

# BENEFITS OF WIND ENERGY FOR NEW ENGLAND

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February 1, 2023

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# BENEFITS OF RENEWABLE ENERGY IN NEW ENGLAND

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A look at how adding more wind generation in New England can improve prices, reliability, and emissions rates.

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Prepared with



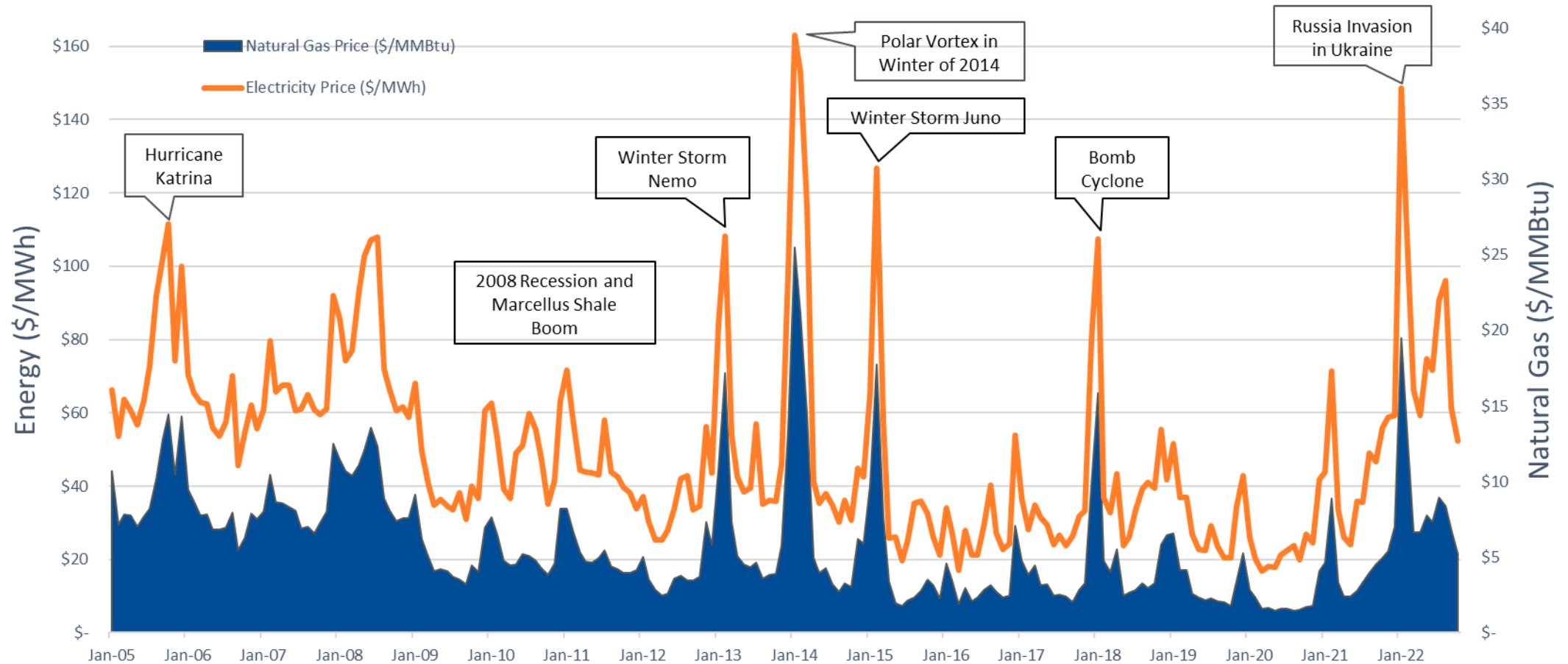
## RENEWABLE CONTRACTS HEDGE RISING ENERGY PRICES

- New England is vulnerable in the winter to energy price spikes associated with constraints in the delivery of natural gas, leaving consumers on the hook for high natural gas costs.
- Long-term renewable contracts, which lock in steady prices for decades at a time, provide benefits that offer less price volatility and lower electricity market prices.
- As New England continues to invest in renewable energy, consumers will benefit from the effective hedges against natural gas prices.



# NATURAL GAS AND ELECTRICITY PRICES ARE VOLATILE TO EXTERNAL EVENTS

Natural gas prices drive electricity prices and are subject to many sources of volatility. Domestic and reliable renewable contracts can hedge against rising prices and volatility.



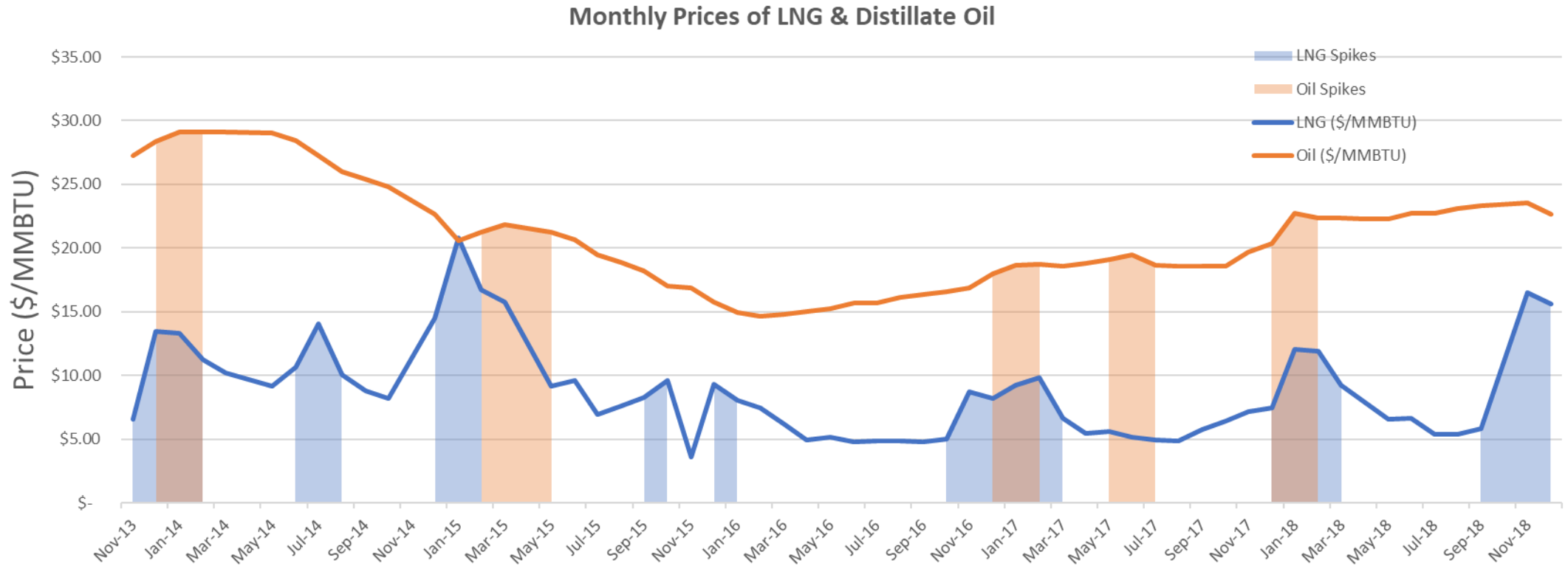
Historical Natural Gas and Electricity prices were pulled from S&P using their screener function. The price of energy is at ISO-NE Internal Hub. The price of natural gas is at Algonquin City Gates.





