NORA UPDATE

John Huber, President

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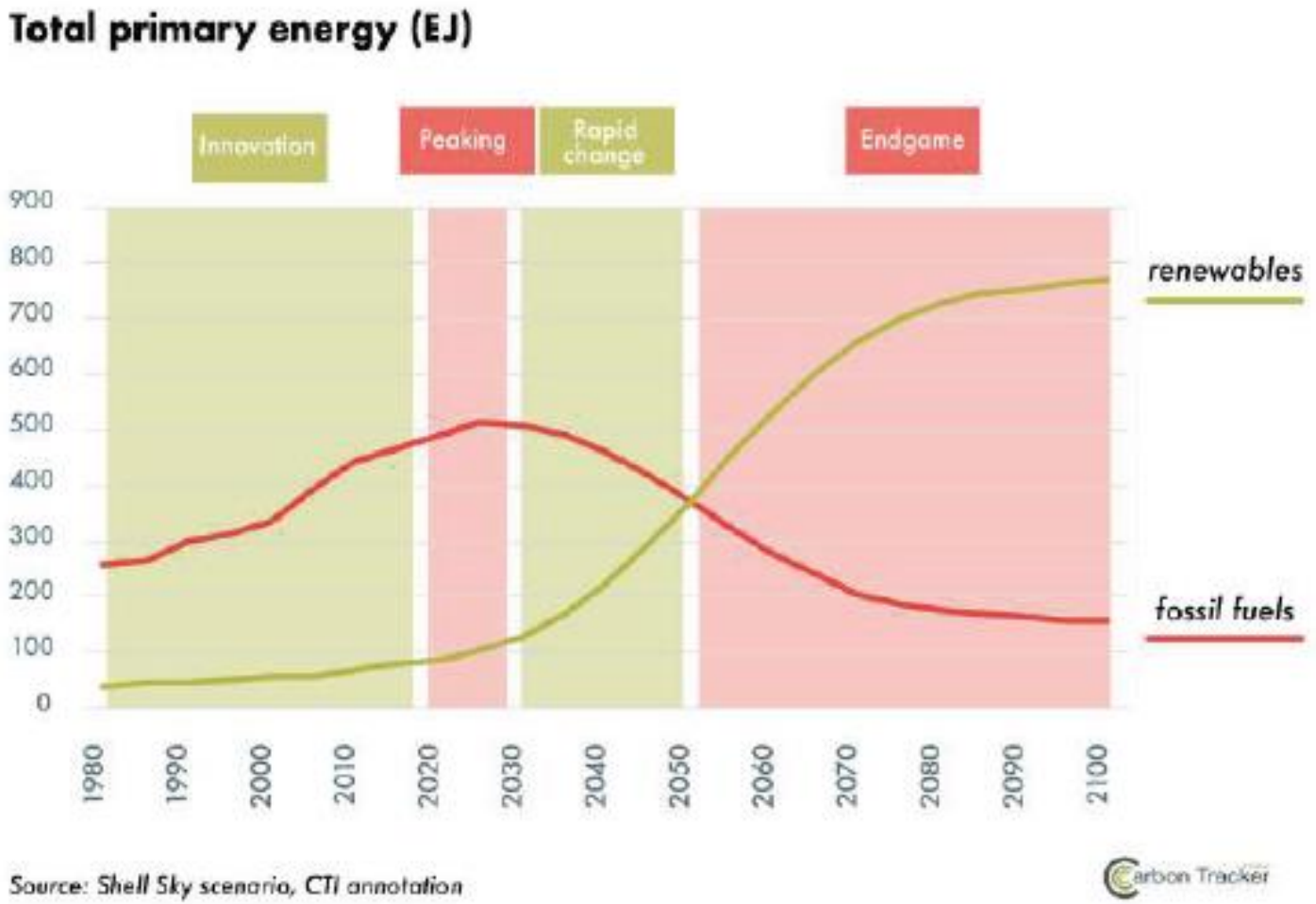
Is Electricity the “Only” Future

- Electricity can power homes, cars, factories.
- If made from renewables, it could be a transition from our fossil fuel based economy to a renewable economy.
- Storage and Production and Demand Management are still major issues.

BENEFICIAL RENEWABLE ELECTRIFICATION

- States Working on Reducing GHG versus 1990 Emissions by
  - 50 percent in 2030, or 80 percent by 2050 (NY, 2040)
- Emissions Today Roughly the Same as in 1990
- Some sectors (Airlines) may not be able to make changes, so others may need to do more
- Many States See Electrification as the Solution, and that the Grid will take on Load and Move to Renewable Electricity

Thinking on the Relationship of Carbon & Renewables



Fundamental changes are taking place in the global energy system which will affect almost all countries and will have wide-ranging geopolitical consequences. Renewables have moved to the centre of the global energy landscape. Technological advances and falling costs have made renewables grow faster than any other energy source. Many renewable technologies are now cost-competitive with fossil fuels in the power sector, even before taking into account their contributions to the battles against air pollution and climate change.

These trends are creating an irreversible momentum for a global energy transformation. While the surge in wind, solar and other renewables has taken place mostly in the electricity sector, new technologies are enabling this transformation in other sectors. Electric vehicles and heat pumps are extending the deployment of renewables in transport, industry and buildings. Innovations in digitalization and energy storage are expanding the potential for renewables to flourish in ways that were unimaginable just a decade ago.

Global Commission on Renewable Energy 2019

Report Release: Electrifying Buildings for Decarbonization

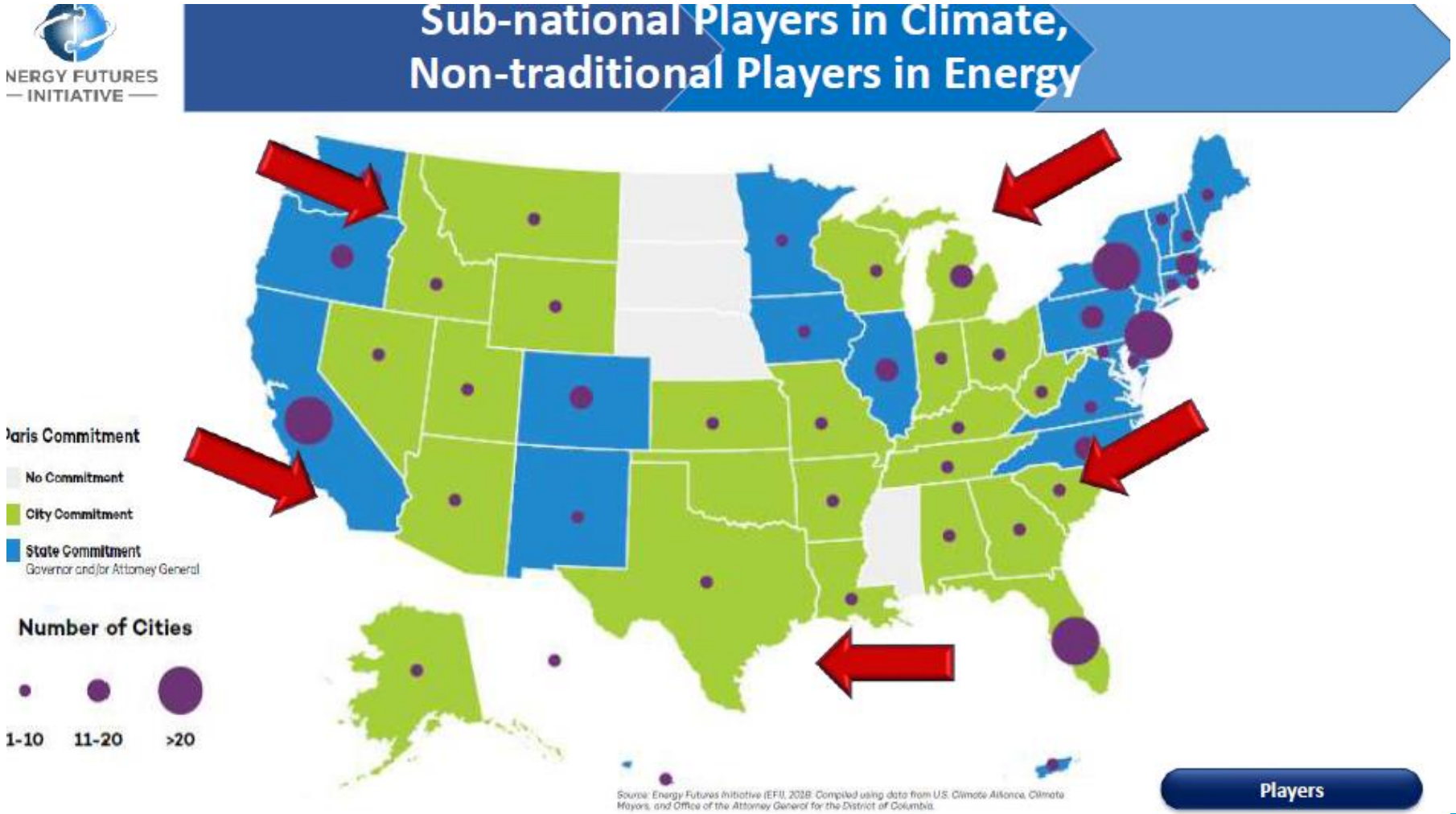
The Role of Electric Space and Water Heating

