

Vermont Energy Sector Update

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Topics

- Orientation of regulated entities and policies
- Regional markets and transmission
- Vermont's electric system and trends
- Implications for system costs and ratepayer impacts

Major Themes

- Beneficial electrification
- Grid modernization
- Rate design
- Cost allocation

Regulated Entities and Policies

Who is the Public Utility Commission?

Public Utility Commission = the judges



From left: Commissioners Cheney, Roisman, and Hoffman

PUC Mission: To ensure the provision of high quality public utility services in Vermont at minimum reasonable costs, consistent with the long-term public good of the state....

<http://puc.vermont.gov/>

Who is the Public Service Department?

The Public Service Department = represents the interests of the people of the state as a whole

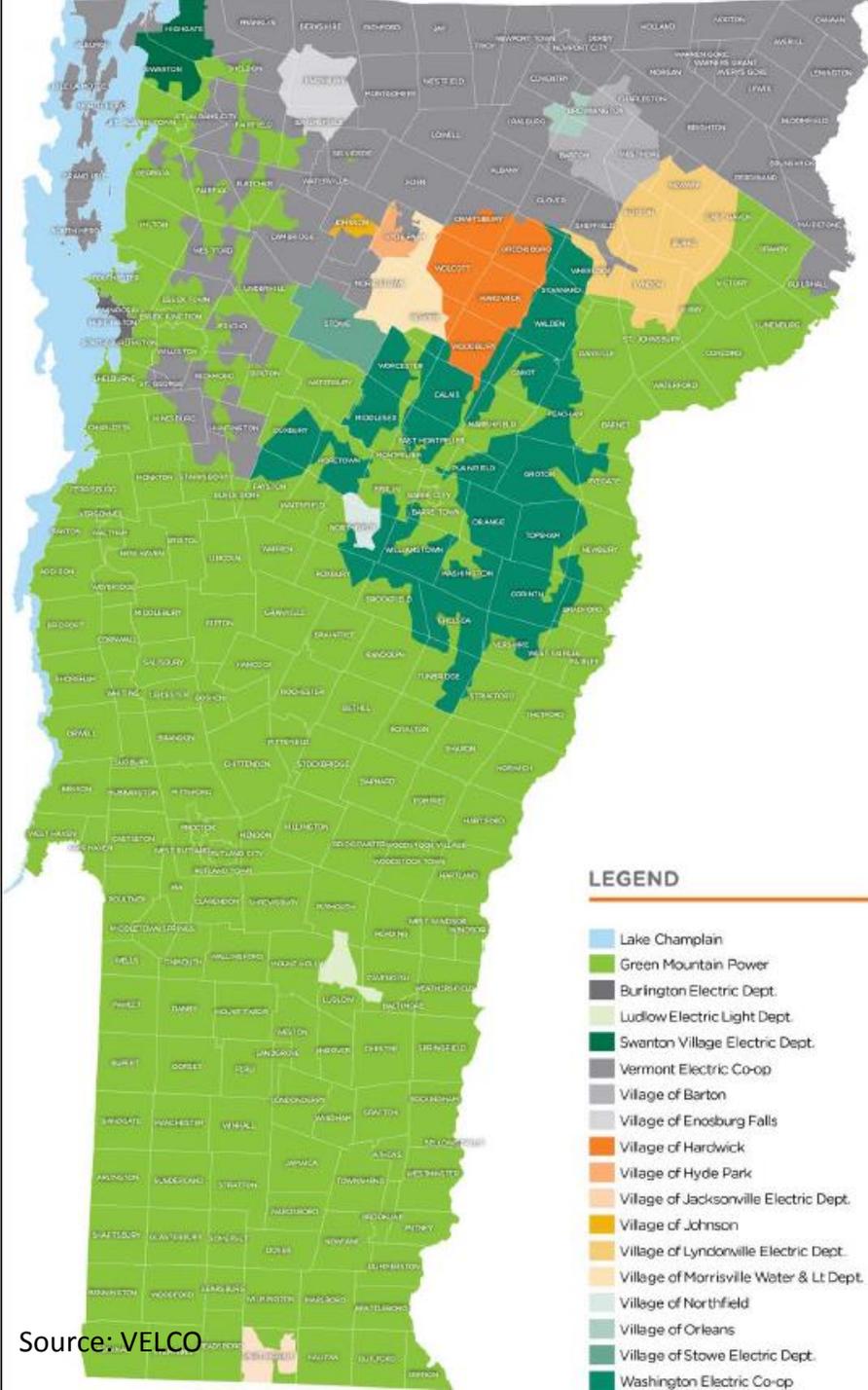


- Represents public interest in utility cases
- Provides long-range planning for the state's energy and telecom needs
- Ensures all Vermonters share in the benefits of modern
 - communications
- Administers federal energy programs
- Resolves utility customer complaints
- Informs public about utility-related matters
- Makes and administers power purchase contracts



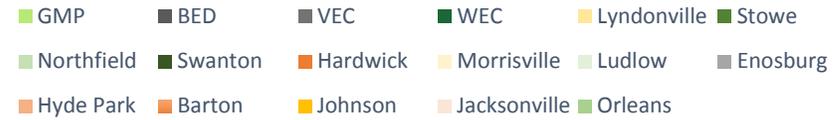
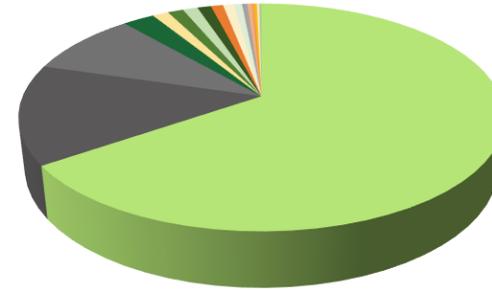
Commissioner June E. Tierney

<http://publicservice.vermont.gov/>



Source: VELCO

Share of VT load



Vermont Electric Utilities

- 1 IOU, serving ¾ of VT load or 260,000 customers (GMP)
- 2 Coops (VEC, WEC)
- 14 Municipals
- 1 transmission utility (VELCO)

Vermont Renewable Deployment

- 300 MW Solar PV
- 150 MW Wind
- 200 MW In-State Hydro
- 70 MW Biomass
- 8 MW Landfill Gas
- 5 MW Methane Digesters

1000 MW Peak

Energy Efficiency Utilities

- Efficiency Vermont
 - City of Burlington Electric Department
 - Vermont Gas Systems
-
- Responsible for reducing electric and thermal usage
 - Funded by energy efficiency charge on customers' bills

State Energy Policy

30 V.S.A. § 202a

It is the general policy of the State of Vermont:

- (1) To assure, to the greatest extent practicable, that Vermont can meet its energy service needs in a manner that is adequate, reliable, secure, and sustainable; that assures affordability and encourages the State's economic vitality, the efficient use of energy resources, and cost-effective demand-side management; and that is environmentally sound.
- (2) To identify and evaluate, on an ongoing basis, resources that will meet Vermont's energy service needs in accordance with the principles of least-cost integrated planning; including efficiency, conservation and load management alternatives, wise use of renewable resources, and environmentally sound energy supply.

Goals in Statute

- Renewable policies that promote economic benefit, efficient use of resources, stable prices, market development, air and water quality, grid stability, climate change mitigation, and diversity of resources. (30 V.S.A. § 8001)
- 25% renewable by 2025. (10 V.S.A. § 580(a))
- 50% GHG emission reduction by 2028, and 75% (if practicable) by 2050. (10 V.S.A. § 578(a))
- Building efficiency – weatherize 25% of housing stock by 2025. (10 V.S.A. § 581)

Requirements in Statute

Renewable Energy Standard (30 V.S.A. § 8005)

- Total renewable energy (55% in 2017 growing to 75% in 2032)
 - Any size/vintage renewable resource, provided it delivers into New England
- Distributed generation (1% to 10%, carve-out of Tier 1)
 - Under 5 MW, commissioned after 6/30/15, connected to VT distribution
- Energy transformation (2% to 12%, not a carve-out)
 - Fossil fuel reduction

Standard Offer Program (30 V.S.A. § 8005a)

- Long-term contracts for resources 2.2 MW or less, adding up to 127.5 MW

Net Metering (30 V.S.A. § 8010)

- Compensation based on residential rates with adjustors for siting and RECs

Regional Context: Vermont as a part of ISO New England

ISO New England

- Regulated by the Federal Energy Regulatory Commission
- Responsible for:
 - Designing and implementing wholesale electricity markets
 - Day-ahead and Real-time Energy Markets, Forward Capacity Market, Ancillary Services
 - Operating the New England transmission system
 - VELCO owns but operation is under the direction of ISO-NE
 - Power system planning to meet federal reliability standards



- 7.1 million households and businesses; population 14.7 million
- More than 1,500 generating resources:
 - Approximately 340 resources modeled in the Energy Management System
 - More than 1,200 settlement-only generating resources
 - More than 100,000 grid-connected and behind-the-meter solar PV installations
- Approximately 400 participants in the marketplace (those who generate, buy, sell, transport, and use wholesale electricity and implement demand resources)

- About 9,000 miles of transmission lines
- 13 interconnections to electricity systems in New York and Canada
- 136,355 gigawatt-hours (GWh), all-time annual energy served, set during 2005
- All-time peak demand of 28,130 megawatts (MW), set on August 2, 2006
- 22,818 MW all-time winter peak demand, set on January 15, 2004
- Approximately 30,500 MW of total generating capability for 2017 (summer seasonal claimed capability; SSCC)
- Approximately 2,800 MW of demand resources for 2017 (active demand response and energy efficiency)

- Market value in 2016—\$5.4 billion total; \$4.1 billion energy market; \$1.2 billion capacity market; \$0.1 billion ancillary services market
- Approximately \$8.35 billion in transmission investment since 2002; approximately \$4.0 billion planned

Source: ISO-NE
Regional System
Plan 2017

<https://www.iso-ne.com/system-planning/system-plans-studies/rsp>

Source of New England production cleaner with natural gas and renewables

Sources of Electricity Production

Major shift from oil and coal to natural gas over the past 17 years



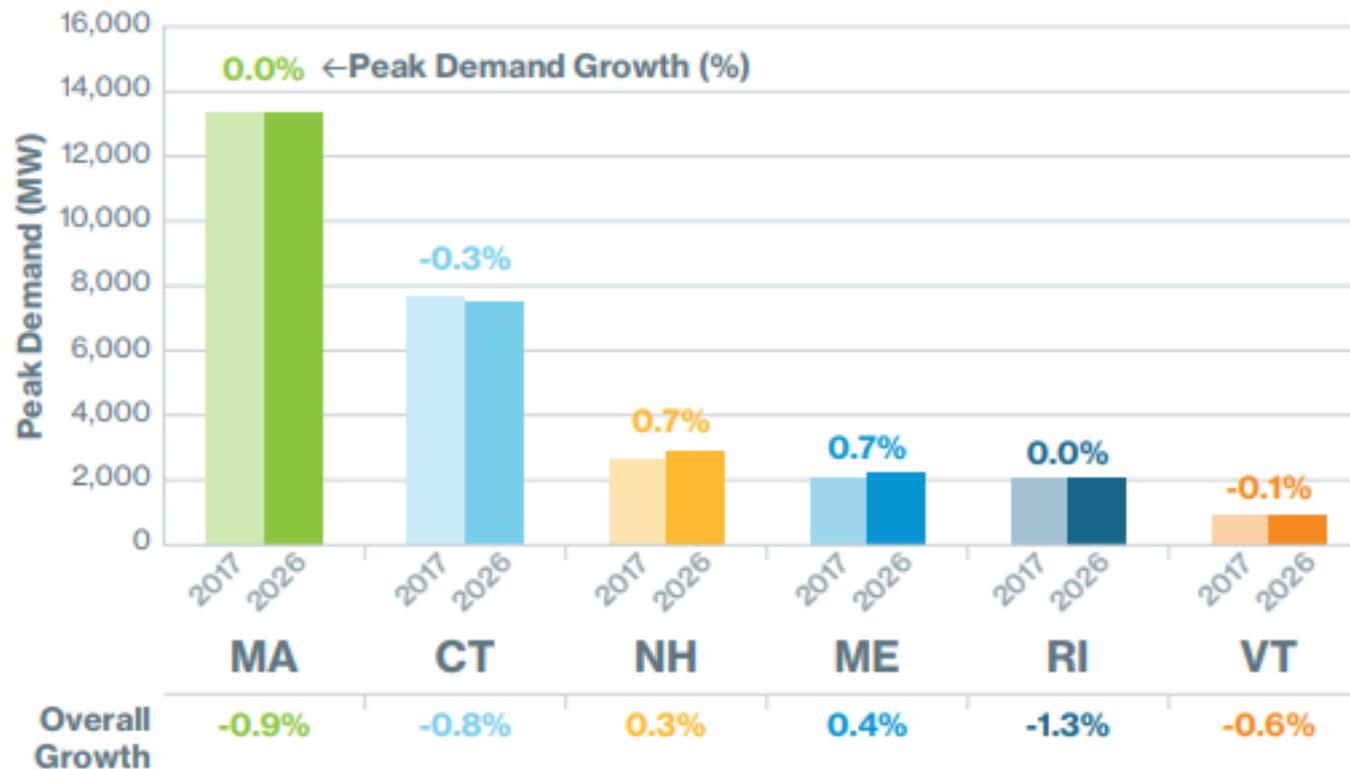
Source: ISO-NE

https://www.iso-ne.com/static-assets/documents/2018/02/ne_power_grid_2017_2018_regional_profile.pdf

Regional declining loads and peak

Electricity Demand Growth Has Slowed in New England

Compound annual growth rates for peak demand and overall electricity use, net of energy efficiency and solar photovoltaic (PV), 2017-2026