# ADDITIONAL RENEWABLES REDUCES RELIANCE ON HIGH PRICE LNG AND FUEL OIL

Liquefied Natural Gas and Distillate Oil is used primarily in the winter, when pipeline natural gas is used for heating. The price of Liquefied Natural Gas and oil tends to jump in the winter months, with the conflict in Ukraine and rising gas prices in the winter, exacerbating the price.



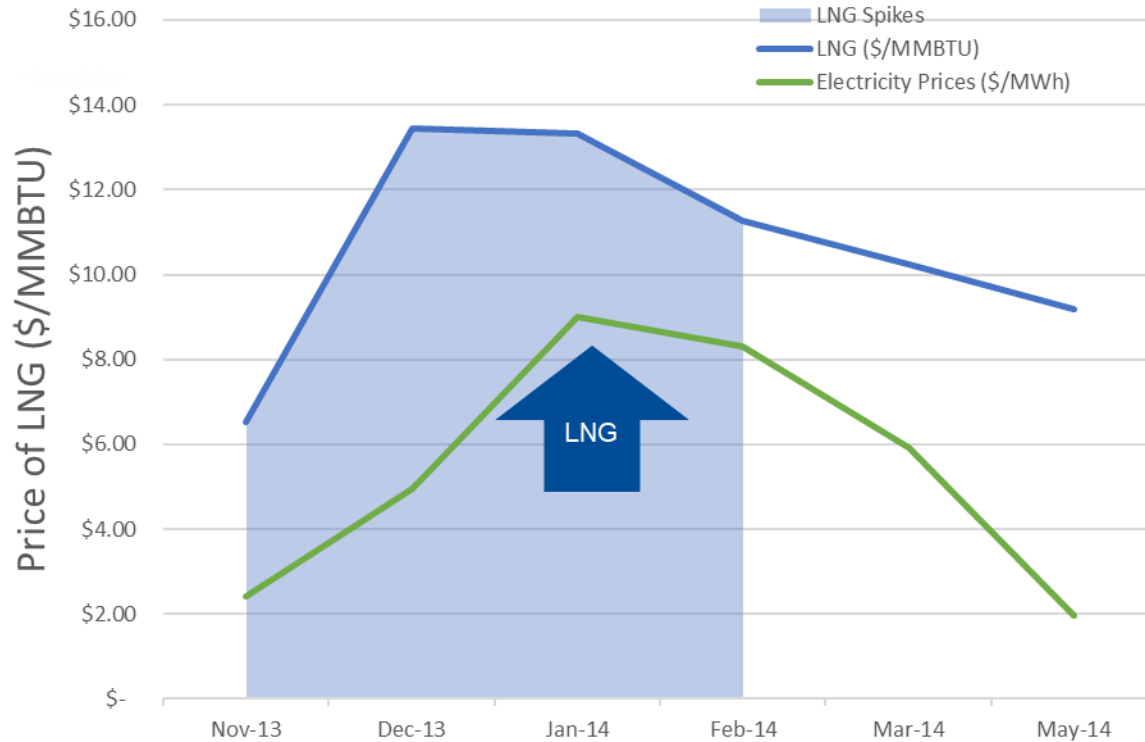
Monthly Liquefied Natural Gas prices at Everett, MA and distillate oil prices were pulled from EIA. The data represents the price of Liquefied Natural Gas at Everett, MA. The shaded areas represent the price peaks during the winter months.



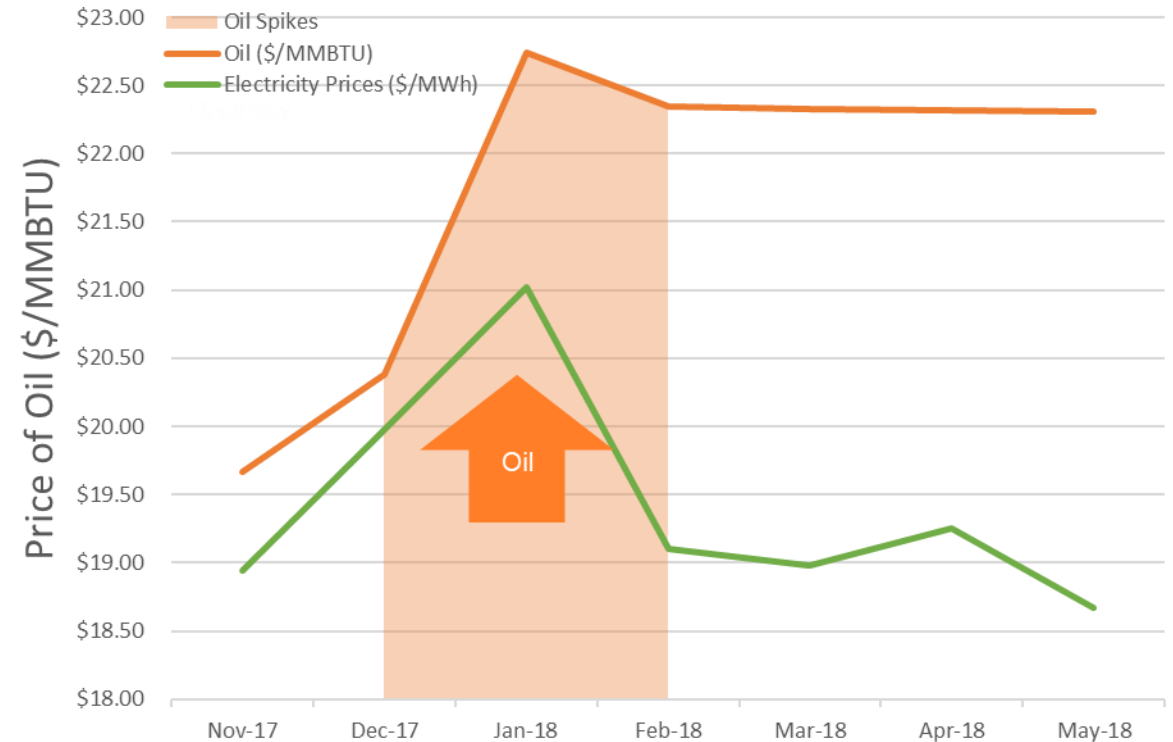
# ADDITIONAL RENEWABLES REDUCES RELIANCE ON HIGH PRICE LNG AND FUEL OIL

Liquified Natural Gas and Distillate Oil is used primarily in the winter, when pipeline natural gas is used for heating. The following graphs are snapshots of the Polar Vortex in 2014 and the Bomb Cyclone in 2018.

