April 16, 2020

VERMONT PUBLIC SERVICE DEPARTMENT

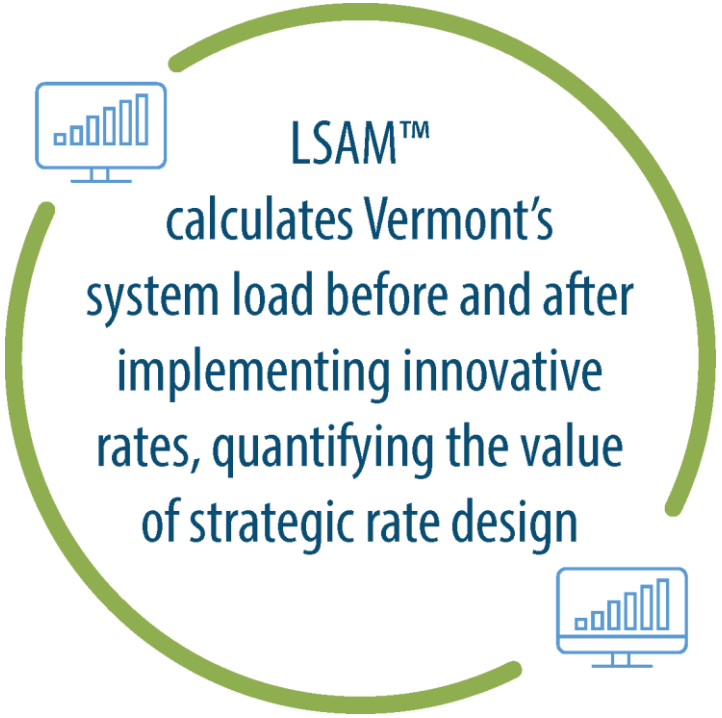
RATE DESIGN INITIATIVE / DISTRIBUTED ENERGY RESOURCES STUDY
STAKEHOLDER ENGAGEMENT MEETING #3

NewGen Strategies & Solutions

VERMONT RATE DESIGN INITIATIVE

LSAM™ AND THE VT RATE DESIGN INITIATIVE

- LSAM™ allows iteration of input assumptions to evaluate a multitude of future states of the electric market in Vermont
  - Future electric usage will vary vis-à-vis market forces, decarbonization, and technology adoption
- LSAM™ allows the user to manage system peaks through
  - Electric rates to send price signals to manage load
    - Static and dynamic rate design
    - Behavioral change, technology adoption, or both
  - Directly manage load through flex capacity
  - Controllable flex load “calls”, timing and duration



VERMONT RATE DESIGN INITIATIVE

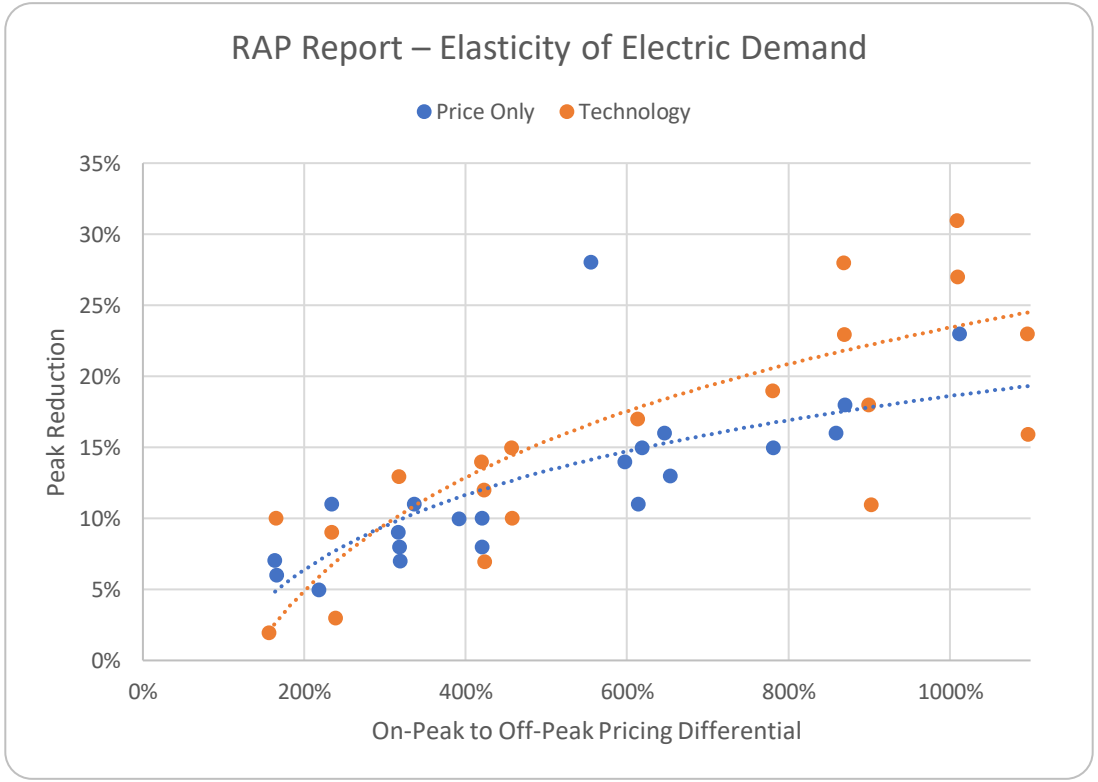
LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

- Updated demand elasticity
- Carbon accounting refinement
- “Dynamic” rate design
- Increased detail on Utility Cost Key Performance Indicators (KPIs)
- Increased model functionality from stakeholder feedback

VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

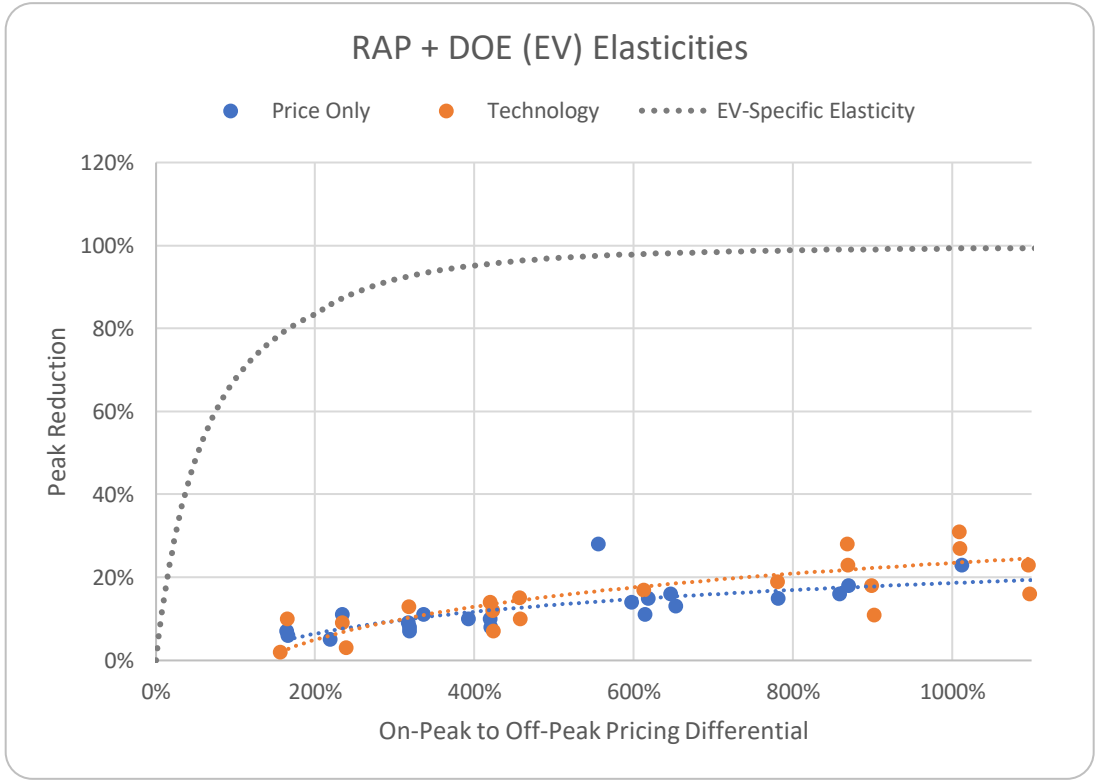
- Updated demand elasticity
  - RAP/Brattle survey of Critical Peak Pricing (CPP) / Time-of-Use (TOU) program elasticity for non-electric vehicle (EV) loads



VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

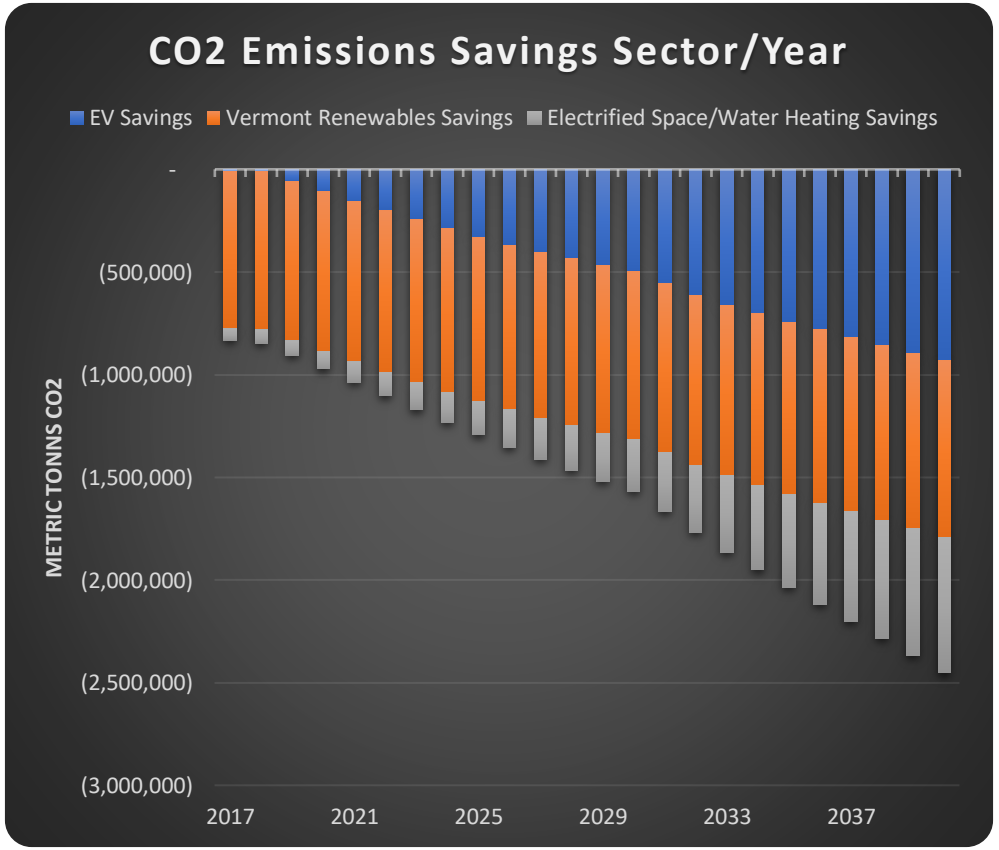
- Updated demand elasticity
  - RAP/Brattle survey of Critical Peak Pricing (CPP) / Time-of-Use (TOU) program elasticity for non-electric vehicle (EV) loads
  - EV short-run elasticity is assumed to be substantially greater, per Department of Energy (DOE) EV Project



VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

- Carbon accounting refinement
  - Feedback from EAN Vermont
  - Increased detail on accounting for current space / water heating fuel portfolio
    - Feedback from Biomass Energy Resource Center (BERC)



VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

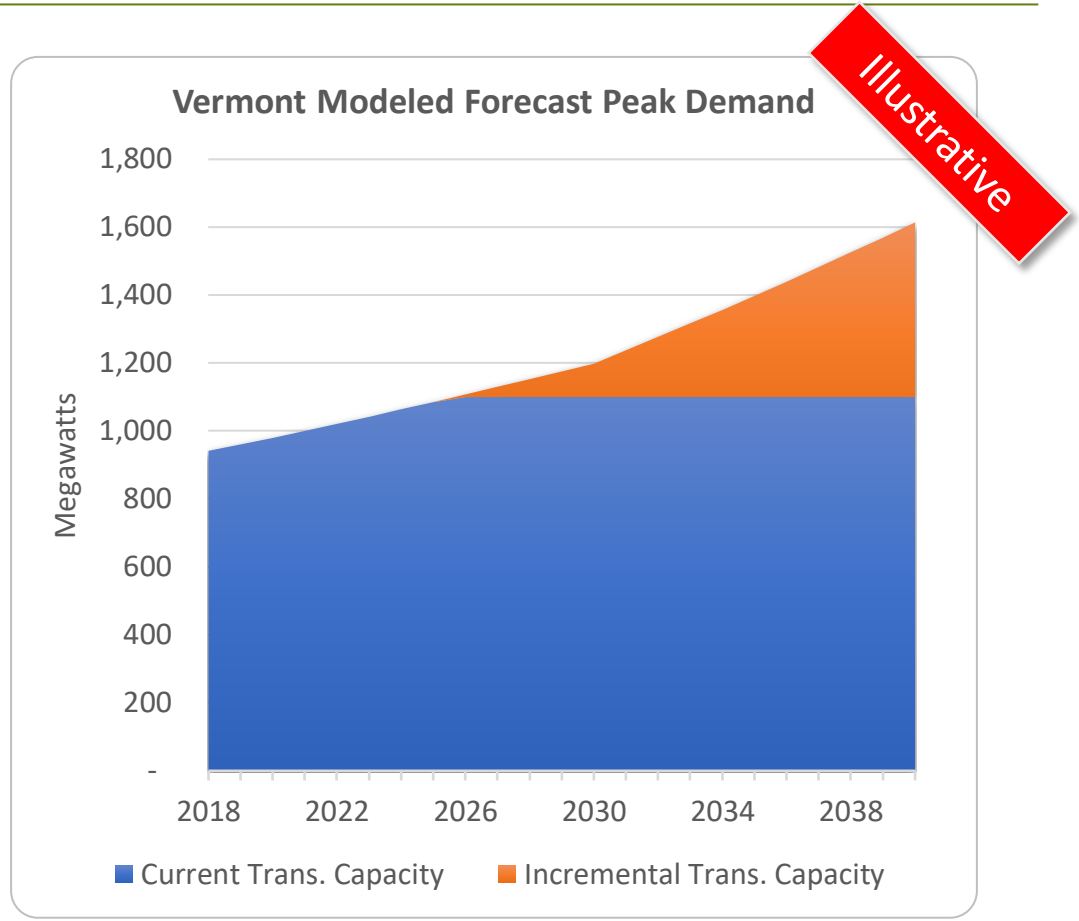
- Dynamic rate design
  - Critical Peak Pricing (CPP)
    - Regional Network Service (RNS) annual capacity costs moved into an energy rate to be "called" by the model user up to 60 times in a modeled year
  - Real-Time Pricing
    - Passes-through 2018 actual ISO-NE hourly Day-Ahead energy charges to the customer
- Rate design is separated for EV and non-EV load

Rate Design Policy		Rate Design Policy Options		
Non-EV Rate Strategy	Current	Current	Static/TOU	RTP
EV Rate Strategy	Static/TOU	Current	Static/TOU	
Critical Peak Pricing	On	On	Off	

VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

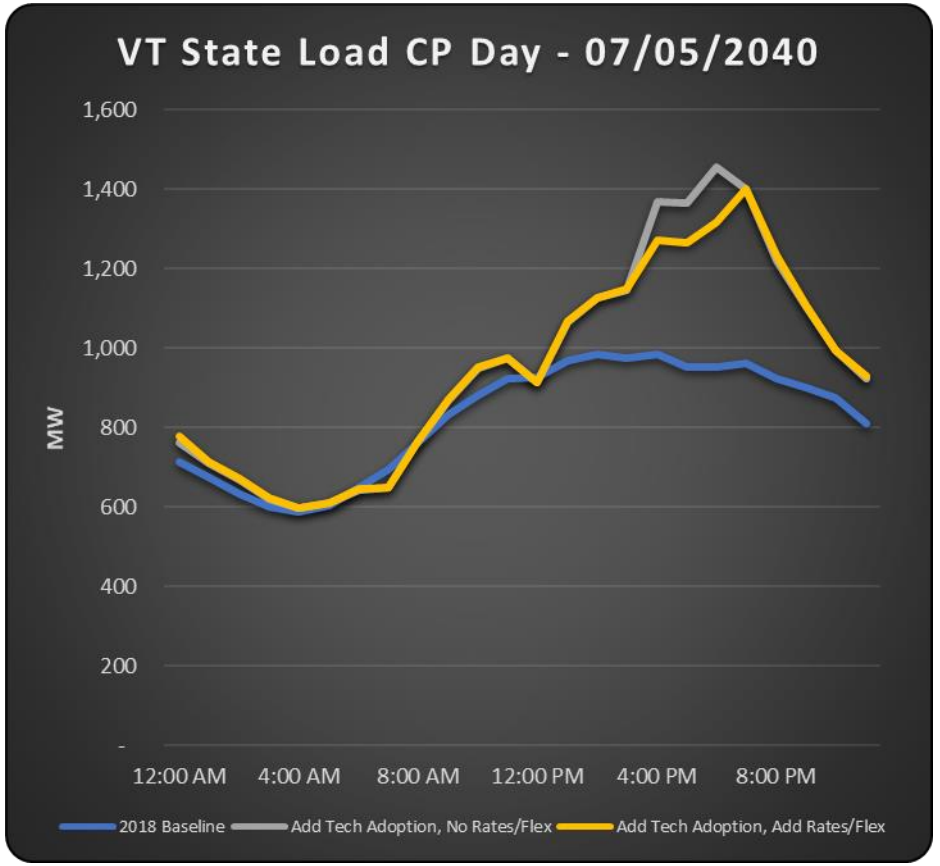
- Increased detail on Utility Cost KPIs
  - RNS-Related Bulk Transmission Costs
    - Embedded costs – current RNS rate forecast from Vermont Department of Public Service (PSD)
    - Marginal costs – for incremental system peaks above 1,100 MW
      - VELCO providing feedback on $/MW of new capacity above embedded costs / RNS rate
  - Incremental Distribution Capacity Costs
    - Feedback from GMP and VEC on costs of substantial new load on distribution system



VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

- Increased model functionality from stakeholder feedback
  - New inputs
    - New rate implementation assumptions: % of customers participating in new rate
    - Discrete EV adoption inputs, % of vehicles that are EV in 2030 and 2040
    - Discrete electric combined cooling, heat and power (CCHP) and heat pump hot water inputs (kWh/yr and % adoption)
- Incremental impacts of rates / flex load:
  - 2018 baseline
  - Including Tech but no rates / flex load
  - Including Tech but with rates / flex load



VERMONT RATE DESIGN INITIATIVE – WORKSHOP 3

- Introduction
- Panel Discussion 1
  - Policymaking and planning in the context of VT electric market evolution
- NewGen presentation on LSAM™ modeling and innovative rate design
- Panel Discussion 2
  - Implementation challenges of electric rate innovation

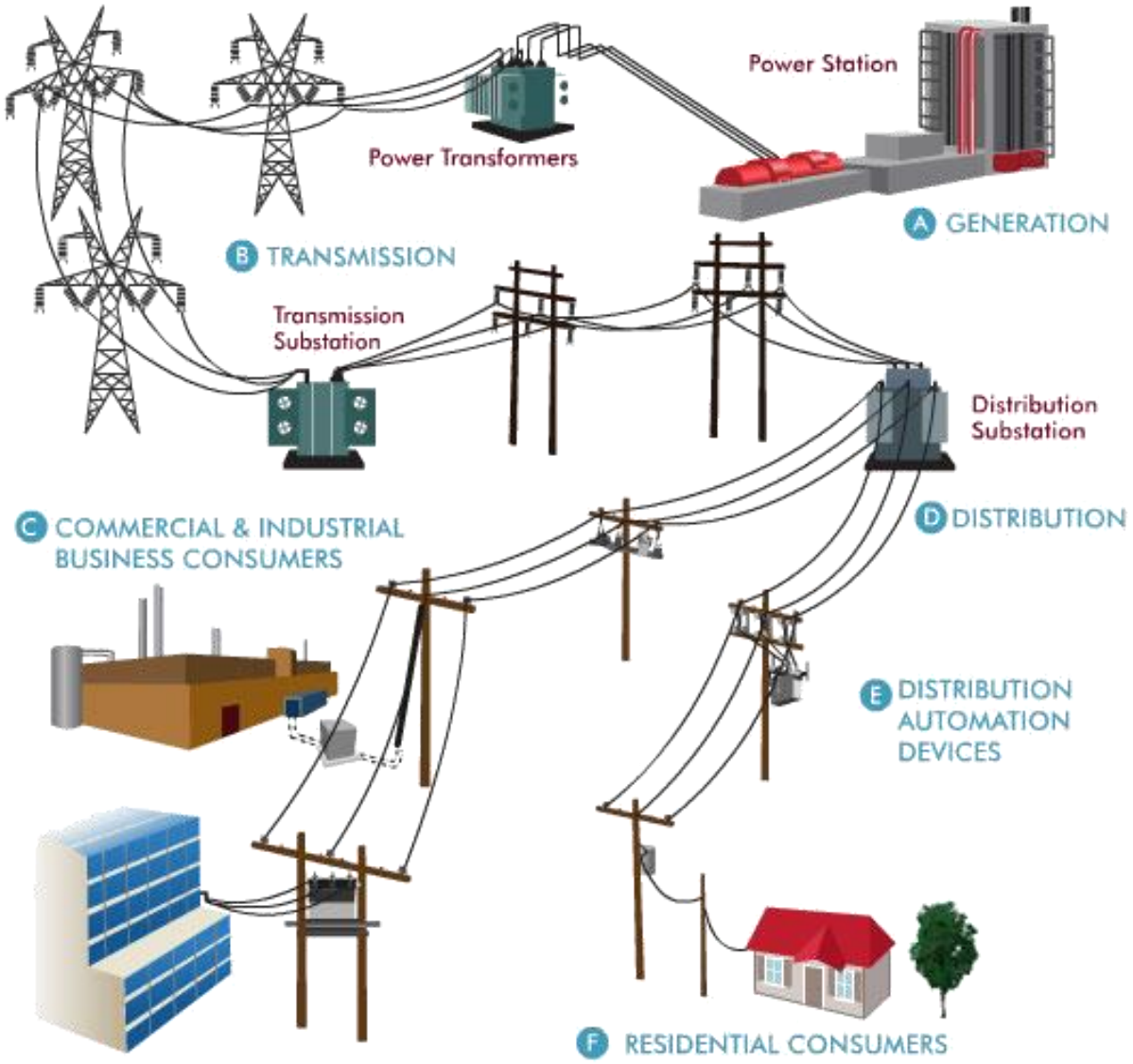
PANEL DISCUSSION 1

UTILITY PLANNING FOR THE FUTURE AND THE STATE'S OBJECTIVES

DYNAMIC RATES AND FRAMEWORK FOR EVALUATING FUTURE OPTIONS

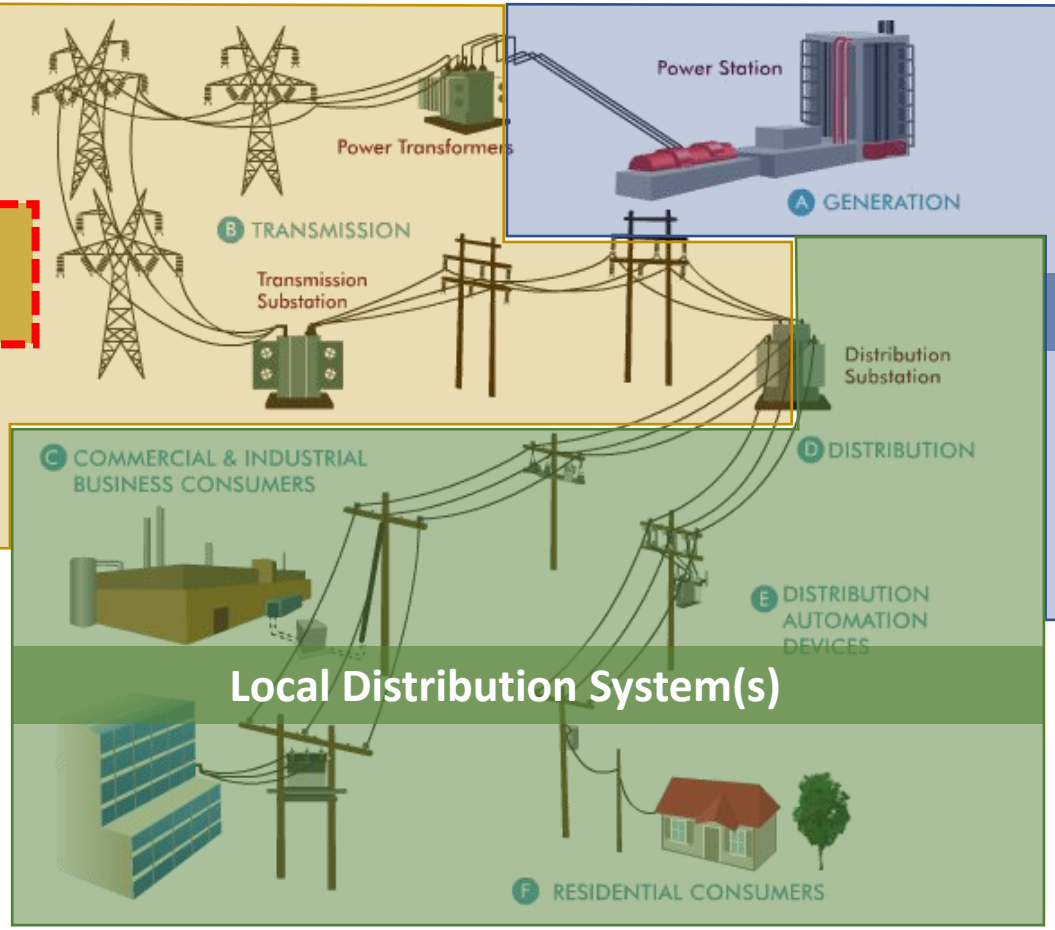
RATE DESIGN INITIATIVE / DISTRIBUTED ENERGY RESOURCES STUDY
STAKEHOLDER ENGAGEMENT MEETING #3

