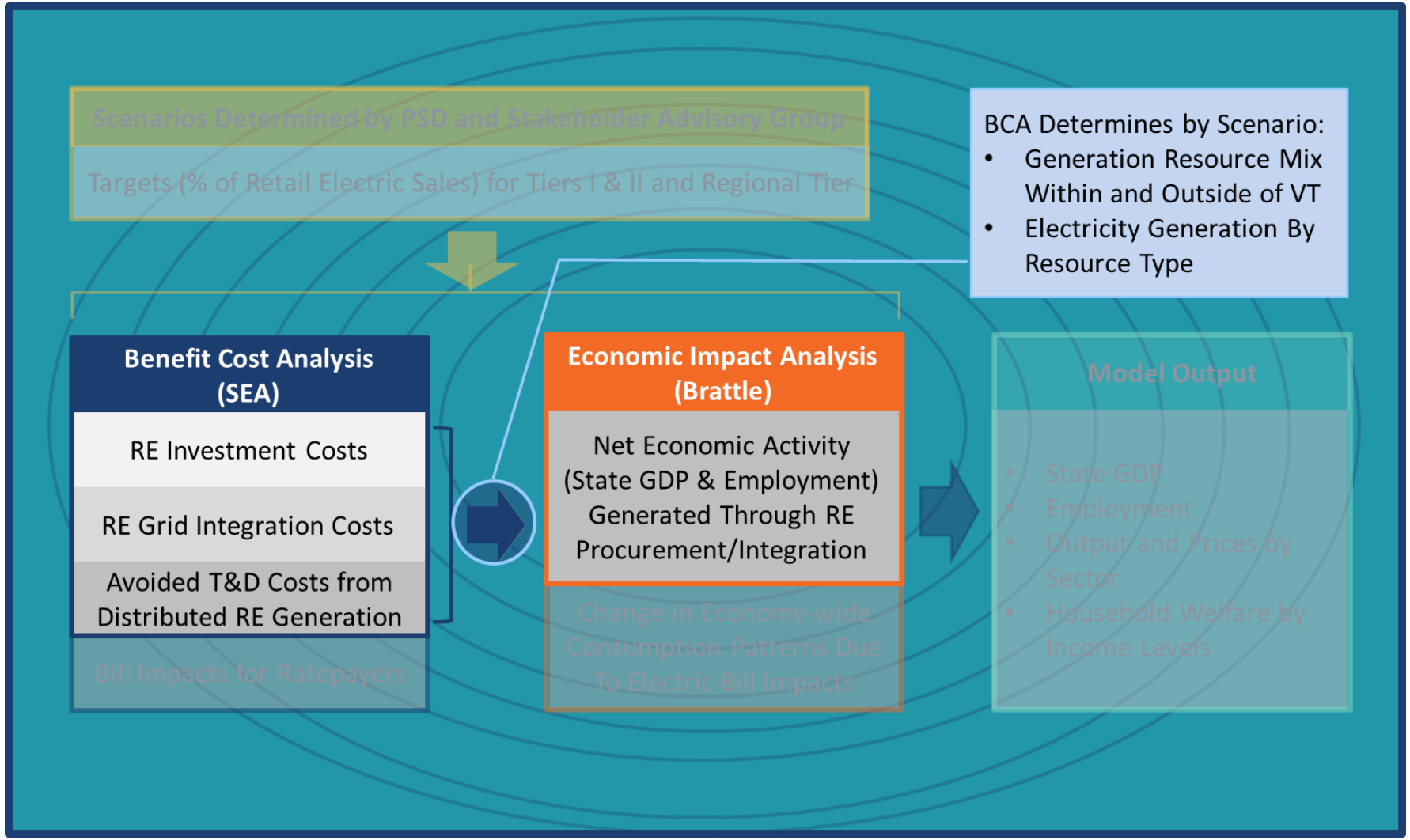
We model the six core scenarios defined by the Department and Stakeholder Advisory Group.

- **Business as Usual (BAU):** 75% by 2032 consisting of 10% Tier I, 65% Tier II.

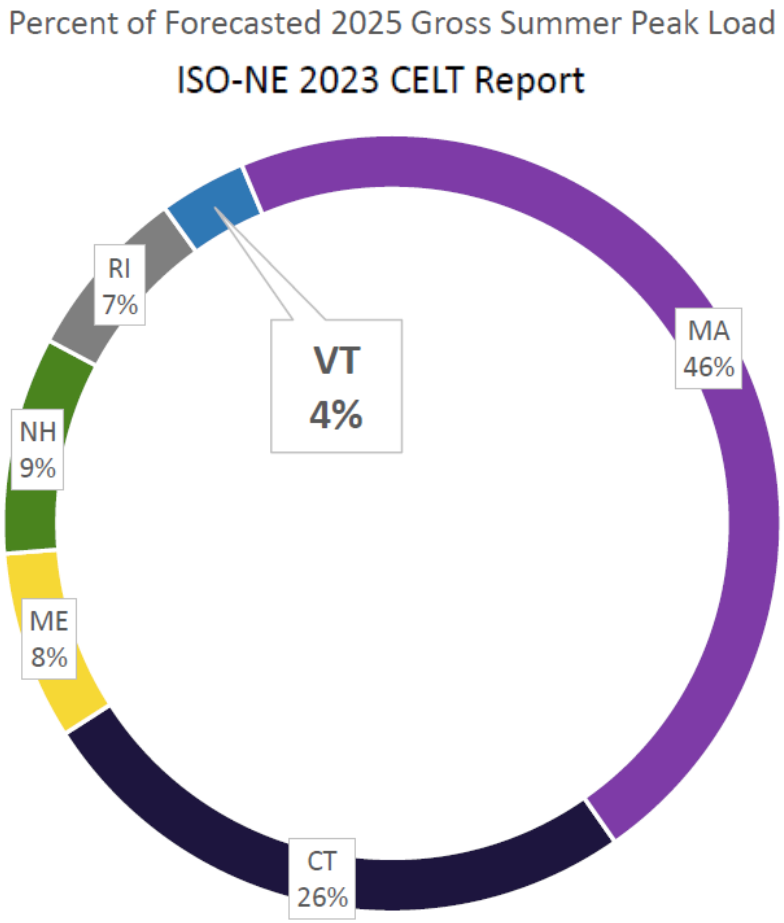
Scenarios → Design Element ↓		BAU	Scenario 1: 100% RES	Scenario 2: 100% RES, incl. Regional Tier	Scenario 3: 100% CES	Scenario 4: 100% CES, incl. Regional Tier	Scenario 5: 100% RES, no biomass	Scenario 6: 100% CES, no biomass, Reg + T-II combo
Tier I, Net	Target	65%	70%	40%	70%	40%	50%	40%
	Target Date	2032	2035	2035	2035	2035	2035	2035
	Eligibility Changes	N/A	None	None	Add nuclear	Add nuclear	Remove biomass	Add nuclear; remove biomass
Tier II	Target	10%	30%	30%	30%	30%	20%	Combined with Regional Tier
	Target Date	2032	2035	2035	2035	2035	2035	
	Eligibility Changes	N/A	None	None	None	None	None	
Regional Tier	Target	N/A	N/A	30%	N/A	30%	30%	60%
	Target Date	N/A	N/A	2035	N/A	2035	2035	2035
	Eligibility*	N/A	N/A	2010+	N/A	2010+	2010+	2010+

- Six core scenarios varying allocation of tiers and technology eligibility in Tier I:
  - **Tier II:** 10%, 20%, 30%; **Regional Tier:** 0%, 20%, 30%, 40%, 50%; **Tier I:** Fills ‘gap’ to 100%
  - **Tier I eligibility:** with/without Biomass; with/without nuclear

