100% Clean Renewable Electricity for New Mexico

FIGHTING CLIMATE CHANGE 350 NEW MEXICO

Webinar for Turner Conference On 100% Clean Renewable Energy

Sept 1, 2017

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Webinar Summary

- **Part 1** is the presentation used at the Sept 1, 2017 interim committee on Economic and Rural Development, "Moving New Mexico towards 100% clean renewable energy"
- **Part 2** is a deep dive into the model and calculations used to generate the conclusions, charts and tables in part 1. How much to build, what does it cost, how much do we save in fuel, etc.

Clean Renewable Energy Means Economic Growth for New Mexico

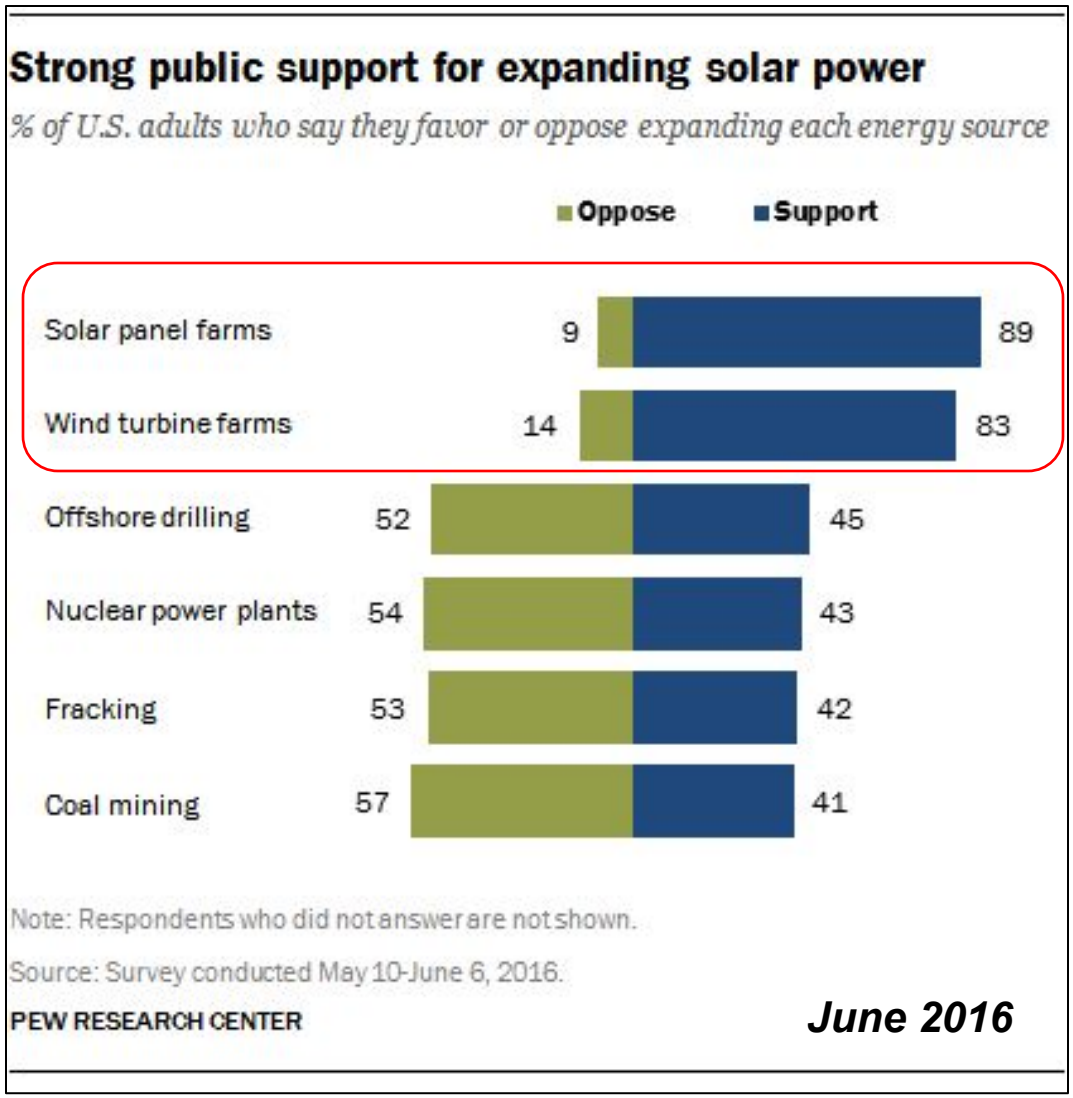
- New Mexico needs to **revive our economy**, help preserve a **livable climate** and make the state a **healthier** place to live.
- How? A bold new Renewable Portfolio Standard (**RPS**) for electricity.
  - Current RPS maxes at 20% by 2020. Extend to 100%
- The electricity RPS has **NO IMPACT on oil** jobs or oil revenue, since **oil is not used** in NM to generate electricity. <7% NM nat. gas for electricity.

Why

100% Clean Renewable Energy?

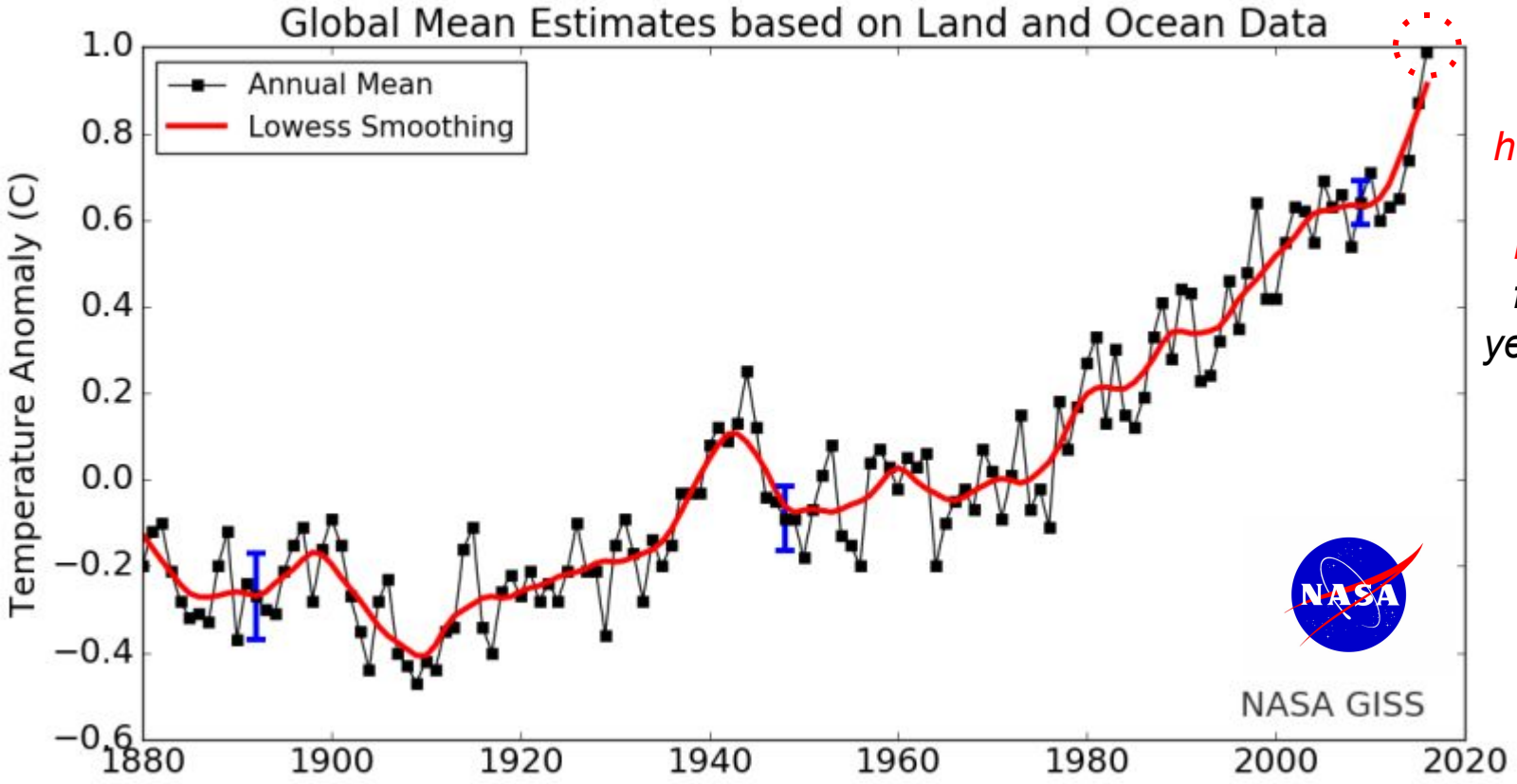
86% Support More Clean Energy

- **HUGE** majorities support expanding Solar and Wind energy, **by 7:1**
  - Bipartisan support includes 75% of Trump voters
- And strong majorities <u>oppose</u> expanding fossil fuel and nuclear energy.



http://www.pewresearch.org/fact-tank/2016/10/05/americans-strongly-favor-expanding-solar-power-to-help-address-costs-and-environmental-concerns/

Warming is Happening Now



2016:

The new hottest year ever recorded, for the 3rd year in a row

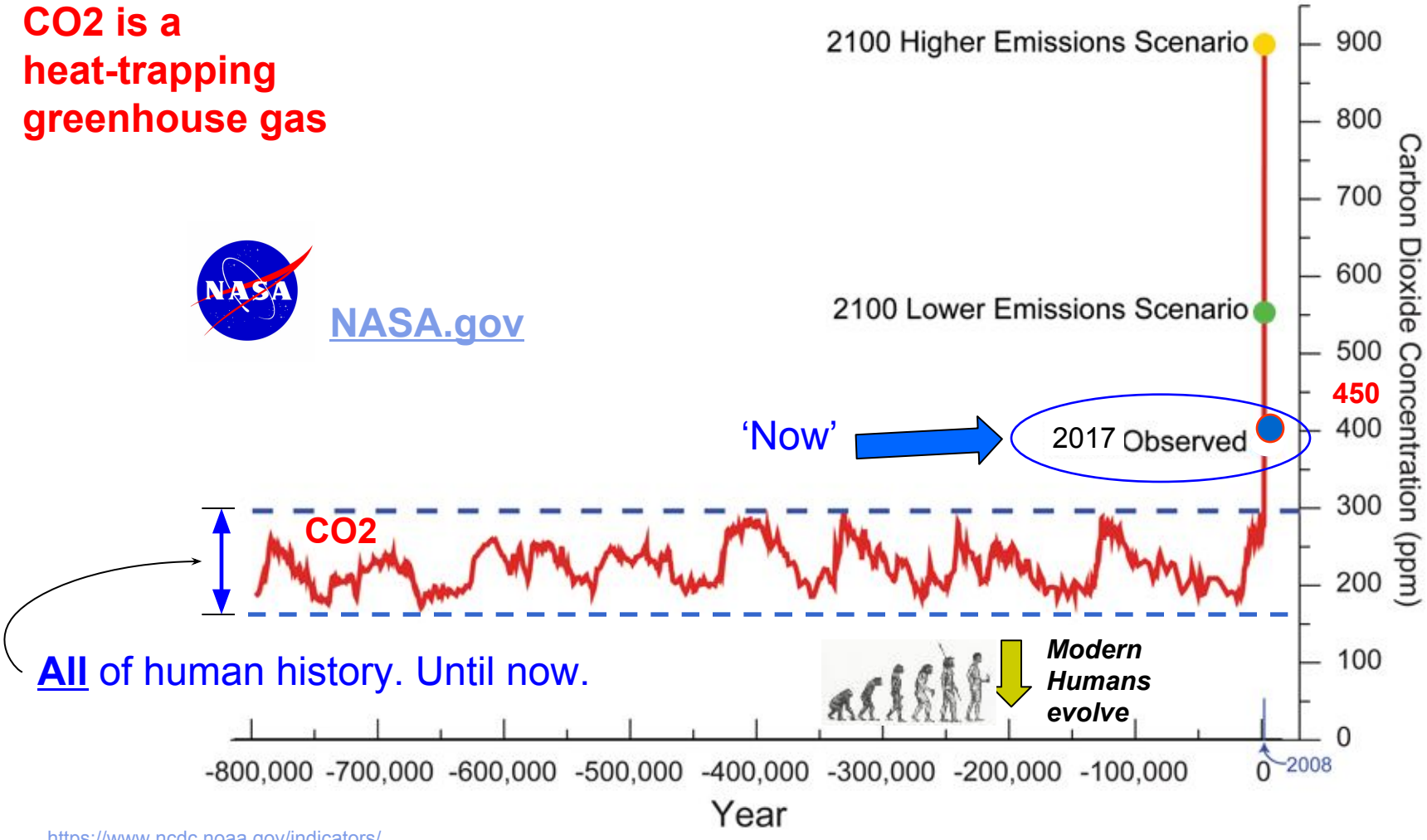
- **2016 – The warmest year on record, by far**
  - https://www.sciencedaily.com/releases/2017/01/170118112554.htm/

http://data.giss.nasa.gov/gistemp/graphs/

CO2 Levels: Higher Now Than Any Time in Human History

CO2 is a heat-trapping greenhouse gas

NASA.gov



https://www.ncdc.noaa.gov/indicators/

http://climate.nasa.gov/key_indicators
https://scripps.ucsd.edu/programs/keelingcurve/

Our Current Path: 450ppm by ~2035

450ppm CO2 is cited as driving dangerous 2.0C warming

450

Ice–core data before 1958. Mauna Loa data after 1958.

CO2

Latest CO_2 reading
May 02, 2017

408.50 ppm

Dr. Hansen's limit

CO_2 Concentration (ppm)

400
350
300
250
200

1750 1800 1850 1900 1950 2000

Dr. Charles Keeling 1928-2005

SCRIPPS INSTITUTION OF OCEANOGRAPHY
The Keeling Curve

450

2035

Impacts Are Being Felt Now

http://climate.nasa.gov/interactives/climate-time-machine

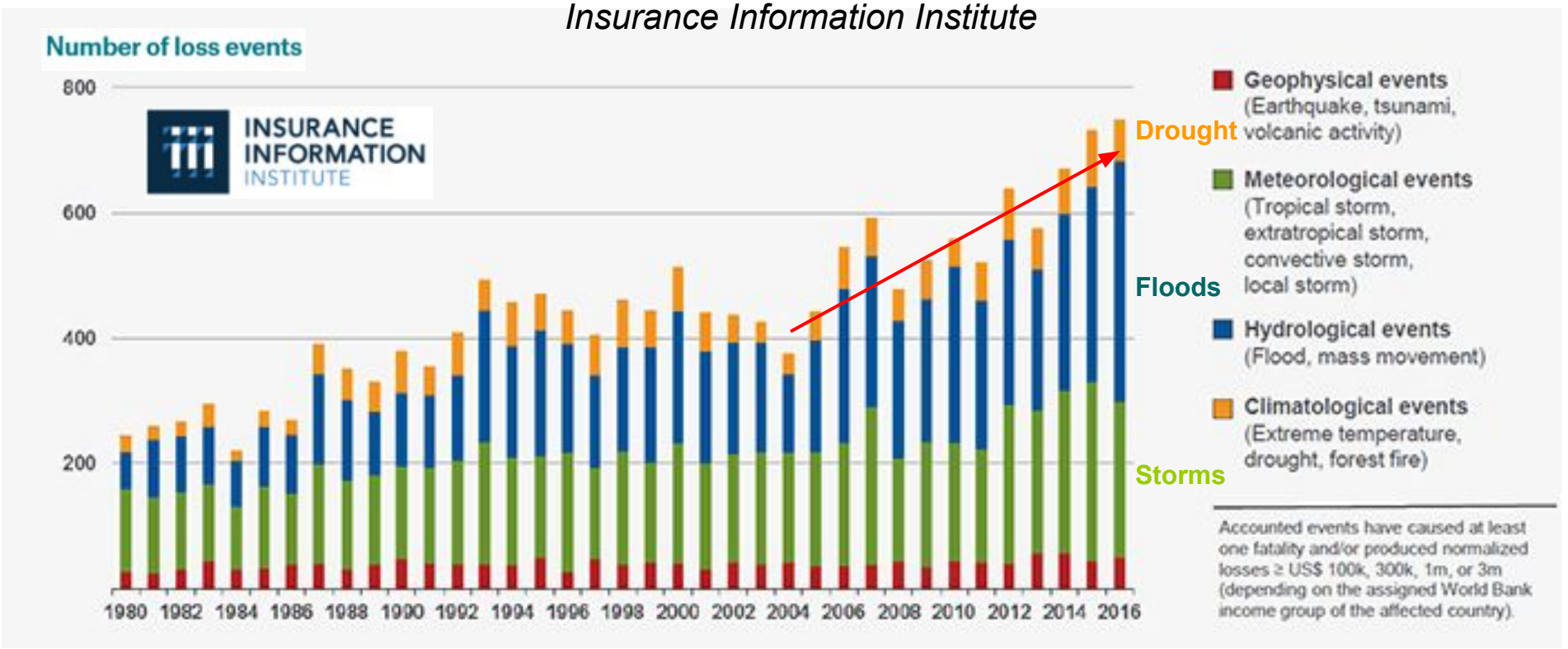
Superstorm Harvey Aug 2017

Houston, TX

Climate Disasters Up 3X Since 1980

Number Of World Natural Catastrophes, 1980-2016

Insurance Information Institute



Source: © 2017 Munich Re, Geo Risks Research, NatCatSERVICE.
Insurance Information Institute http://www.iii.org/fact-statistic/catastrophes-global