### LNG Spikes Causes Electricity Spikes (Winter 2014)



### Distillate Oil Spikes Cause Electricity Spikes (Winter 2018)

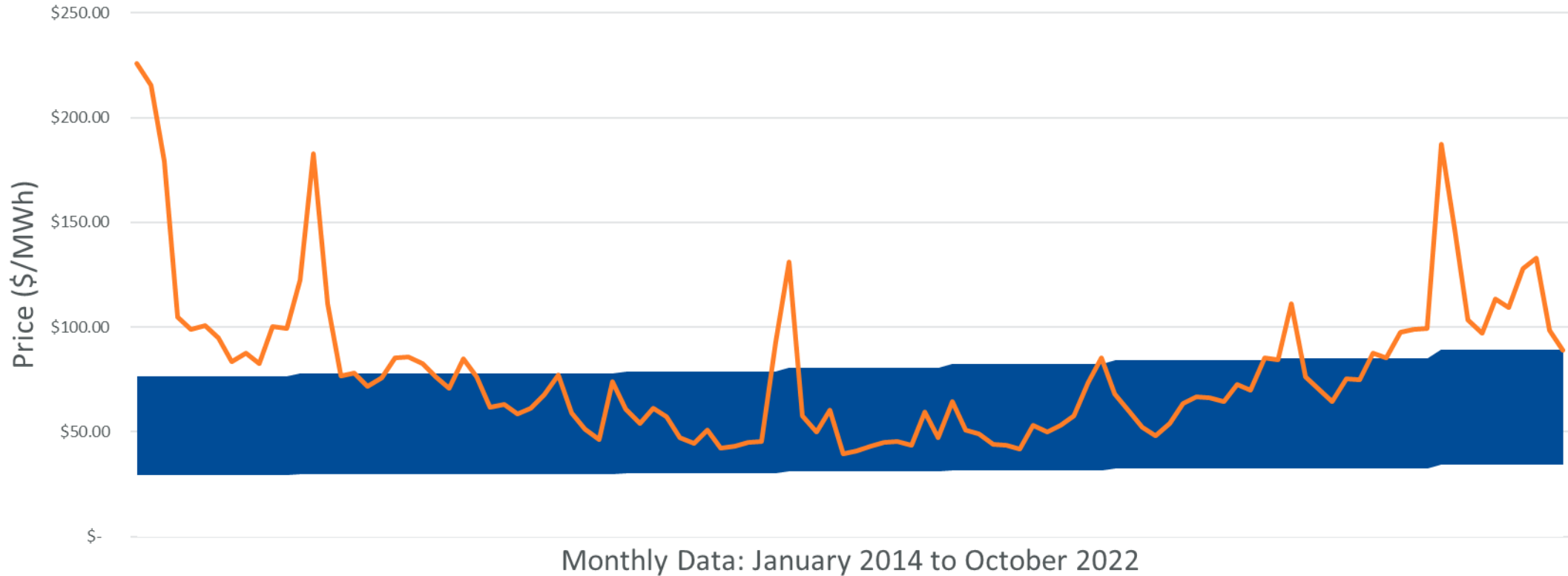


Monthly Liquified Natural Gas prices at Everett, MA and distillate oil prices were pull from EIA. The shaded areas represent the price peaks during the winter months. Weekly electricity prices were pulled from S&P and averaged into monthly. Graph reflects average monthly prices, which is due to limited information regarding LNG prices. In the Winter of 2014, LNG was driver of Electricity prices, thus when LNG spiked, Electricity did too. Similarly, to 2014, in 2018 Oil spiked, thus leading to Electricity prices to spike as well.



# WIND CONTRACTS OFFER COMPETITIVE PRICES AND LOWER VOLATILITY

Wind contract prices are bundled with the price of energy and renewable energy certificates. Had these offshore & onshore wind farms been operational, they would have hedged against energy price volatility.



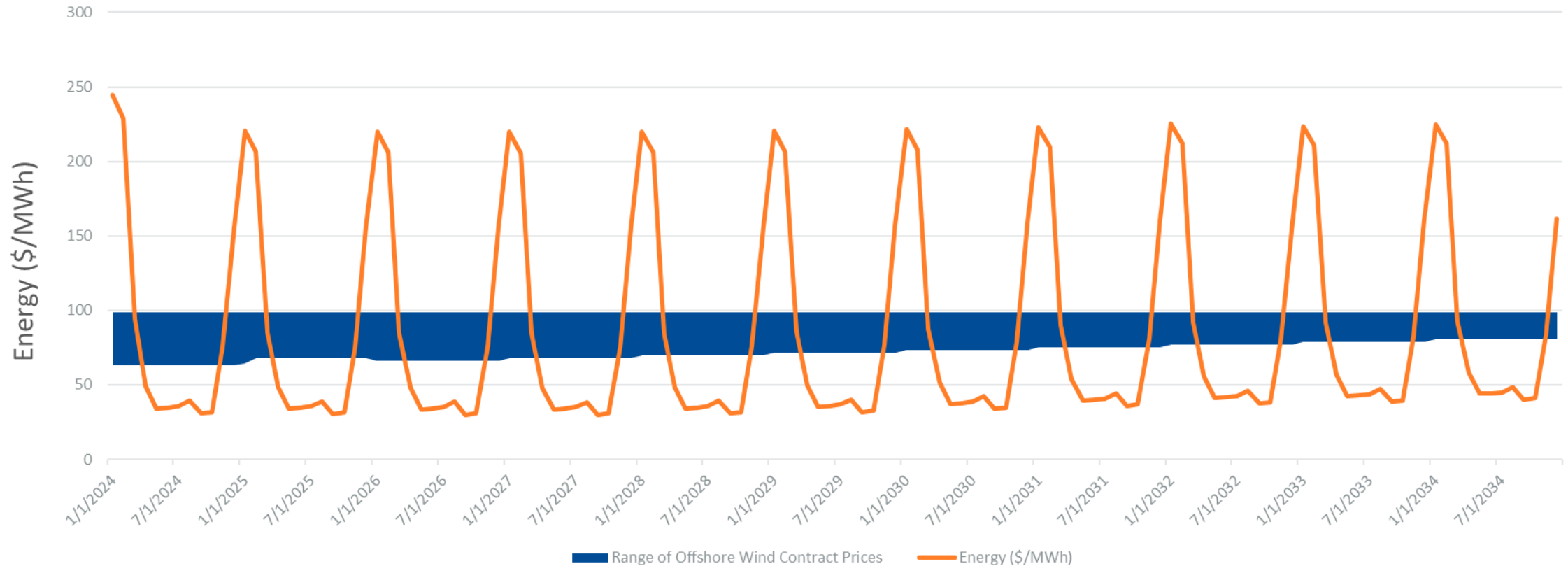
*Historical New England Energy Market Prices were pulled from S&P with the location set to ISO-NE's Internal Hub. Historical REC Prices were pulled from S&P and represent MA Class I RECs. The blue shaded area shows the range of offshore & onshore wind contracts, if it would have been signed in earlier years. The price of the current offshore PPA agreements were deflated to estimate what the price would be in those previous years. This does not consider improvements in technology or cost differences since 2014.*





# OFFSHORE WIND CONTRACTS WILL HEDGE AGAINST FUTURE MARKET PRICES

Offshore wind contract prices are bundled with the price of energy and renewable energy certificates, providing less volatility and hedging wholesale prices for consumers.