Investment Costs of Renewable Energy and Economic Growth



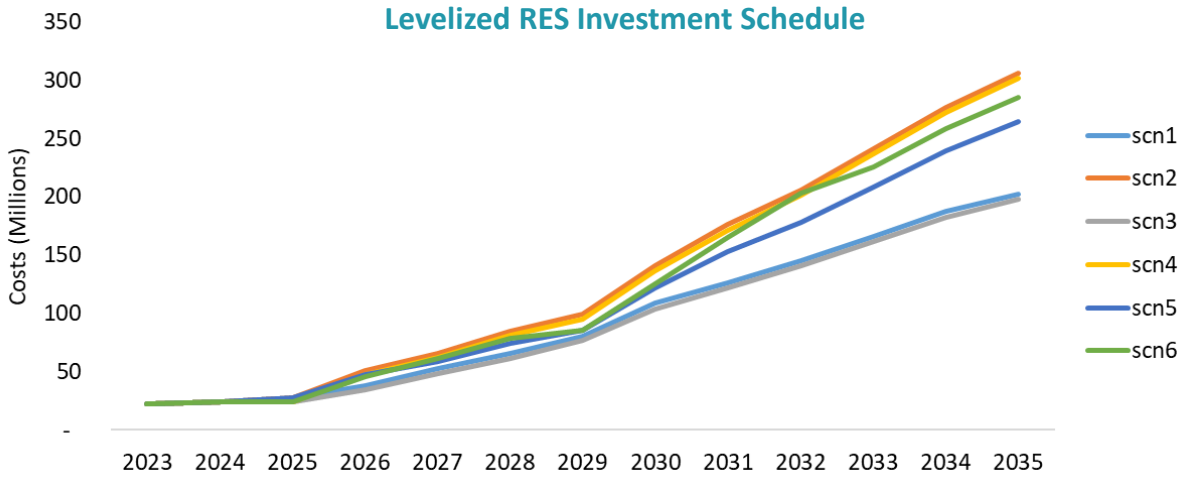
RES Investment Costs Borne by Vermont

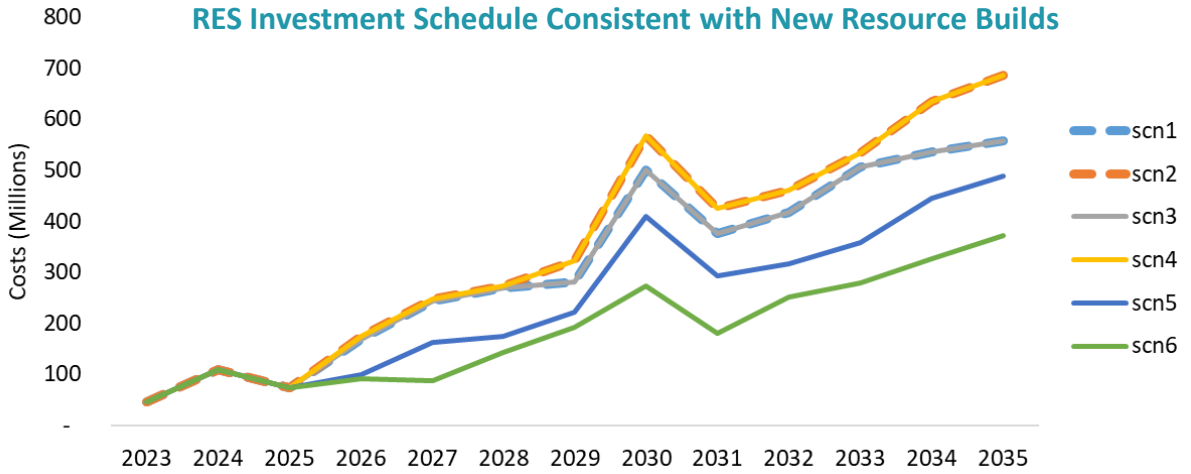


- Vermont consumers bear the costs of RES expansion:
  - Benefits of new renewable generation are shared by all New England ratepayers.
  - Vermont similarly benefits from resources driven by programs originating from other New England states.
  - In the BCA's incremental cost calculation, only the 3-4% of benefits accruing to Vermont are accounted for.

RES Investment Costs: New Resource Investment

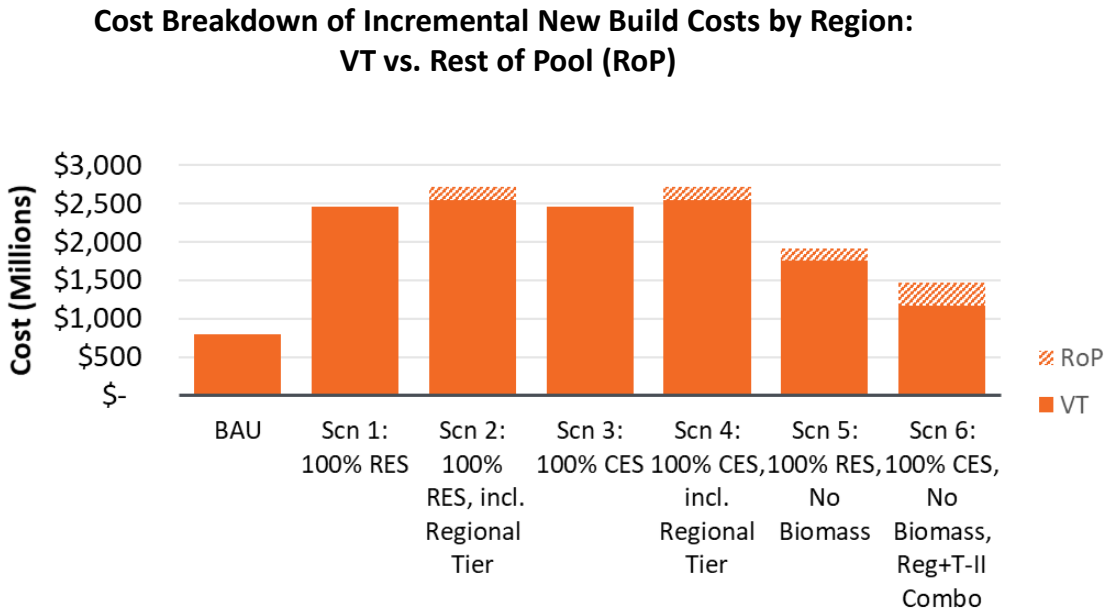
- In the BCA, the costs of renewable energy are levelized:
  - The "lumpiness" of investments involved in building and operating resources are smoothed over the life of resources.
  - Cost smoothing is important in comparing costs and benefits across RES scenarios.
- To capture the economic impacts from investment in *new resources*, Brattle and SEA estimated an "unlevelized" investment schedule that assumes new facility builds occur immediately prior to deployment.
- Costs of *existing resources* are assumed to included in the macroeconomic dataset.





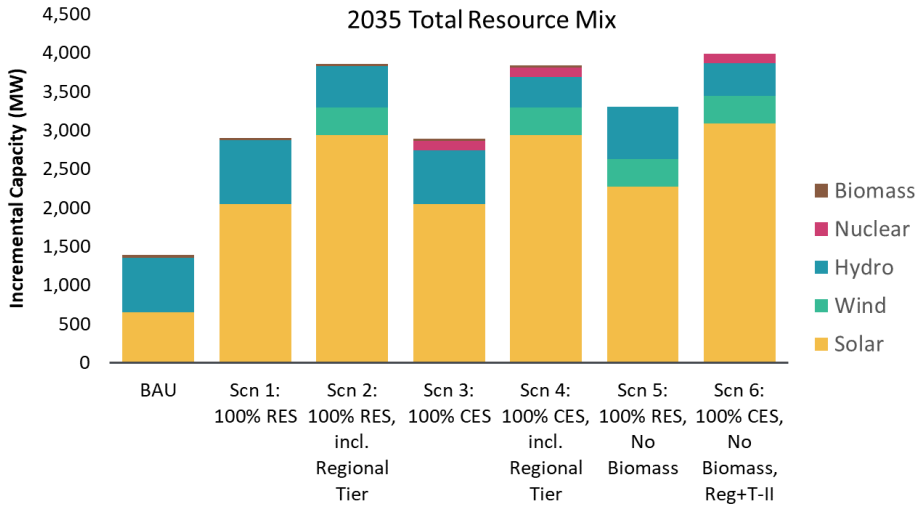
Geographic Distribution of New Resource Investment

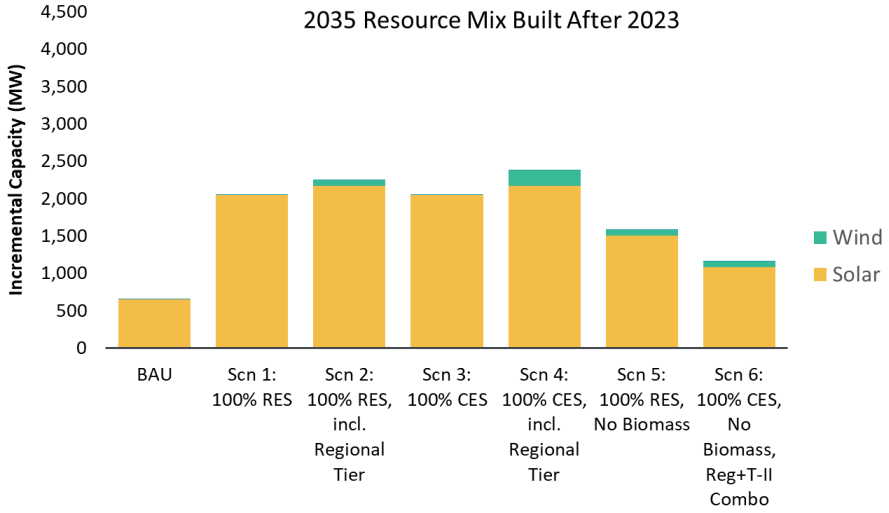
- Incremental resources procured within Vermont create economic activity (increased state GDP and employment) predominantly within Vermont.
  - Projects within Vermont will still require some out-of-state and foreign industrial inputs.
- Out-of-state resource procurement projects are assumed to create economic activity in the rest of the pool (RoP).