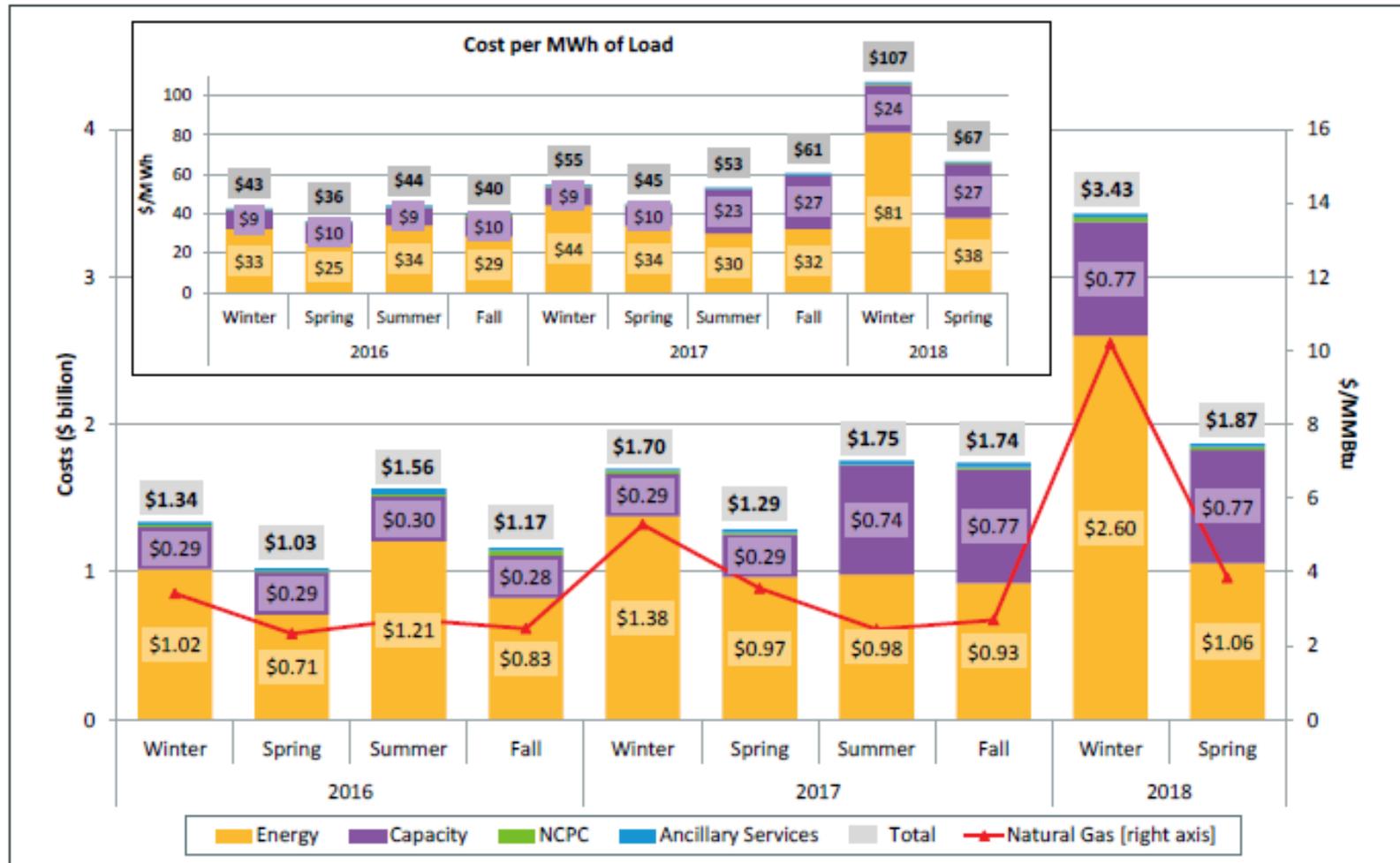


Source: ISO-NE

Source: ISO-NE 2017 Capacity, Energy, Loads, and Transmission Report; and 2017 Energy Efficiency Forecast

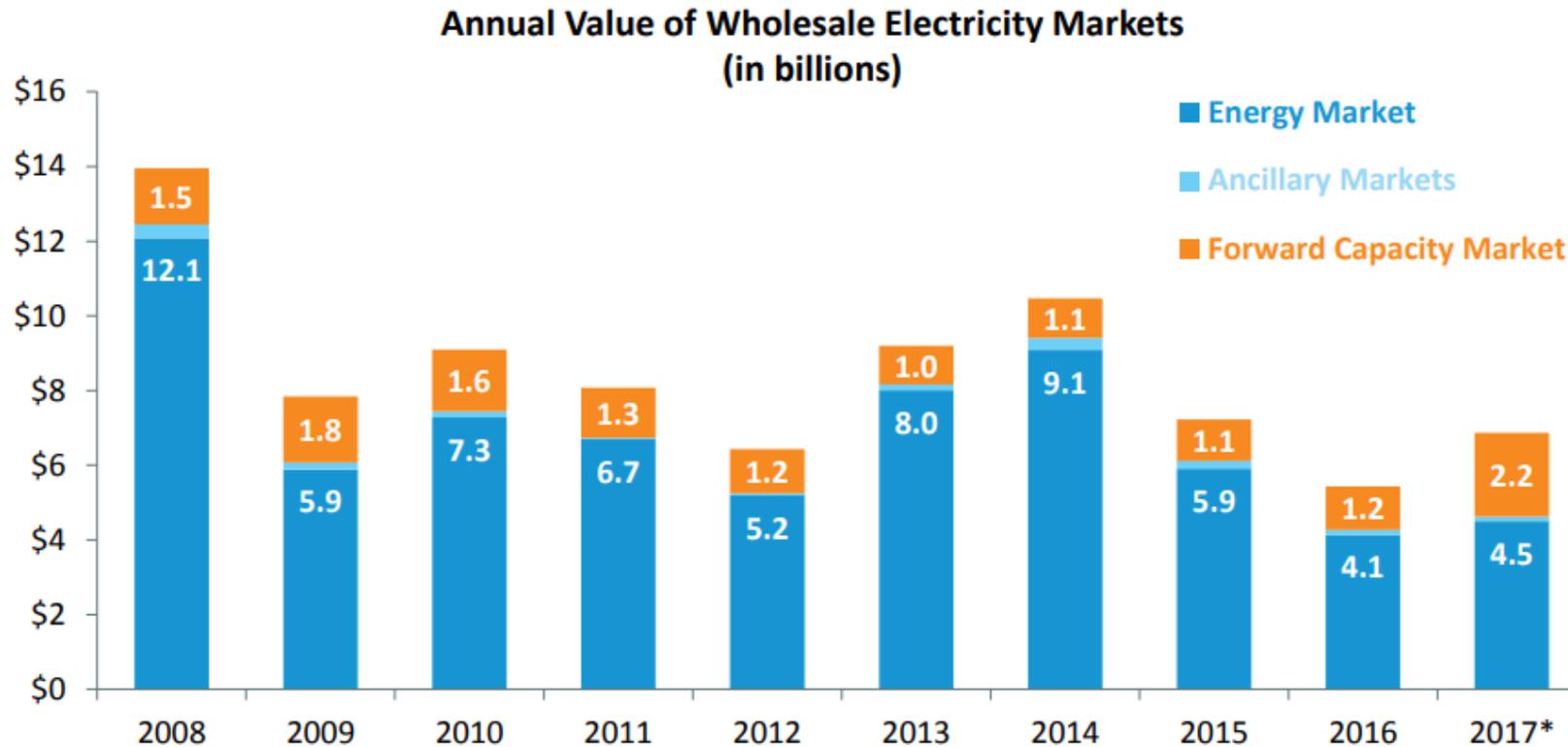
New England Wholesale Prices Spike in Winter

Figure 2-1: Wholesale Market Costs and Average Natural Gas Prices by Season



Source:
ISO-NE

New England regional market price has been declining



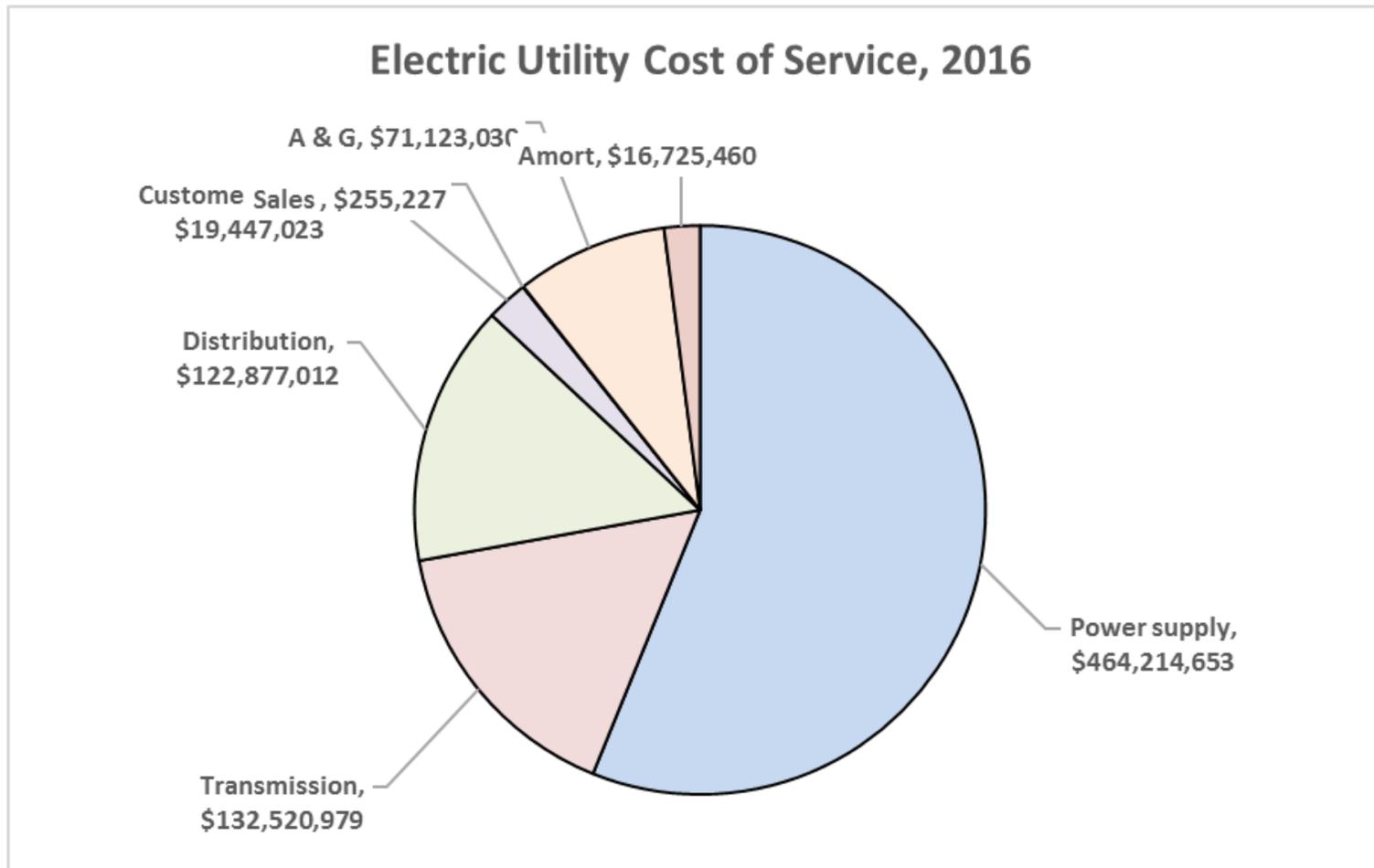
Source: [2016 Report of the Consumer Liaison Group](#); *2017 data is preliminary and subject to resettlement
Note: Forward Capacity Market values shown are based on auctions held roughly three years prior to each calendar year.

Vermont utilities are hedged for generation

- ~ 20% of generation from owned units
- Long term contracts
 - System power contracts (e.g., HQ)
 - Unit contingent contracts (mostly weather contingent like wind and solar)
- Standard offer contracts and net metering

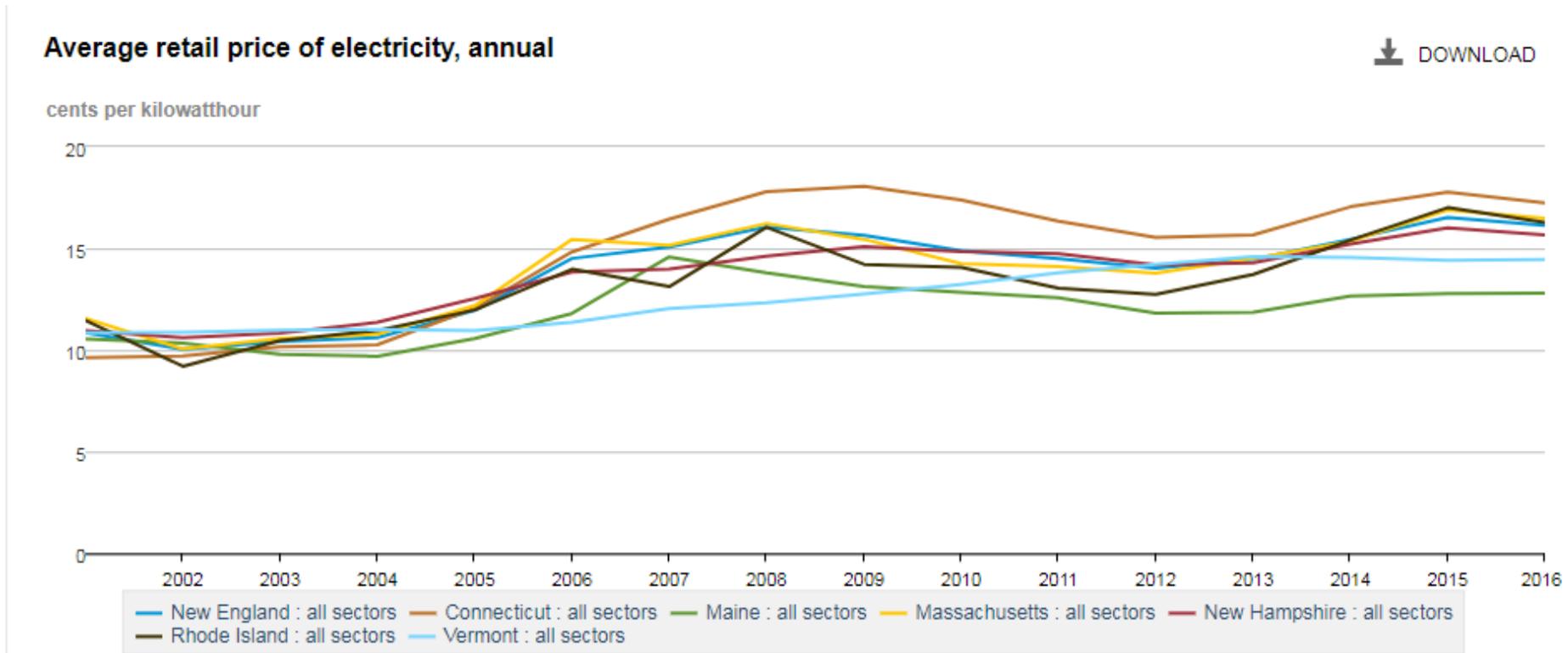
Vermont Electric Prices

Many factors go into customers' electric bills



Source: VT PSD

Vermont retail prices are currently low relative to other states in the region, save Maine