Global Food Shortages, Then Famine

Worst Case Timing

Year / °C warming	% Loss in Crop Yields
2020's / 1°C	-10%
2040's / 2°C	-30%
2050's / 3°C	-40%
2060's / 4°C	-60%

Tyndal says 4C by 2050

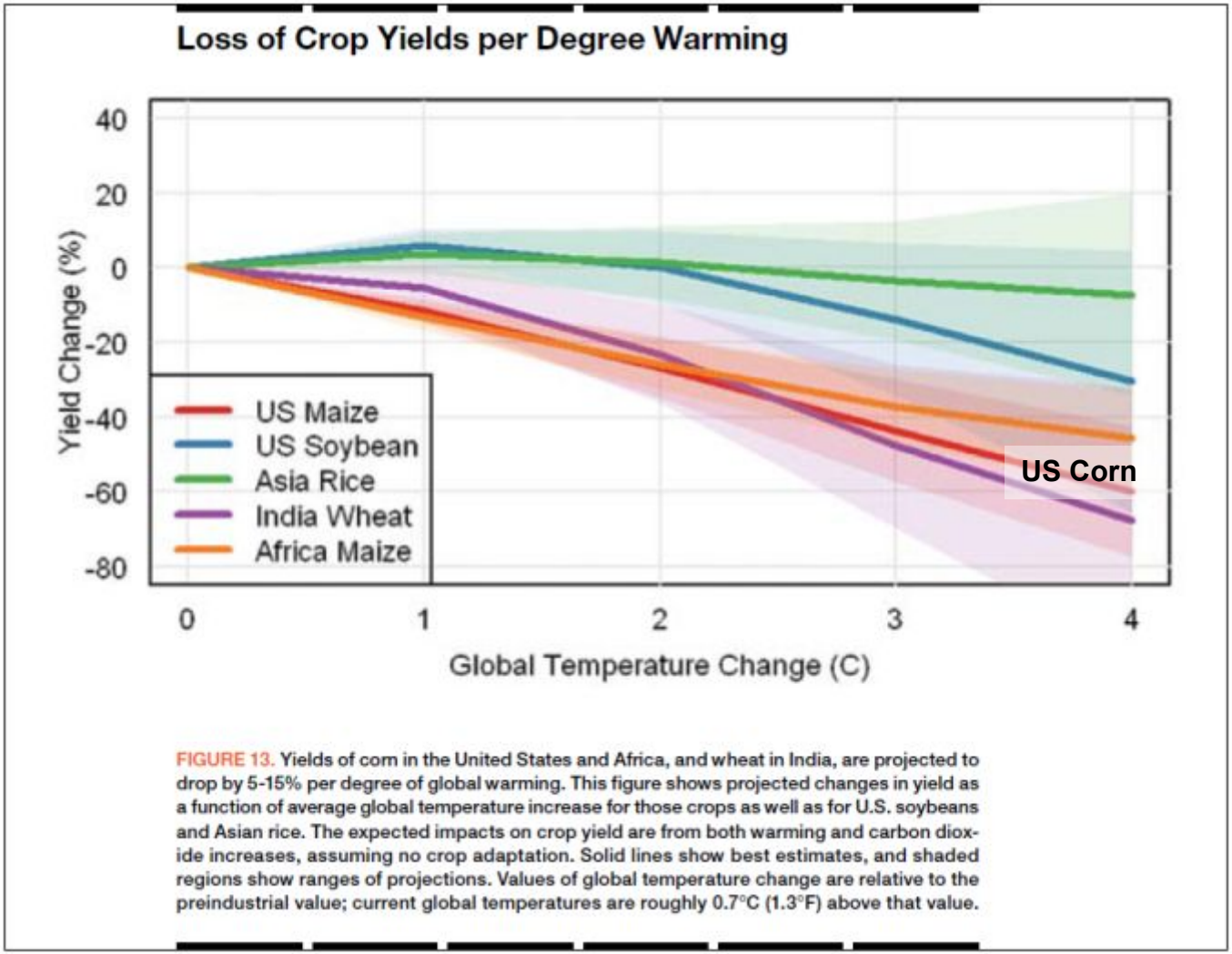


FIGURE 13. Yields of corn in the United States and Africa, and wheat in India, are projected to drop by 5-15% per degree of global warming. This figure shows projected changes in yield as a function of average global temperature increase for those crops as well as for U.S. soybeans and Asian rice. The expected impacts on crop yield are from both warming and carbon dioxide increases, assuming no crop adaptation. Solid lines show best estimates, and shaded regions show ranges of projections. Values of global temperature change are relative to the preindustrial value; current global temperatures are roughly 0.7°C (1.3°F) above that value.

***Source*: The National Academy of Sciences –**

Warming World: Impacts by Degree 2011

Future Warming, by Degree

Worst case, if we don't rapidly change course

Decade	Warm-ing °C	% Loss in Crop Yields	Commentary
2020's	**+1°C**	-10%	2x-4x worse wildfires, drought in SW, coastal flooding
2030's	**+1-2°C**	-20%	Major food shortages (corn, wheat); coral reefs dying; increasing extreme weather. **Miami 1m underwater.**
2040's	**+2°C**	-30%	Most summers hotter than 2003 EU **heat wave**. 30% species risk extinction. Mountain **ecosystems dying**. 4x-8x worse **wildfires**. Pervasive drought in sub-tropics. **Extensive starvation**.
2050's	**+3°C**	**-40%**	40%-70% species extinction. Amazon & boreal forest dieback. Decline in all cereal crop yields in Africa. Release of CO2 and methane from permafrost, tripling from 1.5C. **Wars. Mass starvation.**
2060's	**+4°C**	**-60%**	**Game over**. Ecosystem supports <1 billion people. Climate likely past tipping points for further warming.

Read more in New York Magazine, July 9, 2017. **The Uninhabitable Earth**

From: National Academy of Sciences, 2011, the US National Climate Assessment, 2014 & UK Met office

What Must We Do Instead?

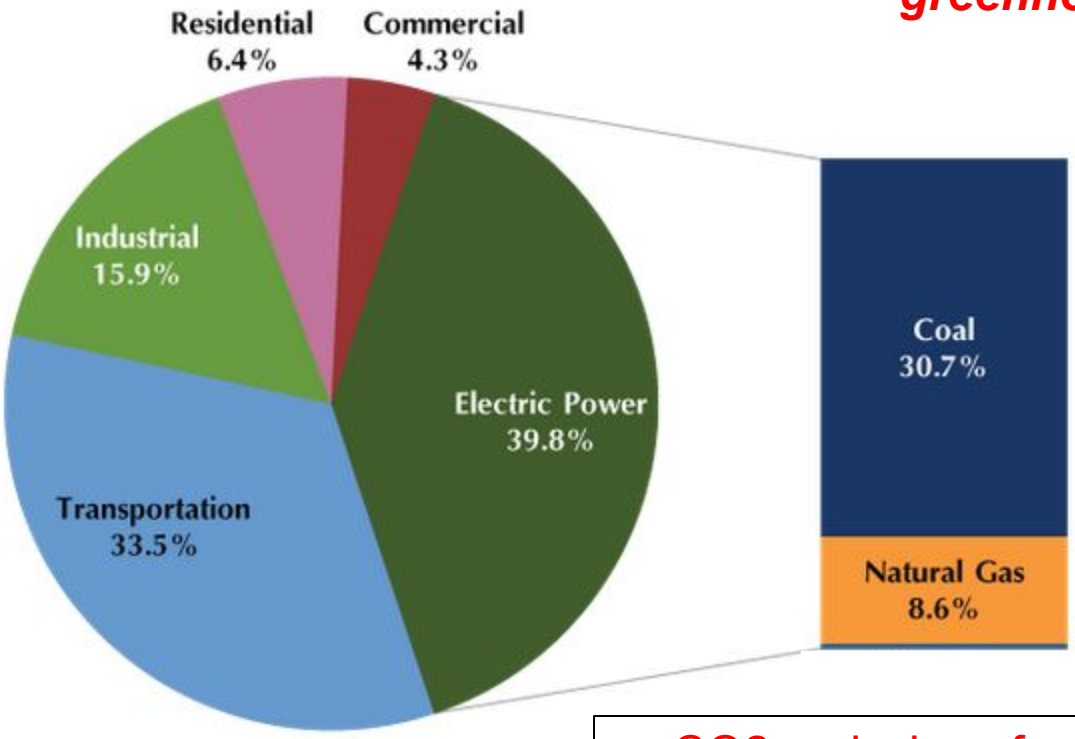
Urgently **mobilize**
to **convert** our energy system
from **fossil fuels** to
carbon-free renewables.

Priority 1: Renewable Electricity

CO2 Emissions in the US

CO2 is a heat-trapping greenhouse gas

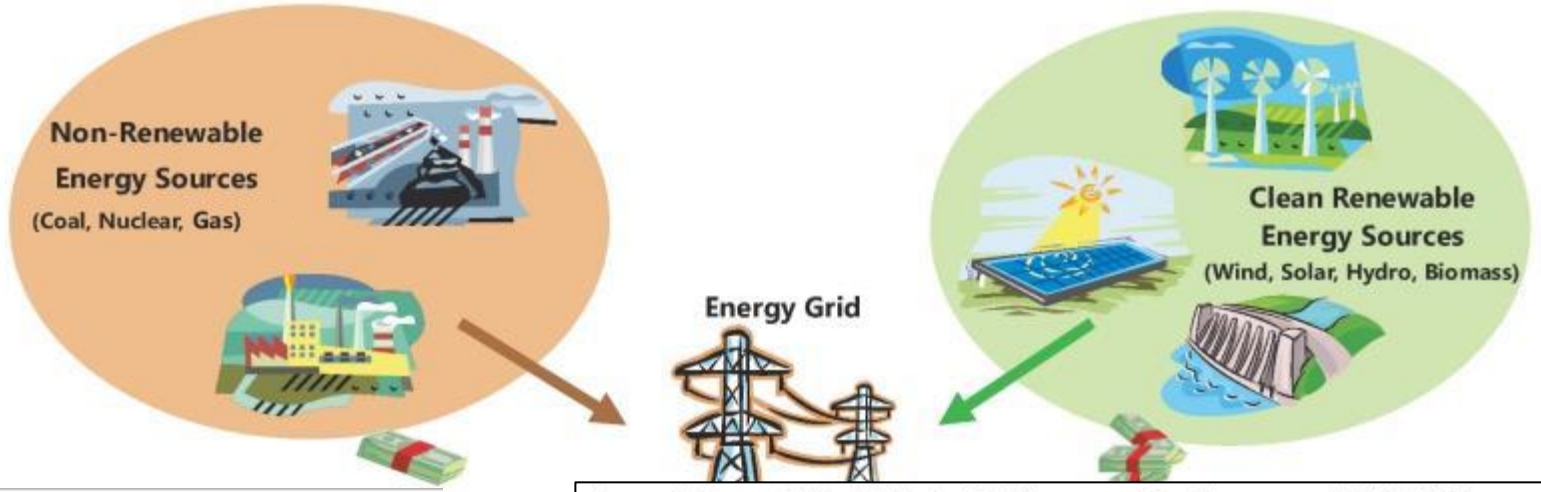
Figure 1: 2013 U.S. CO2 Emissions

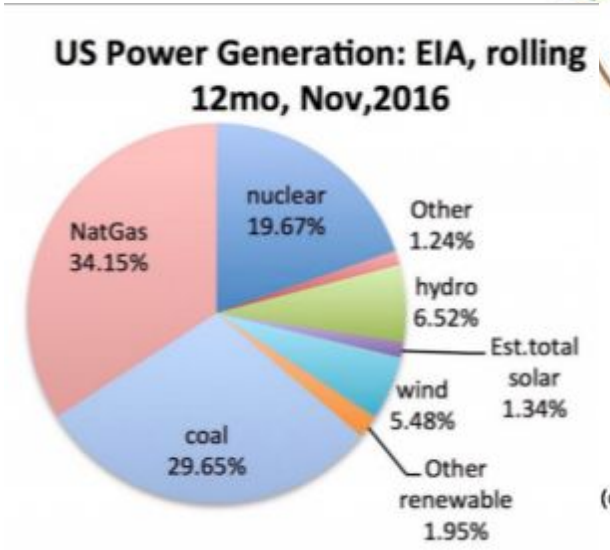


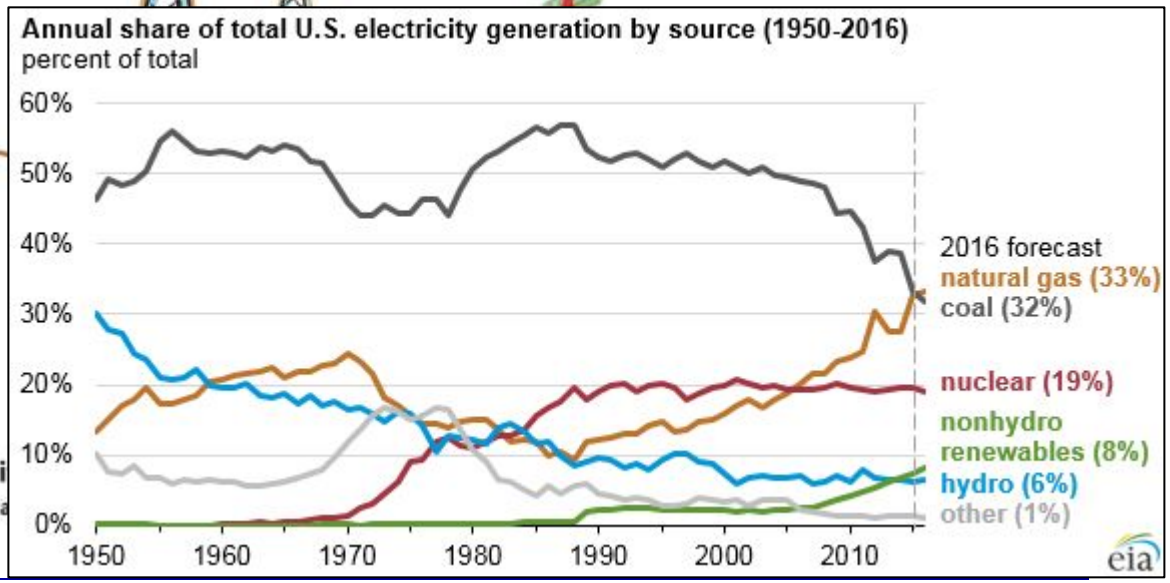
Source:
US Energy Information Administration

- CO2 emissions from fossil fuels must **cease worldwide** by 2050 if we hope to avoid catastrophic global warming of 1.5-2.0°C.
- The #1 source of CO2 emissions is **burning coal and natural gas** to generate electricity.

Where Does Electricity Come From?