Distribution of New Resource Investment by Resource Type

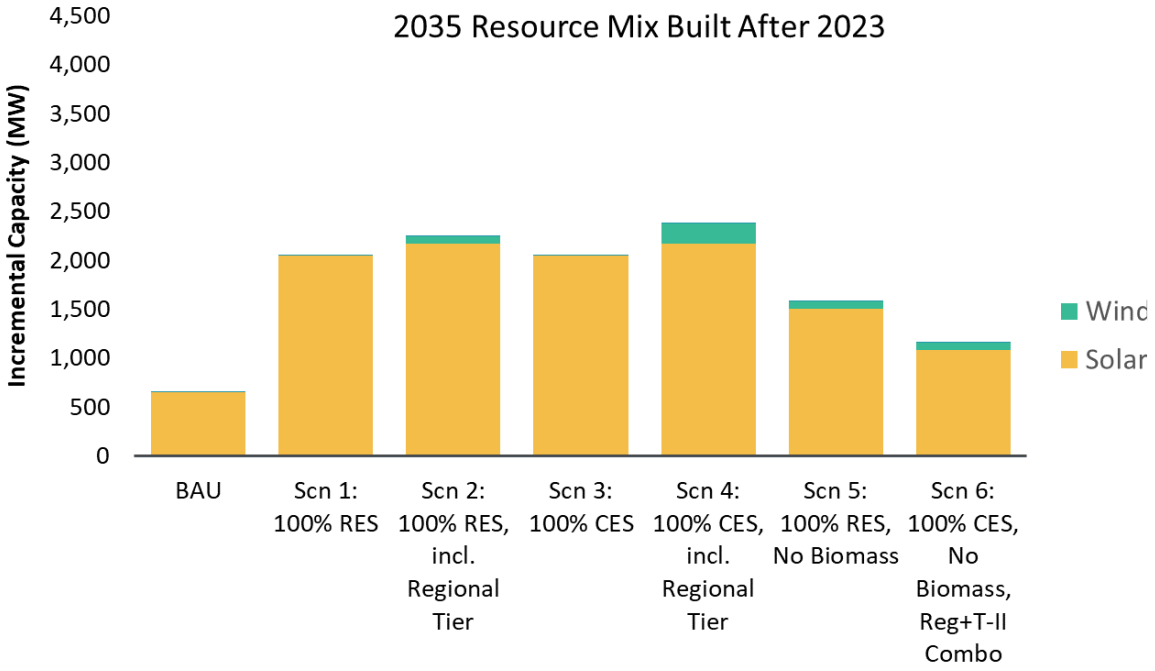
- BCA also provides incremental resource additions by scenario. Incremental renewable energy costs are used to invest in a scenario-specific resource mix.
- Costs incurred by Vermont's electricity sector are payments to the production sectors of the economy involved in the procurement of resources.
- Different resource types will use different (and different amounts of) industrial inputs; i.e., the resource mix will determine how investment costs are distributed throughout the economy.

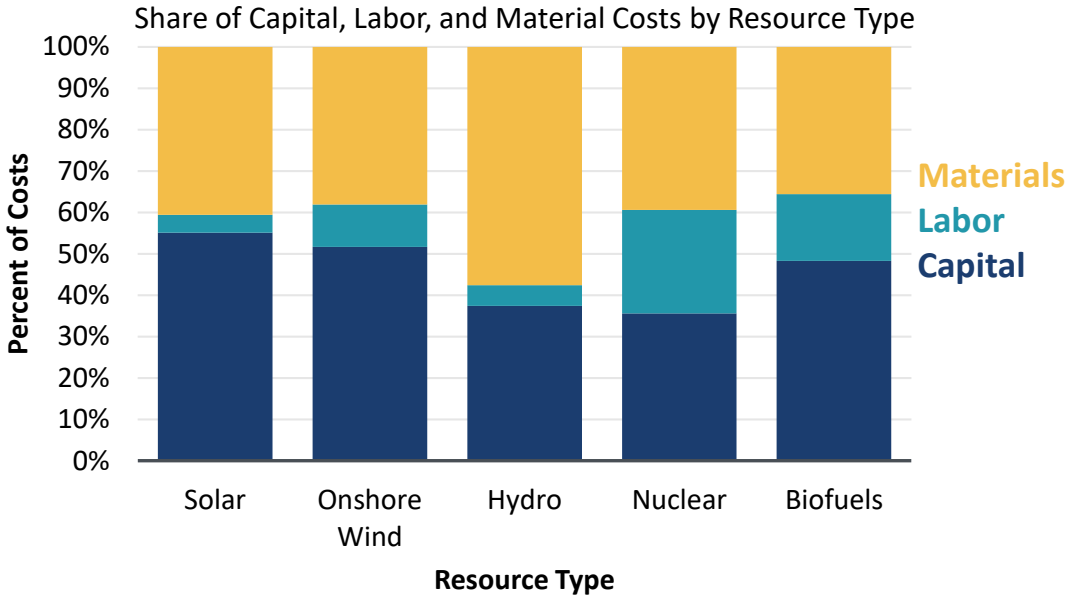




Translating New Resource Investment into Industrial Inputs

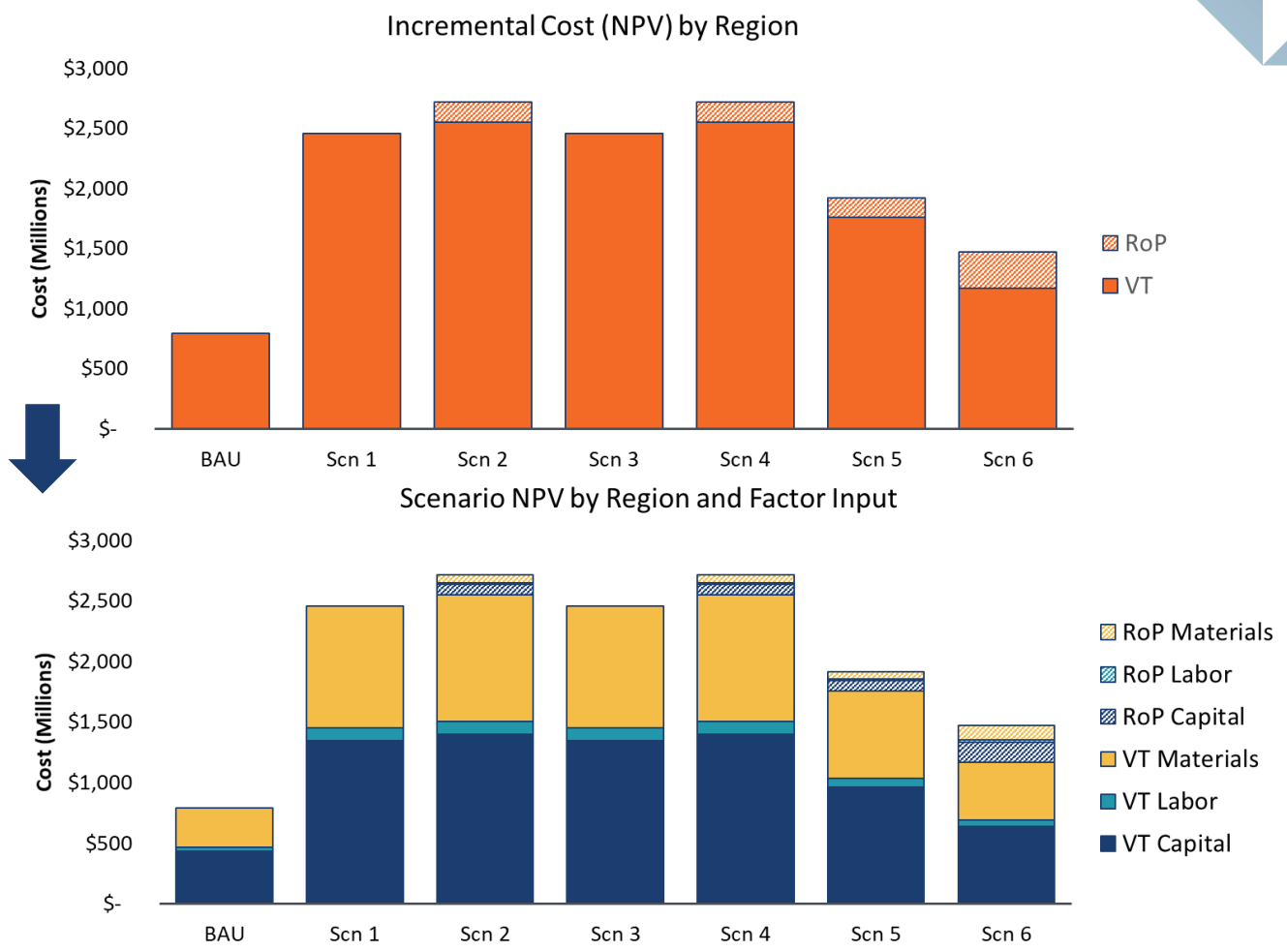
- Electricity generation technology cost data from the Energy Information Administration (EIA), International Energy Agency (IEA) and the National Renewable Energy Laboratory (NREL), are used to breakdown resource costs into economic factors of production.
- Factors include physical capital (e.g., computers), labor employment and intermediate input goods (materials). Intermediate goods refer to goods produced by other sectors.