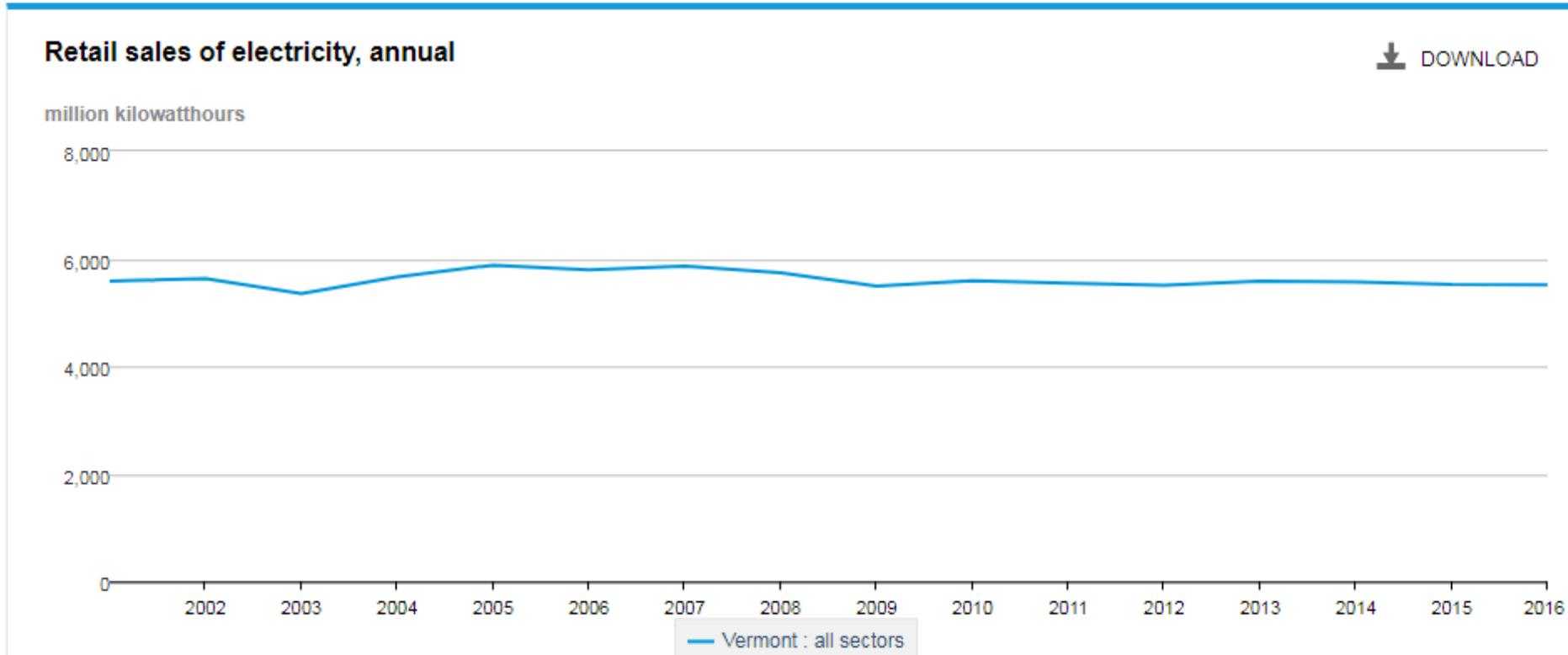


Data source: U.S. Energy Information Administration

Source: EIA.GOV

Vermont kWh Sales

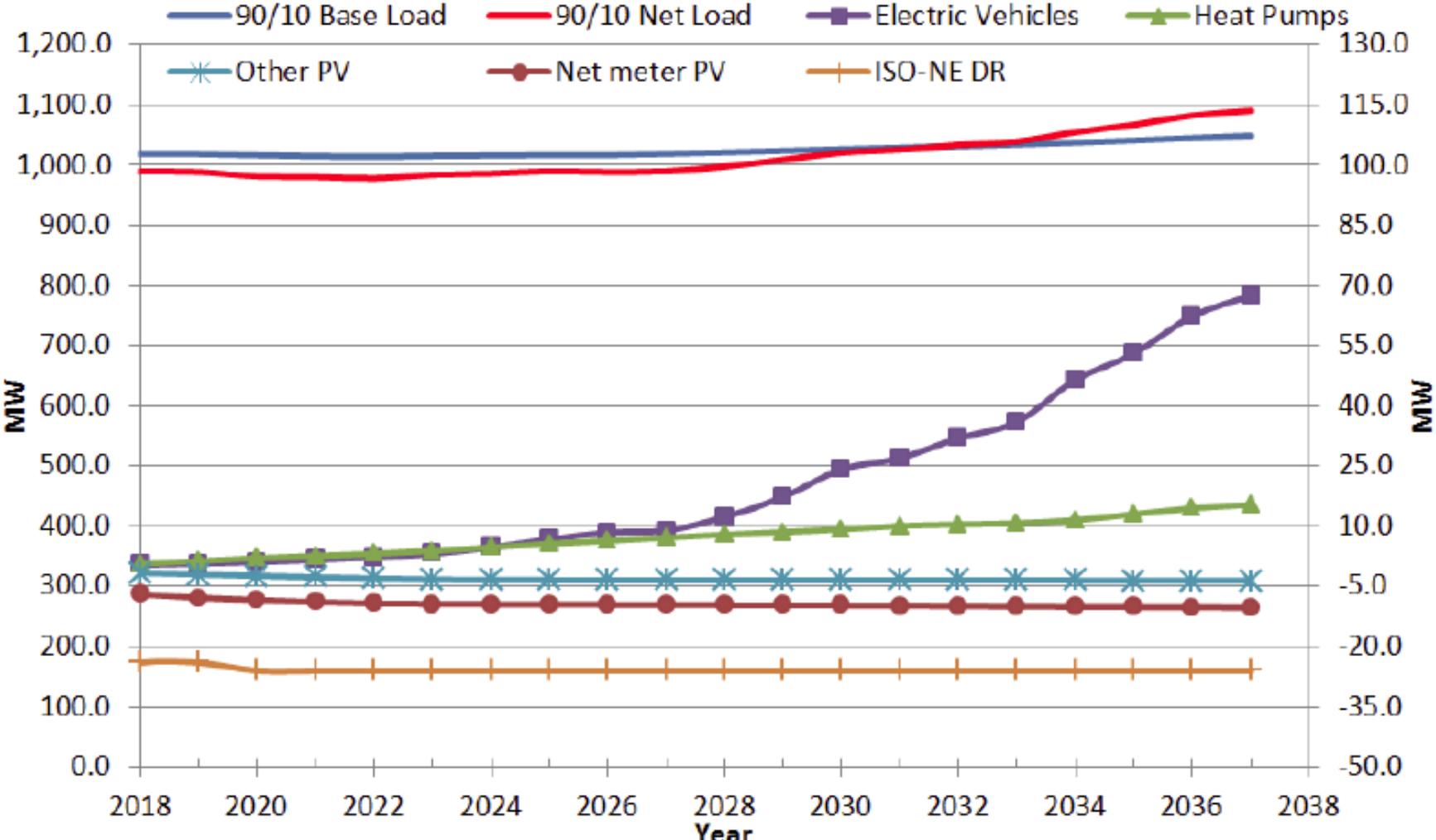
Retail sales in Vermont have been flat to declining since 2005; sales in 2016 below 2001



Source:
EIA.GOV

Forecast is for continued flat and below historic levels

PROJECTED VERMONT SUMMER PEAK LOAD AND ITS COMPONENT FORECASTS

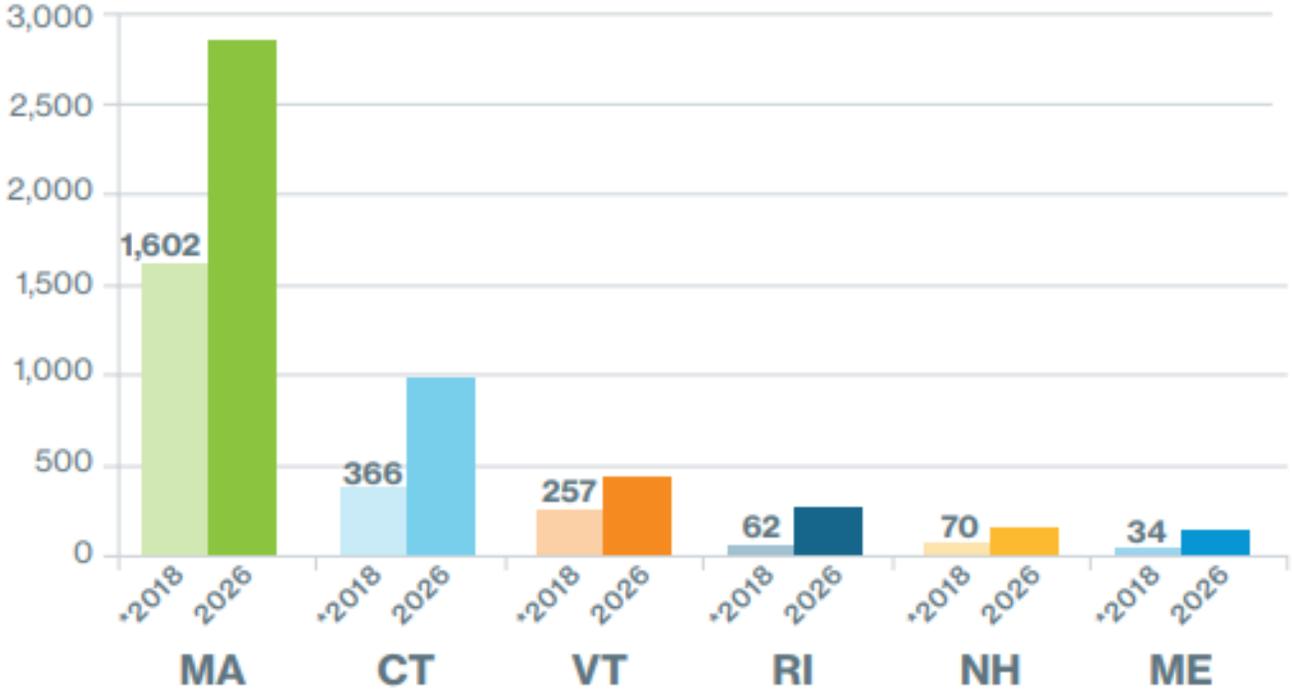


Source: VELCO Long Range Transmission Plan
https://www.velco.com/assets/documents/2018%20LRTP%20Final%20_asfiled.pdf

Vermont has developed more solar than New Hampshire, Rhode Island and Maine combined

ISO-NE Forecasts Strong Growth of Solar PV Resources

Values are alternating current (AC) nameplate capacity (MW)



Source: Final 2017 PV Forecast, ISO-NE, May 2017
*Start of 2018

Policy drivers of sales trends

Down

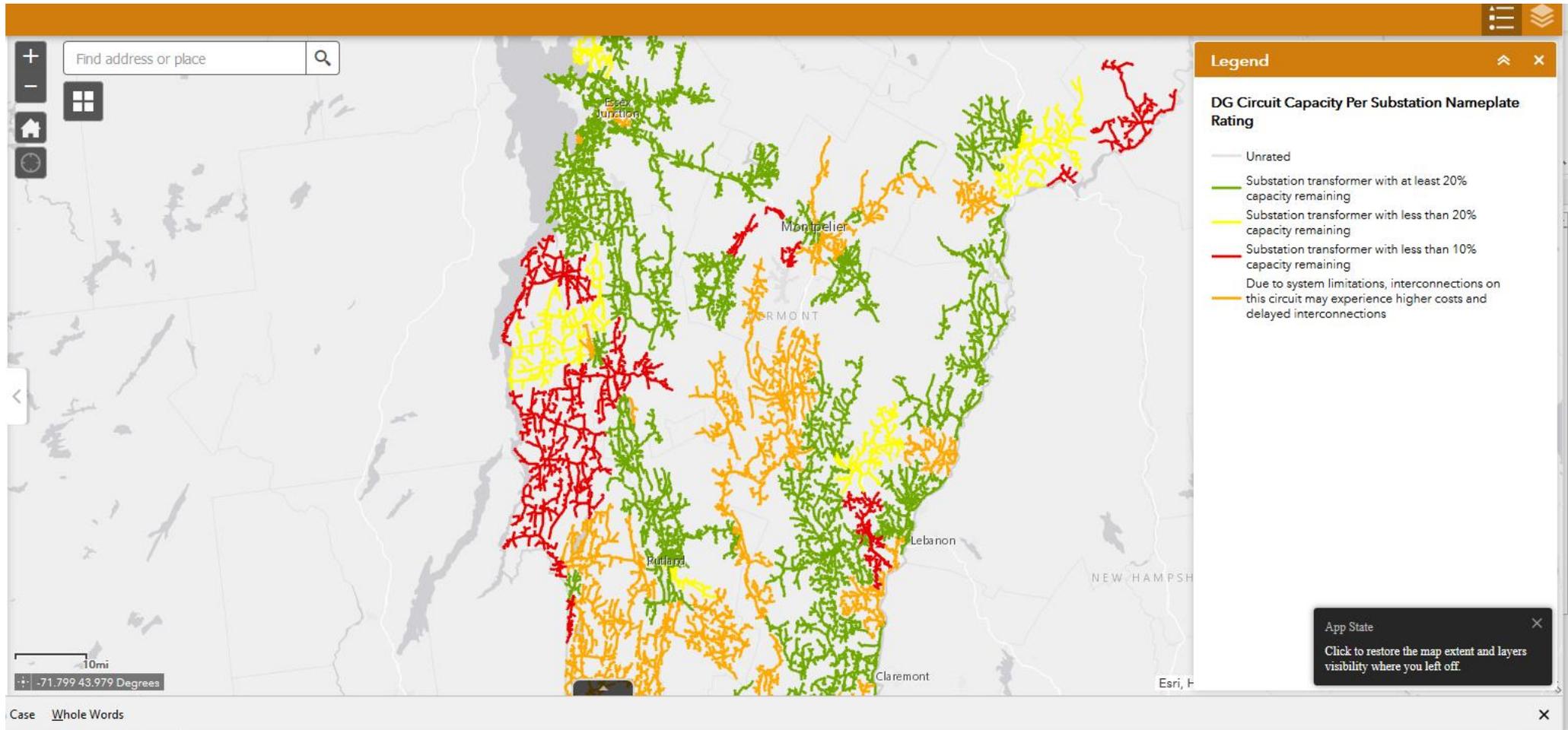
- Energy efficiency
- Net metering
- Federal appliance standards

Up

- Beneficial electrification
 - Custom projects (electrifying sugaring operations and saw mills)
 - Electric Vehicles
 - Cold Climate Heat Pumps

Moving Forward

Challenges for integrating solar looking forward...