June 14, 2018 | By Sherri Billimoria, Leia Guccione, Mike Henchen

Download RMI's new report, The Economics of Electrifying Buildings

Seventy million American homes and businesses burn natural gas, oil, or propane on-site to heat their space and water, generating 560 million tons of carbon dioxide each year—one-tenth of total US emissions. But now, we have the opportunity to meet nearly all our buildings' energy needs with electricity from an increasingly low-carbon electric grid, eliminating direct fossil fuel use in buildings and making obsolete much of the gas distribution system—along with its costs and safety challenges. Reaching "deep decarbonization" goals of 75 percent or greater reduction in greenhouse gas emissions will require eliminating most of the CO_2 produced by furnaces and water heaters across the country, alongside other measures across the economy. Further, electric space and water heating can be intelligently managed to shift energy consumption in time, aiding the cost-effective integration of large amounts of renewable energy onto the grid.

Everyone In Oilheat Territory Working on GHGs



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What Will it Require

- Massive Growth in Electricity Production…at Competitive Prices
- Massive Growth in Electricity Transmission and Distribution
- A Smart Grid to Help Balance the Load
- RELIABILITY!!!!

What Type of Load

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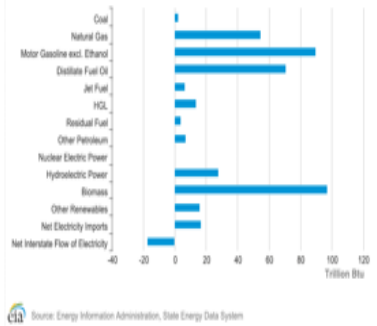
State of Maine

Best Available U.S. DOE Energy Consumption Data

Version 1.0-01082018



- Nearly 90% of Maine is forested, and wood products, including biomass fuels, are an important part of the state's rural economy.
- Maine had the lowest average electricity price in New England in 2017, in part because of the state's low average industrial sector power price that reflects the use of less costly wood and wood waste as a generating fuel.
- Nearly two-thirds of Maine households use fuel oil as their primary energy source for home heating, a higher share than in any other state.
- In 2017, about three-quarters of Maine's net electricity generation came from renewable energy resources, with 30% from hydroelectricity, 26% from biomass (mainly wood products), and 20% from wind.
- Maine leads New England in wind power, as the state's wind turbines accounted for two-thirds of the wind generation in the region during 2017.

Last Updated: June 21, 2018

Fossil Fuel Conversion to Electricity Impact Estimator

https://www.eia.gov/electricity/state/maine/	Grid Impact of Converting Energy Uses to Electricity		
	Increase in Electricity Consumption MWh	Average Hourly Impact MW*	Potential Capacity Impact MW**
Conversion Impact Motor Gasoline to Electric Vehicles	3,915,825	671	2,012
Conversion Impact Motor Distillate Fuel to Electric Vehicles	671,563	345	345
Conversion Impact NG Heating to Cold Climate Heat Pumps	10,613,859	3,342	5,012
Conversion Impact Oil Heating to Cold Climate Heat Pumps	4,611,542	1,533	2,299
Potential Total Conversion Impact to Electricity Impact	19,812,790	5,890	9,668
State Electricity Profilesand avg per hour	11,213,674	1,280	4,920***

https://www.eia.gov/electricity/state/

*Vehicle Hourly Impact based on 16 hour cycle 7 days a week, heating base on expected heating hours - see tables below

** peak assumes vehicle charging and heating peaks at night, so an estimate of 3 times average hourly is used for vehicles and 1.5 for buildings

*** Net summer in state generation capacity (megawatts)

Fossil Fuel Conversion to Biodiesel GHG Impact Estimator

	GHG Impact of Converting Heating Oil to B100 Biodiesel				
	Gallons	lb CO_{2e}/MMBtu *(HHV)	MMBtu (HHV) / Gallon	lb CO_{2e}(HHV)	lb CO_{2e}(HHV) Percent reduction
Current Heating Oil Use	313,913,000	193.32	0.14	8,404,964,071	0%
Conversion to B50 by 2030	313,913,000	121.36	0.14	5,276,145,328	37%
Conversion to B100 by 2040	313,913,000	49.39	0.14	2,147,326,585	74%

**Analysis of Fuel Cycle Energy Use and Greenhouse Gas Emissions from Residential Heating Boilers, June 2018* July 2017 Attribute Analysis 100 Atmospheric Lifetime with Carbon Feedback

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Sharp Decline in Prices for Wind Power

Average US Wind Price Falls to $20 per Megawatt-Hour

Wind prices have dropped by $50 per megawatt-hour in eight years, new DOE research shows.