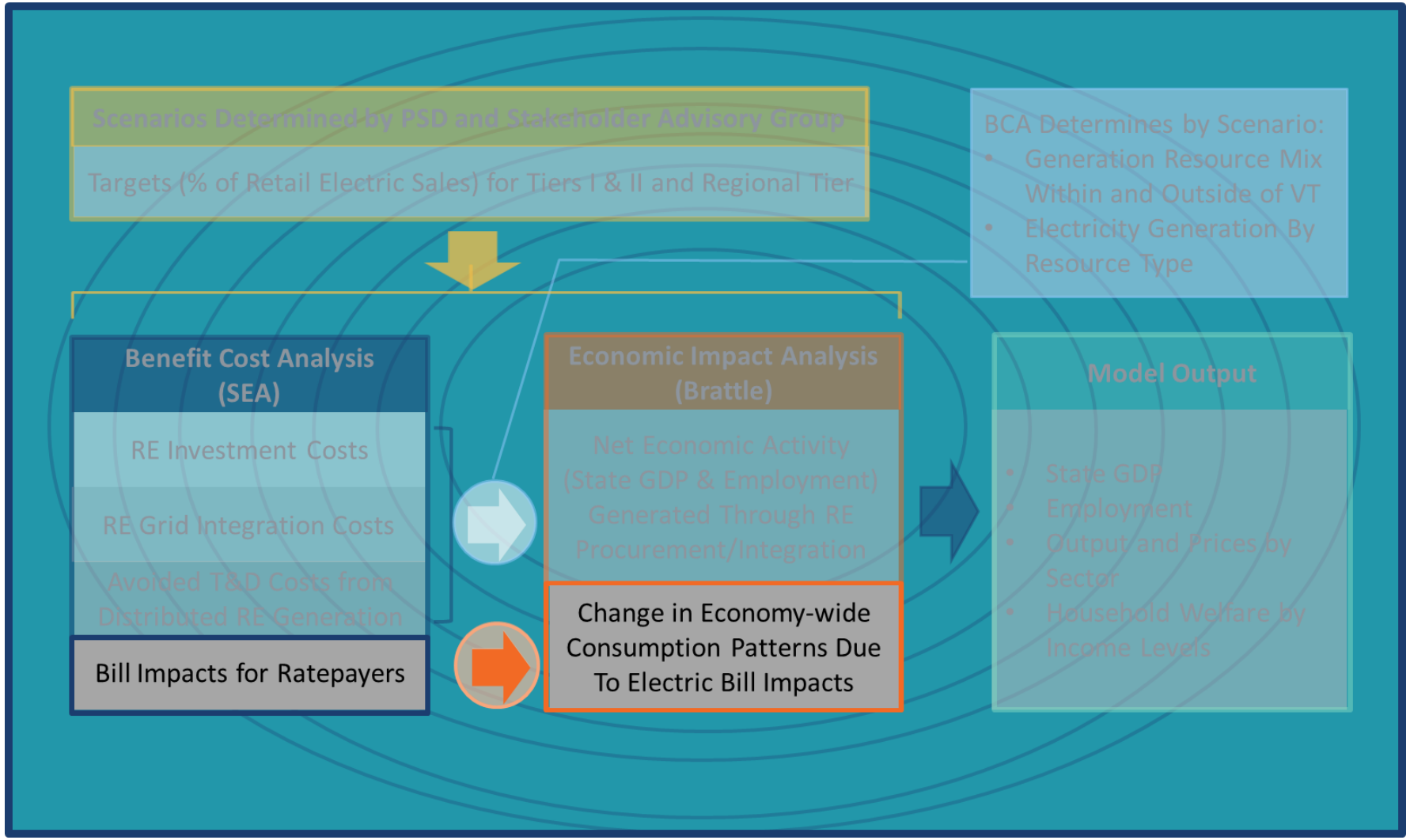


Translating RES Investment into Production Factors

- The result is each regional electricity sector's incremental factor use, which is obtained using:
  - Resource mix for each scenario
  - Geographic distribution of resources in Vermont and the rest of the pool
  - Resource cost breakdown into economic factors of production
- Procurement of renewable and clean energy resources in New England generates demand for other goods and services and creates price effects in the labor and capital markets.

