We Can Win the Clean Energy Battle

May 16, 2024 – BEC

Why Im Optimistic
We'll Get to 100% Clean Energy before 2050

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Why We Can Win the Climate Mitigation and Clean Energy Transition

May 16, 2024

Why Im Optimistic
We'll Get to 100% Clean Energy before 2050
Local Actions

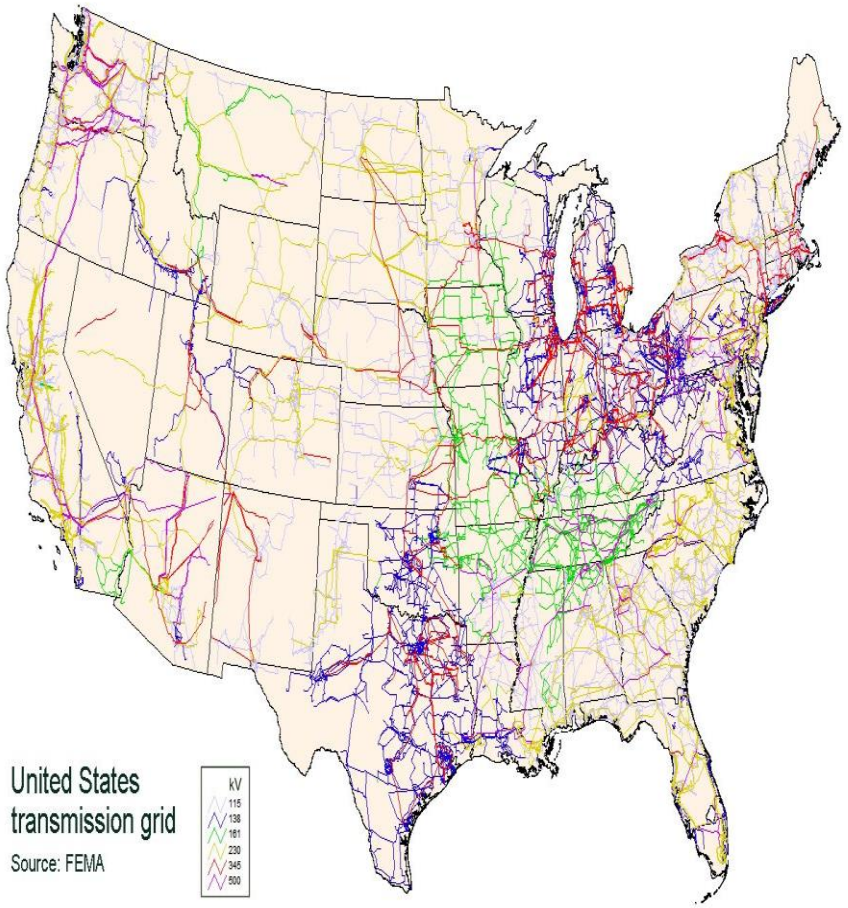
- **The Size of the Issue – Climate and Energy Systems**
- **Mitigation Strategies - Planning at the State, Local, and Household Levels**
- **The Costs and Benefits of those Mitigation Strategies/Measures**

- **Energy Policies to reduce GHG emission Pollution – It starts with a Plan**
- **4 Charts on why I'm Optimistic**

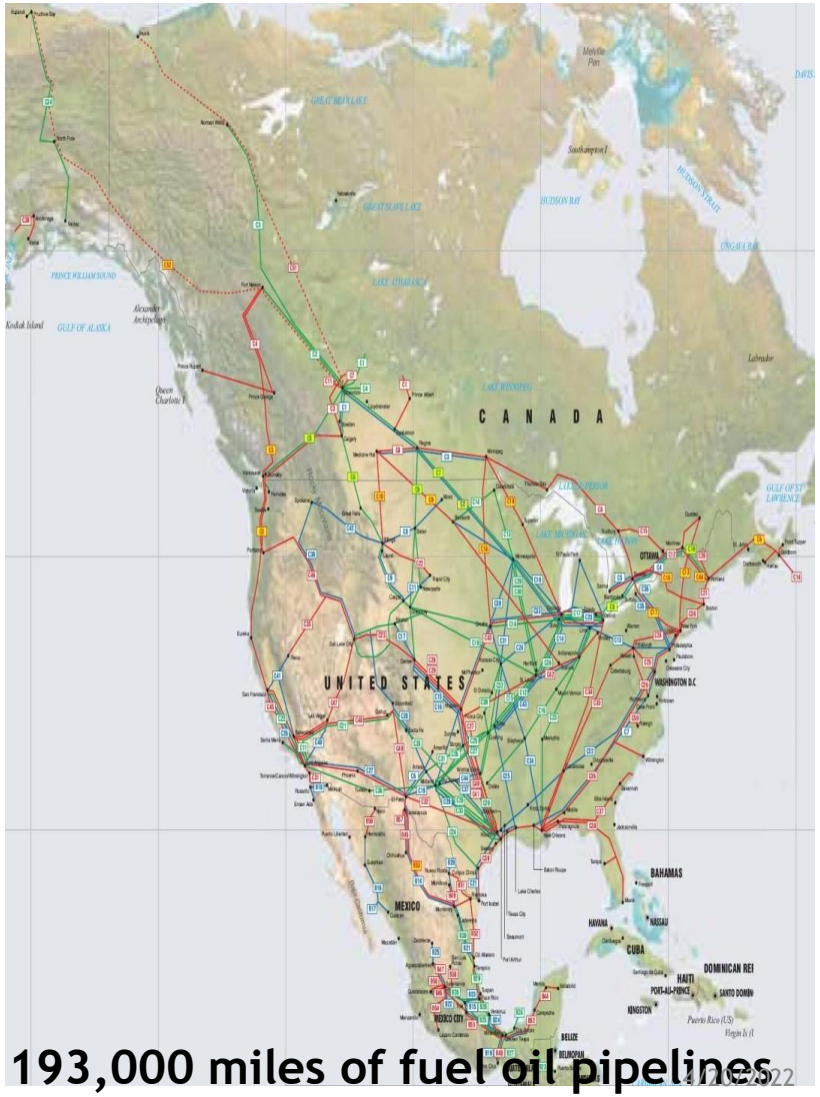
The US Energy System of pipes and wires are large enough to X-cross the US over 200 times

Energy is over $1.96 trillion – almost 6% of US GDP - In NJ - $43.6B almost 6% of NJ GDP

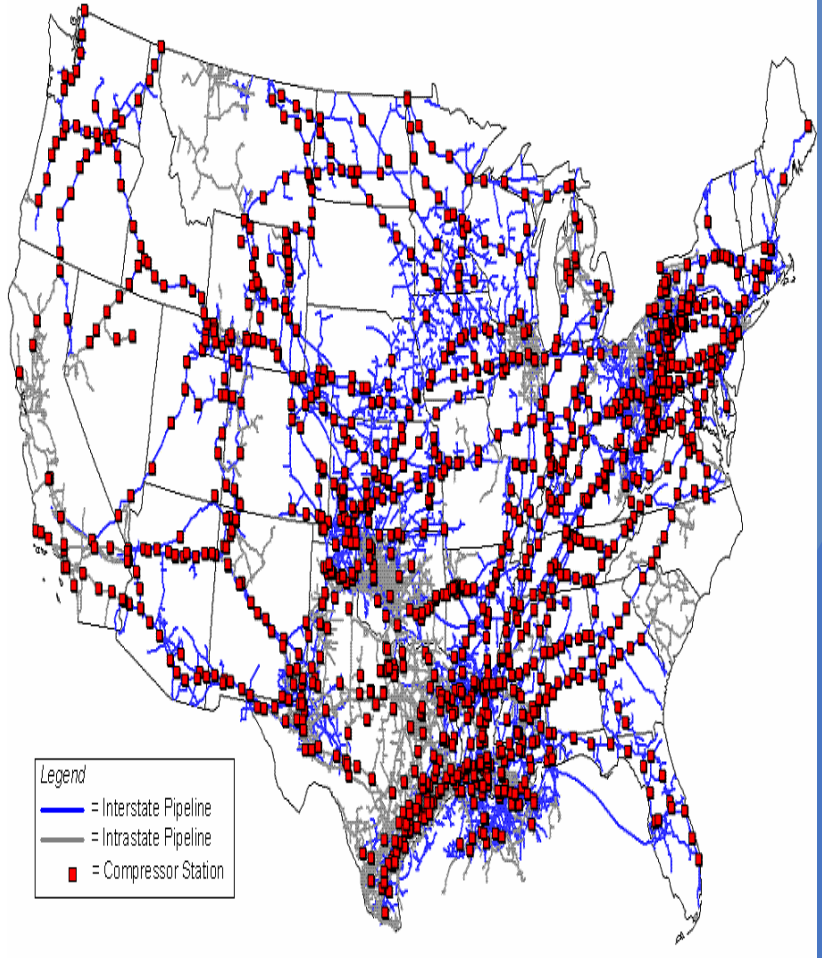
U.S. Energy Information Administration - EIA - Independent Statistics and Analysis



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



193,000 miles of fuel oil pipelines in US



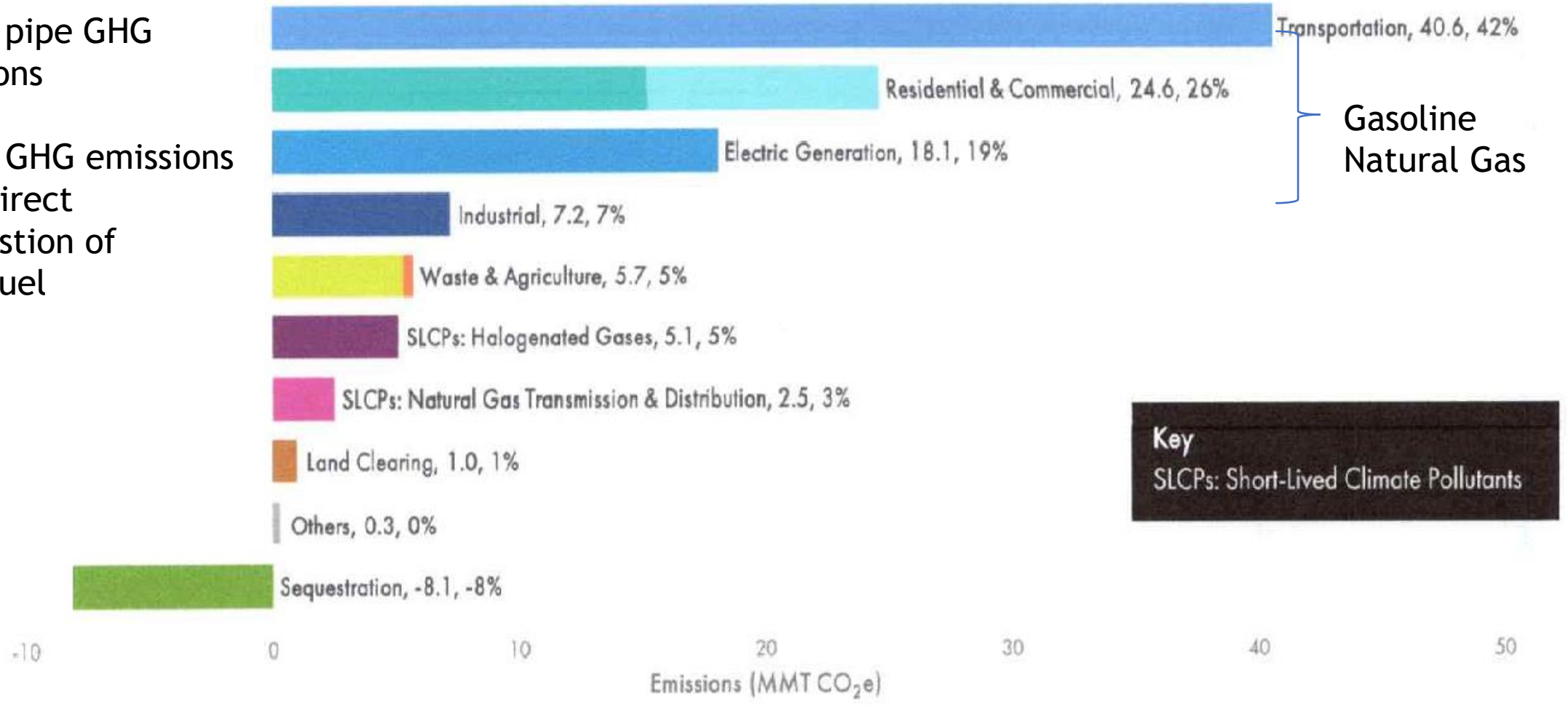
300,000 miles of inter and intrastate natural gas pipelines and 2.1 M miles of distribution pipes

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.