UTILITIES INCUR COSTS DIFFERENTLY BY UTILITY FUNCTION



OVERVIEW OF LSAM™ "UTILITY COST KPIS"

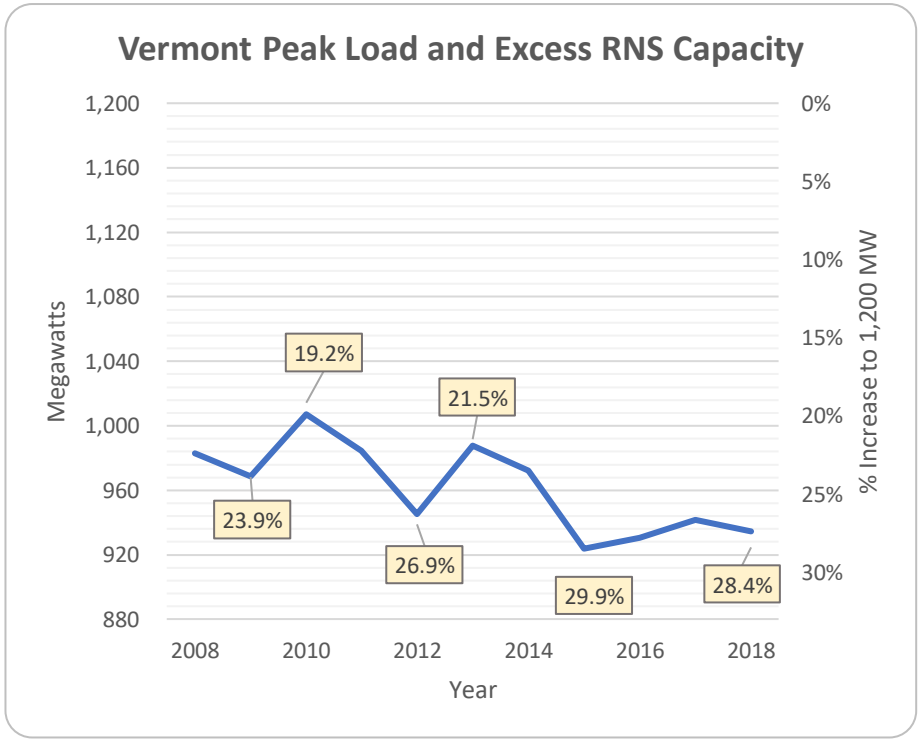
Bulk Transmission
Regional Network Service (RNS)



ISO-NE Power Supply Costs

REGIONAL NETWORK SERVICE (BULK TRANSMISSION)

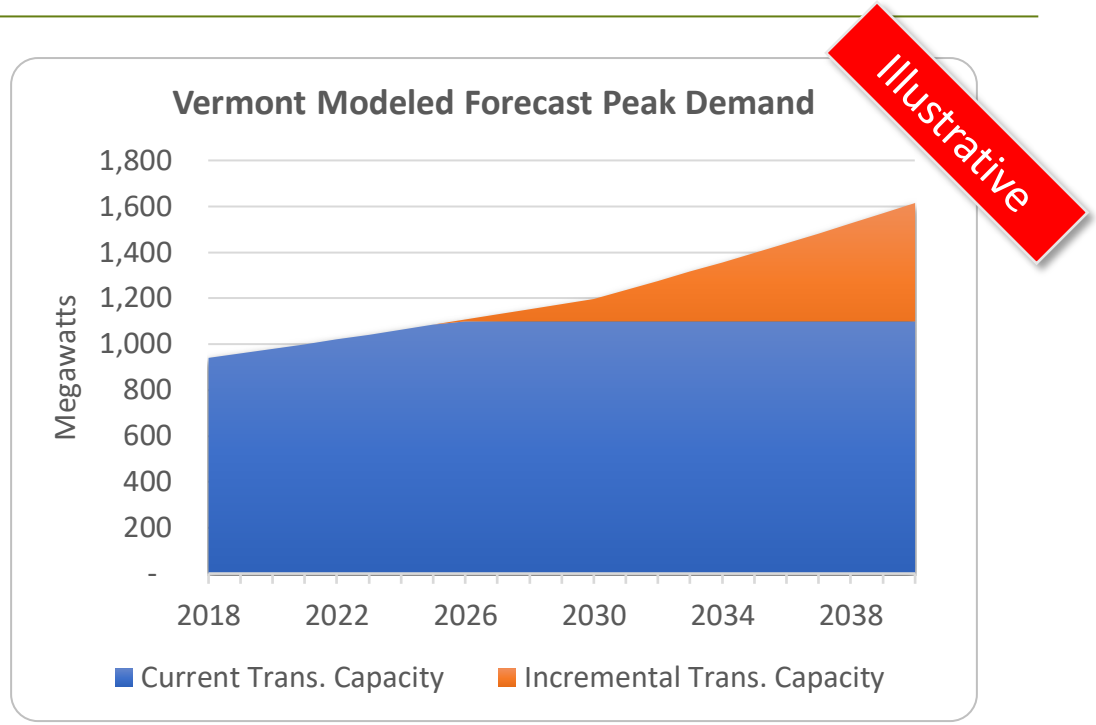
- Bulk Transmission is pooled in New England
  - Vermont is charged for average of state's aggregate peak load per month
- Future RNS costs depend on several factors:
  - Total transmission costs in pool
  - Regional transmission rate design
  - Vermont load



VELCO: Vermont's system can handle ~1,200 MW without new investment, but for long-term planning, new investment is needed in the 1,100-1,150 MW range

REGIONAL NETWORK SERVICE (BULK TRANSMISSION)

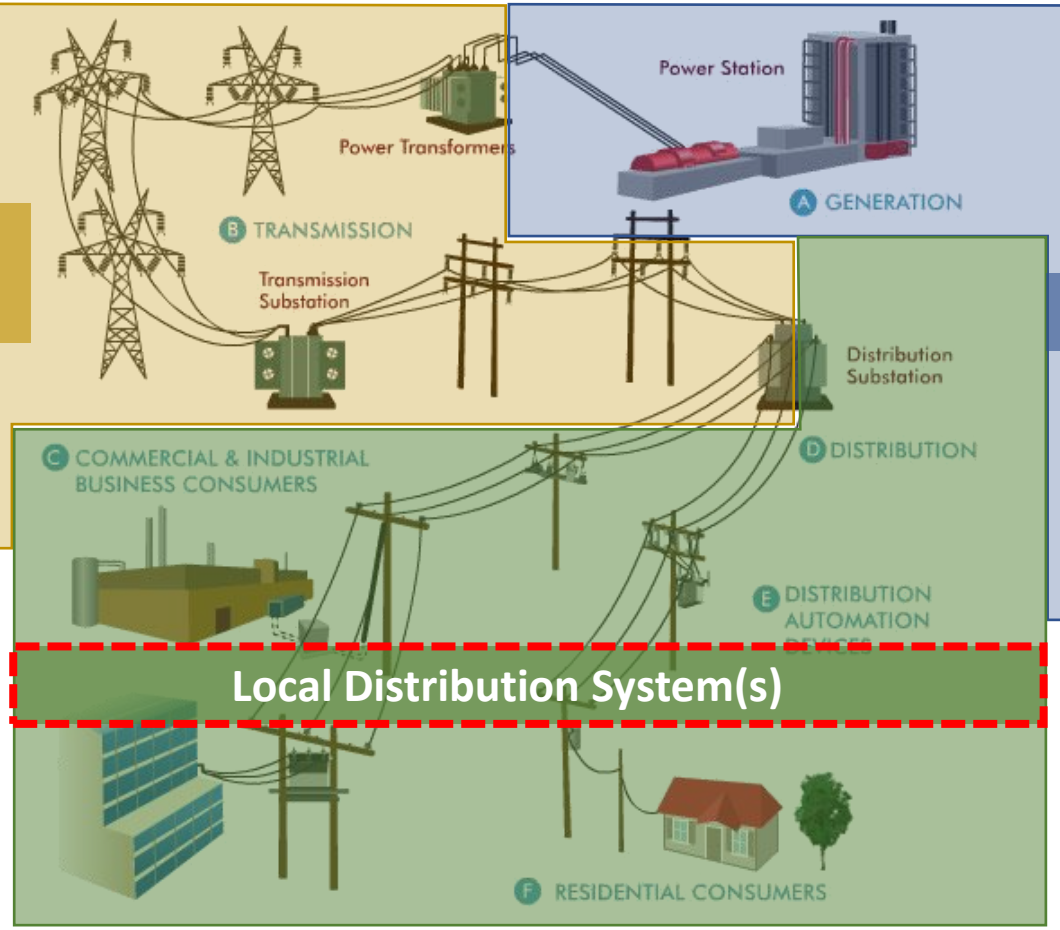
- For this study, we assume the regional transmission pool = Vermont
  - Capacity has headroom (~28%)
  - Transmission rate design remains constant
- Vermont load incurs transmission costs in two ways:
  - Load <1,100 MW billed forecast RNS rate
  - Load >1,100 MW billed incremental $/MW
    - Assumed $94/kW-year from updated screening tool values used for Efficiency Vermont, which was comparable to VELCO levelized cost



VELCO: Vermont's system is built for ~1,200 MW without new investment, but due to long-term nature of transmission planning, new transmission costs would begin in the 1,100-1,150 range

OVERVIEW OF LSAM™ "UTILITY COST KPIS"

Bulk Transmission
Regional Network Service (RNS)



ISO-NE Power Supply Costs

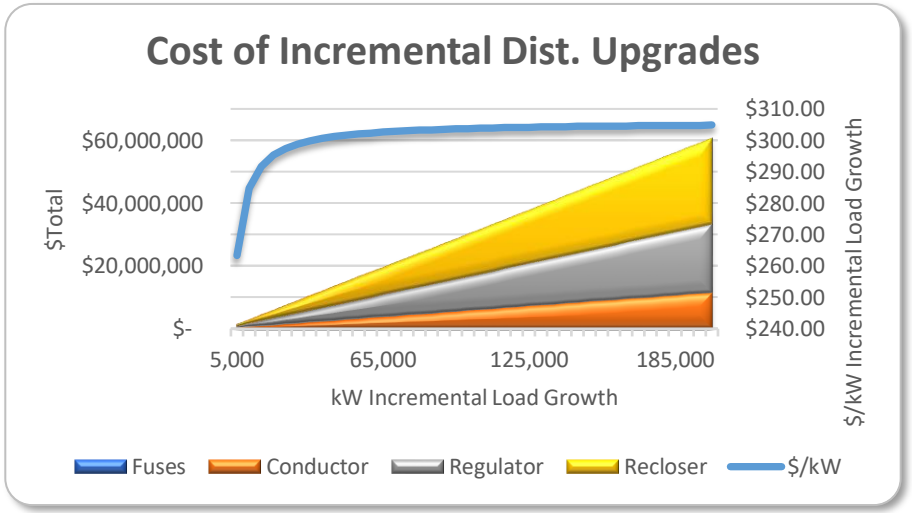
VERMONT RATE DESIGN INITIATIVE
LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

- Increased detail on incremental Distribution capacity costs
  - Feedback from GMP and VEC on costs of substantial new load on distribution system

GMP Data

Dist. Element	$/Overload
Fuses	$400
Conductor[1]	$9,470
Regulator	$130,000
Recloser	$50,000