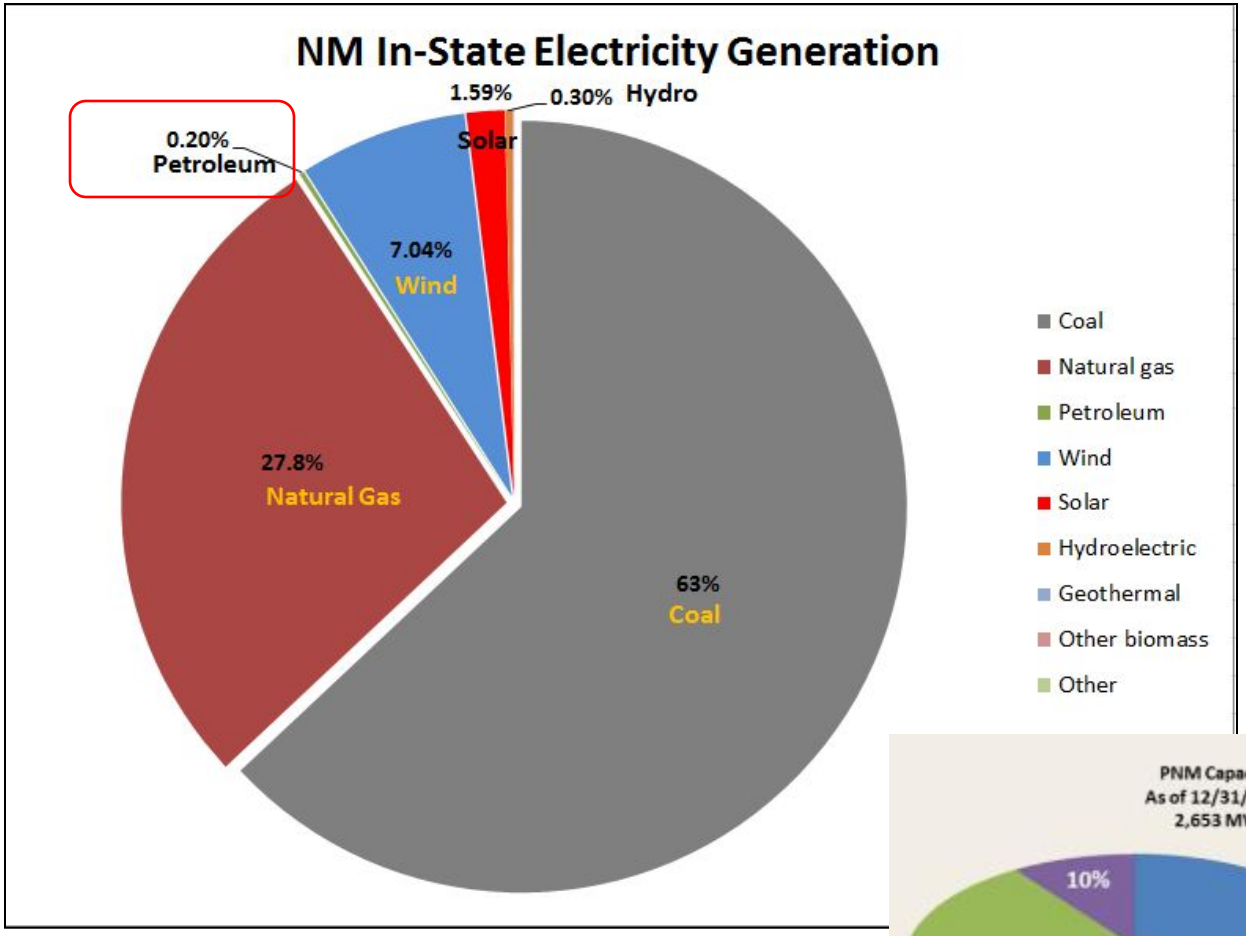




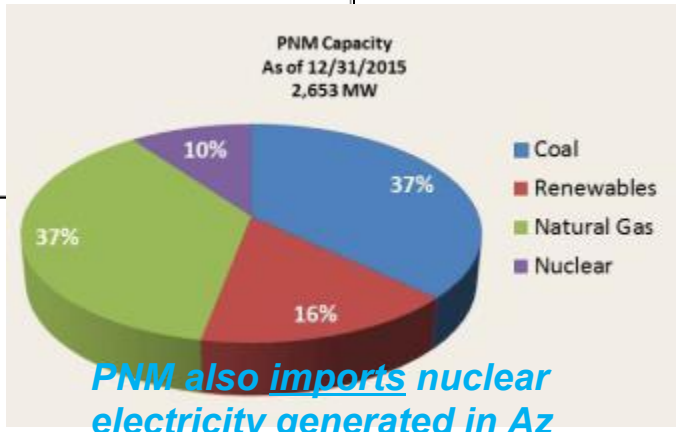


https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

NM Electricity Generation by Source



- **63% coal, 28% natural gas.**
- 0.20% from petroleum



PNM also imports nuclear electricity generated in Az

Amend the NM 'Renewable Energy Act' for 100% RPS

- Current RPS requirements peak & hold in 2020 at 20%
- The proposed schedule keeps the RPS increasing to reach 50% by 2030, towards 100% by 2050.

Current law

Year	RPS
2020	20%
2025	35%
2030	**50%**
2035	65%
2040	**80%**

3% per year

- Then 2% per year 2040 to 2050
- SB312 was a 2017 bill for 80% by 2040.
  It passed the Senate Conservation comm.

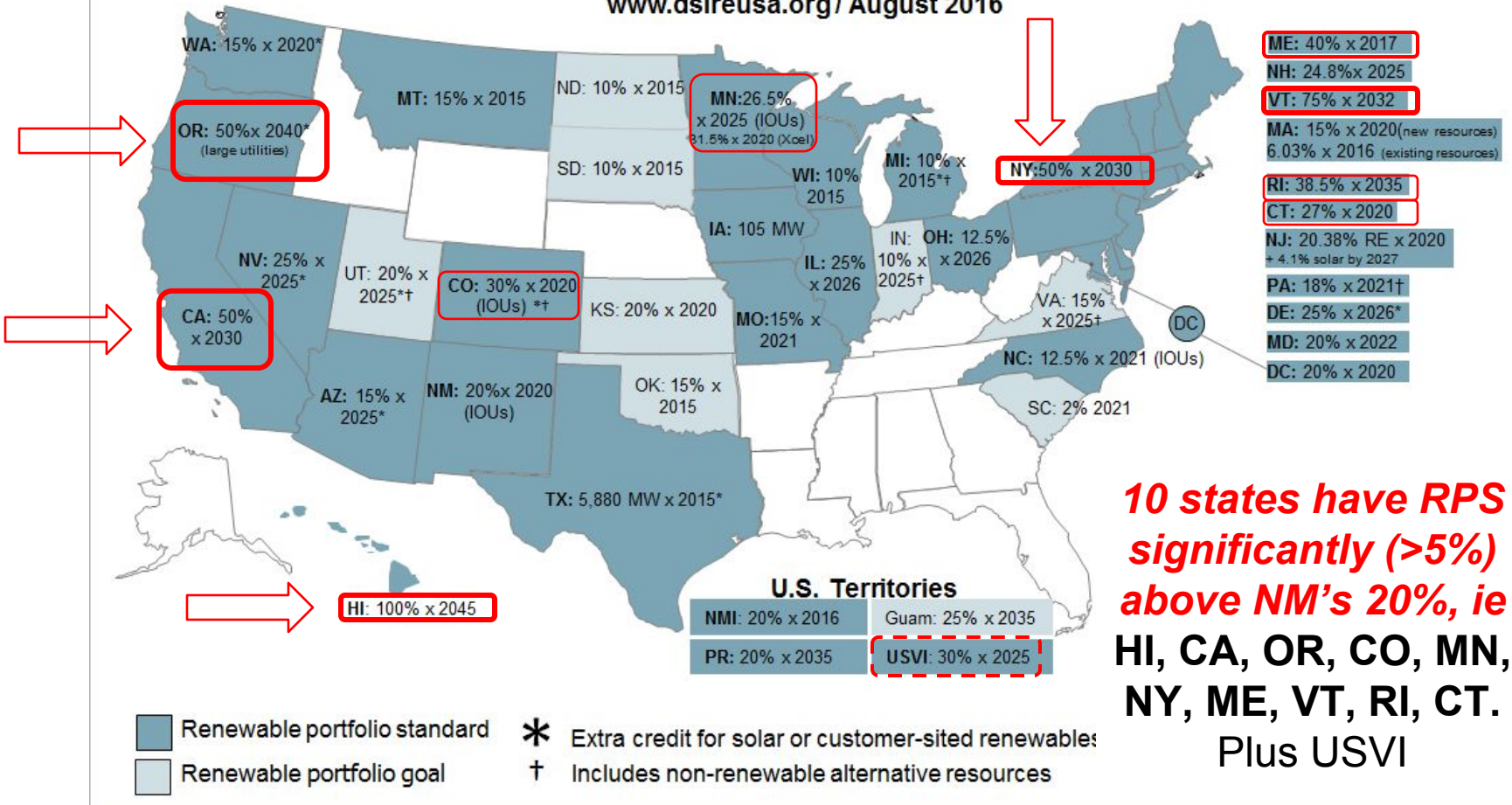
https://ilsr.org/rule/renewable-portfolio-standards/2569-2/

Ten States Have Better RPS Policy Than NM

DSIRE® | NC CLEAN ENERGY TECHNOLOGY CENTER | U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Renewable Portfolio Standard Policies

www.dsireusa.org / August 2016

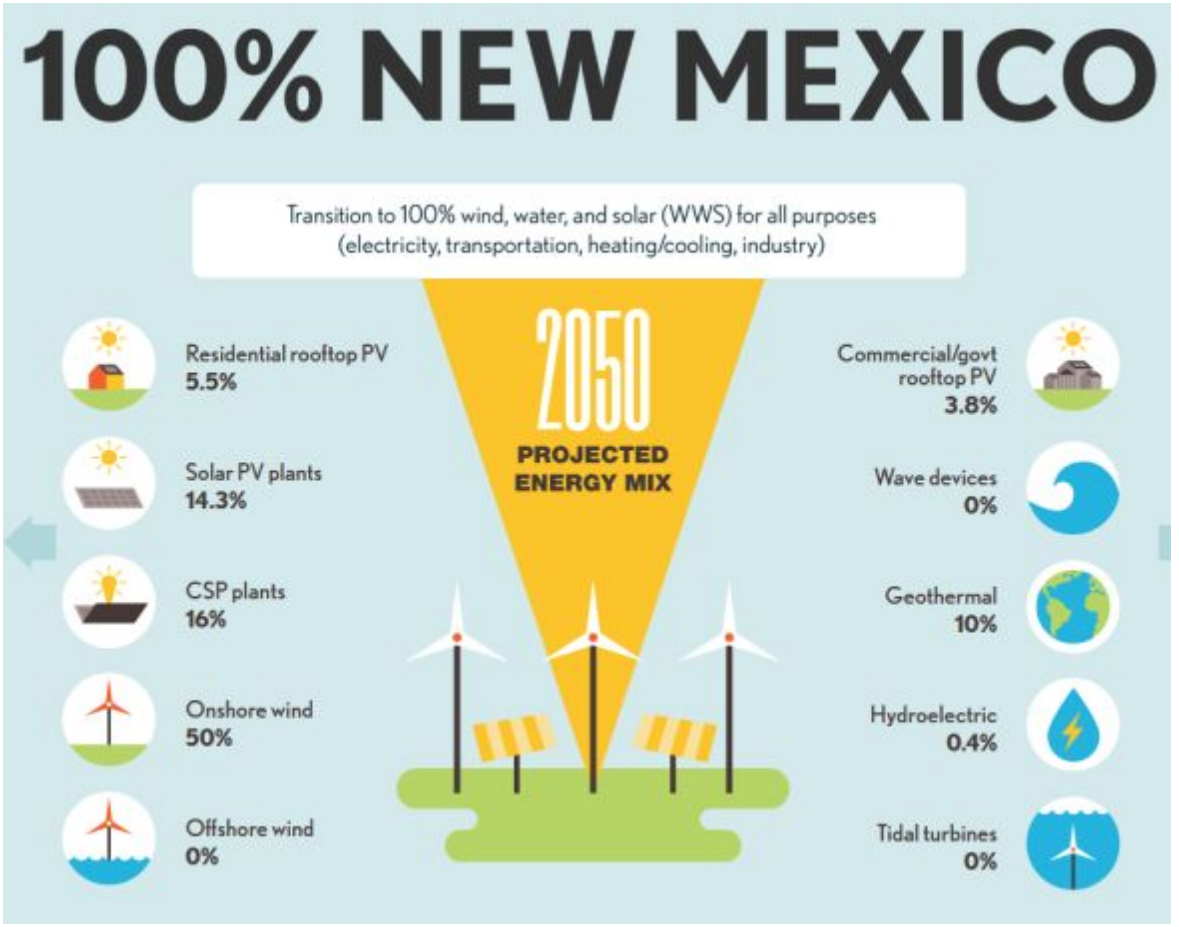


10 states have RPS significantly (>5%) above NM's 20%, ie **HI, CA, OR, CO, MN, NY, ME, VT, RI, CT.** Plus USVI

Energy Mix: 100% Renewables

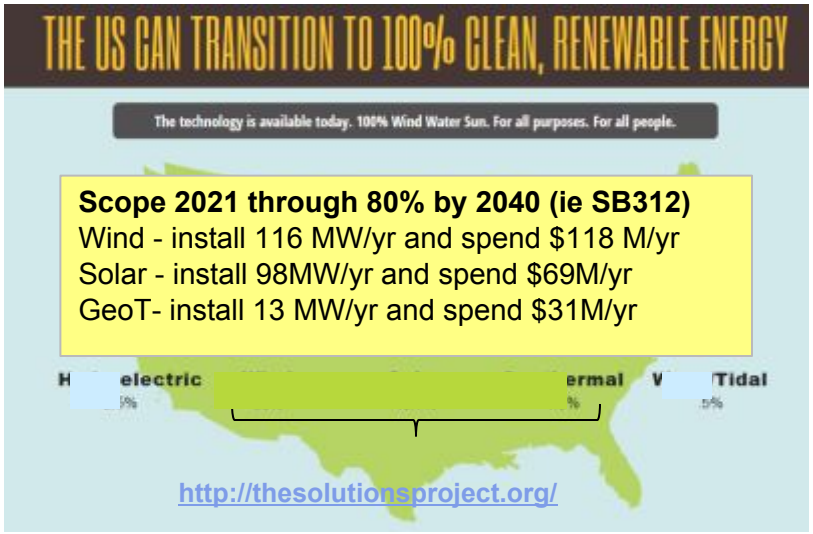
A 100% Renewable Energy Mix for NM:

- **50% Wind**
- **40% Solar** (39.6%)
  - 30.3% utility scale
  - 5.5% residential
  - 3.8% comm / govt
- **10% Geothermal**
- Recommended by Stanford University based each state's native resources.



Energy mix for NM as recommended by published analysis for all US States, from ***Stanford University*** *www.thesolutionsproject.org.*

Summary:
What to Build to Reach 100% RPS



For **30 years**, (2021-2050), NM would **install** on avg **200 MW/year**:

Clean Renewable Energy	# MW /yr	Cost /yr	Power / unit
 Solar Panels	103 MW	$51 M	300 W
 Wind Turbines	87 MW	$101 M	5 MW
 Geothermal Plants	10 MW	$26 M	10 MW
Yearly Total:	200 MW	$178 M	

- This will supply the 23M MWh consumed within our state

2016 electricity revenue was $1.9B for Utilities + Co-ops. $178M is 9%

Why it will work

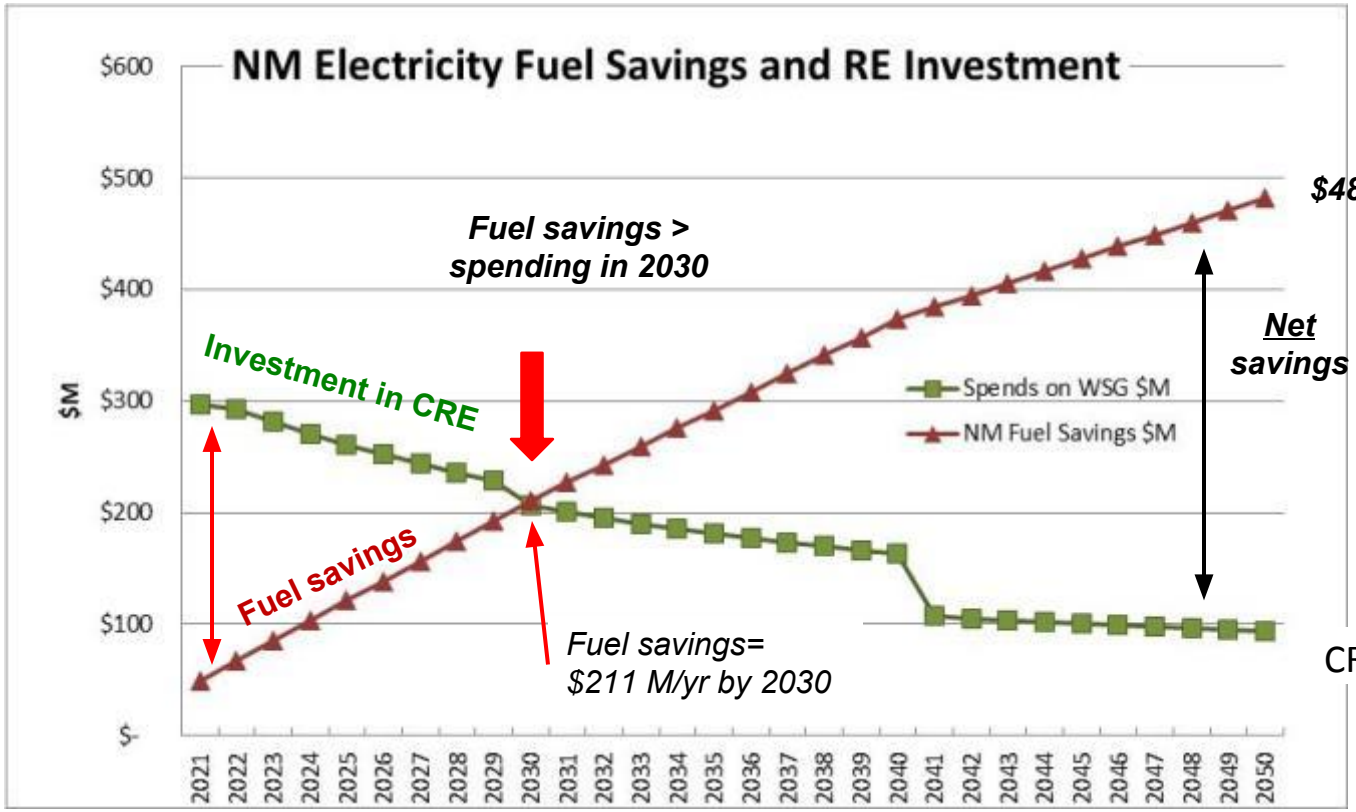
- Old power plants must be replaced as they age. NM's aging coal plants average **40 yrs old**. The RPS helps NM be pro-active, replacing them with clean renewables at zero fuel cost
- Utilities will do the major investment, plus cities, businesses & homeowners. Renters too, if we pass 'community solar'.
- Electricity costs will ultimately drop as we convert to zero-fuel electricity
- Known & **predictable fixed costs** for electricity reduce investment risk for companies moving into NM.
  (no fuel = no fuel price increases)
- We leverage NM's **natural advantages**: available **land, wind, sun, geothermal**, and an underemployed **workforce**

NM Fuel Savings Pay for Investment

Net CRE costs avg $127M thru 2030.