100 MMT per year
11 MT per person (14.9/4.75 MT/person)
Our World in Data

End of pipe GHG Emissions

84% of GHG emissions from direct combustion of fossil fuel



Gasoline
Natural Gas

NJDEP GHG Inventory -2024-ghg-inventory-report.pdf (nj.gov)

New Jersey's Clean Energy Goals per the 2019 Energy Master Plan - https://nj.gov/emp/

Achieving 100% Clean Energy and reducing the 2006 GHG emission levels by 80% by 2050

Clean Energy is defined in the 2019 EMP as:

Maximizing the electrification of the
transportation and building sectors
Powered by 100% carbon neutral electricity generation

Currently 23 states and DC have 100% Clean Energy goal
CA, CO, CT, DE, DC, HI, IL, LA, ME, MD, MA, MI, MN, NE, NV, NJ, NM, NY, NC, OR, PR, RI, VA, WA, WI - 53% of US [population
Table of 100% Clean Energy States - Clean Energy States Alliance (cesa.org)

2019 NJ Energy Master Plan – Strategies to get to 100% Clean Energy by 2050
The EMP puts mitigation in 5 basic buckets – a more integrated approach https://nj.gov/emp/

2019 NJBPU EMP STRATEGIES	INTEGRATED ENERGY PLAN
Reduce energy use and emissions from the transportation sector	Accelerate the transition to electric vehicles powered by clean renewable electricity
Accelerate the deployment of renewable energy and Distributed Energy Resources (DER)	Expand in-state renewables and within PJM to supply clean electricity for the transportation and building sectors Retain near term but no expansion of existing natural gas and nuclear capacity for reliability
Maintain energy efficiency and peak demand reduction	Continue and expand existing EE and DR programs with a focus on heat pumps and EVs - powering New Jersey economy w clean energy
Reduce energy use and emissions from the building sector	Existing building electrification powered by clean renewable electricity Develop electrification programs for new construction
Decarbonize and modernize the New Jersey energy systems	Electricity to double by 2050 Plan grid modernization - integrated distribution plans Natural gas and gasoline usage declines

How does the 2019 NJBPU Energy Master Plan Translate to what you can do and what local governments can do

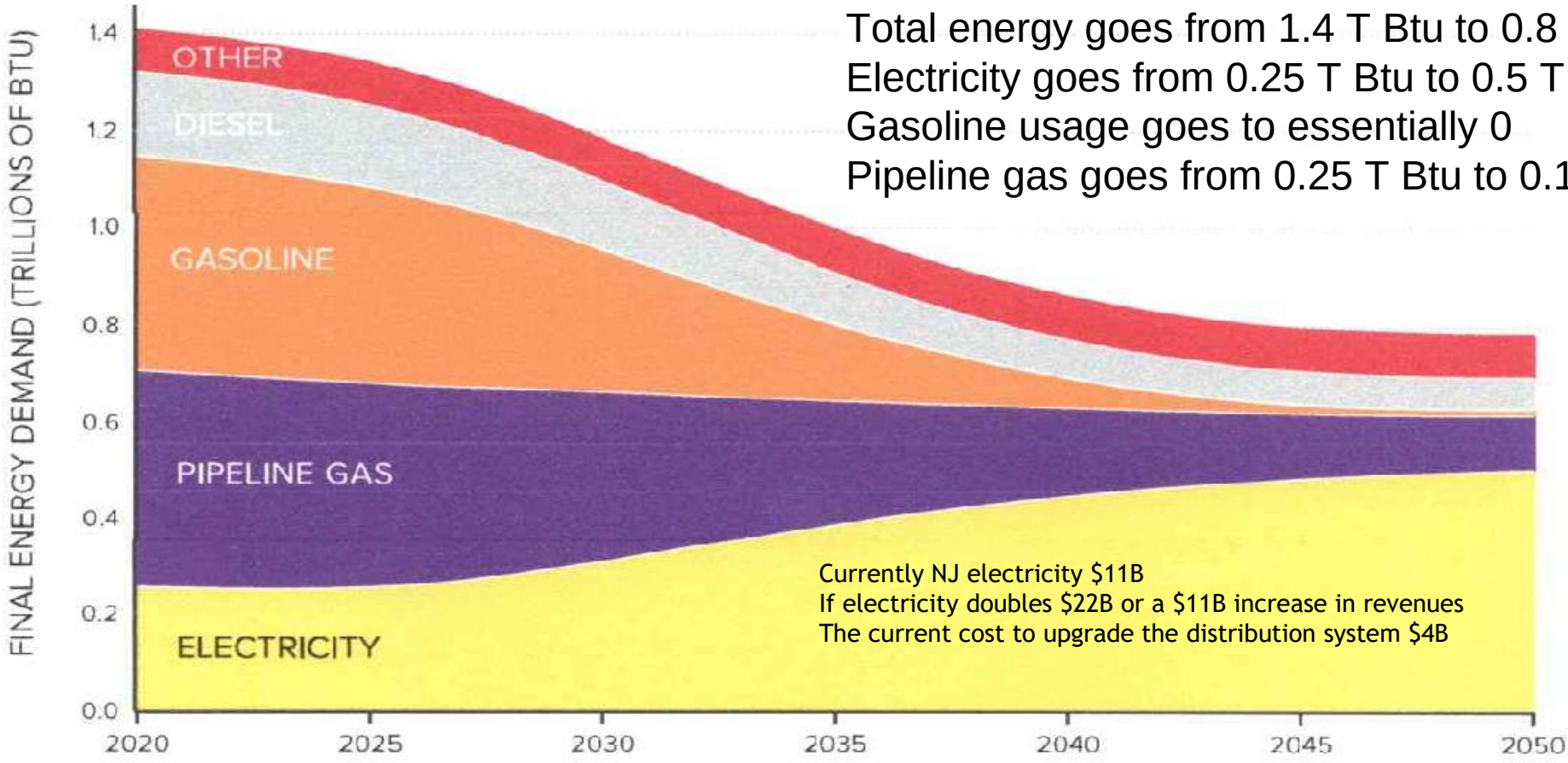
- **Energy Storage – 2,000 MW by 2030**
- Renewable Energy Portfolio Standard (RPS)- 50% by 2030 (100% clean electricity by 2035)
- Solar - additional 3,750 MW from 2021 by 2026 (existing 5,200 MW 7.6% total generation)
- Offshore Wins (OSW) - 7,000 MW by 2035 (11,000 MW by 2040)
- Electric Vehicles (EV) - 330,000 by 2025, 2 million by 2035
- EV Charging Stations (EVCS) – 1,000 level 2 and 400 DC by 2025
- **Cold Climate Heat Pumps – (400,000 residential, 20,000 Commercial)**
- Energy Efficiency electricity – 2% annual reduction in use
- Energy Efficiency natural gas - 0.75%annual reduction in use
- Clean Energy – (100% clean energy by 2050)
- Greenhouse Gas (GHG) reduction – 80% reduction in 2006 level by 2050
- GHG reduction – 50% reduction in 2006 level by 2030)
- GHG reduction – 28% reduction in 2005 level by 2025 – Paris Agreement

New Jersey does not reach its goals unless every municipality reaches these goals
Every municipality does not reach these goals unless
every household and business reaches these goals

Energy Savings to Electrify the Building and Transportation Sectors Powered by Renewable Energy

FIGURE H.

Final energy demand in the Least Cost scenario



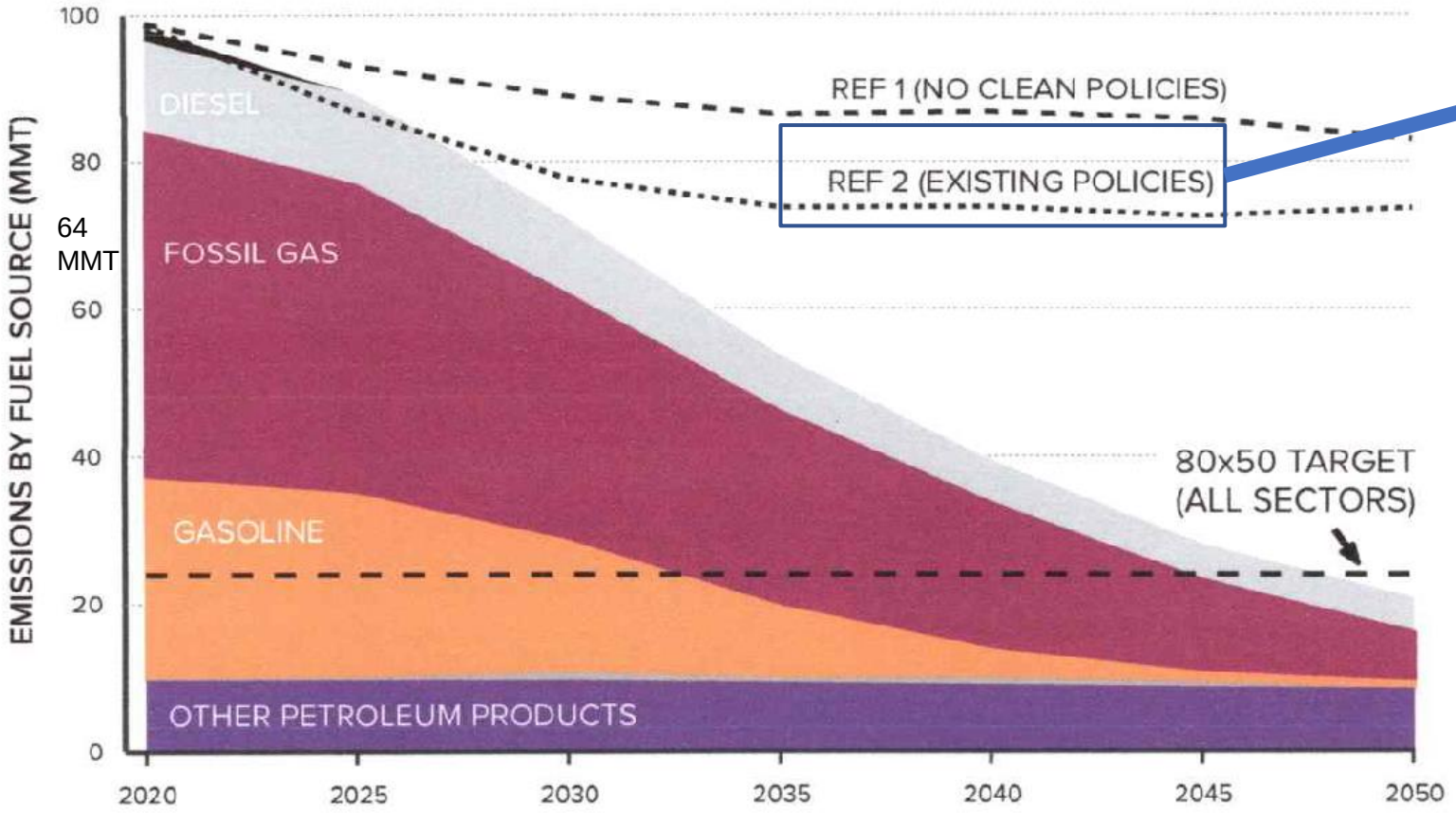
Total energy goes from 1.4 T Btu to 0.8 T Btu
Electricity goes from 0.25 T Btu to 0.5 T BTU
Gasoline usage goes to essentially 0
Pipeline gas goes from 0.25 T Btu to 0.1 T Btu