EMMA FOEHRINGER MERCHANT | AUGUST 24, 2018

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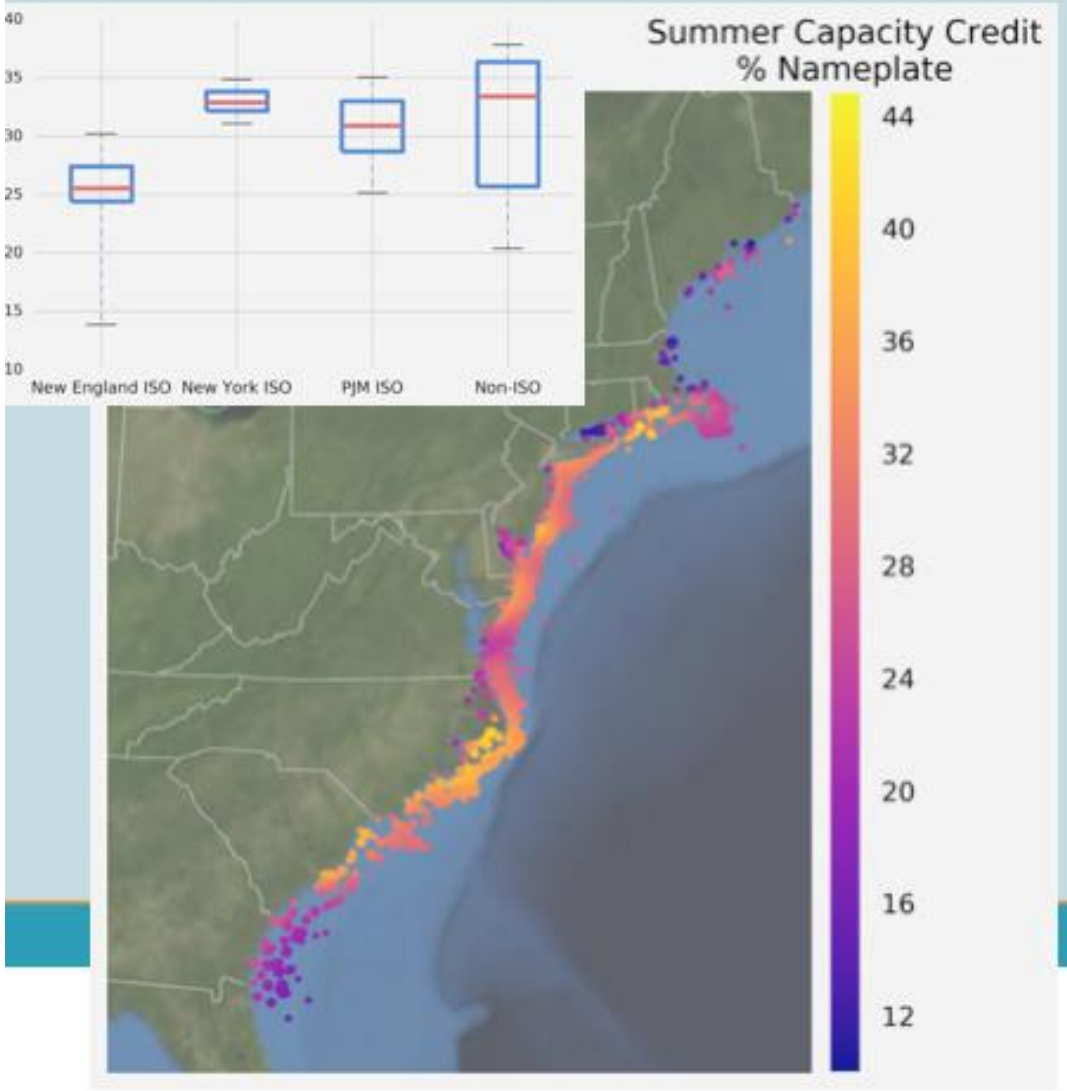
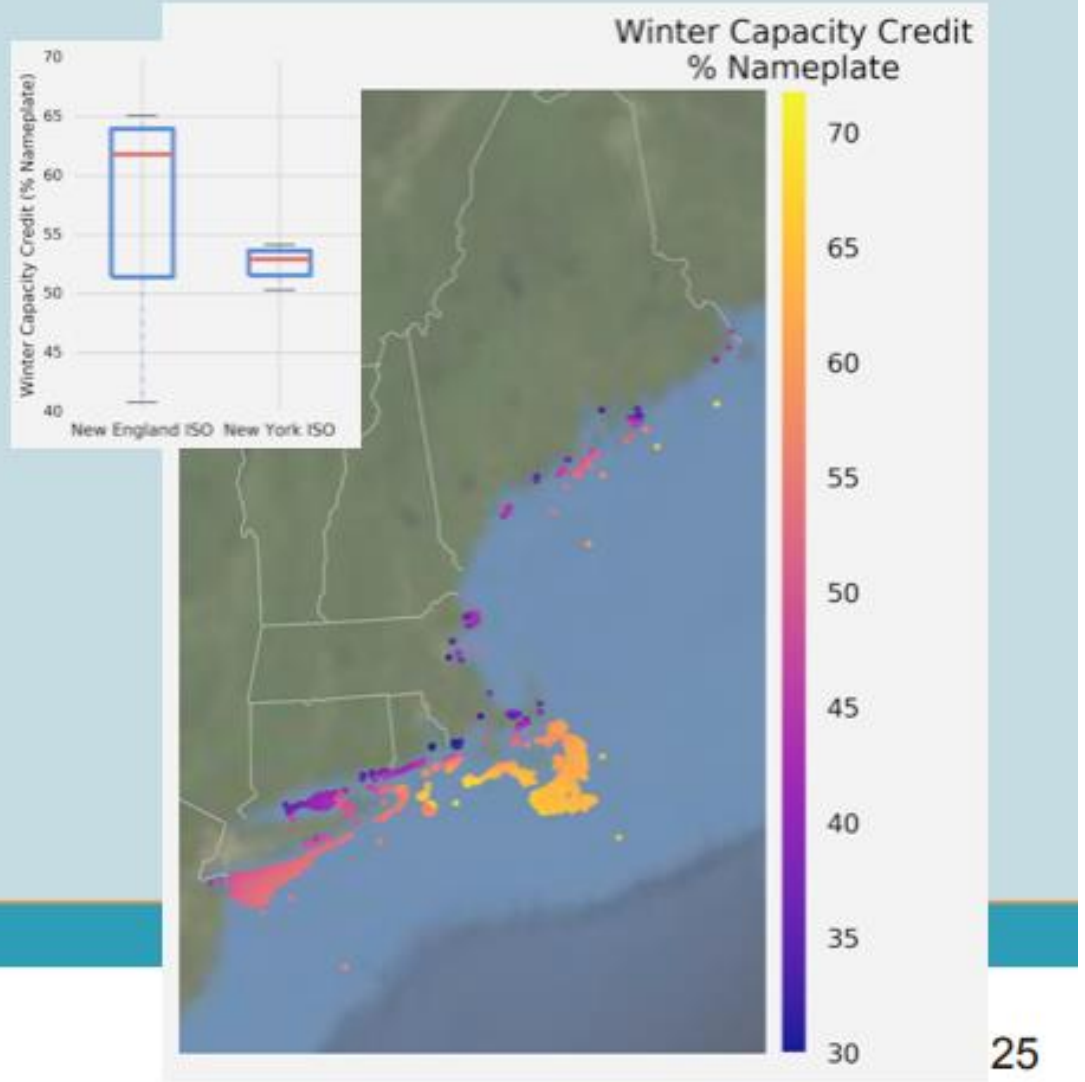
SUMMER AND WINTER CAPACITY CREDIT





