



When Even the Y Isn't Known

NYISO Load Forecasting Task Force, October 18, 2023

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A Whole New Level of Complexity

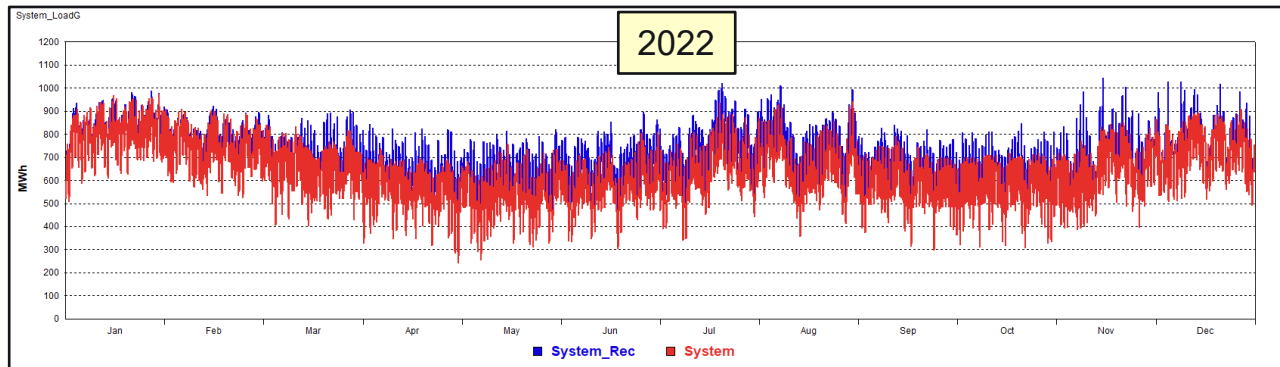
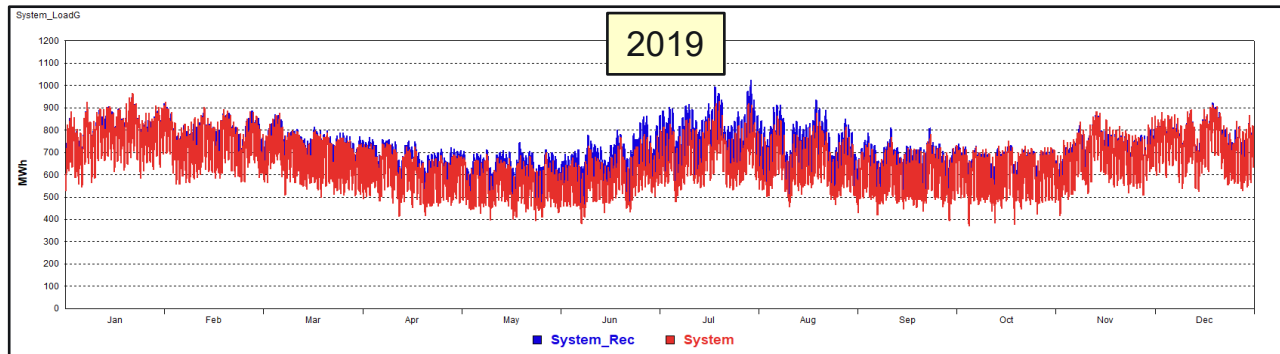
- » If we can't see it, how do we forecast it?
 - Behind the meter solar masking demand
 - Heat pumps masking COVID
 - Efficiency masking economic growth
- » Policy reshaping the future
 - Climate change and electrification
 - State greenhouse reduction goals
 - EV mandates
 - The Inflation Reduction Act
- » When we put it all together, what do we have ?



Looking at Vermont

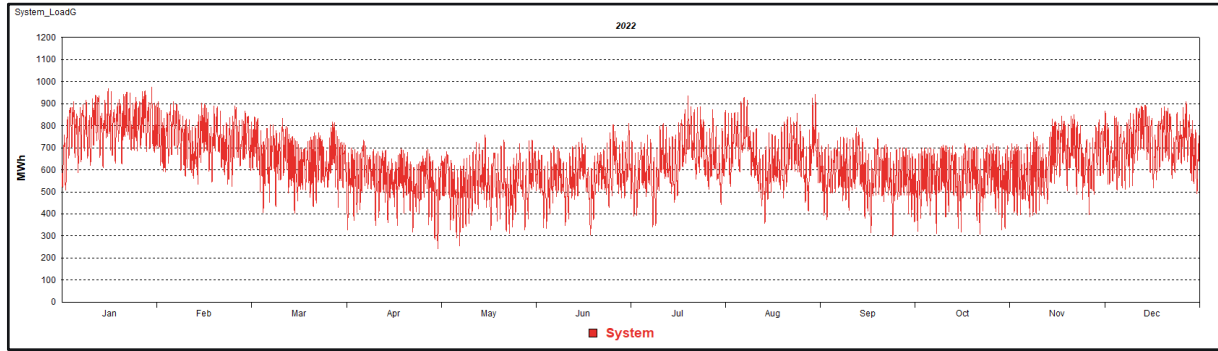
» In three years, a lot has changed

- Red is what we see and measure
- Blue is what we think is used
- COVID has changed how and where we work
- Significantly more behind the meter solar
 - The load we can't see
- Adoption of heat pumps that's reshaping loads
 - Can't see this either

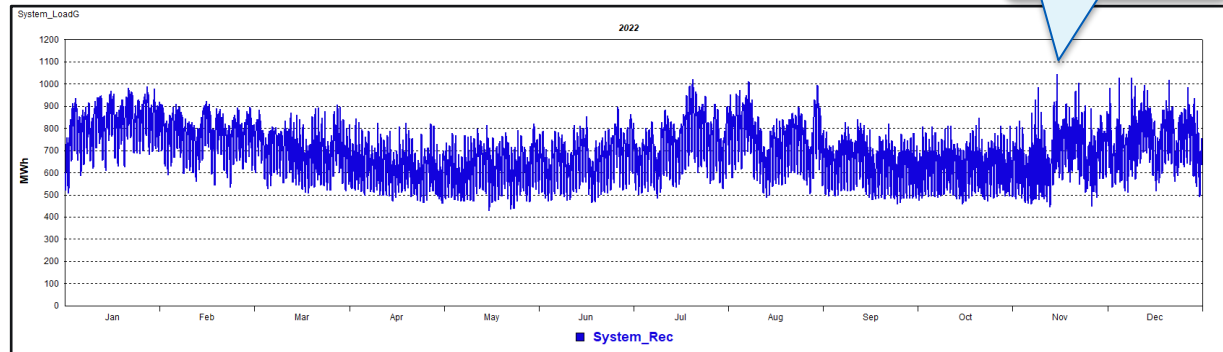


Comparison with Reconstituted Loads - 2022

What's Measured



When Reconstituted for Solar



» System peaks in November on a 32-degree day

Peak time shifts too

» 2019

- Measured peak between 6:00 PM and 8:00 PM
- Reconstituted peak between 1:00 PM and 3:00 PM

• 2022

- Measured peak between 6:00 PM and 8:00 PM
- Reconstituted peak 10:00 AM to 12:00 PM

• Fall and Spring Reconstituted Peaks

- 2019: between 5:00 PM and 6:00 PM
- 2022: between 9:00 AM and 10:00 AM

Date	PeakTime	Measured	PeakTimeRec	Reconstituted
Jan-19	1/21/2019 17:00	966.2	1/21/2019 17:00	966.2
Feb-19	2/12/2019 17:00	901.3	2/12/2019 17:00	901.3
Mar-19	3/7/2019 18:00	875.2	3/7/2019 18:00	875.2
Apr-19	4/9/2019 18:00	742.2	4/1/2019 11:00	771.8
May-19	5/28/2019 18:00	697.6	5/20/2019 14:00	743.8
Jun-19	6/27/2019 19:00	781.4	6/28/2019 15:00	863.8
Jul-19	7/20/2019 20:00	928.8	7/30/2019 13:00	1,024.5
Aug-19	8/19/2019 18:00	877.7	8/19/2019 14:00	936.3
Sep-19	9/23/2019 18:00	780.9	9/11/2019 13:00	811.1
Oct-19	10/17/2019 18:00	752.8	10/17/2019 18:00	752.8
Nov-19	11/13/2019 17:00	881.3	11/13/2019 17:00	881.3
Dec-19	12/19/2019 7:00	912.8	12/19/2019 9:00	923.7