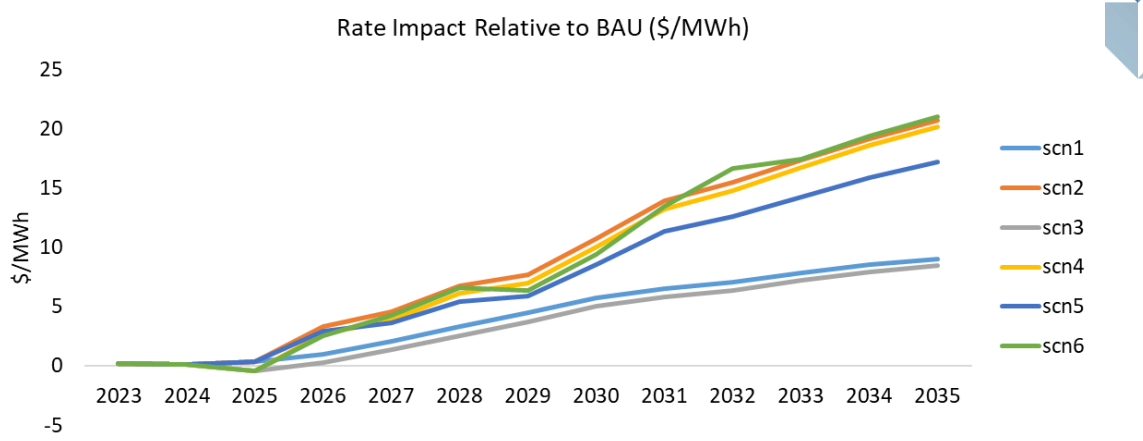


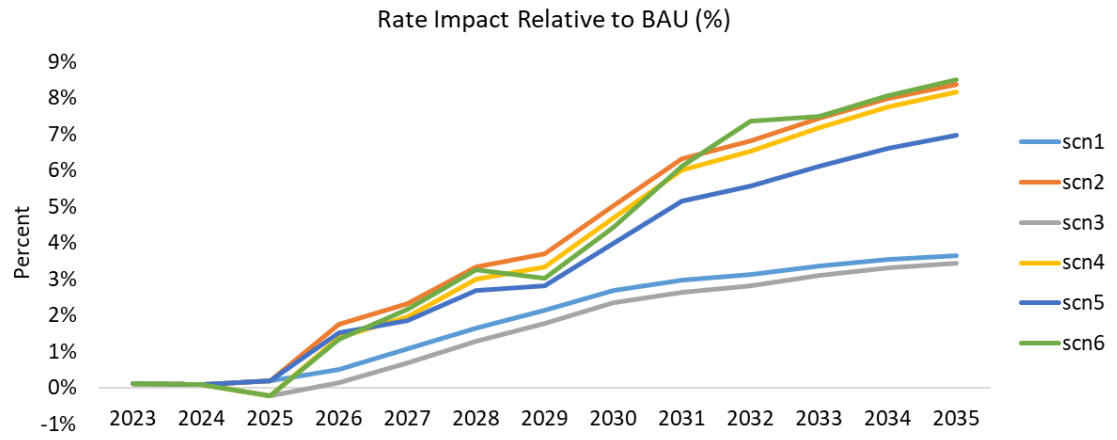
Rate Impacts



Rate Impacts by Scenario

- Rates are expressed as change from the BAU scenario. Rates account for both incremental costs and benefits that would impact bills.
- BCA shows that rate impact increases as RES target increases.
- Scenario 6 has the highest rate impact in 2035. Rate increase relative to BAU reaches approximately 8.5% by 2035.
- All else equal, increased rates translate to less disposable income for ratepayers:
  - Less income for non-electricity goods can lead to decreased demand for those goods
  - Less budget for non-electricity inputs can induce less production in production sectors.





BCA Perspective Used in Calculating Net Costs

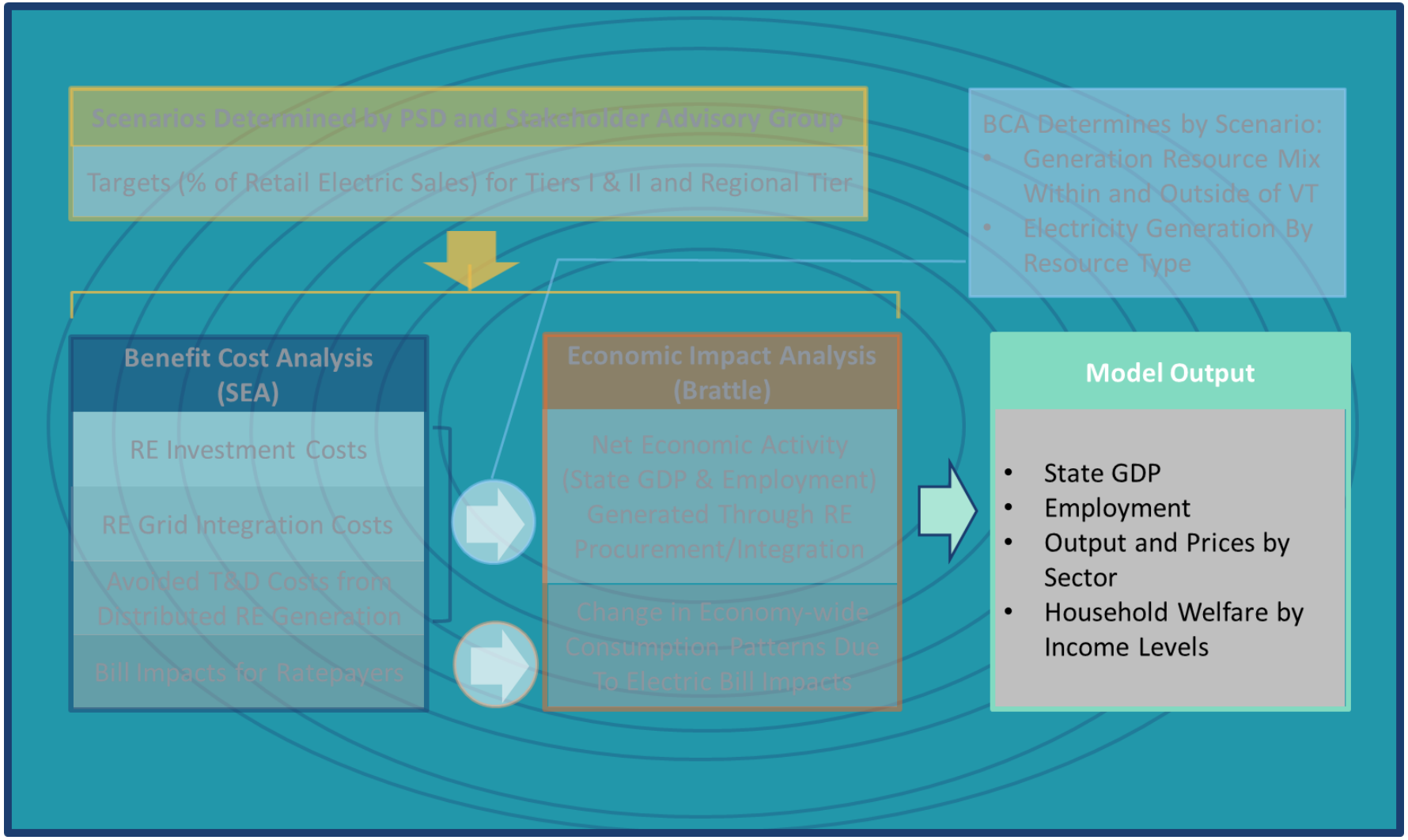
SEA outputs BCA results based on two perspectives: Reference Case

- Societal Cost Test (SCT)
  - Includes all market costs and benefits
- Ratepayer Impact Measure (RIM)
  - Includes only costs and benefits that would affect Vermont electricity bills

Economic impact analysis (EIA) uses the RIM-based BCA results.

Value Stream	Societal Cost Test (SCT)	Ratepayer Impact Measure (RIM)
Incremental cost of resource	Cost	Cost
Transmission integration costs	Cost	Cost (VT only)
Intercxn distribution system upgrades	Benefit	Benefit
Uncleared capacity value	Benefit	Benefit (VT only)
Reduced share of capacity costs	N/A	Benefit
Price suppression	Benefit	Benefit (VT only)
Avoided transmission costs	Benefit	Benefit (VT only)
Reduced share of transmission costs	N/A	Benefit
Reduced distribution costs	Benefit	Benefit
Reduced transmission losses	Benefit	Benefit (VT only)
Reduced distribution losses	Benefit	Benefit
Improved generation reliability	Benefit	Benefit (VT only)
Non-embedded GHG emissions	Benefit	N/A
NOx emissions	Benefit	N/A
Local pollutants	Benefit	N/A
RE development land use	Cost (not monetized)	N/A
Fossil fuel water use	Benefit (not monetized)	N/A

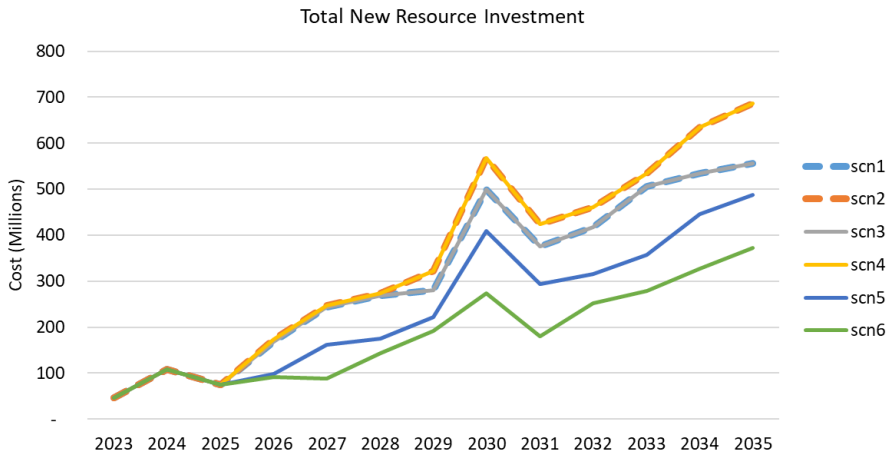
Economic Impacts

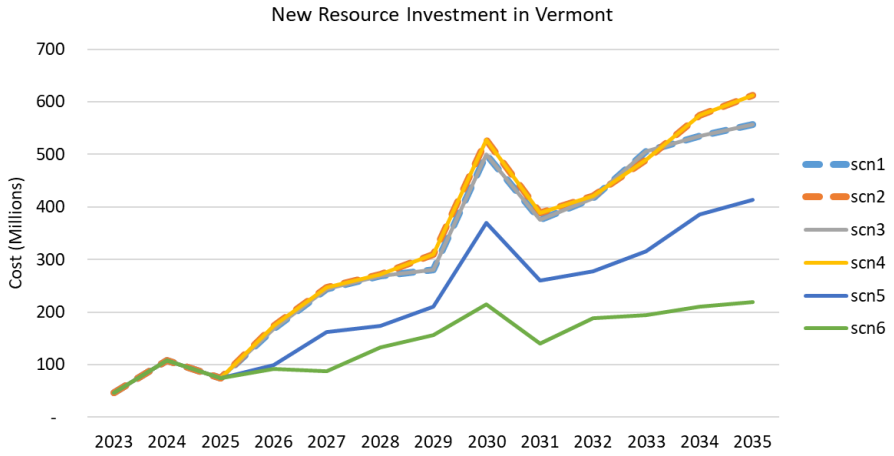


Key Drivers of Economic Impacts

Economic impacts in each scenario are driven by:

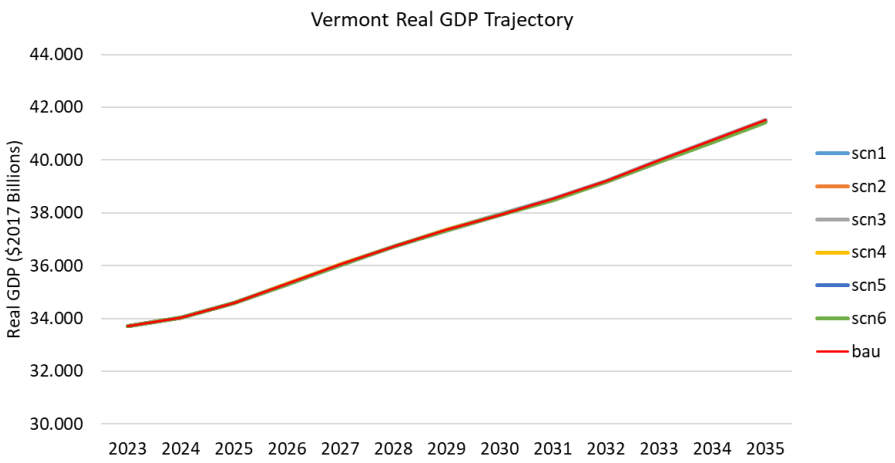
- **Total investment needs to meet Vermont's RES:**
  Total investment costs determine the efficiency in which the RES is satisfied. A more cost-efficient scenario means more production ending up as final consumption and less as industrial inputs used for electricity generation.
- **Amount of investment that takes place in Vermont:**
  Incremental resources built within Vermont create economic activity in non-electricity sectors. Production and employment in the transportation, energy-intensive manufacturing, and services sectors contribute to GDP.
- **Electricity rate changes:**
  Increase in rates results in less disposable income for consumers and producers to spend on non-electricity goods and services.

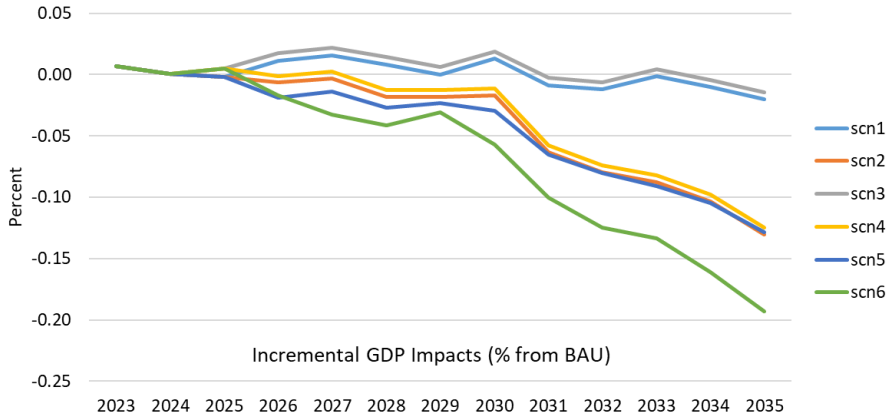




Economic Impacts: GDP Growth

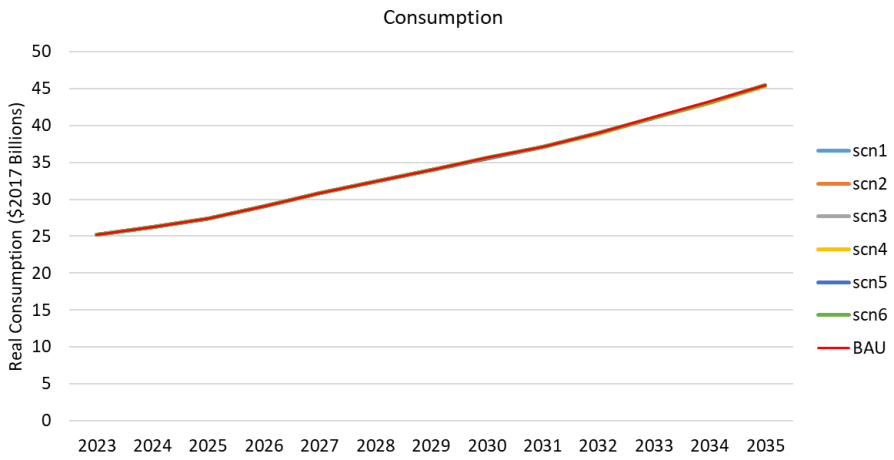
- GDP grows but at a *slightly* slower rate relative to BAU
- 100% RES (Scn1) and CES (Scn3) scenarios result in the highest GDP growth
  - High investment in new renewable resources in Vermont
  - Low rate changes
- 100% CES, No Biomass, Regional+T-II Combo scenario (Scn6) results in the lowest GDP growth
  - Low investment in new renewable resources in Vermont
  - High rate changes
- High VT investment levels and high rates offset each other in the 100% RES (Scn2) and CES (Scn4) scenarios
  - Produces similar GDP impact as in the 100% RES, No Biomass scenario (Scn5) characterized by medium rates and medium VT investment.