Challenges associated with export of energy from northern Vermont ...

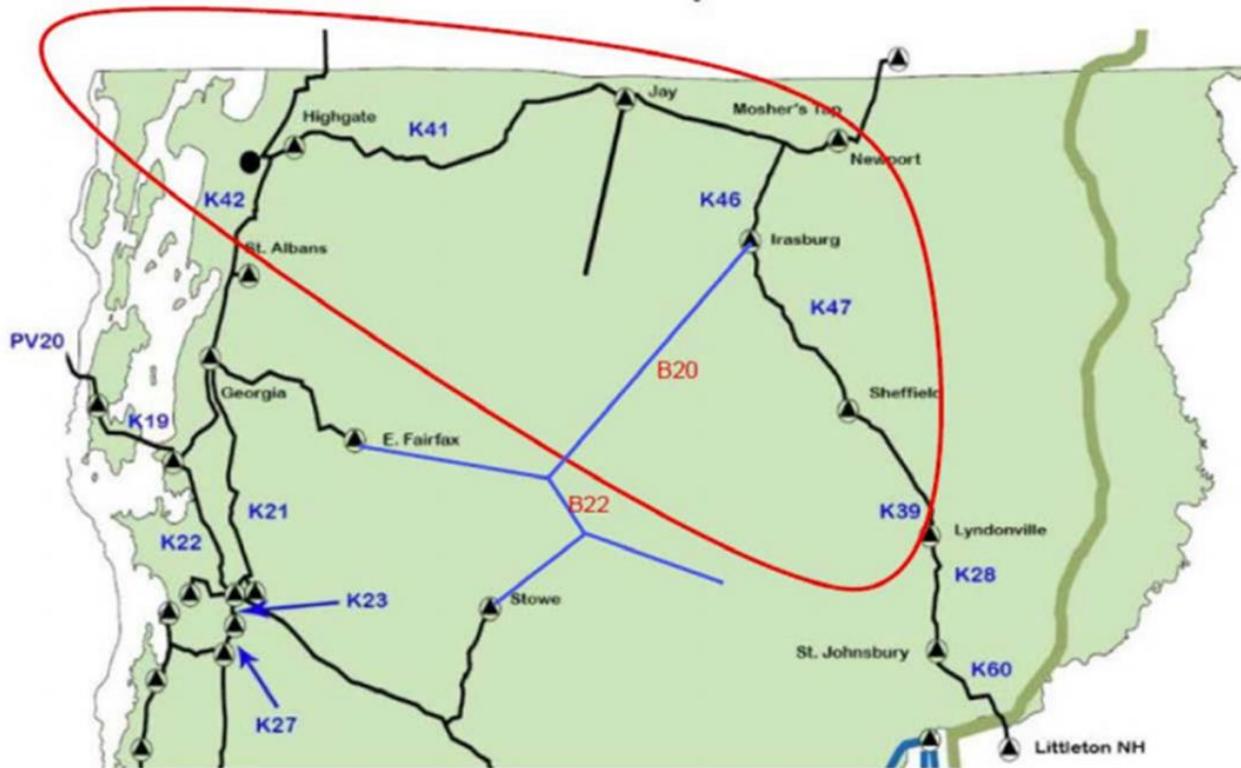


Figure 1: The Sheffield-Highgate Export Interface (SHEI)

<https://www.vermontspc.com/grid-planning/shei-info>

System Planning is Increasing in Importance

- Vermont has several planning requirements in place:
 - Integrated Resource Plans are required of utilities
 - VELCO Long-Range Transmission Plan
 - Demand Resources Plan required of energy efficiency utilities
- Location Matters
 - Generation or energy efficiency in a constrained area provides positive value to the individual customer but likely negative value to the system (and to other customers)
 - Beneficial Electrification will have more value in a generation constrained area than elsewhere
- Need to Choreograph Load and Generation (Timing Matters)
 - Utilities' electrification efforts should not increase T&D costs
 - Charging an EV after dark doesn't help ease generation constraints caused by daytime solar generation

April 2018 Load Comparison

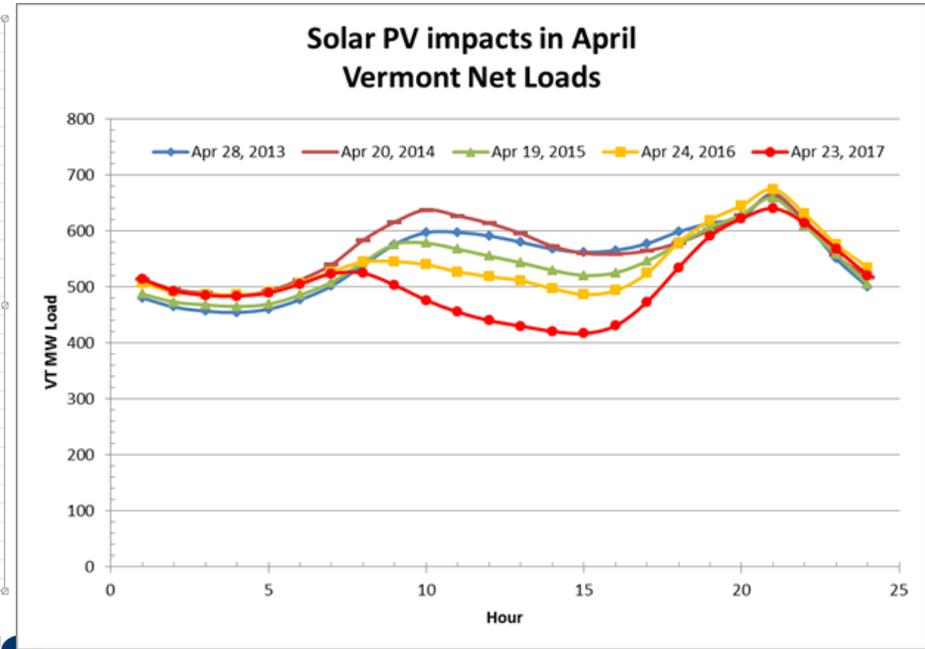
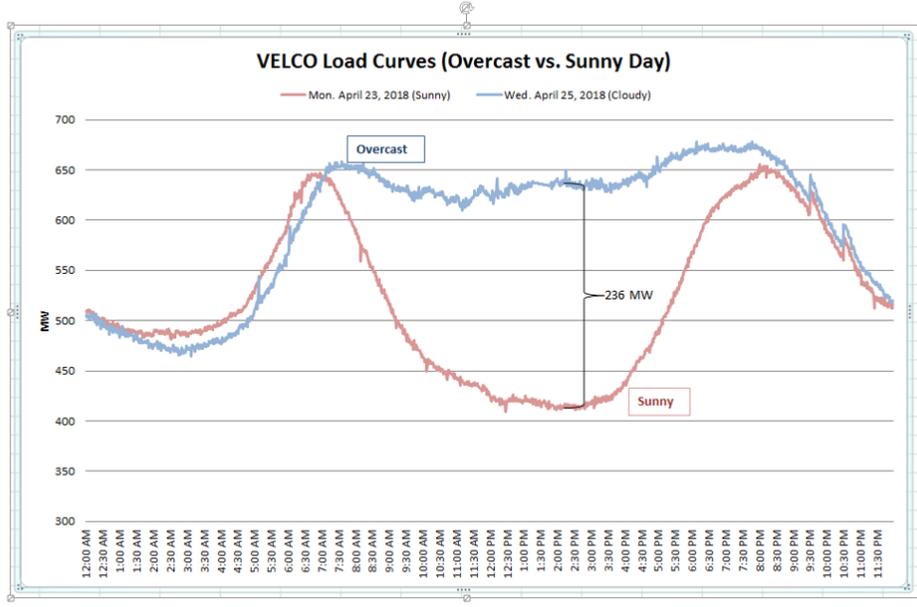
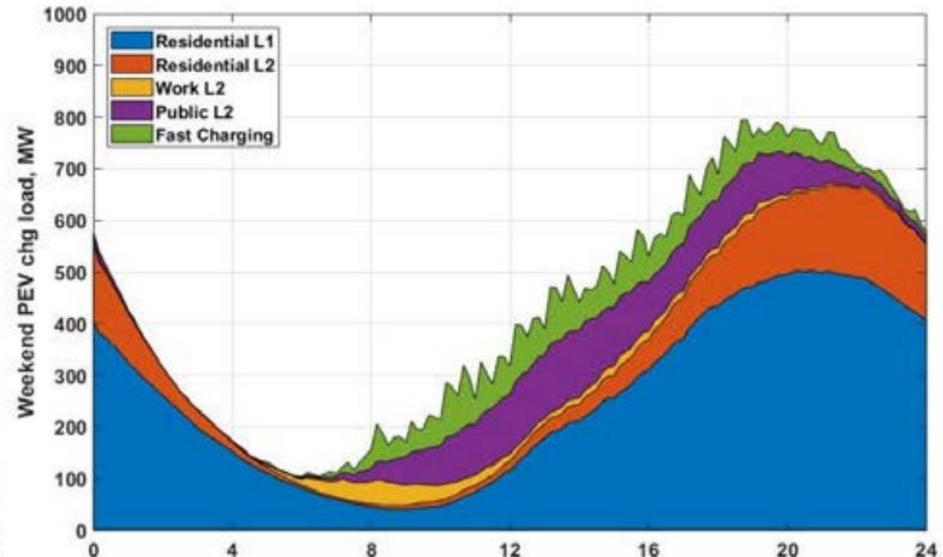
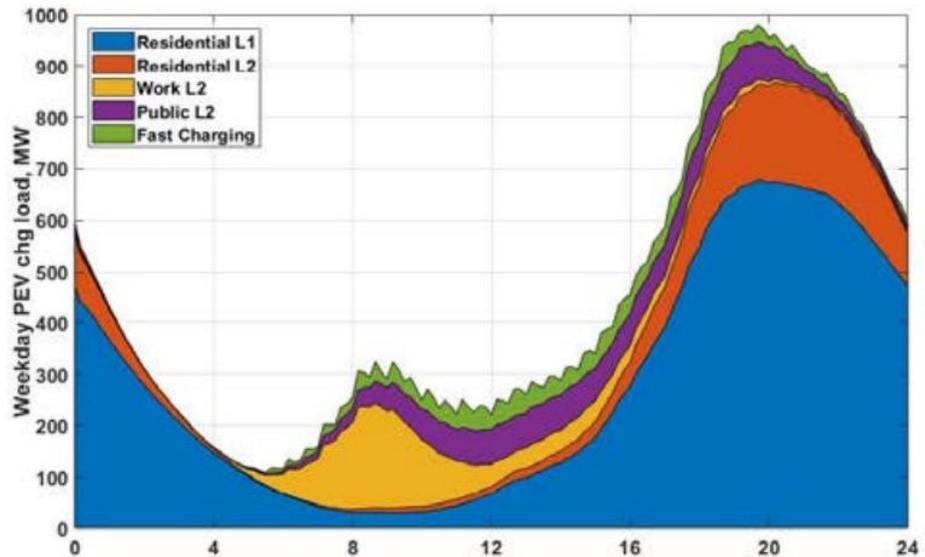


Figure ES.2: PEV Charging Load Profiles in 2025



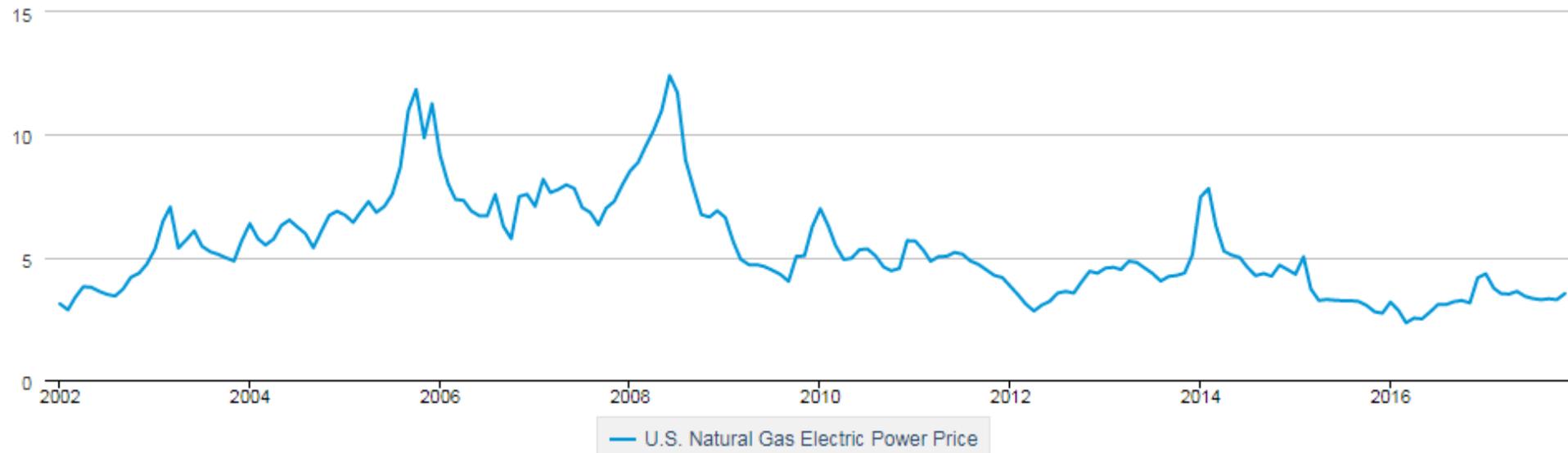
Questions?