But consider: the SJGS maintenance budget in 2013 was $40M. Plus $10 /yr for capex. Plus costs of pollution controls, etc

2016 electricity revenue was $1.9B



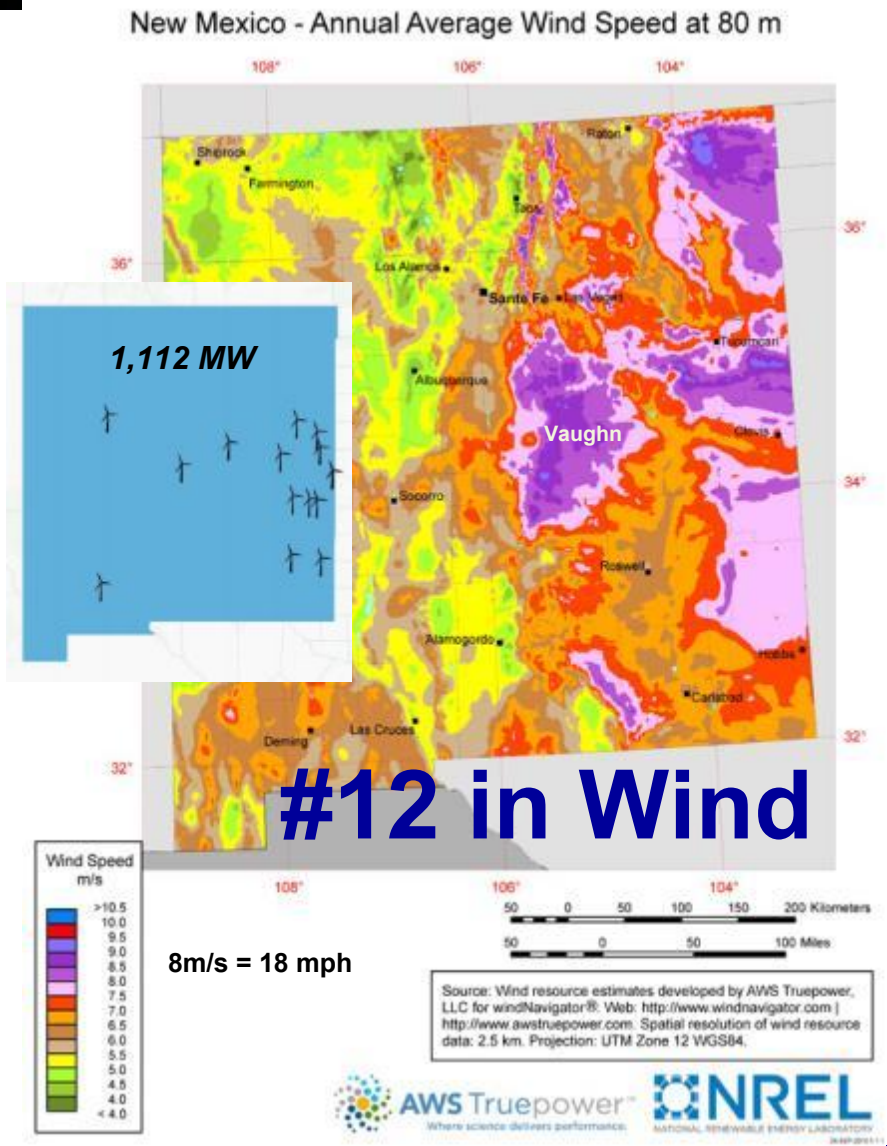
- New Mexico spends $482M/year on coal & gas **fuel** to generate electricity
- For every **10%** we add to CR Energy, we **save $48M**/year on fuel.
- **Fuel savings pay for all investment after 2030.** Until then, net CRE investments average $127M/yr. And savings increase every year.
- So after we reach 50% by 2030, fuel savings pay for all new RE investment.

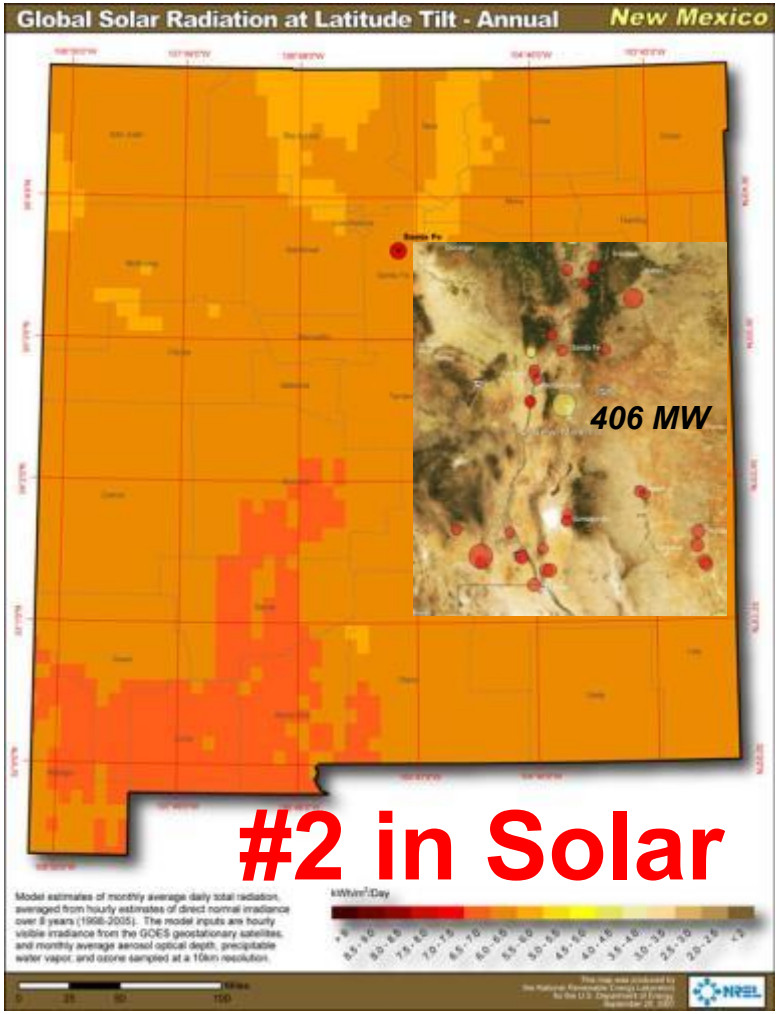
**WSG= wind, solar & geothermal*

The Benefits It Will Bring

- **Jobs of the future** in a growing economic sector, replacing jobs of the past.
- Plus:
  - Cleaner air & water
  - Less water consumption
  - Healthier New Mexicans (less emphysema, asthma, etc), with fewer deaths and lower health care spending. Medicaid is ~31% of the NM state budget
  - Helps stop climate change

New Mexico's Great Wind & Solar





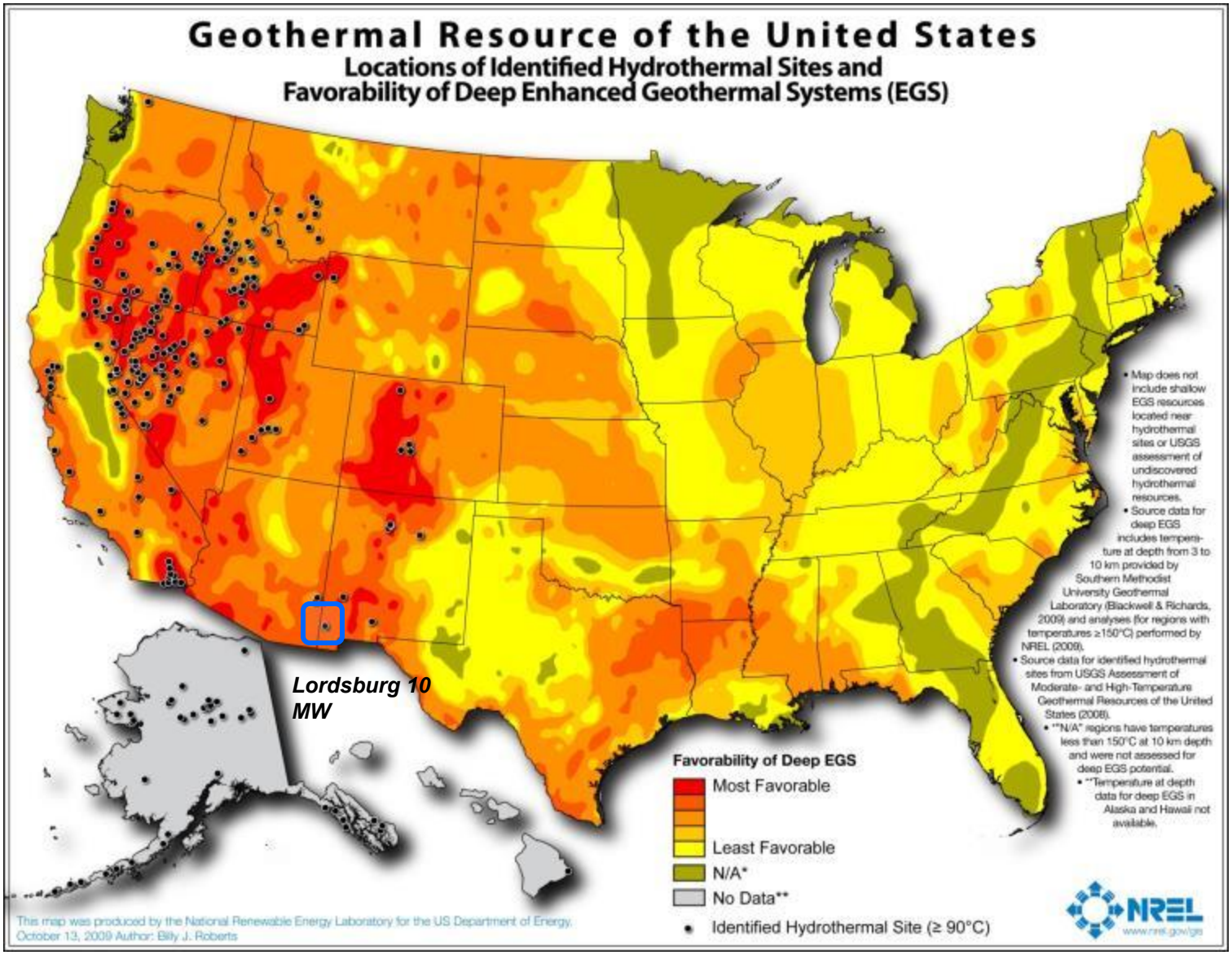
http://www.seia.org/map/majorprojectsmap.php
http://www.seia.org/state-solar-policy/new-mexico

US Geothermal Resource Map

Per the USGS: Geothermal power plants are currently generating 2,500MW in six states: Alaska, California, Hawaii, Idaho, Nevada, and Utah. The electric power generation **potential** from identified geothermal systems is **9,057 Megawatts-electric (MWe), over 13 states.**

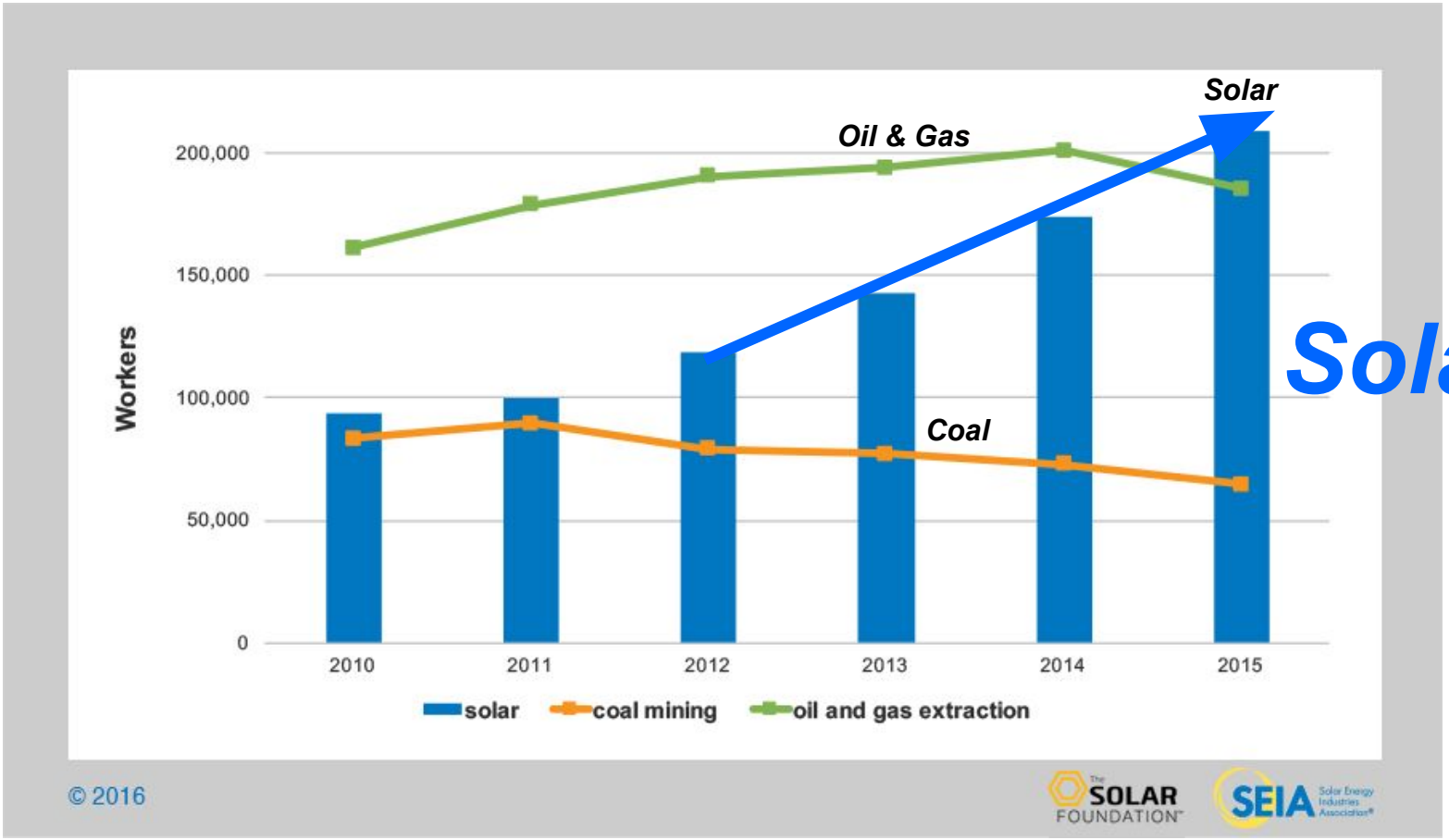
The mean estimated power production potential from undiscovered geothermal resources is **30,033 MWe**.

Additionally, another estimated **517,800 MWe** could be generated through implementation of technology for creating geothermal reservoirs in regions characterized by high temperature, but low permeability, rock formations.