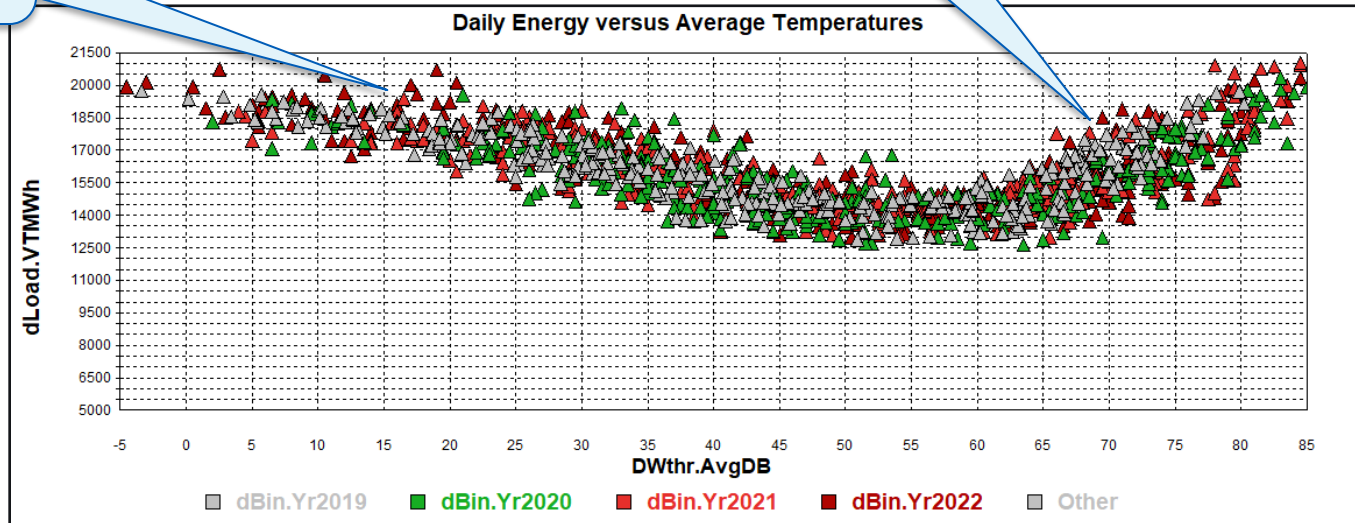
Date	PeakTime	Measured	PeakTimeRec	Reconstituted
Jan-22	1/29/2022 17:00	976.0	1/27/2022 10:00	989.0
Feb-22	2/5/2022 18:00	908.7	2/15/2022 9:00	920.6
Mar-22	3/1/2022 18:00	842.3	3/29/2022 10:00	905.4
Apr-22	4/7/2022 19:00	733.9	4/4/2022 9:00	844.1
May-22	5/16/2022 18:00	756.5	5/31/2022 12:00	819.4
Jun-22	6/26/2022 21:00	804.5	6/27/2022 10:00	894.6
Jul-22	7/20/2022 21:00	933.7	7/21/2022 14:00	1,020.4
Aug-22	8/30/2022 18:00	942.6	8/8/2022 11:00	1,009.2
Sep-22	9/12/2022 20:00	789.2	9/12/2022 10:00	841.4
Oct-22	10/26/2022 19:00	717.4	10/21/2022 9:00	845.9
Nov-22	11/21/2022 19:00	848.6	11/15/2022 9:00	1,042.9
Dec-22	12/27/2022 19:00	908.4	12/5/2022 9:00	1,028.6

Not only is solar shifting loads, but so are heat pumps

Another interesting view

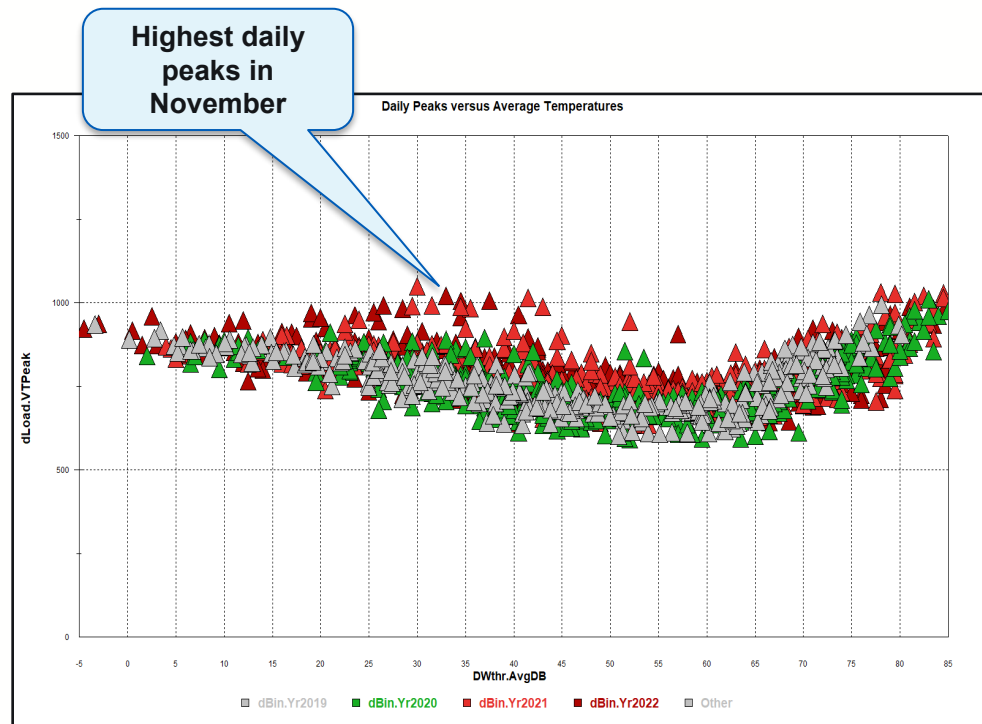
Higher average
winter loads for
same temperature

Higher average
summer loads for
same temperature



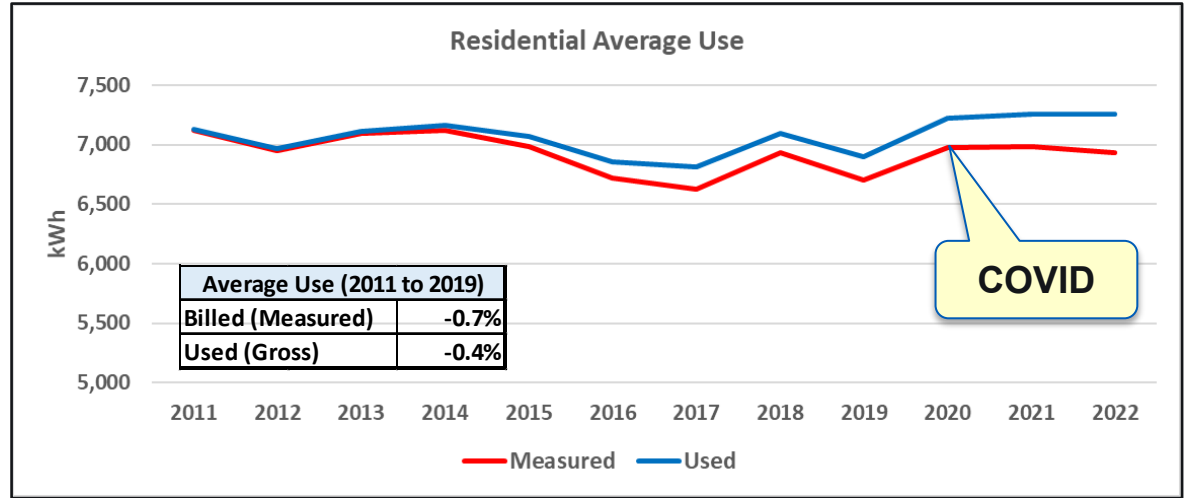
Daily peaks (reconstituted) vs. temperature

- » In 2021 and 2022, highest daily peaks in occur in November
 - Daily peaks are consistently higher between 25 and 60 degrees
- » The 2021 and 2022 coldest temperature peaks are no higher than prior years
- » May indicate how supplemental heat pumps are being used
 - Running through the fall with maximum output
 - Running at a lower rate or not at all on the coldest days
 - The primary heating system is doing all or most of the work
- » Does November become the new peak month?