Currently NJ electricity $11B
If electricity doubles $22B or a $11B increase in revenues
The current cost to upgrade the distribution system $4B

New Jersey's 2019 Integrated Energy Plan - https://nj.gov/emp/
Policies are in law, regulations, codes, standards, executive orders must do

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

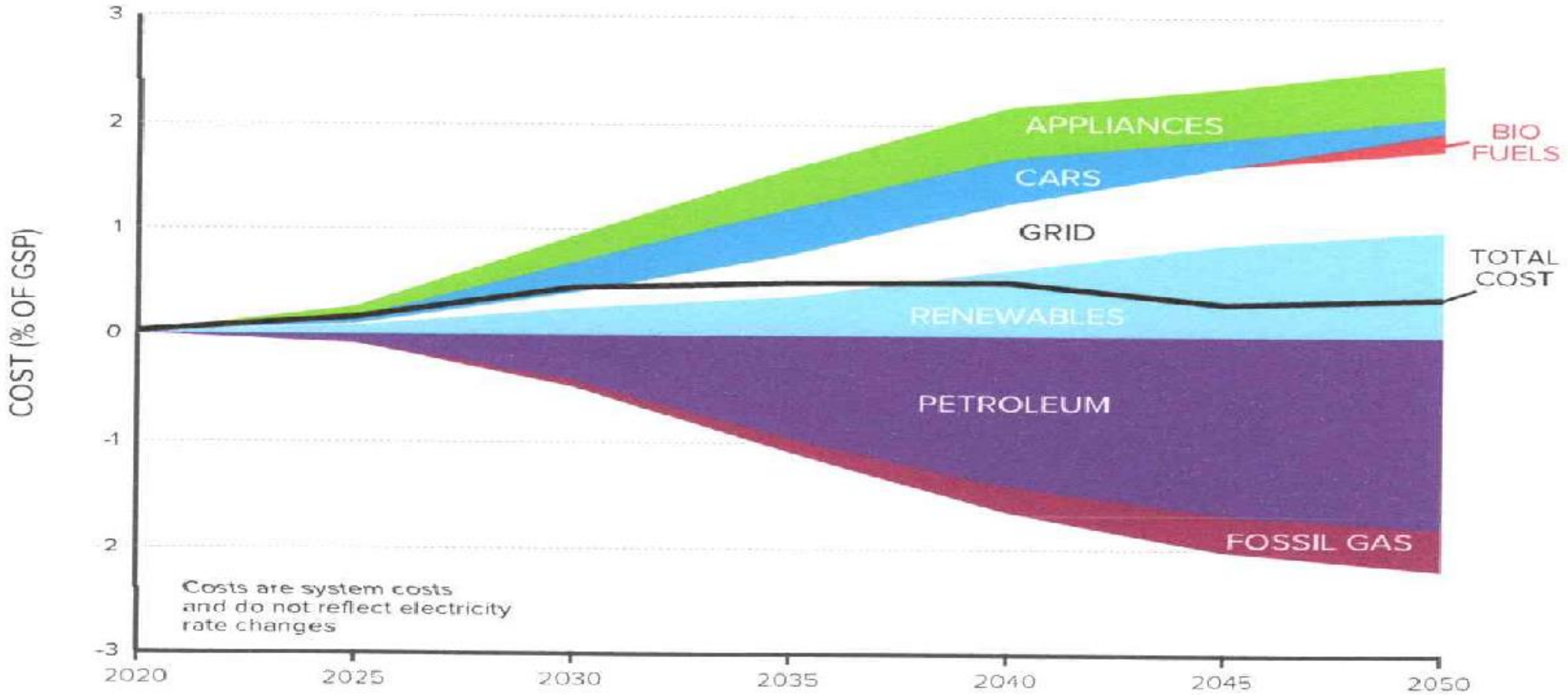
OSW goal of 3,500 MW

Cost to Electrify the Building and Transportation Sectors Powered by Renewable Energy

FIGURE G.

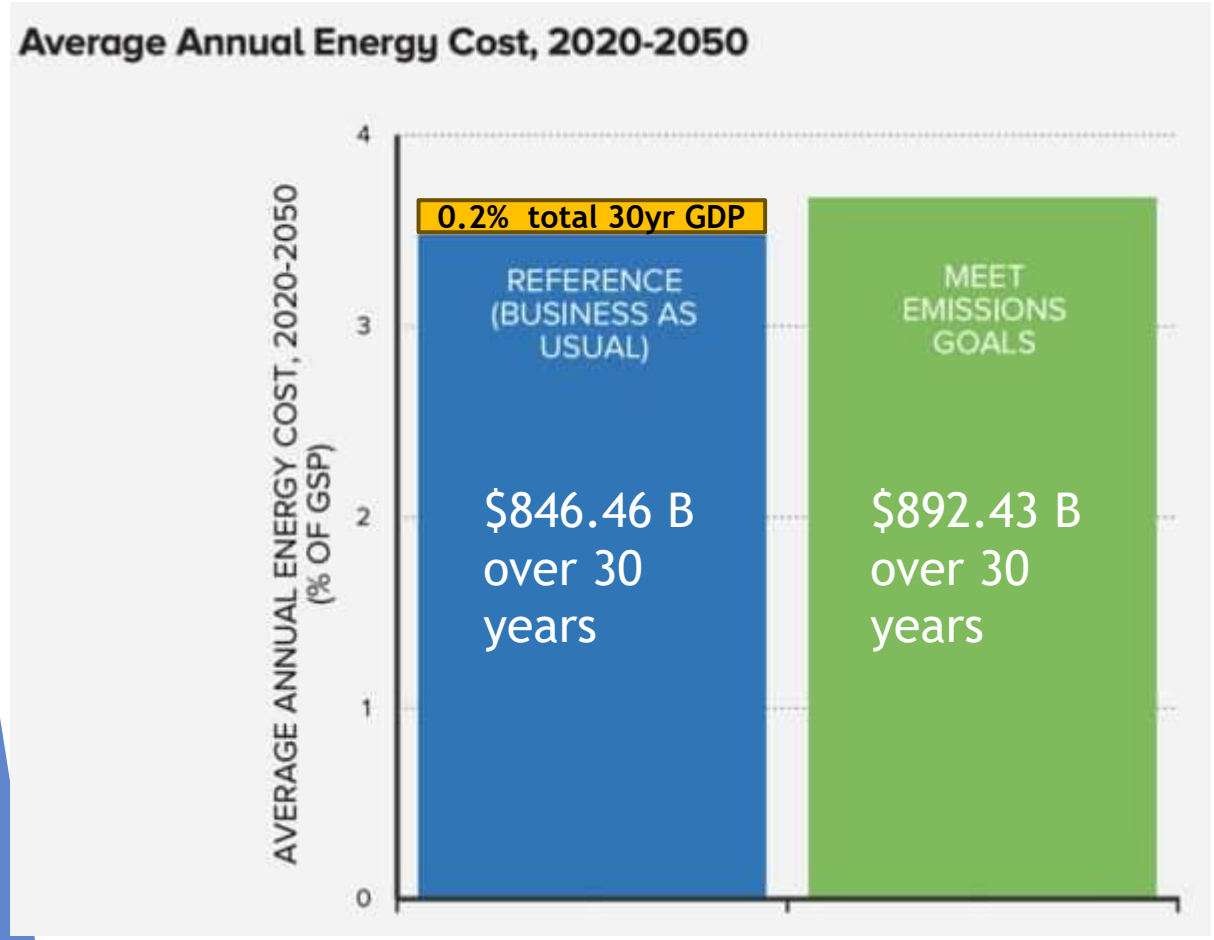
Incremental and avoided costs in the Least Cost scenario

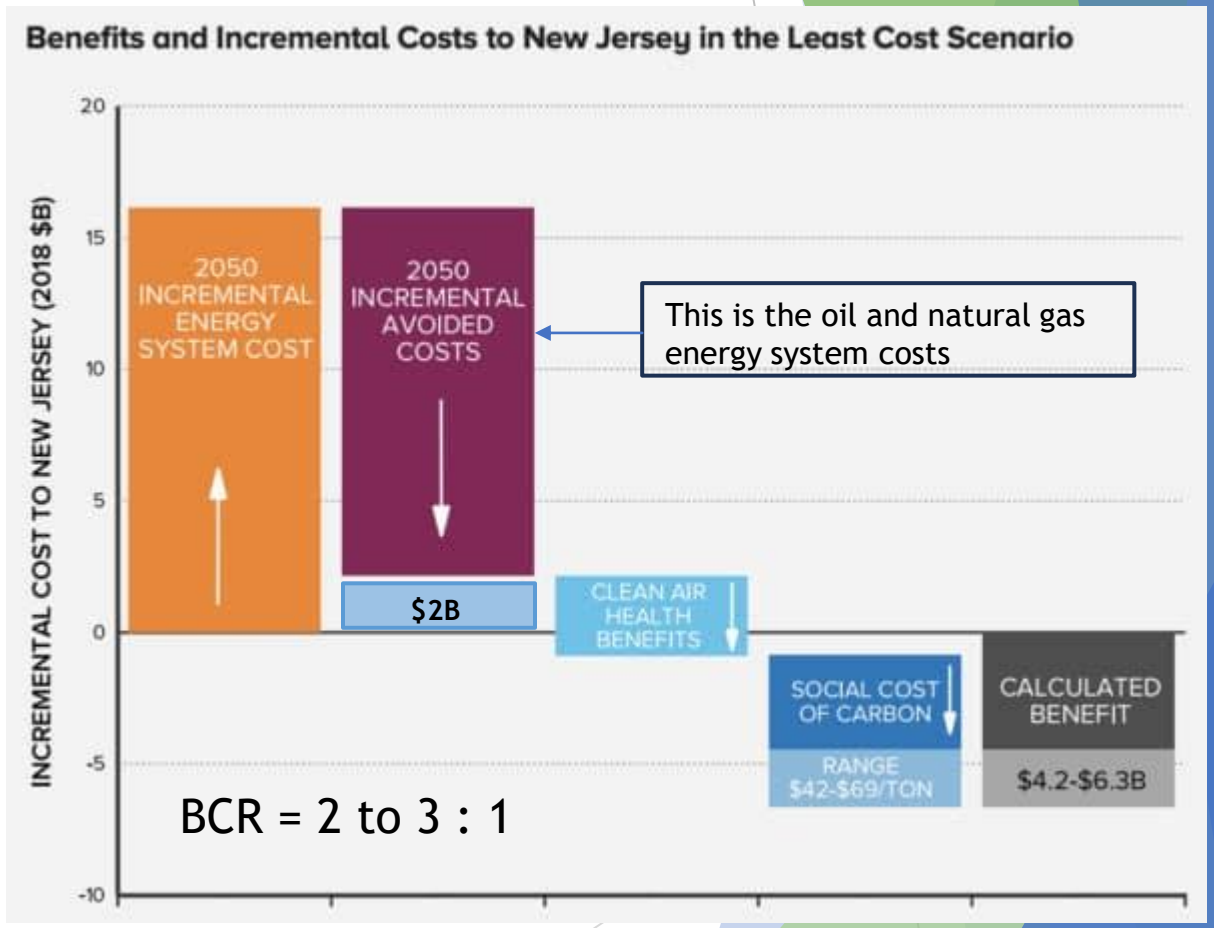
See call-out box for description of this and similar charts.