1. Conductor is priced $200k/mi, with each overloaded conductor event equating to 250 ft. of conductor



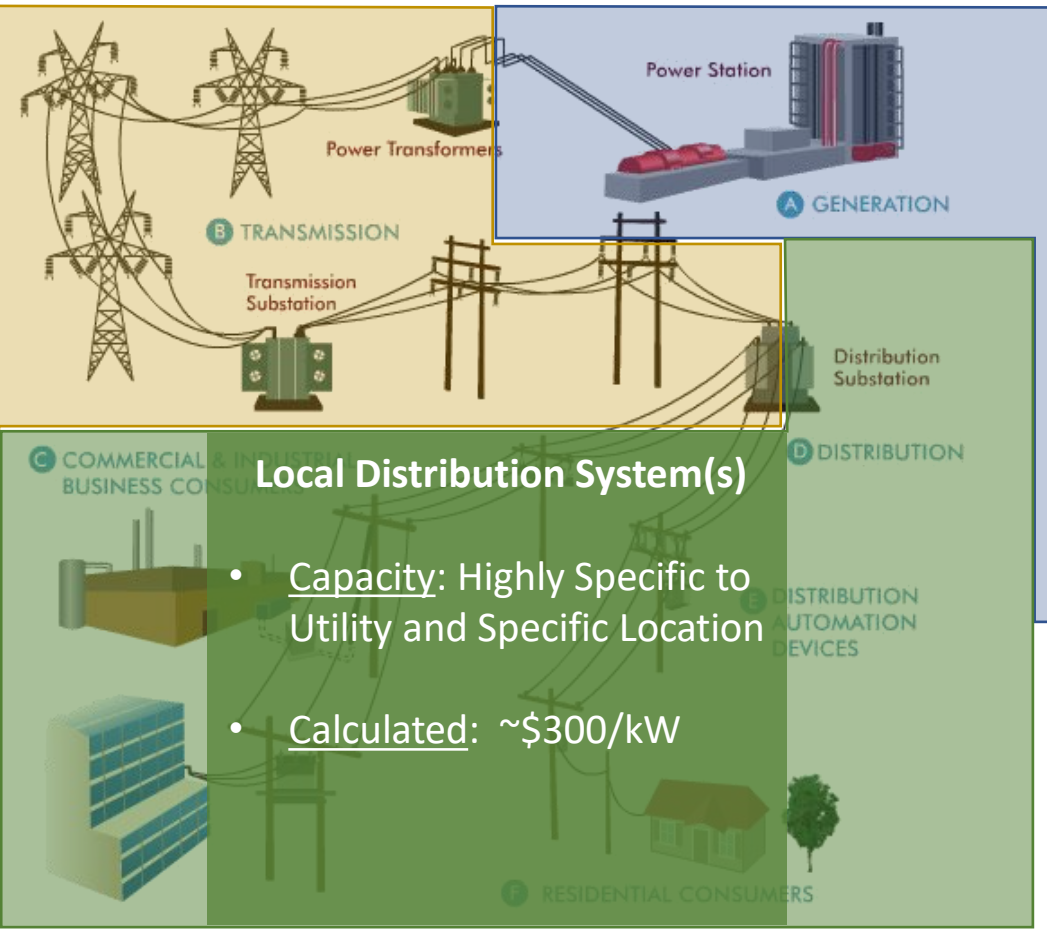
- Cost estimate currently under further review
- Cost does not currently include cost of upgrading nearly all poll transformers, currently <10 kVA
  - ~$1,400/transformer, ~1,000 transformers on 10 evaluated circuits

REFINED "UTILITY COST KPIS" FOR LSAM

Bulk Transmission
Regional Network Service (RNS)

- Embedded Capacity:
  ~$110-$200/kW-yr
  Avg. of 12 Monthly Peaks
- Incremental Capacity:
  $94/kW-yr >1,100 (2020)

Important Note:
LSAM Utility Cost KPIs do not make up the entirety of VT utilities' revenue requirements



Local Distribution System(s)

- Capacity: Highly Specific to Utility and Specific Location
- Calculated: ~$300/kW

ISO-NE Power Supply Costs

- Energy: ~$0.03-$0.07/kWh
  Depending on Timing
- RES Compliance: ~$1.50-$12.00/MWh over period
- Capacity: ~$6-$7/kWh
  During 1 ISO-NE CP Hour

CALCULATING "UTILITY COST KPIS" FOR LSAM

Component	Billing Determinants and Forecast Cost Basis
ISO-NE Capacity	VT Demand during ISO-NE CP Time x Forecast Forward Capacity Price
ISO-NE Energy	All Purchased Energy from ISO-NE x Forecast All-In Energy Rate
RES Compliance Costs	All Purchased Energy from ISO-NE x RES % x Forecast REC Price
RNS Capacity (Embedded Costs)	Average Total VT Monthly Peak Demand x Forecast RNS Capacity Rate
Incremental Bulk Transmission Cost	Incremental Annual Peak Demand (>1,100MW) x Incremental Trans. Cost
Incremental Distribution Cost	Incremental Annual Peak Demand (>2018 Baseline) x ~$300/kW + infl.

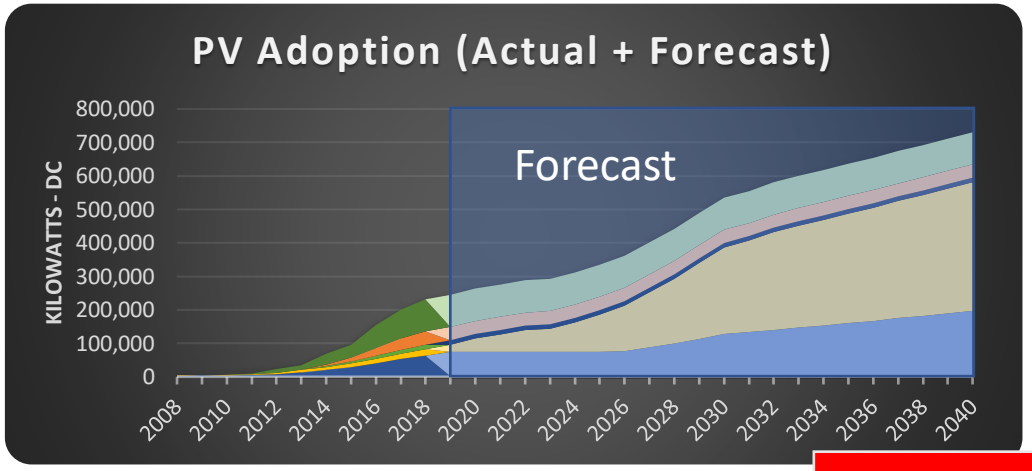
LSAM™ SCENARIO ANALYSIS – KEY ASSUMPTIONS/OUTPUTS

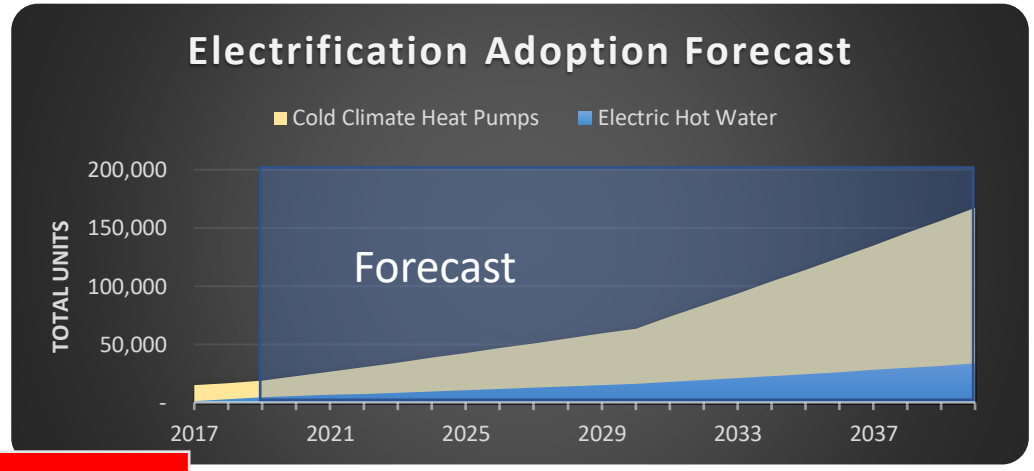
PROVIDED FOR ILLUSTRATIVE PURPOSES

PV Policy:

Offsetting onsite load credited at retail;

Excess generation credited at $0.09/kWh, trued-up hourly





Elec. Adoption:

CCHP: 20% by 2030

H2O: 5% by 2030

CCHP: 50% by 2040

H2O: 10% by 2040

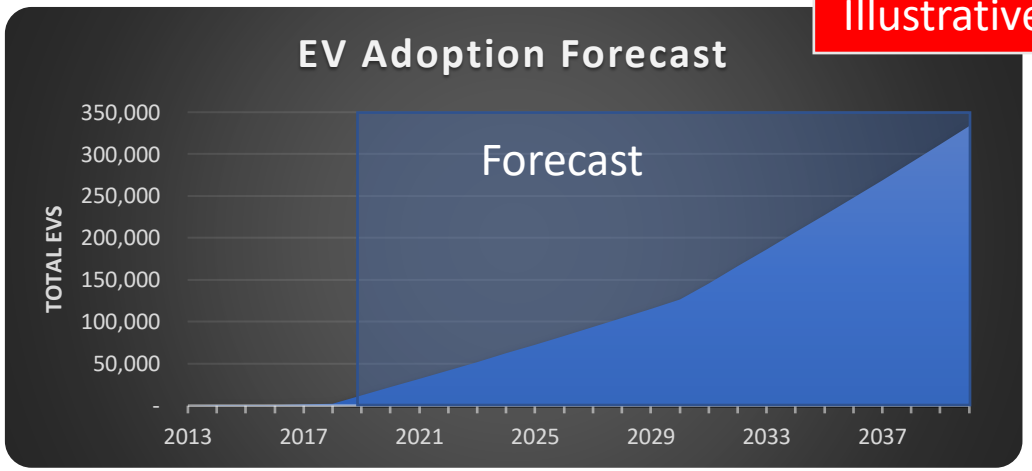
Illustrative Scenario

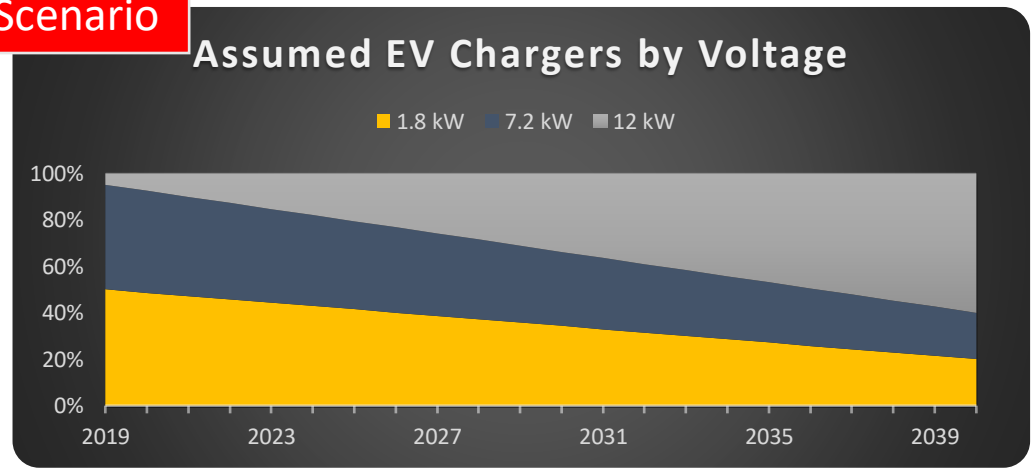
EV Adoption:

20% of all consumer vehicles by 2030

50% of all consumer vehicles by 2040

10% of vehicles have access to at-work charging



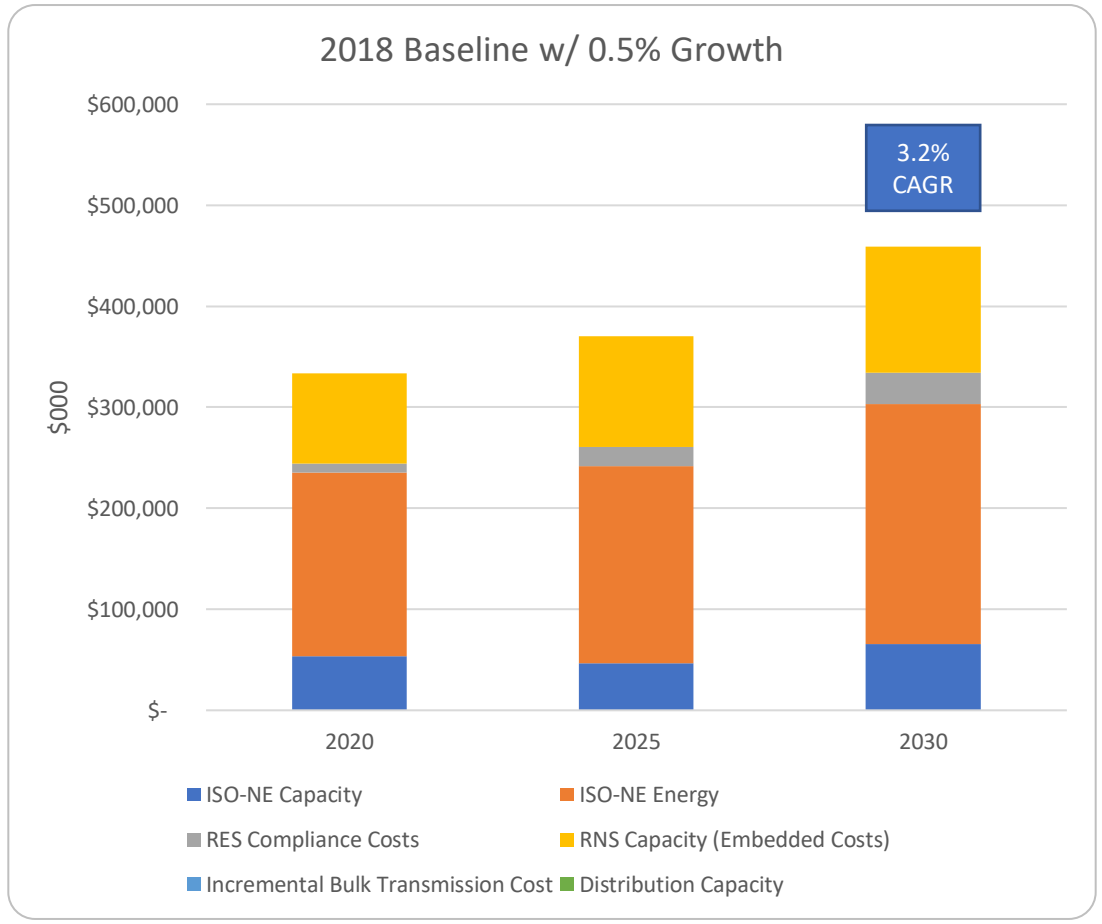


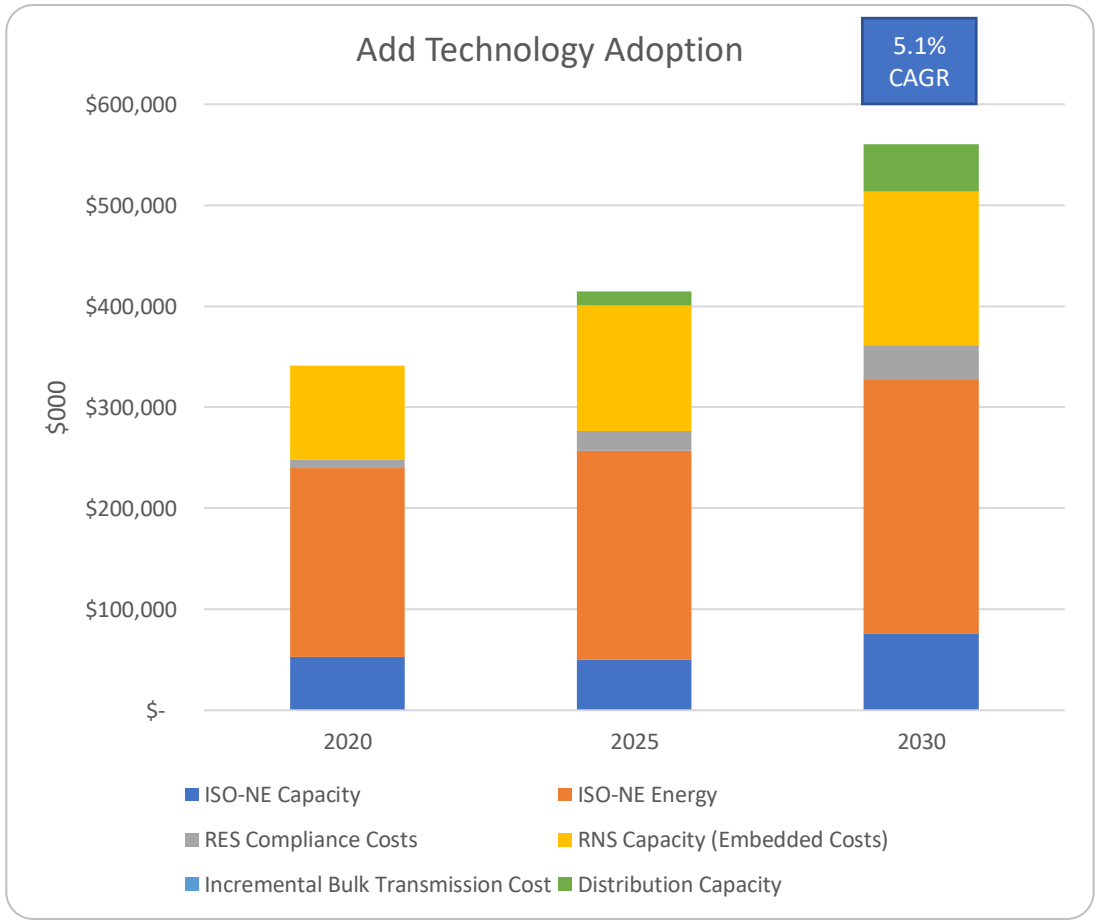
EV Charger Voltage:

Reasonable assumptions based on currently available models, assumed to increase in voltage over time

COMPARISON BETWEEN MODELED SCENARIOS

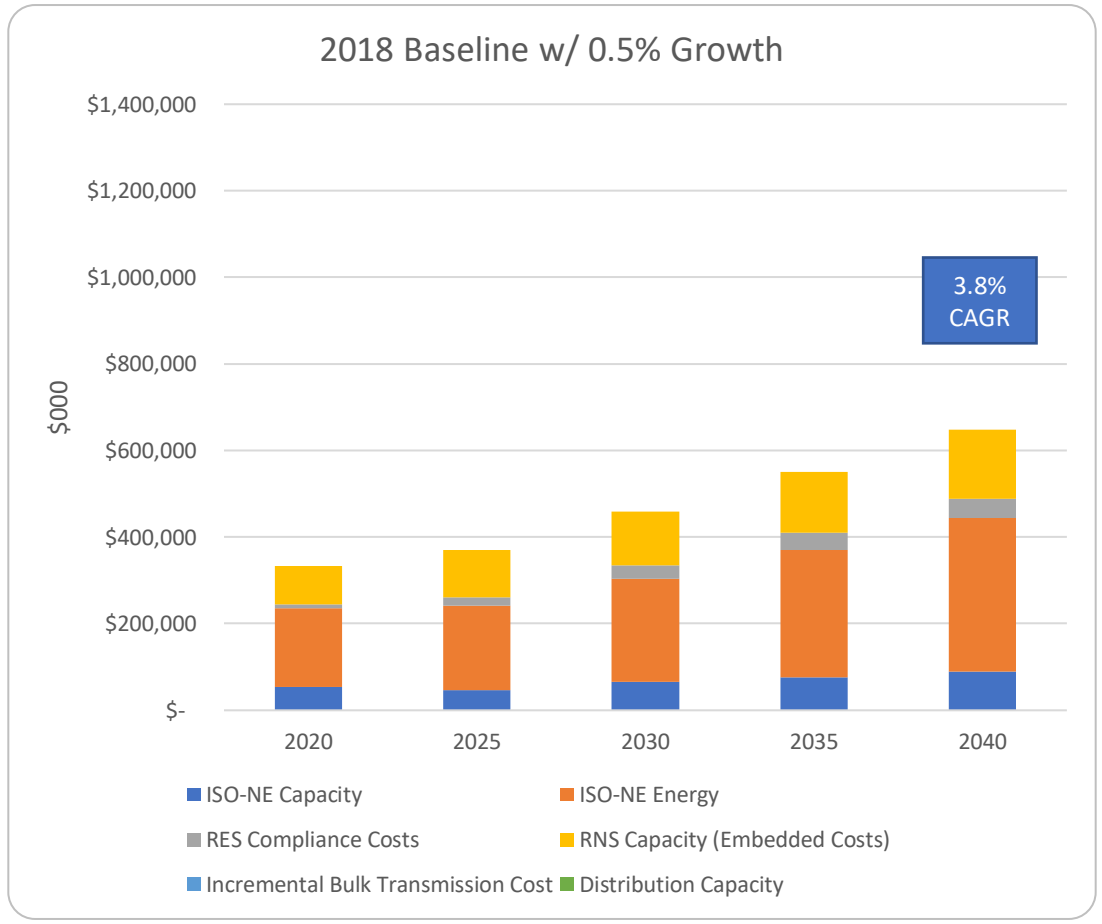
BASELINE VS. INCLUDING TECHNOLOGY ADOPTION - 2030

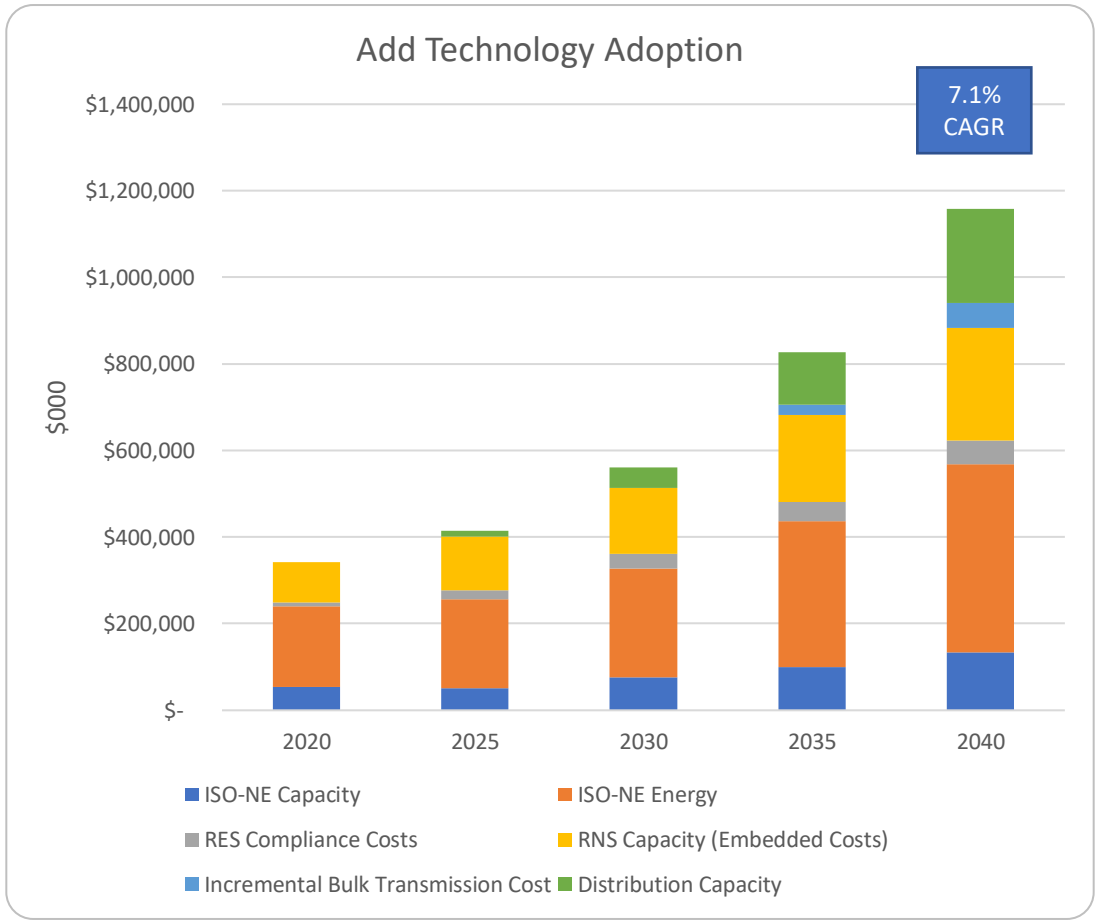




COMPARISON BETWEEN MODELED SCENARIOS

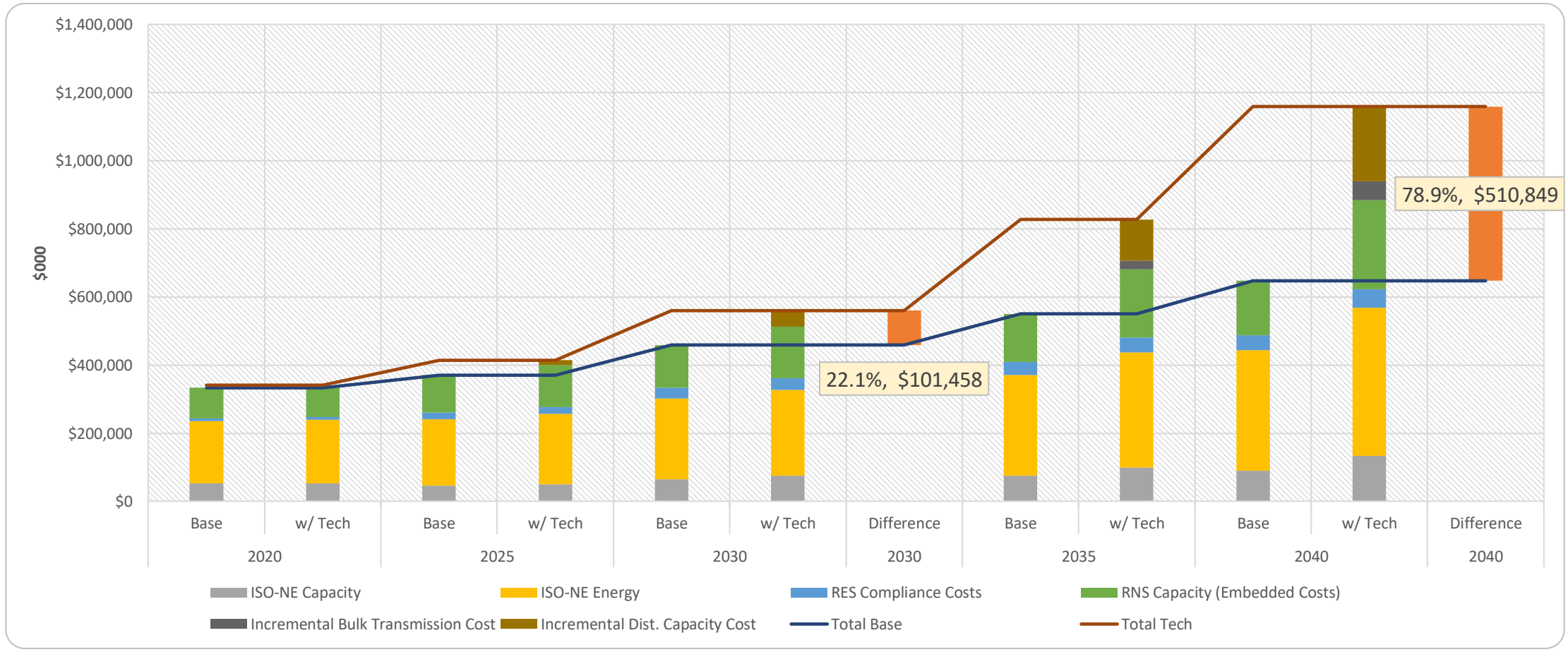
BASELINE VS. INCLUDING TECHNOLOGY ADOPTION - 2040





