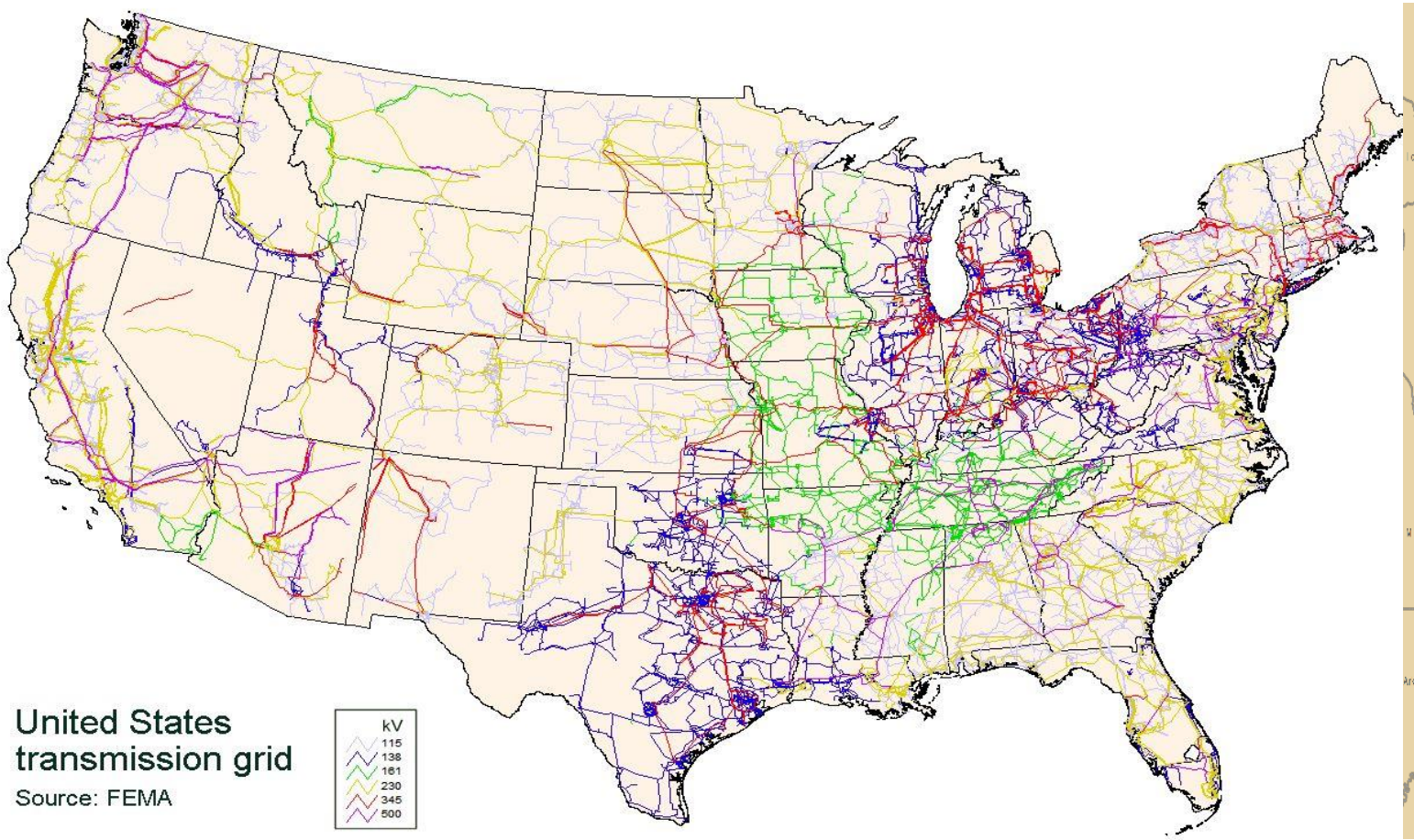
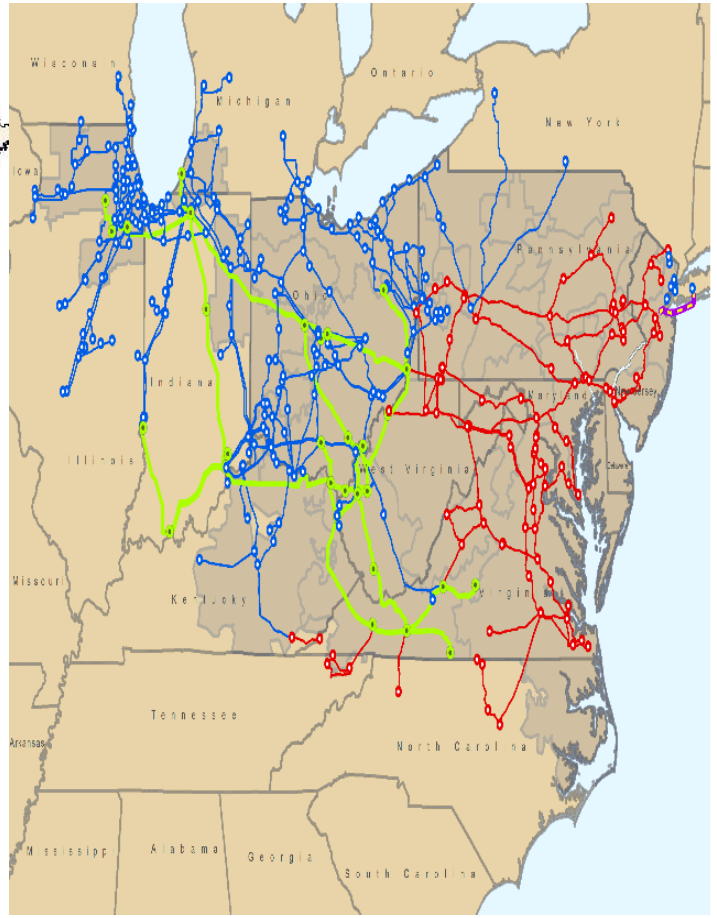
Reason to be Optimistic

that we will get to
100% Clean Energy
and
80% Redution in GHG emissions
before 2050

Its really relatively easy to get to net zero

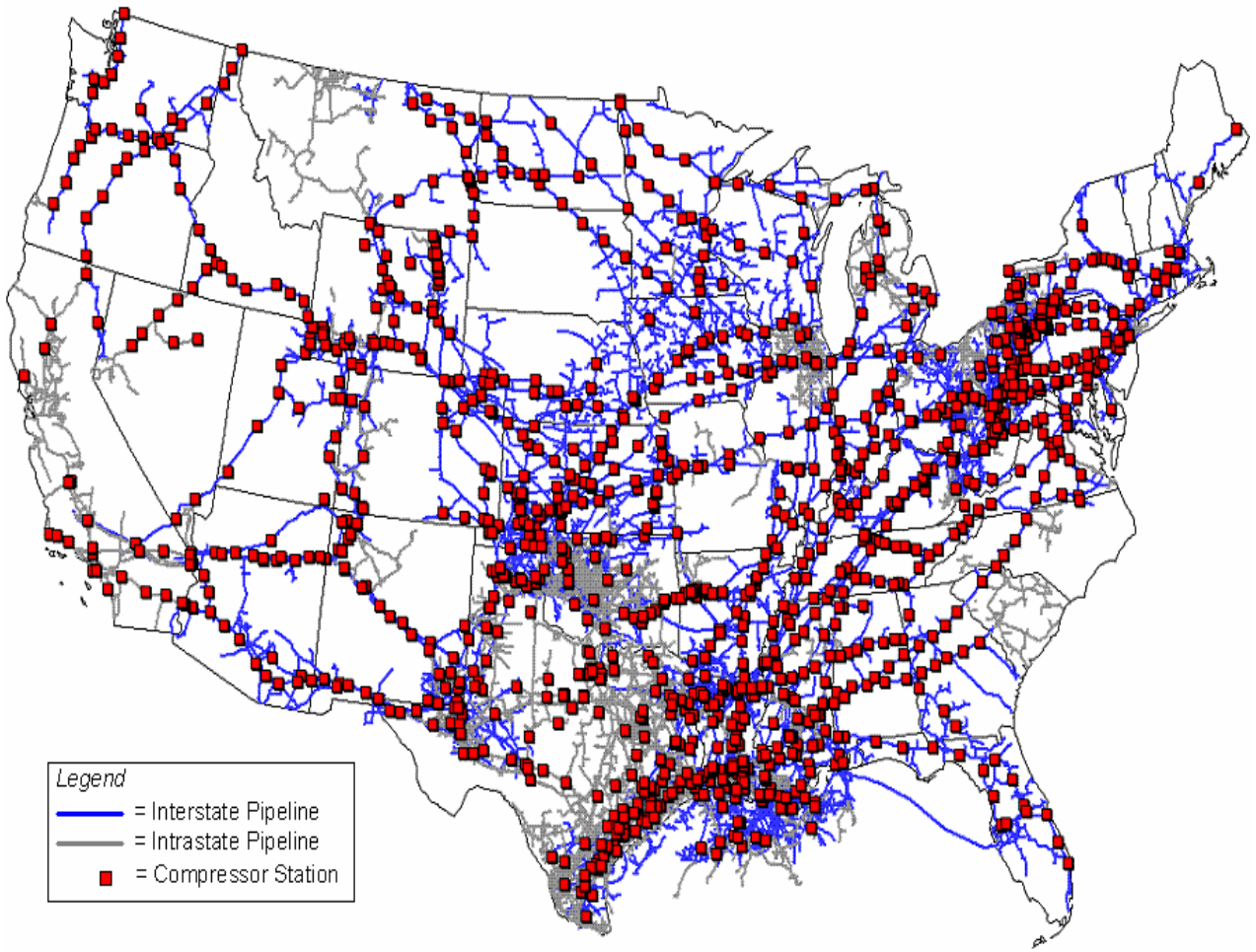
Just change the demand curve from the bottom up



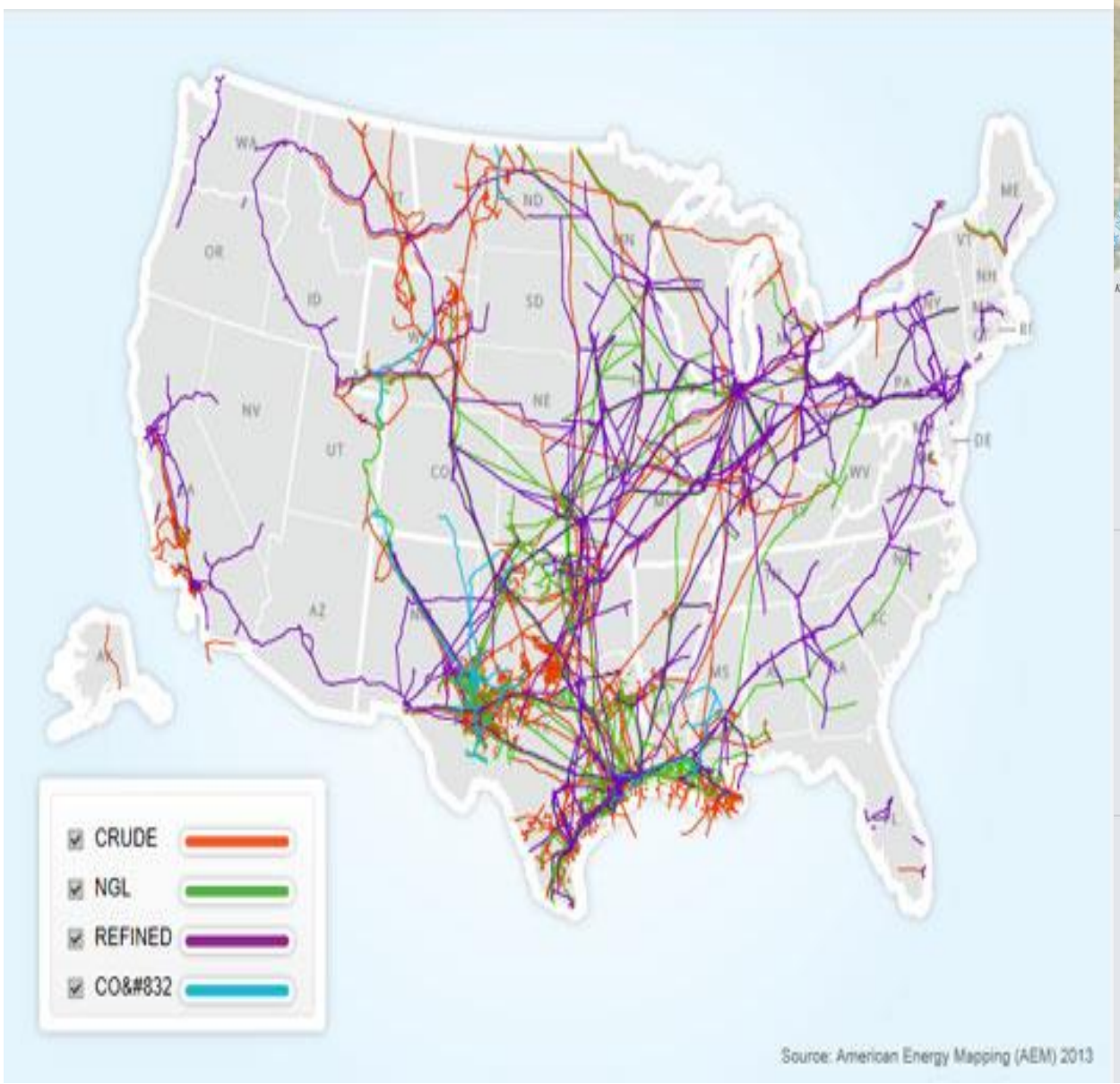


200,000 miles of transmission lines and 5.5 million miles of distribution wires

Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System



300,000 miles of inter and intrastate pipelines and 2.1 M miles of distribution pipes



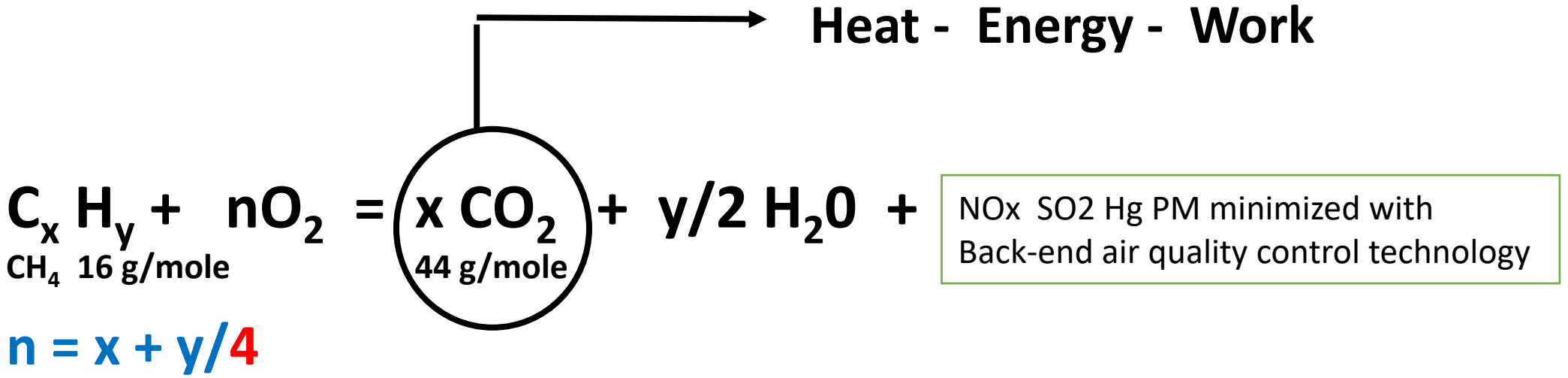
193,000 miles of fuel oil pipelines in US

Energy is Carbon - Seven Basic Facts of Energy and Climate Change by Mike Winka

1. Work makes the world go round and you need to generate energy to do work.
2. Almost all the energy we generate comes from the combust of fossil fuels.
3. Fossil fuels are just organic matter sequestered over millions of years – the organics matter on the earth today will be fossil fuel millions of years from now.
4. When you burn fossil fuels for energy you release the sequestered matter that was in the fossil fuels one of which is CO2 as part of the combustion process.
5. Coal has more sequestered matter than oil and oil more than natural gas.
6. There is no end of the pipe control technology for CO2 – if there were there would be no debate on the science of climate change
7. Increasing CO2 increases temperature, increasing temperature increases energy in weather impacts and the volume of water which leads to sea level rise.

It is not climate change that is the issue climate will always change –
It is the rate of change – can we adapt to the rate of change

Basics of Climate Change and the Science of Energy by Mike Winka



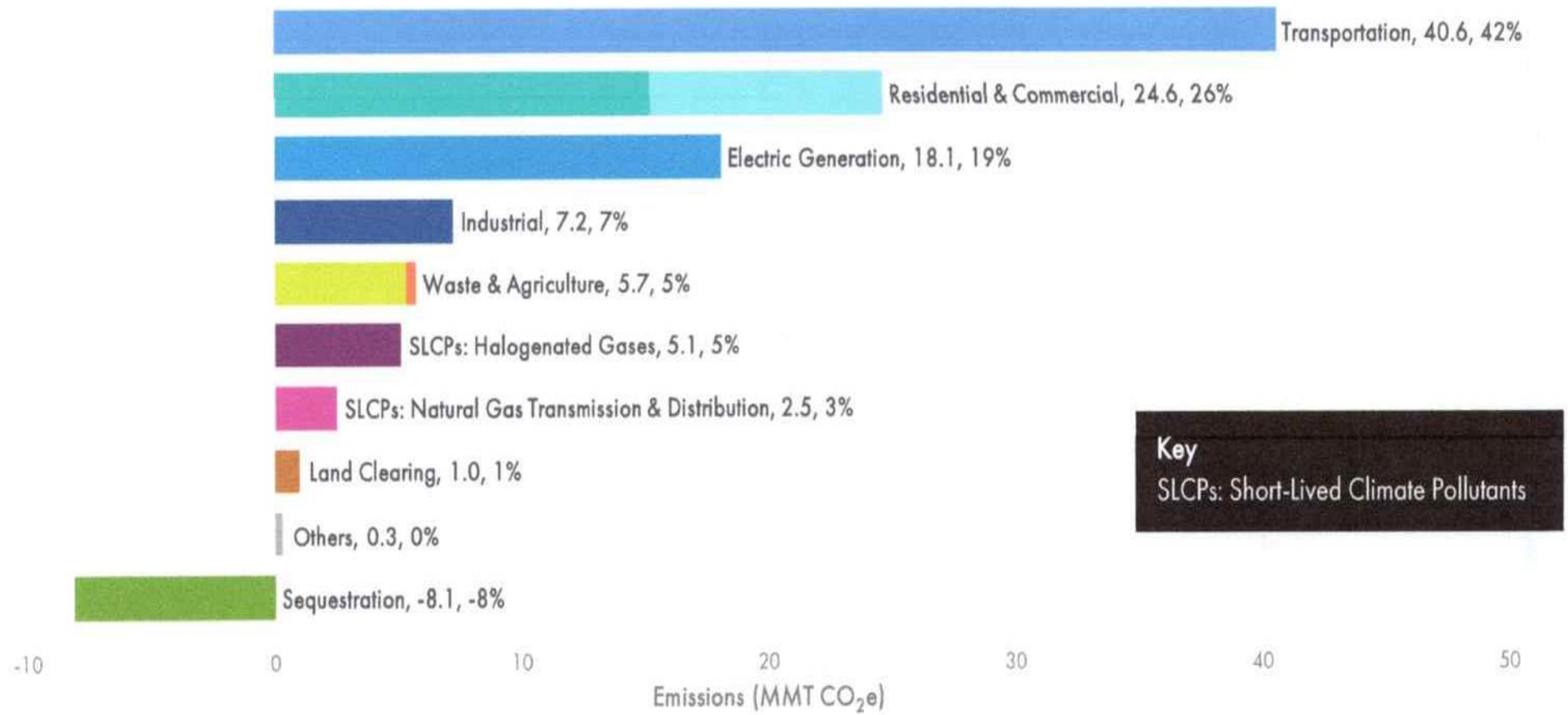
Work makes the world go round - You have to produce energy to do work
And it cost real money to generate energy

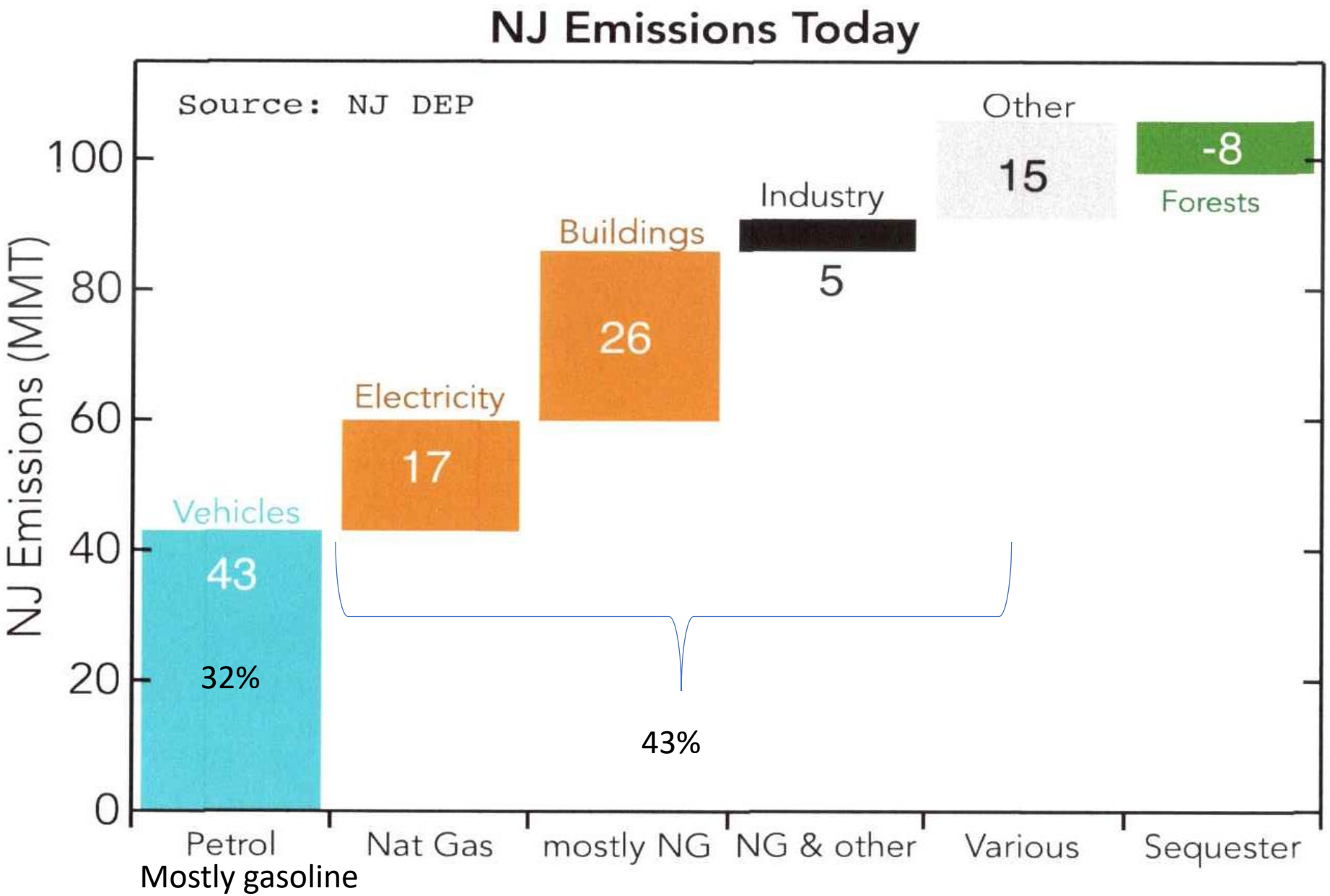
Sustainability is that ability to transfer energy to move heat or do work with the least amount of negative environmental, economic and equity impacts

CO2 emissions cannot be control with back–end air quality control technology
The control technology for reducing CO2 emissions is:
Make it Cleaner or more Efficient – Renewable Energy and Energy Efficiency

Figure ES.2. New Jersey GHG Emissions Inventory for 2018 (MMT CO_2e and Percentage).