The Incremental Cost and Benefits to Electrify the Building and Transportation Sectors Powered by Renewable Energy – **Its Cost Effective**

$2B incremental cost in a $1 T NJ economy or 0.2% increase





From the 2019 NJ Integrated Energy Plan presentation – Nov 2018

Summary of Key Finding presented by Rocky Mountain Institute

- New Jersey Can meet the goals of the 2019 EMP for 100% clean energy and 80% reduction in GHG emissions by 2050 with existing technologies
- Cost to meet the 2019 EMP goals are relatively small compared to total energy spending and offset by the benefits by 2 to 1
- Existing policies reduce GHG emissions but are not enough to achieve the 2019 EMP goals
- **The least cost energy systems are substantially different from today's energy system**

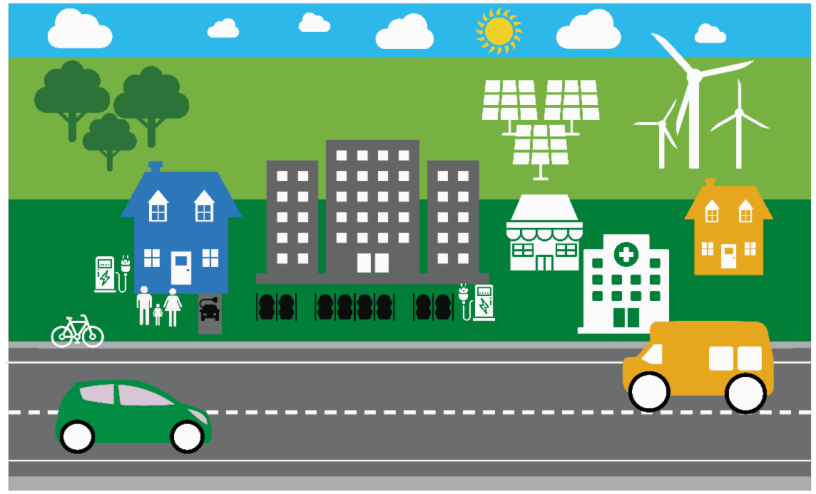
Six Simple Currently Cost Effective (without subsidies) Clean Energy Technologies (EE/RE) that can be Implemented

Incrementally and Integrated -not siloed
to Mitigate Climate Change by Reducing GHG at the HH and Local Level.

- Energy Efficiency – Whole House Weatherization (EE) (high efficiency shell measures)
- Building electrification – Heat pumps – induction stove - LED
- Electric Vehicles (EE) and EV Charging
- On-site Solar (RE) – Community Solar –(Grid scale Renewables -OSW)
- On-site Storage electric and thermal (CE) – (Grid scale storage) -
- Smart Grid – Grid Interactive Efficient Buildings (GEB)

How to Implement Energy and Climate Mitigation at a Local Level

Community Energy **Plan** – New Jersey Board of Public Utilities



Sustainable Jersey Guide for **Sustainable Energy Communities**

[Community Energy Plans | NJ OCE Web Site (njcleanenergy.com)]

$10K per town $25K OBC
Up to $250K for implementation

A SUSTAINABLE JERSEY GUIDE

Community Energy Plan Workplan Template

https://www.sustainablejersey.com/fileadmin/media/Actions_and_Certification/Actions/Energy/SJ_Sustainable_Energy_Communities_Guide10_2021.pdf

https://www.sustainablejersey.com/fileadmin/media/Actions_and_Certification/Actions/Energy/Community_Energy_Plan_Workplan_Template10_2021.pdf

Aggregated Community-Scale Utility Energy Data for Lawrence Township Mercer County

Municipality	County	Year	Utility	Residential Electricity	Commercial Electricity	Industrial Electricity	Street Lighting Electricity	Total Electricity (kWh)	Utility	Residential Natural Gas	Commercial Natural Gas	Industrial Natural Gas	Street Lighting Natural Gas
Lawrence township	Mercer	2015	PSEG	106,134,154	187,842,638	38,105,296	1,649,698	333,731,786	ETG/PSEG	9,648,317	12,973,782	2,288,252	NDA
Lawrence township	Mercer	2016	PSEG	105,603,678	199,808,852	38,262,441	1,646,646	345,321,617	ETG/PSEG	8,838,046	12,309,951	2,121,839	NDA
Lawrence township	Mercer	2017	PSEG	100,970,931	194,926,118	32,032,660	1,646,096	329,575,805	ETG/PSEG	9,191,212	12,872,924	1,880,139	NDA
Lawrence township	Mercer	2018	PSEG	104,482,043	202,739,946	35,160,031	1,652,724	344,034,744	ETG/PSEG	9,939,680	12,974,053	2,503,676	NDA
Lawrence township	Mercer	2019	PSEG	99,352,338	187,065,495	31,462,578	1,649,129	319,529,540	ETG/PSEG	9,448,441	13,179,329	2,152,911	NDA
Lawrence township	Mercer	2020	PSEG	102,989,913	161,806,084	50,289,084	1,669,701	316,754,782	ETG/PSEG	8,900,888	9,168,669	3,730,152	NDA
Lawrence township	Mercer	2021	PSEG	103,062,151	171,368,117	37,733,814	1,664,212	313,828,294	ETG/PSEG	9,306,149	11,290,947	3,637,900	NDA

Community-Scale Greenhouse Gas (GHG) Emissions - Metric Ton Carbon Dioxide Equivalent (MTCO2e)

Municipality	County	Year	Residential Electricity	Commercial Electricity	Industrial Electricity	Street Lighting Electricity	Residential Natural Gas	Commercial Natural Gas	Industrial Natural Gas	Street Lighting Natural Gas	Other Heating Fuels	On-Road Vehicles
Lawrence township	Mercer	2015	26,881	47,576	9,651	418	51,388	69,100	12,188	NDA	4,451	168,040
Lawrence township	Mercer	2020	22,998	36,131	11,230	373	47,407	48,834	19,867	NDA	3,046	214,346

Electric Vehicle (EV) Ownership Data

June 2022

* Further information on Notes sheet

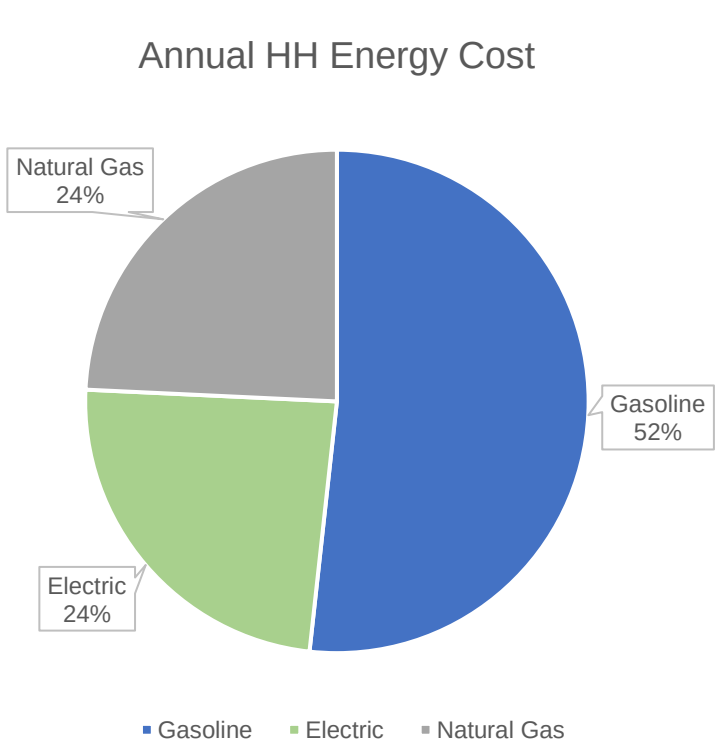
Municipality	County	Year	Total Personal Vehicles	# of EVs	% of EVs
Lawrence township	Mercer	2015	21,570	43	0.20%
Lawrence township	Mercer	2020	21,566	237	1.10%

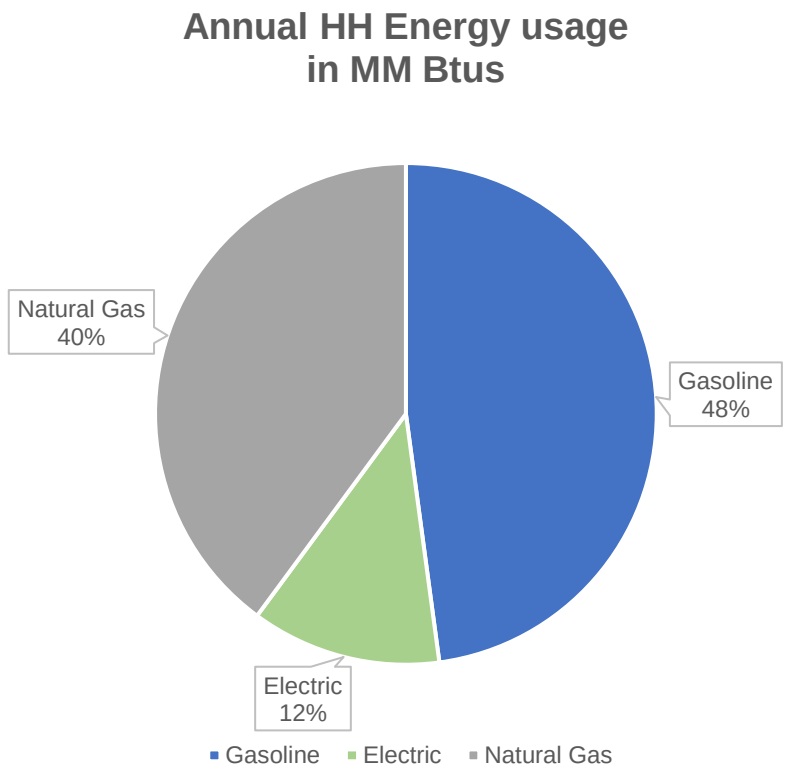
EV in Lawrence

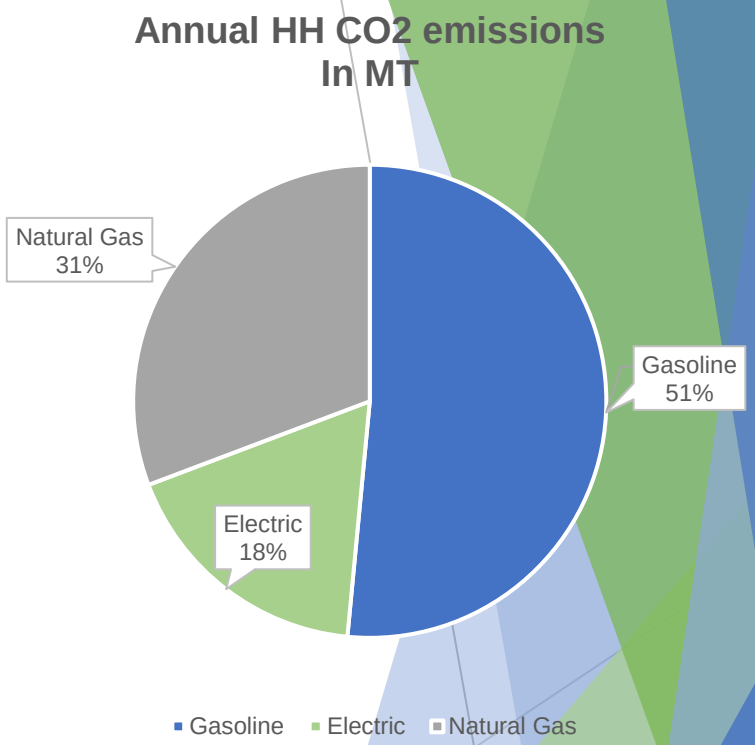
237 LT EV make up only 1% of total LDV 21,566
Each EV avoids 3.8 MT of CO2 per year
Each EV avoids 0.5 bbl of oil per year
LT EV avoid 909 MT of CO2 per year
LT EV avoid 119 barrel of oil per year