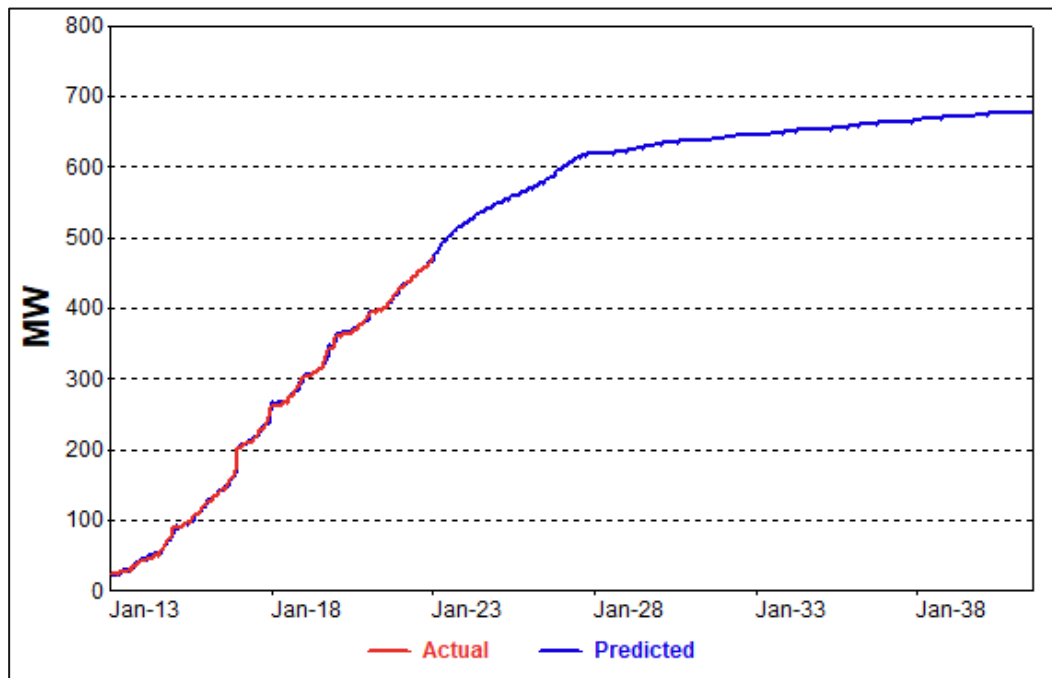
Solar also masks customer use

- » Want to forecast energy requirements. Not just what's purchased.
- Add back in what we think is own-use (vs sold back to the utility)
- Billed use (prior to COVID) is declining 0.7% per year
- But actual use is declining only 0.4% per year
 - Have been over-estimating the impact of energy efficiency



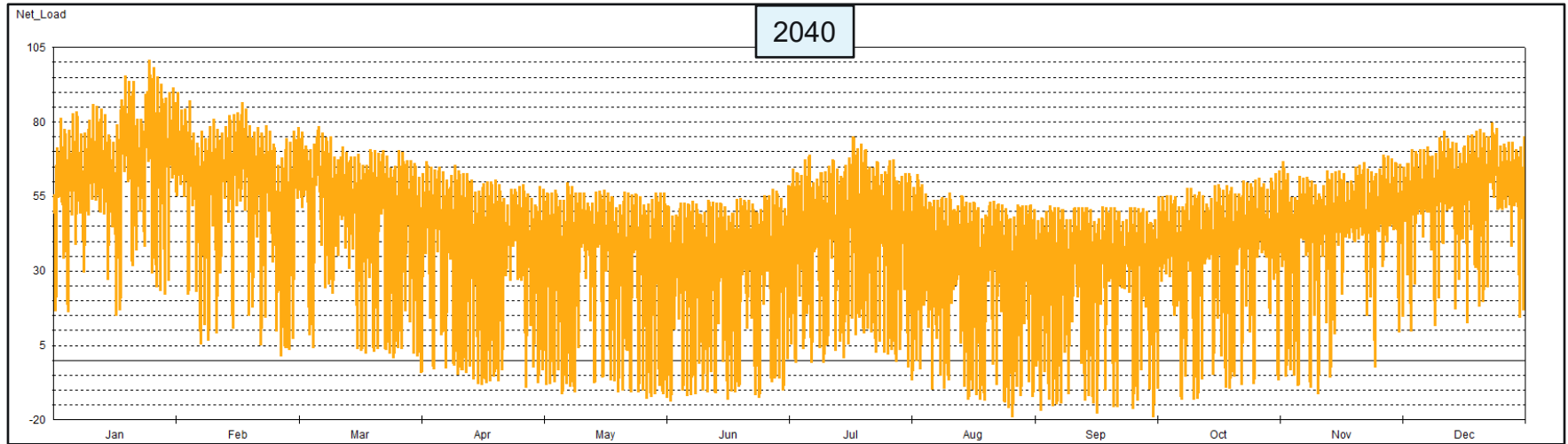
And BTM solar continues to increase

- » Inflation Reduction Act extends and increases the federal tax credit from 26% to 30%
- » Tax credits plus favorable payment for excess generation translate into continued strong PV adoption
 - Paying average retail rate (16.6 cents per kWh)