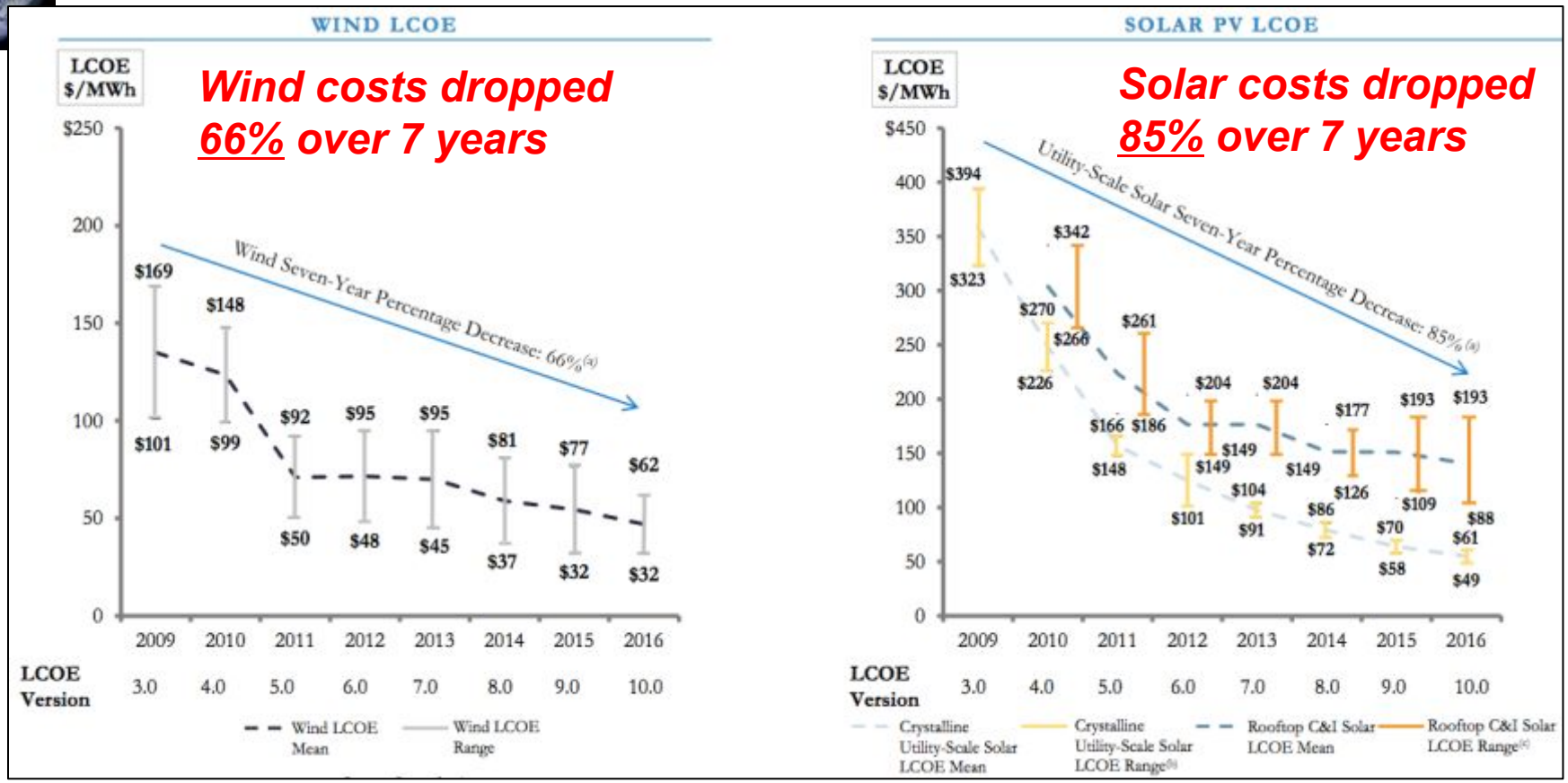
US Solar Jobs Are Booming

Nearly 209,000 Americans work in solar >double the number in 2010, at more than 9,000 companies in every U.S. state.
By 2020, that number will double to more than 420,000 workers.



http://www.seia.org/research-resources/solar-industry-data

Wind & Solar Costs Dropping



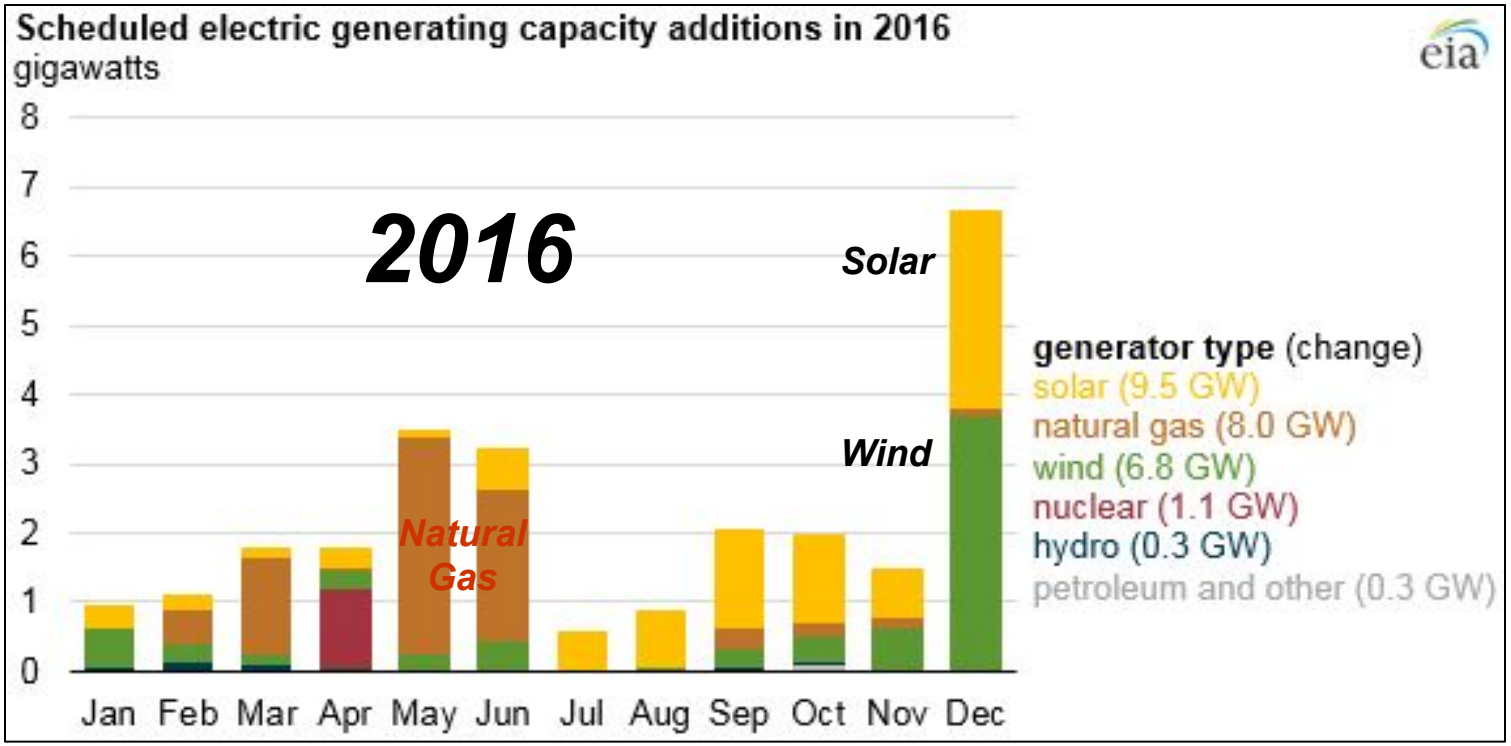
Source: Lazard

- "On an LCOE* basis, onshore wind is the cheapest form of electricity; utility-scale thin-film solar PV is the second cheapest." – *Lazard Investments & Banking*

https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-100/

*LCOE = levelized cost of energy

63% of New US Power from Solar & Wind



- The EIA reported the US added 26 GW of electric generating capacity in 2016. **63% from Solar + Wind**.
  - 9.5GW Solar + 6.8GW wind
- 2016 will be the first year in which utility-scale solar additions exceed additions from any other single energy source.

https://cleantechnica.com/2016/12/19/solar-wind-natural-gas-account-2016-electricity-generation-additions/

NM Solar Industry Has 2,929 Jobs

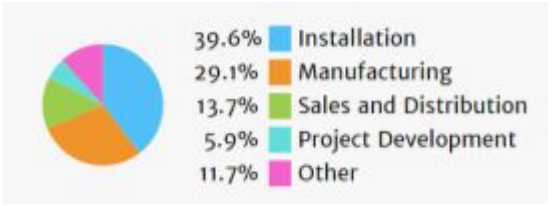
CNN Money

American Opportunity

Solar jobs growing 17 times faster than US economy

by Matt Egan @mattmegan5

May 25, 2017: 4:20 PM ET



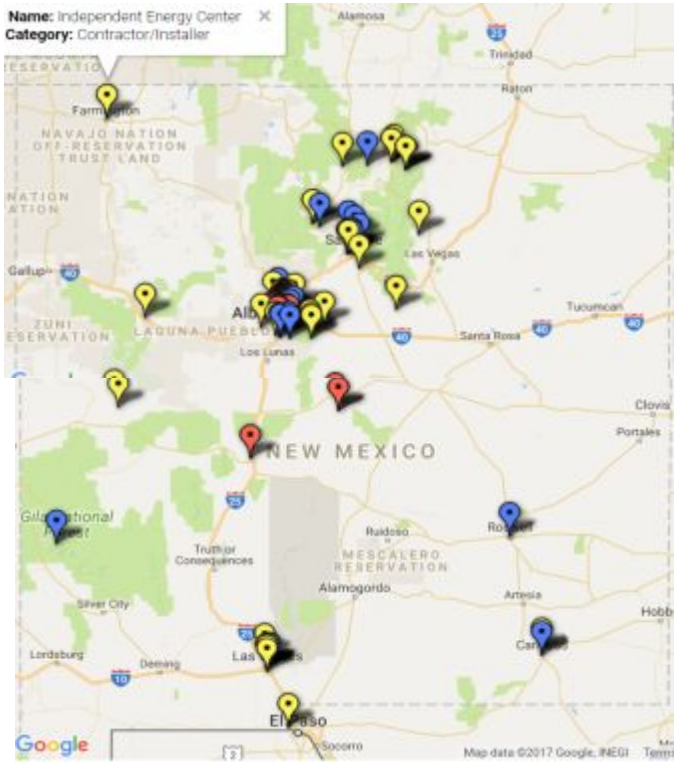
- The Solar Foundation reported that in 2016, New Mexico has:
  - **76** Solar companies
  - **2,929** solar industry jobs, a growth rate of **54%** in one year.
  - Installers median wage of **$20** per hr*

New Mexico

2,929	Solar jobs
1,160	Installation jobs
851	Manufacturing jobs
401	Sales and distribution jobs
172	Project development jobs
344	Other solar jobs
76	Total solar companies
26	Solar patents (2010 – 2015)

State Solar Worker Demographics

Women	45.4%
African-American	6.9%
Latino or Hispanic	33.0%
Asian or Pacific Islander	10.4%
Veterans of the U.S. Armed Forces	8.6%



http://www.seia.org/state-solar-policy/new-mexico

** 2015 data*

http://www.thesolarfoundation.org/solar-jobs-census/

By Extending RPS, NM Should Add >1000 Solar Jobs

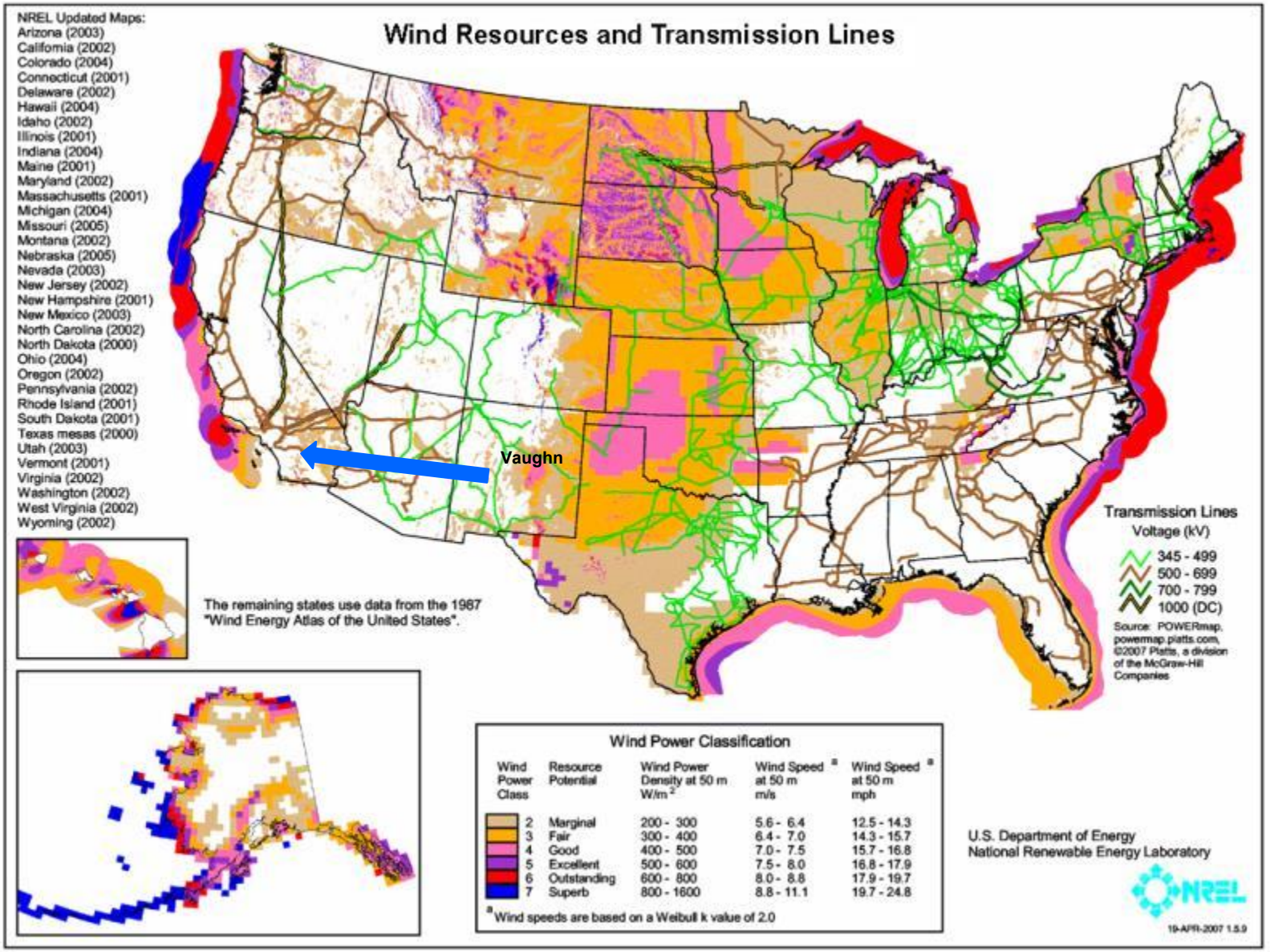
- In 2015 New Mexico had 1,899 solar workers, supporting that year's installation of **56 MW/yr**.
  - That's 34 workers per MW/yr.
- The new RPS should double that install rate to **116 MW/year**. So the NM solar workforce must double from 2015, to about 3,900.
- This **adds 1,000 jobs** just for solar. We'll need these workers by 2021.
  - Then **add even more jobs** by installing more solar for **export**. And more still, with a solar **Gigafactory**.

http://www.thesolarfoundation.org/wp-content/uploads/2016/01/TSF-2015-National-Solar-Jobs-Census.pdf

US Wind Power Resource Map

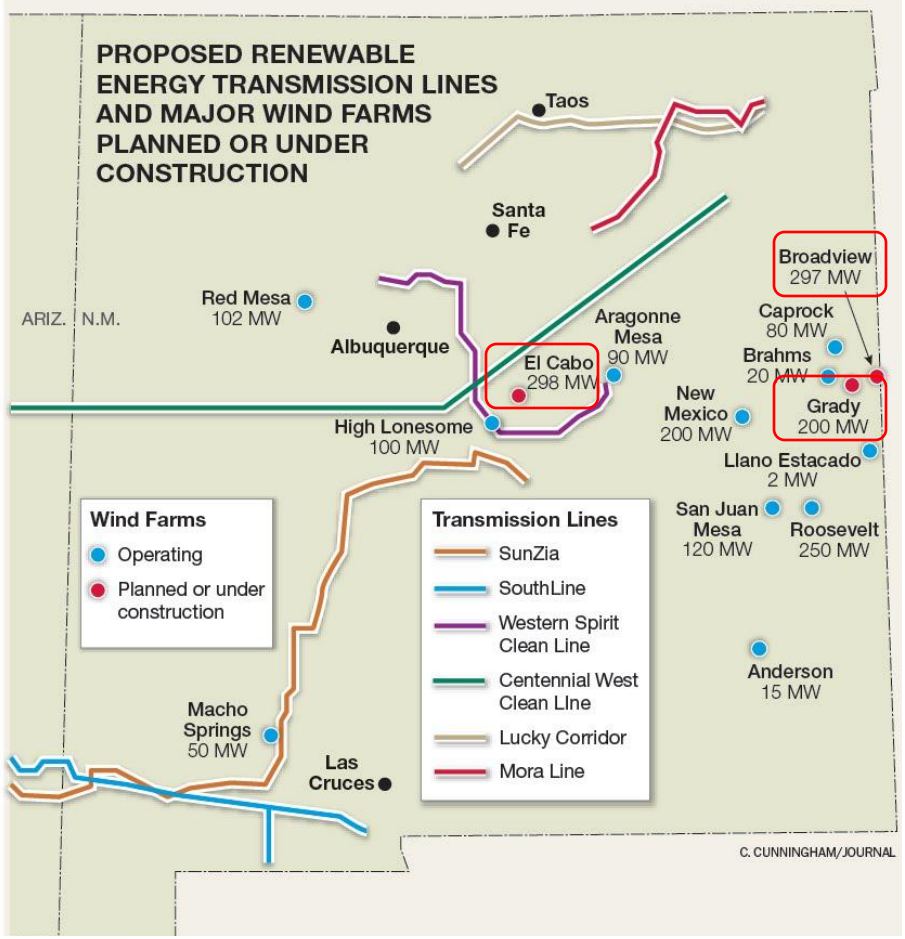
NM is the closest windy state to California

CA needs more wind but will have to import it.