NJ EV goal for LT 1,200 EV by 2025
Or 7,300 by 2030

Average New Jersey Single-Family Home -
2,400 sq ft 2 cars at 25 mpg
uses 1,000 gallons of gasoline per year, 1,000 therms of natural gas per year, 9,000 kwh of electricity per year







$6,200

250 MM Btus

38,000 lbs.
17 MT

The key to reducing energy, cost, and GHG emissions is a plan

Transportation Sector - Going Electric

How to Change the Demand Curve for Oil and Gasoline to Prevent Future Oil pipelines
Just think Integrated

An EV is about $10,000 more than an ICEV

An EV is about 4 times more energy-efficient then a similar ICEV (25 mpg vs 03.kWh/mi)

EV is about 3 times lower cost to fuel then a similar ICEV ($3.5/gal vs $0.18/kWh)

Per car mag 40% less cost to maintain
The EV over 10 years than a similar ICEV including the cost to replace the batteries

3.5 kilowatts (kW) of solar
SPB 10 years w/o incentive 4.5 years -
"free" fuel for 20+ years
Avoiding 4.62 MT of CO2 - (54%<)
Reducing both gasoline and natural gas demand and emissions and storage solar electricity

MM Btu is a million Btus

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

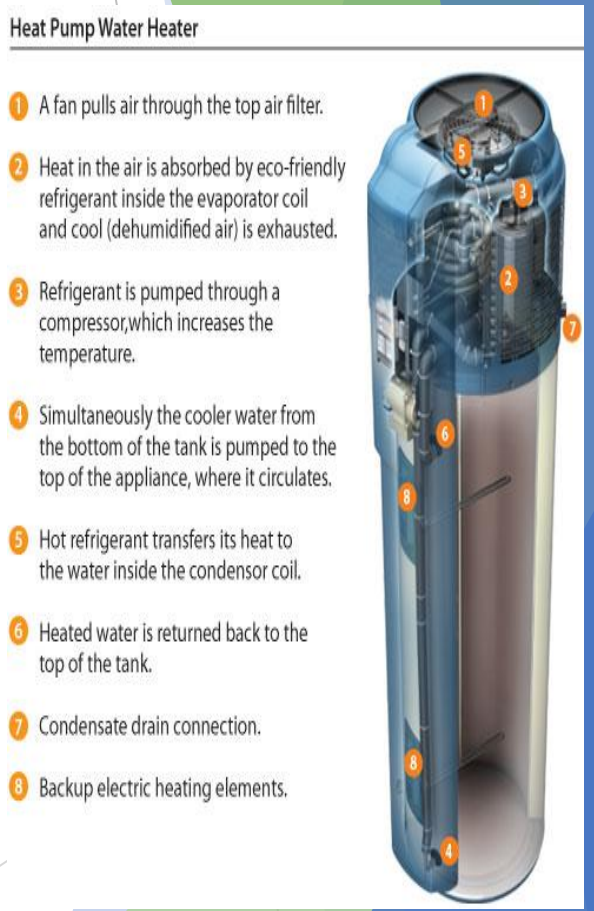
Heat Pump water heater is 2 times the cost of an efficient gas water heater

Heat pump water heater uses 3 times less energy than an efficient gas water heater

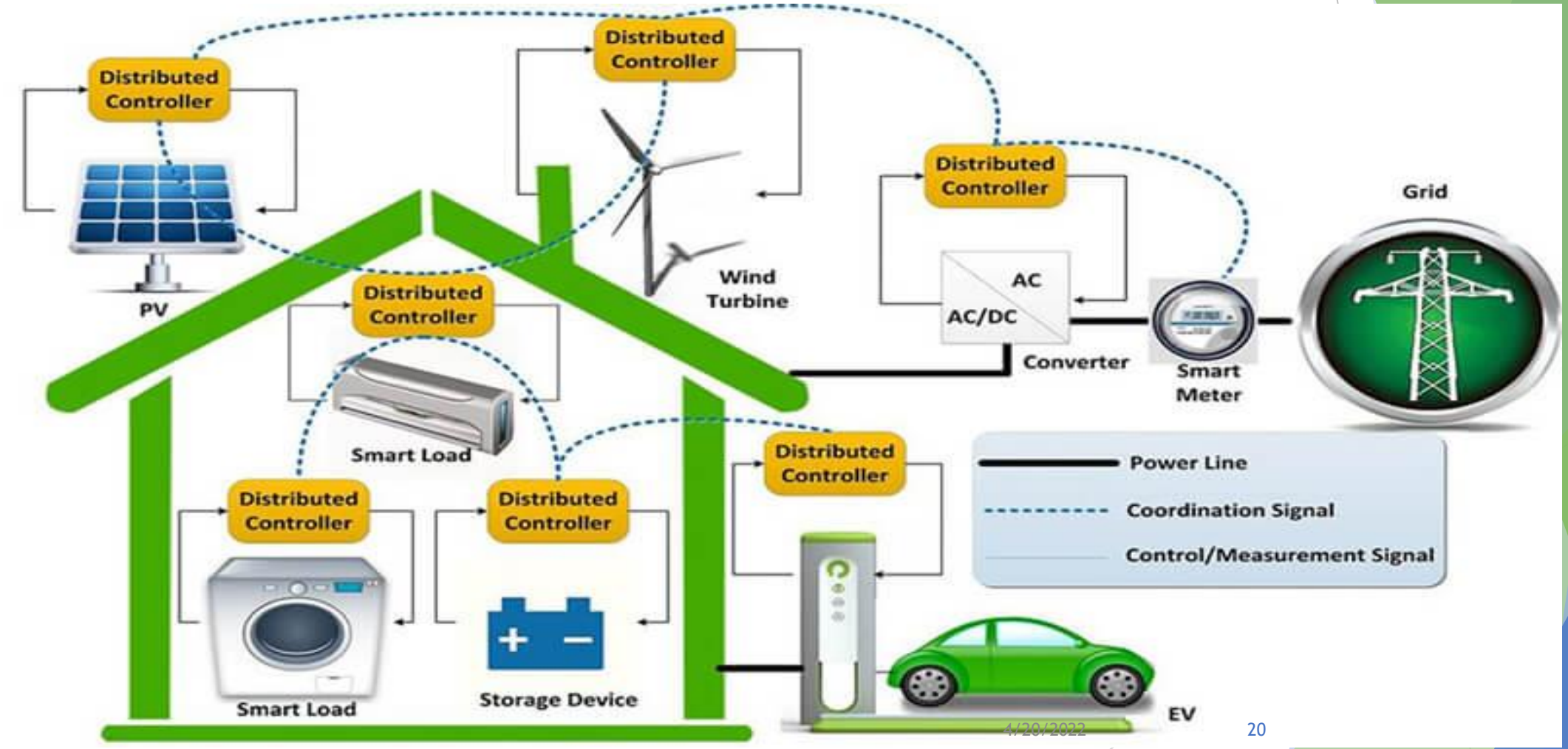
But costs the same to operate since natural gas is 3 times lower cost

1.5 kilowatts (kW) of solar
HPWH + solar = 9 years
Free hot water after that
Avoiding 2.3 MT (13% >) - 67%

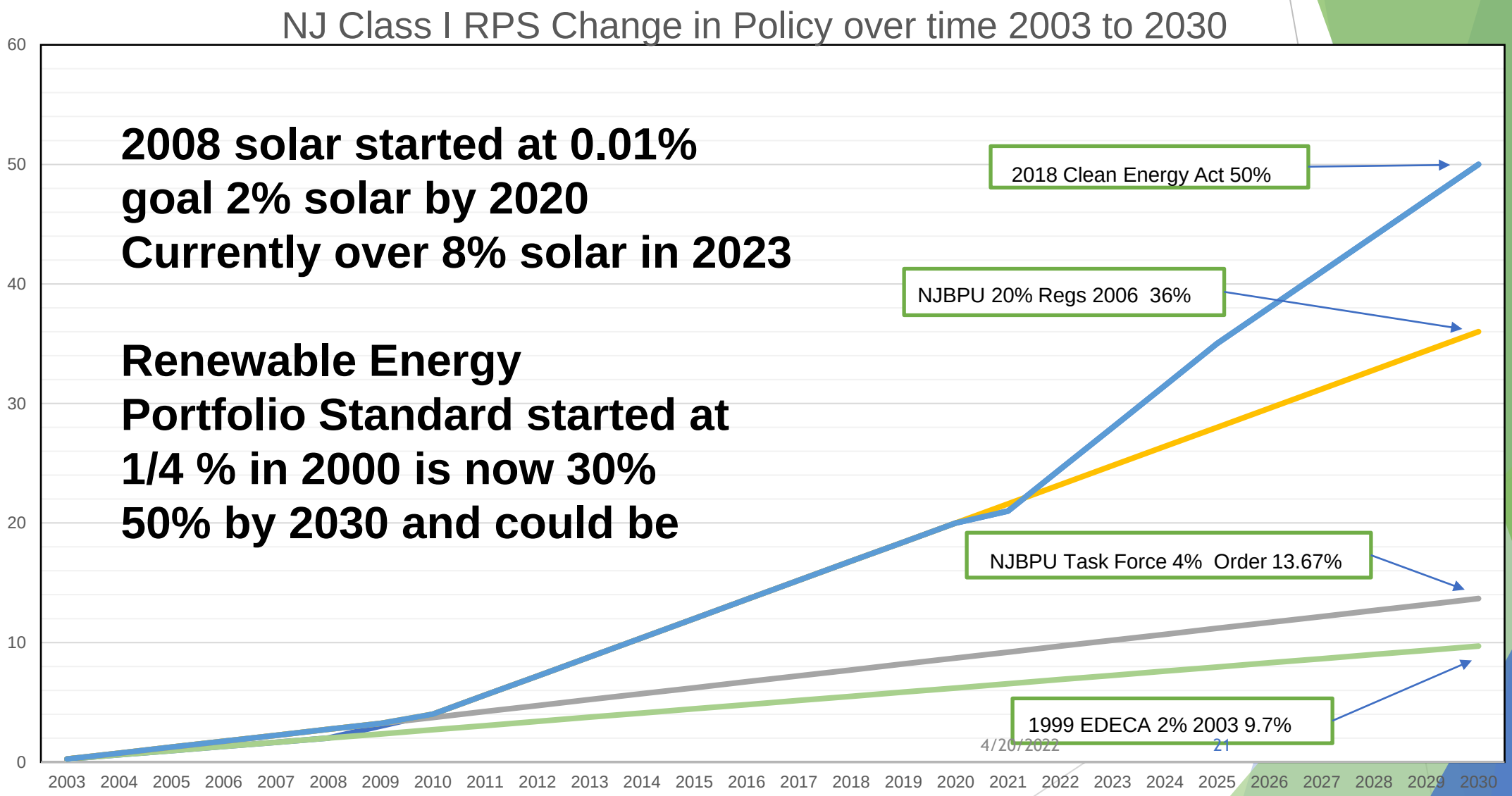
Reducing natural gas demand in electric and heating sectors
A major advantage is you can store your solar electricity in the HPWH