Loads at some delivery points go negative Central

Unless you start capping solar and reduce incentives

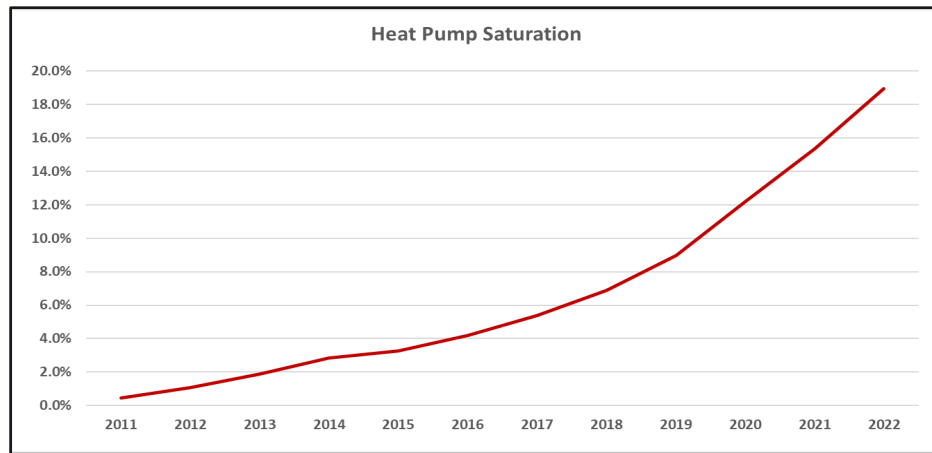
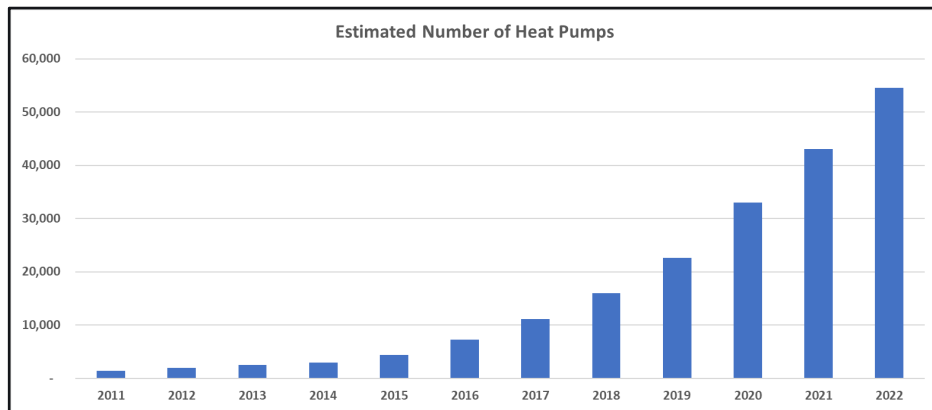
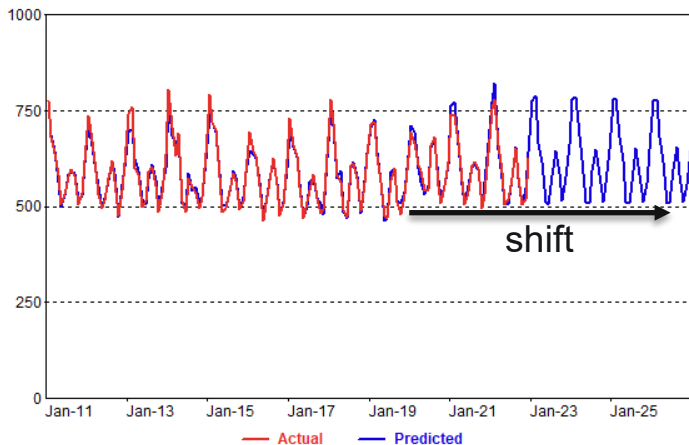


Or start adding battery storage

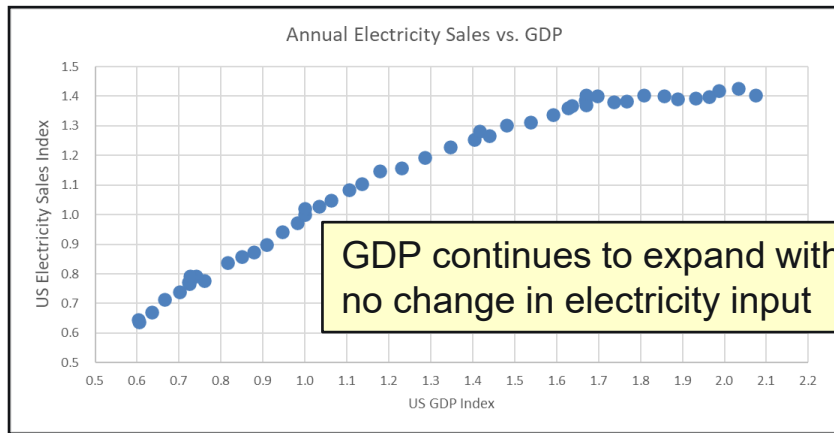
Heat pump adoption masks COVID impacts

» What we thought was all COVID related behavior (elevated residential customer use) is masked by significant increase in cold climate heat pumps (CCHP)

- Over 45,000 heat pumps since 2017.
- Saturation increasing from 5% to 19%.

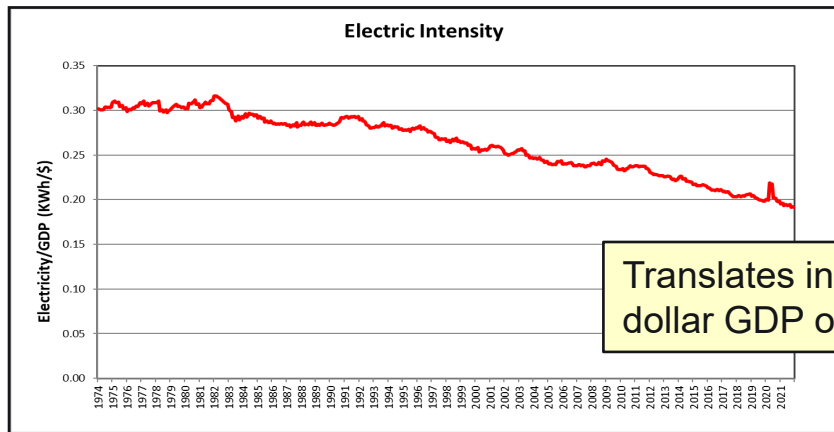


Further Complicating Matters: Relationship with Economics



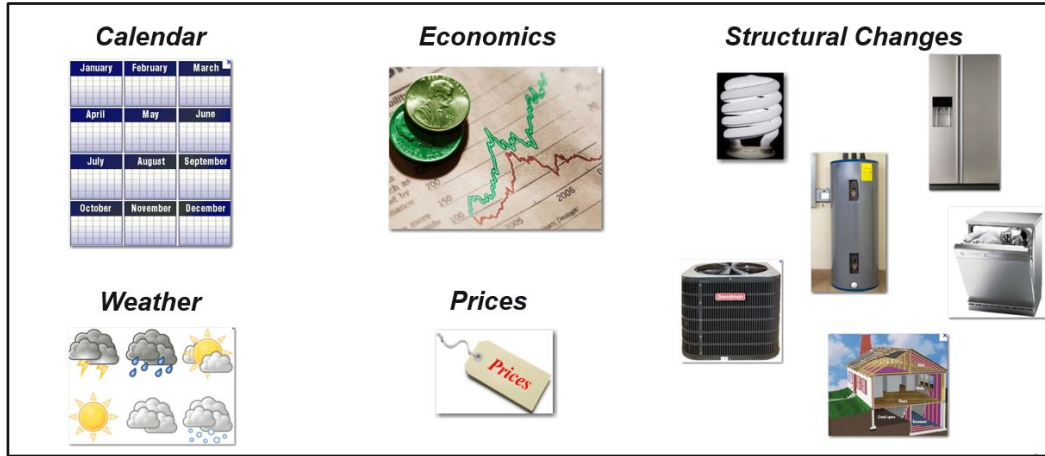
GDP vs. Electricity

Period	Correlation
1974-1979	0.987
1980-1989	0.982
1990-1999	0.989
2000-2009	0.962
2010-2019	0.692
2020-2021	0.330



➤ How can we use economic drivers to forecast electric sales when the direct relationship is weak and even negative?

All things matter – it's the interactions that drive demand



- » You can't capture the impact of one factor without accounting for another
- Impact of weather depends on the amount of air conditioning and heating loads in place
 - Price, income, and GDP impacts depend on the efficiency of the underlying equipment
 - Efficiency depends on appliance costs, standards, and rebates

All adds complexity to the underlying models

Climate Policy Drives the Forecast

» Vermont Climate Action Plan (CAP)

- Requires state to reduce greenhouse gases 26% below 2005 levels by 2025
- 40% below 1990 levels by 2030
- 80% below 1990 level by 2050
- Provides rebates for heat pumps, heat pump water heaters, and electric vehicle purchases