Opportunities for emissions reductions are present in each of the categories.





Mostly gasoline

2019 Energy Master Plan – Strategies to get to 100% Clean Energy by 2050
The EMP puts mitigation in buckets – more integrated approach

EMP Strategy	Integrated Energy Plan Insights and Recommendations
1. Reduce energy consumption and emissions from the transportation sector	• **Accelerating the transition to electric vehicles** allows the transportation sector, currently the largest source of carbon emissions in New Jersey, to run on clean electricity.
2. Accelerate deployment of renewable energy and distributed energy resources	• **Continuing deployment of in-state renewables** and distributed energy resources, above current goals, is consistent with a least-cost path to meeting 2050 targets. • **Coordination with neighboring states and regional markets** can allow New Jersey to complement in-state renewables with low-cost, out-of-state resources. • **Retention, but not near-term expansion, of existing gas and nuclear capacity** can allow New Jersey to preserve reliability and meet clean energy goals.
3. Maximize energy efficiency and conservation and reduce peak demand	• **Continued prioritization of energy efficiency** measures and programs can significantly reduce energy consumption—including through the adoption of electric vehicles and heat pumps—and lower the costs of powering New Jersey's economy with clean energy.
4. Reduce energy consumption and emissions from the building sector	• **Building electrification reduces final energy demand** and allows buildings to efficiently utilize clean electricity for space heat and water heat. • **Electrification programs for new construction** can lay the groundwork for an in-state workforce to retrofit existing buildings.
5. Decarbonize and modernize New Jersey's energy system	• **New Jersey's electricity load doubles by 2050** due to building and vehicle electrification. • **Carefully planned grid modernization** investments can support electrification while containing costs for ratepayers. • **New Jersey's natural gas use declines to less than one fifth of today's levels by 2050**, likely reducing the need for gas distribution system expansion.

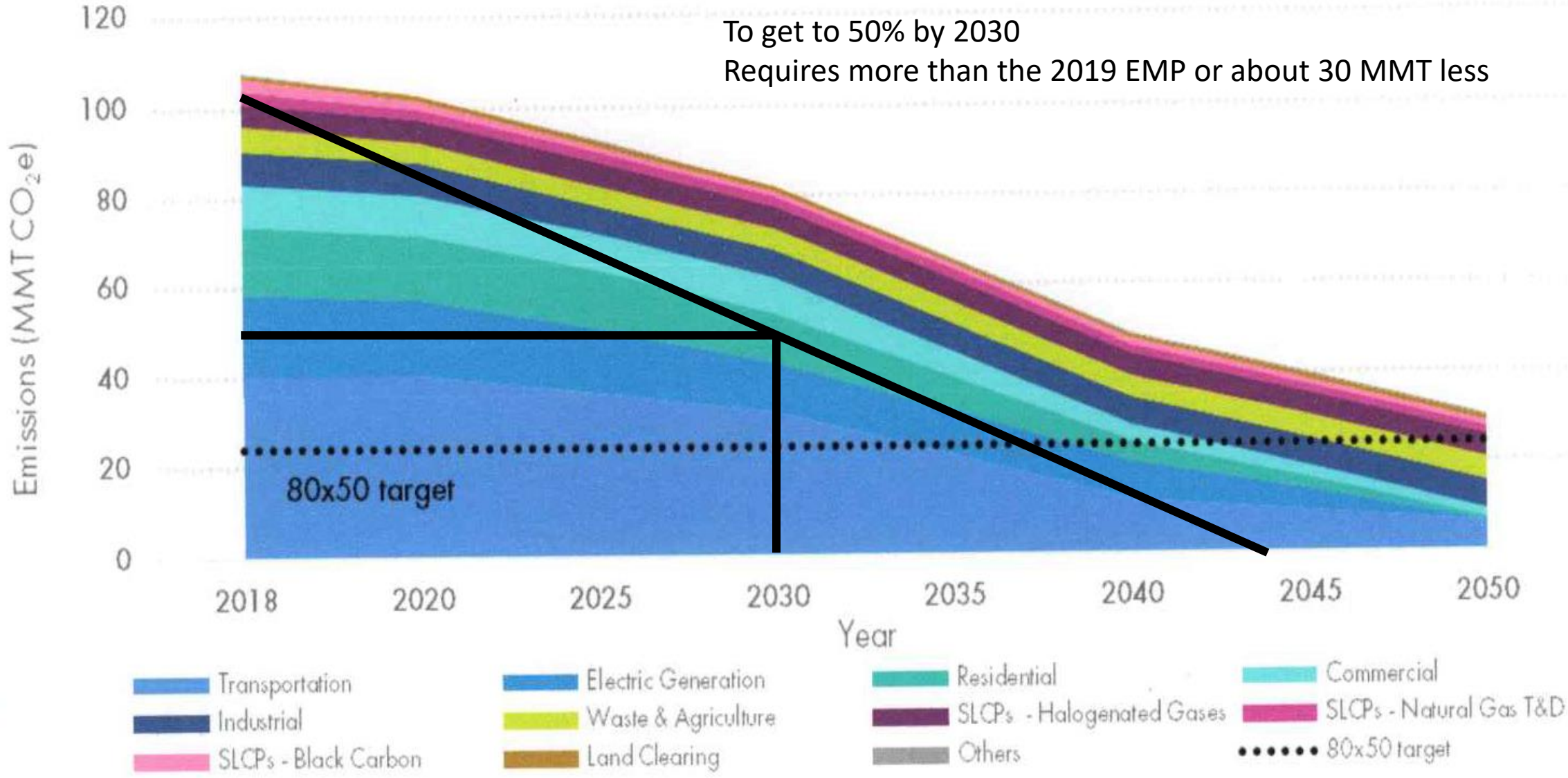
2019 EMP Goals

Achieving 100% clean energy and 80% reduction in 2006 greenhouse gas emissions (125 million metric tons to 24 million metric tons statewide) by 2050. 100% clean energy is defined as 100% carbon-neutral electricity generation and maximum electrification of the transportation and building sectors - specifically heating.

Figure ES.3. New Jersey GHG Emissions Pathway to 2050 (MMT CO_2e).

The 2019 EMP least cost pathway combined with non-energy sector strategies, and carbon sequestration (not shown) have the potential to reduce net emissions below th

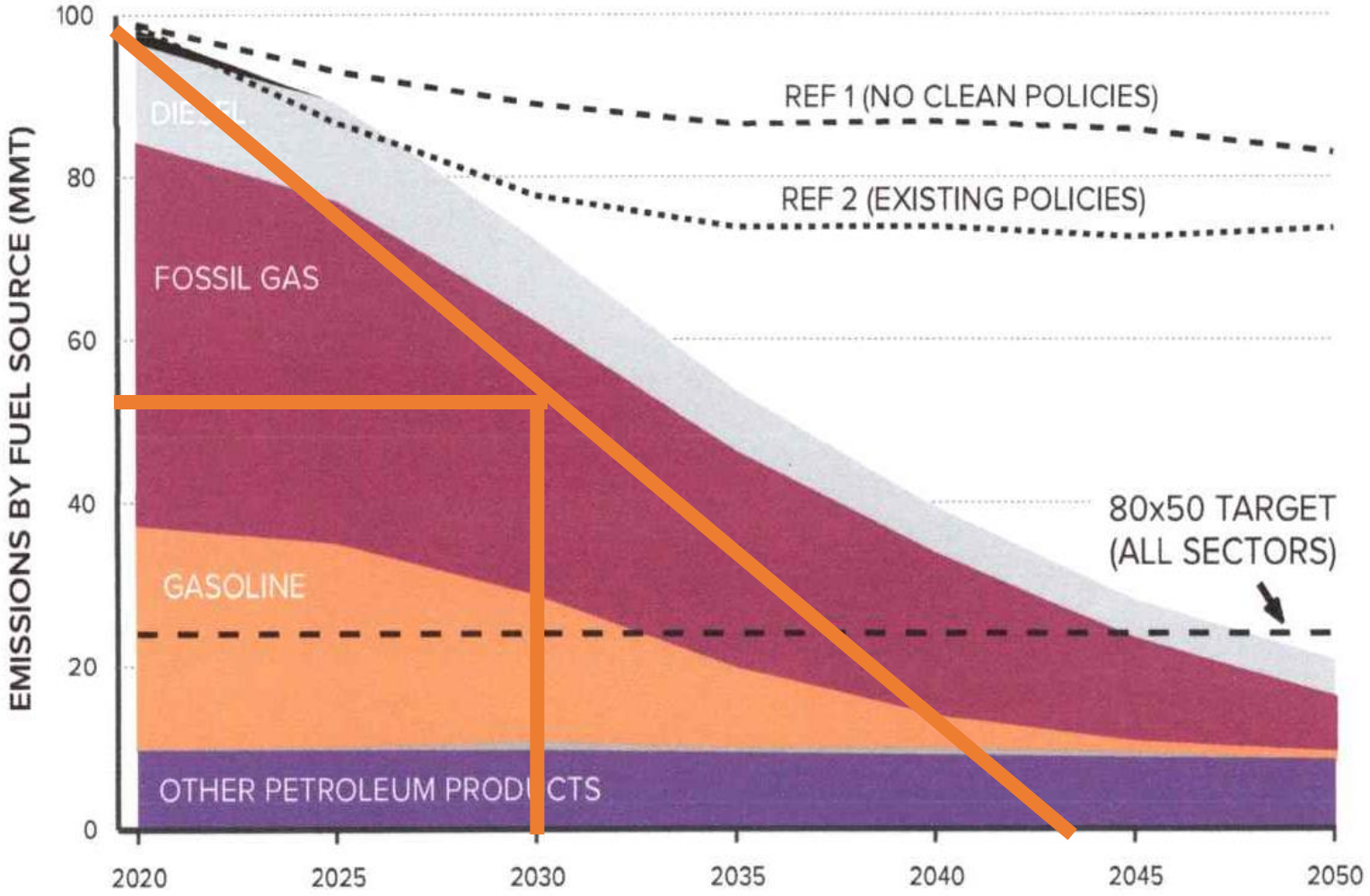
80x50 target prior to 2050.



To get to 50% by 2030
Requires more than the 2019 EMP or about 20 MMT less

FIGURE 7.

Energy Emissions by Fuel Source, Least Cost Scenario



Clean Energy Act of 2018 –Ref 2

The Clean Energy Act of 2018 was enacted by Governor Murphy in May 2018 and included the following:

Energy storage goal of 600 MW by 2021 and 2,000 MW by 2030

Class I RPS of 21% by 2021, 35% by 2025 and 50% by 2030 with a cap of 7% on the total cost .

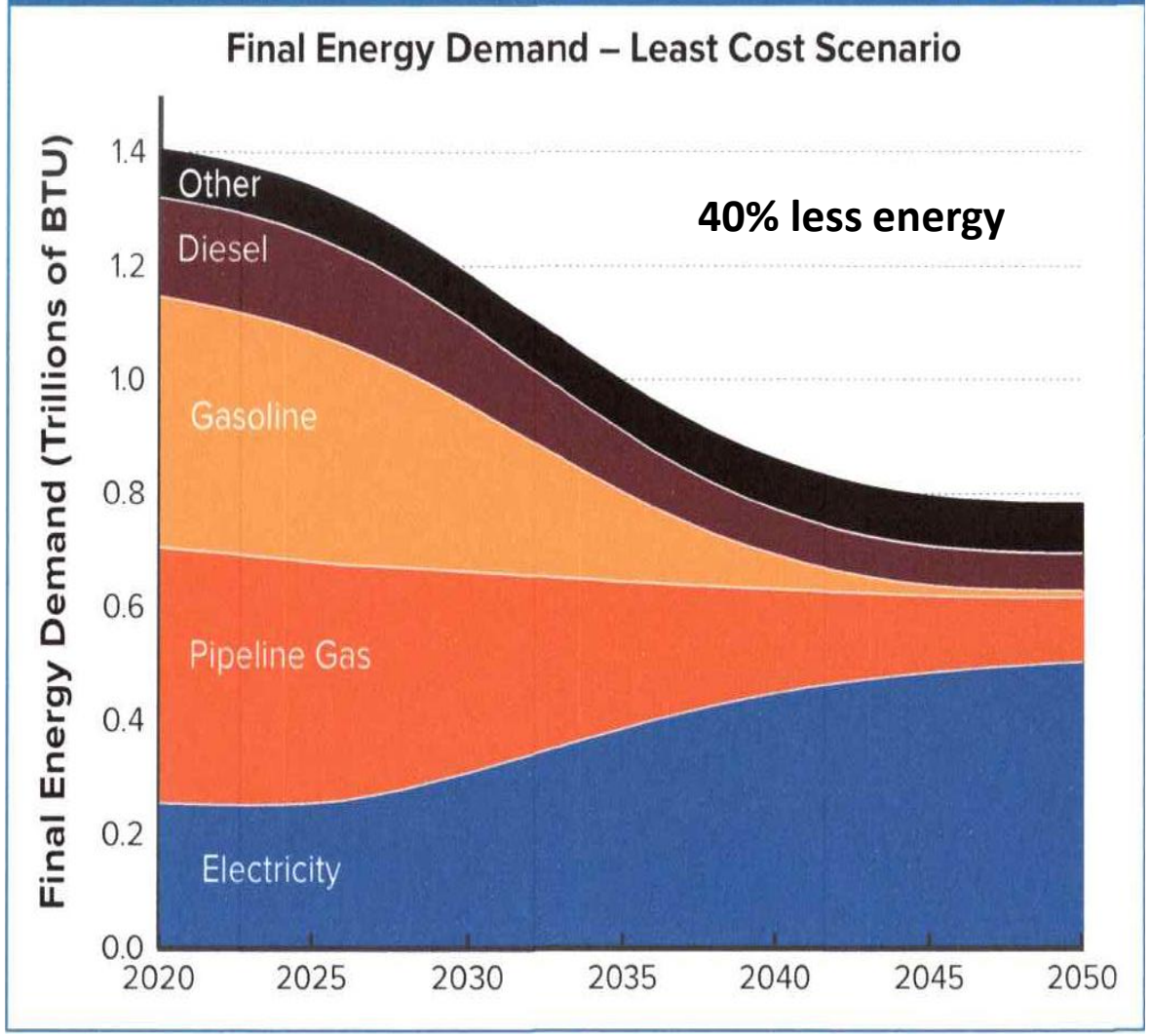
Modify or replace the SREC program

A community solar program

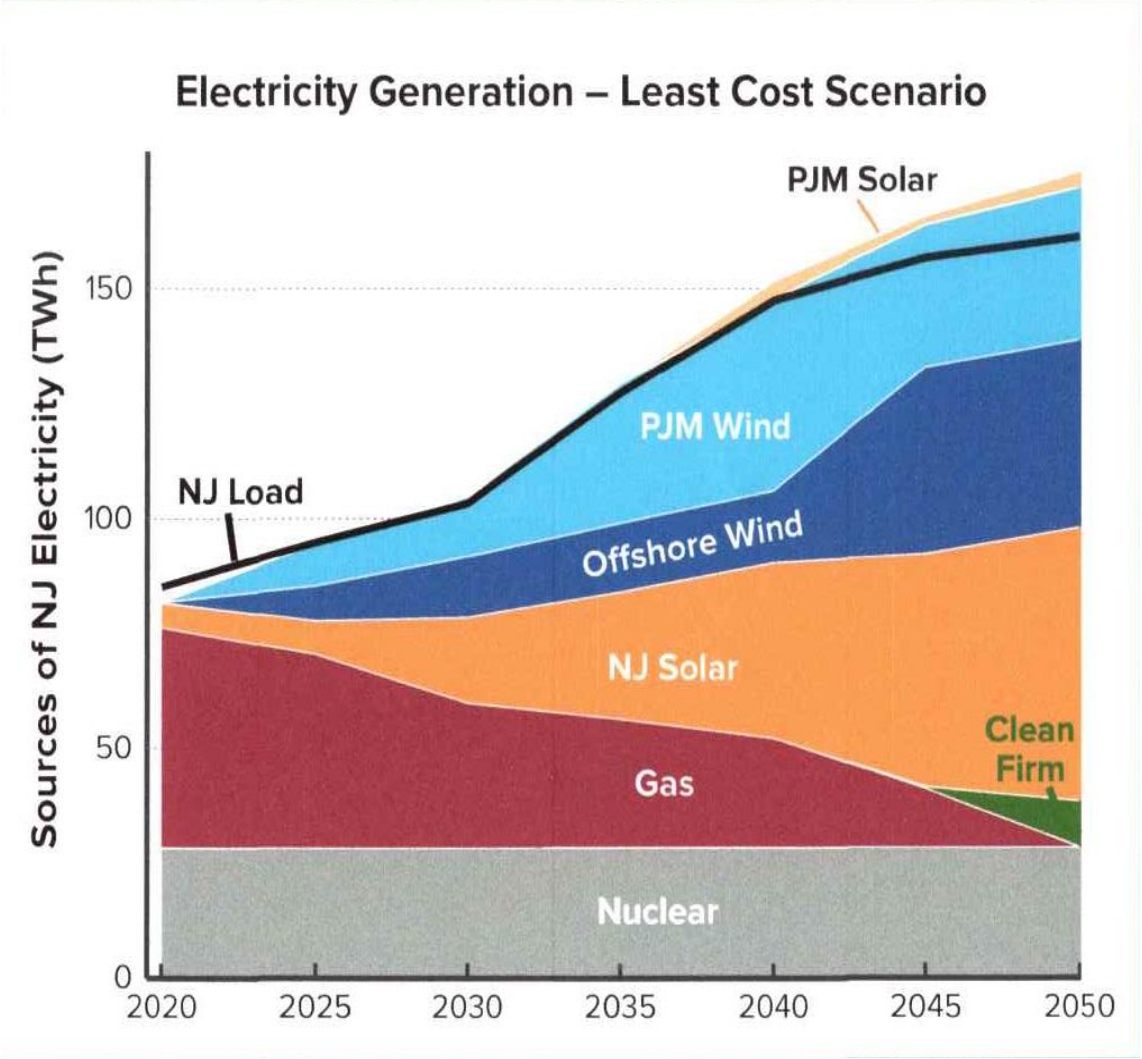
Utility EE goals of 2% annually for electricity and 0.75% for natural gas