National and global trends, declines in wholesale electricity from impacts from shale gas

U.S. Natural Gas Electric Power Price

↓ DOWNLOAD

Dollars per Thousand Cubic Feet

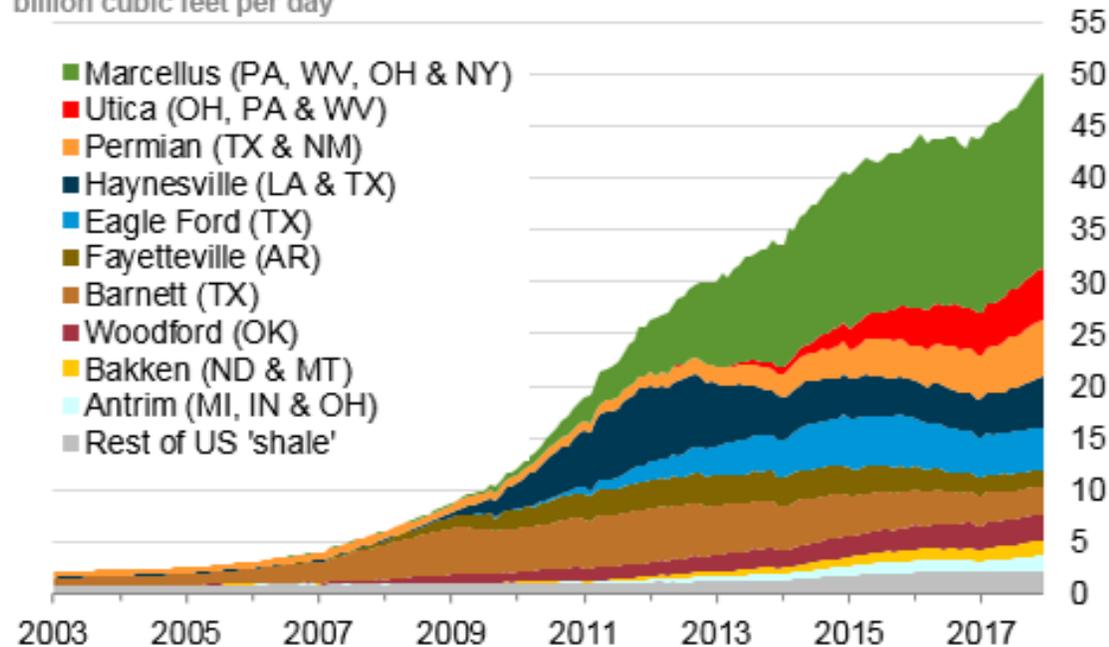


 Source: U.S. Energy Information Administration

Shale gas production in the US...., demand is roughly 75 Bcf/d

Monthly dry shale gas production

billion cubic feet per day

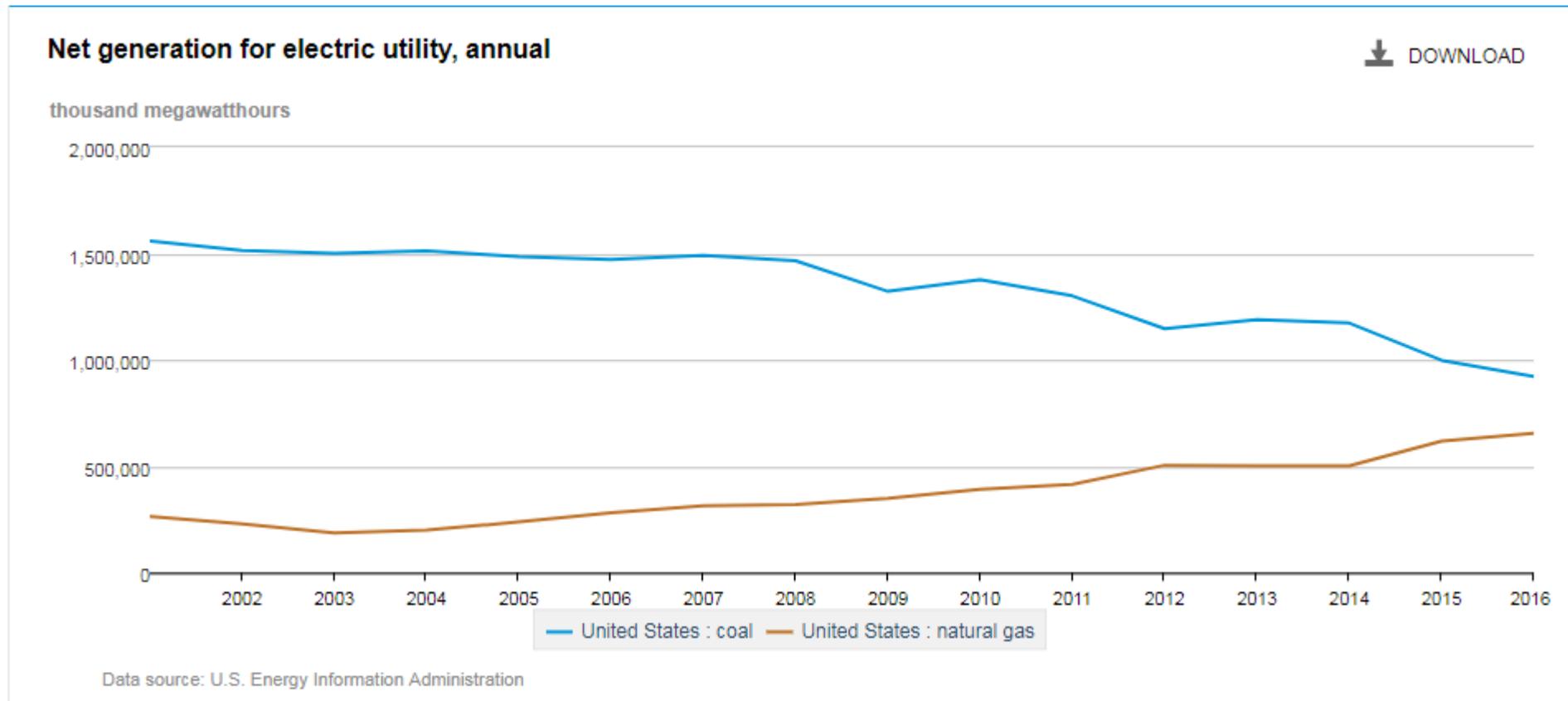


Source: EIA

Sources: EIA derived from state administrative data collected by DrillingInfo Inc. Data are through December 2017 and represent EIA's official shale gas estimates, but are not survey data. State abbreviations indicate primary state(s).