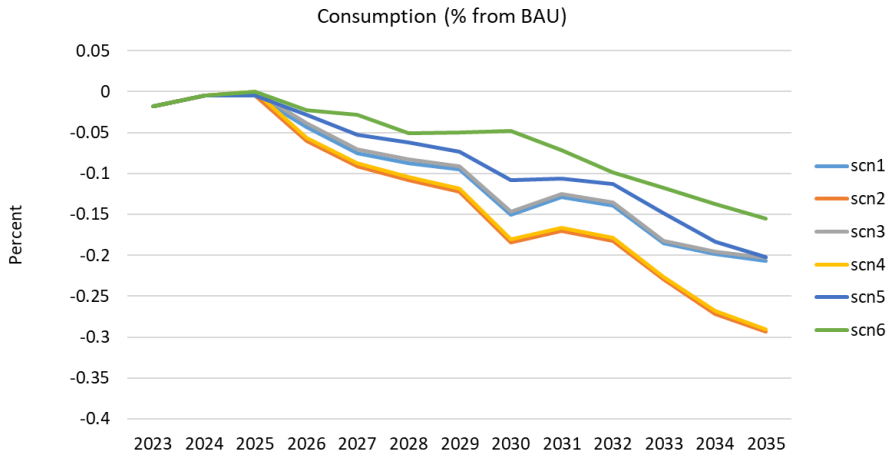




Economic Impacts: Consumption

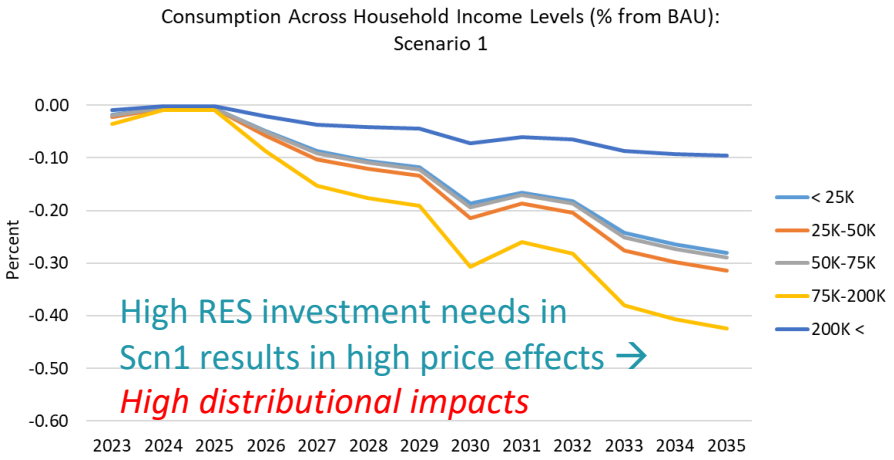
- Similar to GDP, consumption grows at a *slightly* slower rate relative to BAU.
- Consumption impacts are driven largely by the total investment needs to meet RES, and rate impacts.
- The 100% RES and CES w/ Regional Tier scenarios (Scn 2,4) have the slowest consumption growth since:
  - Increased production from high VT investment is consumed by the electricity sector to satisfy RES.
  - Higher demand for industrial inputs due to high-RES investment needs raises prices in non-electricity goods; e.g., services, energy-intensive manufacturing goods.
  - Coupled with higher rates, consumption decreases.
- Scenario 6 has the fastest growth due to low new investment needs. Scn 6 boosts GDP growth in RoP, also contributing to faster consumption growth.

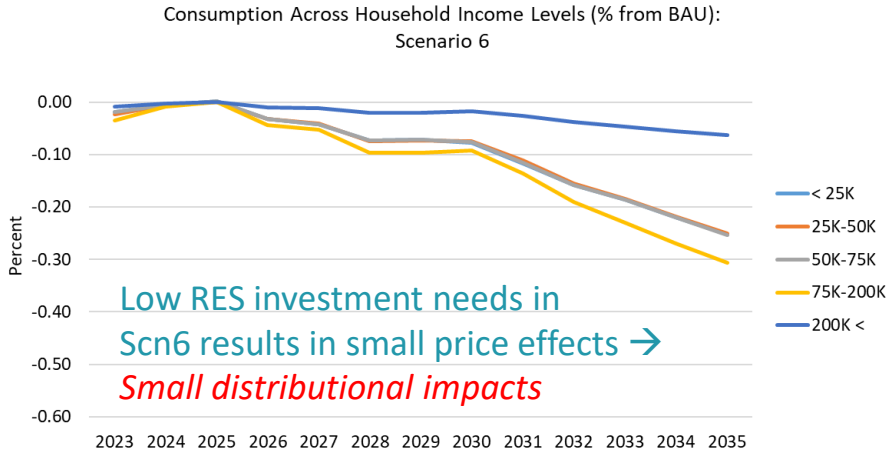




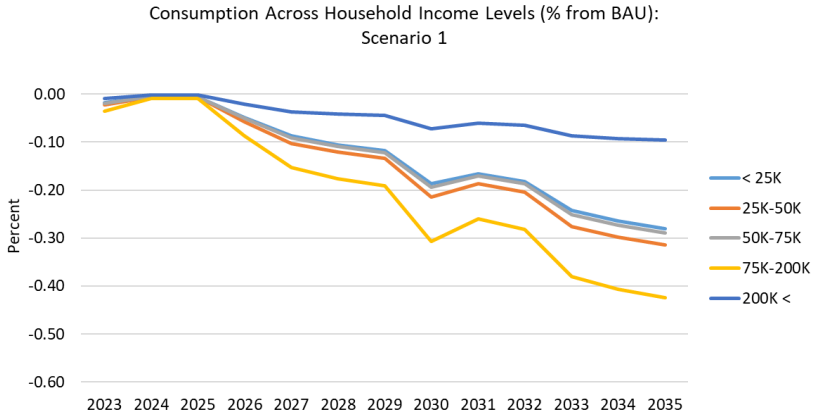
Economic Impacts: Consumption Across Income Levels

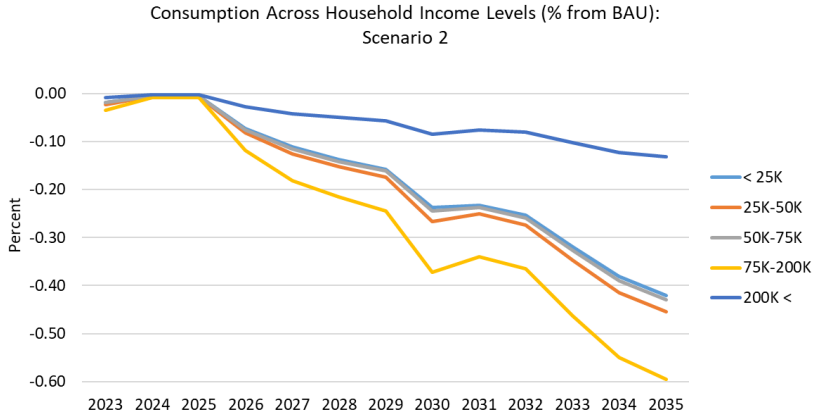
- Model uses input-data from the peer-reviewed work of the Wisconsin National Data Consortium (WiNDC).
  - Representative households by income group, used to characterize the economic behavior of an average consumer in their respective income levels, are modeled based on the Statistics of Income (SOI) data from the IRS.
- Consumption impacts across income groups are driven by the income share spent on consumption goods.
  - Lowest income households spend highest share of income on electricity.
  - But all income groups spend far more on services and energy-intensive manufacturing goods, goods that experience the highest price increase due to RES.
  - Among the sub-200K income groups, 75K-200K income group spends the most on these goods.

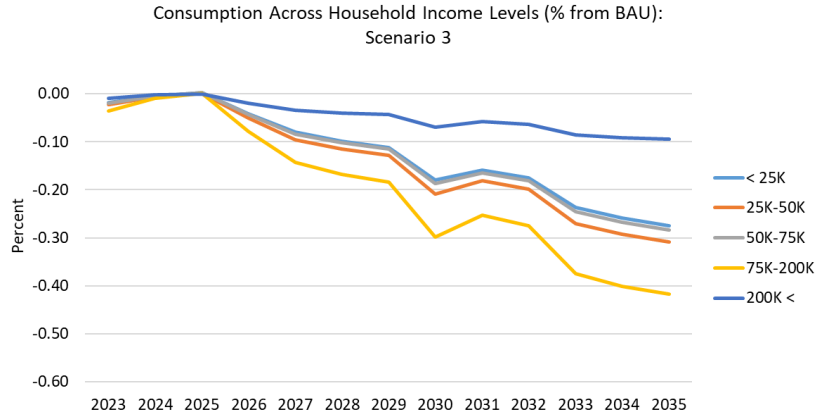


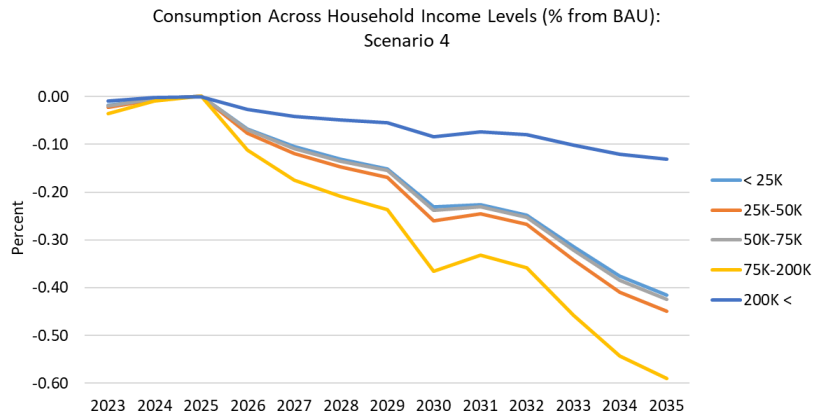


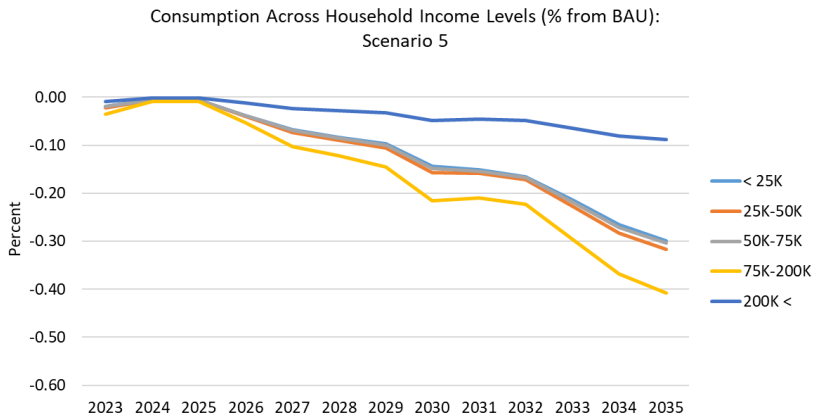
Economic Impacts: Consumption Across Income Levels