OSW goal of 3,500 MW

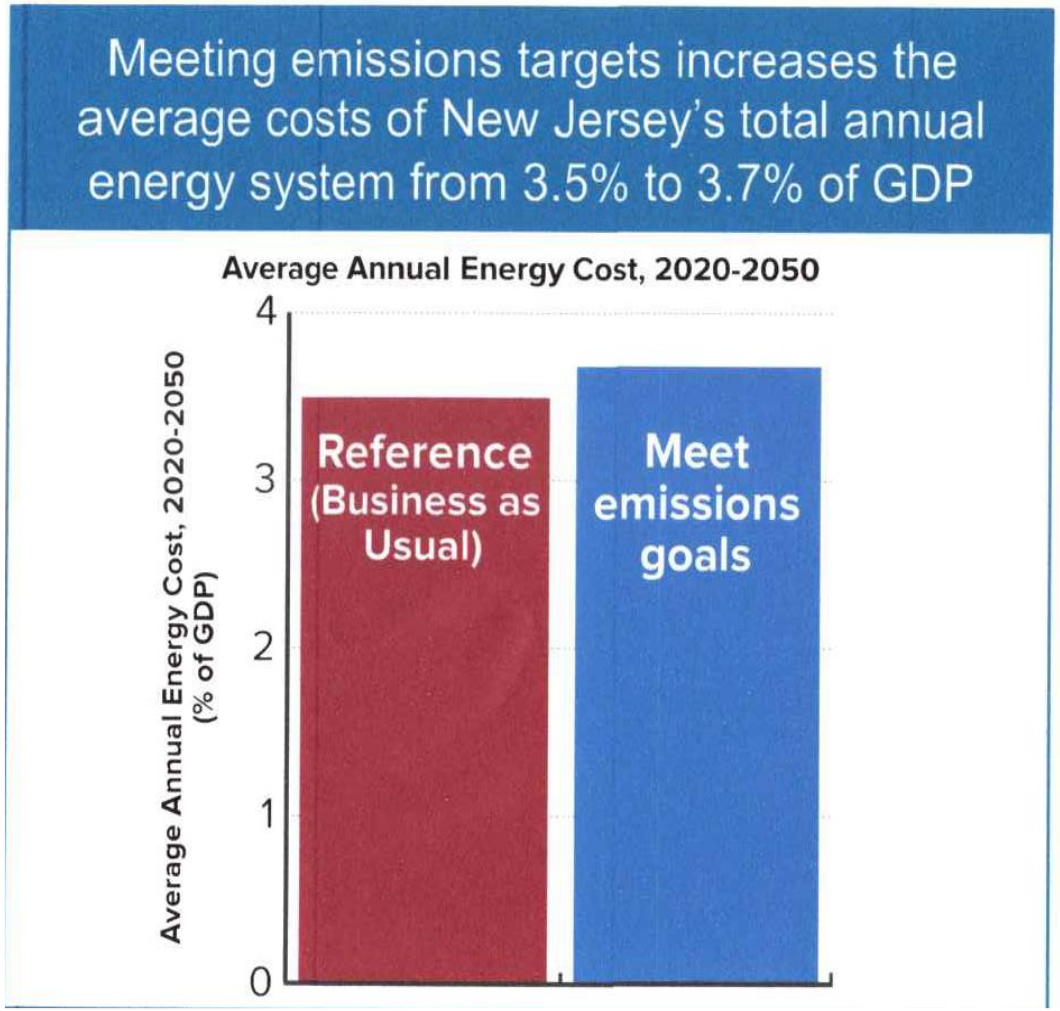
Near-term EV adoption reduces gasoline use through 2035. Building electrification reduces gas use starting in late 2020s.

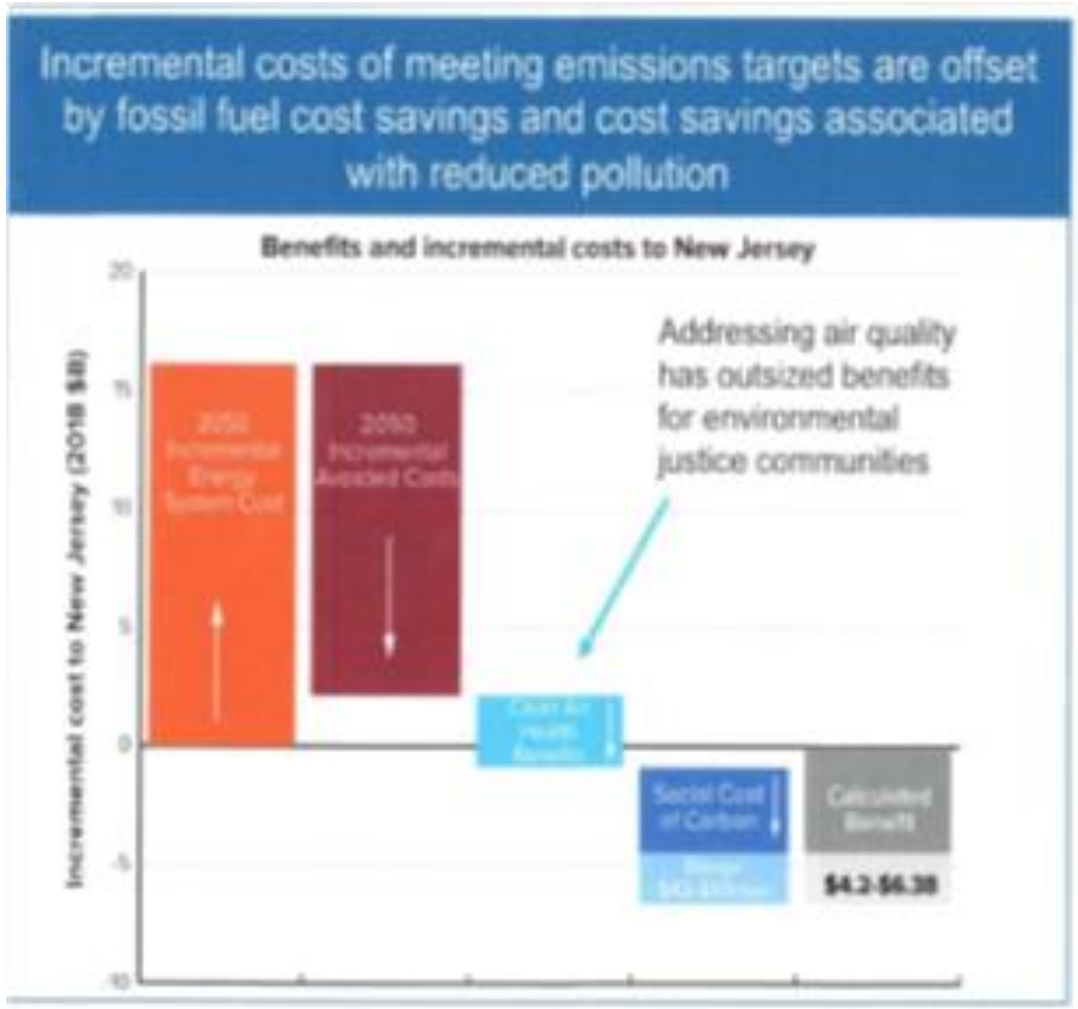


Carbon-neutral electricity grows and transitions to meet 100% Clean Energy



2019 Energy Master Plan – Costs and Benefits





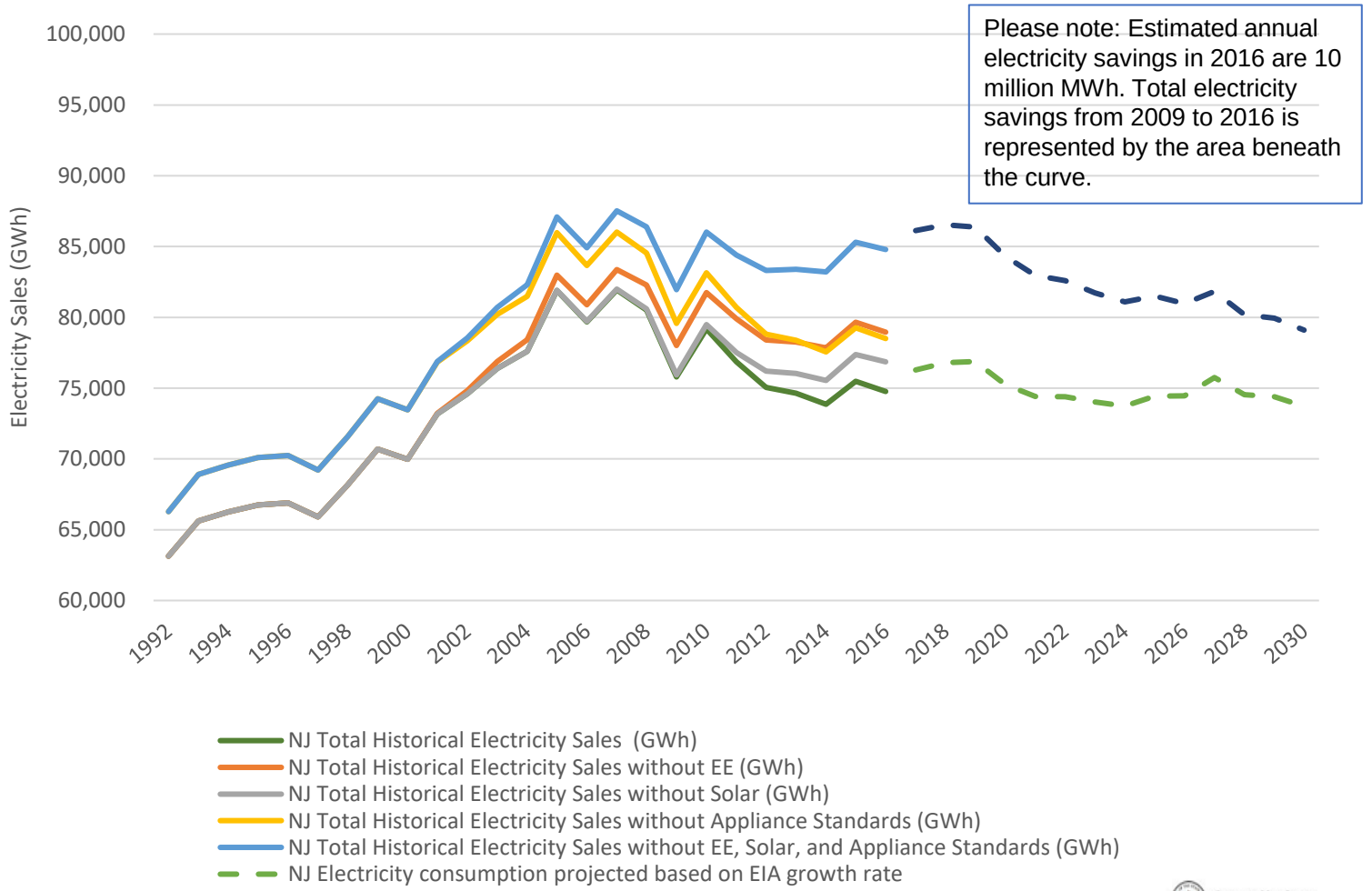
The overall cost is a 0.2% increase in New Jersey's total GDP at an estimated cost of $2.1 billion and a benefit of $4.2 to $6.3 billion. That is a benefit to cost ratio of 2 times to 3 times. A benefit to cost ratio that is greater than one is defined as cost effective.

From the 2019 Integrated Energy Plan presentation – November 2018

Summary of key findings presented today

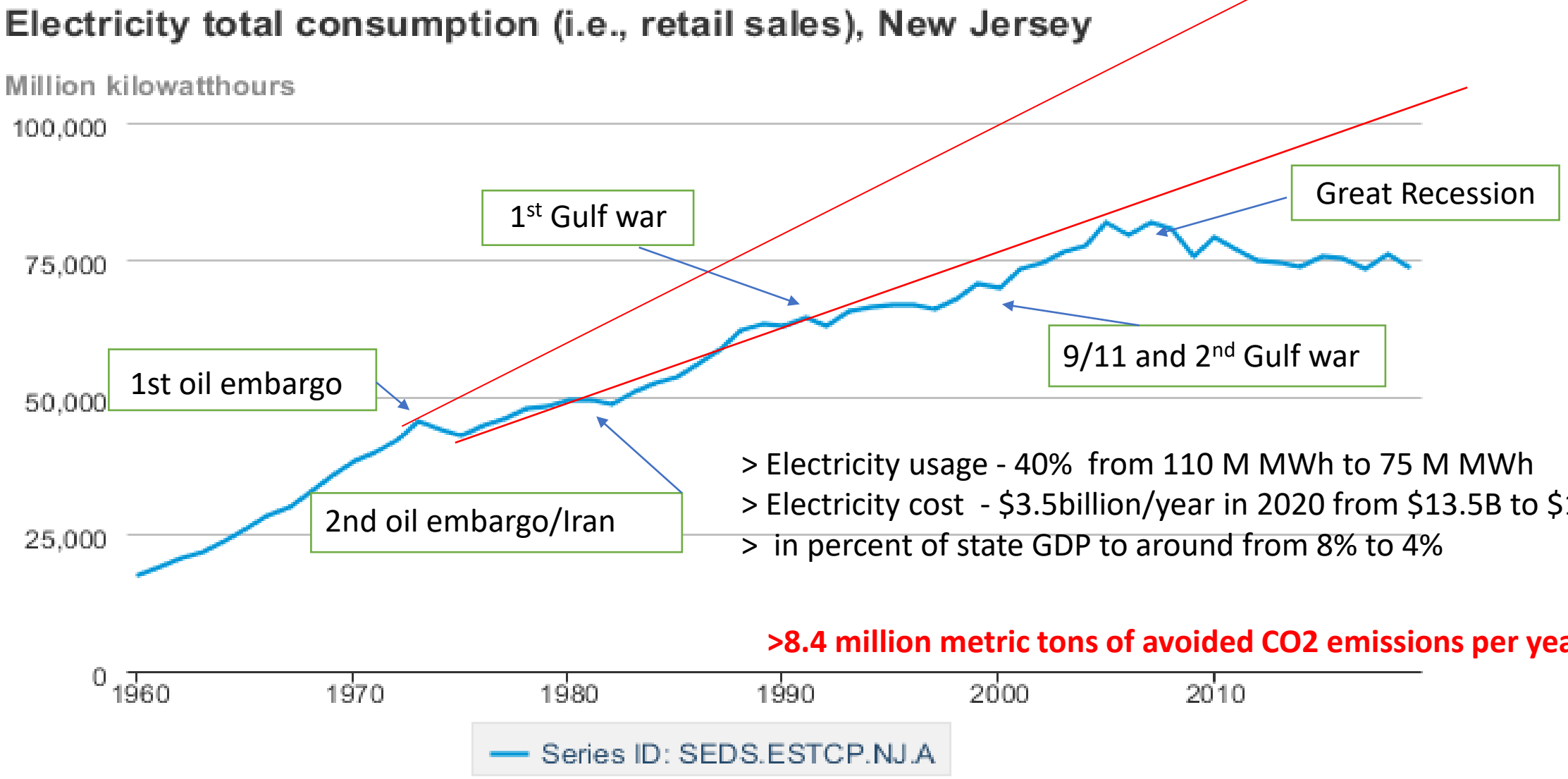
1. New Jersey can meet Global Warming Response Act and 100% Clean Energy with existing technologies
2. Costs to meet NJ emissions targets are small compared to total energy system spending and offset by clean air benefits
3. Existing policies reduce emissions, but are not sufficient to meet GWRA and 100% Clean Energy targets
4. A least-cost energy system that meets New Jersey's goals is substantively different in a number of ways from today's

NJ Electricity Sales with and without EE, Solar and Appliance Standard Savings



State of New Jersey
Energy Data Center
http://njenergydata.rutgers.edu/

Pre-1973 Energy Policies were Economic Policies – that changed with Energy Efficiency

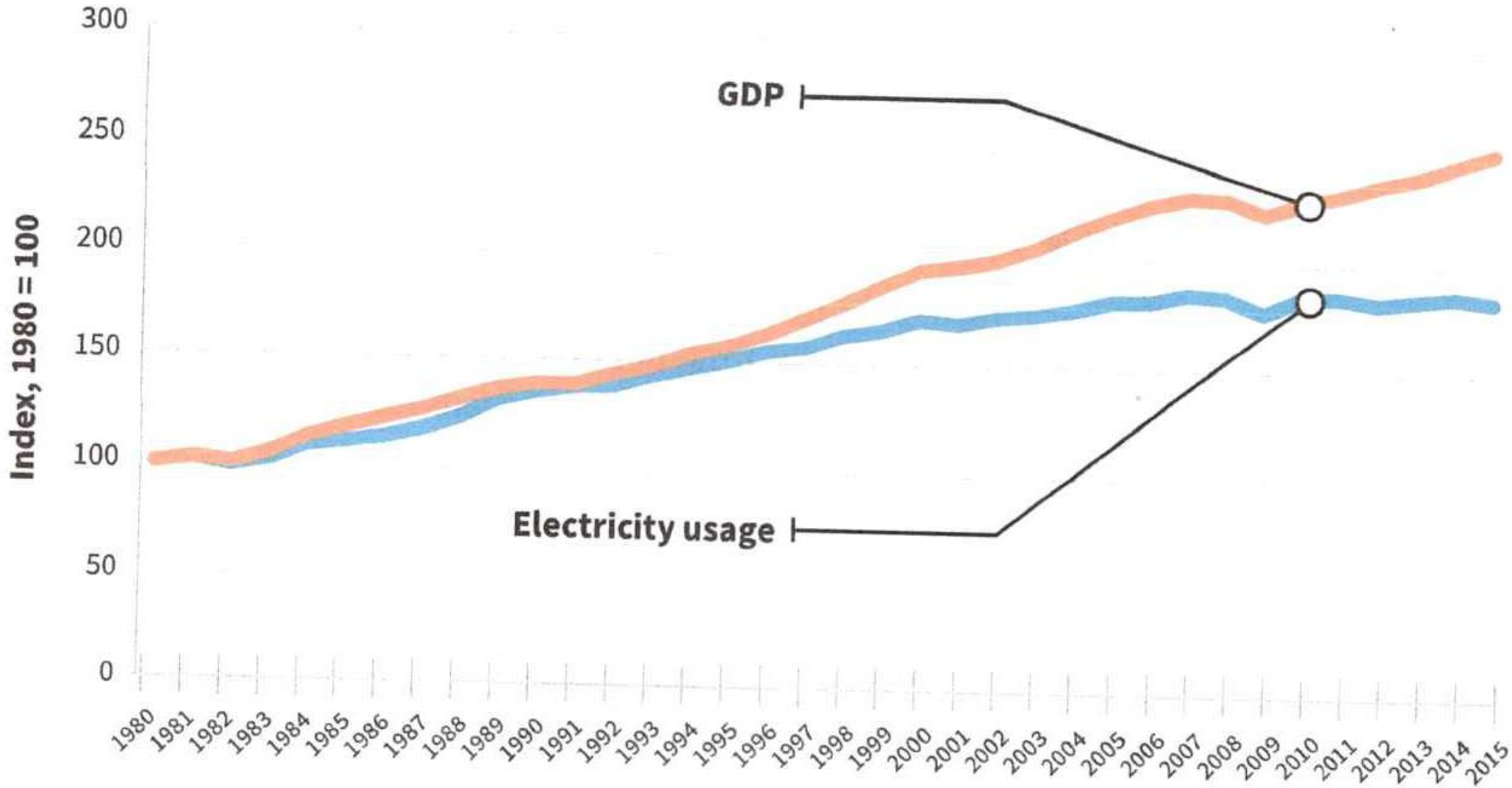


> Electricity usage - 40% from 110 M MWh to 75 M MWh
> Electricity cost - $3.5billion/year in 2020 from $13.5B to $10 B
> in percent of state GDP to around from 8% to 4%