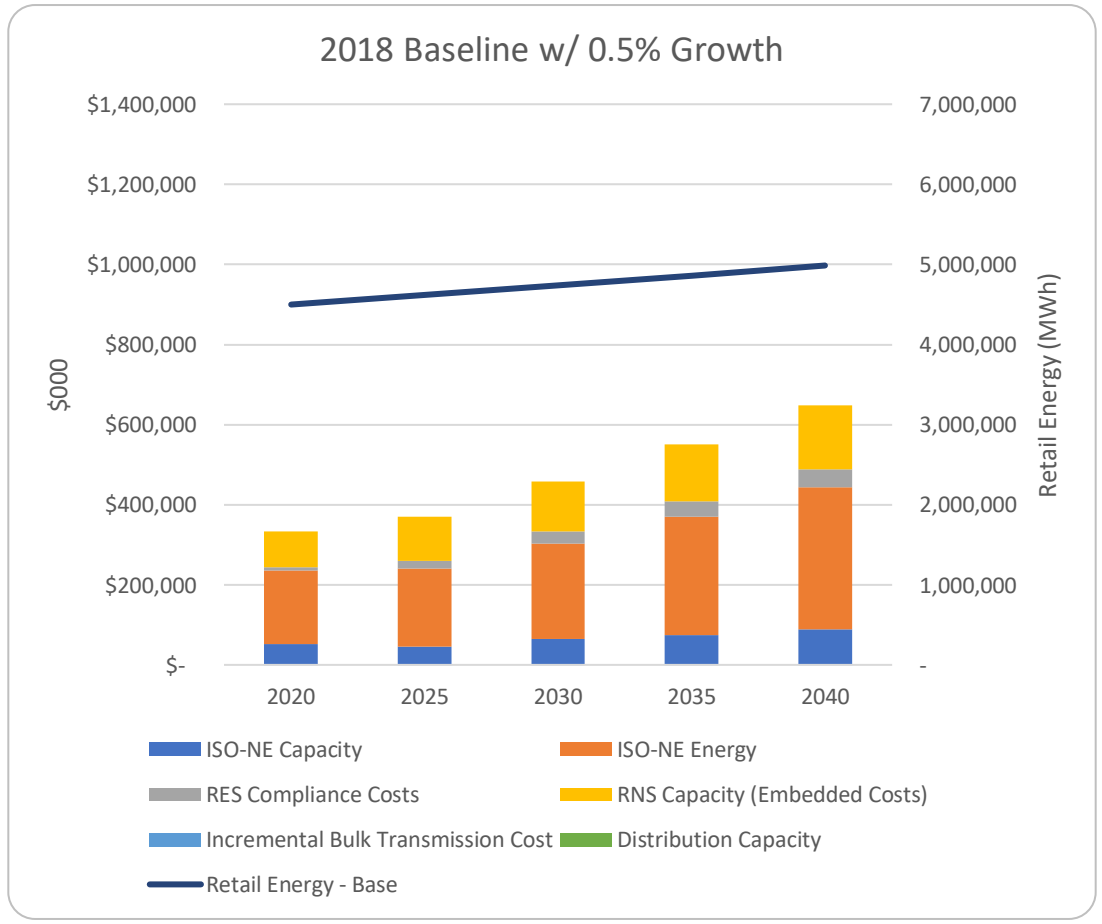
COMPARISON BETWEEN MODELED SCENARIOS

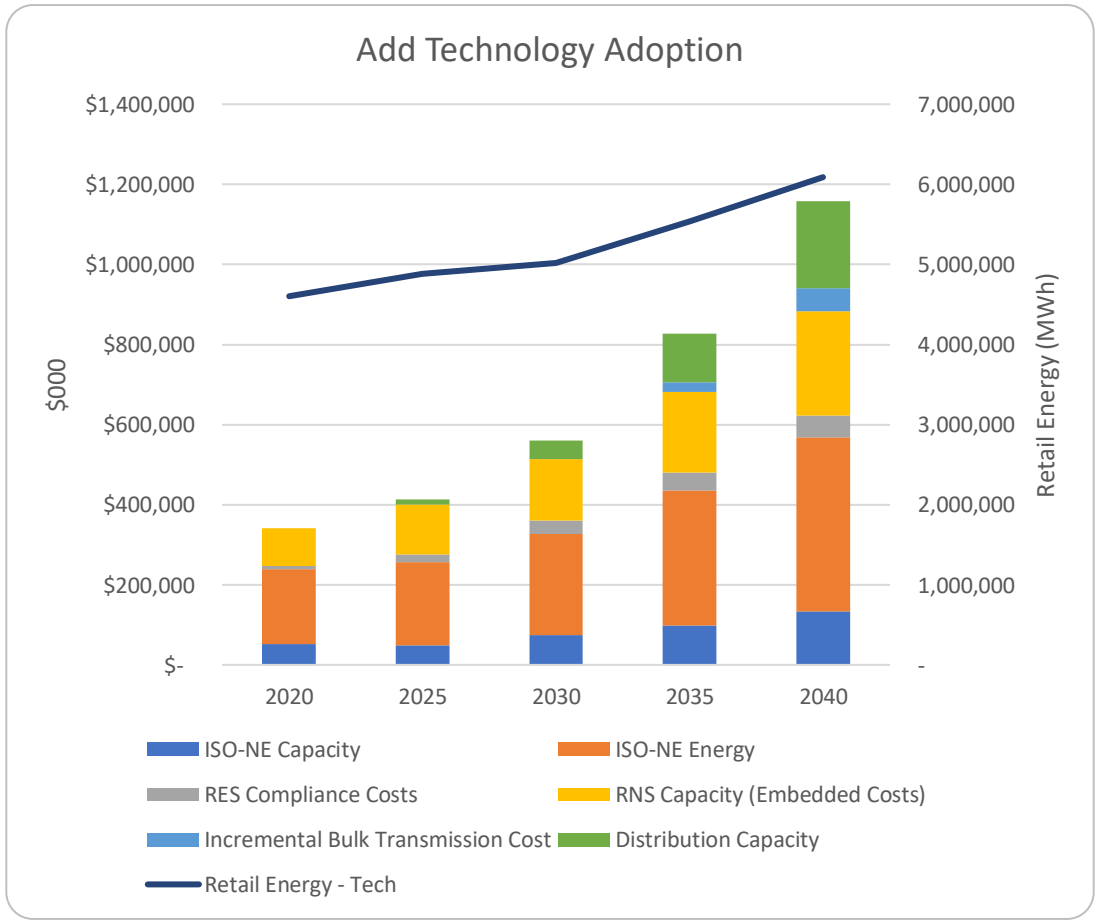
BASELINE VS. INCLUDING TECHNOLOGY ADOPTION - 2040



COMPARISON BETWEEN MODELED SCENARIOS

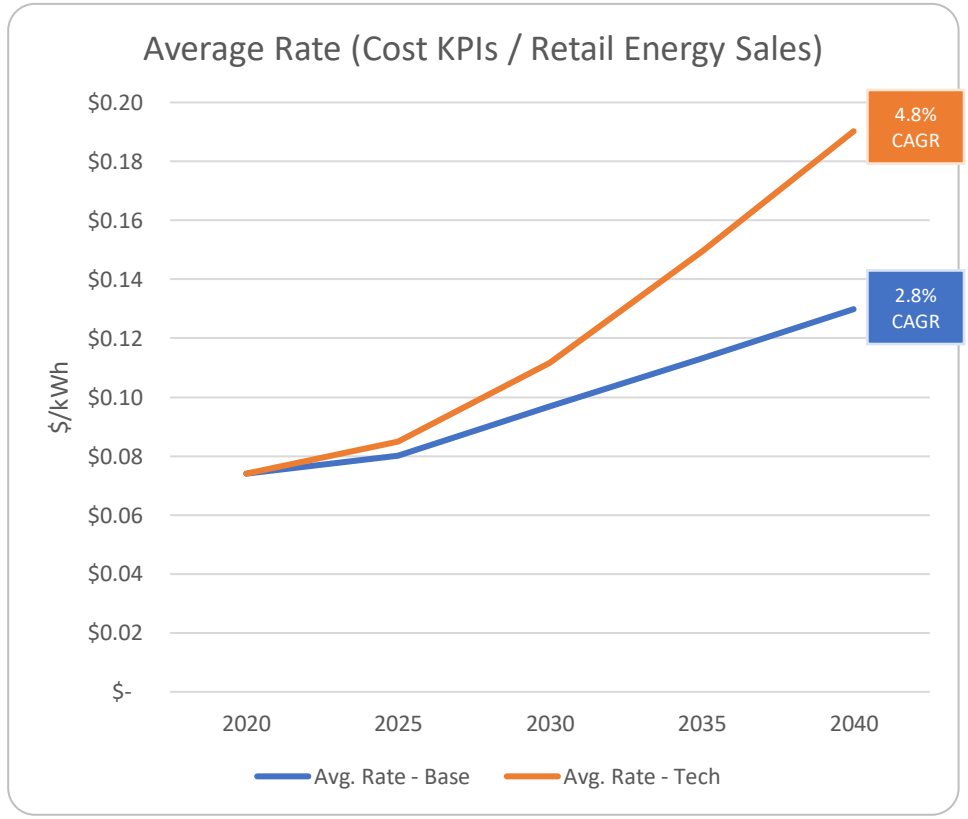
BASELINE VS. INCLUDING TECHNOLOGY ADOPTION - 2040





OPTIONS TO MANAGE UPWARD RATE PRESSURE

- Increasing electrification drives both new utility revenues and costs
  - LSAM™ modeling suggests costs outpace revenue growth
- Options to manage upward rate pressure:
  - "Pay the bill"
    - Continue to buy capacity/energy from the "market"
  - "Acquire" capacity and energy in other ways



FUTURE VERMONT CAPACITY PROCUREMENT

Wholesale-Side Management

- Generation
  - ISO-NE Capacity
  - VT Utility-Owned Gen/Storage
- Transmission
  - RNS Capacity Cleared in Market
  - VT Utility-Owned Gen/Storage

Load-Side Management

- Sources of controllable load
  - EV
  - Industrial/Lg. Commercial
  - Residential
  - Energy storage
- Control
  - Direct: Utility, Third-Party
  - Indirect: Customer (Rate Design)

FUTURE VERMONT CAPACITY PROCUREMENT

Wholesale-Side Management

- Sources of controllable load
  - EV
  - Industrial/Lg. Commercial
  - Residential
  - Energy storage
- Control
  - Direct: Utility, Third-Party
  - Indirect: Customer (Rate Design

Customer Load Control – Rate Design

- Static Rate Design
  - Non-TOU
  - TOU
    - Demand, Energy
    - Seasonal
    - Tiered
- Dynamic Rate Design
  - Real-Time Pricing (RTP)
  - Critical Peak Pricing (CPP)