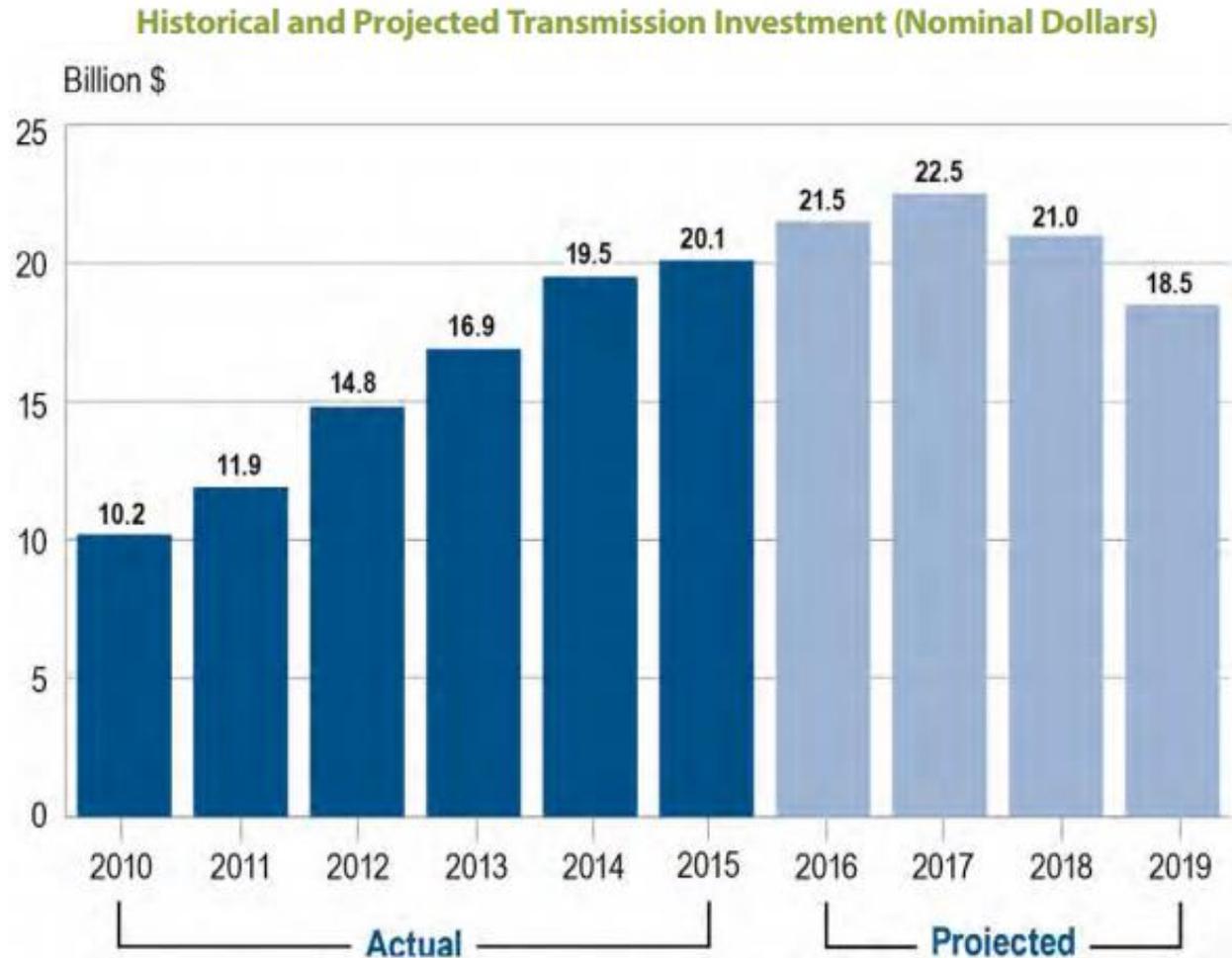


Coal is on the decline, natural gas on the rise

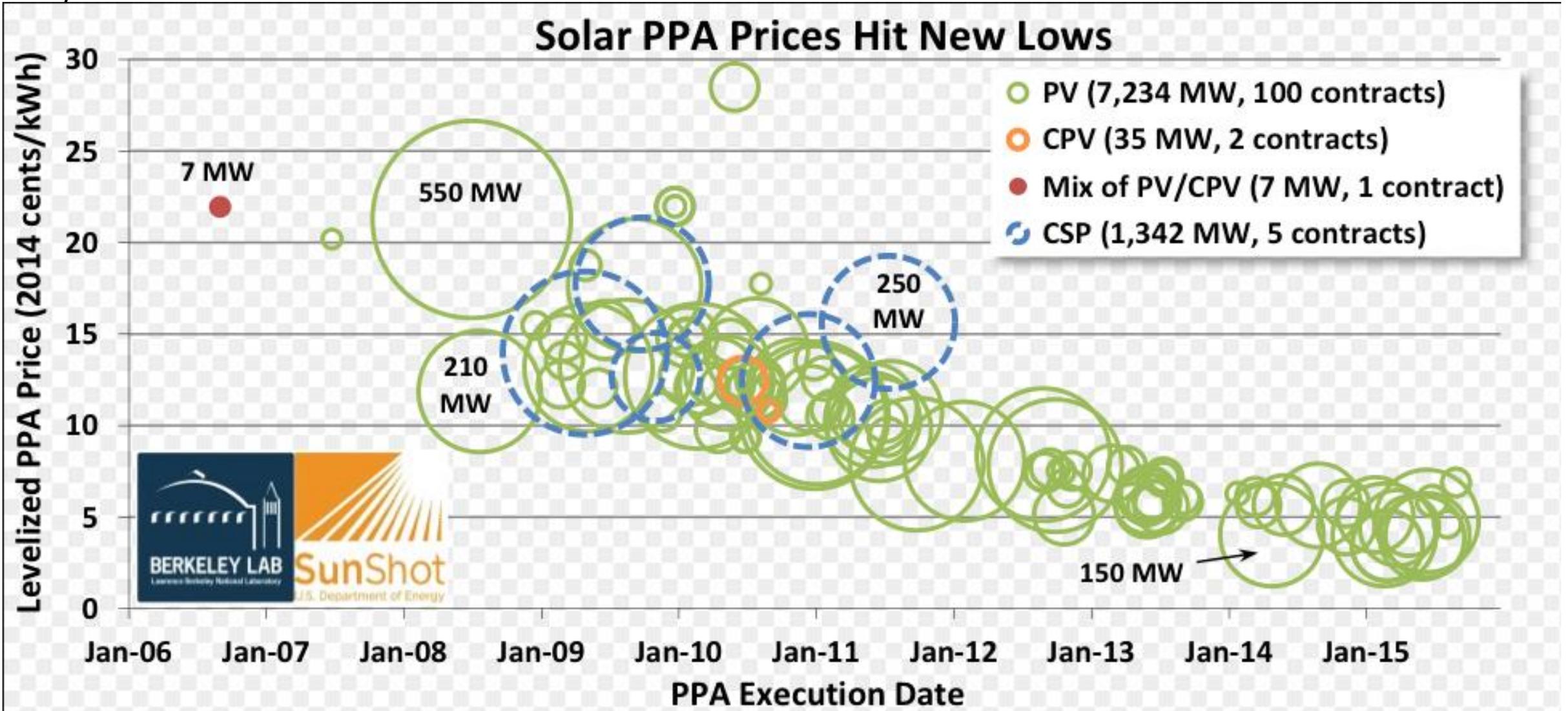


Source: EIA

Transmission costs have been on the rise nationally



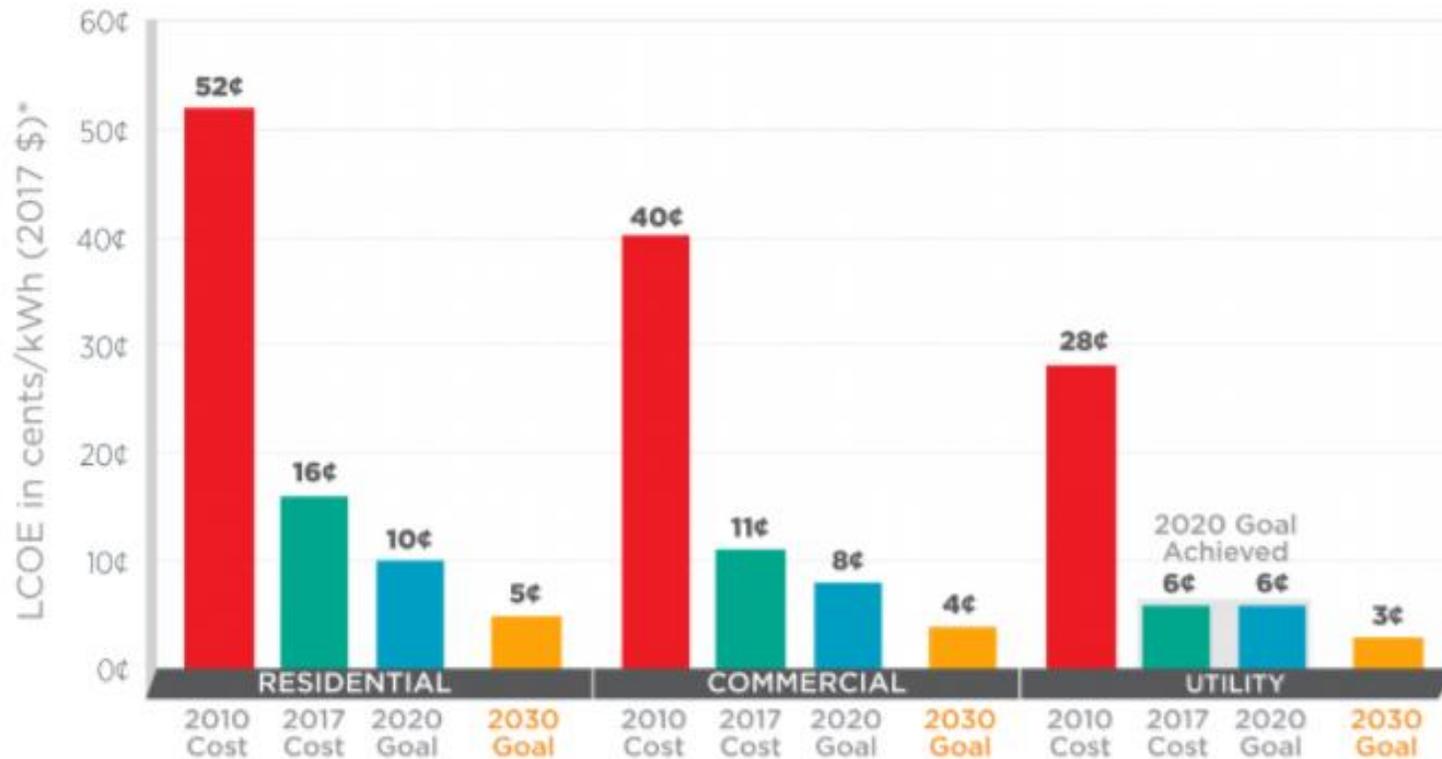
“Price of Solar Energy in the United States Has Fallen to 5¢/kWh”



Source: LBNL <http://newscenter.lbl.gov/2015/09/30/price-of-solar-energy-in-the-united-states-has-fallen-to-5¢/kWh-on-average/>

DOE 2020 targets for solar (sans incentives) met in 2017

SunShot Progress and Goals



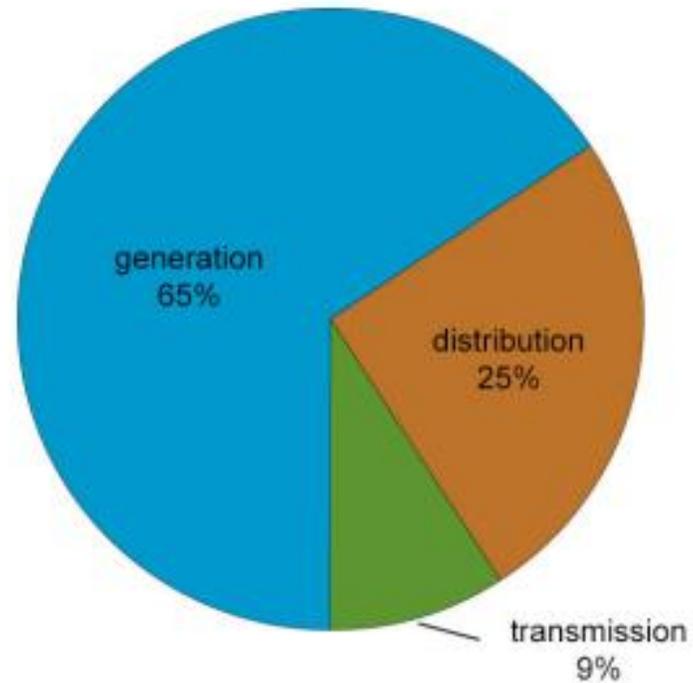
Source: DOE

<https://www.energy.gov/eere/solar/articles/2020-utility-scale-solar-goal-achieved>

*Levelized cost of electricity (LCOE) progress and targets are calculated based on average U.S. climate and without the ITC or state/local incentives. The residential and commercial goals have been adjusted for inflation from 2010-17.

Major components of cost of electricity, US

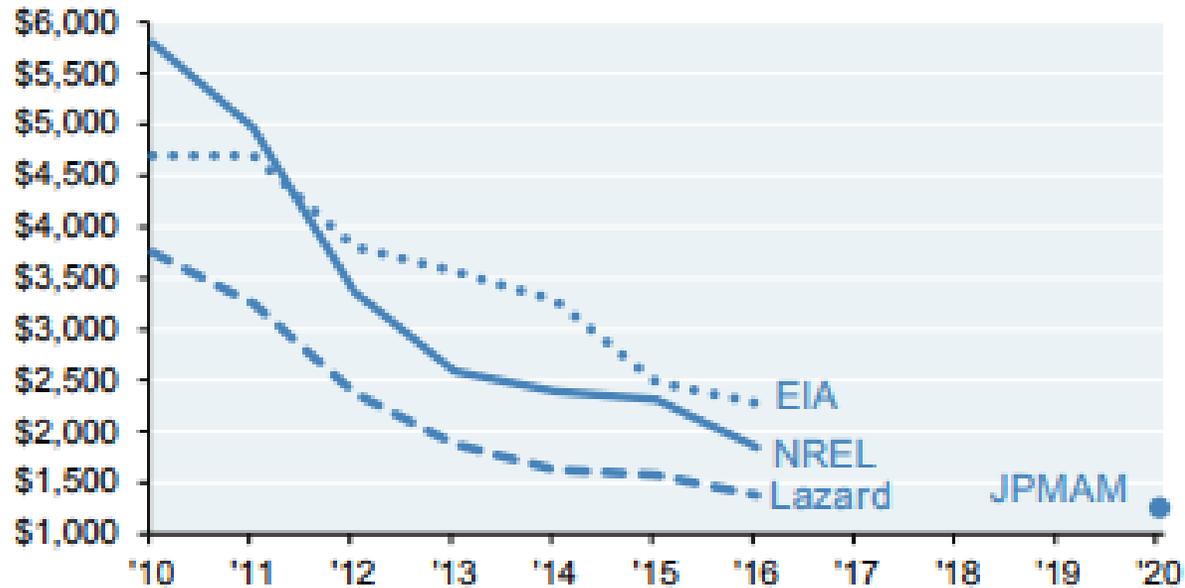
Major components of the U.S. average price of electricity, 2014



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2015*, Reference Case, Table 8: Electrical supply, disposition, prices, and emissions

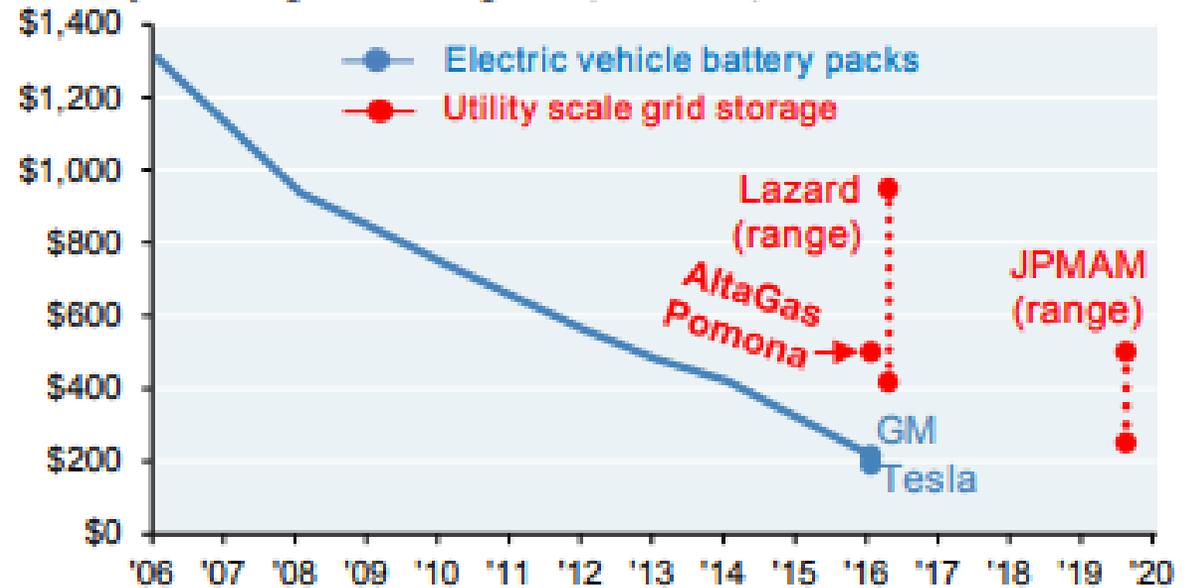


Utility scale solar PV capital cost estimates
 US\$/kW-AC, assuming 1.3 inverter DC-AC loading ratio



Source: NREL, EIA, Lazard, JPMAM. April 2017.