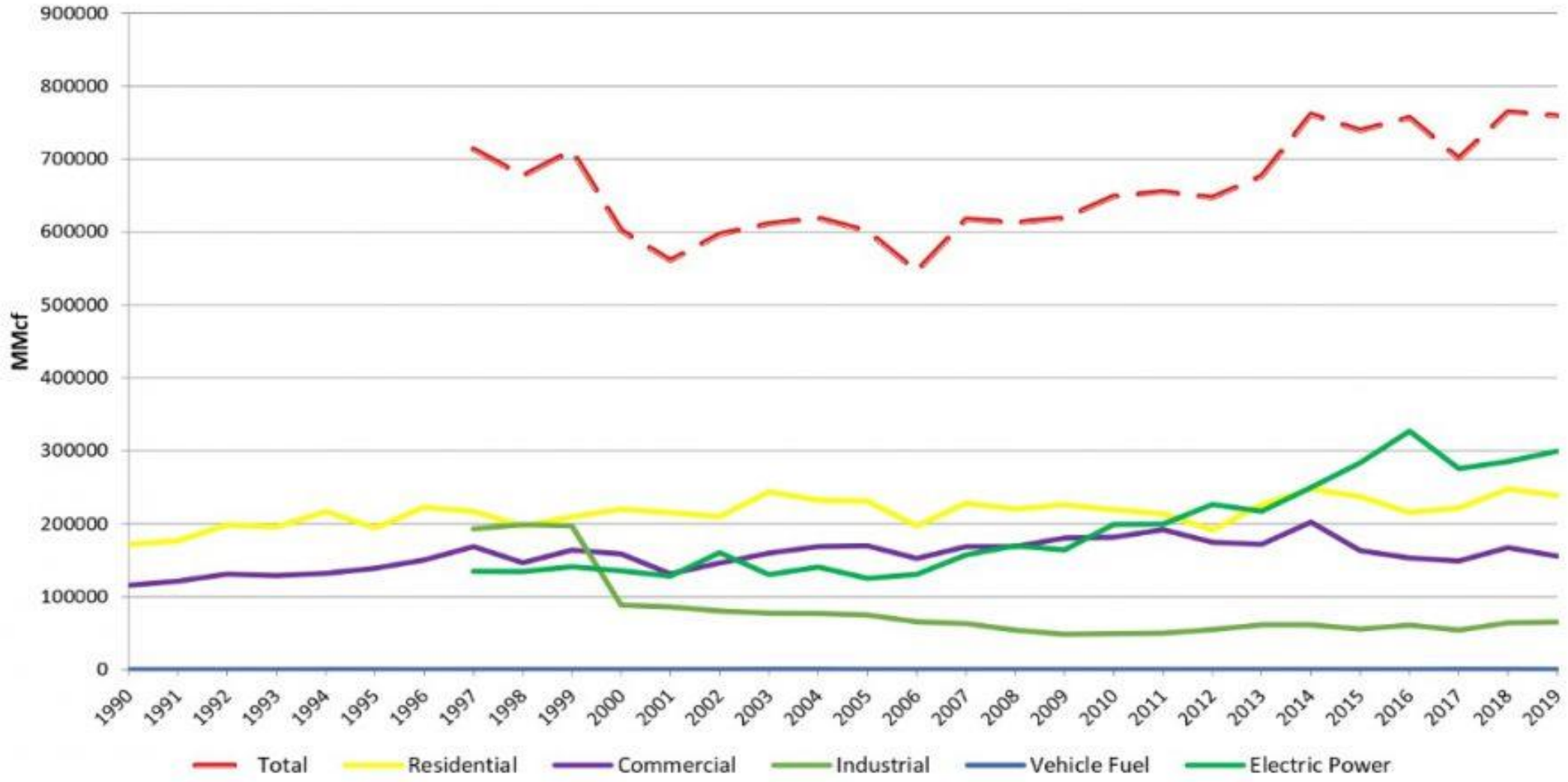
>8.4 million metric tons of avoided CO2 emissions per year

eia Source: U.S. Energy Information Administration

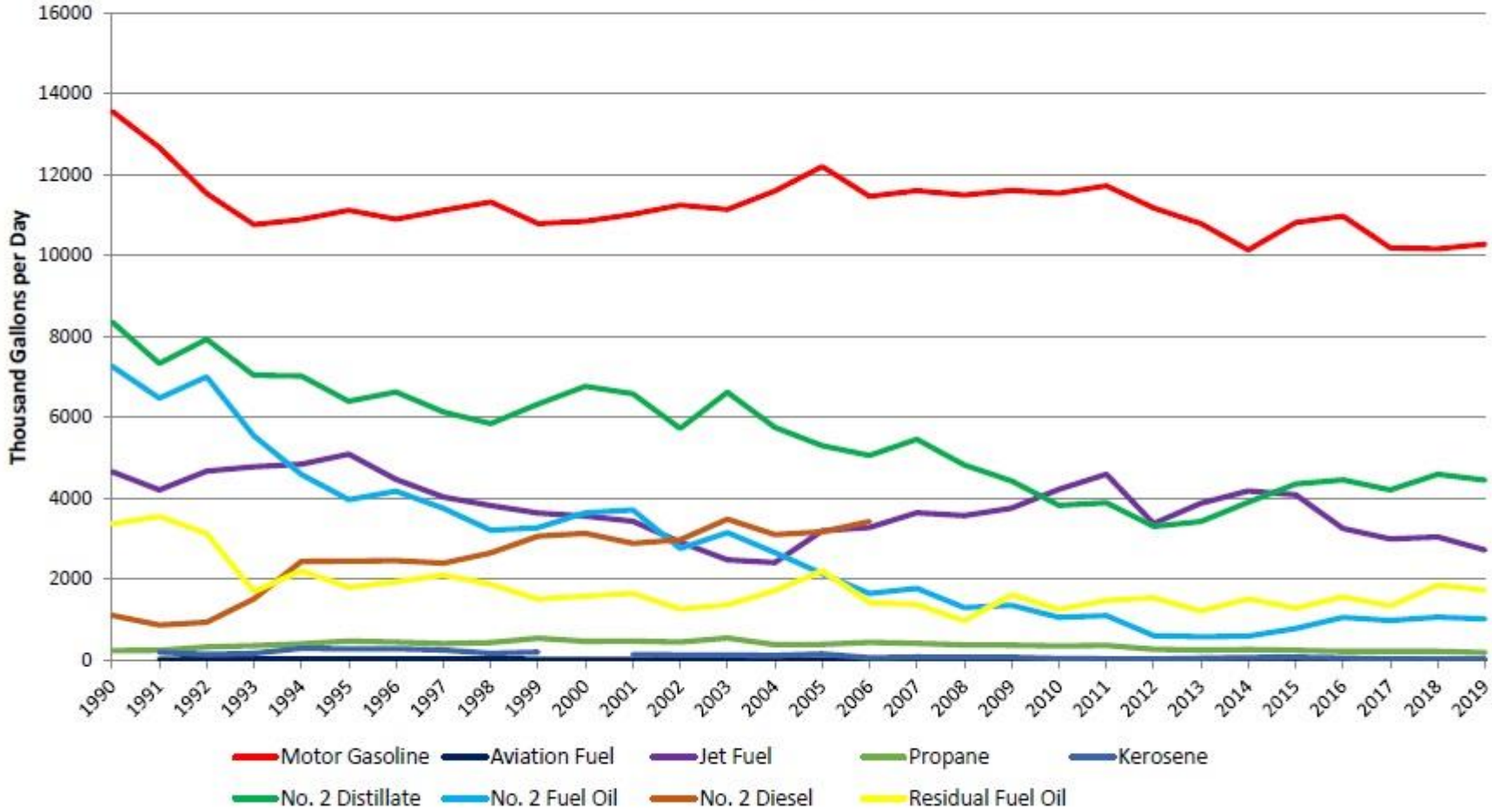
Figure 2. US growth trends in electricity usage (TWh) versus gross domestic product (GDP)



NJ Natural Gas Consumption by Sector
1990-2019

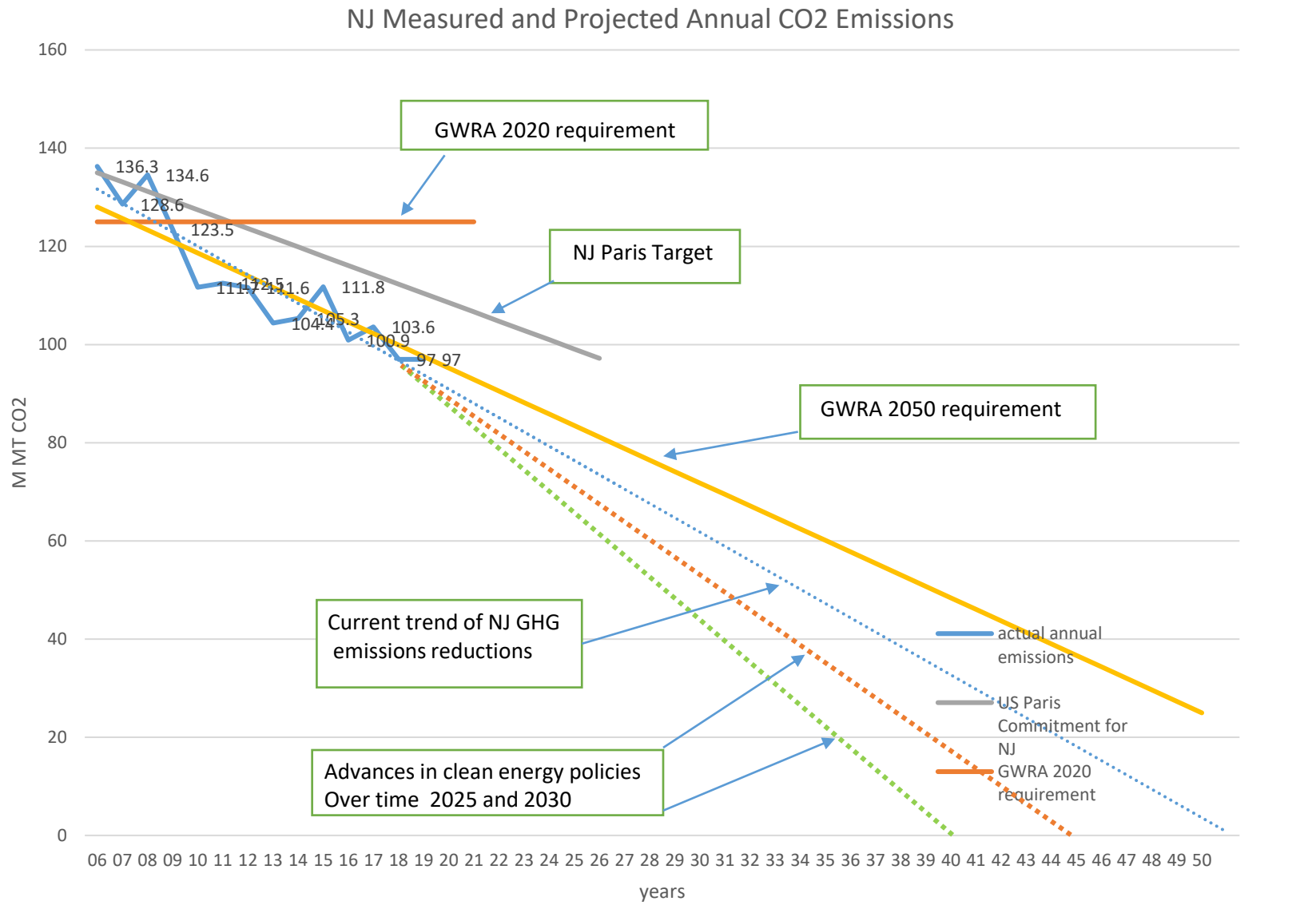


NJ Liquid Fuel Consumption
1990-2019



Source: https://www.eia.gov/dnav/pet/pet_sum_mkt_dcu_SNJ_a.htm

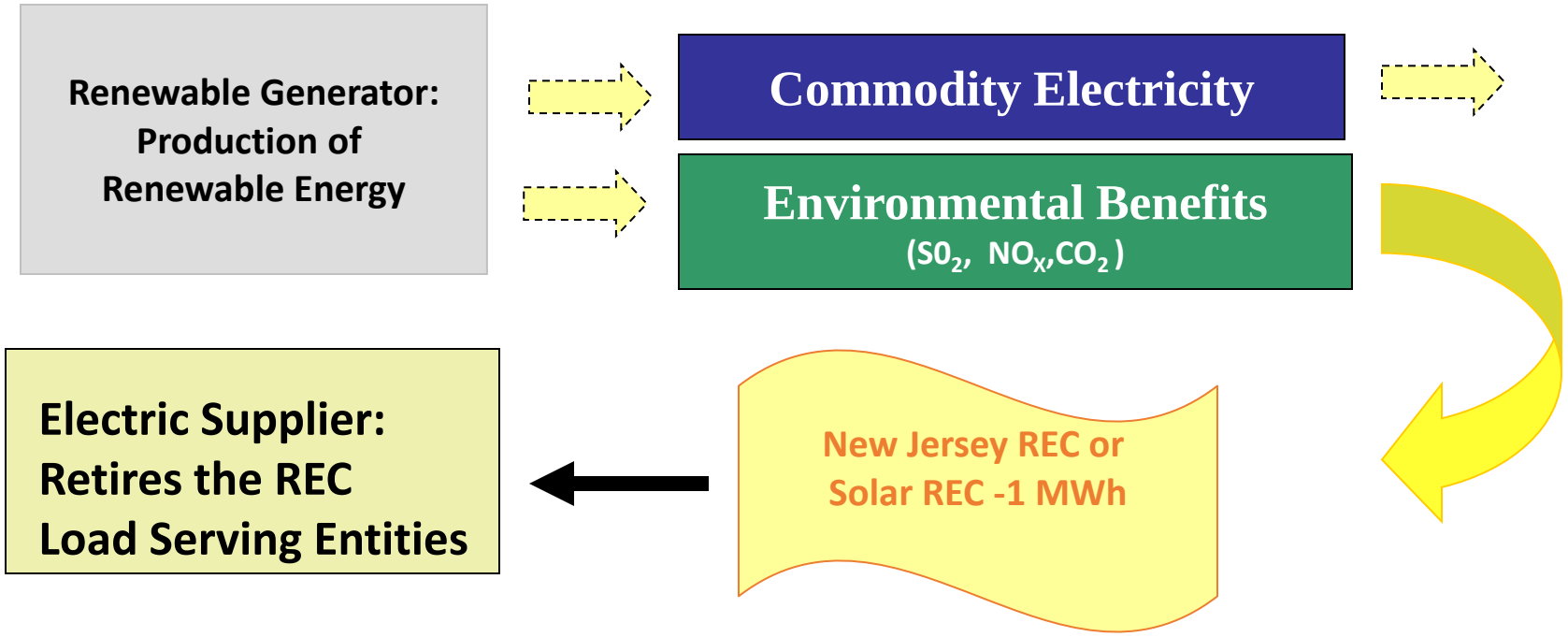
New Jersey's Progress to achieving its GHG emissions reduction goals and more



Source for actual data NJDEP GHG emissions Inventory Report https://www.nj.gov/dep/aqes/NJ_GHGinventory2015Update.pdf

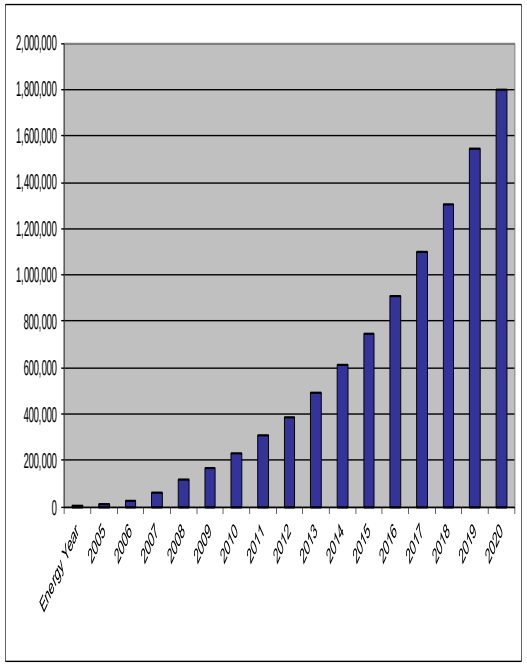
New Jersey

Renewable Energy Certificates (RECs)



Certificates represent the environmental benefits and other attributes associated with electricity generated from a renewable energy generator . May be traded independently of underlying electricity.

What is a Solar Renewable Energy Certificate (SREC) ?
How Does the SREC Market Works to help pay for your Solar



RPS

Buy

LSE's

SREC Market

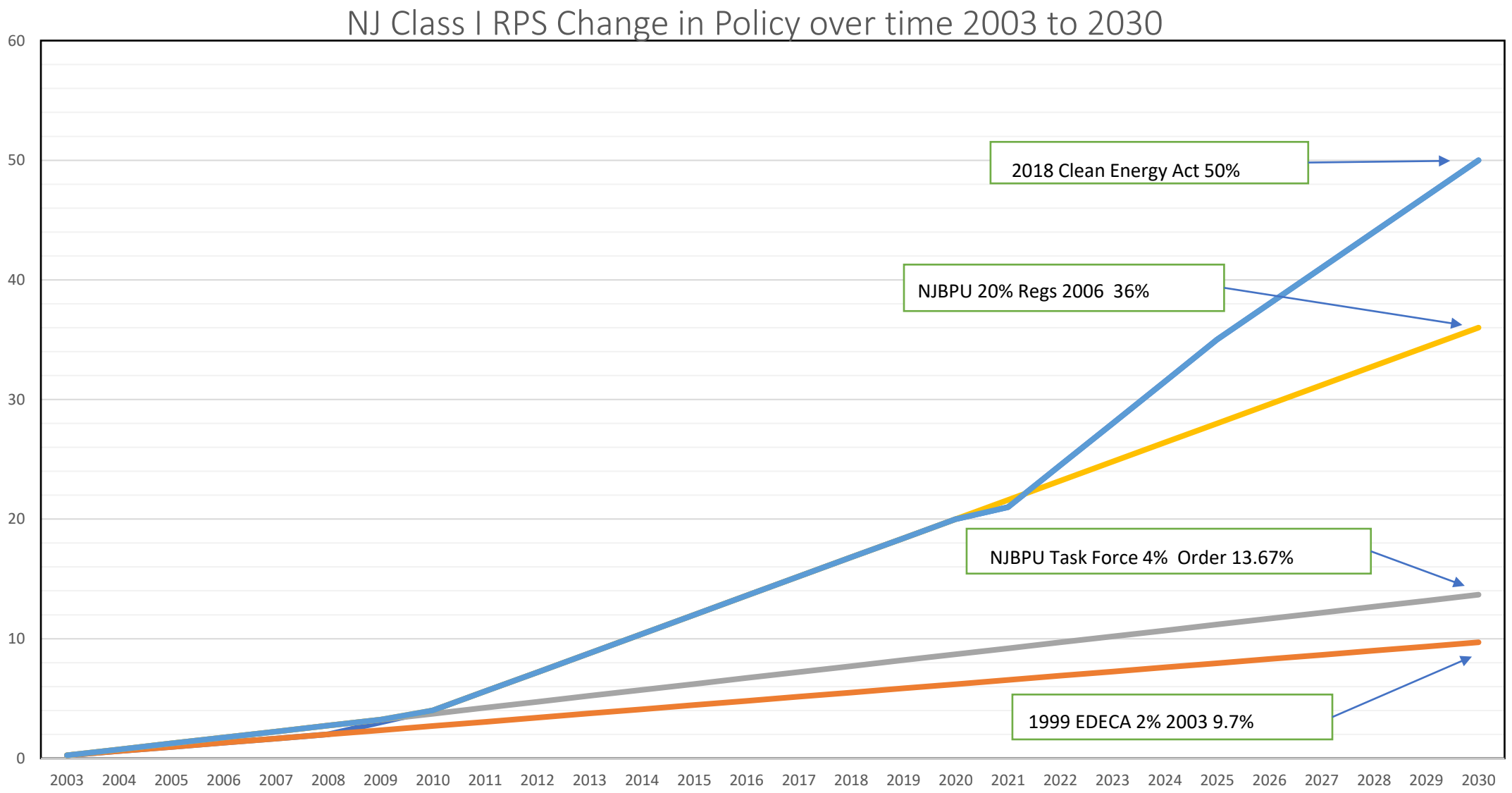
PJM –EIS GATS

Sell

Solar Projects

Or the LSE can Choose to pay the Solar Alternate Compliance Payment (SACP) upper limit on price (cap)

How Clean Energy Policy Changes over time – to achieve larger goals



To get to 100% clean energy by 2050 or
80 x 50 or 50 x 30
You don't really need a federal carbon tax or a federal clean electricity standard or a state carbon cap and trade

Nice to have but not needed to mitigate the impacts of greenhouse gas emissions today

You beat this large energy system
"From the inside out"

Five Simple Currently Cost Effective (even without subsidies) Clean Energy Technologies (EE/RE) that can be Implemented Incrementally to Mitigate Climate Change by Reducing Greenhouse Gas Emissions

- **Solar (RE)**
- **Storage (CE)**
- **Electric Vehicles (EE)**
- **Heat Pumps (EE)**
- **Smart Grid (CE)**

What is your household Carbon Footprint

Just need to know your household annual energy usage

Annual household electric use – electric bill
Annual household natural gas use – natural gas bill
Annual household gasoline use – gasoline bills/mileage

Your household CO_2 =
energy usage * emission factor (lbs/unit of energy)

Household Energy use assumptions

2,400 sq ft single family home

3 member household 2 adult 1 child under 18

2 average fuel economy cars driven the average miles/ year

Gasoline – per EPA/DOE and USDOT-FHWA

13,000 miles/year/vehicle * 2 / 25 miles/gal = 1,000 gals/yr

Natural Gas per EIA average eff furnace and hwh = 1,000 therms per year

Electricity per EIA average CAC and lighting = 9,000 kWh per years

Gasoline

1,000 gal/yr * 19.6 lbs of CO2/gal = 19,600 lbs of CO2/yr

$3.20/gal * 1,000 gal/yr = $3,200/yr (4% annual cost at medium income)

Natural gas

1,000 therms/yr * 11.7 lbs of CO2/therms = 11,700 lbs of CO2/yr

$1.10/therm * 1,100 therms/yr = $1,100/yr (1.4% at medium income)