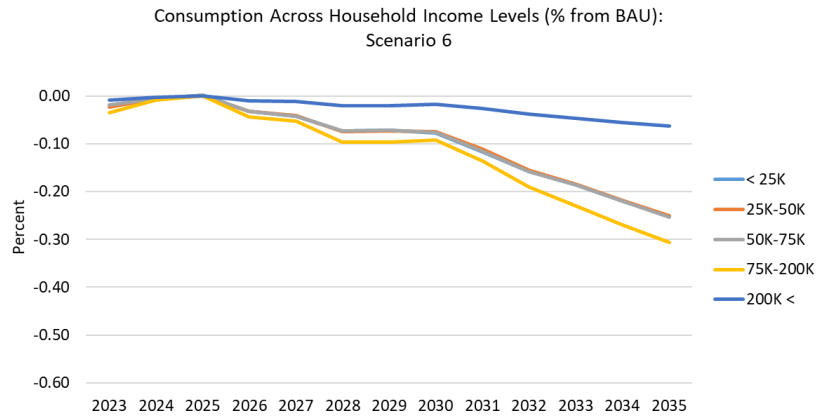






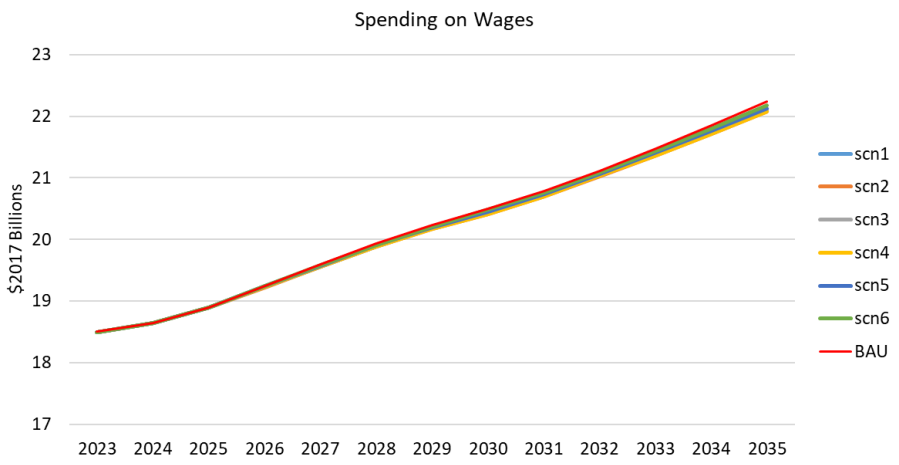


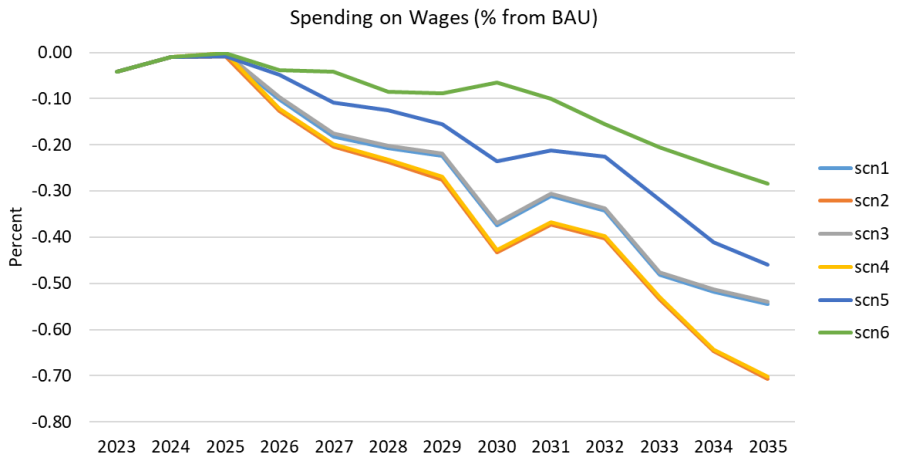




Economic Impacts: Employment

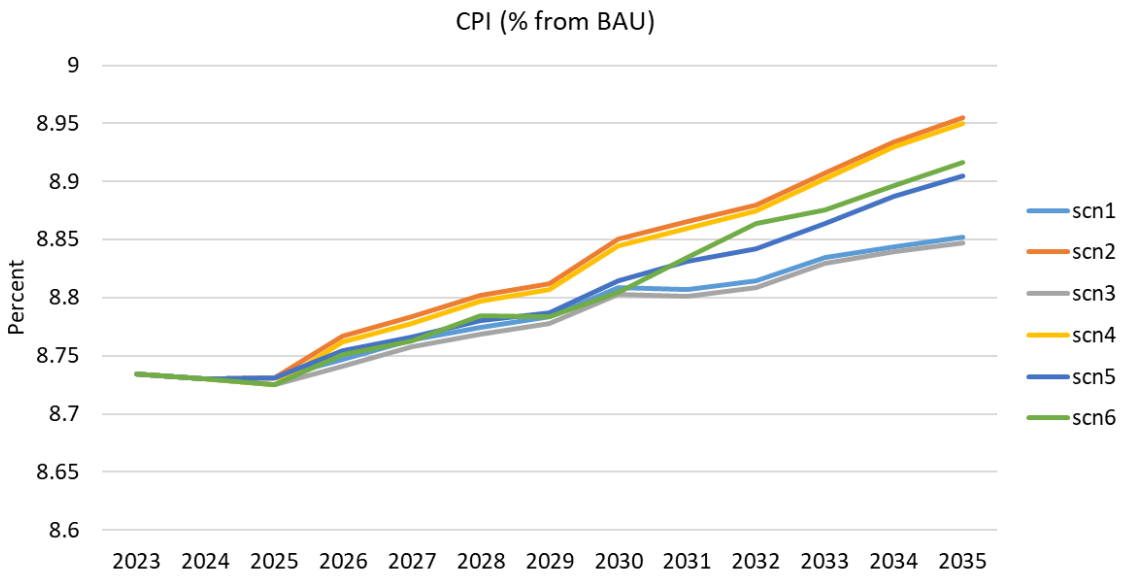
- Similar to GDP and consumption, spending on wages grows at a *slightly* slower rate relative to BAU.
- Employment follows a similar trajectory to consumption as both are driven largely by the total investment needed to meet Vermont's RES.
- Low RES investment needs means less employment needed to build and operate new facilities to satisfy RES. This contributes to higher marginal productivity of labor; i.e., higher wages.
- Faster growth in scenario 6 is attributed to the lower total resource builds.
  - Scenario 6 also has highest investment in RoP, contributing to an increase in GDP for the rest of New England, and hence employment in Vermont.





Economic Impacts: Consumer Price Index (CPI) in Vermont

- Similar to consumption, growth in the Consumer Price Index (CPI) is largely driven by total investment needs to meet RES, and rate impacts.
- The 100% RES and CES scenarios w/ Regional Tier (Scn 2,4) result in the highest increase in the CPI due to high rate impacts and high-investment needs.
  - High-investment needs create competition for resources in the economy, raising their prices.
- The 100% RES and CES scenarios (Scn 1,3) result in the lowest CPI increase due to low rate impacts.



Economic Impacts: Tax Revenue

- Sector output, the use of production inputs (capital, labor, goods produced by other sectors) and final consumption by households, are taxed.
- Scenarios 1-4 (Combination of 100% RES and CES w/ and w/out Regional Tier) have high new resource investment in Vermont, leading to higher production levels in parts of Vermont's economy. This leads to higher tax revenue than in the BAU.
- Scenario 6 has the least amount of investment in Vermont, leading to low tax revenue from production. High rates also slow the economy down, contributing to lower tax revenue that BAU.