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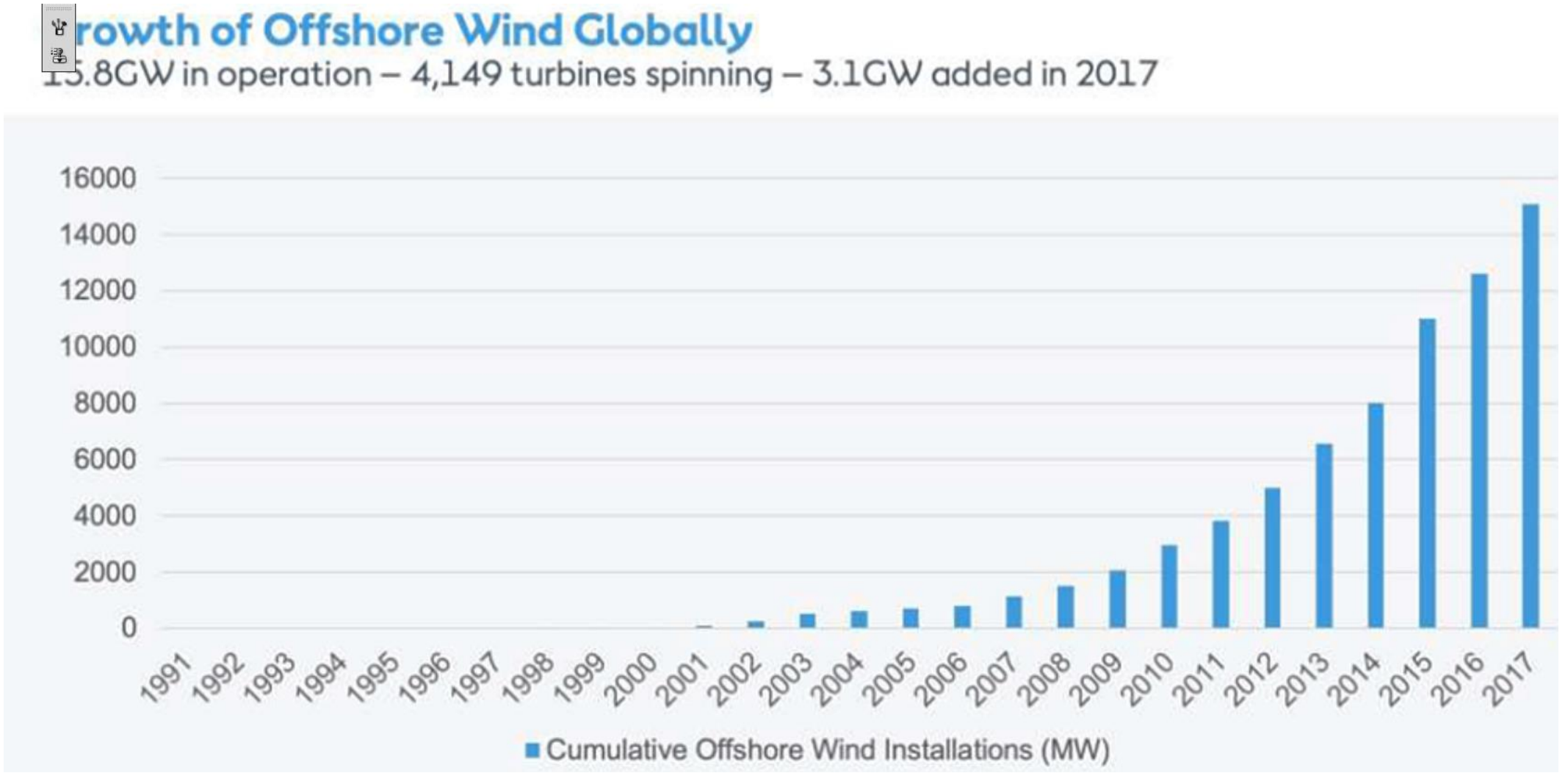
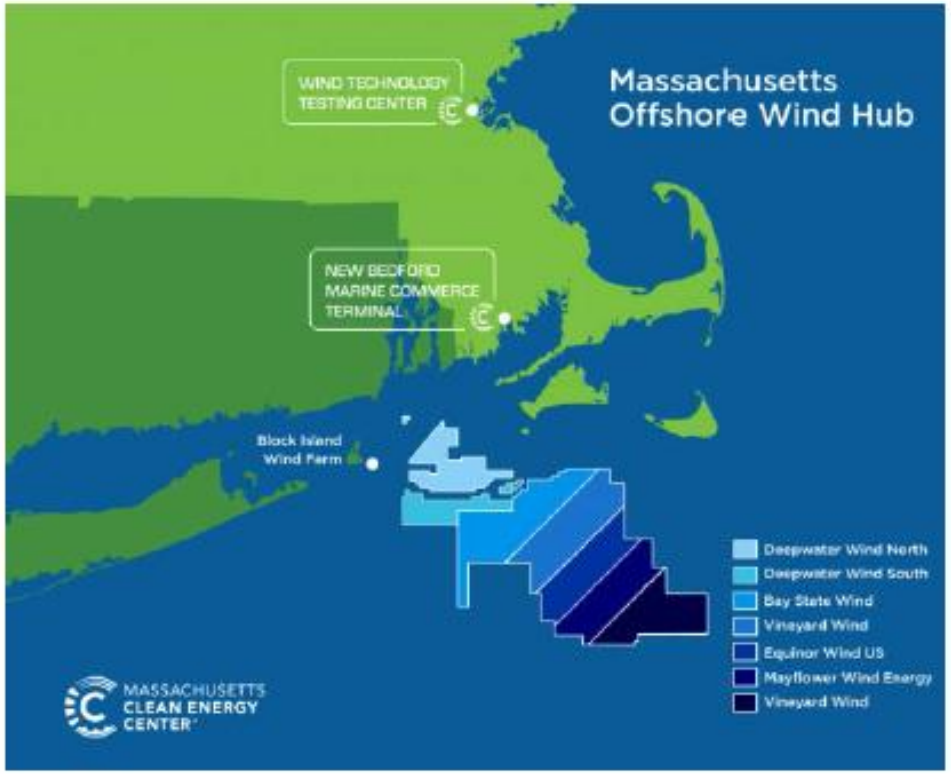
International Offshore Wind



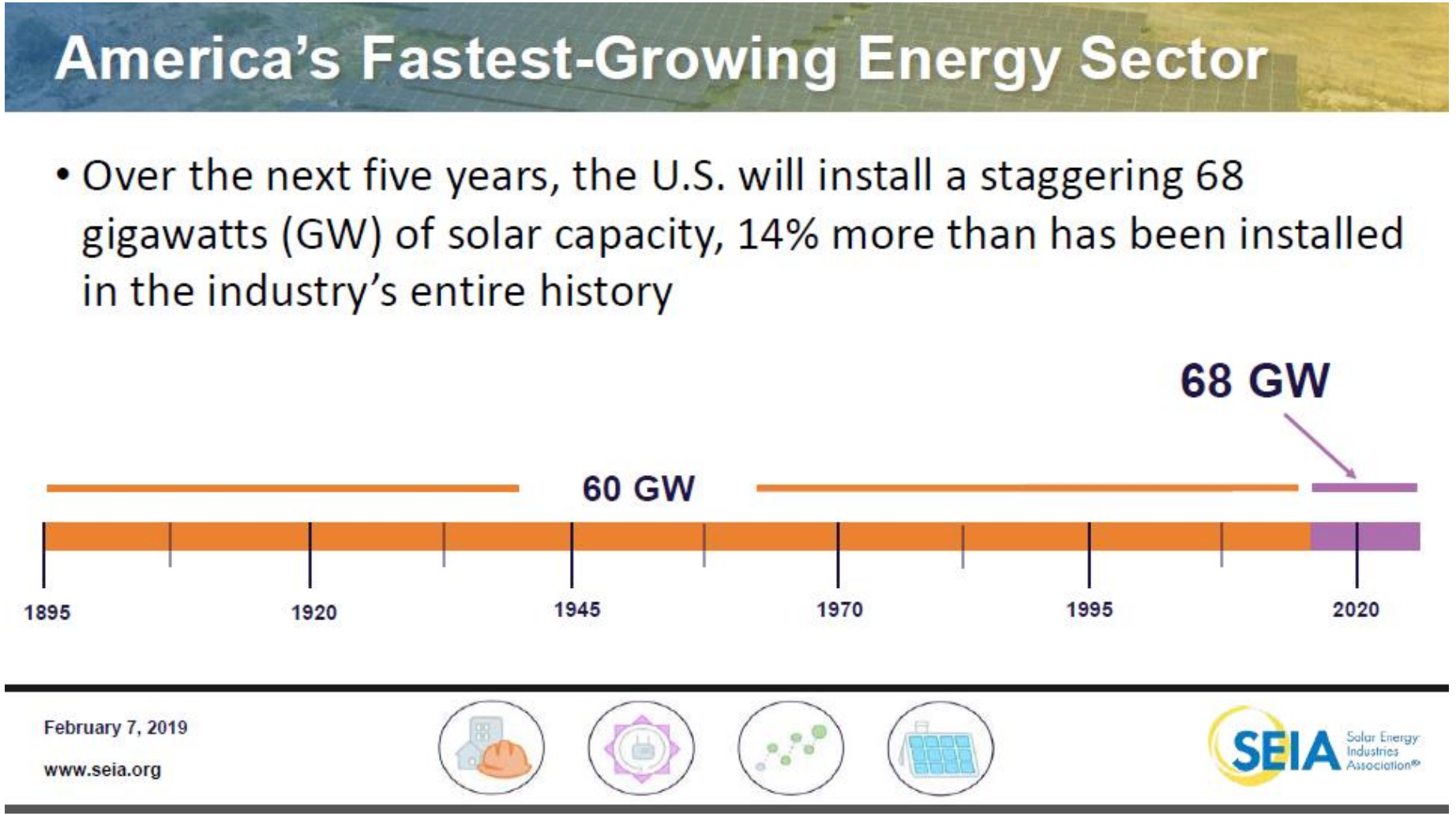
Huge Amount of Increase, but Still Small Compared to Demand