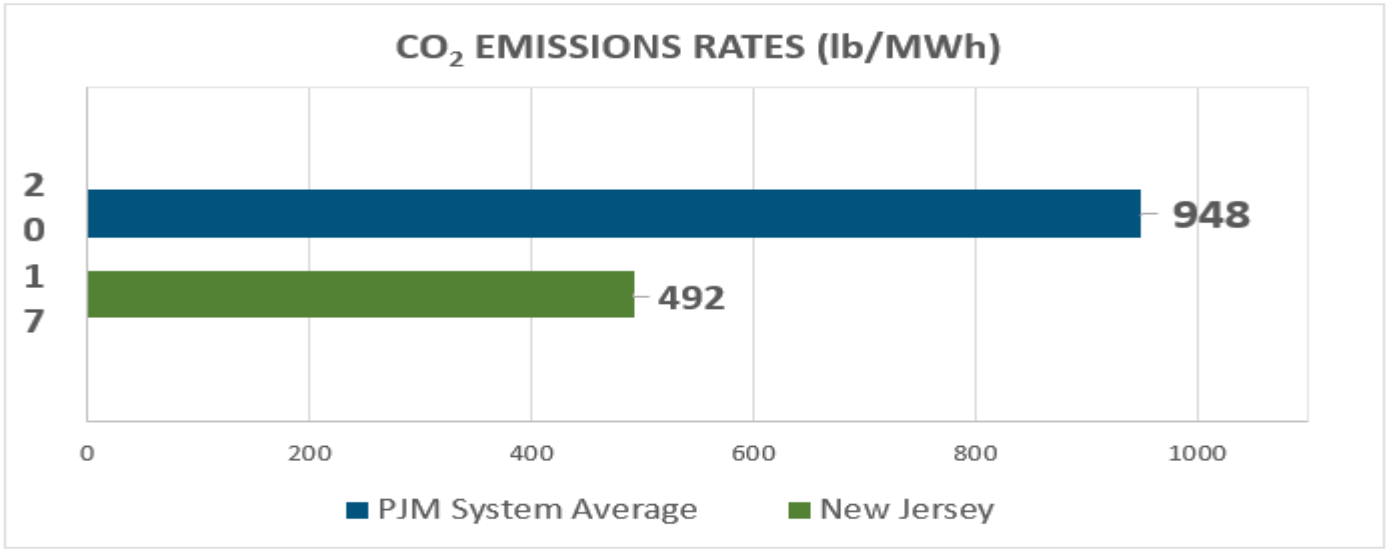
Electricity

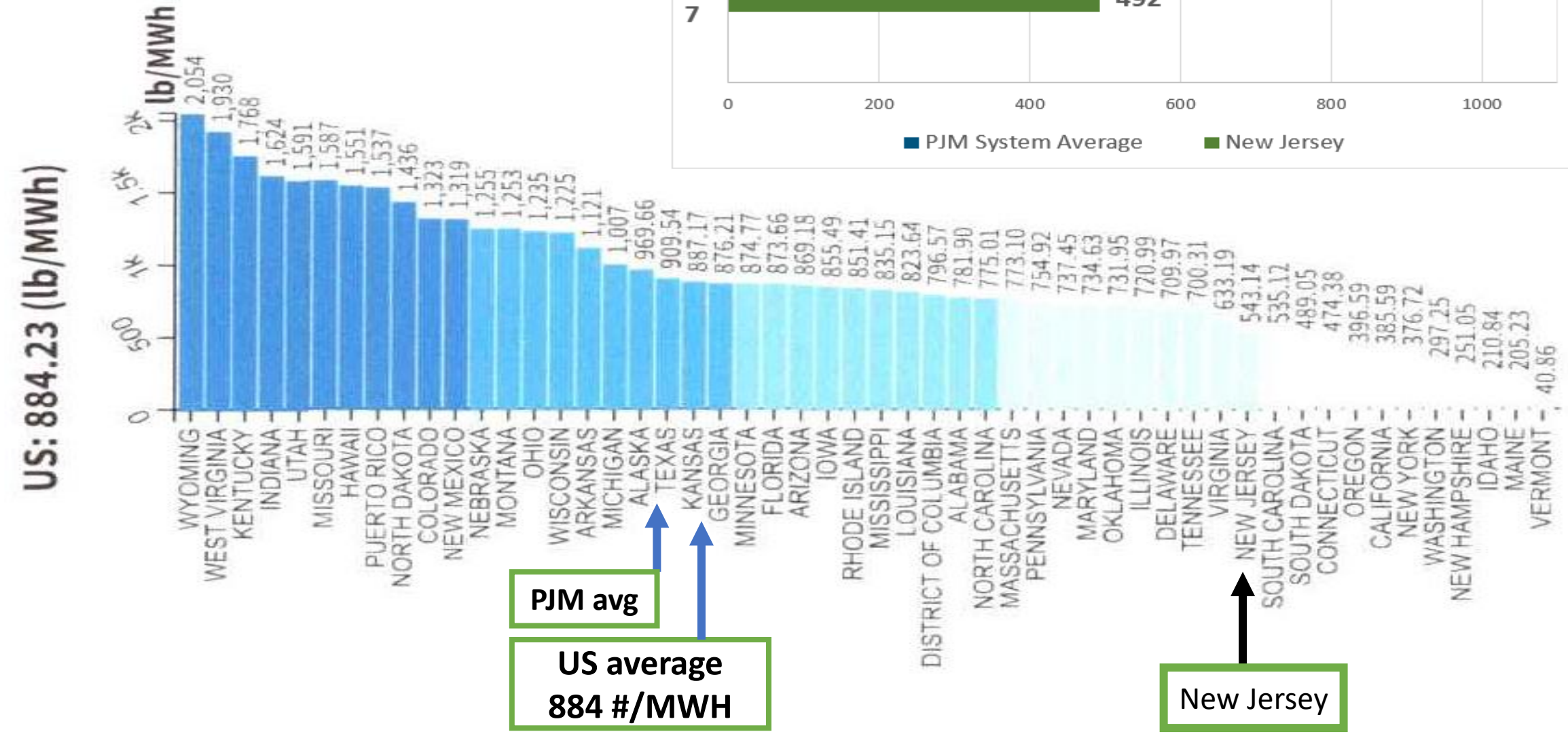
9,000 kWh/year * 0.75 lbs of CO2/kWh = 6,750 lbs of CO2/yr

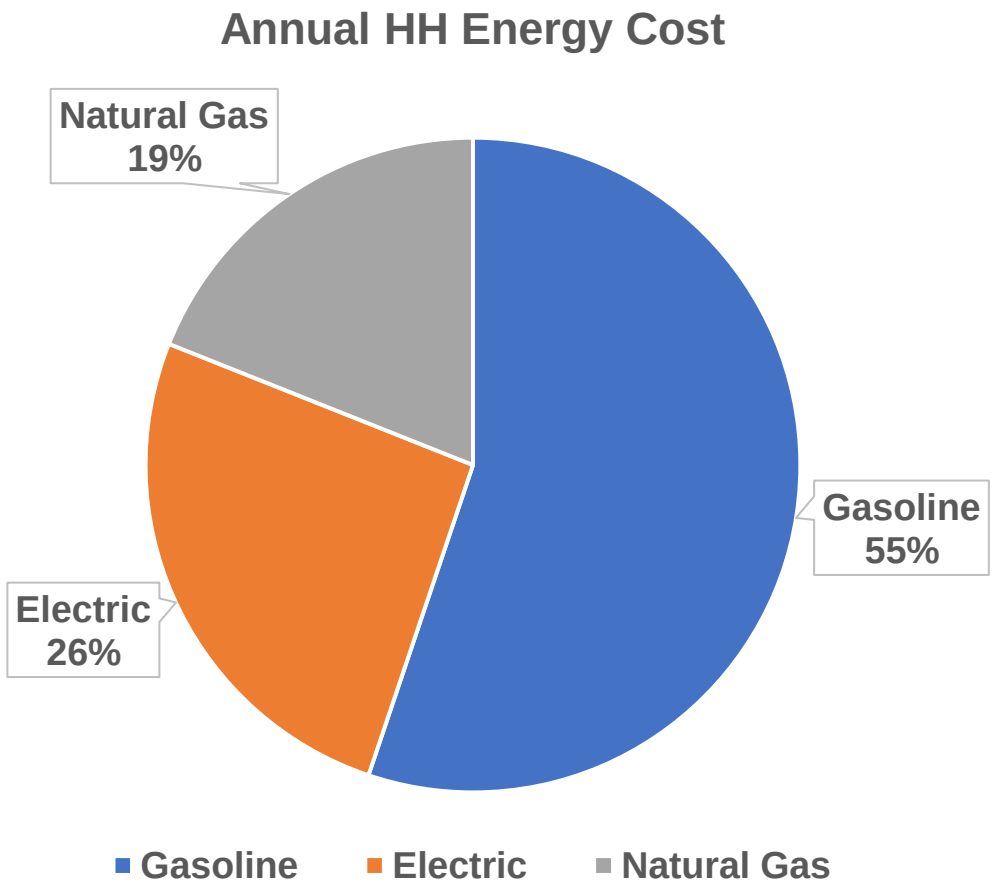
$0.165/kWh * 9,000 kWh/yr = $1,500 (2% at medium income)

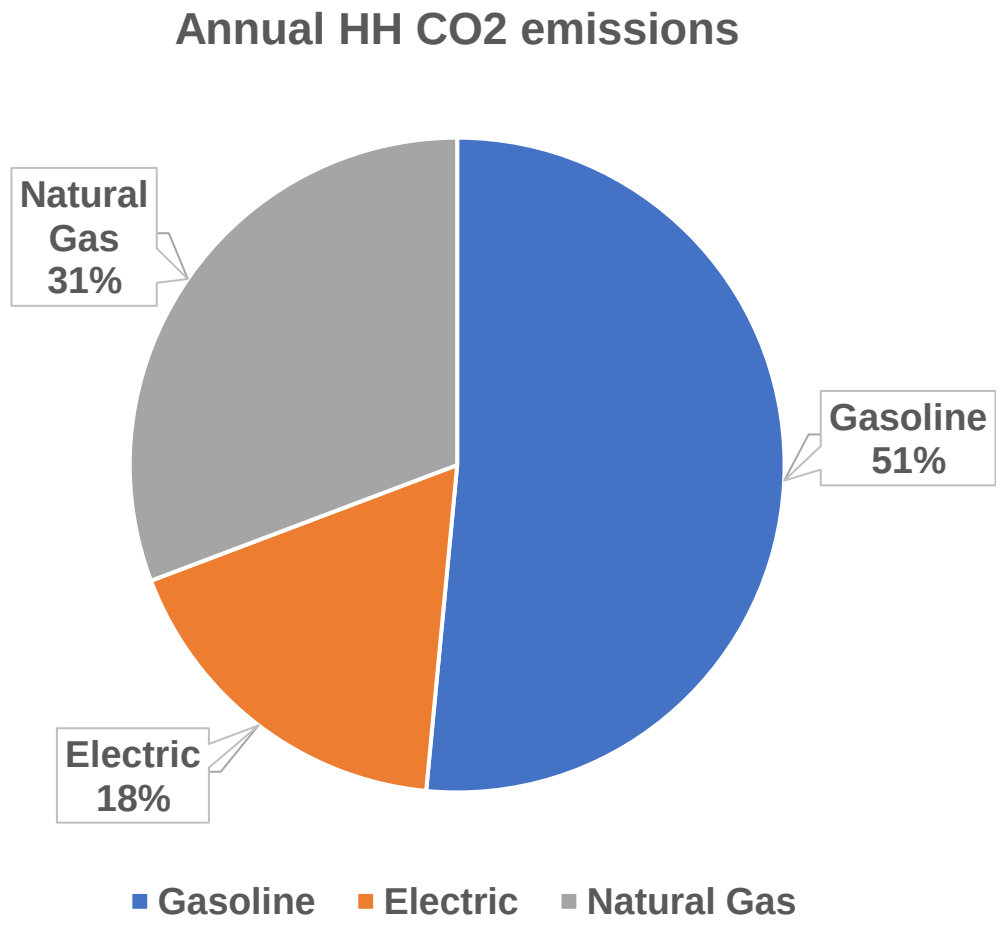
Total = 40,010 lb of CO2 / HH or 20 T/HH - $5,800/yr (7% at medium income)

Electric Generation Facilities in-state Emissions Rate









Total HH energy cost - $5,800 per year Total HH carbon footprint 40,000 # - 18 MT
Your HH CO2 footprint is 0.00004% of NJ total and 0.0000007% of US total
NJ 115 MMT of CO2 US 6,500 MMT of CO2 and 433,000 MMT of CO2 Global
NJ is < 2% of US total CO2 emissions and US is 15% of Global CO2 emissions

Your electric bill and Natural gas heating usage and costs

www.pseg.com/home/save/manage_costs/tips_tools.jsp

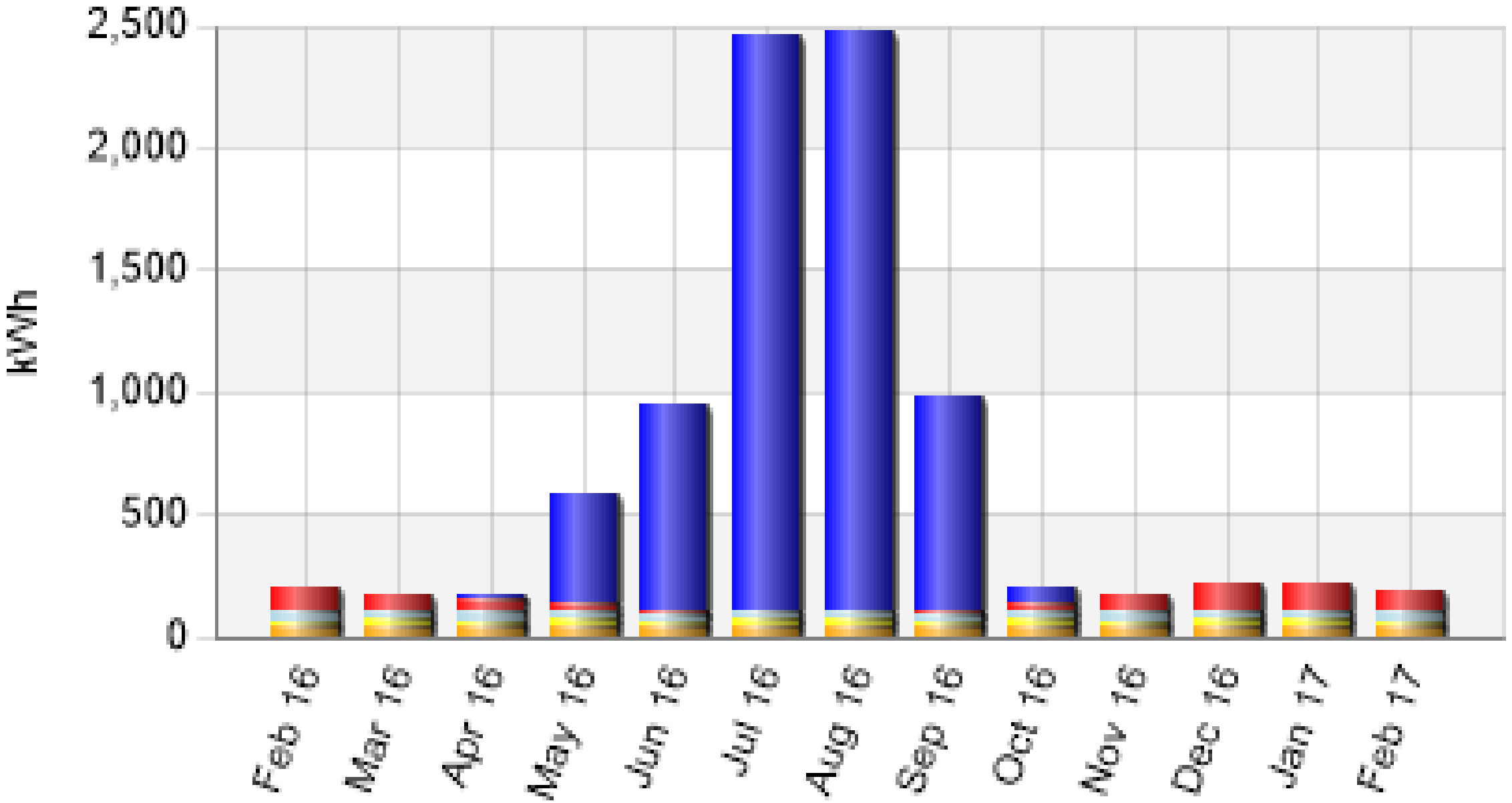
https://www.firstenergycorp.com/save_energy/save_energy_new_jersey/for_your_home_nj.html
https://www.njng.com/save-energy-money/ctp/index.aspx

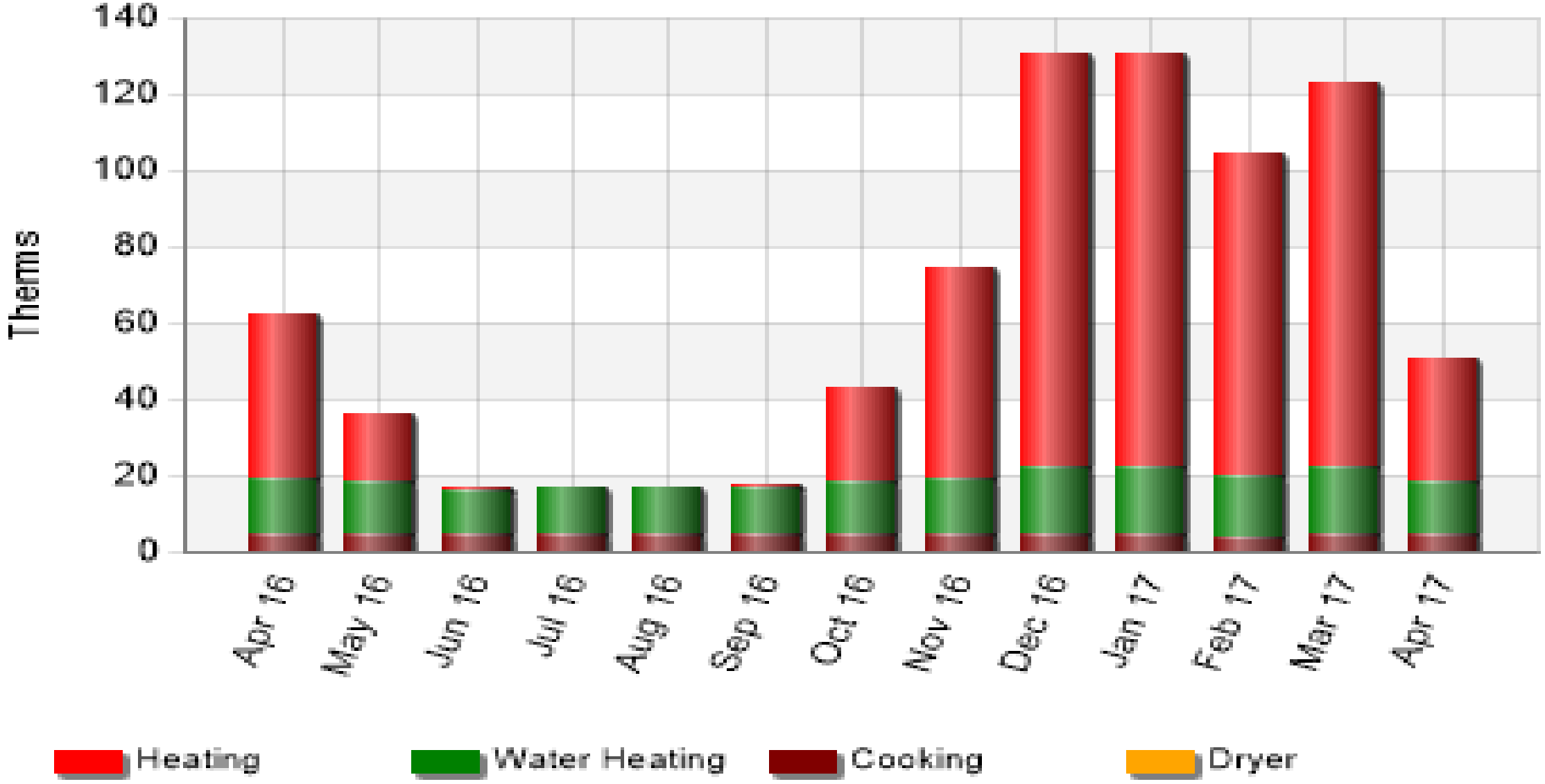
Home Energy Calculator

https://nj.pseg.com/saveenergyandmoney/energysavingpage/homeenergyanalyzer
https://www.firstenergycorp.com/save_energy/home_energy_analyzer.html
https://www.njng.com/save-energy-money/ctp/dashboard.aspx

Fill in question on Home type/age, insulation, windows, HVAC, HWH, Refrig/Freezer, TV, Kitchen …

	kWh	Electric Costs
Cooling	6,929	$1,142
Heating	498	$73
Refrigerators/ Freezers	511	$78
Lighting	288	$44
Dishwasher	49	$7
Clothes Washer	28	$4
Clothes Dryer	469	$72
Elec. Base Charge	N/A	$29
Total Per Year	8,771	$1,450
Average Per Month	731	$121


kWh
2,500
2,000
1,500
1,000
500
0
Feb 16
Mar 16
Apr 16
May 16
Jun 16
Jul 16
Aug 16
Sep 16
Oct 16
Nov 16
Dec 16
Jan 17
Feb 17


Therms
140
120
100
80
60
40
20
0
Apr 16
May 16
Jun 16
Jul 16
Aug 16
Sep 16
Oct 16
Nov 16
Dec 16
Jan 17
Feb 17
Mar 17
Apr 17
Heating
Water Heating
Cooking
Dryer

How much solar do you need for an average Single family home (SFH) approx. 2,500 sq ft