New Wind Projects 2016-2017 And New Transmission

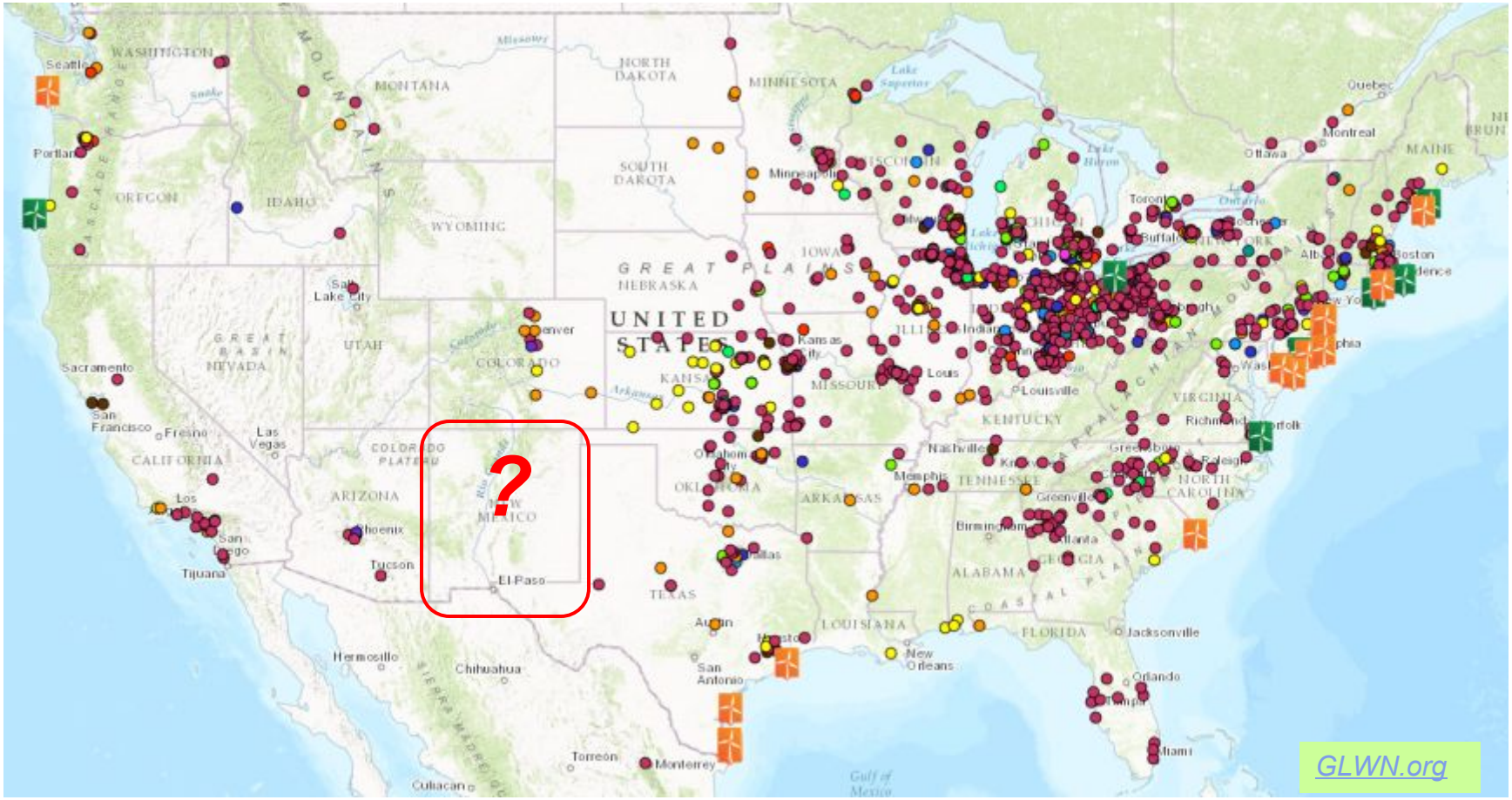
- **Big wind new projects:**
  - El Cabo 298 MW
  - Broadview 297 MW
  - Grady 200 MW
- **Three major export transmission lines:**
  - Centennial West Clean Line
  - SunZia
  - SouthLine



Dec 27 2016 https://www.abqjournal.com/915514/gust-of-windgenerated-energy-sweeping-toward-nm.html

US Wind Turbine Manufacturing

But New Mexico is <u>one of only three states</u>
with <u>no</u> wind turbine manufacturing.



Building: towers, blades, generators, gearboxes, hubs, nacelles, etc

http://energy.gov/eere/wind/wind-manufacturing-and-supply-chain
http://energy.gov/sites/prod/files/2014/09/f18/U.S.%20Wind%20Energy%20Manufacturing%20and%20Supply%20Chain%20Competitiveness%20Analysis_0.pdf

Kit Carson: Renewables Save $50M

Seeking more renewables, Kit Carson Co-op exits relationship with Tri-State G&T

Renewable Taos Study

June 2016 **"30% Solar by 2022"**

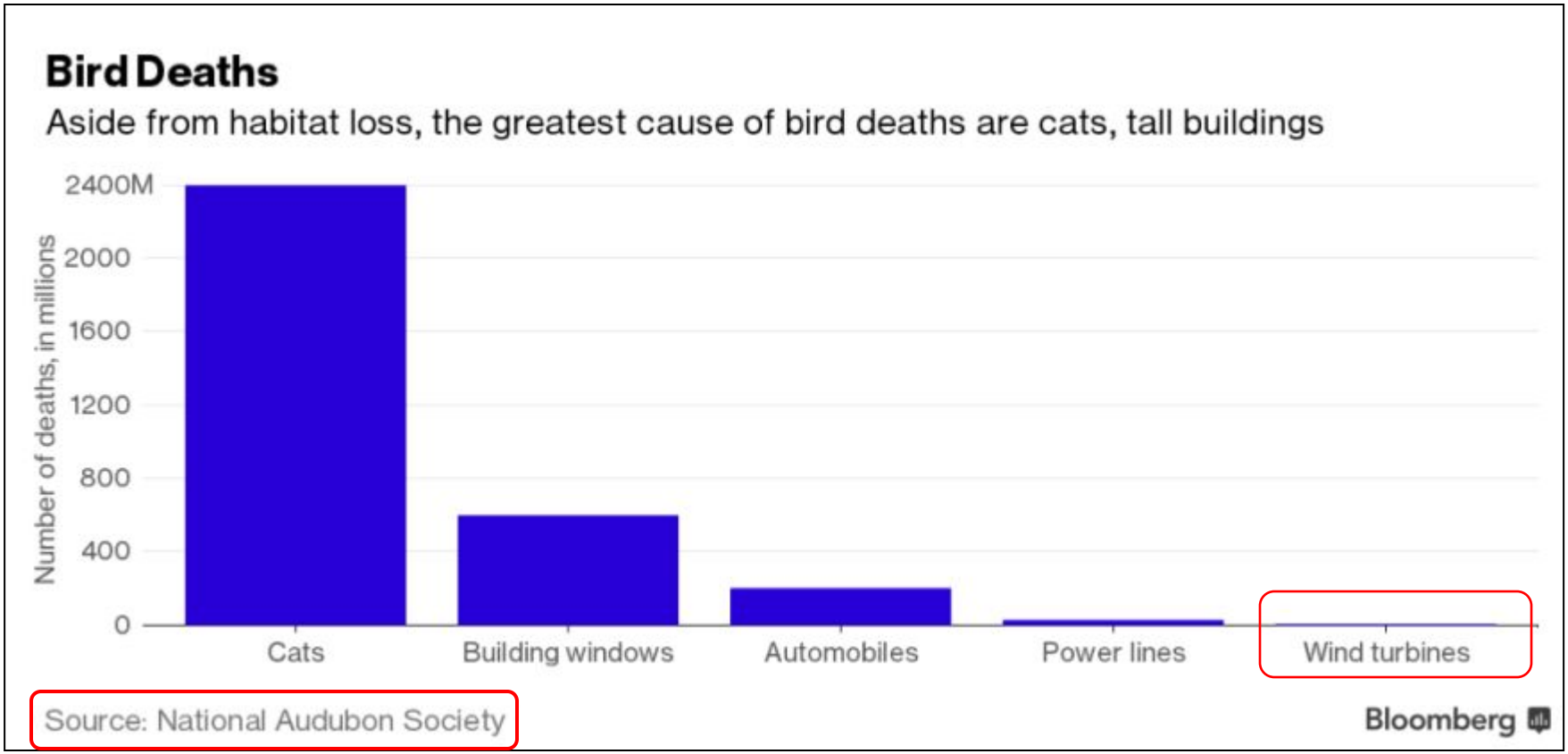
- Kit Carson Electric Cooperative in New Mexico has **exited its agreement with the Tri-State Generation** and Transmission Association and is entering a long-term deal w **Guzman Renewable Energy Partners** of Florida.
- Kit Carson Electric says the switch will **save its 30,000 customers $50 million** over the term of the 10-year agreement.
- 30 MW of solar arrays to be built from May 2017-**2022**, when locally generated solar energy will supply around **30 percent of Kit Carson's total electricity demand**, and 100 percent of its needs during daylight hours on sunny days. Solar production will exceed electricity demand during peak hours. Land is also being set aside for battery storage.

http://www.kitcarson.com/content/kcec-solar-initiative

Summary

- The clean energy sector is booming worldwide as costs have dropped to make solar and wind the **cheapest sources of new energy**.
- NM has **world-class** Solar, Wind & Geothermal resources ready to develop – but to win, **we must strengthen NM's RPS policy**.
- **Let's spark a NM investment boom in clean energy**, bringing **thousands of good jobs –** by committing our state to clean renewable electricity: 50% by 2030 & 100% by 2050.
  - And remember - electricity RPS has **NO IMPACT on oil** jobs or oil revenue. Oil is **not used** in NM to generate electricity; <7% uses nat. gas.

Cats Kill 10,000x More Birds Than Wind



- Study: fossil fuel power plants **kill 35 times more birds** per GWh than wind turbines

RPS Benefits

NREL NATIONAL RENEWABLE ENERGY LABORATORY

BERKELEY LAB

2016 Report by US Dep of Energy*:

- **Health:** In the 'High RE' case, the health benefits of these reduced emissions are estimated for the US to be **$558 billion** on a present-value basis (or 5.0¢/kWh-RE).
- **Water use:** Cumulatively (2015-2050), each MWh of RE serving existing RPS represents average **savings of 3,400 gallons of water** withdrawal and 290 gallons of consumption, **down 18%.**
  - NM uses 23M-MWh of electricity
- Plus jobs increase and fuel use drops.

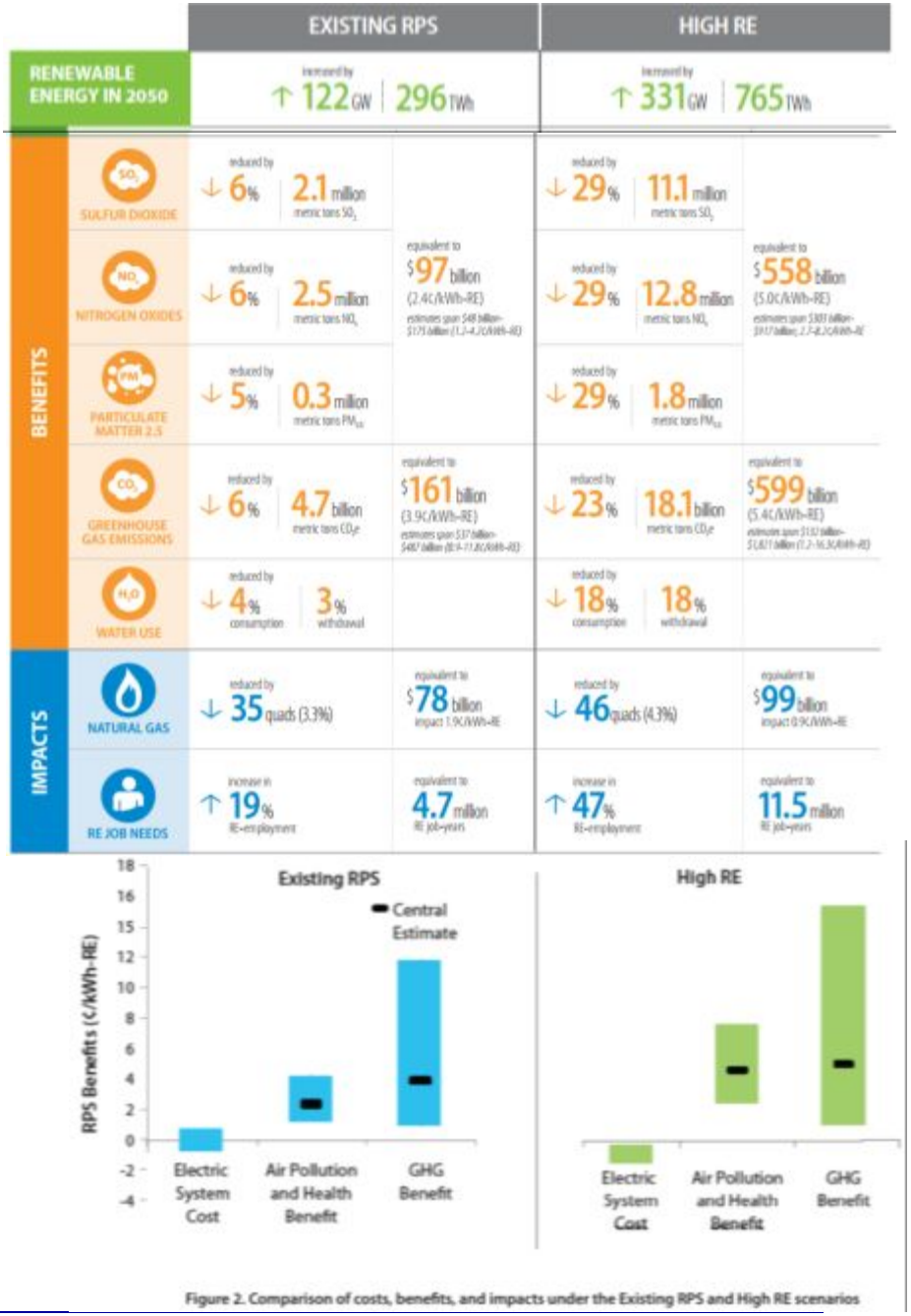


Figure 2. Comparison of costs, benefits, and impacts under the Existing RPS and High RE scenarios

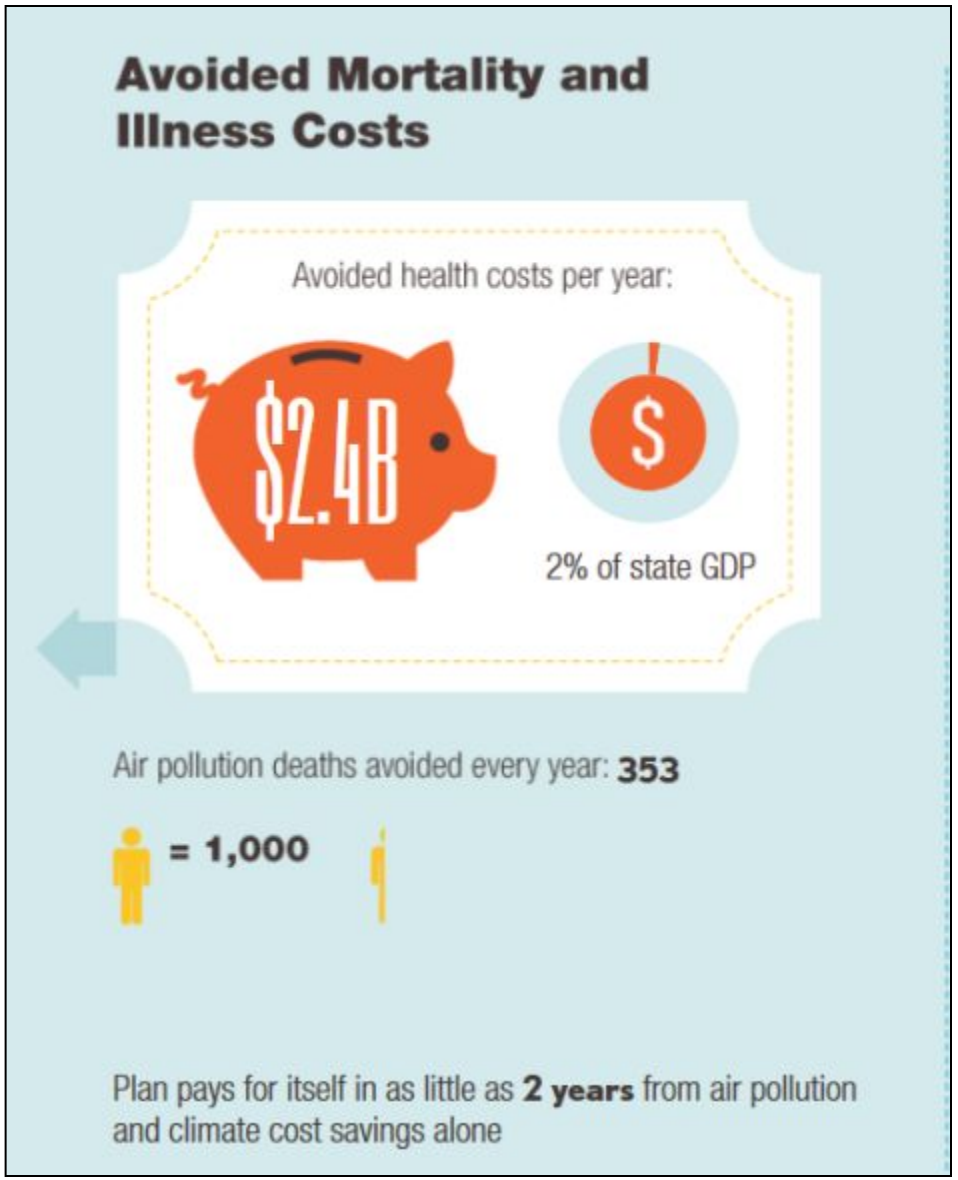
* https://emp.lbl.gov/sites/default/files/rps_fact_sheet_final.pdf

Abq 25% Solar by 2025

- The Abq City Council approved 25% Solar electricity for city buildings ‘by 2025’. After analysis, vote was 9-0. O-17-42
  - Financed w $52M in CREB low interest bonds
  - Funding for first 50% of projects (12 for $25M & 998KW) was approved June 2017, now in RFP. All projects cash positive from year 1. R-17-207
  - Saves the city money. 6 yr payback
  - Project completion expected within two years
- Sen. Heinrich’s office: city toolkit on-line Q3’17
  - Contact Katie Richardson

New Mexico Health Savings

- 353 fewer deaths per year from air pollution
- $2.4B /year saved in avoided health costs



http://thesolutionsproject.org/infographic/#nm

FIGHTING CLIMATE CHANGE

350 NEW MEXICO

Find 350NM:

On Facebook: 350 New Mexico
On the Web: www.350NM.org
On Twitter: @350NM
On Instagram: @350NewMexico
The national site: www.350.org

- **350 New Mexico** is the **New Mexico** chapter of 350.org. We're an **international** grassroots organization building a **global movement to fight climate change**.