To extend the usability of solar energy
Smart Grid – Grid modernization – Smart Home or Office

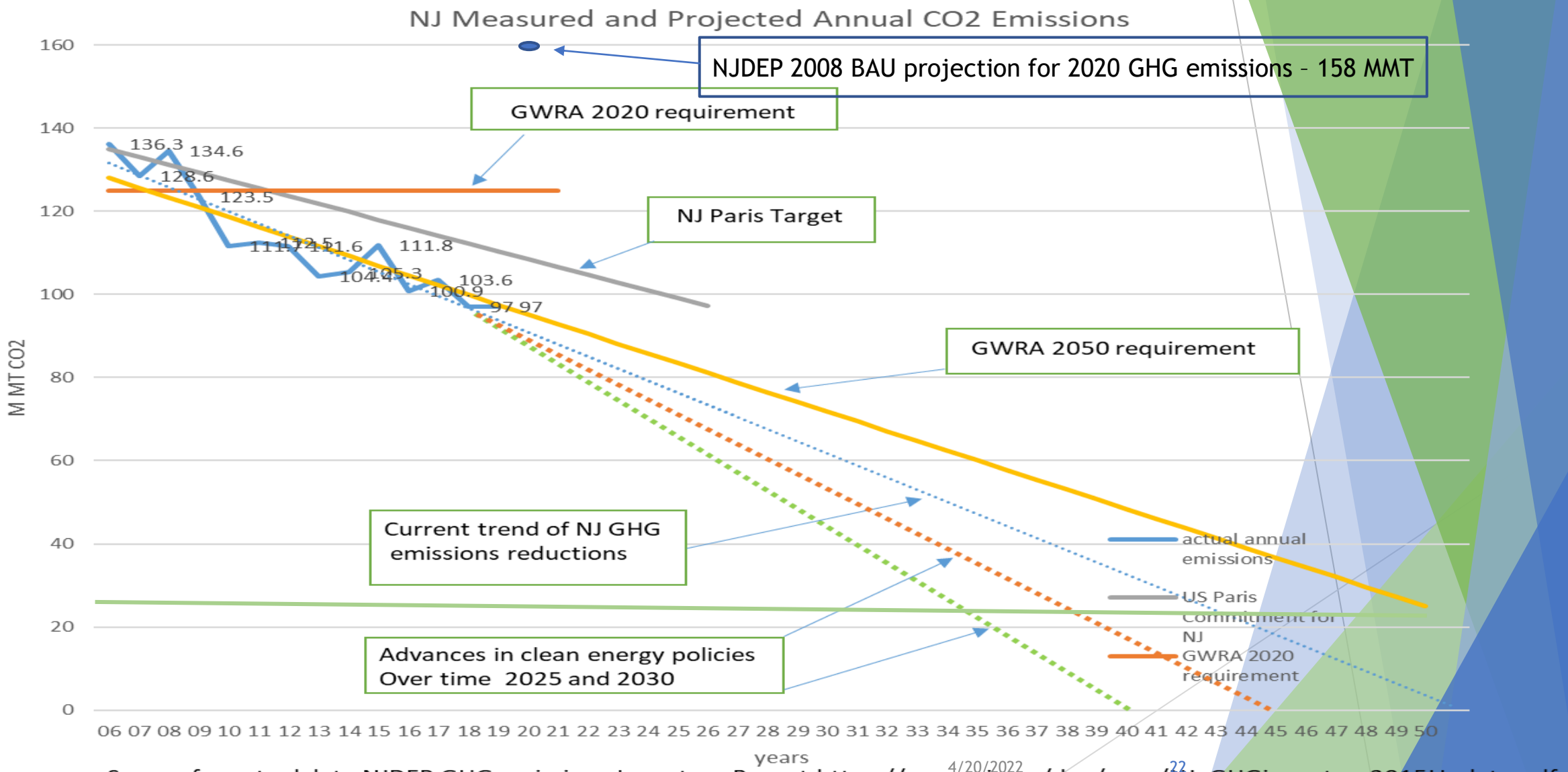


How Clean Energy Policy Changes over time – to achieve larger goals
Optimism Curve



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

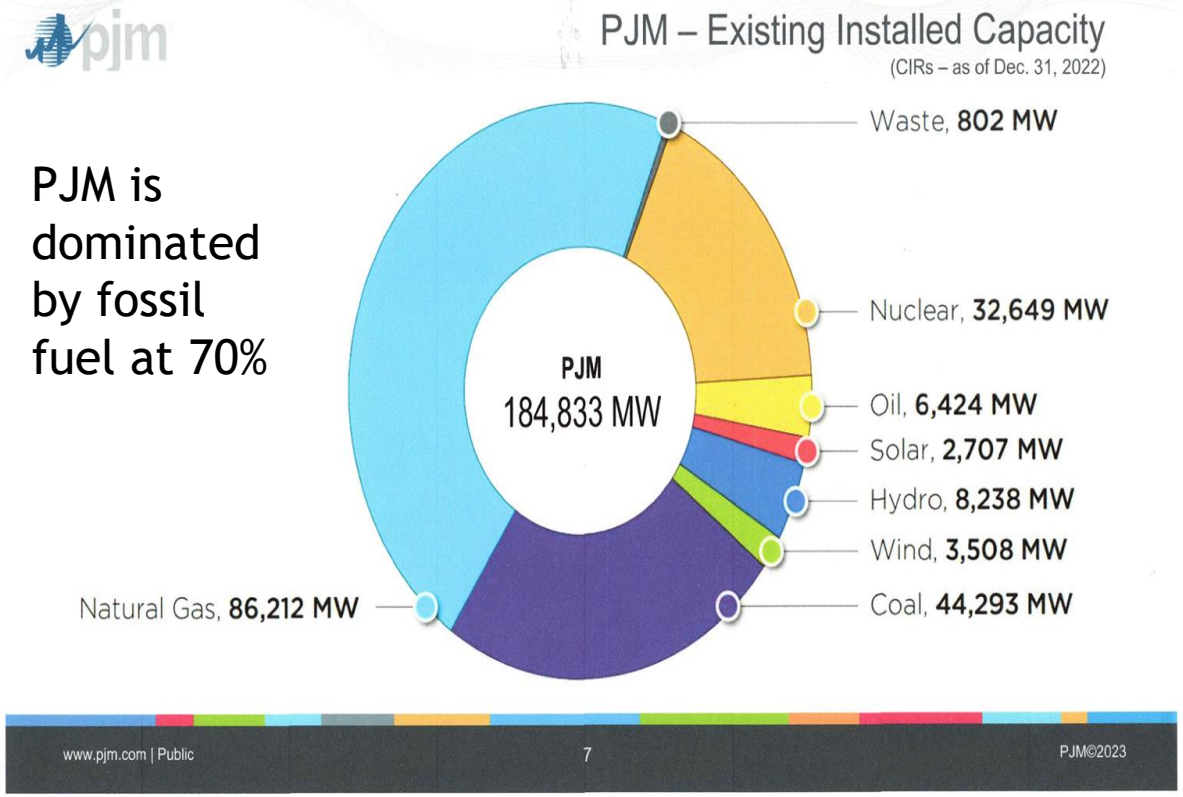
Why I'm Optimistic Getting to 50% by 2030 and beyond depends on us