Offshore Wind Opportunity

- Clean, affordable and resilient energy future
- Massive opportunity
  - +10GW potential
- Lease auctions - competition and market confidence increasing
  - 2013 – 2 sites, $3.8 million
  - 2015 – 2 sites, $400 thousand
  - 2018 – 3 sites, $405 million

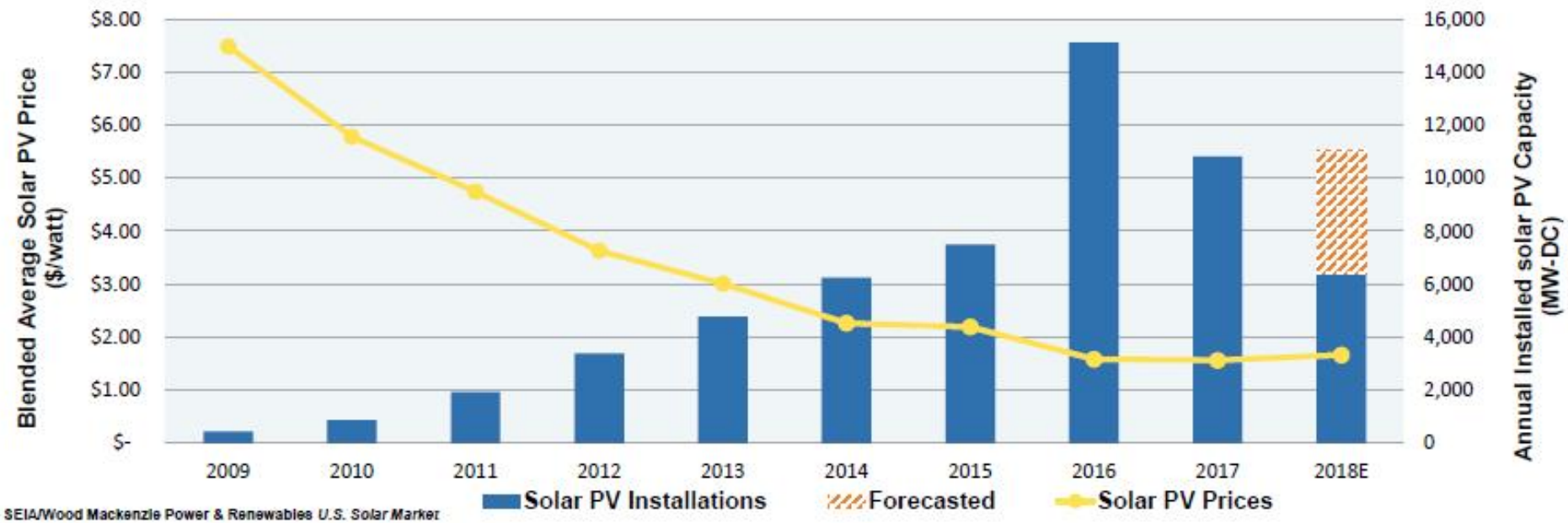


Solar Also Important



Falling Prices Drive Solar Forward

- The solar industry's rapid growth is largely due to declining prices. PV prices have fallen 80% in the last decade and 52% over the last 5 years alone



Source: SEIA/Wood Mackenzie Power & Renewables *U.S. Solar Market Insight;*
Lawrence Berkeley National Laboratory, *Tracking the Sun*

February 7, 2019

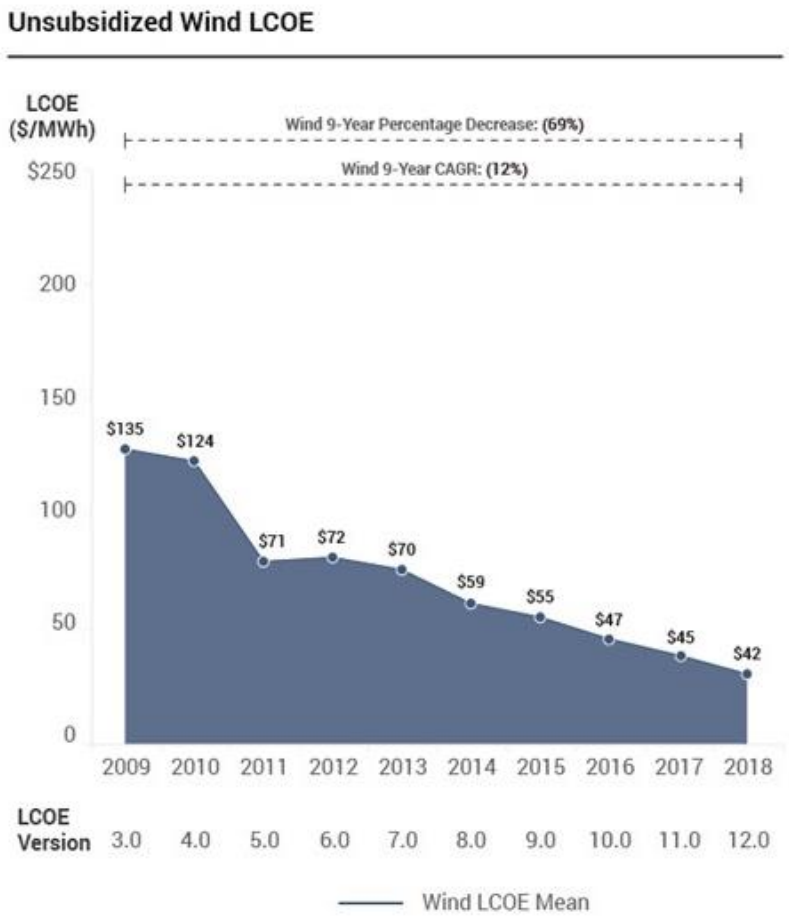
www.seia.org

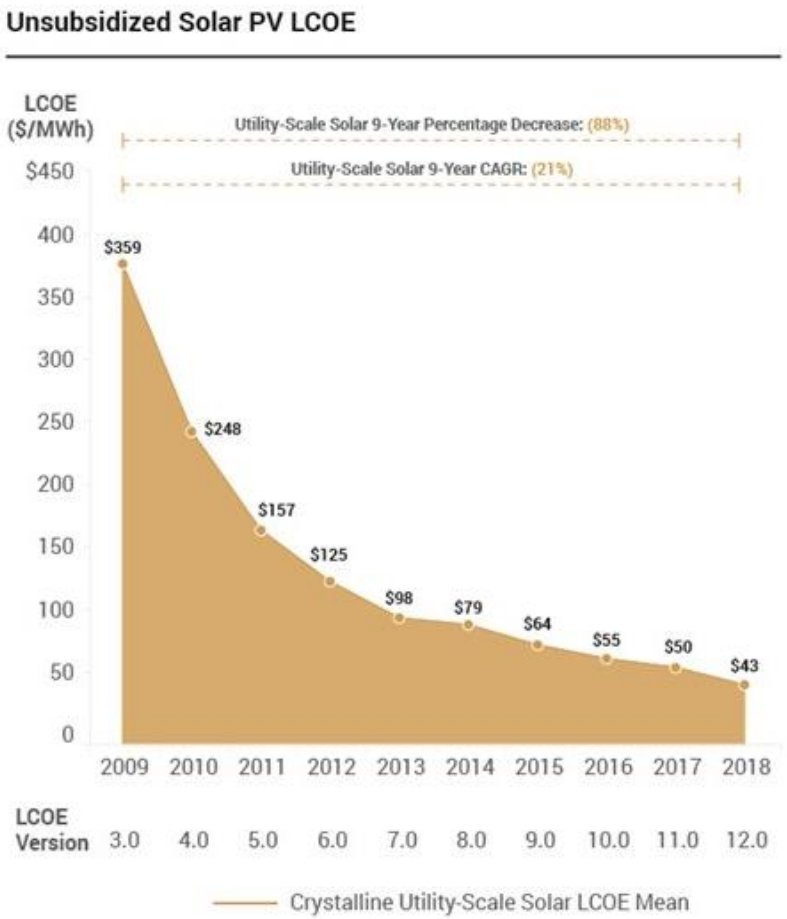
Lots of New Power- But How Far from Goal

- Exergy Analysis of States indicates Approximately 100 Gwh of Power(Peaking) Currently Consumed in New England, New York and New Jersey, a small fraction of that is Renewable.
- Exergy Analysis indicates that another 150Gwh of Power (peaking) may be Required. And then you still have to deal with Existing Supply.
- Not Only do You Have to Generate it, You also have to Move it. (Transmission and Distribution)

Cost of Wind and Solar Falling Over Time

The cost of generating energy from utility-scale solar photovoltaic (PV) and onshore wind technologies continue to decline. The mean levelized cost of energy of utility-scale PV technologies is down approximately 13% from last year and the mean levelized cost of energy of onshore wind has declined almost 7%.