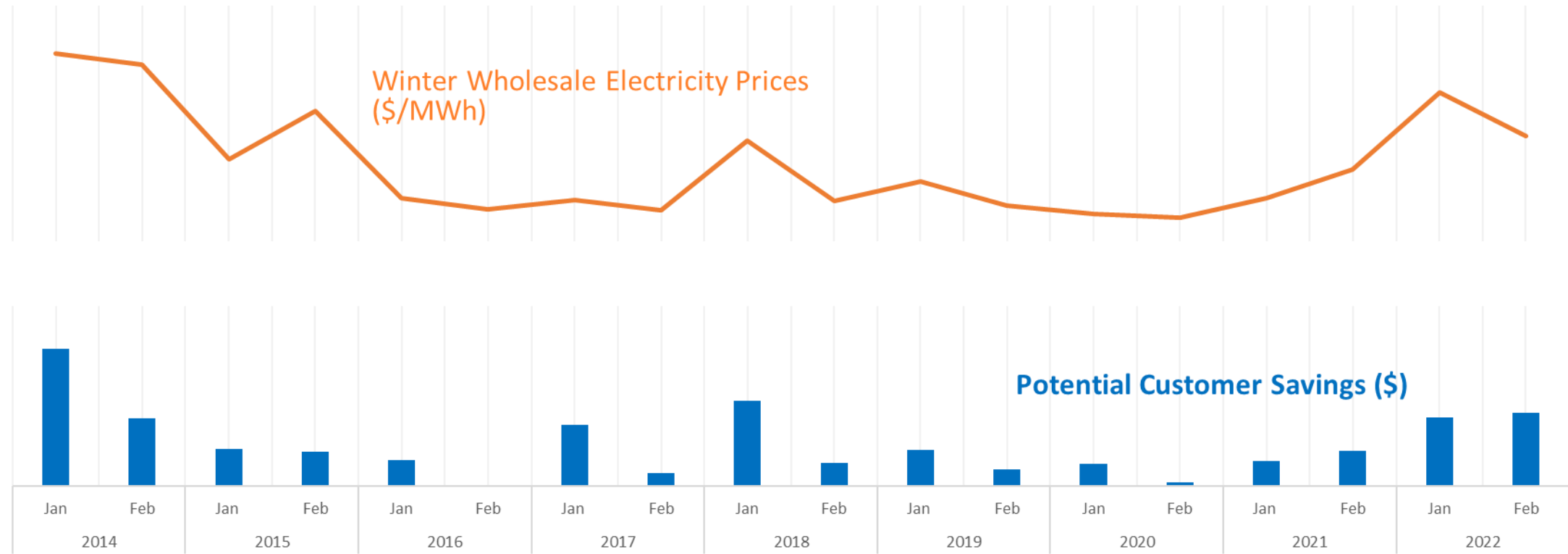


Forecasted market prices are based on S&P monthly Natural Gas Forwards (2023 - 2034). Capacity is excluded from this graph because most renewable PPAs in New England (including all Mass OSW and all the recent Maine PPAs) do not purchase capacity, so a fair comparison is market energy prices to a bundled PPA.



# ADDING WIND PRODUCTION TRENDS TOWARDS SAVING CUSTOMERS MONEY

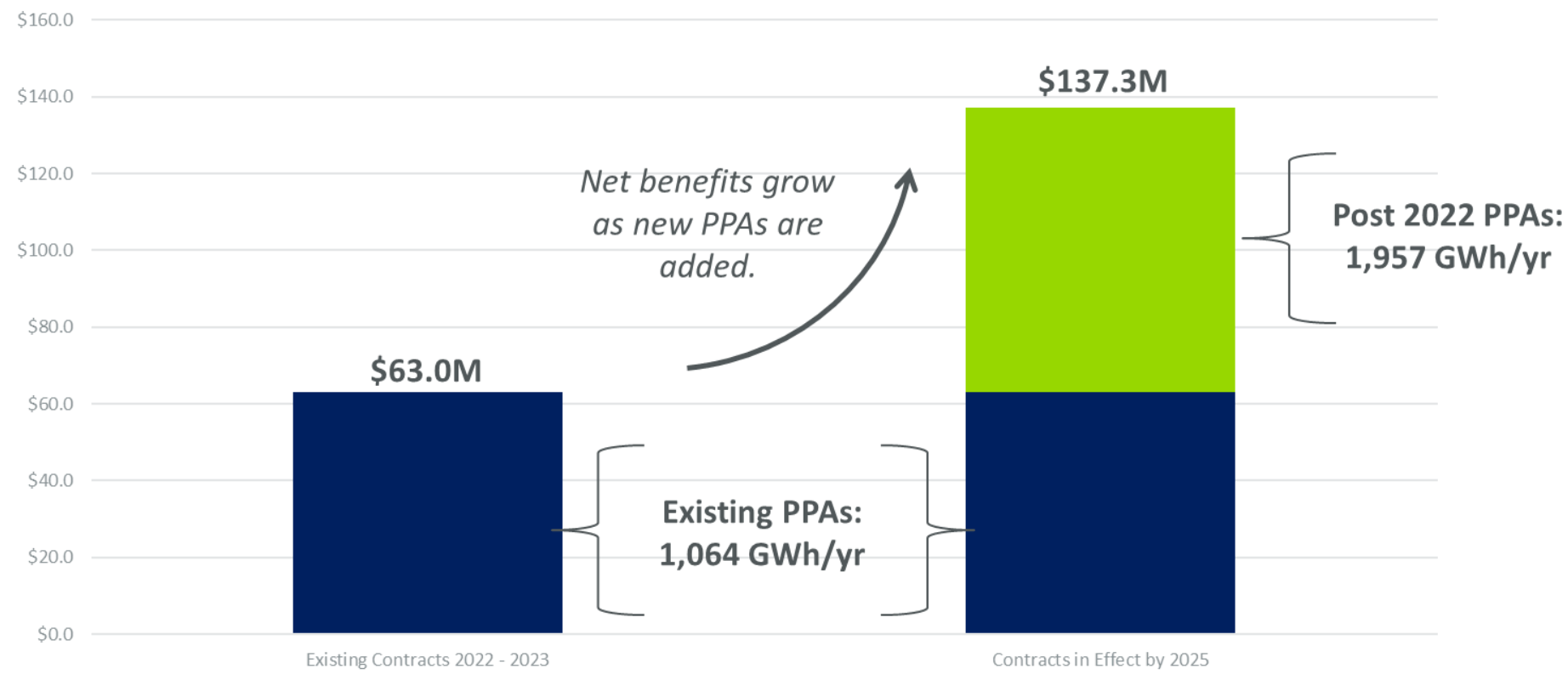
This graph shows that had an 800 MW offshore wind plant been operating during the winter months between 2014 and 2022, customers would have likely experienced lower wholesale electricity prices. This analysis demonstrates a general trend; thus, no specific savings values are provided.



Customer Savings were calculated using historical hourly LMP prices in New England (S&P), historical hourly load in New England (S&P), and hourly offshore capacity factor in New England (System Advisor Model; NREL). Projected hourly power generation from the NREL model was subtracted from the historical hourly load and new hourly LMP was calculated. Monthly customer energy cost was calculated by multiplying the historical hourly LMP and the LMP with an 800 MW offshore wind system to the historical hourly load. The difference is the customer savings. Wholesale Electricity prices were obtained from EIA. No

# EXISTING RENEWABLE CONTRACTS ALREADY PROVIDE RATEPAYER BENEFITS

Recent renewable energy procurements approved by Maine Public Utilities Commission, will generate approximately \$140M in net benefits for customers in 2025. Given the additional energy procurements price are lower than market prices, ratepayer savings are generated.