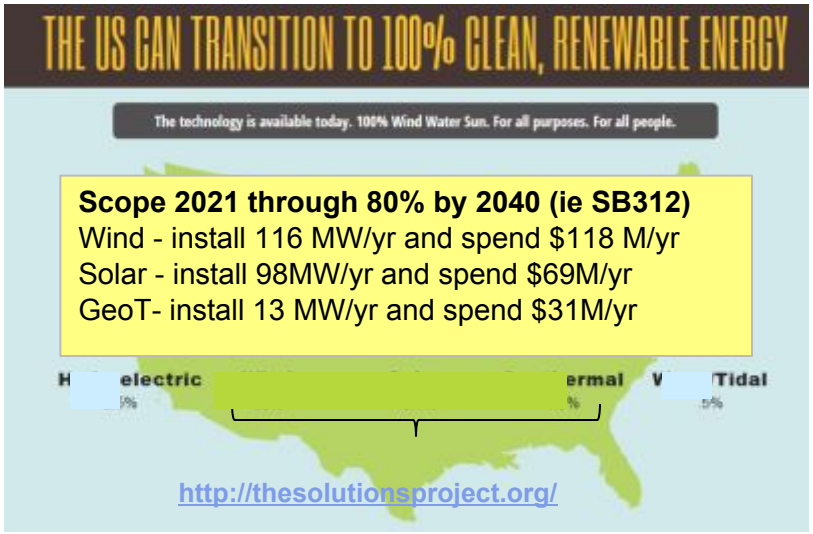
- **Our work:** We seek an urgent and 'just transition' of New Mexico's energy economy from fossil fuels to **100% clean renewable energy**, in time to prevent global warming of 1.5-2.0°C. We work to:
  - Convert electricity generation to 100% renewable energy before 2050, with 50% by 2030
  - Keep 80% of fossil fuels in the ground
  - Educate the public on the urgency of acting on climate, with plans to do so
  - Promote sustainable practices and work in coalition with like-minded groups

Webinar Pt 2: 100% CRE Model

Webinar: Explaining the Models

- How does the NM **100% CRE model** calculate:
  1. **How much to build** of nameplate capacity for solar, wind & geothermal generation?
  2. How much it will **cost?**
  3. How much is the **fuel savings**?
  4. What % of NM **natural gas production** goes to electricity?

Summary:
What to Build to Reach 100% RPS



For **30 years**, (2021-2050), NM would **install** on avg **200 MW/year**:

Clean Renewable Energy	# MW /yr	Cost /yr	Power / unit
 Solar Panels	103 MW	$51 M	300 W
 Wind Turbines	87 MW	$101 M	5 MW
 Geothermal Plants	10 MW	$26 M	10 MW
Yearly Total:	200 MW	$178 M	

- This will supply the 23M MWh consumed within our state

2016 electricity revenue was $1.9B for Utilities + Co-ops. $178M is 9%

Calculating the 100% RPS Build

To generate just the electricity consumed within New Mexico

How much CRE* electric generation capacity needs to be built from 2021-2050? For that we need:

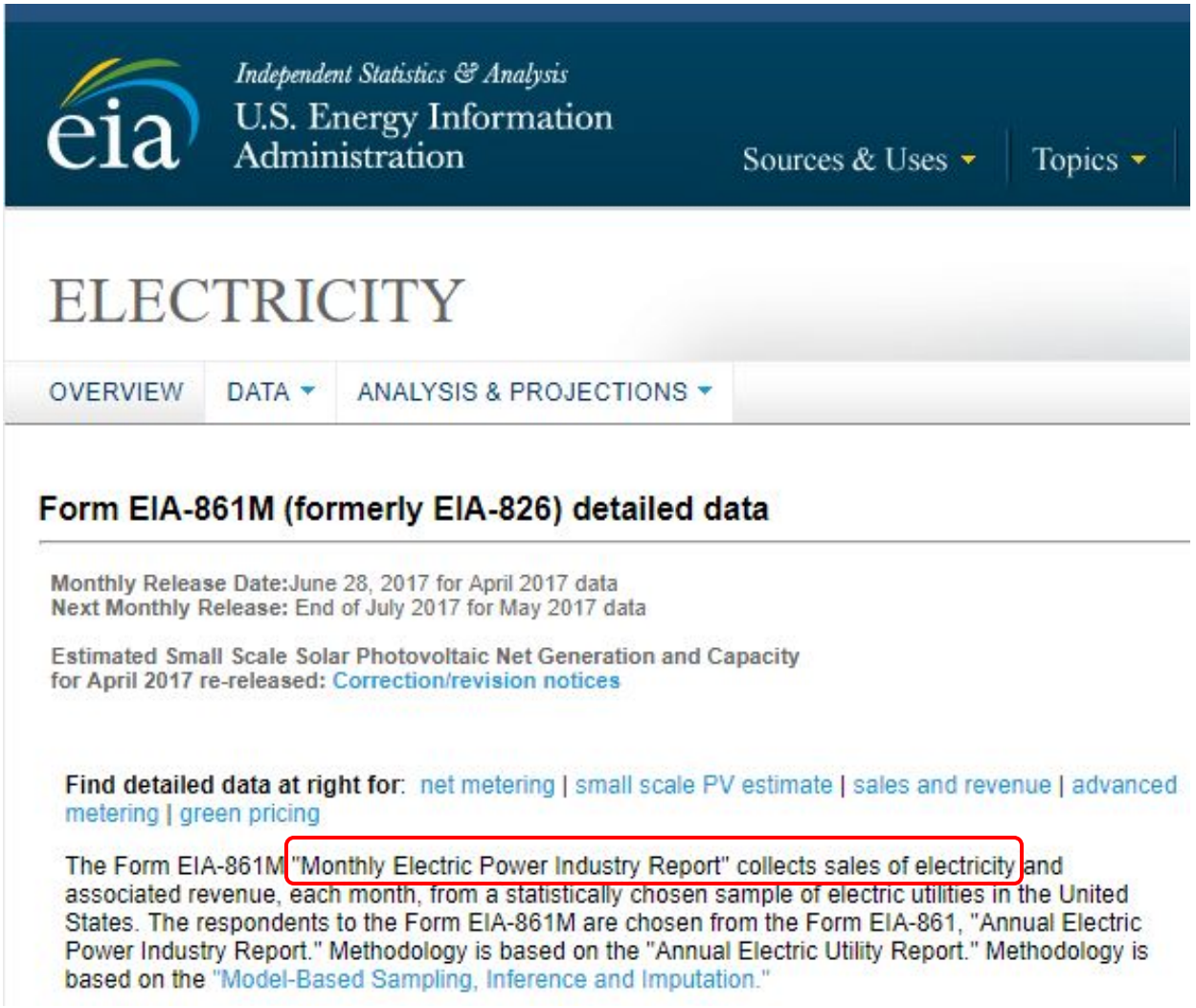
- Load growth assumption 2021-2050 (=flat)
- Electricity sales in NM (=**23M** MWh per EIA)
- Added capacity to cover peaking and storage (+11.59% Jacobson)
- Capacity factors by CRE source, for conversion to nameplate
  - Capacity factors = 45% wind, 30% solar, 90% geothermal
- Mix of CRE sources: (50% wind, 40% solar, 10% geothermal)
- How much CRE will already be built by 2020 (=20%)

NM CRE Power Component	MWh	MW	MW/CF	Cap'y Factr
NM 2014 Avg Pwr +11.59%	25,739,338	2936		
50% Wind	-	1468	3263	45%
40% Solar	-	1175	3861	30%
10% Geothermal	-	**294**	**326**	90%
Total nameplate gen'n			7450	

**CRE = clean renewable energy*

EIA 826: Electricity Sales

Report: EIA-826 Electricity Sales by State and Utility (renamed as 861M)



Electricity Consumption in NM

*Per the US EIA spreadsheet EIA-826, NM electricity sales in 2015 were **23.066 TWh** . Also = **23.066 M MWh***

Utility	MWh	% of NM
PNM total	8,986,090	39%
EPE total	1,651,781	7%
SPS total	5,097,984	22%
IOU utilities ttl	15,735,855	68%
Coop/Muni +Adjs	7,322,750	32%
Solar Bhind mtr	7,385	0.03%
NM total	23,065,990	100%

A similar statistic is published in the US EIA sector risk profile report.

NEW MEXICO STATE FACTS

US Energy Information Agency (EIA)

State Overview
Population: 2.09 million (1% total U.S.)
Housing Units: 0.91 million (1% total U.S.)
Business Establishments: 0.04 million (1% total U.S.)

Annual Energy Consumption
Electric Power: 23.2 TWh (1% total U.S.)
Coal: 14,500 MSTN (2% total U.S.)
Natural Gas: 1,205 Bcf (5% total U.S.)
Motor Gasoline: 20,900 Mbarrels (1% total U.S.)
Distillate Fuel: 14,700 Mbarrels (1% total U.S.)

Annual Energy Production
Electric Power Generation: 36.6 TWh (1% total U.S.)
Coal: 25 TWh, 68% [4.4 GW total capacity]
Petroleum: 0 TWh, 0% [0 GW total capacity]
Natural Gas: 8.8 TWh, 24% [3.8 GW total capacity]
Nuclear: 0 TWh, 0% [0 GW total capacity]
Hydro: 0.2 TWh, <1% [0.1 GW total capacity]
Other Renewable: 2.2 TWh, 6% [0.9 GW total capacity]

Coal: 22,500 MSTN (2% total U.S.)
Natural Gas: 1,220 Bcf (5% total U.S.)
Crude Oil: 85,200 Mbarrels (4% total U.S.)
Ethanol: 600 Mbarrels (<1% total U.S.)

https://energy.gov/sites/prod/files/2016/09/f33/NM_Energy%20Sector%20Risk%20Profile.pdf

http://www.eia.gov/electricity/state/NewMexico/

CRE Electricity Generation in NM

How much to build?

Methodology for calculations

A. Use New Mexico data from EIA-826, 2015 for electricity sales by source (=23M MWh) (link)

B. Add 11.59% per Jacobson*, to cover peaking and storage. Total=25.7M MWh

C. Convert MWh to MW avg/year (/8766 hrs/yr) = 2,936 MW

D. Calculate nameplate generation required by RE source, by dividing MW by capacity factors. = **7,450MW**

Electricity Sold in NM in 2015

Utility	MWh	% of NM
PNM total	8,986,090	39%
EPE total	1,651,781	7%
SPS total	5,097,984	22%
IOU utilities ttl	15,735,855	68%
Coop/Muni +Adjs	7,322,750	32%
Solar Bhind mtr	7,385	0.03%
NM total	23,065,990	100%

From EIA-826_2015b1.xls

A

NM CRE Power Component	MWh	MW	MW/CF	Cap'y Factr
	B	***C***	***D***	
NM 2014 Avg Pwr +11.59%	25,739,338	2936		
50% Wind	-	1468	3263	45%
40% Solar	-	1175	3861	30%
10% Geothermal	-	294	326	90%
Total nameplate gen'n			7450	

Nameplate MW required to build for 100% RPS, to only replace in-state consumption

SunZia is built to export another 3GW. http://www.sunzia.net/

Conclusion: To replace the 2015 electricity sales within New Mexico with all Wind, Solar and Geothermal electricity, including an extra 11.59% to cover peaking and storage, we must build the nameplate capacity to generate **7450 MW** from 50% Wind, 40% Solar and 10% Geothermal.

*Jacobson: http://web.stanford.edu/group/efmh/jacobson/Articles/I/USStatesWWS.pdf

Calculating 100% RPS Costs

- How will the installed price per Watt decline between 2021 and 2050? For that we need:
  - Current “installed costs per Watt” for solar (SEIA), wind (AWEA) & geothermal (US EIA)
  - Historical rates of decline (SEIA and AWEA) and forecasts of future decline (NREL)

Solar PV System Costs Are Dropping 7% per year

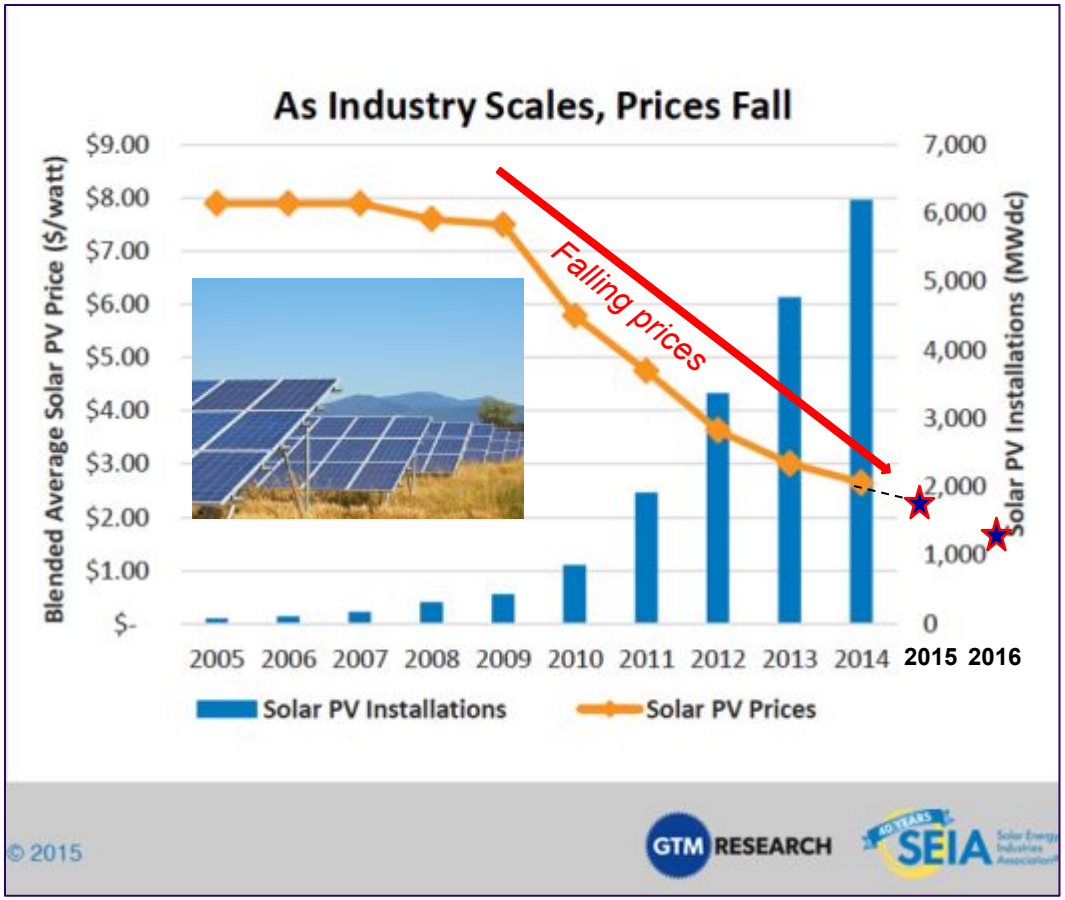
*Per the **US Dept of Energy**: http://www.nrel.gov/docs/fy14osti/62558.pdf*

From 2009-14, the installed price of PV dropped 6-8% per year. And this when installs were <5 GW/yr.