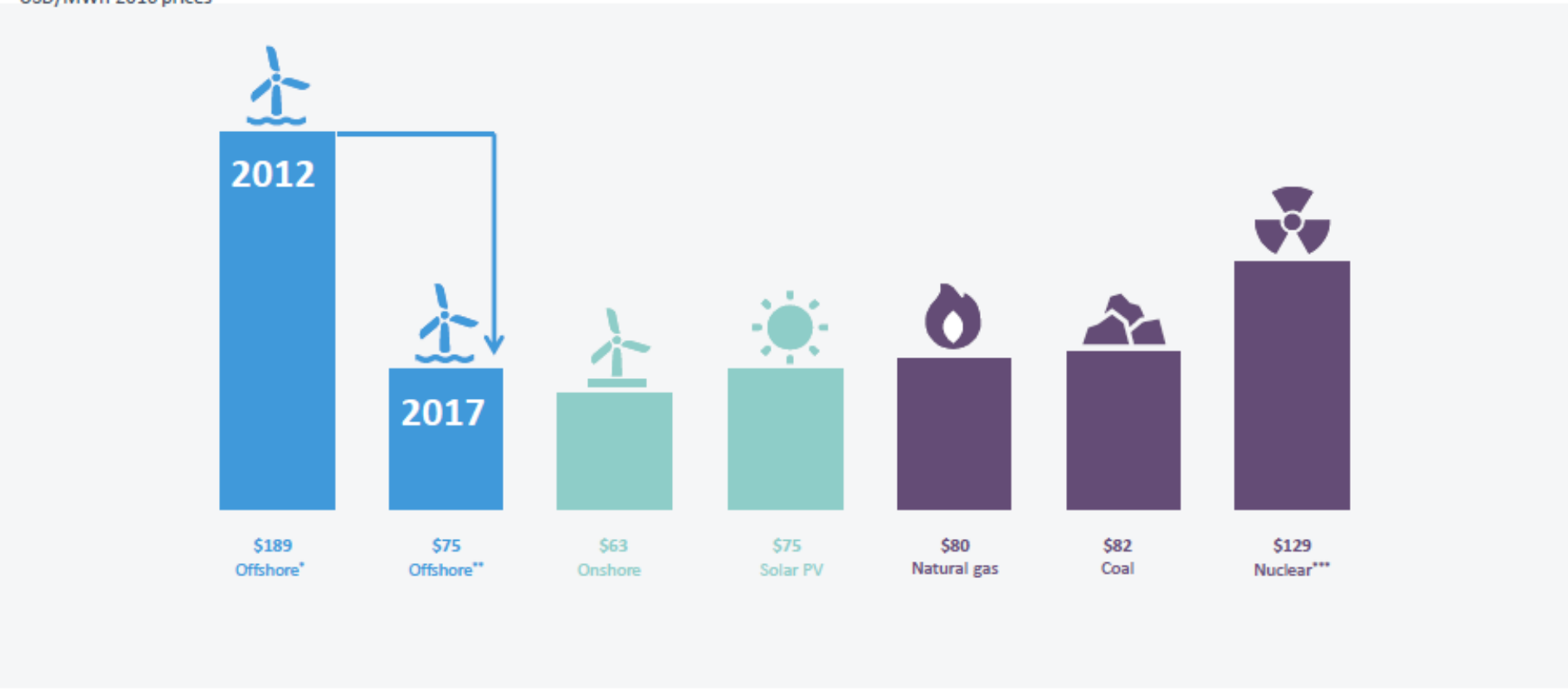
https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2018/

Sharp Decline in Offshore Wind Cost, Competitive with Fossil Fuels

Levelized cost of electricity for different technologies

The rapid cost reductions in the industry, have made offshore wind power competitive relative to conventional power generation based on fossil fuels

USD/MWh 2016 prices



Source: Bloomberg New Energy Finance (BNEF) for CCGT and Coal plants for Northwest Europe, Danish Energy Agency and BNEF for Offshore Wind.
For offshore wind: Including cost of transmission – Calculated as Levelized revenue (subsidy and market price) of electricity over 20yrs lifetime as a proxy for the levelized cost of society. 3,5% real discount rate used. *Generic Offshore Wind, Northwest Europe, FID 2012. In 2012 our goal was to reduce offshore wind costs to 100 Euro/MWh in 2020, ** Hornsea 2, UK, *** Hinkley Point, UK. Same approach as for Offshore Wind. Strike price of 92,5 £/MWh in 2012 real prices. Lifetime of 60yrs, 91% capacity factor.