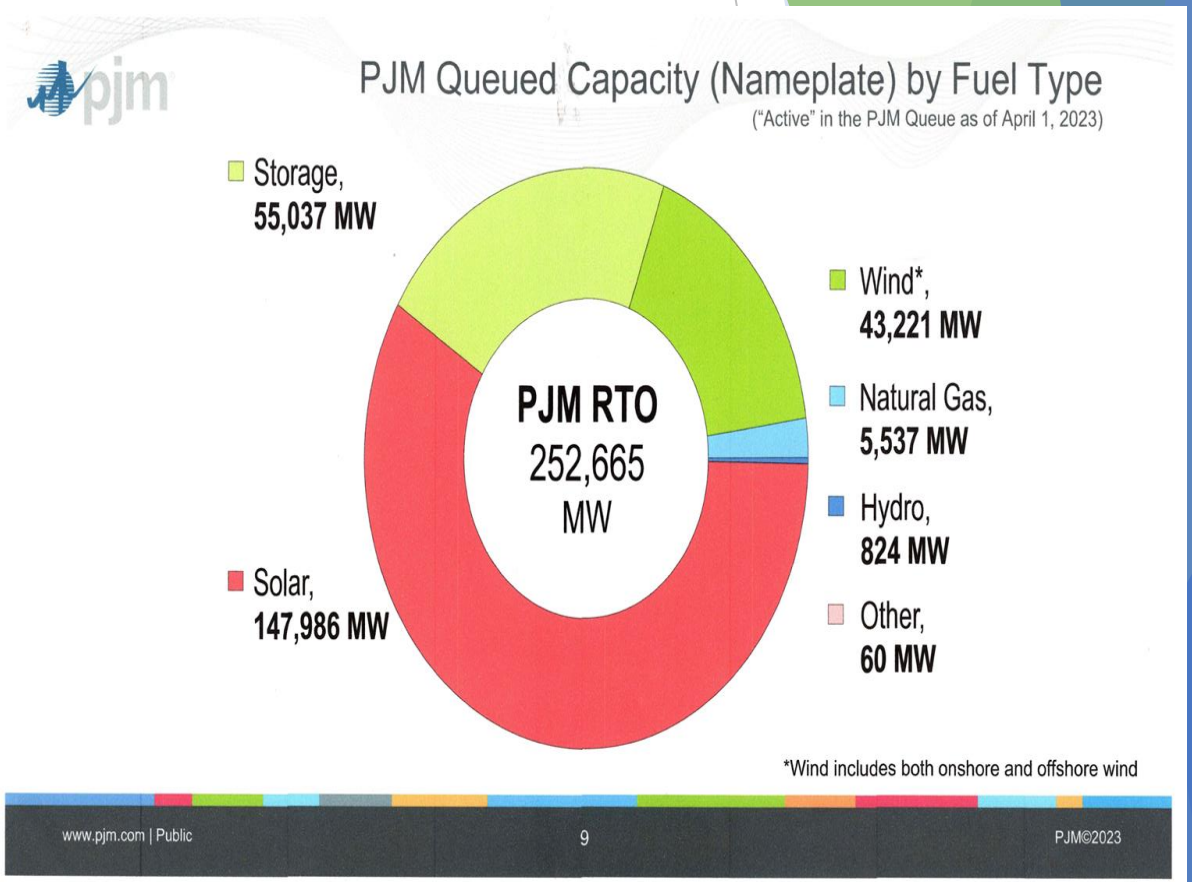


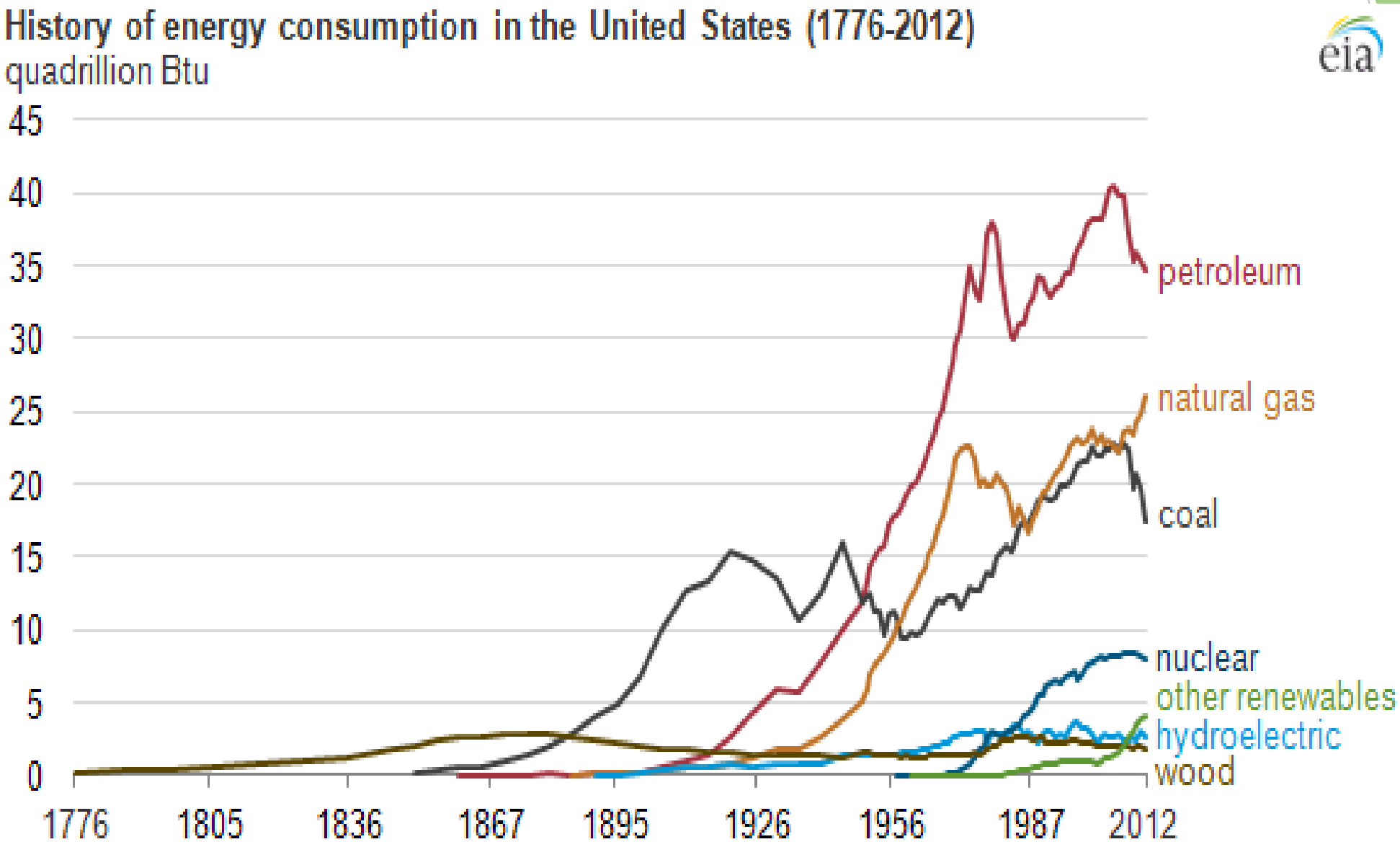
Source for actual data NJDEP GHG emissions Inventory Report https://www.nj.gov/dep/aqes/NJ_GHGinventory2015Update.pdf

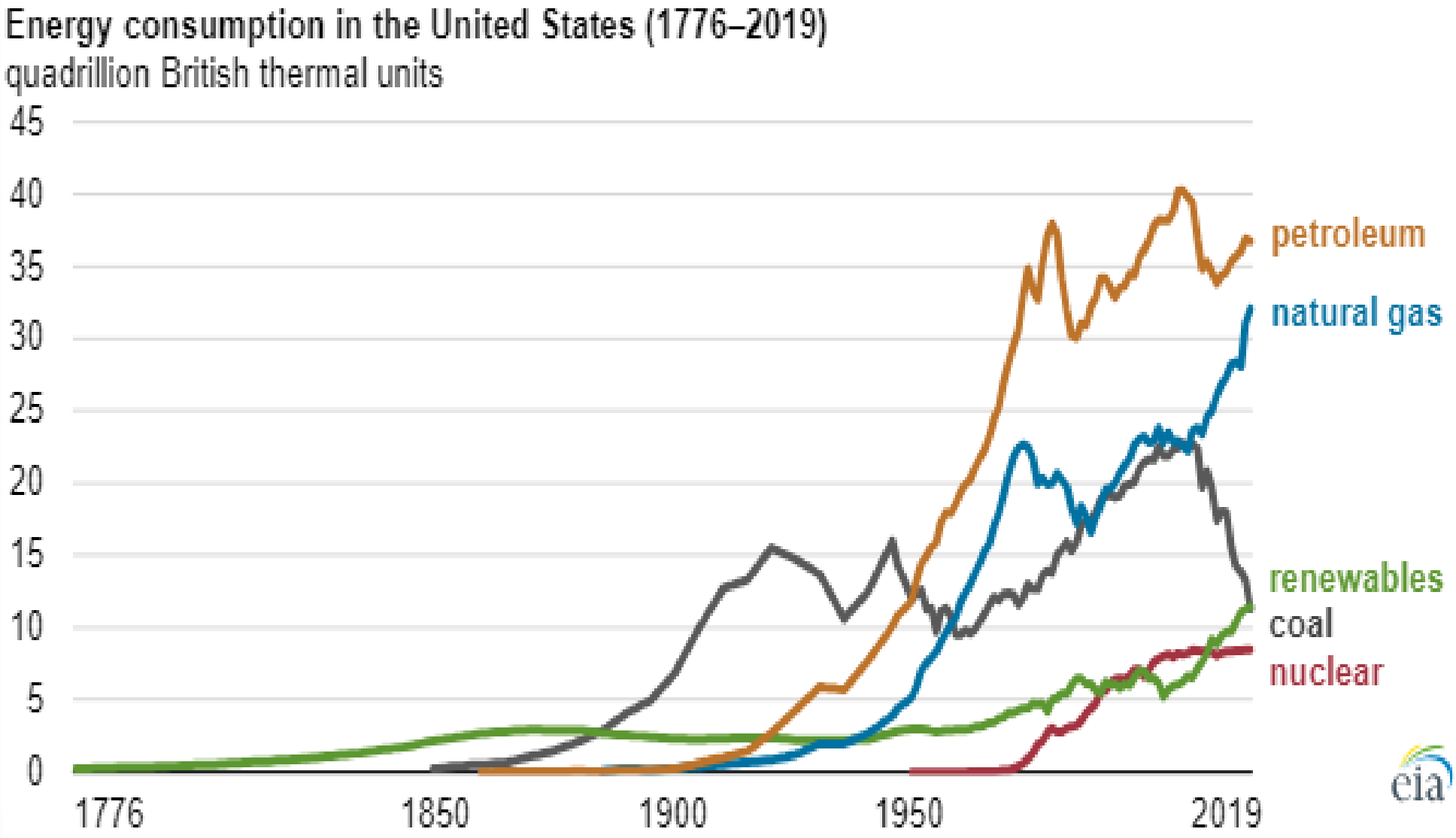
This is why I am 100% convinced we will get to 100% Clean Energy well before 2050

PJM is dominated by fossil fuel at 70%






History of energy consumption in the United States (1776-2012)
quadrillion Btu
45
40
35
30
25
20
15
10
5
0
1776
1805
1836
1867
1895
1926
1956
1987
2012
petroleum
natural gas
coal
nuclear
other renewables
hydroelectric
wood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quadrillion British thermal units
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40
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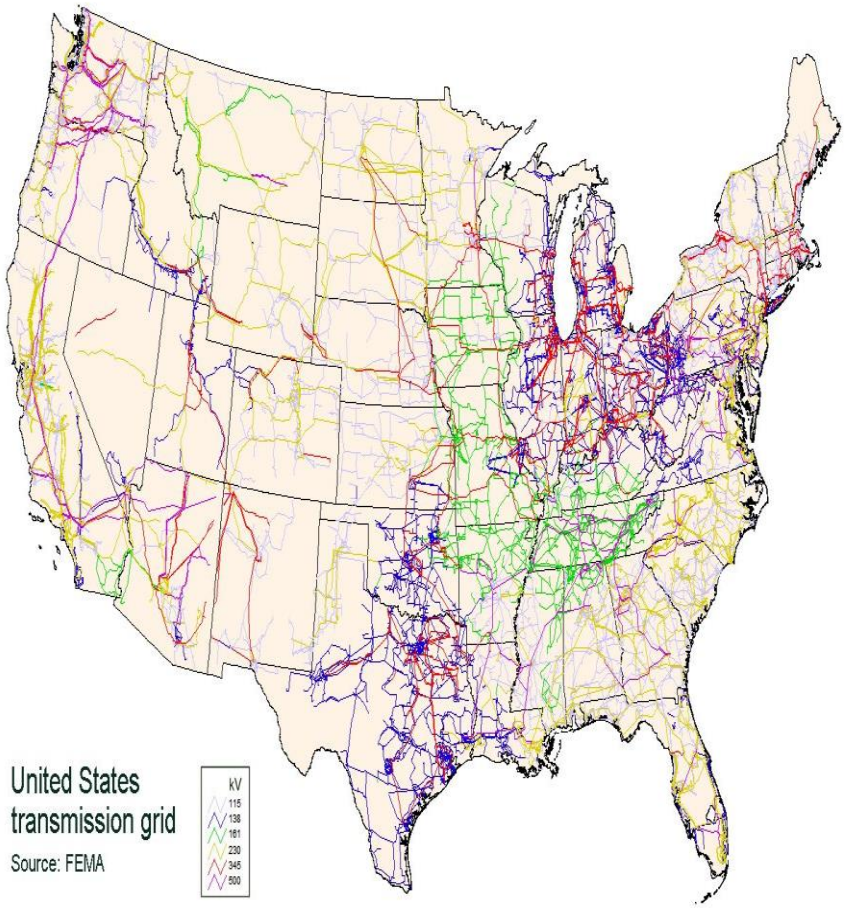
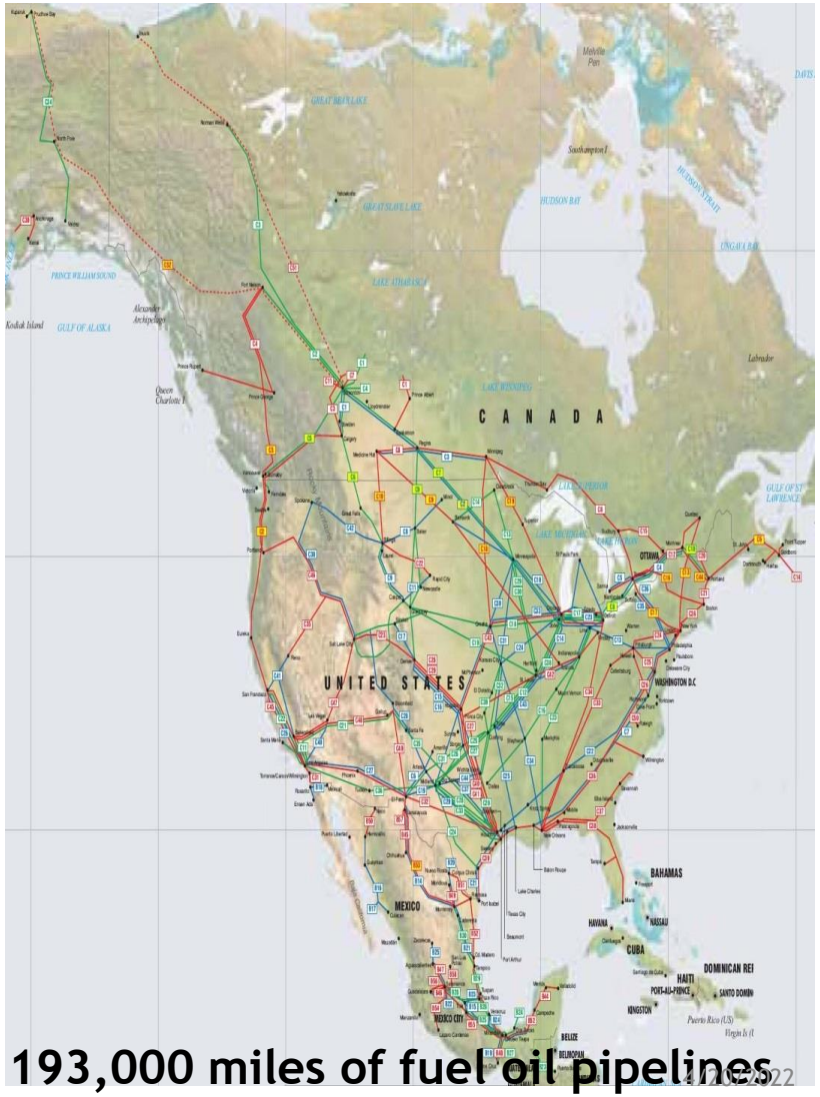
1850
1900
1950
2019
petroleum
natural gas
renewables
coal
nuclear
eia