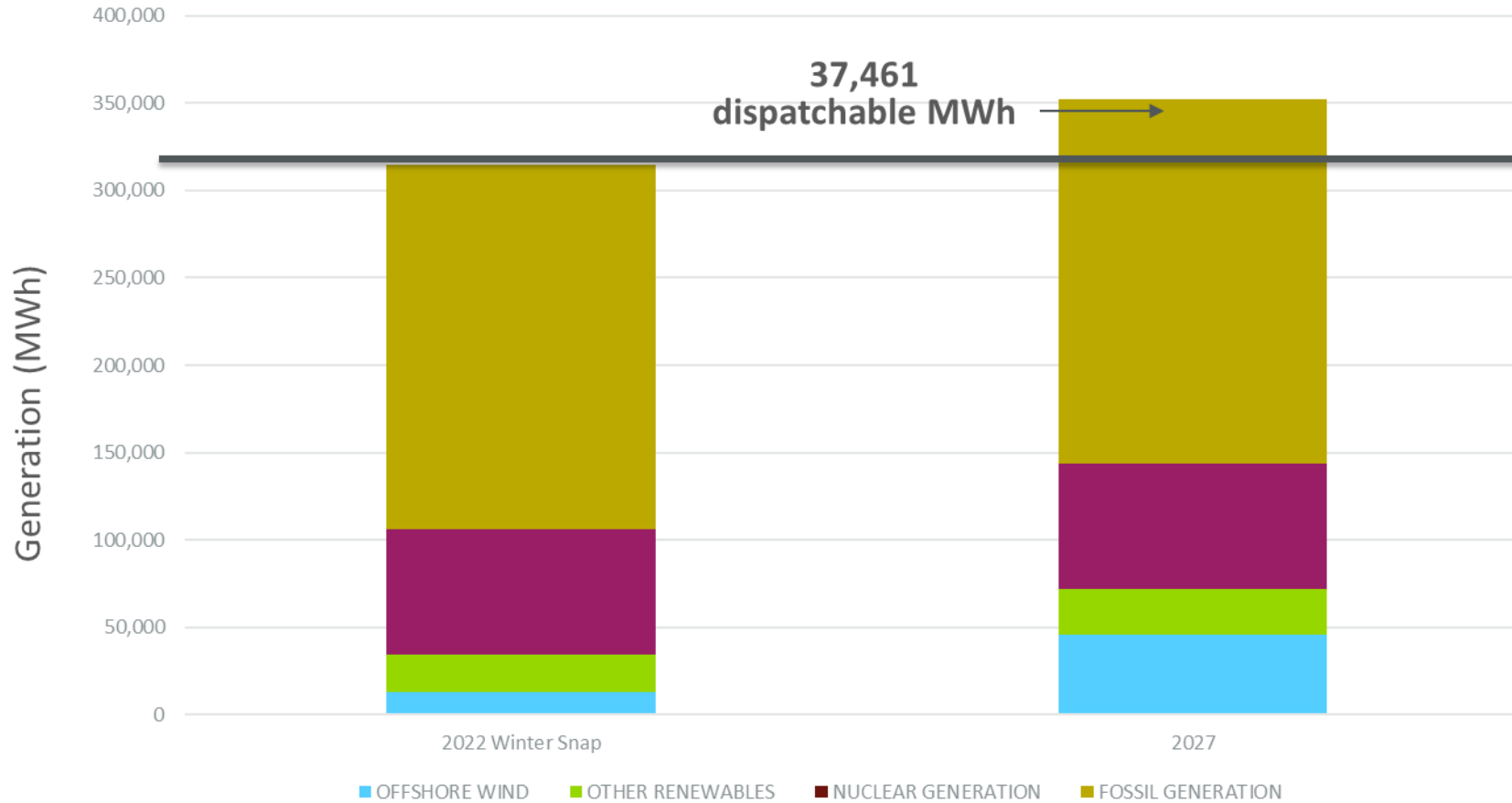


*Expected energy and PPA costs were derived from Maine PUC dockets 2022-00042 and 2022-00102. Future benefits were calculated off the post 2022 PPA costs. Assuming the same market revenue for the new PPA's based on the additional expected energy from the new PPA's. Nameplate capacity for CMP contracts range from 60 MW for Evergreen Wind Power III LLC and 0.7 MW for Kennebago Hydro. Nameplate capacity for Versant contracts range from 72.6 MW for Weaver Wind to 0.5 MW for Green Lake Hydro.*

# RENEWABLE RESOURCES IMPROVE SYSTEM RELIABILITY DURING WINTER PEAKS

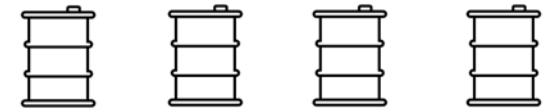
- During peak winter periods when the system is stressed, renewable resource are meeting an increasing portion of load. This frees up additional conventional resources to serve as operating reserves, improving system reliability.
- As additional renewable capacity is added to the grid, system reliability will increase.
- Offshore wind typically has greater output during winter peak conditions. As more offshore wind is added to the grid, system reliability will most likely improve during winter cold snaps.

# RENEWABLES FREE-UP FUEL INVENTORY DURING COLD SNAPS



With additional renewables added in the future, **this line** marks where oil and other dispatchable resources could be used for reserves. The dispatchable energy equates to:

**1.9M of barrels of oil reserves**



and

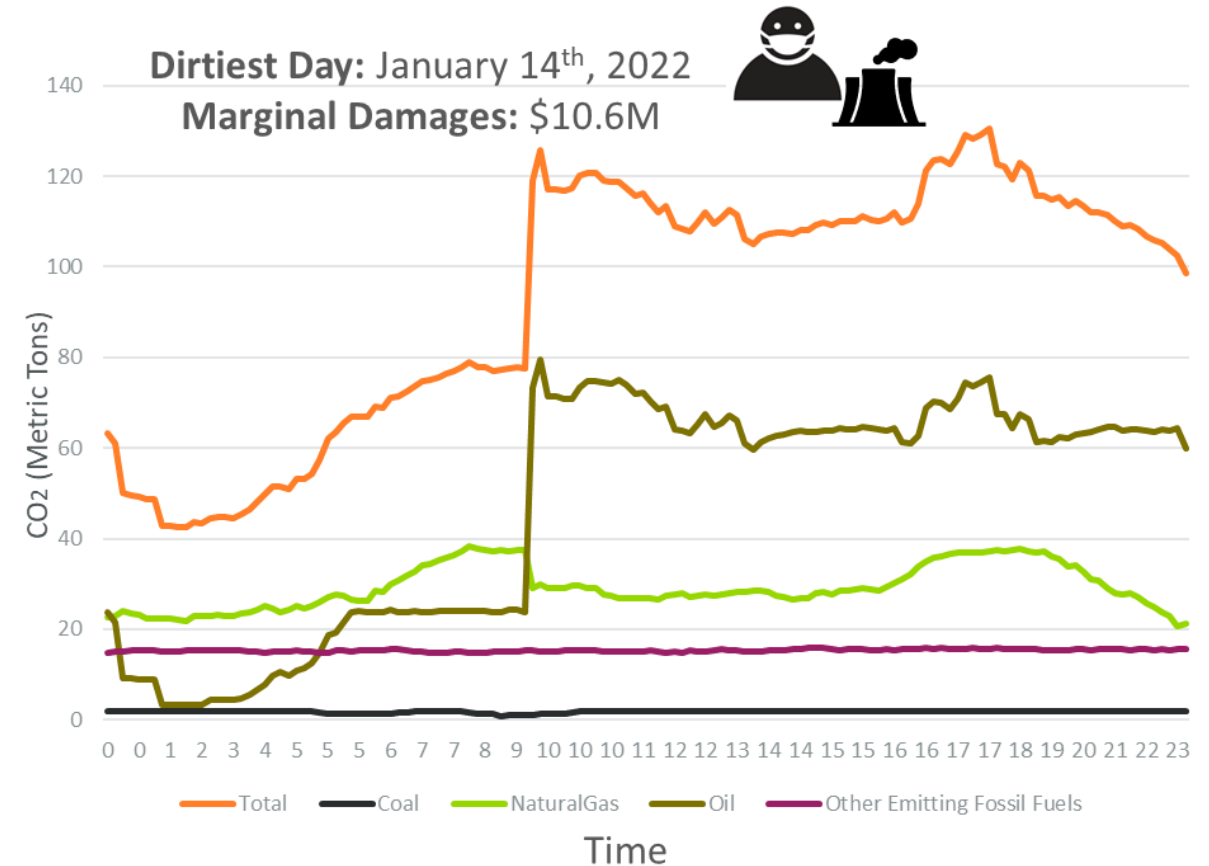
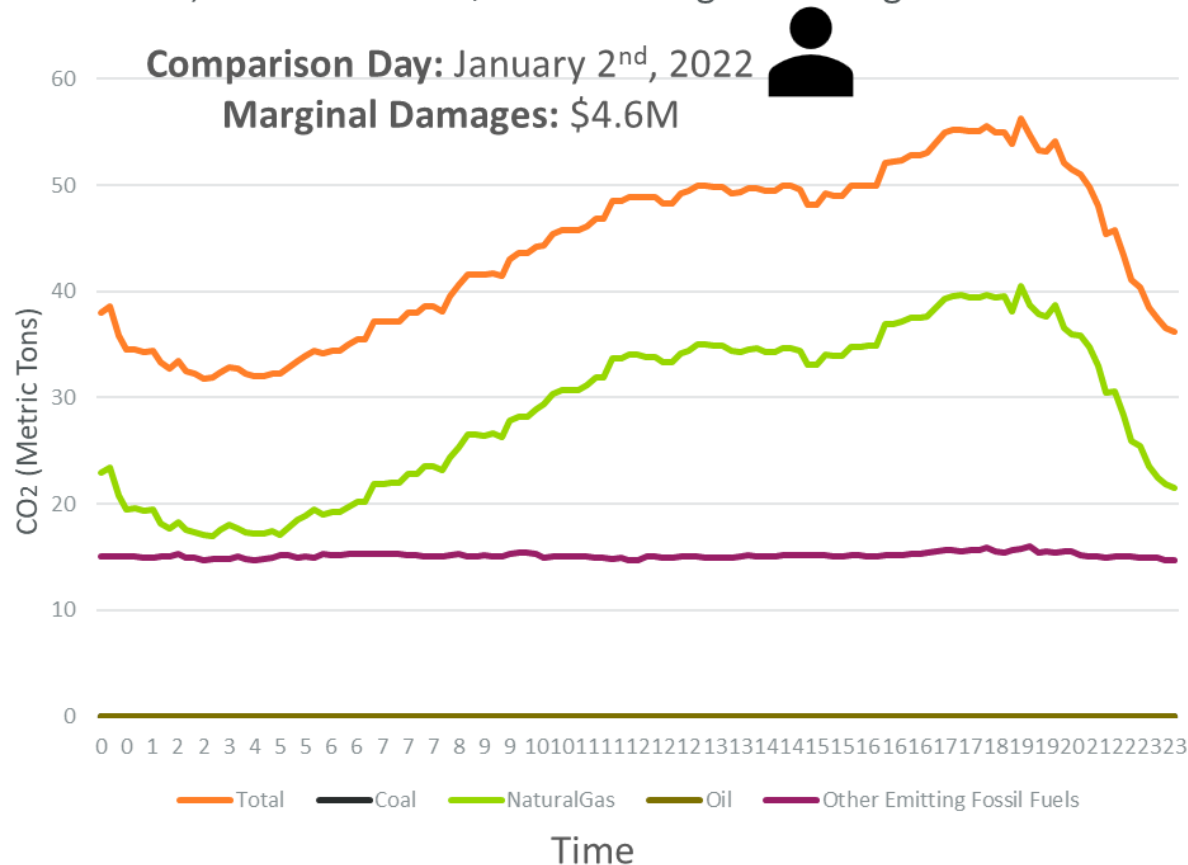
**79.9M lbs of CO<sub>2</sub> emissions avoided**, which is equivalent to **7,879 gasoline-powered** passenger vehicles removed for one week.



Generation by fuel type was pulled from ISO-NE Daily Generation by Fuel Type. The data represent, in megawatt-hours (MWh), the amount of electricity assigned to each fuel type during the week. The data provided are for the full system, including "settlement only" generators that do not actively offer their output into the wholesale markets. Current conditions data was pulled from 2022 for specific weather event periods. 2027 data was estimated based on historic trends of the ISO-NE CELT report. OSW estimations were pulled from production modeling of 2300 MW of Wind added to the grid. Assumed of 5.8 MMBtu per barrel of oil. Using EPA's eGRID, the weighted average of annual CO<sub>2</sub> emissions was summed for Gas-CT, Gas-CC, Oil, and Coal. Also using the EPA's assumption that a typical passenger vehicle emits about 4.5 metric tons of CO<sub>2</sub> per year.

# DIRTIEST WINTER DAY OF 2022 CAUSED \$10M IN HEALTH & ENVIRONMENTAL DAMAGES

January 14<sup>th</sup> was the dirtiest winter day in 2022, with a total generation of 235,645 MWh. This equates to \$10.6M in adverse health and environmental impacts (marginal damages). Compared to a more moderate winter day, was January 2<sup>nd</sup> at 102,971 MWh with \$4.6M in marginal damages.

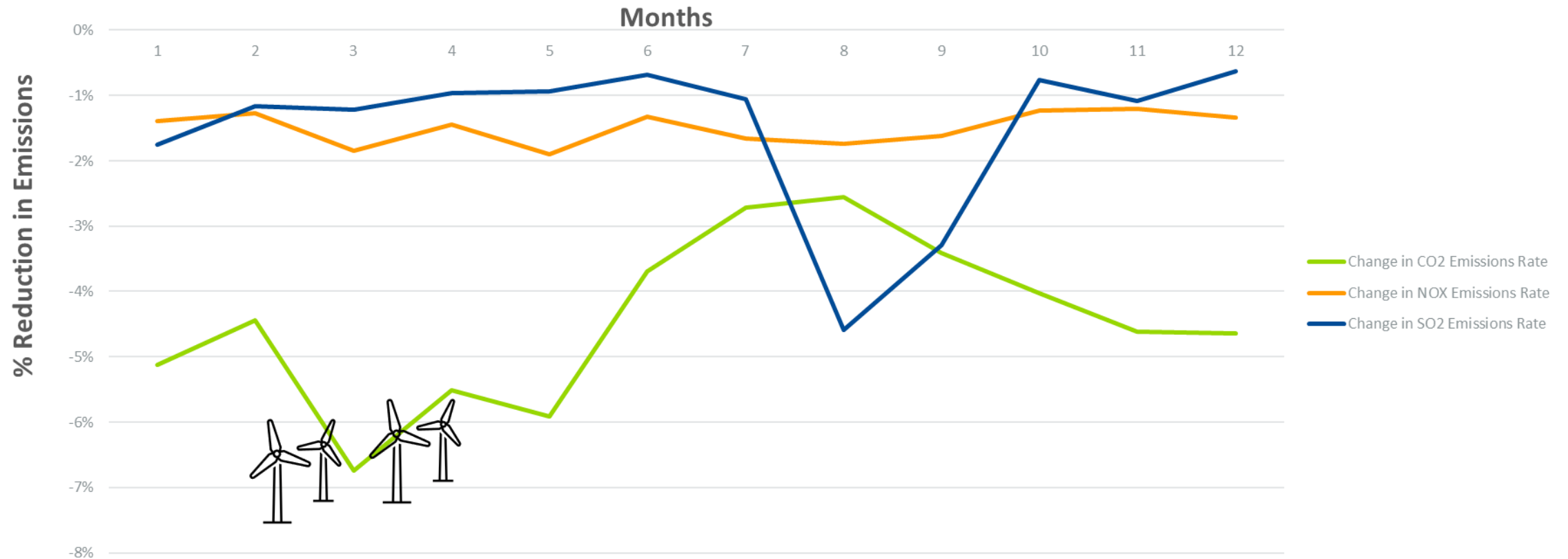


Generation by fuel type was pulled from ISO-NE Daily Generation by Fuel Type was pulled to determine the highest amount of fossil fuel generation used in winter of 2022. ISO-NE Estimated CO<sub>2</sub> Emissions data was pulled for the specific day of the highest amount of fossil fuel generation and a day the week earlier was pulled to compare.