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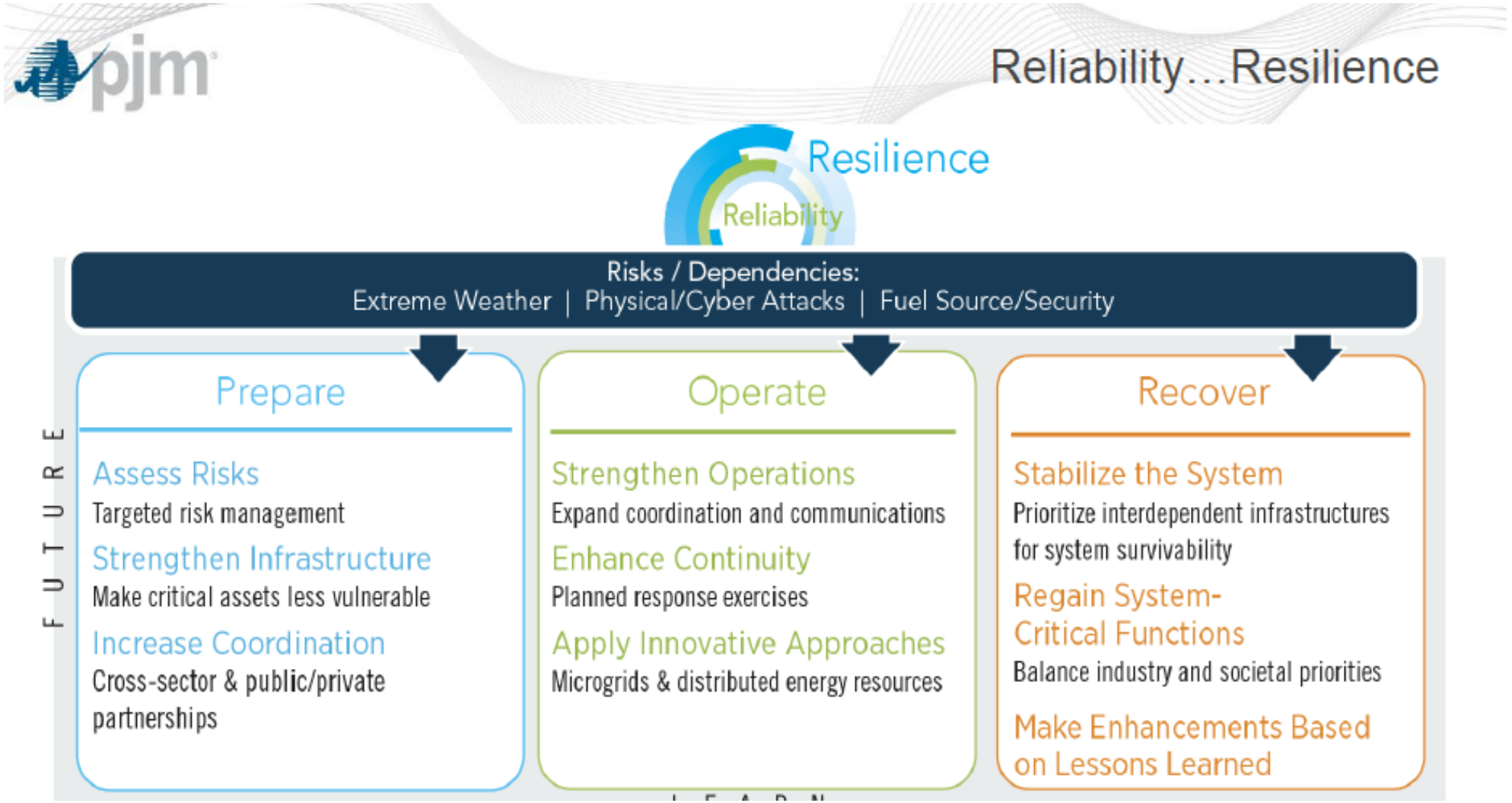
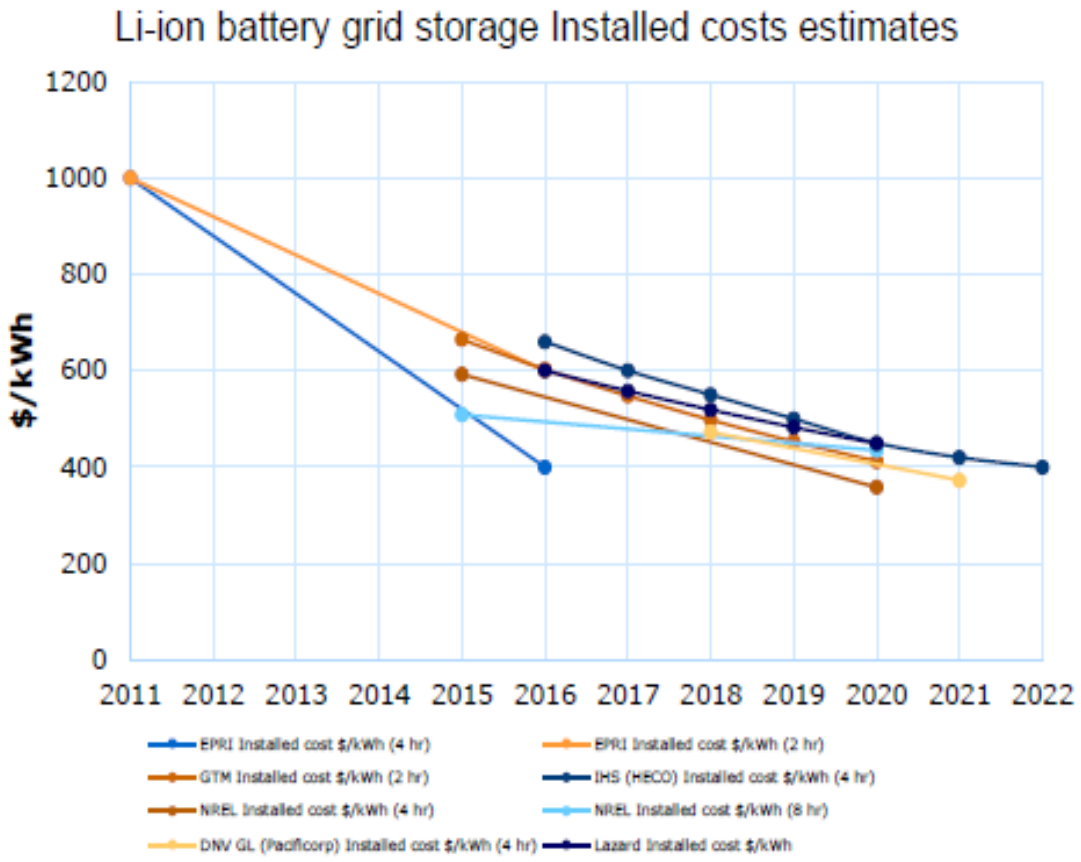
Reliability of Renewables, the Challenges



Load Matching a Challenge – Storage Important

Steep cost declines



TEP (AZ)

30 MW, 4-hr storage

+100 MW solar

$0.045/kWh

KIUC (HI)

20 MW, 5-hr storage

+ 28 MW solar

$0.11/kWh

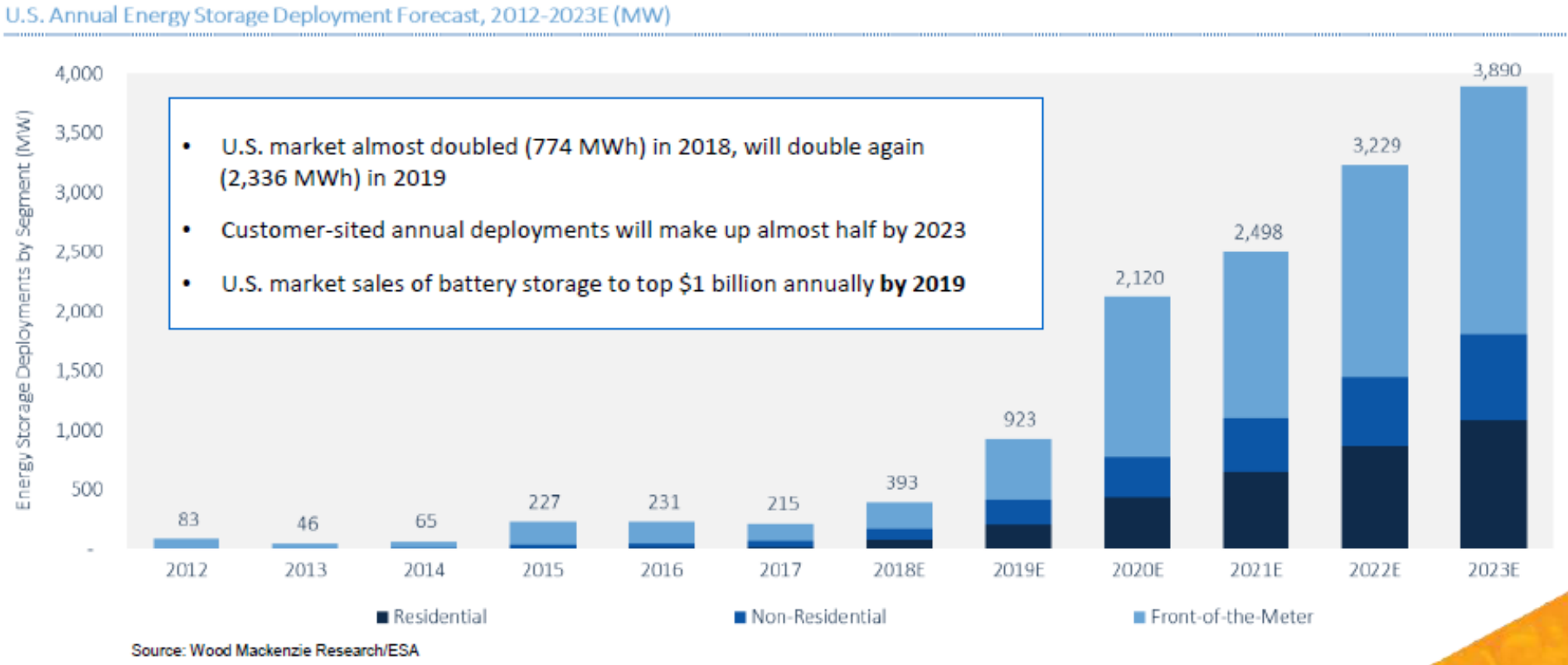
Xcel (CO)