Rule of Thumb – 1,100 kWh per year per KW installed

- 1,200 kWh/kW for HE panels

Solar panels = 45 sq ft / kW to 60 sq ft / kW

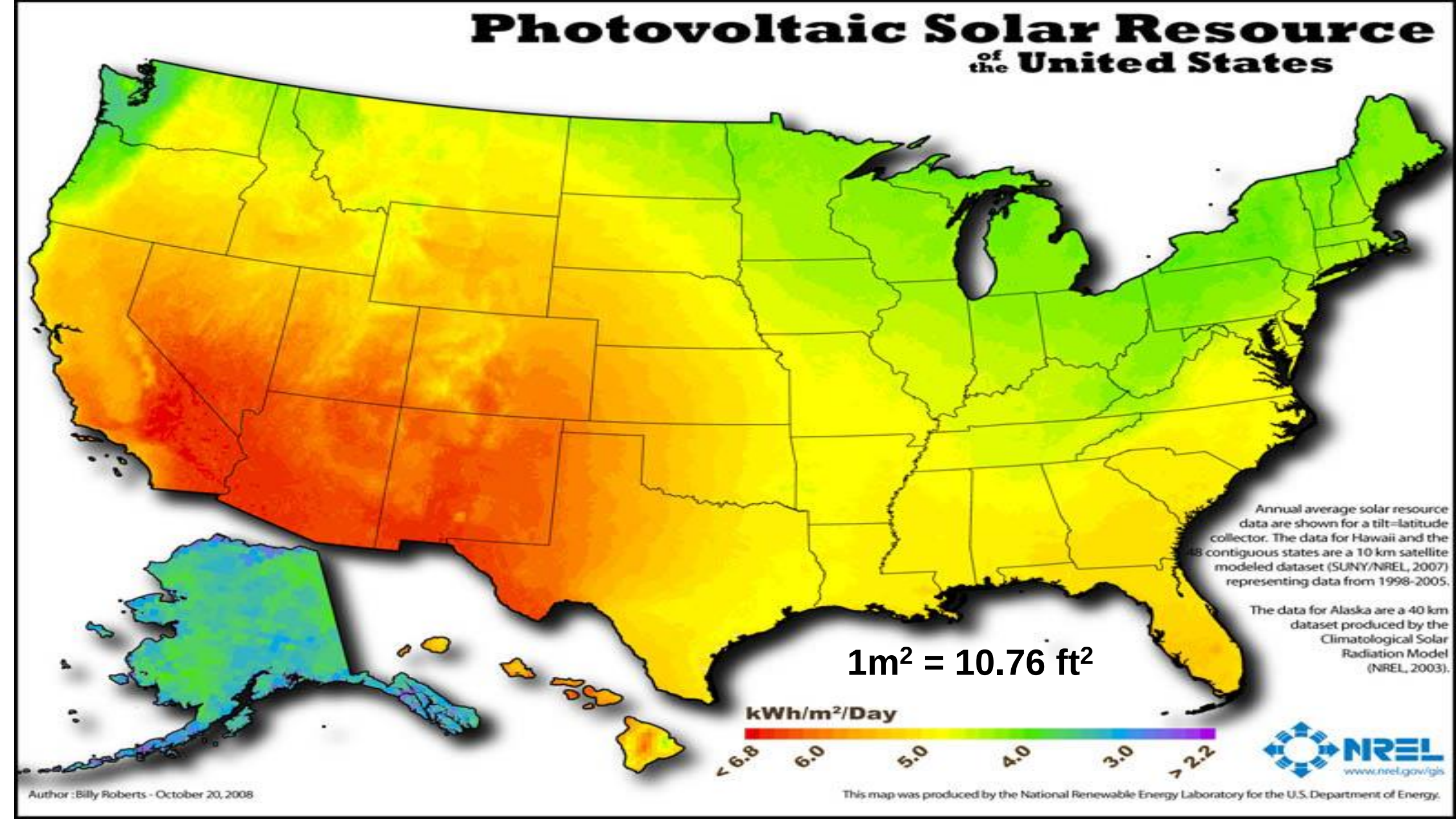
SFH uses

9,000 kWh /1,100 = 8 kW

9,000 kWh /1,200 = 7.5 kW

7.5 kW X 50 sq ft/kW = 375 sq ft – 24 solar panels

375 sq ft = 16 ft X 24 ft - 3 rows of 8 solar panels


Photovoltaic Solar Resource of the United States
Annual average solar resource data are shown for a tilt=latitude collector. The data for Hawaii and the 48 contiguous states are a 10 km satellite modeled dataset (SUNY/NREL, 2007) representing data from 1998-2005.
The data for Alaska are a 40 km dataset produced by the Climatological Solar Radiation Model (NREL, 2003).
1m² = 10.76 ft²
kWh/m²/Day
< 6.8
6.0
5.0
4.0
3.0
> 2.2
NREL
www.nrel.gov/gis
Author : Billy Roberts - October 20, 2008
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.

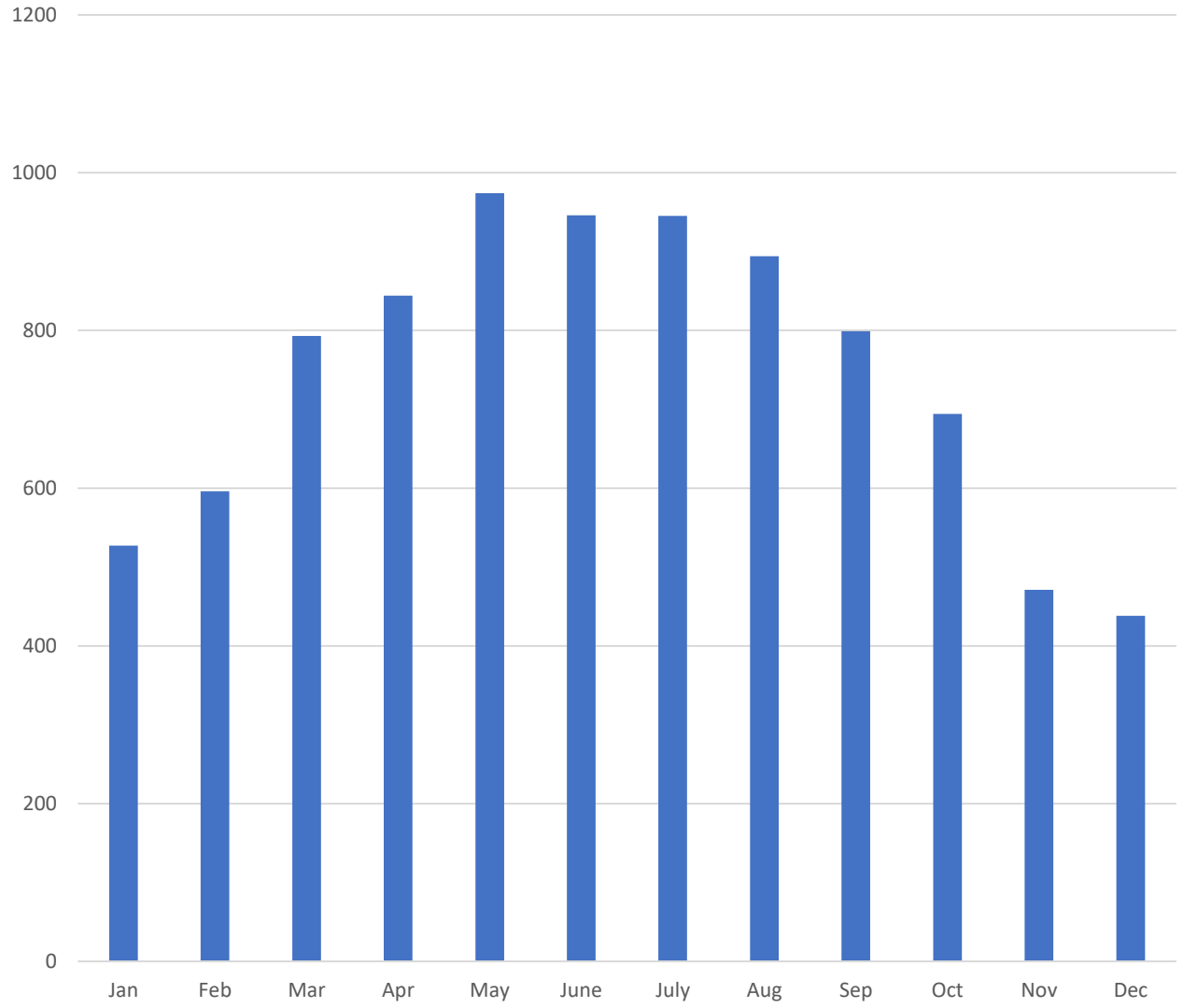
NREL's solar installation model – PV WATTS http://pvwatts.nrel.gov/
http://www.njcleanenergy.com/files/file/Renewable_Programs/NJCEPPVWattsCalculatorTraining21815.pdf

DC System Size (kW): 7.0
Module Type: Standard
Array Type: Fixed (open rack)
System Losses (%): 14
Tilt (deg): 20
Azimuth (deg): 180
Draw Your System - customize your system on a map. (optional)
Average Cost of Electricity Purchased from Utility ($/kWh): 0.165

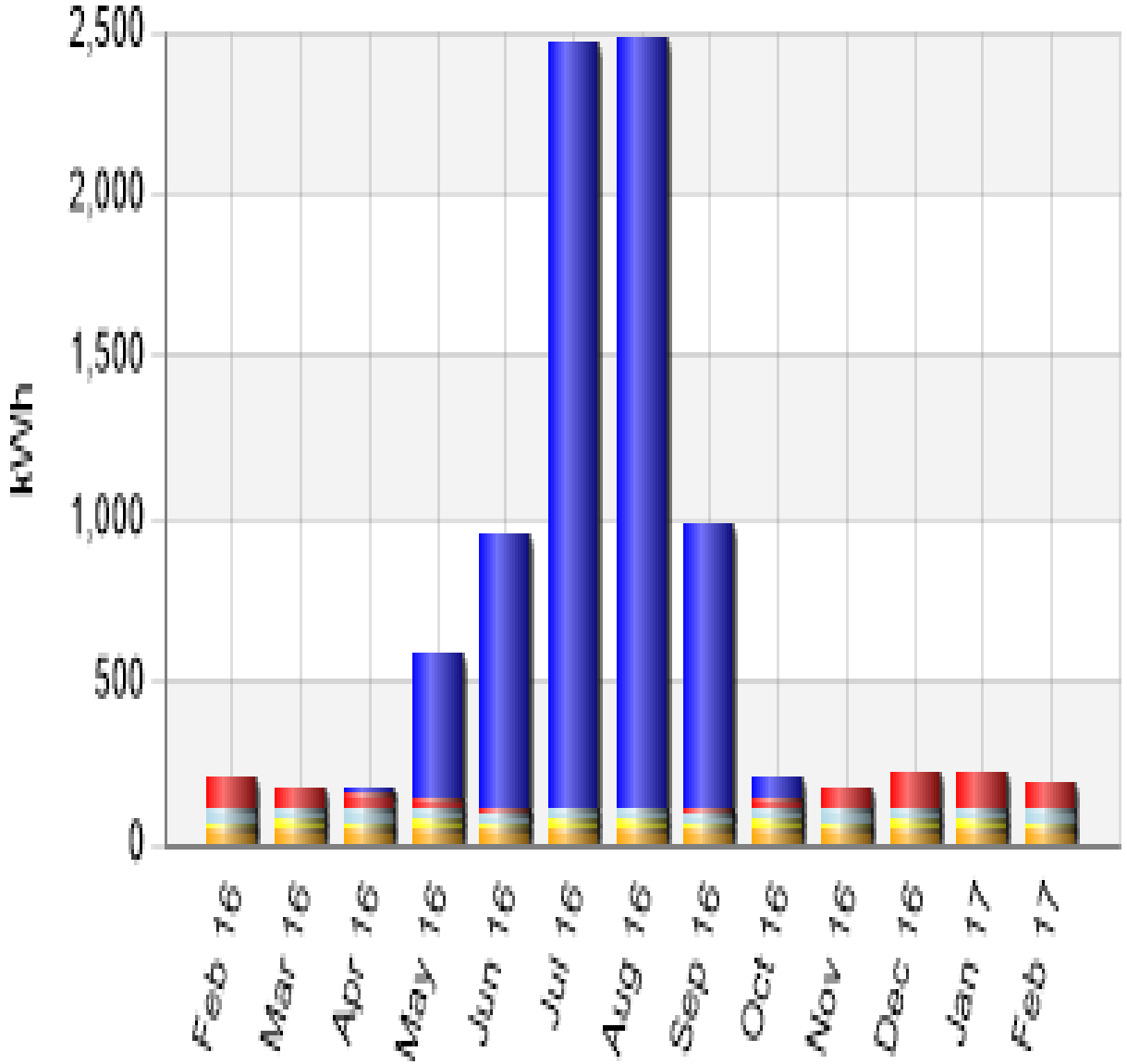
NREL solar installation, performance cost and financing model - System Advisor Model SAM https://sam.nrel.gov/

NREL's solar installation model – PV WATTS http://pvwatts.nrel.gov/

Month	Solar Radiation(kWh / m2 / day)	AC Energy(kWh)	Energy Value($)
January	2.78	527	95
February	3.52	596	107
March	4.34	793	143
April	4.95	844	152
May	5.69	974	175
June	5.86	946	170
July	5.73	945	170
August	5.47	894	161
September	4.91	799	144
October	3.99	694	125
November	2.68	471	85
December	2.35	438	79
Annual	4.36	8,921	$ 1,606



7.0 KW south facing at 20° tilt



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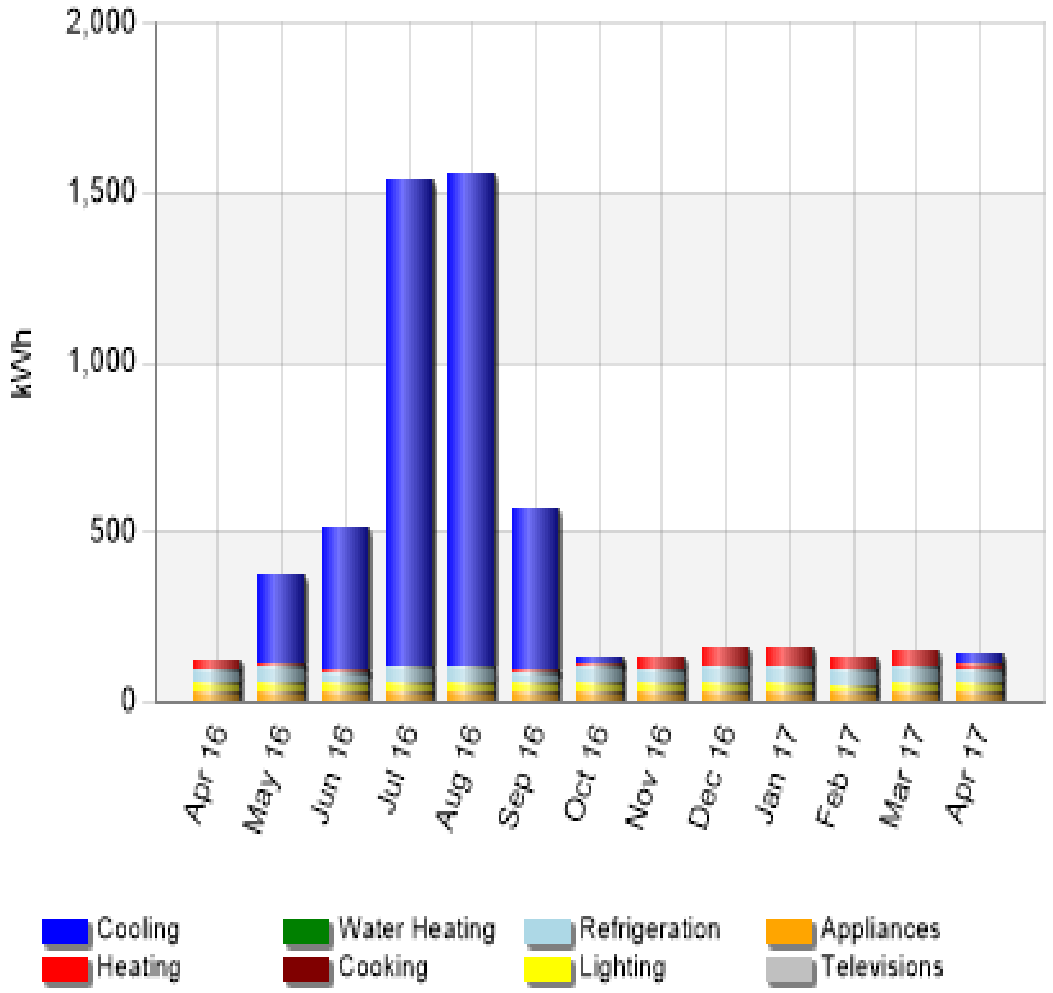
October	3.99	694	125
November	2.68	471	85
December	2.35	438	79
Annual	4.36	8,921	$ 1,606

July and August electricity usage = 1,500 KWh/month more than the PV system generates = $250/month



Month	Solar Radiation(kWh / m2 / day)	AC Energy(kWh)	Energy Value($)
January	2.78	527	95
February	3.52	596	107
March	4.34	793	143
April	4.95	844	152
May	5.69	974	175
June	5.86	946	170
July	5.73	945	170
August	5.47	894	161
September	4.91	799	144
October	3.99	694	125
November	2.68	471	85
December	2.35	438	79
Annual	4.36	8,921	$ 1,606

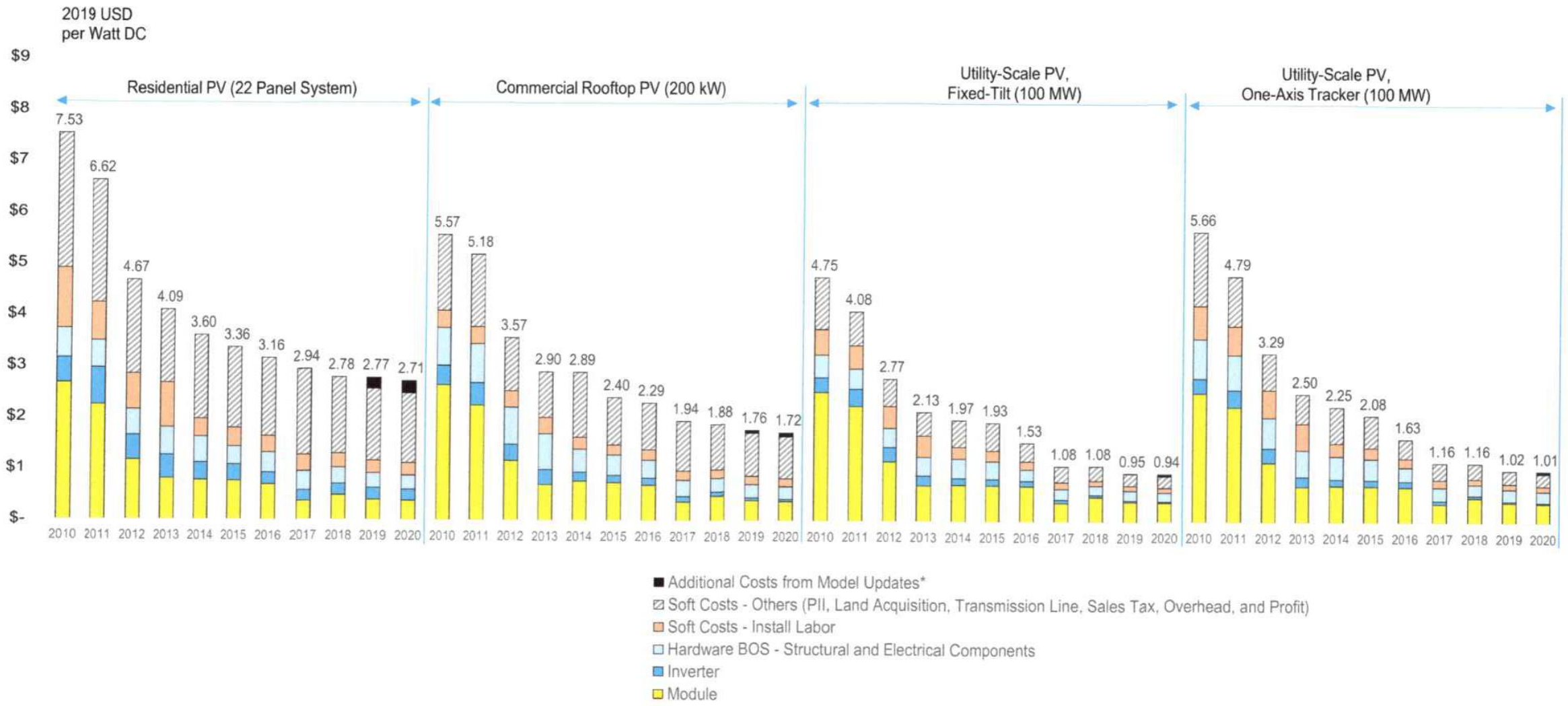
July and August electricity usage = 500 KWh/month
More than the PV system generates = $250/month

Step 4. Calculate your cost

7 kW X $3 per watt installed = $21,000
Exempt from sales tax – Exempt from property tax >
26% federal Investment tax credit ITC = $5,460

$15,540 is the net cost of the 7 kW solar PV system after accounting for your ITC