» Recently passed Affordable Heating Act

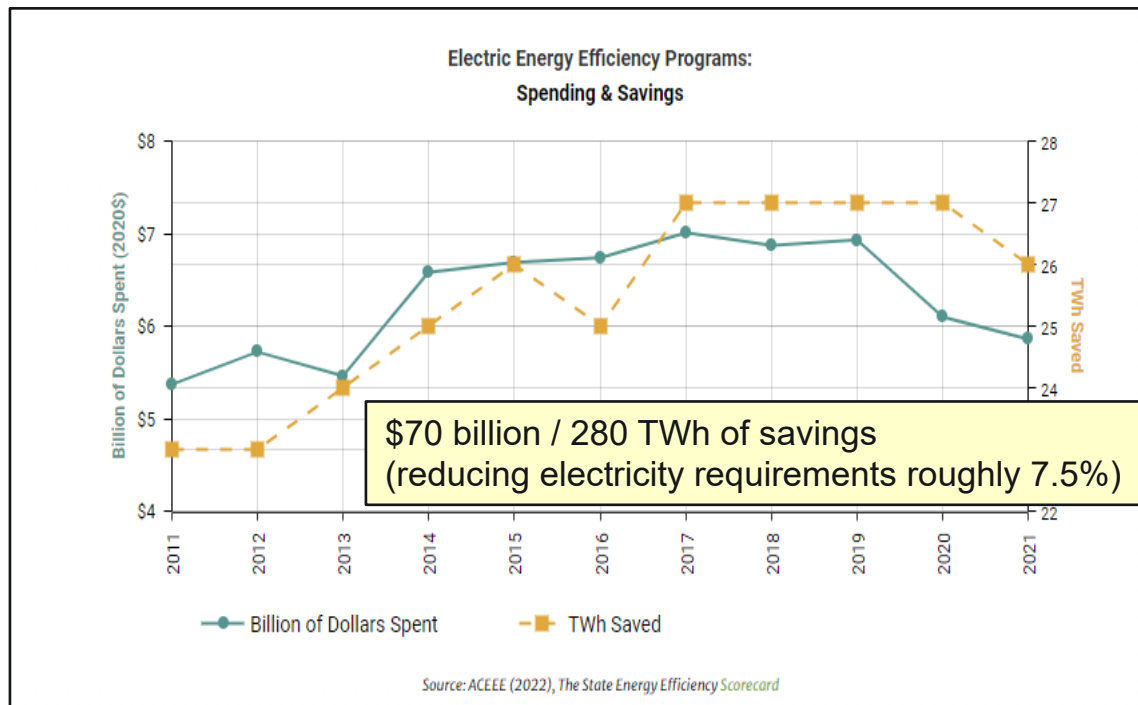
- Requires fossil fuel suppliers (heating oil, propane, natural gas) to offset heating fuel sales with clean heat credits.
 - Purchase credits or earn credits through displacing greenhouse gases by through weatherization and converting customers to non-fossil fuel heating options

The Inflation Reduction Act

Efficiency and electrification is about to get super charged

» Provides \$18 billion in federal grants and \$36.5 billion in tax credits for efficiency and electrification.

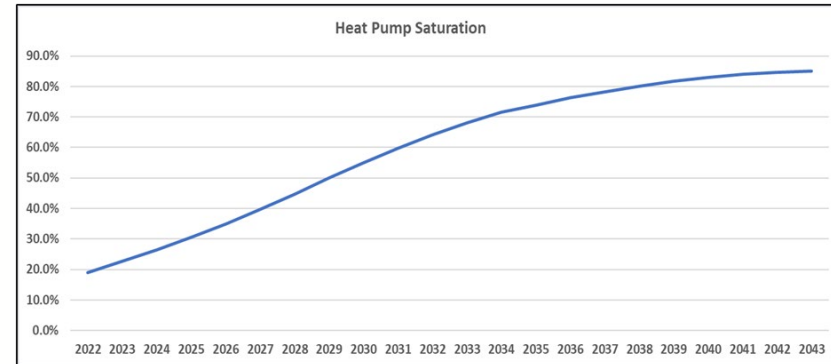
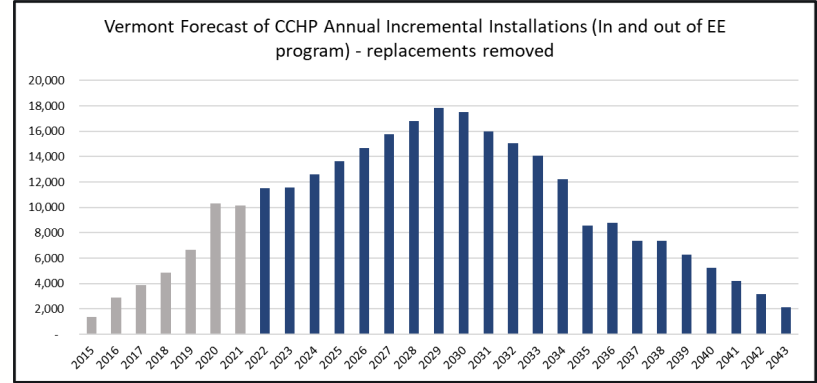
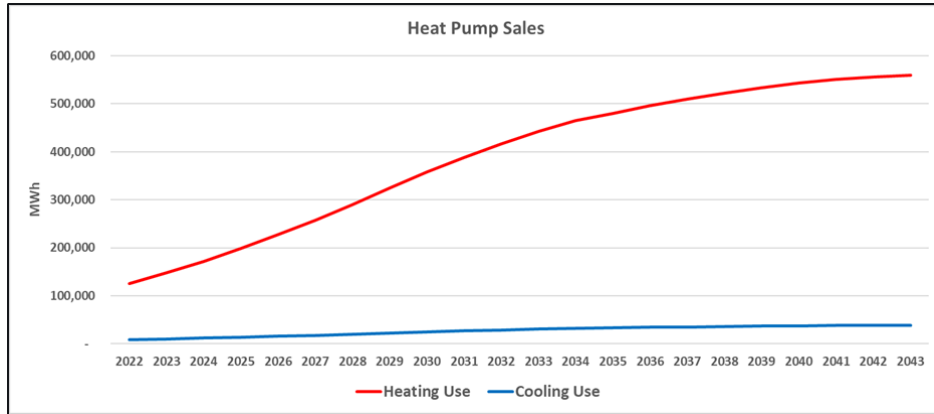
- Rebates will flow through the states and energy efficiency entities starting next year
- Home Energy Rebate Program
- \$55.5 million allocated to Vermont
 - Weatherization
 - Electrical panel upgrades
 - Heat pumps and heat pump water heaters



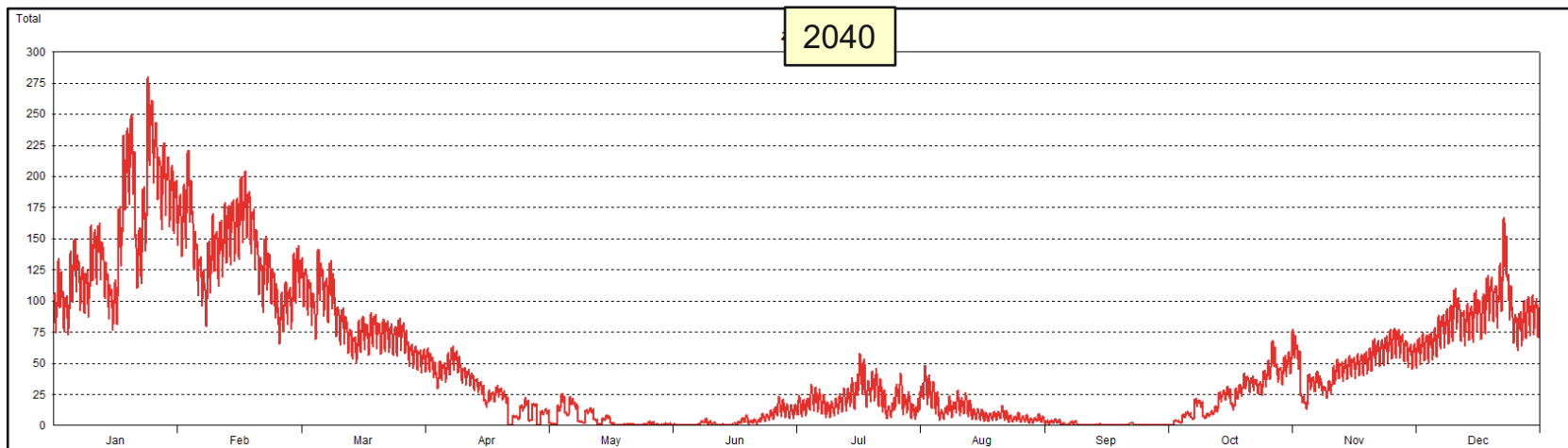
To meet CAP, projecting strong heat pump adoption

» Currently adding approximately 10,000 units per year – projected to increase to nearly 18,000 per year by 2030.