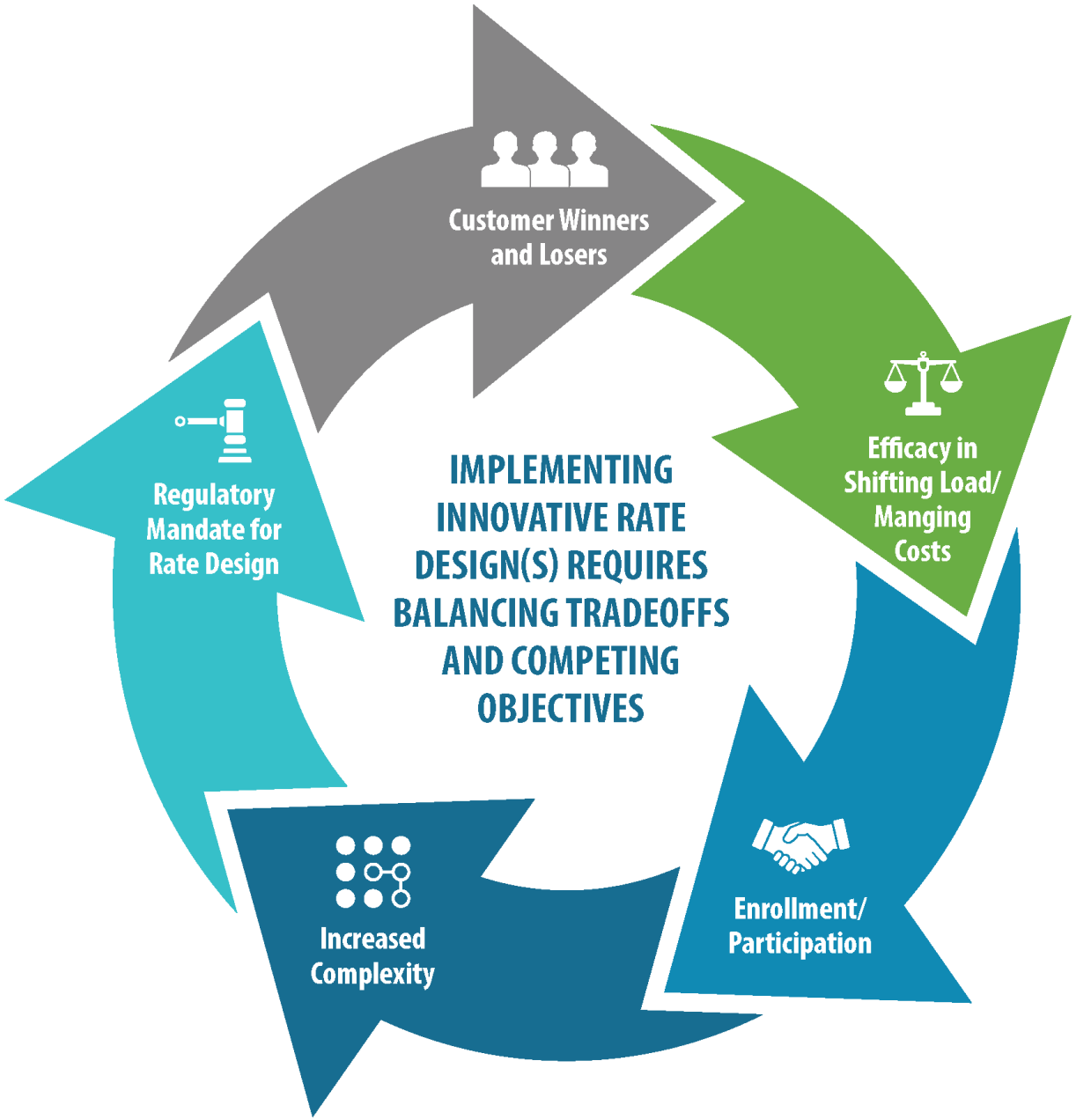
BREAK FOR LUNCH

11:30 – 12:30 EST

DYNAMIC RATES AND FLEXIBLE LOADS TO MANAGE UTILITY COST KPIS

RATE DESIGN INITIATIVE / DISTRIBUTED ENERGY RESOURCES STUDY
STAKEHOLDER ENGAGEMENT MEETING #3

INNOVATIVE RATE DESIGN



INNOVATIVE RATE DESIGN AND IMPLEMENTATION

CHALLENGES

- Without management, increasing electrification will drive an increase in capacity costs outpacing increased revenue
- Rates can serve as a resource in managing loads, but challenges exist:
  - Efficacy in managing loads requires:
    - Higher enrollment in innovative rates / programs
      - Regulatory mandates
      - Self-selecting enrollment
      - Other options?
    - Customers changing usage patterns
      - Third-party and/or technology facilitation

RATE DESIGN

COMPLEXITY, EFFICACY & RESPONSIVENESS STATUS

Rate Design	Enrollment	Pricing Strategy	Complexity to Customer	Efficacy in Managing Load	Responsiveness to Rapid Market Evolution
Static Rate Design					
Non-TOU	Status Quo	Status Quo	🟢	🔴	🔴
TOU	High	Aggressive		🟢	
	Mid	Less-Aggressive	🟡 / 🔴	🟡	🟡
	Low	Less-Aggressive		🔴	
Dynamic Rate Design					
Real-Time Pricing	High	Market pass-through		🟢	
	Low	Market pass-through	🔴	🟡 / 🔴	🟢
Critical Peak Pricing	High	Aggressive		🟢	
	Mid	Less-Aggressive	🟡 / 🔴	🟡	🟢
	Low	Less-Aggressive		🔴	

RATE DESIGN

COMPLEXITY, EFFICACY & RESPONSIVENESS STATUS – FILTERED FOR EFFICACY

Rate Design	Enrollment	Pricing Strategy	Complexity to Customer	Efficacy in Managing Load	Responsiveness to Rapid Market Evolution
Static Rate Design					
TOU	High	Aggressive			
Dynamic Rate Design					
Real-Time Pricing	High	Market pass-through			
Critical Peak Pricing	High	Aggressive			

Aggressive pricing in which there are substantial customer "winners and losers" will not result in high rates of voluntary enrollment

Higher enrollment can stem from:
1. Regulatory mandate
2. "Opt-Out" structure
3. Third-Party load management

Mandates are challenging with more aggressive pricing/greater efficacy

"Opt-Out" and Third-Party unlikely to get as much enrollment

PANEL DISCUSSION 2

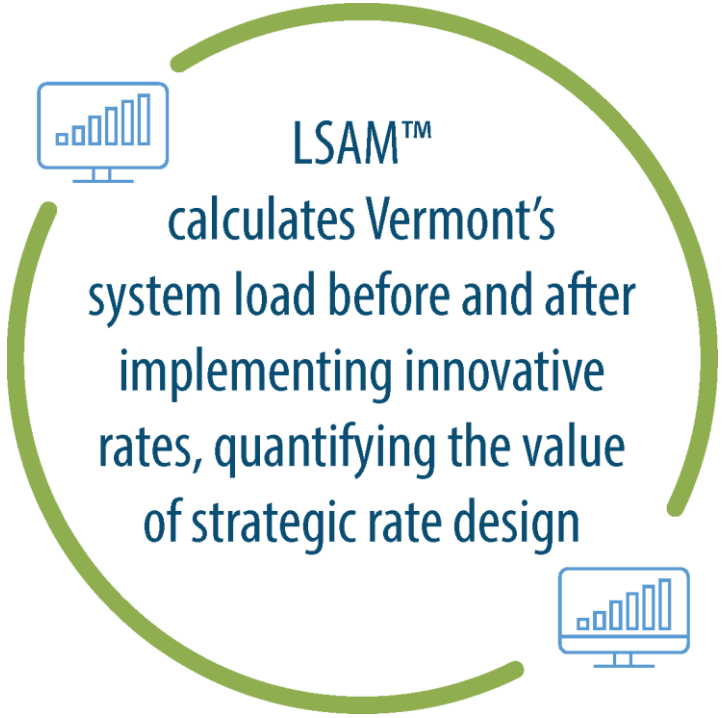
UTILITY PLANNING FOR THE FUTURE AND THE STATE'S OBJECTIVES

ADDITIONAL SCENARIO MODELING: THE MODELED VALUE OF INNOVATIVE RATES

RATE DESIGN INITIATIVE / DISTRIBUTED ENERGY RESOURCES STUDY
STAKEHOLDER ENGAGEMENT MEETING #3

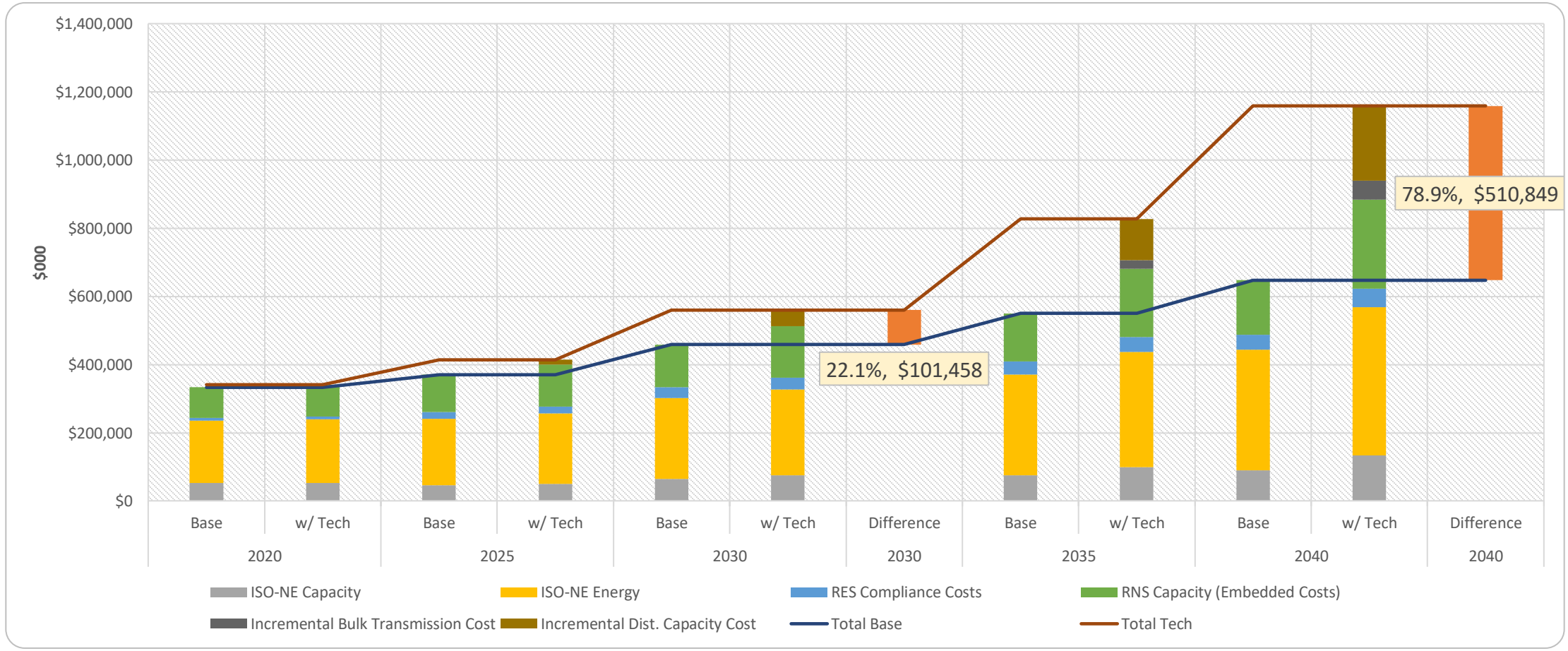
LSAM™ MODELED SCENARIO

- Tech adoption assumptions previous employed
  - PV adoption based on updated NM policy
  - EV adoption
    - 20% of vehicles by 2030; 50% by 2040
  - Electric space and water heating
    - CCHP: 20% of Residential by 2030, 50% by 2040
    - Heat pump H20: 5% of Residential by 2030, 10% by 2040