USDOE NREL and LBL Tracking the Sun



https://www.nrel.gov/docs/fy21osti/77324.pdf

https://emp.lbl.gov/sites/default/files/2_tracking_the_sun_2021_report.pdf

Step 5. Calculate your simple payback

Total cost / total annual revenues = years needed to pay for the system

You need to know the value of your:

Avoided retail electricity cost from Net Metering
Value of Solar Renewable Energy Certificate SREC II
How long will you receive these revenues

ADI Capacity Blocks by Market Segment

Market Segments	System Size	MW (dc) Capacity Blocks
Net-Metered Residential	All Sizes	150 MW
Net Metered Non-Residential	All sizes at or below 5 MW (dc)	150 MW
Community Solar including LMI and Non-LMI	All sizes at or below 5 MW (dc)	150 MW
Interim Subsection (t) Grid	All Sizes	75 MW (Interim Basis)

https://njcleanenergy.com/renewable-energy/programs/susi-program/adi-program

Market Segments	System Size MW (dc)	Incentive Values ($/SREC-II)	*Public Entities (($20 Adder)
Net-Metered Residential	**All Sizes**	**$90**	**N/A**
Small Net-Metered Non-Residential located on Rooftop, Carport, Canopy and Floating Solar	**Projects smaller than 1 MW (dc)**	**$100**	**$120**
Small Net Metered Non-Residential Ground Mount	**Projects smaller than 1 MW (dc)**	**$85**	**$105**
Large Net Metered Non- Residential located on Rooftop, Carport, Canopy and Floating Solar	**Projects 1 MW to 5 MW (dc)**	**$90**	**$110**
Large Net Metered Non-Residential Ground Mount	**Projects 1 MW to 5 MW (dc)**	**$80**	**$100**
Community Solar LMI	**Up to 5 MW (dc)**	**$90**	**N/A**
Community Solar Non-LMI	**Up to 5 MW (dc)**	**$70**	**N/A**
****Interim Subsection (t) Grid**	**All Sizes**	**$100**	**N/A**

Step 5. Calculate your simple payback

The New Jersey Solar Incentive is now a feed-in-tariff

Successor Solar Incentive (SuSI) – SREC II

The incentive is administratively determined

Value of SuSI is fixed based on blocks

Residential IX - $90 per MWh or per SREC II

Qualification life = 15 year

Step 5. Calculate your simple payback (SPB)

Method to calculate SPB

Total cost for a 7 kW system w/o ITC = $21,000

Total cost for a 7 kW system after 26% ITC = $15,540

Avoided electricity generated at 8,900 kWh per year

Annual value for NM/IX at $0.165/kWh = $1,468 per year

SREC II generated = 8.9 per year

SuSI – ADI at $90 per MWh = $801

Total solar revenues = $1,468 + $801 = $2,269/year

Step 5. Calculate your simple payback
SPB Results

$15,700 / $2,269/year = 6.85 years with ITC – NM/IX – SRECII
Estimated ROI = 14.5%

$21,000 / $2,269/year = 9.26 years w/o ITC with NM/IX – SRECII
Estimated ROI = 10.8%

$15,700 / $1,498/year = 10.48 years with ITC with NM/IX
Estimated ROI = 10.5%

$21,000 / $1,498/year = 14 years w/o ITC with NM/IX
Estimated ROI = 7.1%

Step 6. Options to Purchase your solar

1. Pay Cash upfront
2. Finance through a loan 10/15 year loan
3. Lease your roof space 15 + year lease
4. Power Purchase Agreement – buy solar e^- for 15+ years

Evaluate your costs and benefits within your risk profile

https://www.njcleanenergy.com/renewable-energy/tools-and-resources/ownership-financing-options

https://www.cesa.org/wp-content/uploads/Homeowners-Guide-to-Solar-Financing.pdf

NREL System Advisor Model SAM https://sam.nrel.gov/

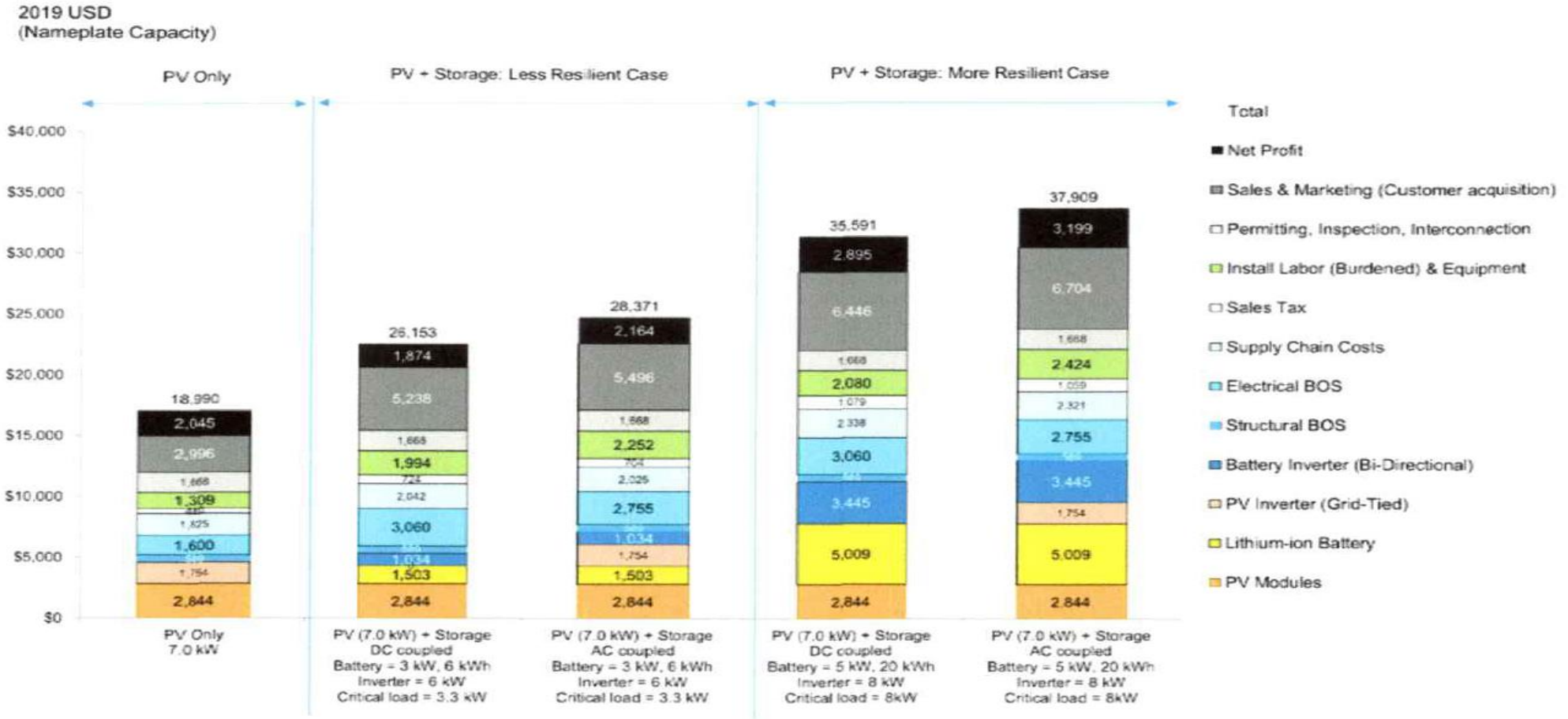
CREST Cost for Renewable Energy Spreadsheet Tool

https://financere.nrel.gov/finance/content/crest-cost-energy-models

NREL U.S. Solar Photovoltaic System and Energy Storage Cost - Benchmark: Q1 2020

Added $10K to PV system cost for ¼ of the PV average output

Double the PV system cost for the PV average daily output



Q1 2020 U.S. benchmark: Residential PV-plus-storage system cost (2019 USD/W_{DC})

https://www.nrel.gov/docs/fy21osti/77324.pdf

NREL U.S. Solar Photovoltaic System and Energy Storage Cost - Benchmark: Q1 2020

The energy generation cost $/kWh decreases as battery storage duration time increase the capital cost $/kW increases
A 4 hour battery cost = $1,364 per kW vs a 1 hour battery cost = $587 per kW vs a ½ hour battery cost of $422 per kW

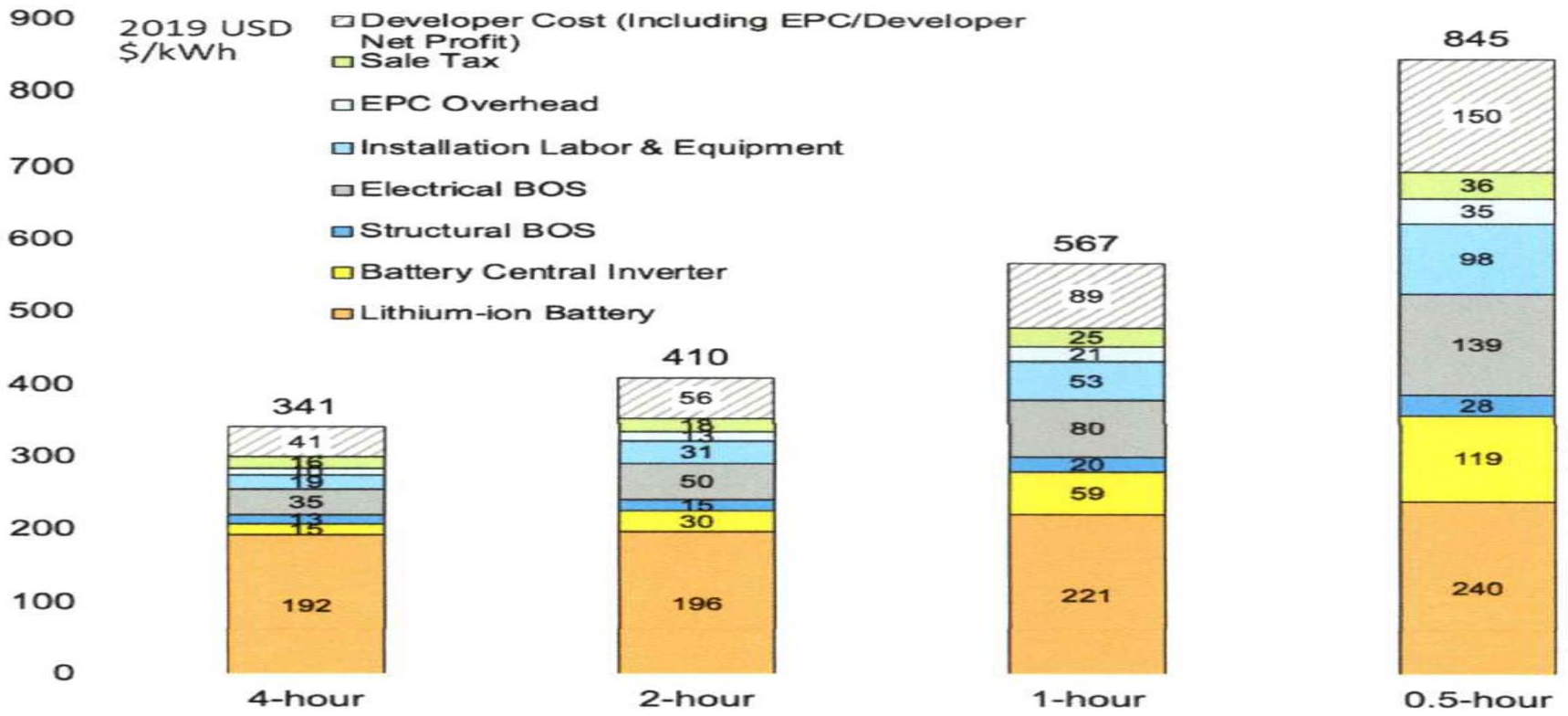
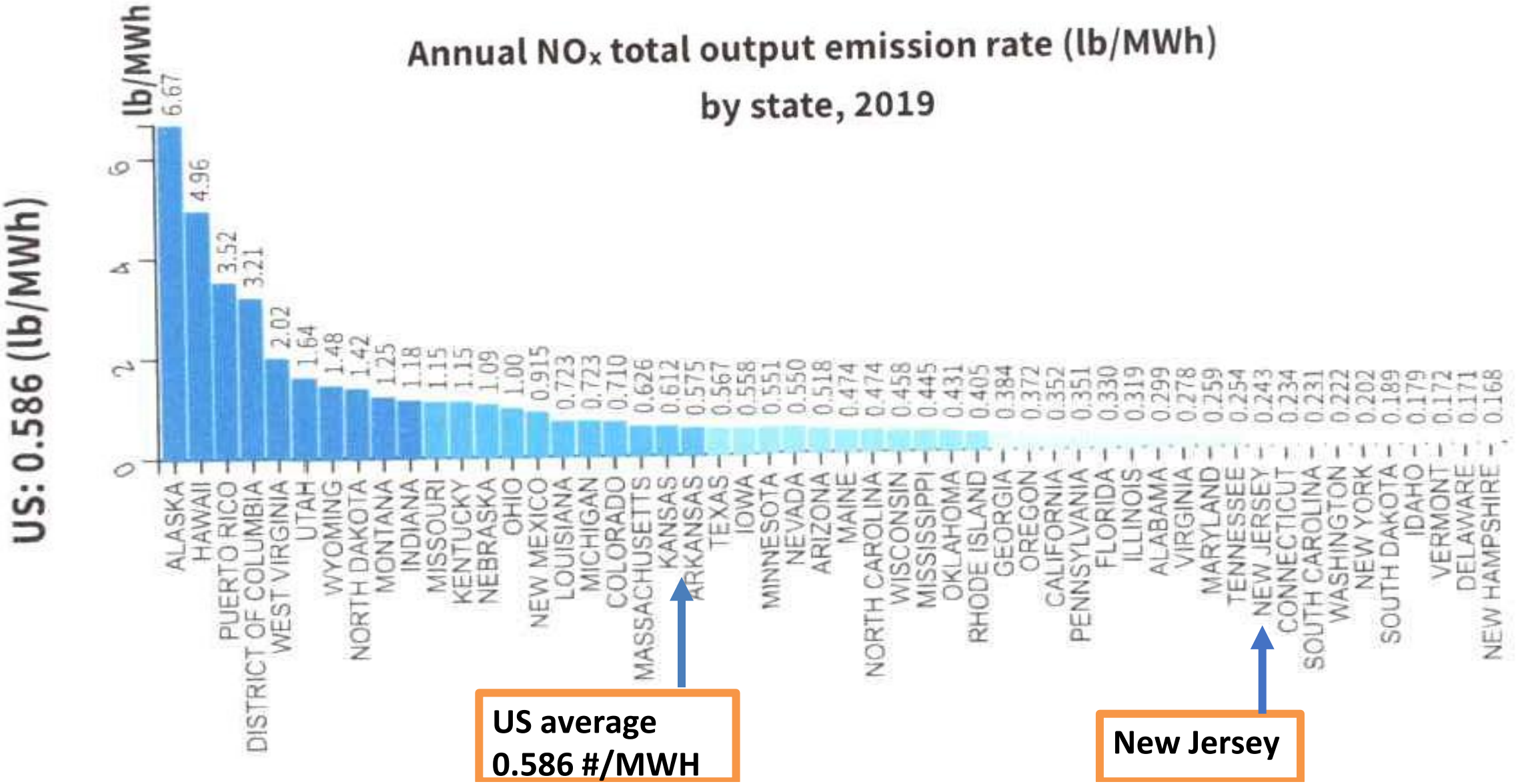


Figure 47. U.S. utility-scale Li-ion battery standalone storage costs for durations of 0.5–4.0 hours (60 MW_{DC}), Q1 2020

https://www.nrel.gov/docs/fy21osti/77324.pdf

Electric Generation Facilities in-state Emissions Rate

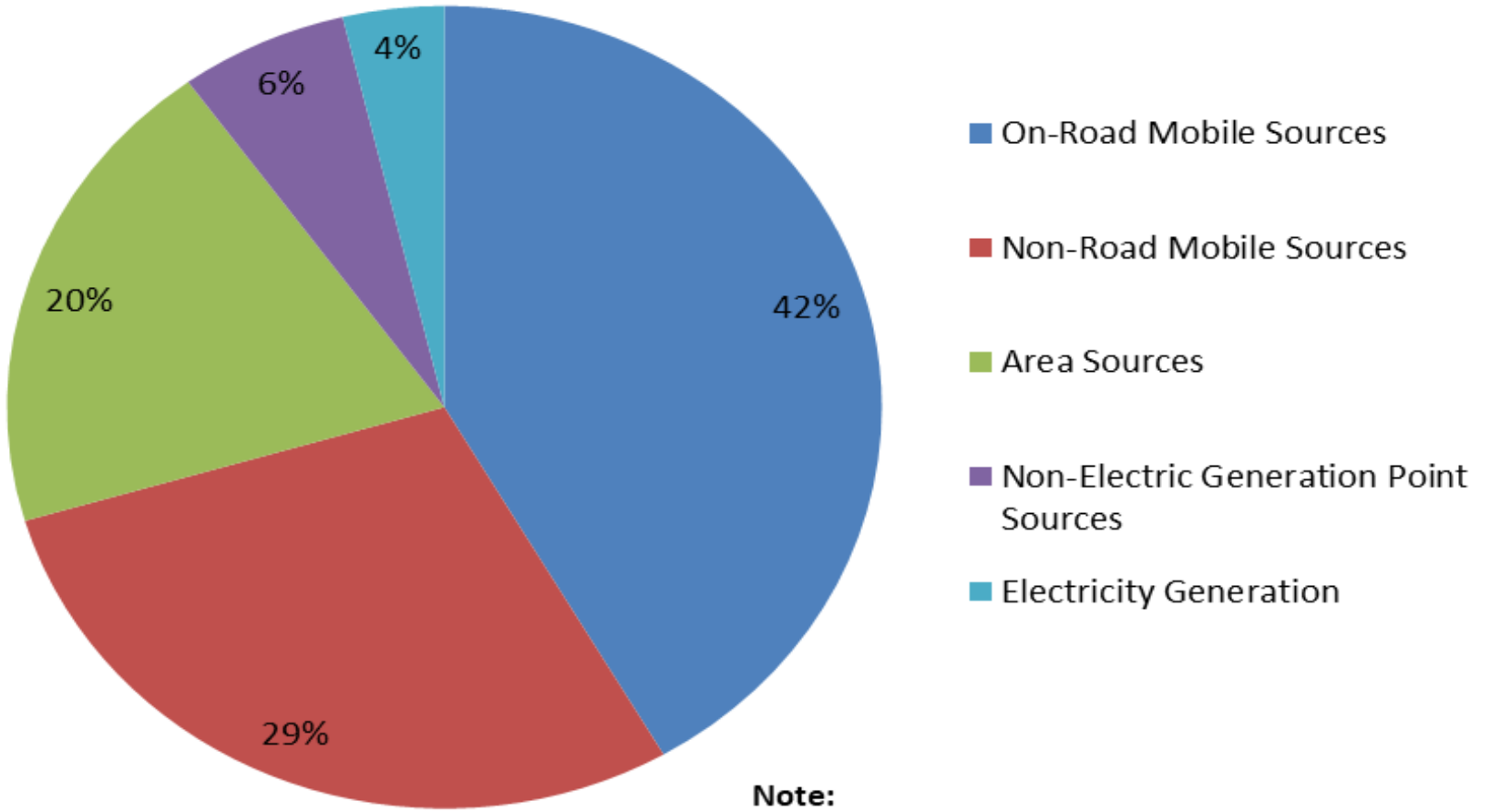
Annual NO_x total output emission rate (lb/MWh) by state, 2019



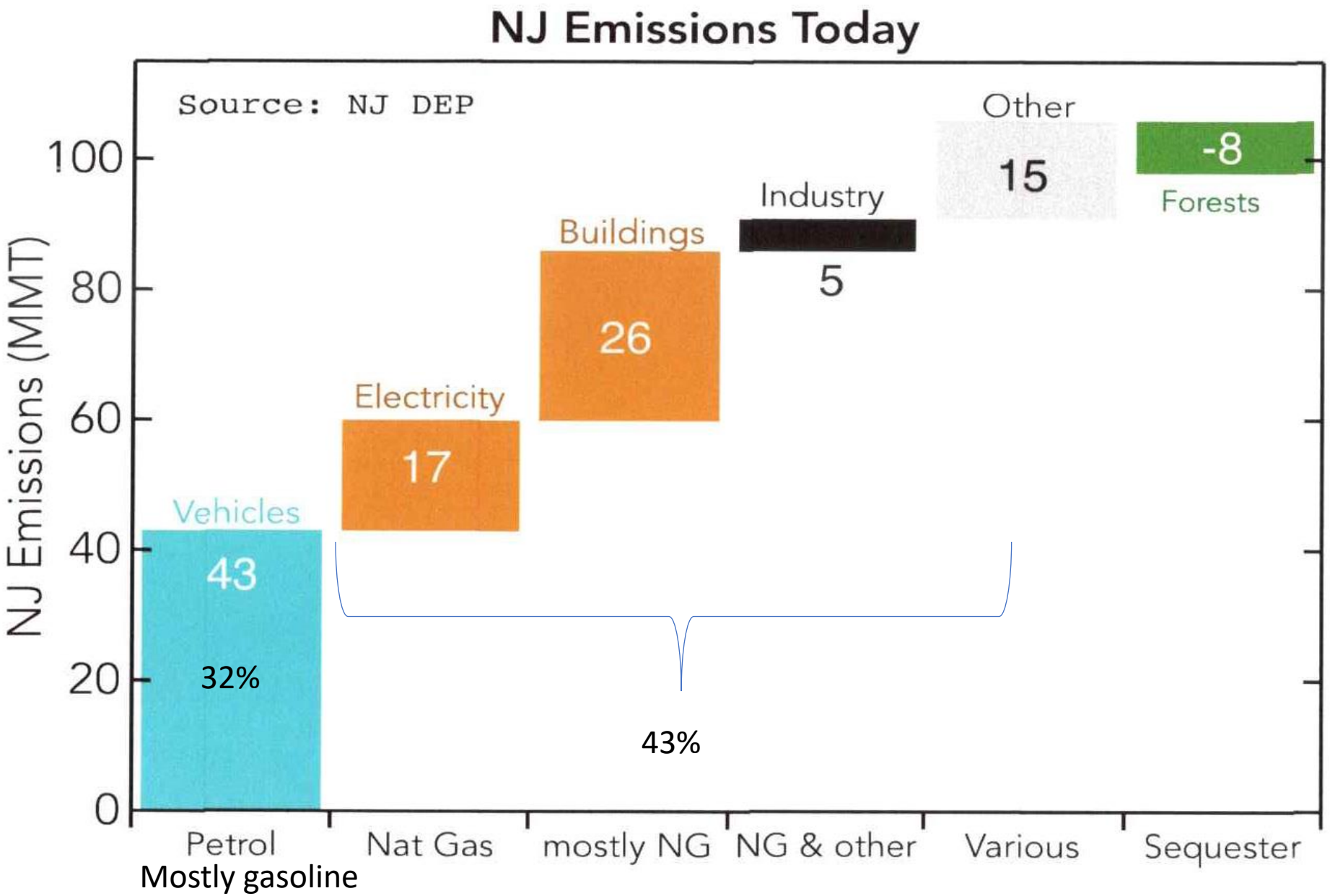
US average 0.586 #/MWH

New Jersey

2017 NOx Emissions in New Jersey (tons per year)



Note:
The area source annual NOx % is higher than summer NOx % due to heating and wood burning. Conversely, electricity generation source summer NOx % is higher than the annual NOx % due to electric demand.