The US Energy System of pipes and wires are large enough to X-cross the US over 200 times
Energy is over $1.96 trillion – almost 6% of US GDP - In NJ - $43.6B almost 6% of NJ GDP

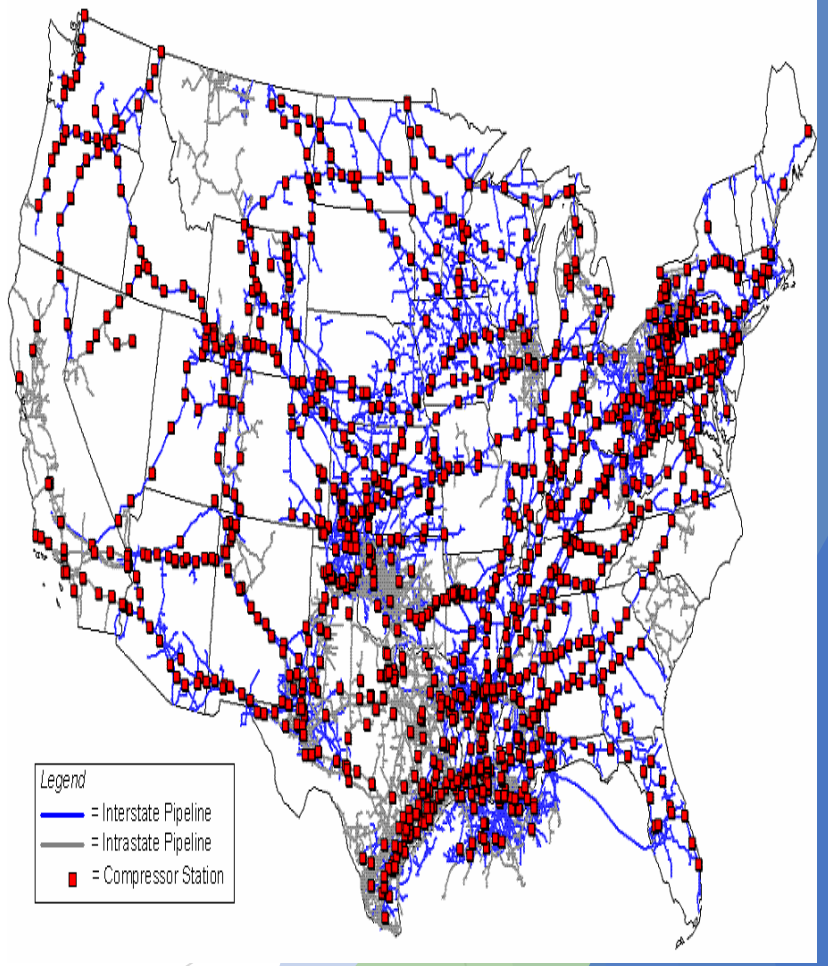
U.S. Energy Information Administration - EIA - Independent Statistics and Analysis



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



193,000 miles of fuel oil pipelines in US



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

Why we are winning in the Clean Energy Transition And Climate Mitigation

Why Im Optimistic
We'll Get to 100% Clean Energy before 2050
Local Action – Tracking Progress

Thank You - Questions????

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Additional Slides for reference

Is New Jersey a High Energy Cost State?
The answer is No – we are average at worst

Electricity NJ is ranked 12th highest at $0.1648 per kWh compared to the US average of $0.1319 per kWh

Natural Gas NJ is ranked 36st highest at $1.48 per therms
Compared to the US average of $1.260 per therms

Gasoline NJ is ranked 28th highest at $3.41 per gallon
Compared to the US average of $3.20 per gallon.

https://www.eia.gov/beta/states/states/nj/overview

https://www.eia.gov/beta/states/states/nj/data/dashboard/energy-indicators

IRA Tax Credits - State Incentives

IRA Clean Vehicles https://www.irs.gov/clean-vehicle-tax-credits https://www.energy.gov/save

New - Tax credit up to $7,500 new, qualified plug-in EV or fuel cell electric vehicle (FCV). Based on battery size and where manufactured Income limits $300K Limit of vehicle price
Used electric vehicle (EV) or fuel cell vehicle (FCV) $25,000 or less, tax credit equals 30% of the sale price up to a maximum credit of $4,000. Income limit $150K limits on battery size and vehicle wt.
EV Charging – Personal $1,000 - Businesses $100,000

New Jersey
NJDEP https://dep.nj.gov/drivegreen/
Sale and used tax exemption on zero emission vehicles
Grants to offset Businesses installation EV charging equipment costs $750 for Level 1 and $4,000 for a Level 2

NJBPU https://chargeup.njcleanenergy.com/home-ev-charger-incentive
$250 grant for residential EV charging equipment
Multi unit charger rebates
EV rebates between $1,500 to $4,000 depending on the vehicle
EV Charging incentive information is available from Atlantic City Electric, PSE&G, RECO and JCP&L.

PA – PADEP https://www.dep.pa.gov/Citizens/GrantsLoansRebates/Alternative-Fuels-Incentive-Grant/Pages/Alternative-Fuel-Vehicles.aspx

400% of the federal Poverty level – Up to $3,000 depending on income level and vehicle type

IRA Tax Credits

Home Energy
Primary residents, Renter and second homes used as residents

Energy Efficient Home Improvement Credit -These expenses may qualify -requirements detailed on energy.gov:

- Exterior doors, windows, skylights and insulation materials
- Central air conditioners, water heaters, furnaces, boilers and heat pumps
- Biomass stoves and boilers
- Home energy audits

Tax credit is a percentage of the total improvement expenses in the year of installation:

- 2022: 30%, up to a lifetime maximum of $500
- 2023 through 2032: 30%, up to a maximum of $1,200 (heat pumps, biomass stoves and boilers have a separate annual credit limit of $2,000), no lifetime limit

Residential Clean Energy Credit These expenses may qualify requirements detailed on energy.gov:

- Solar, wind and geothermal power generation
- Solar water heaters
- Fuel cells
- Battery storage (beginning in 2023)

The amount of the credit you can take is a percentage of the total improvement expenses in the year of installation:

- 2022 to 2032: 30%, no annual maximum or lifetime limit
- 2033: 26%, no annual maximum or lifetime limit
- 2034: 22%, no annual maximum or lifetime limit

Get details on the Residential Clean Energy Credit.

New Jersey Clean Energy Program. More information on the Clean Energy Program can be found on this **website**.

NJBPU and NJCEP Administered Programs

New Jersey's cleanenergy program™

- New Construction (residential, commercial, industrial, government)
- Large Energy Users
- Energy Savings Improvement Program (financing)
- State Facilities Initiative*
- Local Government Energy Audits
- Combined Heat & Power & Fuel Cells

*State facilities are also eligible for utility programs

Utility Administered Programs

atlantic city electric™ AN EXELON COMPANY

Jersey Central Power & Light A FirstEnergy Company

PSE&G

Rockland Electric Company

ELIZABETHTOWN GAS

SOUTH JERSEY GAS

New Jersey Natural Gas

- Existing buildings (residential, commercial, industrial, government)
  - **Energy Audit**
- Efficient Products
  - Lighting & Marketplace
  - HVAC
  - Appliance Rebates
  - Appliance Recycling

https://www.nj.gov/bpu/assistance/incentives/

https://www.njcleanenergy.com/

What is your household Carbon Footprint
The average Single family House (SFH)
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 CO2 =
energy usage * emission factor (lbs/unit of energy)

Household Energy use assumptions
2,400 sq ft single family home
Two average fuel economy cars driven the average per 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 hot water heater
1,000 therms per year
Electricity per EIA average central AC and lighting
9,000 kWh per years

Gasoline

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

$3.50/gal * 1,000 gal/yr = $3,500/yr (3.6% annual cost at medium income)

120,000 Btus per gallon = 120 MM Btus

Natural gas

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

$1.30/therm * 1,000 therms/yr = $1,300/yr (1.7%)

100,000 Btu per therm = 100 MM Btus

Electricity

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

$0.18/kWh * 9,000 kWh/yr = $1,6200 (1.7%)

3,412 Btu per kWh = 30.7 MM Btus

Total = 38,010 lb of CO2 / HH or 20 T/HH - $6,420/yr (6.9%)

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

GWH = $1,200
230 therm - 23 million Btus $340/yr emitting 2.3T
HPWH = $2,500
2,000 kWh 6.8 million Btus $330 /yr emitting 0.5T
3 times less energy - Avoiding 1.8 MT of CO2

2,000 kWh /year = 1.5 kilowatts (kW) of solar
@ $3/W = $3,330 - $990 = $2,310
HPWH + solar = 10.5 years (ROI 9.5%)
Avoiding 2.3 T of CO2

Reducing natural gas demand in electric and heating sectors
A major advantage is you can store your solar electricity in the HPWH

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

MM Btu is a million Btus

Used EV for under $20,000 (+ $2,000 - level 2 charger)
50 miles RT for 260 days (5 day work week)

An average ICE vehicle
520 gal/ yr - 60.3 MM Btus -$1768/yr.

An average EV
3,900 kWh /yr - 13.3 MM Btu - $644/yr.
4.5 times less energy - 2.7 times less cost
Savings $1,124/yr. avoiding 3.74 MT of CO2

3,900 kWh / year - 3.5 kilowatts (kW) of solar @$2/watt SPB for EV and solar 15 yrs. (ROI 6.7%) - after 4.3 years driving on "free" fuel
Avoiding 4.62 MT of CO2
Reducing both gasoline and natural gas demand and emissions and storage solar electricity