COMPARISON BETWEEN MODELED SCENARIOS

BASELINE VS. INCLUDING TECHNOLOGY ADOPTION - 2040



Upward Pressure

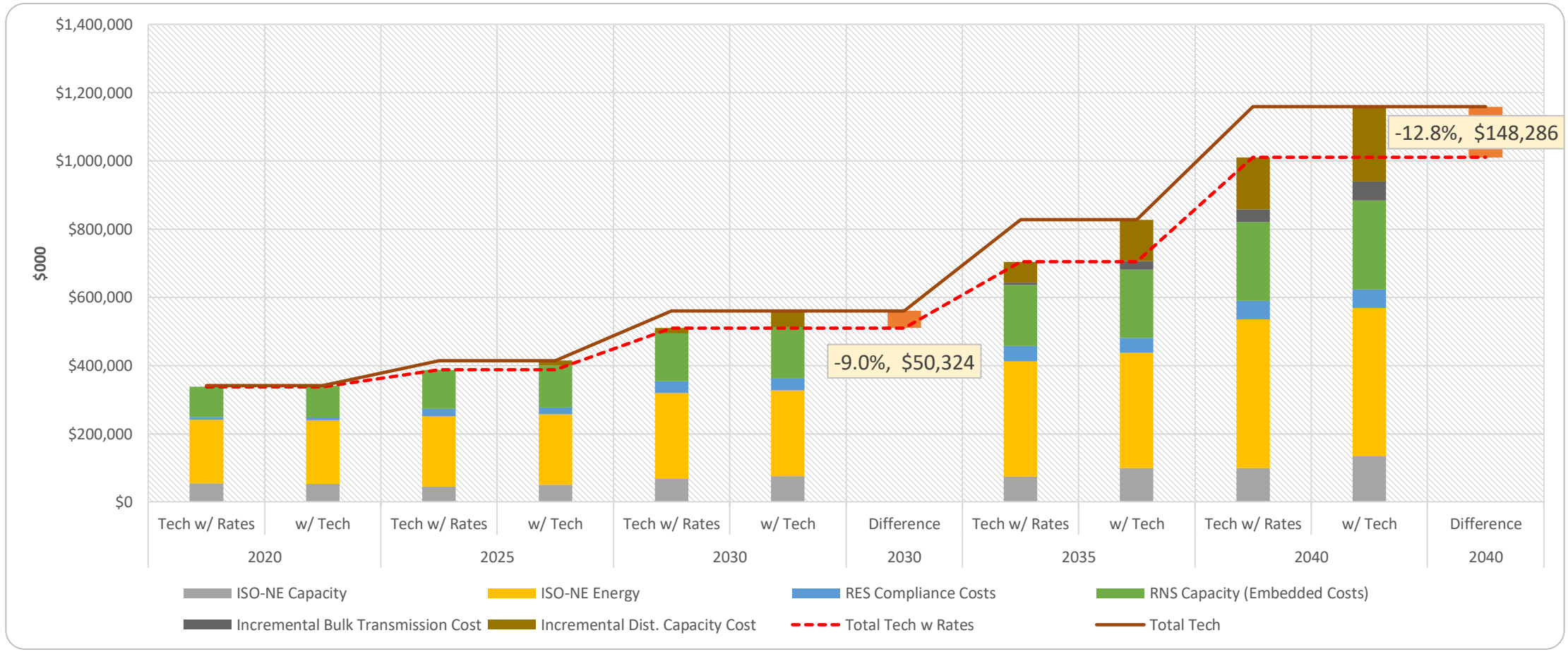
LSAM™ MODELED SCENARIO

STRATEGIC RATE DESIGN

- Static TOU Rates
  - EV charging rates set with 3-4 hour on-peak evening window
    - On-Peak rate is current otherwise effective energy rate
    - Off-Peak rate is set to 2/3 of On-Peak rate
- Up to 24 flexible load events “called,” with capacity ½ max EV load
  - Duration of 4 hours, limited at one/day
- RNS capacity costs recovered through Critical Peak Events
  - Up to 5x per month, with duration of 4 hours, limited at one/day

COMPARISON BETWEEN MODELED SCENARIOS

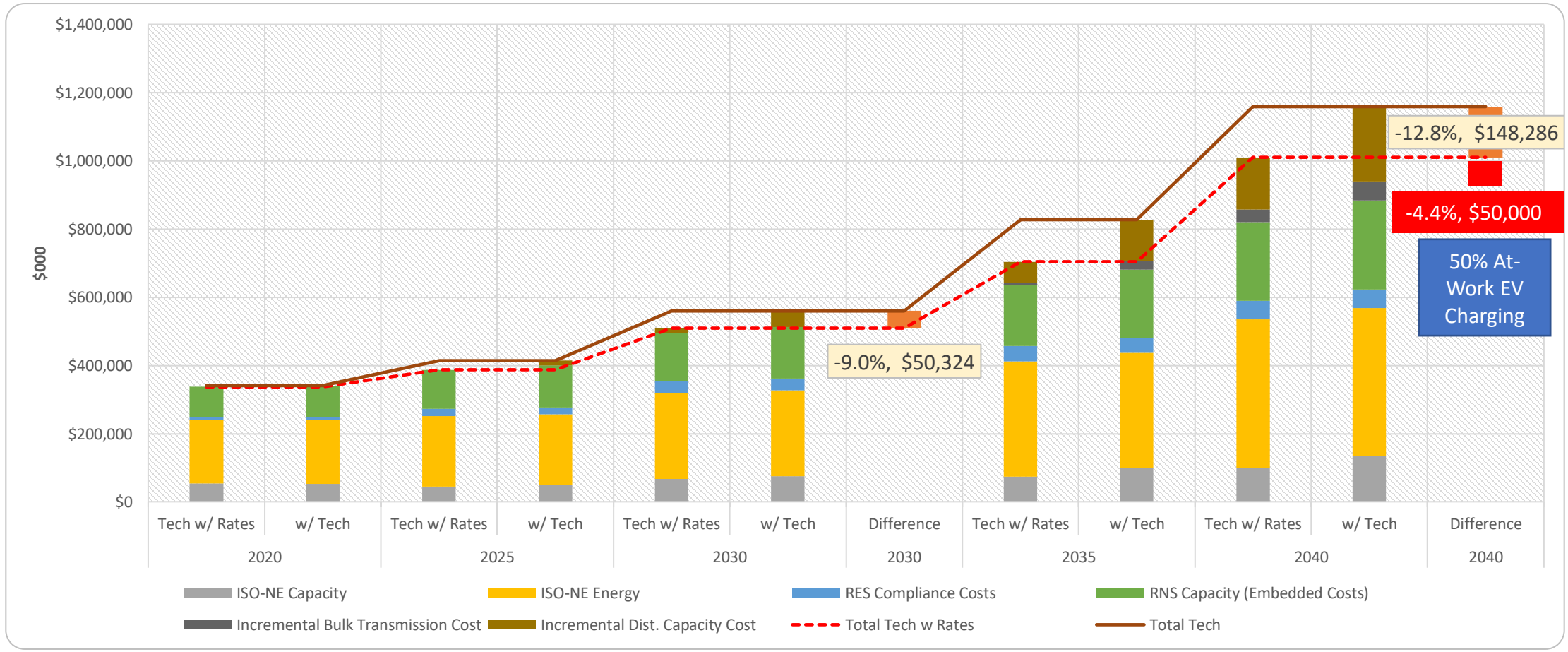
TECHNOLOGY ADOPTION FUTURE VS. TECH W/ RATES - 2040



Downward Pressure

COMPARISON BETWEEN MODELED SCENARIOS

TECHNOLOGY ADOPTION FUTURE VS. TECH W/ RATES, AT-WORK EV - 2040



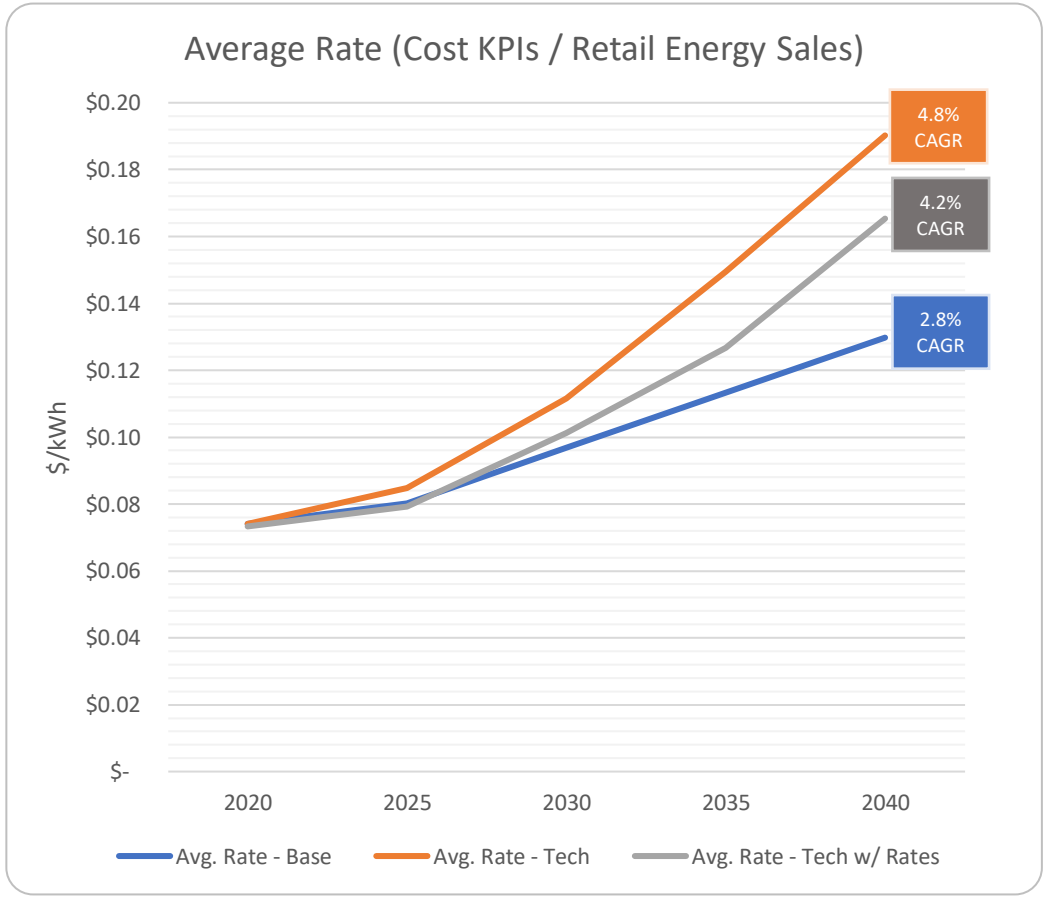
Downward Pressure

CONCLUSIONS AND KEY TAKEAWAYS

RATE DESIGN INITIATIVE / DISTRIBUTED ENERGY RESOURCES STUDY
STAKEHOLDER ENGAGEMENT MEETING #3

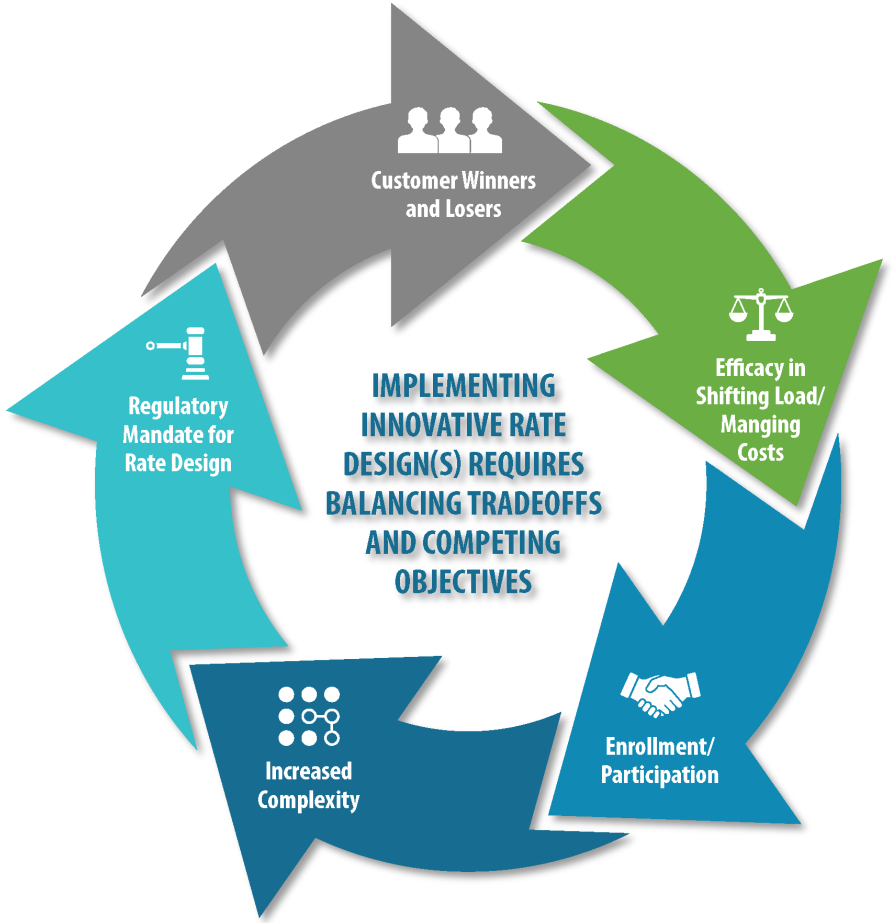
CONCLUSIONS AND KEY TAKEAWAYS

- Electric market evolution will exert upward rate pressure
  - CAGR of 4.8% vs. 2.8% (Base)
- Innovative rates can send price signals for customers to change usage and manage costs
  - Initial modeled savings $150M-$200M



CONCLUSIONS AND KEY TAKEAWAYS

- There are challenges in implementing innovative rates:
  - Increased complexity to the customer
  - Efficacy in reducing peaks
  - Program enrollment
  - Regulatory approval
  - Third-party participation



NEXT STEPS

May 21st - Draft Results Online Workshop

"Unconstrained" 2030 and 2040 Utility Cost KPIs

A recommended set of innovative rates / programs to manage cost pressure

Recommendations on managing implementation challenges

June 25th - Final Results and Draft Report Online Workshop

Revise the LSAM™ Technical Working Group

A supplemented version of LSAM™ to be made available for use and review

Contact Riley, if interested

NewGen Strategies & Solutions

THANK YOU FOR YOUR PARTICIPATION!

VERMONT DEPARTMENT OF PUBLIC SERVICE