- 50% saturation by 2030
- 85% saturation by 2043



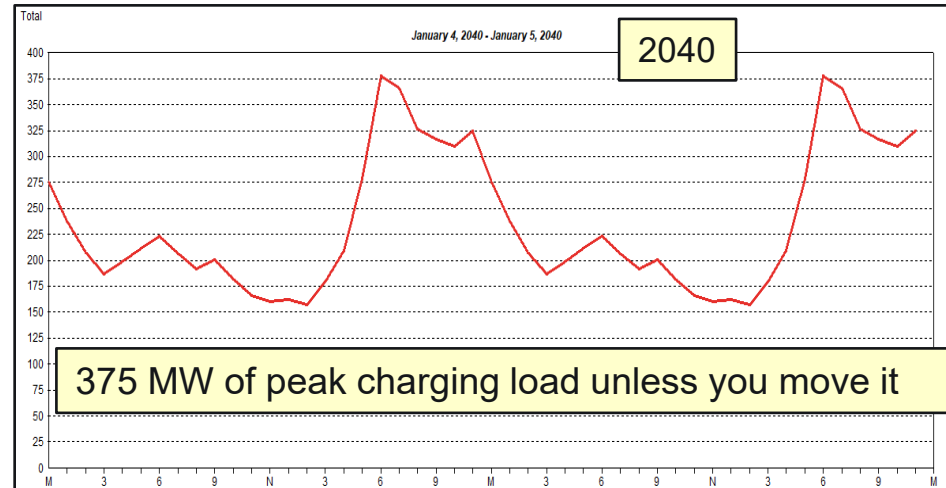
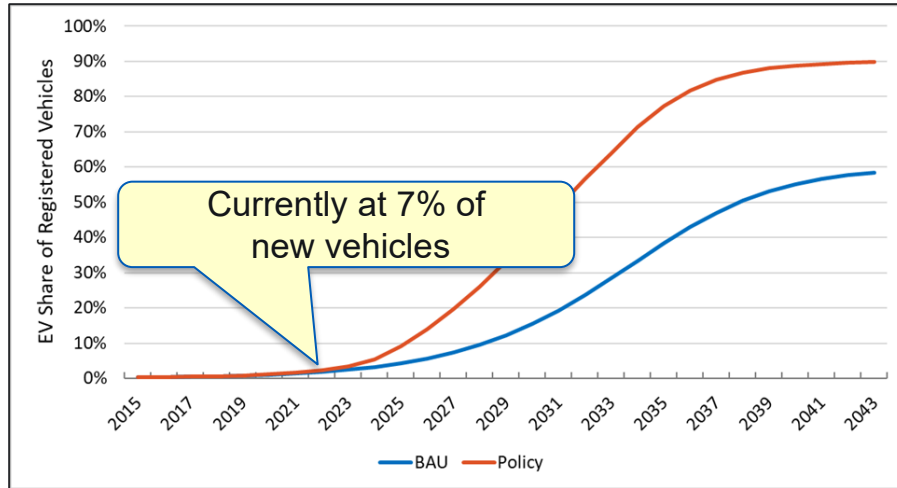
Heat Pump Load Forecast



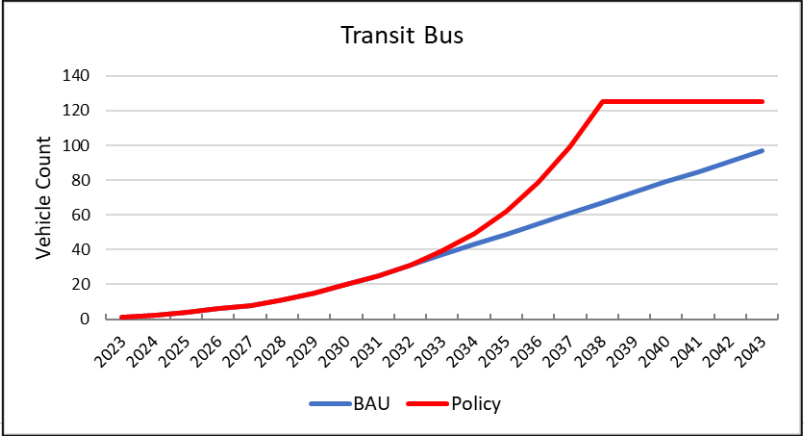
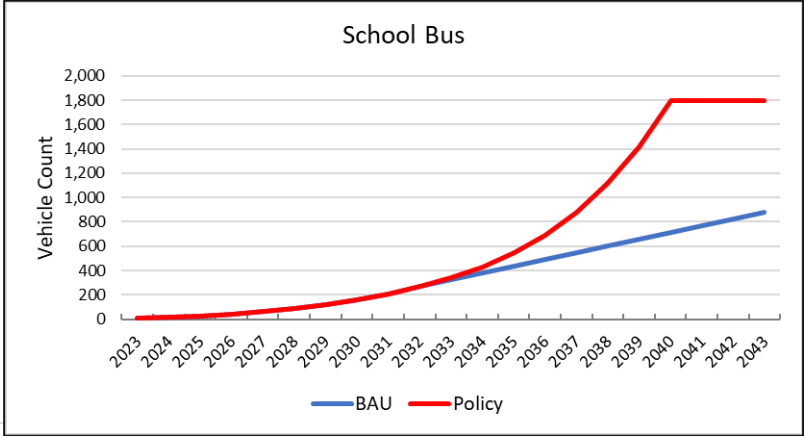
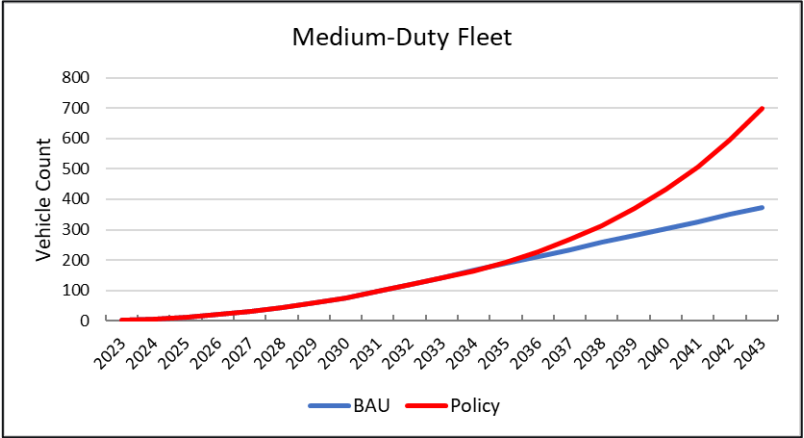
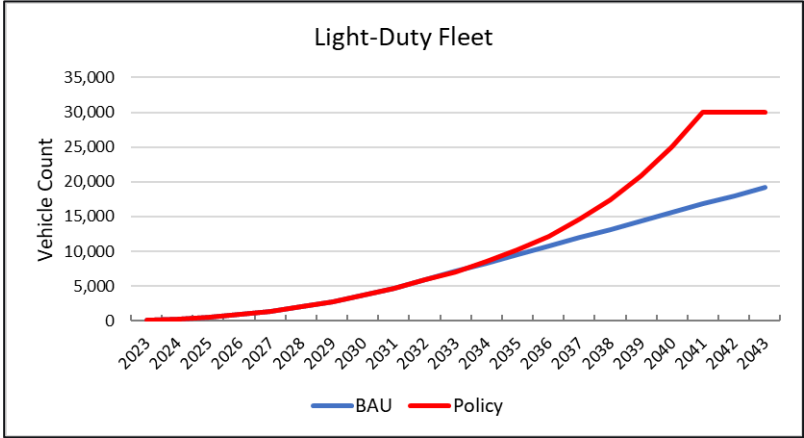
- » Combine shapes with energy results in 275 MW peak heat pump load at 7:00 AM
 - Assuming we get everyone to use their heat pump “correctly”