Mostly gasoline

Five Simple Currently Cost Effective (even without subsidies) Clean Energy Technologies (EE/RE) that can be Implemented Incrementally to Mitigate Climate Change by Reducing Greenhouse Gas Emissions

- **Solar (RE)**
- **Storage (CE)**
- **Electric Vehicles (EE)**
- **Heat Pumps (EE)**
- **Smart Grid (CE)**

Transportation Sector - Going Electric

How to Change the Demand Curve for Oil and Gasoline to Prevent Future Oil pipelines
Start slow and small and build into a movement

How to Change the Demand Curve for Oil and Gasoline to Prevent Future Oil pipelines
Start slow and small and build into a movement

New Tesla Model X base price $86,000 – Range 328 miles on a charge
New Tesla Model S base price $81,000 – Range 373 miles on a charge
New Volve Recharge base price $55,000 - Range 208 miles on a charge
New Ford Mustang Mach E base price $44,000 - Range 300 miles on a charge
New VW ID4 base price $41,000 – Range 353 miles on a charge
New Tesla Model 3 base price $41,000 – Range 220 miles on a charge
New Chevy Bolt base price $37,000 – Range 259 miles on a charge
New Nissan Leaf base price $32,000 – Range 149 miles on a charge
New Mini-electric base price $31,000 -Range 110 miles on a charge

Cost for a new Bolt battery pack $15,000

How to Change the Demand Curve for Oil and Gasoline to Prevent Future Oil pipelines
Start slow and small and build into a movement

Dozen used EV models for under $20,000

Used Leaf $10,000 new battery set $5,000 = $15,000
Level 2 Charger $2,000
Total used car and charger $17,000
0.34 kWh/ miles
80 miles on a charge

How to Change the Demand Curve for Oil and Gasoline to Prevent Future Oil pipelines
Start slow and small and build into a movement
Replace your second vehicle with a used EV

40 miles RT for 260 days (5 day work week)
40 miles/day x 5 days/ week x 52weeks/year = 10,400 miles/yr
Drive an ICE vehicle at 25 mpg = 416 gal/ yr
1 gal of gasoline 116,020 Btu - 416 gal = 48.3 MM Btu
416 gal @ $3.20/gal = $5.12/day or $1,331/yr.
416 gal @ $3.40/gal = $5.44/day or $1414/yr.

How to Change the Demand Curve for Oil and Gasoline to Prevent Future Oil pipelines
Start slow and small and build into a movement
Replace your second vehicle with a used EV

40 miles RT for 260 days (5 day work week)
40 miles/day = 10,400 miles/yr
Typical EV get 0.34 kWh/ mile x 40 miles/day =13.6 kWh / day
13.6 x 5 days/week x 52 weeks/year = 3,536 kWh /yr
1 kWh = 3,412 Btu – 3,526 kWh = 12.1 MM Btu
13.6 kWh/day @ $0.165/kWh = $2.24/day or $584/yr.

Savings $747/yr.
Avoided GHG emissions
(416 x 19.6) – (3,536 X 0.75) = 5,502 lbs or 2.75 T of avoided CO2

How to Change the Demand Curve for Oil and Gasoline to Prevent Future Oil pipelines
Start slow and small and build into a movement

40 miles RT for 260 days = 3,536 kWh /yr

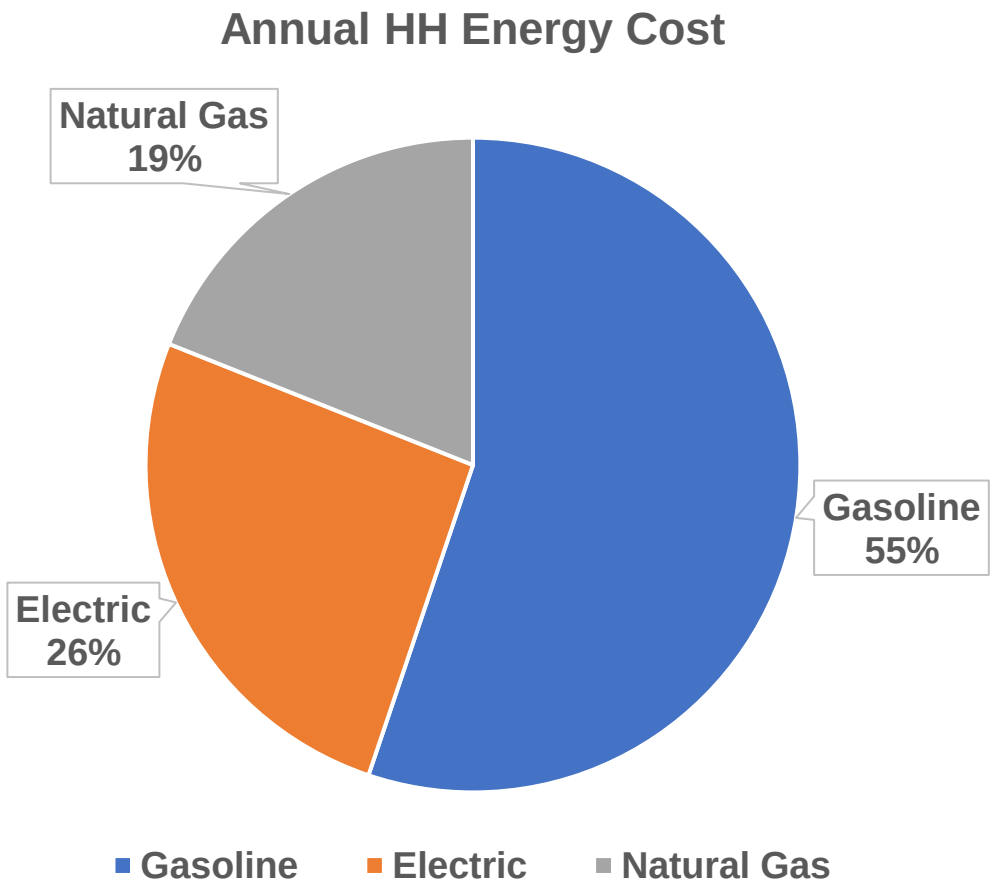
3,536 kWh / yr / 1,100 kWh / kW installed = 3.21kW

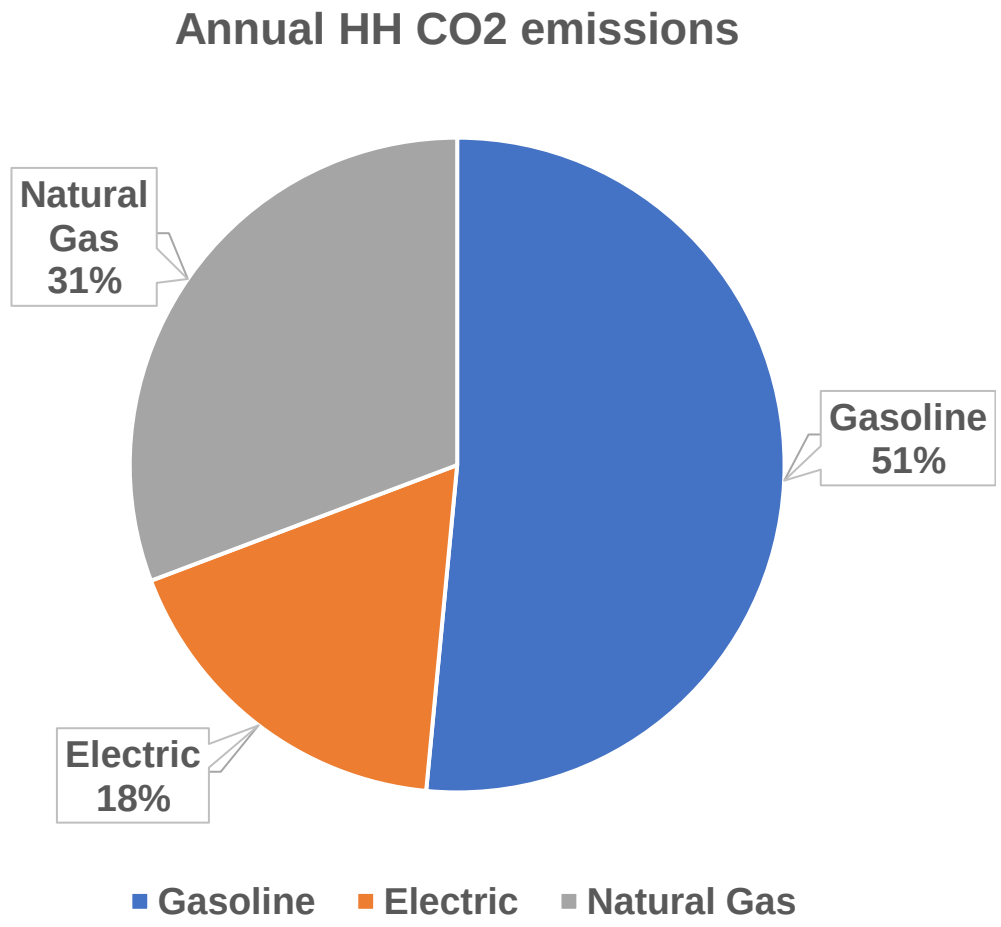
@$3/watt * 3,21 kW = $9,630 - $2503 (26% ITC) = $7,126

$7,126 + $17,000 = $24,126 / $1,632 = 14.8 yrs. (ROI 6.75%)

Total avoided cost of gasoline $1,331 + $301/yr for SRECII = $1632

8,154 lbs (4 T) of avoided CO2 emissions.





Total HH energy cost - $5,800 per year Total HH carbon footprint 40,010 # - 20T
Your HH CO2 footprint is 0.00004% of NJ total and 0.0000007% of US total
NJ 115 MMT of CO2 US 6,500 MMT of CO2 and 433,000 MMT of CO2 Global
NJ is < 2% of US total CO2 emissions and US is 15% of Global CO2 emissions

Building Sector - Going Electric

How to Change the Demand Curve for Natural Gas to Prevent Future Natural gas pipelines Start slow and small and build into a movement

Heat Pump Water Heater

1. A fan pulls air through the top air filter.
2. Heat in the air is absorbed by eco-friendly refrigerant inside the evaporator coil and cool (dehumidified air) is exhausted.
3. Refrigerant is pumped through a compressor,which increases the temperature.
4. Simultaneously the cooler water from the bottom of the tank is pumped to the top of the appliance, where it circulates.
5. Hot refrigerant transfers its heat to the water inside the condensor coil.
6. Heated water is returned back to the top of the tank.
7. Condensate drain connection.
8. Backup electric heating elements.

How to Change the Demand Curve for Natural Gas to Prevent Future Natural gas pipelines Start slow and small and build into a movement

HE Gas Water Heater (GWH)
vs a HE Electric Heat Pump Water Heater (EHPWH)

GWH = $1,200 - $150 = $1050
@ 230 therms /yr Operating cost = $250/yr emitting 2,668 lbs of CO2/yr (2.3T)

EHPWH = $2,500 - $750 = $1,750
@ 2,000 kWh/yr Operating cost = $330 /yr emitting 1,000 lbs of CO2/yr (0.5T)

The incremental cost of the EHPWH over the GWH = $750
The additional operating cost of the GWH of the EHPHWH = $80
The additional avoided CO2 emissions of the EHPWH over the GWH = 1,668 (1.8 MT)

How to Eliminate your Fuel Use – How to Prevent Future NG pipelines
Start slow and small and build into a movement –

2,000 kWh /yr. / 1,200 kWh/kW = 1.5 kW of solar
@ $3/W = $4,500 - $1,170 (26% ITC) = $3,330
@ $0.165/kWh = $320/year in avoided electricity costs
2 SREC II @ $90/SREC = $180
$320 (avoided e^- cost) + $180 (SREC II) = $500
$3,330 / $500/yr = 6.7 yrs

$5,250 (the incremental cost of the EHPWH + cost of solar w ITC) / $500 = 10.5 years
$7,000 (full cost of EHPWH and solar) / $500 = 14 years

The major advantage is you can store your solar electricity in an electric heat pump hot water heater

How to Change the Demand Curve for Natural Gas to Prevent Future Natural gas pipelines Start slow and small and build into a movement

Per the 2018 Clean Energy Act – the Utilities now manage the HVAC EE programs

HE Electric Heat Pump Water Heater (EHPWH) rebates from
The 4 New Jersey Electric Distribution Co

PSE&G $450
JCP&L $750
ACE $750
RECo $1,000

Same price for a HE Electric Heat Pump Water Heater
Same price to install a HE Electric Heat Pump Water Heater
But different HE Electric Heat Pump Water Heater rebate by Utility area?

How much solar do I need to power my stuff to light, heat, and cool my home and to charge my EV's at home to change the demand curves for natural gas and gasoline

7 kW for cooling – 7 kW for heating – 7 kW for 2-EV – 850 sq ft (30' x 30')and $63k SPB - 11 years ROI 9%
The average roof is 2,200 sq feet – assuming 50% coverage and 17 sq ft per 300 w panel = 20 kW = 20,000 kWh

Month	Solar Radiation(kWh / m2 / day)	AC Energy(kWh)	Energy Value($)
January	1.03	172	31
February	1.75	272	49
March	2.79	493	89
April	3.92	668	120
May	5.03	866	156
June	5.45	888	160
July	5.20	863	155
August	4.51	742	134
September	3.37	539	97
October	2.09	340	61
November	1.15	184	33
December	0.85	143	26
Annual	3.10	6,170	$ 1,111

7 KW north facing at 20° tilt
SPB = 10 years with ITC -

Month	Solar Radiation(kWh / m2 / day)	AC Energy(kWh)	Energy Value($)
January	1.87	346	62
February	2.68	450	81
March	3.62	662	119
April	4.48	768	138
May	5.40	928	167
June	5.73	929	167
July	5.45	901	162
August	5.03	827	149
September	4.19	684	123
October	3.10	537	97
November	2.01	347	62
December	1.61	291	52
Annual	3.76	7,670	$ 1,379

7 KW east facing at 20° tilt
SPB = 8 years with ITC

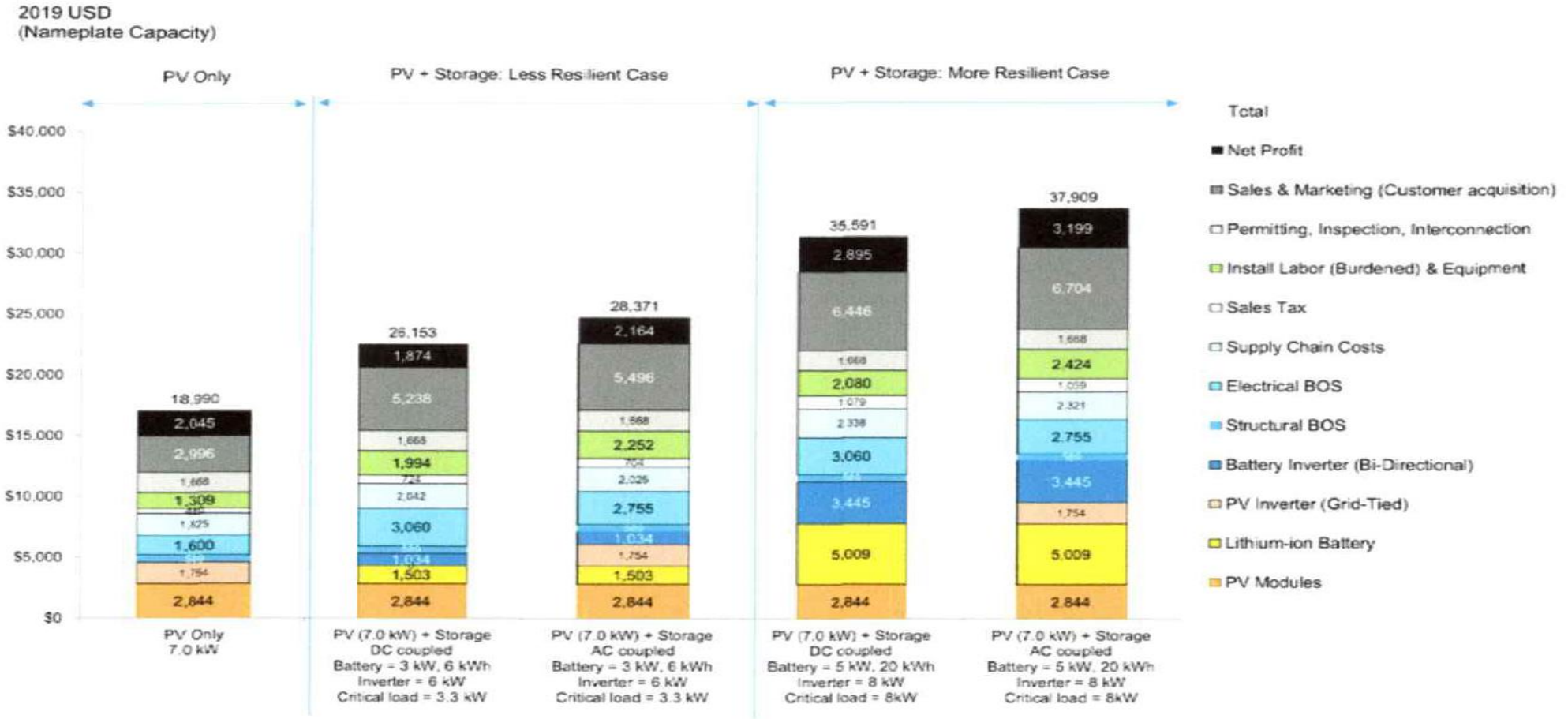
Month	Solar Radiation(kWh / m2 / day)	AC Energy(kWh)	Energy Value($)
January	1.97	363	65
February	2.66	443	80
March	3.59	653	118
April	4.45	762	137
May	5.38	923	166
June	5.63	910	164
July	5.52	913	164
August	5.00	822	148
September	4.17	678	122
October	3.06	526	95
November	1.86	318	57
December	1.60	288	52
Annual	3.74	7,599	$ 1,368

7 KW west facing at 20° tilt
SPB = 8 years with ITC

NREL U.S. Solar Photovoltaic System and Energy Storage Cost - Benchmark: Q1 2020

Added $10K to PV system cost for ¼ of the PV average output

Double the PV system cost for the PV average daily output



Q1 2020 U.S. benchmark: Residential PV-plus-storage system cost (2019 USD/W_{DC})

https://www.nrel.gov/docs/fy21osti/77324.pdf

Some thoughts to help get to 50 X 30
By integrated GHG emissions mitigation technologies

- **How many houses, businesses, organization, public institutions in Middletown have solar?**
- **How many of these have EVs?**
- **How many of these have heat pumps?**
- **How can we link these together to install solar, EVs and heat pumps?**
- **How many parking lots/garages can install solar canopies?**
- **How many parking lots/garages can install can install EV charges?**
- **How can we link these together to install solar canopies and EV charges together?**
- **How to get community solar for Middletown low income residents and small businesses?**
- **How can we link community solar with EV charges/heat pumps?**
- **How can we link solar and battery storage for distributed grid reliability and resiliency?**

- **How to collect performance data to educate and advocate change?**

Middletown 50 x 30 Green Team Oct 21, 2021
Reasons to be Optimistic

Thank You

Michael Winka
energy translator
mwinka@comcast.net