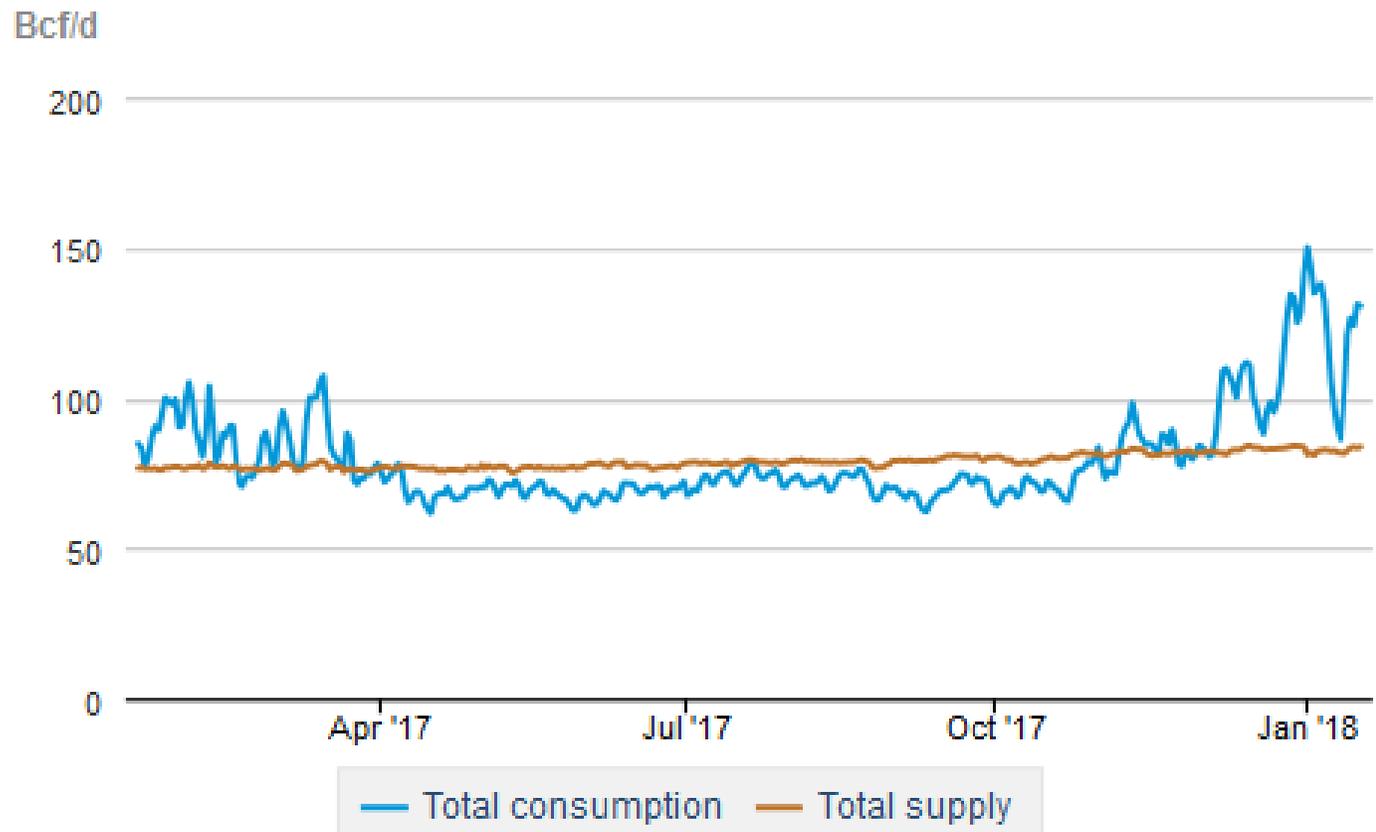
Lithium ion energy storage costs: EV battery packs vs utility scale grid storage, capital cost per kWh



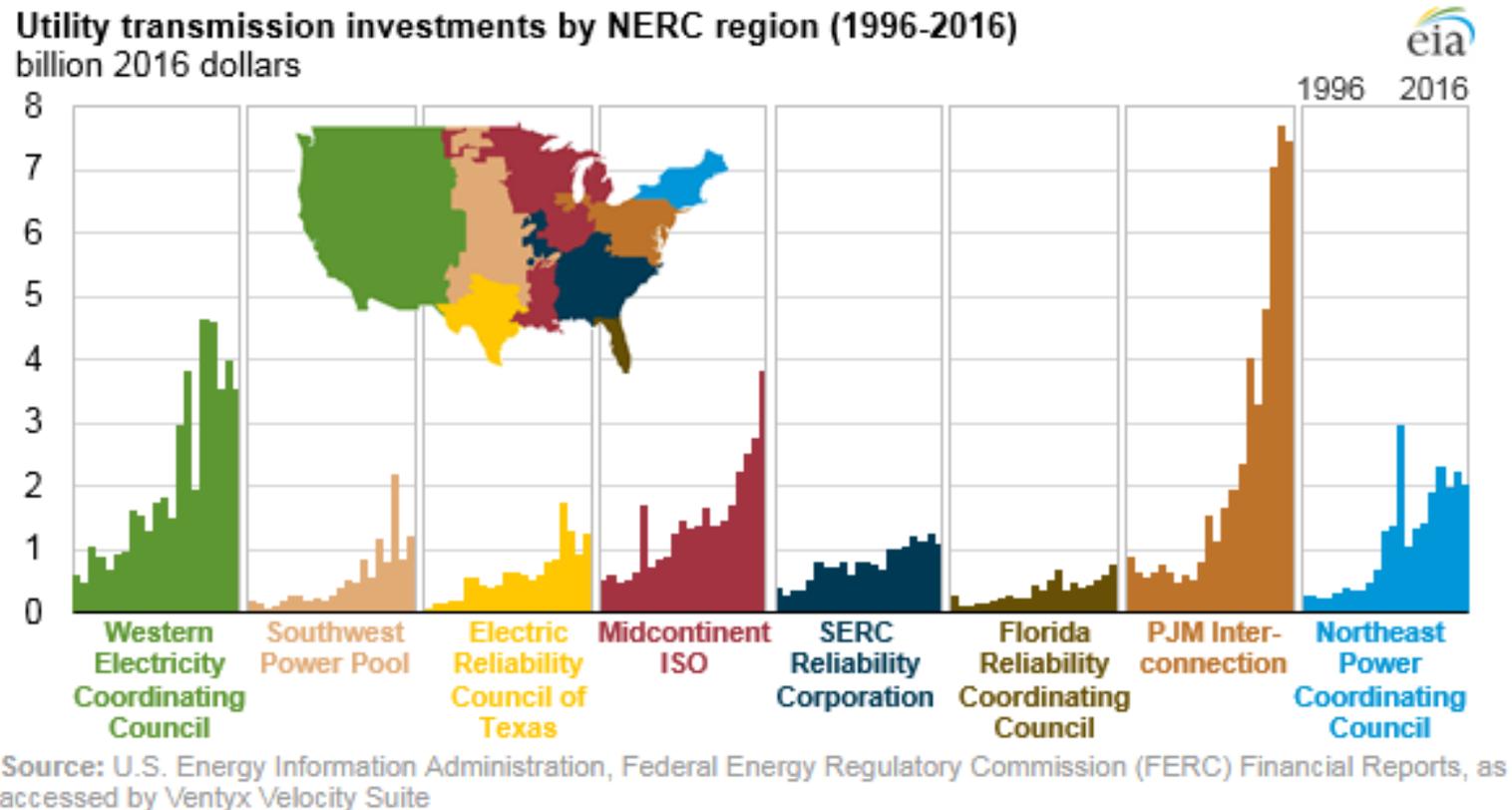
Source: Lazard, Nykvist, et. al., Green Car Reports, Utility Dive. April 2017.

US Demand and Production roughly in balance in recent years at about 75 Bcf/d

Total supply/demand balance (last 365 days)



Transmission investments have been on the rise regionally and nationally



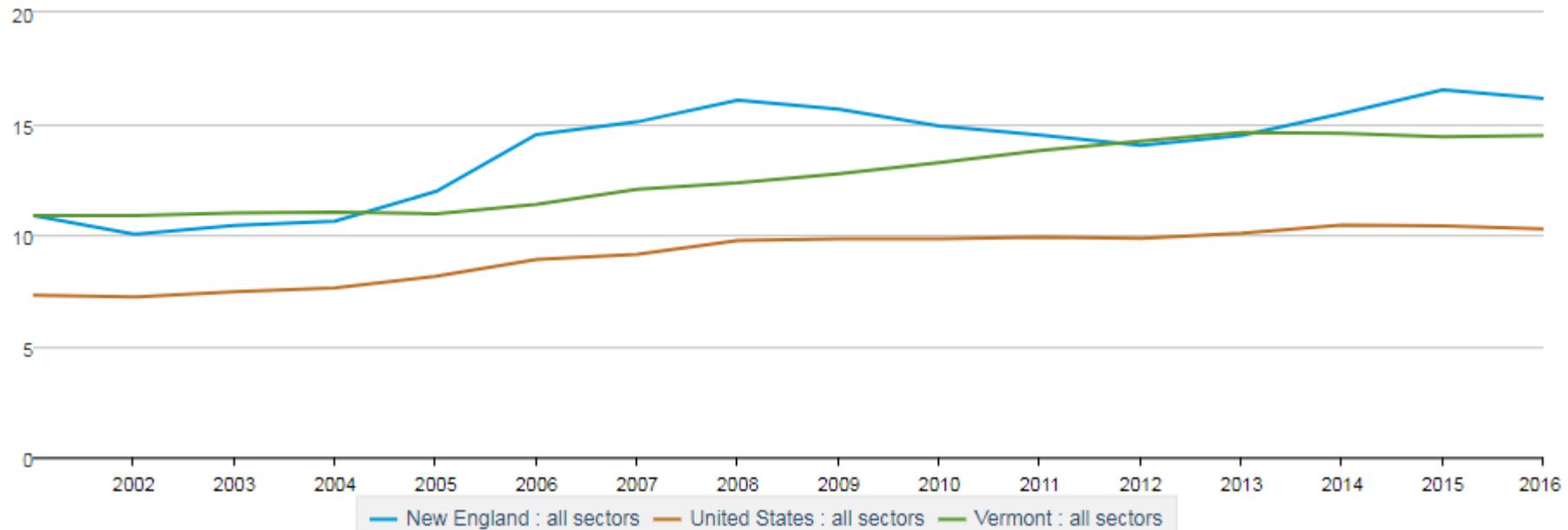
Source: EIA, <https://www.eia.gov/todayinenergy/detail.php?id=34892>

Electricity prices in Vermont are below the region but well above national

Average retail price of electricity, annual

DOWNLOAD

cents per kilowatthour

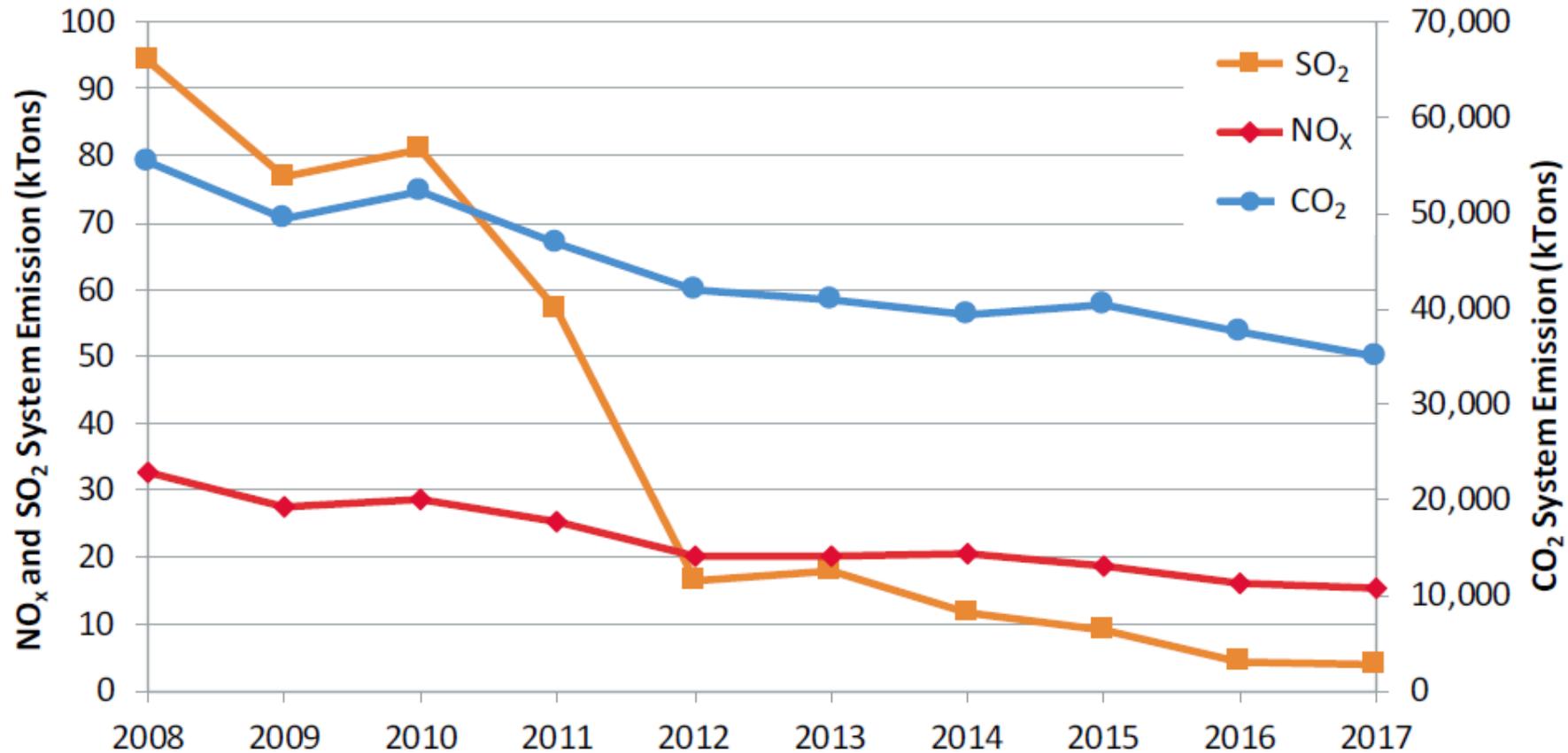


Source: EIA.GOV

The practical effect of some programs is that there is re-spreading of some costs...