Then Throw in Electric Vehicles

- » Vermont has adopted the California Advanced Clean Cars II rule along with New York, New Jersey, Massachusetts, Connecticut, Rhode Island, Oregon, and Washington)
 - Requires zero-emission vehicles represent 35% of new car sales by 2026, 68% by 2030, and 100% by 2035.
 - Vehicle incentives extended as part of the Inflation Reduction Act

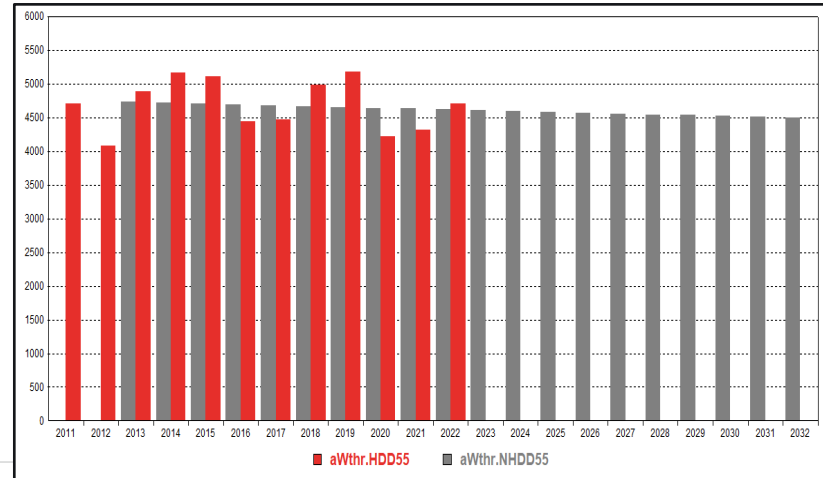
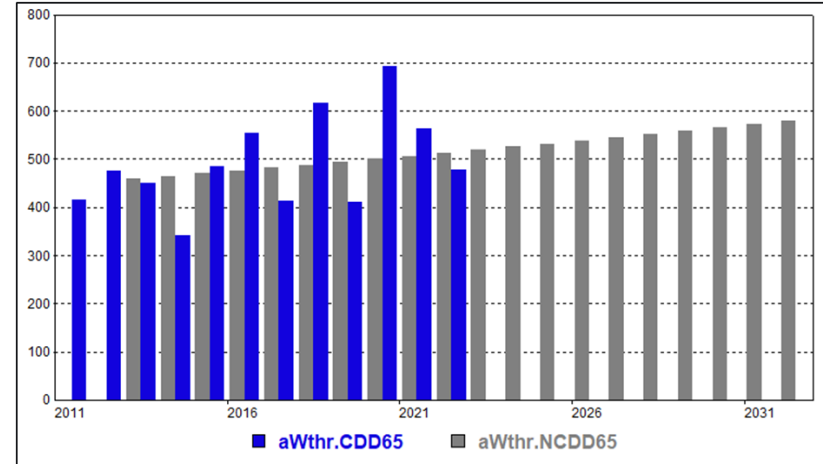
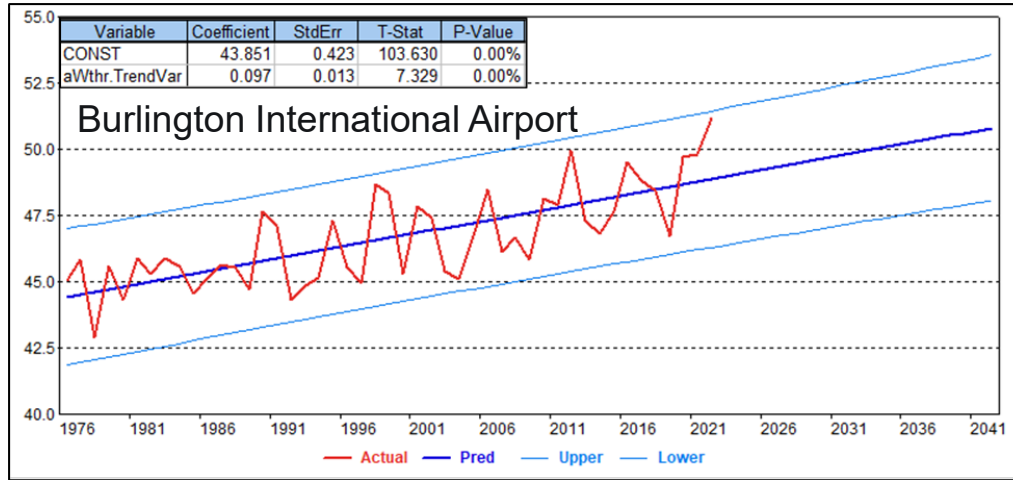


And the Latest Addition - Fleet Electric Vehicle

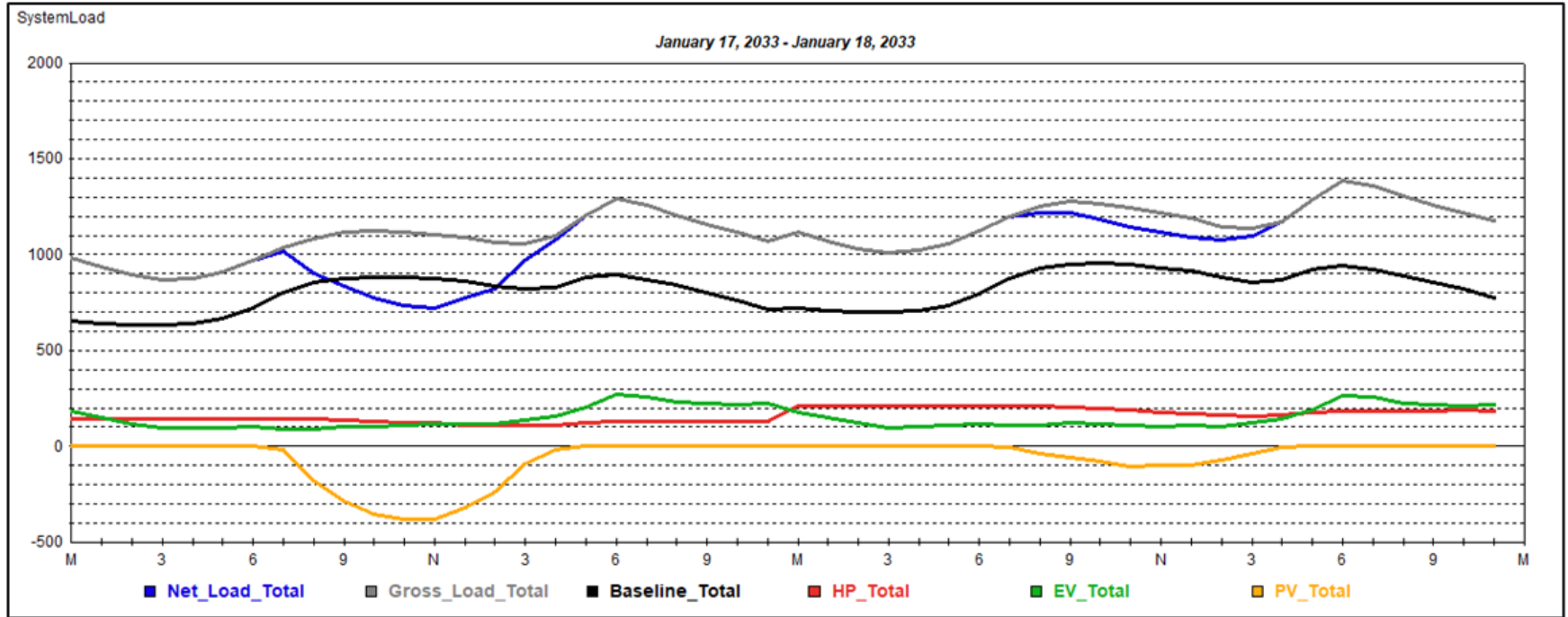


And it's still getting warmer

- » Average temperature increasing 0.097 degrees per year
 - Nearly 1 degree per decade