solar+storage **$0.036/kWh**

wind+storage **$0.021/kWh**

Storage and Production – Key Partnership

Battery installations are growing



Source: Wood Mackenzie Research/ESA

Energy Storage Association

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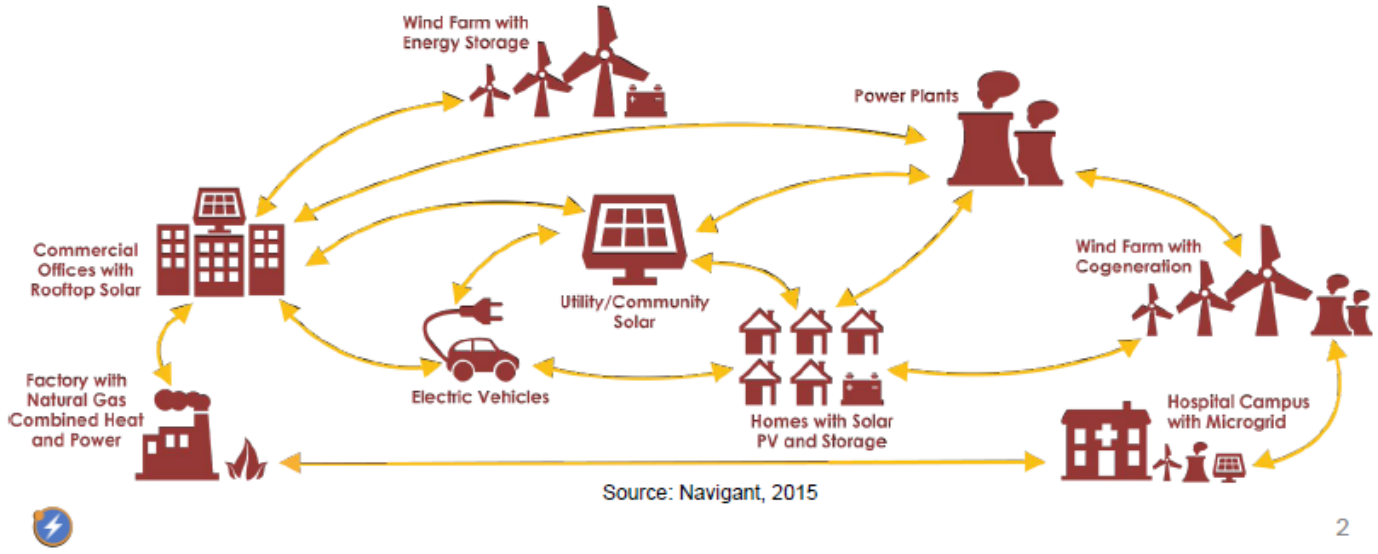
Microgrids Will Solve All Problems???

The grid of the future: more dynamic and complex

Greater customer engagement	New products and services	Greater focus on value vs. cost
High DER penetration	Two-Way Energy Flows	Digitalization of the Grid



Source: Navigant, 2015

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Nothing Works if It is Too Expensive

Factors Affecting Electricity Prices – Basics

Many factors influence electricity prices

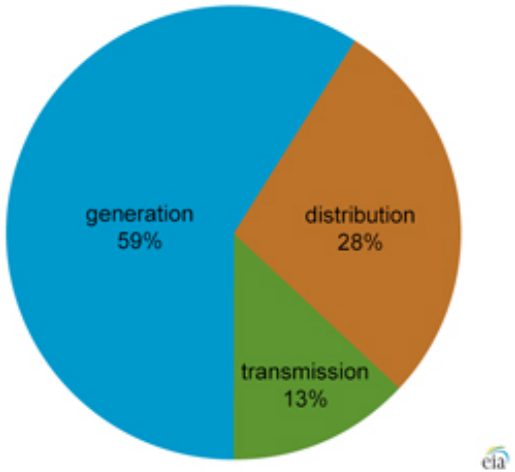
Electricity prices generally reflect the cost to build, finance, maintain, and operate power plants and the electricity grid (the complex system of power transmission and distribution lines). Some for-profit utilities also include a financial return for owners and shareholders in their electricity prices.

Several key factors influence the price of electricity:

- **Fuels**: Fuel costs can vary, especially during periods of high demand. High electricity demand can increase demand for fuel, such as natural gas, which can result in higher prices for the fuel and, in turn, higher costs to generate electricity.
- **Power plants**: Each power plant has construction, maintenance, and operating costs.
- **Transmission and distribution system**: The electricity transmission and distribution systems that deliver electricity have maintenance costs, which include repairing damage to the systems from accidents or extreme weather conditions.
- **Weather conditions**: Rain and snow provide water for low-cost hydropower generation. Wind can provide low-cost electricity generation from wind turbines when wind speeds are favorable. However, extreme temperatures can increase the demand for electricity, especially for cooling, and demand can drive prices up.
- **Regulations**: In some states, public service/utility commissions fully regulate prices, while other states have a combination of unregulated prices (for generators) and regulated prices (for transmission and distribution).

Did you know?
The cost of generating electricity is the largest component of the price of electricity.

Major components of the U.S. average price of electricity, 2017



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*, February 2018, Reference case, Table 8: Electrical supply, disposition, prices, and emissions

How Does Generation Affect Retail Pricing

Table 1. Projected Prices by Service Category (2011 cents per kilowatt-hour)

	2020			2030		
	Generation	Transmission	Distribution	Generation	Transmission	Distribution
Reference	5.6	1.1	2.8	6.0	1.1	2.6
High technology	5.4	1.1	2.9	5.7	1.1	2.7
Best available technology	5.3	1.1	2.9	5.4	1.1	2.7

https://www.epa.gov/sites/production/files/201508/documents/documentation_of_the_retail_price_model.pdf

How Do We Compare Prices

- Converting Electricity to Heating Oil
  - Essentially, multiply cents per kWh by 43
    - $.10 kWh is $4.30 Heating Oil
- What if you add in Efficiency
- Assume 2.5 COP
  - Divide $4.30 by 2.5 to get value and now the Price Equivalence is $1.72
  - And if Heating Oil stays at 90 percent efficient, the Price Equivalence is $1.55

WHAT IS THE FUTURE

- The Hydrocarbon Economy has Dominated the World for Over a Hundred Years
- Whatever Happened to the Hydrogen Economy or Cold Fusion
- Is Electricity a Real Threat
- Do we Have an Answer

Challenges for Electricity

- Battery Storage – Battery Recycling, Reprocessing Disposal
- 100 Percent Reliable
  - Weather
  - Hacking
  - Production
- Smart Grids and Privacy
  - Outside Control of Many Features

What Happened to Natural Gas

- Research is showing that Natural Gas is not the future to a low carbon future.
- Methane is 28 times worse than CO_2 over 100 years
- Methane is 84 times worse than CO_2 over 20 years
- Requires Tremendous infrastructure that is not worthwhile if it is only marginally better than oil.

Can We Succeed by Using Renewables?

- More modest infrastructure Issues Compared to Electricity
- Most changes should come at the production level.
- Residential Customers can naturally transition if we begin transitioning today.
- It is vital that the houses we heat are ready to accommodate the new fuels as requirements come into effect.

Why Us?

- Who would have made enough electricity to heat all the homes in the northeast in December and January of this year.
- Can we afford to produce and store that much electricity for unscheduled and surprise demand
- Our infrastructure with home storage is designed for these types of situations.

Our Challenges

- Storage
- Equipment that is Reliable
- Can our Equipment Adapt to Changing Fuels
  - Our Fleet is Old and in Continuous Transition
- An Industry Driven by Blue Collar Workers –
  - Workers per Home Unit Seems High

Thank you…

This is a workshop, so your questions and thoughts are critical

Let’s all think of what we do to Compete

And make sure to put your ideas and thoughts into discussion tomorrow