# WIND PRODUCTION GENERATES GREATER % REDUCTION IN EMISSIONS

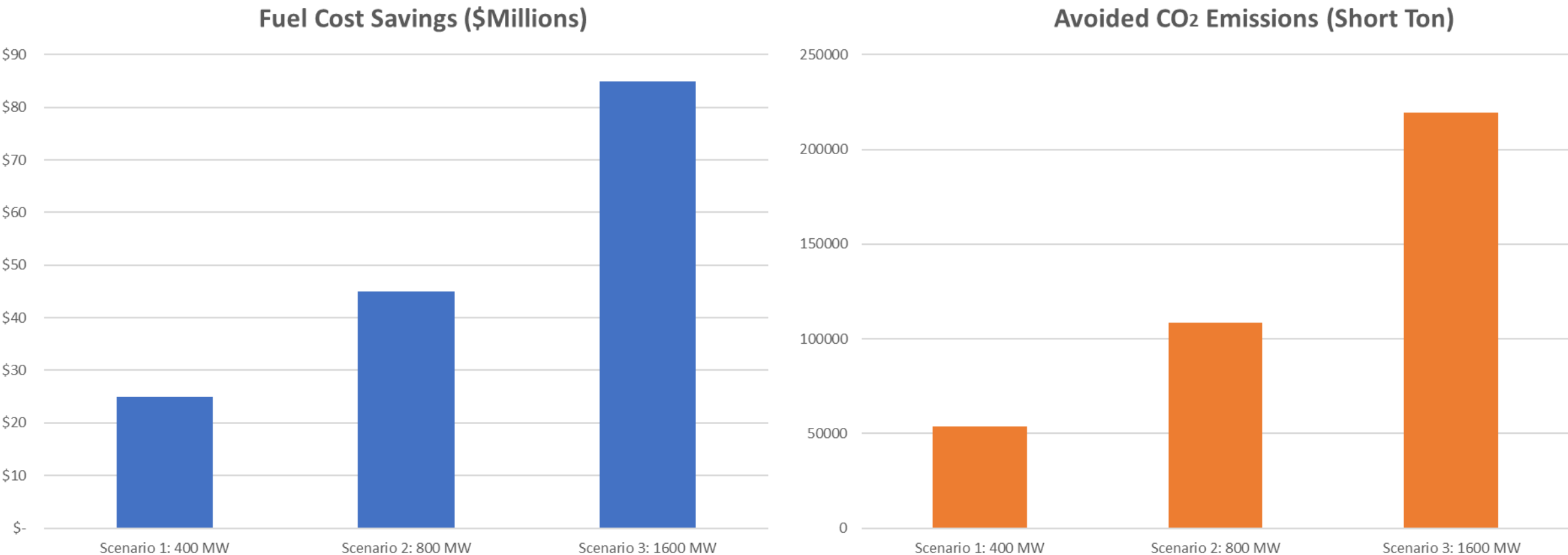
Wind production produces meaningful reduction in emissions. The analysis below demonstrates the percent reduction in CO<sub>2</sub>, NO<sub>x</sub>, and SO<sub>2</sub> emissions when 800 MW of offshore wind production is added on the system dispatch. CO<sub>2</sub> and NO<sub>x</sub> shows greater reduction in emissions in winter and SO<sub>2</sub> in summer.



Estimated percent change in emissions rate with and without wind production in New England. Monthly emissions are based on ISO-NE 2020 air emissions report. Daymark derived wind production data from 800 MW Vineyard Wind project and compared it to L&P load data.

# CUSTOMER SAVINGS AND EMISSION REDUCTIONS FROM OSW DURING 2018 COLD SNAP

During the cold snap in early 2018, MassCEC and ISO-NE produced a report that identified the potential production cost savings and emission reductions that would have resulted from increased offshore wind resources during the 2018 winter.



Using the data from 2018\_iso-ne\_offshore\_wind\_assessment\_mass\_cec\_production\_estimates\_12\_17\_2018\_public analysis, the data was compiled into one graph. Mass CEC showed production data of 106865 MWh (400MW), 215569 MWh (800MW), and 435257 MWh (1600MW).

# THANK YOU.



# SOURCES & NOTES



# SLIDE SOURCES & NOTES

- **Slide 5: Natural Gas and Electricity Prices are Volatile to External Events**
  - Electricity Price (\$/MWh)
    - Historical monthly electricity prices (January 2005 – November 2022) were pulled from S&P Global data. Electricity prices represent the price at ISO-NE's Internal Hub.
  - Natural Gas Price (\$/MMBtu)
    - Historical monthly natural prices (January 2005 – November 2022) were pulled from S&P Global data. Natural gas prices represent the price at Algonquin City Gates in New England.
- **Slide 6: Additional Renewables Reduces Reliance on High Price LNG and Fuel Oil**
  - Historical Liquefied Natural Gas Prices (\$/MMBtu)
    - LNG prices (2011 – 2018) were pulled from EIA. The LNG price represents the price at Everett, MA. Prices after 2018 were marked as withheld on the EIA website.
    - EIA data was converted from \$/Thousand Cubic Feet to \$/MMBtu.
  - Historical Distillate Oil Prices (\$/MMBtu)
    - Distillate oil prices (2011 – 2018) were pulled from EIA. The distillate oil price represents the price at PADD 1A: New England. Time range was because of the available LNG price data.
    - EIA data was converted from \$/Barrel to \$/MMBtu.
- **Slide 7: Additional Renewables Reduces Reliance on High Price LNG and Fuel Oil**
  - The graphs represent snapshots from slide 4 of the winter in 2014 and 2018. Both winters had severe winter storms, Polar Vortex in 2014 and Bomb Cyclone in 2018.
  - Both are examples how peak fuel can drive up electricity. With LNG representing the Winter of 2014 and Oil representing the Winter of 2018.
  - Historical LNG and distillate oil prices were pulled using the same process as in slide 4.
  - Historical Electricity prices (\$/MWh)
    - Electricity prices from the winter of 2014 and 2018 were pulled from S&P Global data.