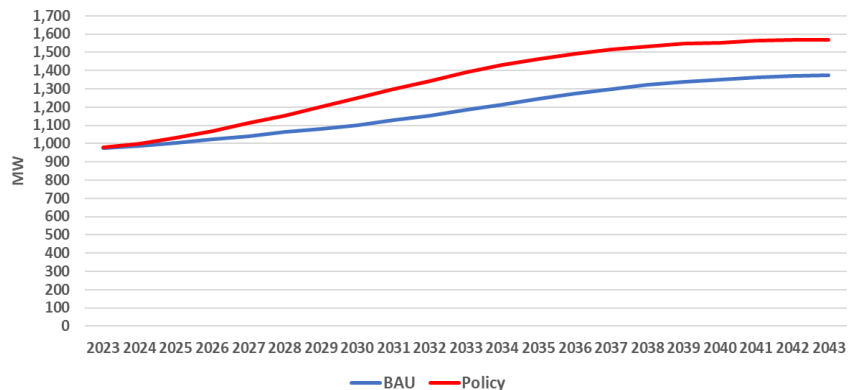
When you put it all together



No idea what you are going to get until you add it up

Net Peak Demand Forecast

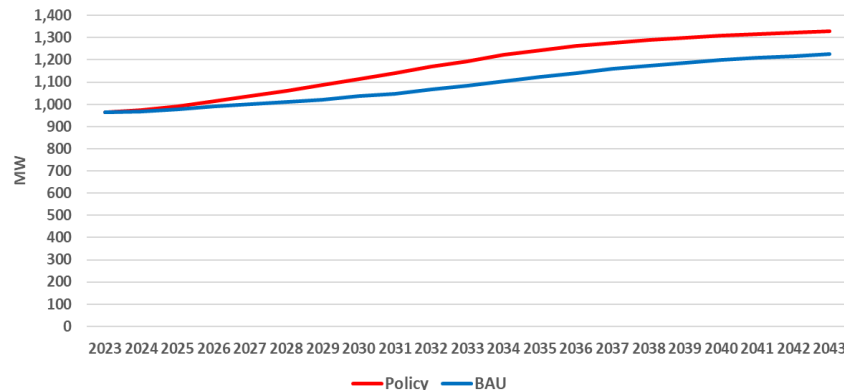
Winter Peak Demand



Date and Time	Policy (MW)				BAU (MW)			
	Peak	Base	HeatPmp	EV	Peak	Base	HeatPmp	EV
1/24/23 6:00 PM	978.4	960.6	12.6	5.3	974.3	960.6	11.4	2.4
1/18/28 6:00 PM	1,154.4	960.5	94.3	99.6	1,062.2	960.5	69.4	32.3
1/18/33 6:00 PM	1,388.8	943.9	182.5	262.4	1,184.9	943.9	126.7	114.3
1/19/38 6:00 PM	1,533.0	938.4	228.9	365.8	1,321.0	938.4	171.9	210.7
1/20/43 6:00 PM	1,568.7	933.8	250.4	384.4	1,374.8	933.8	193.8	247.2
Grwth								
2023 - 33	3.6%				2.0%			
2023 - 43	2.4%				1.7%			

Winter policy peak: 1,389 MW in ten years
1569 MW in twenty years.

Summer Peak Demand



Date and Time	Policy (MW)					BAU (MW)				
	Peak	Base	HeatPmp	EV	PV	Peak	Base	HeatPmp	EV	PV
7/18/23 6:00 PM	965.6	970.7	2.8	3.3	(11.3)	963.5	970.7	2.5	1.5	(11.3)
7/18/28 7:00 PM	1,061.6	976.4	19.6	66.4	(0.9)	1,011.5	976.4	14.4	21.5	(0.9)
7/19/33 7:00 PM	1,194.9	983.2	37.8	174.9	(0.9)	1,084.5	983.2	26.2	76.1	(0.9)
7/20/38 7:00 PM	1,288.9	999.2	47.4	243.4	(1.1)	1,173.9	999.2	35.6	140.2	(1.1)
7/21/43 7:00 PM	1,329.3	1,022.8	51.9	255.5	(0.9)	1,226.3	1,022.8	40.1	164.3	(0.9)
Grwth										
2023 - 33	2.2%					1.2%				
2023 - 43	1.6%					1.2%				

Summer policy peak: 1,195 MW in ten years
1329 MW in twenty years.

Adding 40% to load in 10 years and 60% in 20 years

How accurate is the forecast?

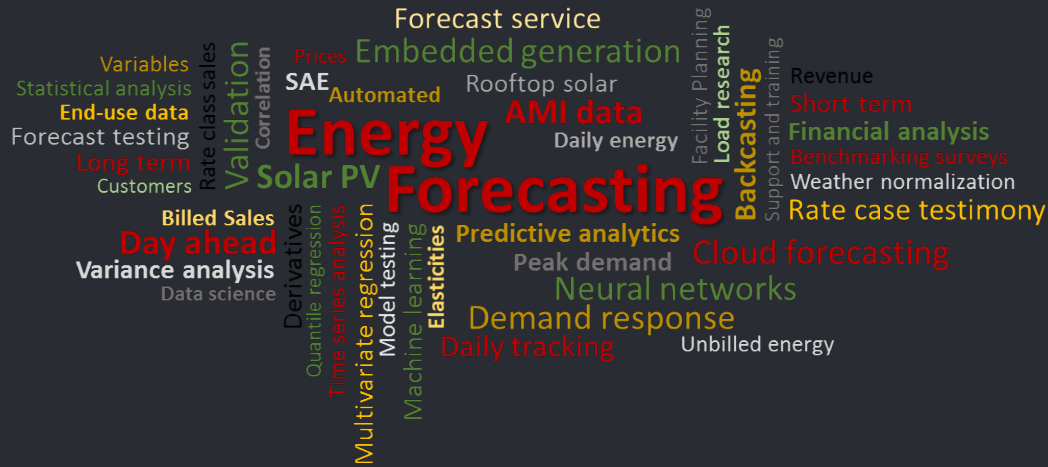
- » System demand has been increasing less than 0.5% per year over the last ten years
 - Now projecting 3.6% growth over the next ten years
- » High level of uncertainty
 - Forecast hinges on significant government action, laws, and incentives
 - People don't always respond like we think they will
- » Need to recognize what we have is a scenario. Need to bound with other possibilities.
 - Income constraints: Heat pumps are expensive even with incentives
 - Lower heat pump market penetration
 - EV targets: Need significant investment in charging infrastructure and vehicles with extended driving distance (Vermont is a relatively rural state, long distances to travel)
 - Takes longer to reach 100% saturation

What can we say?

- » Forecasting is significantly more complicated – need to understand how one aspect of future energy growth impacts another
- » Energy use and loads can be impacted through standards, incentives, and law (we can move the needle)
 - But significant future load-level uncertainties
 - Timing: How quickly can incentives, rebates, and laws impact loads
 - End users: People don't always do what we expect
- » And we really don't even know Y anymore
 - The one thing we could always be confident in was that we had actual loads and sales
 - With BTM solar and increasing EV charging load the best we can hope for is a good estimate

Thoughts?





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Thank You



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