- Average Rates ~ 15 cents/kWh
- Marginal/avoided costs/ratepayer costs/societal costs~
 - Energy 3-4 cents/kWh
 - FCM 1.5 – 2 cents/kWh
 - RNS 1.5 – 2 cents/kWh
 - Carbon at \$100/ton ~ \$5/MWh or ½ cent per kWh (assumes 10% regional power)
 - T&D – negligible
 - Total avoided ratepayer costs – 6-8 cents per kWh
- Margin lost on sales to be re-spread ~ 7 - 8 cents per kWh

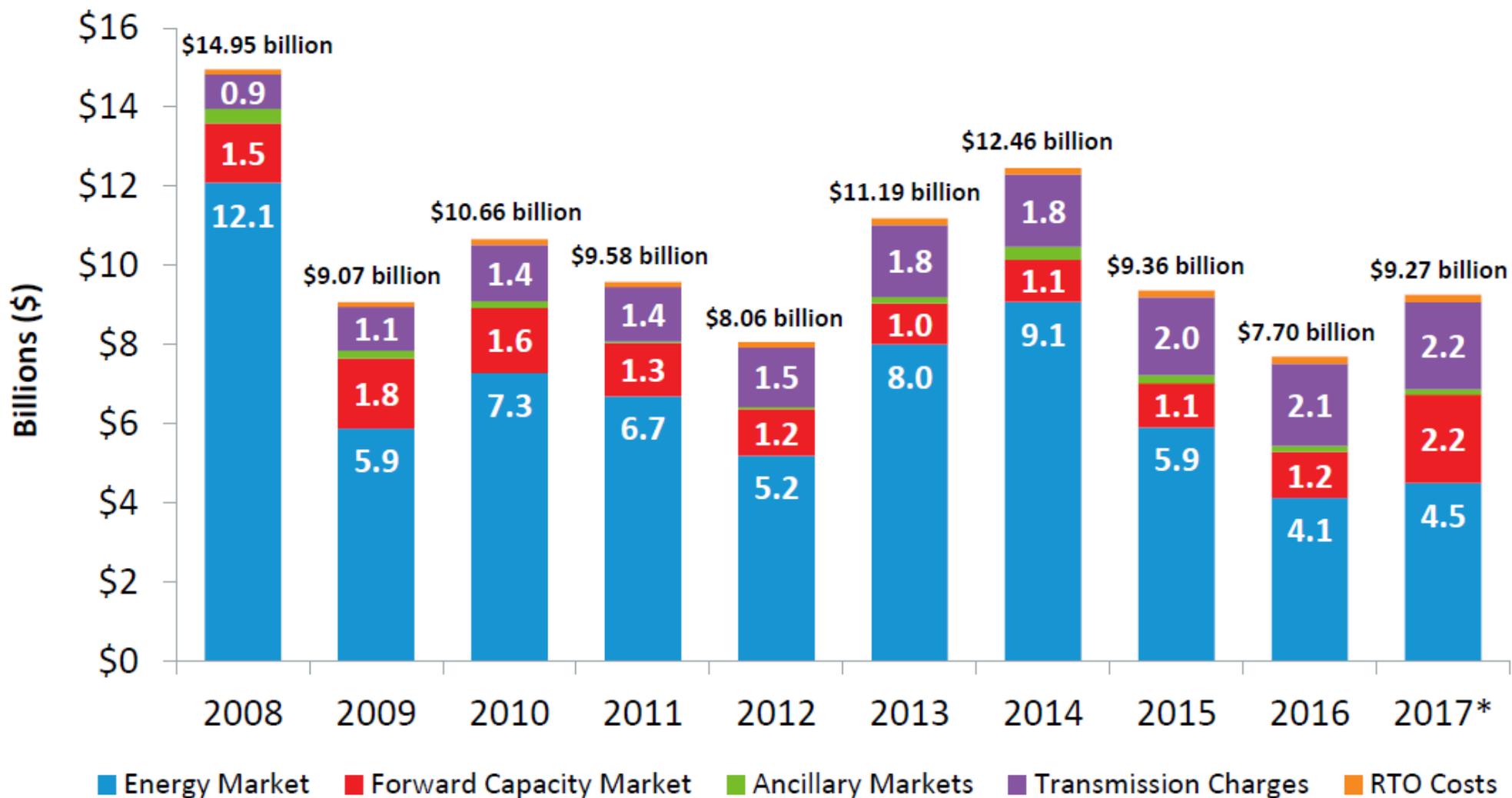
2008 – 2017 ISO-NE Annual System Emission (kTons)



Source: ISO-NE

New England Wholesale Electricity Costs

Annual wholesale electricity costs have ranged from \$7.7 billion to \$15 billion



Source: [2017 Report of the Consumer Liaison Group](#); * 2017 data is subject to adjustment

Note: Forward Capacity Market values shown are based on auctions held roughly three years prior to each calendar year.

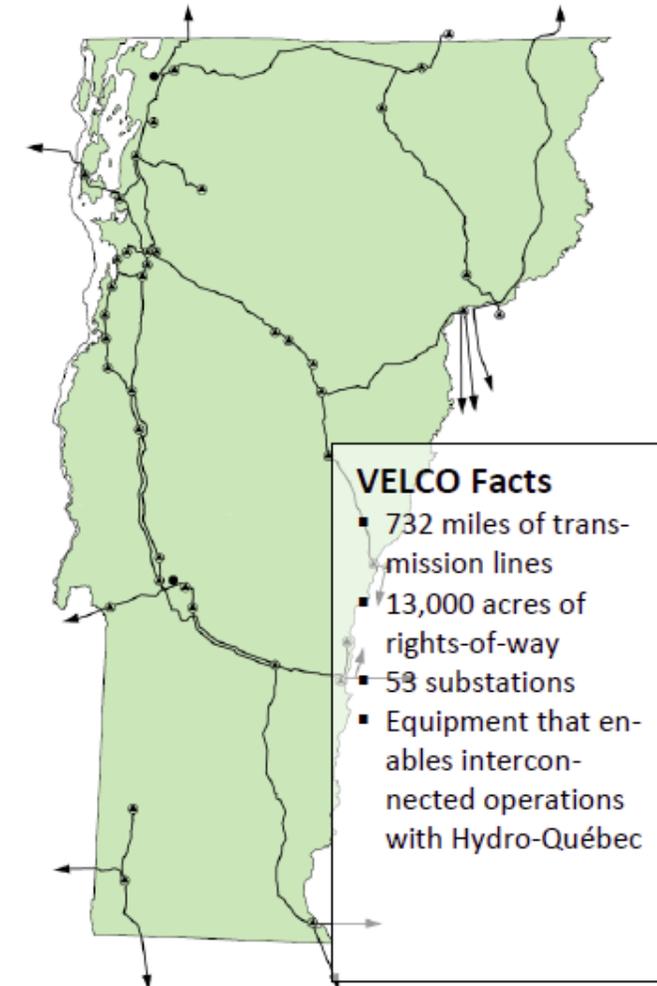
Source: ISO-NE

VELCO

Quick facts on VELCO

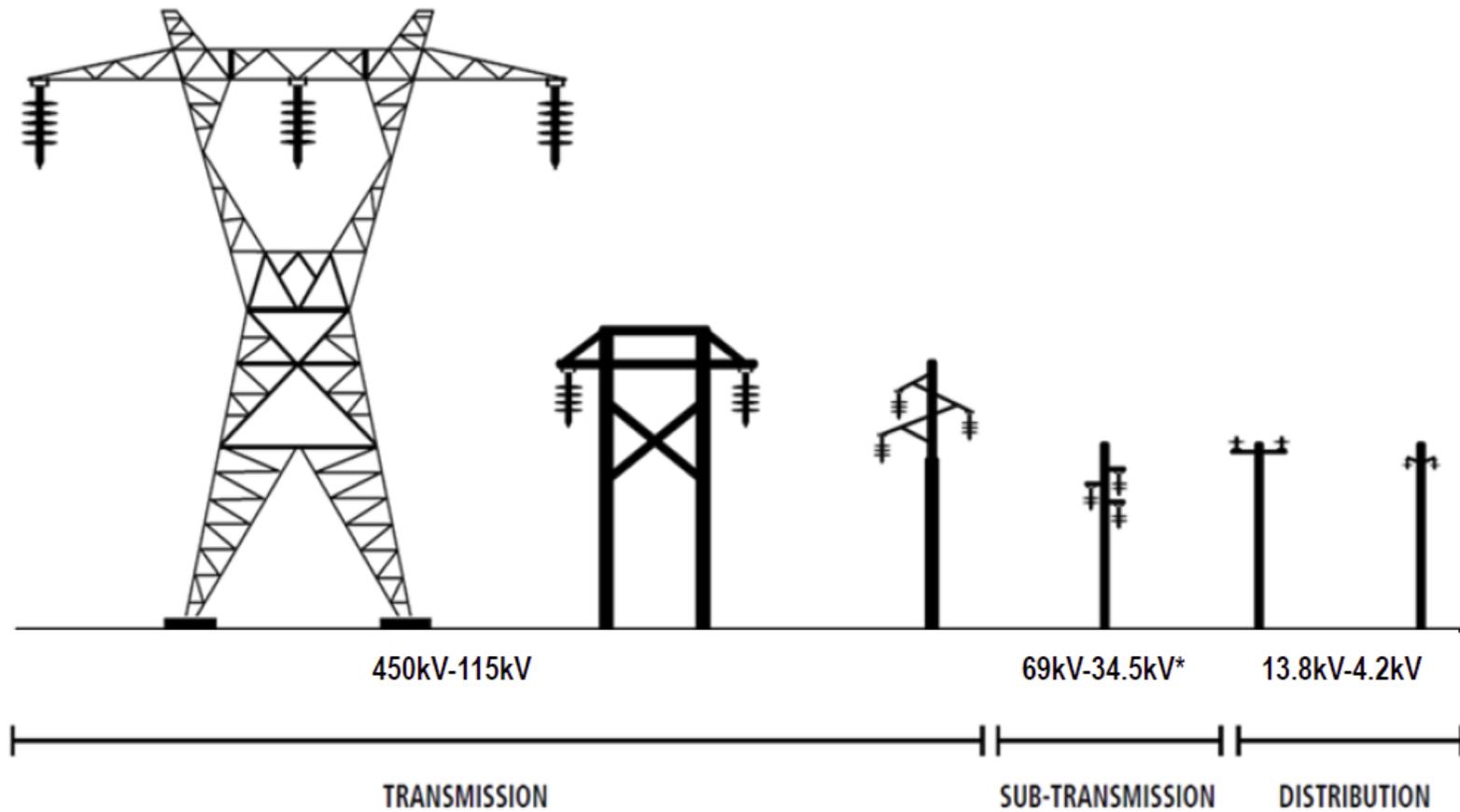
- Founded in 1956 as Vermont corporation
- 152 employees; HQ in Rutland; office in Montpelier
- Builds, operates, maintains facilities owned by VT Transco LLC
 - 738 miles of transmission lines; 1,500 miles fiber; 14,000 acres of ROW; 55 substations, switching stations, terminal facilities
 - \$1.3B in assets; \$21.6M in annual property taxes
- Ownership—17 distribution utilities, Vermont Low-Income Trust for Electricity or VLITE (public benefit corporation)
- Governance—13 member board: GMP(4), BED, VEC, VPPSA, Public Power (2), VLITE (3) and VELCO CEO
- For profit corporation structured to deliver cooperative benefits to Vermont
- Flat budget-fifth year in a row

VELCO TRANSMISSION LINES AND TIES TO
NEIGHBORING STATES AND CANADA



Source: VELCO

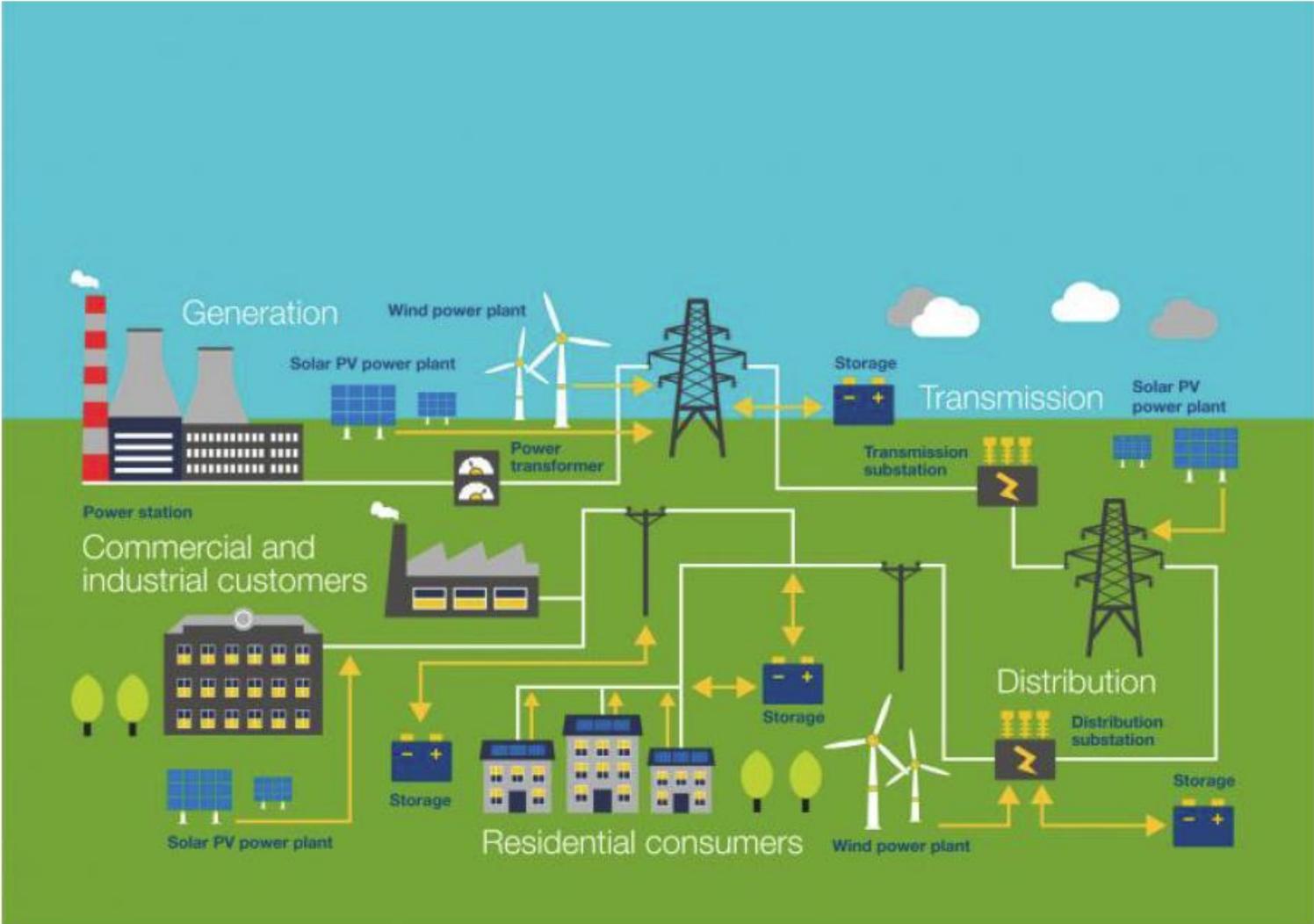
Transmission & distribution



Source: VELCO

*34.5kV may also be a distribution voltage

The evolving grid



Source: VELCO