# SLIDE SOURCES & NOTES

- **Slide 8: Wind Contracts Offer Competitive Prices and Lower Volatility**
- Historical New England Energy Market Prices & REC Prices (2014-2022)
  - Historical energy prices were pulled from S&P Global data. The data represents energy prices at ISO-NE's Internal Hub.
  - Historical REC prices were pulled from S&P Global data. The price represents Massachusetts Class I RECs.
- Hypothetical New England Wind Contract Prices
  - Hypothetical wind contract price was calculated using the current offshore wind contracts procured in New England. That price was then deflated to represent prices in previous year. Deflated contract prices were calculated using the inflation rate of that given year. The onshore wind contract represent contracts currently procured in Maine; these contracts were also deflated to estimate historical prices.
- **Slide 9: Offshore Wind Contracts Will Hedge Against Future Market Prices**
  - 2024 – 2034 Forecasted Market Prices: Monthly Natural Gas Forwards (\$/MWh)
    - Monthly Natural Gas Forwards – monthly natural gas forwards were pulled from S&P Global data screens from 2022 - 2034. Assumed a heat rate of 9000 to convert to \$/MWh. Heat rate was pulled from S&P Global data from HUB and Algonquin's LMP.
  - 2024 – 2034 Range of Offshore Wind Prices:
    - Vineyard Wind 1: Contract price of energy price
    - Vineyard Wind 2: Contract price of energy price
    - Revolution Wind: Fixed Price
  - Capacity is excluded from this graph because most renewable PPAs in New England (including all Mass OSW and all the recent Maine PPAs) do not purchase capacity, so a fair comparison is market energy prices.



# SLIDE SOURCES & NOTES

- **Slide 10: Adding Wind Production Trends Towards Saving Customers Money**
- Customer Savings (\$):
  - Customer savings was calculated using historical hourly wholesale electricity prices at ISO-NE's Internal Hub (pulled from S&P Global), historical hourly load in New England (pulled from S&P Global), and hourly offshore capacity factor in New England (NREL's System Advisor Model)
  - Estimated hourly power generation from the NREL model was subtracted from New England's historical hourly load. The calculated historical hourly load was then used to calculate a new hourly electricity price.
  - The new hourly electricity price and the actual hourly electricity price was then multiplied to the actual load. The monthly totals from each month were added together and the difference between the new and actual costs are the customer savings.
- Average Monthly Wholesale Price (\$/MWh)
  - Wholesale electricity prices were pulled from EIA, which represents the price at ISO-NE's Internal Hub.
- **Slide 11: Existing Renewable Contracts Already Provide Ratepayer Benefits**
  - Existing 2022 – 2023 Contracts
    - Existing PPA's Energy: the sum of the total energy in the CMP 2022-00042 and the Versant 2022-00102 stranded cost filings. Total energy includes hydro, wind, community energy, solar, and renewable portfolio standard.
    - Existing PPA Cost: the sum of the PPA payments in the CMP 2022-00042 and the Versant 2022-00102 stranded cost filings. PPA payments include hydro, wind, wind capacity credit, community energy, solar, and renewable portfolio standard.
    - Market price: divided market revenue (in Millions) by expected energy.
    - Benefits were calculated by subtracting the PPA costs pulled from the above and the entitlement revenue in the CMP 2022-00042 and the Versant 2022-00102 stranded cost filings.
  - Contracts in Effect by 2025
    - Expected MWh in 2025 was calculated by the sum of energy purchased through renewable contracts via the CMP 2022-00042 and the Versant 2022-00102 stranded cost filings.
    - Total PPA cost was collected by summing the PPA price by the expected energy.
    - Market revenue was determined by multiplying the expected energy by the market revenue in 2025 (in Millions).
    - Benefits were calculated by subtracting the expected market revenue with new PPA's from the new total PPA cost.

# SLIDE SOURCES & NOTES

- **Slide 13: Renewables Free-up Fuel Inventory During Cold Snaps**
  - 2022 Winter Snap:
    - Generation by fuel type was pulled for 2014, 2018 and 2022 from ISO-NE.
    - Peak winter periods were found in 2022 by comparing heating degree days from the 2014 Polar Vortex to 2022 conditions. The generation mix for that time period was pulled from the ISO-NE generation by fuel type report.
  - 2027:
    - Cumulative nameplate of solar and wind was pulled from the ISO-NE 2022 CELT Report through the beginning of 2022. We assumed the region would add 400 MW of solar per year for the next 5 years, and would add 1,000 MW of onshore wind.
      - 400 MW is based on annual conditions over the last few years as identified from the CELT report.
      - 1,000 MW is based on the recently approved project in northern Maine.
    - If in early 2022 we had the level of solar and wind output pulled in the Gen-by-Fuel data, we would expect about 1.86 times the amount of solar and 1.68 the amount of wind.
    - We assumed the same generation of non-renewable source in 2022 as 2027.
    - The dispatchable energy is the difference in generation for 2022 and 2027. It was calculated by subtracting the total generation from 2027 and subtracting from 2022.
  - Assuming 5.8 MMBtu for barrel of oil, the dispatchable energy derived from the previous was converted into MMBtu's assuming a heat rate of 9000.
  - Using the [Emissions & Generation Resource Integrated Database \(eGRID\)](#), New England's annual CO2 emissions (lbs/MWh) for Gas-CT, Gas-CC, Oil, and Coal plants was pulled. A weighted average was determined across plant type. Weighted average was then multiplied by the dispatchable energy to determine the lbs of CO2 avoided the week of the cold snap.
  - [Based on the EPA](#), typical passenger vehicle emits about 4.6 metric tons of carbon dioxide per year, the lbs of CO2 for the week of the cold snap was converted into the number of cars avoided during that time period.

# SLIDE SOURCES & NOTES

- **Slide 14: Dirtiest Winter Day of 2022 Caused \$10M in Health & Environmental Damages**
  - Identified the dirtiest day in the Winter of 2022, by summing up fossil fuel generation from the ISO-NE Generation by Fuel Type Report and identifying the greatest amount during winter months. A less polluting day was pulled by doing the same thing, but lowest amount of generation during the winter months.
    - Emissions for the above days was pulled from ISO-NE Estimated CO2 Emissions data
  - Using the Marginal Damage model files from ["Are There Environmental Benefits from Driving Electric Vehicles? The Importance of Local Factors", American Economic Review](#), the average local marginal damage per kWh for NPCC was pulled.<sup>3</sup> This value was multiplied by the dirtiest day in the Winter of 2022 (from previous bullet)
- **Slide 15: Wind Production Generates Greater % Change in Emissions**
  - Monthly average and marginal CO2, NOX, and SO2 data from ISO-NE 2020 air emissions report was pulled.
  - Hourly ISO-NE Actual Load for 2018 – 2022 was pulled from S&P and summed across years for each month.
    - The ISO-NE Load data was multiplied by the average emissions to determine emissions without wind
  - Production data from System Advisor Model (SAM) on Vineyard Wind 1 (800 MW) was pulled.
    - The Vineyard Wind 1 production data was multiplied by the marginal emissions to determine the amount of CO2 avoided with using wind generation.
  - The emissions avoided from using wind was subtracted from the average emissions without wind to determine CO2 emissions with wind production.
  - New monthly average emissions rate was determined by dividing the CO2 emissions with wind production by the ISO-NE load data.
  - The percent change was calculated from the new average emissions rate from the ISO-NE air emissions report.
- **Slide 16: Customer Savings and Emission Reductions from OSW During 2018 Cold Snap**
  - Using the data from [High-Level Assessment of Potential Impacts of Offshore Wind Additions to the New England Power System During the 2017-2018 Cold Spell](#), table 2 – 7 was combined and units were adjusted accordingly.
  - Highest avoided product costs were assumed.