*Competition + massive investment will drive future prices to **continue** to drop at least this fast.*

Why?

*Because companies will compete on price for the **$108B/year** we'll spend to install **200-300 GW /year.***



$0.5

2037

*Note: The 7%/yr model is too conservative. Actual installed system prices dropped by 20% in **both** 2015 and 2016.*

Prices dropped 20% in 2015, to $2.15, =2017 forecast
http://www.seia.org/research-resources/solar-market-insight-2015-q3

*Another **20%** drop in 2016, to $1.57 =2021 forecast*
http://www.seia.org/research-resources/solar-market-insight-2015-q3

2016 Solar Pricing Dropped Again

Utility scale PV installed cost dropped to $1.05-1.20 /Wdc (fixed & tracking)

(per SEIA)

From Q4 2015 to Q4 2016, on average, U.S. **PV system pricing fell by nearly 20%**

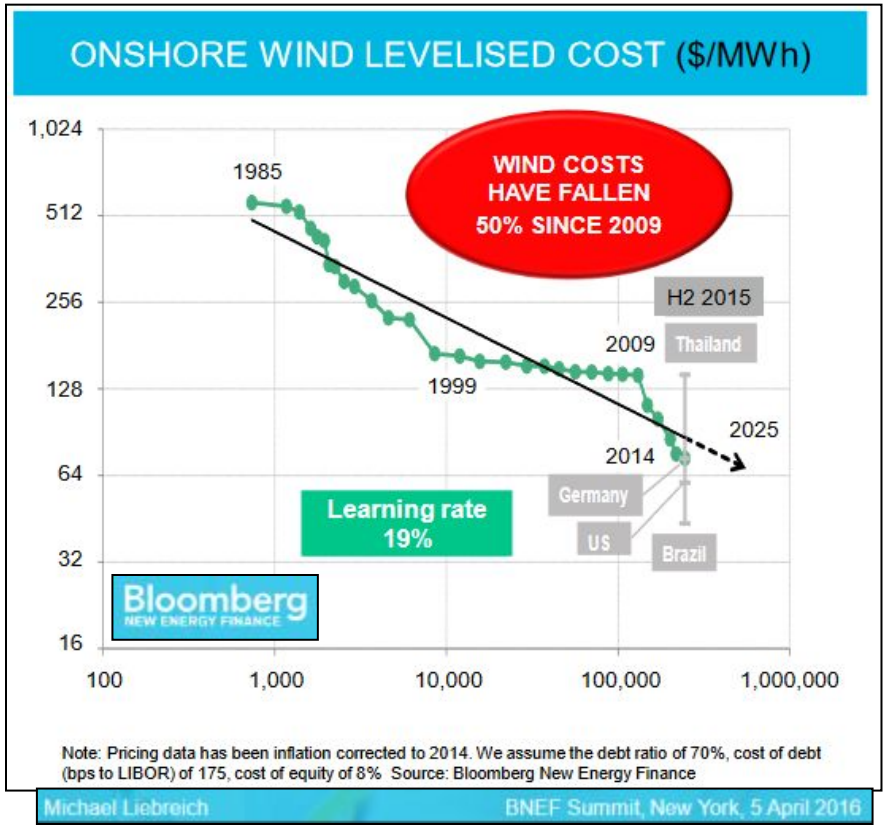
Figure 2.4 Modeled U.S. National Average System Costs by Market Segment, Q4 2015-Q4 2016

http://www.seia.org/sites/default/files/Dn4u8Zl5snSMI2016YIR.pdf

Wind Turbine Costs Also Dropping

- Because:
  - Price competition as the market grows and volumes rise
  - Better designs of generators, blades, electronics, etc.
  - Wind turbines getting taller; lower price per kW.
- Cost reduction study by IEA (May 2012), forecasts a **30%** <u>further</u> drop in price by 2030.
- So:

Year	2015 →	2037
$/W	$1.63	$1.07



https://www.ieawind.org/index_page_postings/WP2_task26.pdf
http://www.evwind.es/2014/03/27/top-10-wind-turbines-suppliers/44405
http://about.bnef.com/content/uploads/sites/4/2016/04/BNEF-Summit-Keynote-2016.pdf

Geothermal Costs = Flat

Office of
ENERGY EFFICIENCY & RENEWABLE ENERGY

- From the US-DOE
  - https://energy.gov/eere/geothermal/geothermal-faqs#cost_to_develop_geothermal_power_plant
  - "The initial cost for the field and power plant is around **$2500 per installed kW** in the U.S."
  - (= **$2.5/Watt**)
- Costs assumed to be flat 2021-2050, probably conservative.

Roll This All Into Spreadsheets

- For solar, for wind and for geothermal, create spreadsheets for the years 2021-2050 that:
  - Build the total nameplate generation required by 2050, with 50% by 2030
  - Use installed $/Watt cost forecasts with reasonable declines based on history and other models, to arrive at total investment

NM Solar for 100% RPS

*Average solar investment is **$51M** per year to install an average 103MW per year.*

Assume "$/Watt installed" continues to drop at 7%/yr.

If cost reduction stops after 2030, avg costs rise to $68M/yr

Clean Renewable Energy	# MW /yr	Cost /yr	Power / unit
Solar Panels	103 MW	$51 M	300 W
Wind Turbines	87 MW	$101 M	5 MW
Geothermal Plants	10 MW	$26 M	10 MW
Yearly Total:	200 MW	$178 M	

1	2	3	4	5	6	7	8	9	10
	New Mexico only		Solar	to replace in state SALES					
	Scenario for NM to achieve 50%, then 100% RPS by 2030 then 2050							7%	2030-2050
		3,861	MW Solar w 100% CRE, all CSP is PV (May 2015.1)					7%	2021-2029
RPS %	#GW PV factories	Year	Yearly PV Installs #MW/yr	NET Installed PV -MW	PV Panel spends/ yr ($M)	CUM PV spends ($M)	Cost to replace 30-yr old panels	PV panel $/W at (7%)/yr	# 300W panels per yr (k)
		2014a		193				$ 2.73	
15%		2015a	56	406				$ 2.51	
		2016a			$ -			$ 1.57	
		2017			$ -			$ 1.460	
		2018			$ -	$ -		$ 1.358	-
		2019			$ -	$ -		$ 1.263	-
20%		2020		772	$ -	$ -		$ 1.174	-
23%	0.12	2021	116	888	$ 127	$ 127		$ 1.092	386
26%	0.12	2022	116	1004	$ 118	$ 244		$ 1.016	386
29%	0.12	2023	116	1120	$ 109	$ 354		$ 0.945	386
32%	0.12	2024	116	1236	$ 102	$ 455		$ 0.879	386
35%	0.12	2025	116	1351	$ 95	$ 550		$ 0.817	386
38%	0.12	2026	116	1467	$ 88	$ 638		$ 0.760	386
41%	0.12	2027	116	1583	$ 82	$ 720		$ 0.707	386
44%	0.12	2028	116	1699	$ 76	$ 796		$ 0.657	386
47%	0.12	2029	116	1815	$ 71	$ 867		$ 0.611	386
50%	0.12	2030	116	1931	$ 66	$ 933		$ 0.568	386
53%	0.12	2031	116	2047	$ 61	$ 994		$ 0.529	386
56%	0.12	2032	116	2162	$ 57	$ 1,051		$ 0.492	386
59%	0.12	2033	116	2278	$ 53	$ 1,104		$ 0.457	386
62%	0.12	2034	116	2394	$ 49	$ 1,153		$ 0.425	386
65%	0.12	2035	116	2510	$ 46	$ 1,199		$ 0.395	386
68%	0.12	2036	116	2626	$ 43	$ 1,242		$ 0.368	386
71%	0.12	2037	116	2742	$ 40	$ 1,281		$ 0.342	386
74%	0.12	2038	116	2857	$ 37	$ 1,318		$ 0.318	386
77%	0.12	2039	116	2973	$ 34	$ 1,352		$ 0.296	386
80%	0.12	2040	116	3089	$ 32	$ 1,384		$ 0.275	386
82%	0.08	2041	77	3166	$ 20	$ 1,404		$ 0.256	257
84%	0.08	2042	77	3244	$ 18	$ 1,422		$ 0.238	257
86%	0.08	2043	77	3321	$ 17	$ 1,439		$ 0.221	257
88%	0.08	2044	77	3398	$ 16	$ 1,455		$ 0.206	257
90%	0.08	2045	77	3475	$ 15	$ 1,470		$ 0.191	257
92%	0.08	2046	77	3552	$ 14	$ 1,484		$ 0.178	257
94%	0.08	2047	77	3630	$ 13	$ 1,497		$ 0.166	257
96%	0.08	2048	77	3707	$ 12	$ 1,508	$ -	$ 0.154	257
98%	0.08	2049	77	3784	$ 11	$ 1,519	$ -	$ 0.143	257
100%	0.08	2050	77	3861	$ 10	$ 1,530	$ -	$ 0.133	257
		Avg to 2050	103	3089	$ 51	avg per yr 2021-2050			343
					Solar	$ 0.40	$ / Watt	panels/day	940

link

NM Wind for 100% RPS

*Average wind investment is **$101M** per year to install an average 87MW per year.*

Avg cost reduction assumed at 1%/year, front-end weighted. (Aug 2017 NREL report says that's conservative and costs could drop 5%/yr through 2030)

Clean Renewable Energy	# MW /yr	Cost /yr	Power / unit
Solar Panels	103 MW	$51 M	300 W
Wind Turbines	87 MW	$101 M	5 MW
Geothermal Plants	10 MW	$26 M	10 MW
Yearly Total:	200 MW	$178 M	

1	2	3	4	5	6	7	8	9	10
	New Mexico only		Wind	to replace in state SALES					
	Scenario for NM to achieve 50% RPS by 2030, then 100% RPS by 2050								
			3,263	MW of Wind Turbines Needed for 100% WWS by 2050 (rev 2015.1)					
RPS %	Year	Yearly Wind Installs #MW/yr	NET Installed Wind - MW	Installed Wind cost/yr ($M)	CUM Wind cost ($M)	Cost to replace 25-yr old Turbines	Wind $/W at x%/yr	Wind cost reductn (x%/yr)	# 5MW turbines per yr
	2014								
15%	2015				0.0		$ 1.690	3.0%	-
	2016				0.0		$ 1.639	3.0%	-
	2017				0.0		$ 1.590	3.0%	-
	2018				0.0		$ 1.542	3.0%	-
	2019				0.0		$ 1.496	3.0%	-
20%	2020		653		0.0		$ 1.451	3.0%	-
23%	2021	98	750	138	$ 138		$ 1.408	3.0%	20
26%	2022	98	848	134	$ 271		$ 1.365	3.0%	20
29%	2023	98	946	131	$ 402		$ 1.338	2.0%	20
32%	2024	98	1044	128	$ 531		$ 1.311	2.0%	20
35%	2025	98	1142	126	$ 657		$ 1.285	2.0%	20
38%	2026	98	1240	123	$ 780		$ 1.259	2.0%	20
41%	2027	98	1338	121	$ 901		$ 1.234	2.0%	20
44%	2028	98	1436	118	$ 1,019		$ 1.210	2.0%	20
47%	2029	98	1533	117	$ 1,136		$ 1.198	1.0%	20
50%	2030	98	1631	116	$ 1,252		$ 1.183	1.0%	20
53%	2031	98	1729	115	$ 1,367		$ 1.171	1.0%	20
56%	2032	98	1827	113	$ 1,480		$ 1.159	1.0%	20
59%	2033	98	1925	112	$ 1,592		$ 1.148	1.0%	20
62%	2034	98	2023	111	$ 1,704		$ 1.139	0.8%	20
65%	2035	98	2121	111	$ 1,814		$ 1.130	0.8%	20
68%	2036	98	2219	110	$ 1,924		$ 1.121	0.8%	20
71%	2037	98	2316	109	$ 2,033		$ 1.112	0.8%	20
74%	2038	98	2414	108	$ 2,141		$ 1.105	0.6%	20
77%	2039	98	2512	107	$ 2,249		$ 1.098	0.6%	20
80%	2040	98	2610	107	$ 2,355	$ -	$ 1.092	0.6%	20
82%	2041	65	2675	71	$ 2,426	$ -	$ 1.085	0.6%	13
84%	2042	65	2741	70	$ 2,497	$ -	$ 1.079	0.6%	13
86%	2043	65	2806	70	$ 2,567	$ -	$ 1.072	0.6%	13
88%	2044	65	2871	70	$ 2,636	$ -	$ 1.066	0.6%	13
90%	2045	65	2936	69	$ 2,705	$ -	$ 1.059	0.6%	13
92%	2046	65	3002	69	$ 2,774	$ 103	$ 1.053	0.6%	13
94%	2047	65	3067	68	$ 2,842	$ 102	$ 1.047	0.6%	13
96%	2048	65	3132	68	$ 2,910	$ 102	$ 1.040	0.6%	13
98%	2049	65	3197	67	$ 2,978	$ 101	$ 1.034	0.6%	13
100%	2050	65	3263	67	$ 3,045	$ 101	$ 1.028	0.6%	13
	Avg	87	2610	$ 101	avg per yr 2021-205(		$ 1.028	# turb/yr	17
				Wind	$ 0.93	$ / Watt			

NREL: costs to drop 50% by 2030 https://www.ecowatch.com/wind-power-costs-2478701894.html

NM Geothermal for 100% RPS

*Average geothermal investment of **$26M** per year to build an average of 10MW per year*

GeoT costs are assumed flat over time at the 2015 US-EIA value of $2.5/Watt installed

Clean Renewable Energy	# MW /yr	Cost /yr	Power / unit
Solar Panels	103 MW	$51 M	300 W
Wind Turbines	87 MW	$101 M	5 MW
Geothermal Plants	10 MW	$26 M	10 MW
Yearly Total:	200 MW	$178 M	

1	2	3	4	5	6	7	8	9
[illegible]	New Mexico only		Geothermal	to replace in state SALES				
	Scenario for NM to achieve 50%, then 100% RPS by 2030 then 2050							
		326	MW of Geothermal for 100% RPS by 2050 (rev 2015.1)					
RPS %	Year	Yearly GeoT Installs #MW/yr	NET Installed GeoT-MW	Installed GeoT cost/yr ($M)	CUM GeoT cost ($M)	Cost to replace 35-yr old GeoT?	GeoT $/W	GeoT cost Redn/yr
	2014		10					
	2015		10	0.000	0.0		$ 2.500	0.0%
	2016		10	0.000	0.0		$ 2.500	0.0%
	2017		10	0.000	0.0		$ 2.500	0.0%
	2018		10	0.000	0.0		$ 2.500	0.0%
	2019		10	0.000	0.0		$ 2.500	0.0%
2%	2020		10	0.000	0.0		$ 2.500	0.0%
7%	2021	13	23	32	32		$ 2.500	0.0%
12%	2022	16	39	41	73		$ 2.500	0.0%
17%	2023	16	55	41	114		$ 2.500	0.0%
22%	2024	16	72	41	154		$ 2.500	0.0%
27%	2025	16	88	41	195		$ 2.500	0.0%
32%	2026	16	104	41	236		$ 2.500	0.0%
37%	2027	16	121	41	277		$ 2.500	0.0%
42%	2028	16	137	41	318		$ 2.500	0.0%
47%	2029	16	153	41	358		$ 2.500	0.0%
50%	2030	10	163	24	383		$ 2.500	0.0%
53%	2031	10	173	24	407		$ 2.500	0.0%
56%	2032	10	183	24	432		$ 2.500	0.0%
59%	2033	10	192	24	456		$ 2.500	0.0%
62%	2034	10	202	24	481		$ 2.500	0.0%
65%	2035	10	212	24	505		$ 2.500	0.0%
68%	2036	10	222	24	530		$ 2.500	0.0%
71%	2037	10	232	24	554		$ 2.500	0.0%
74%	2038	10	241	24	579		$ 2.500	0.0%
77%	2039	10	251	24	603		$ 2.500	0.0%
80%	2040	10	261	24	628	$ -	$ 2.500	0.0%
82%	2041	7	268	16	644	$ -	$ 2.500	0.0%
84%	2042	7	274	16	660	$ -	$ 2.500	0.0%
86%	2043	7	281	16	676	$ -	$ 2.500	0.0%
88%	2044	7	287	16	693	$ -	$ 2.500	0.0%
90%	2045	7	294	16	709	$ -	$ 2.500	0.0%
92%	2046	7	300	16	725	$ -	$ 2.500	0.0%
94%	2047	7	307	16	742	$ -	$ 2.500	0.0%
96%	2048	7	313	16	758	$ -	$ 2.500	0.0%
98%	2049	7	320	16	774	$ -	$ 2.500	0.0%
100%	2050	7	326	16	791	$ -	$ 2.500	0.0%
	Avg	10	$ 816	$ 26	avg per yr 2021-2050			
			316	GeoTh	$ 2.50	$ / Watt		Per the US

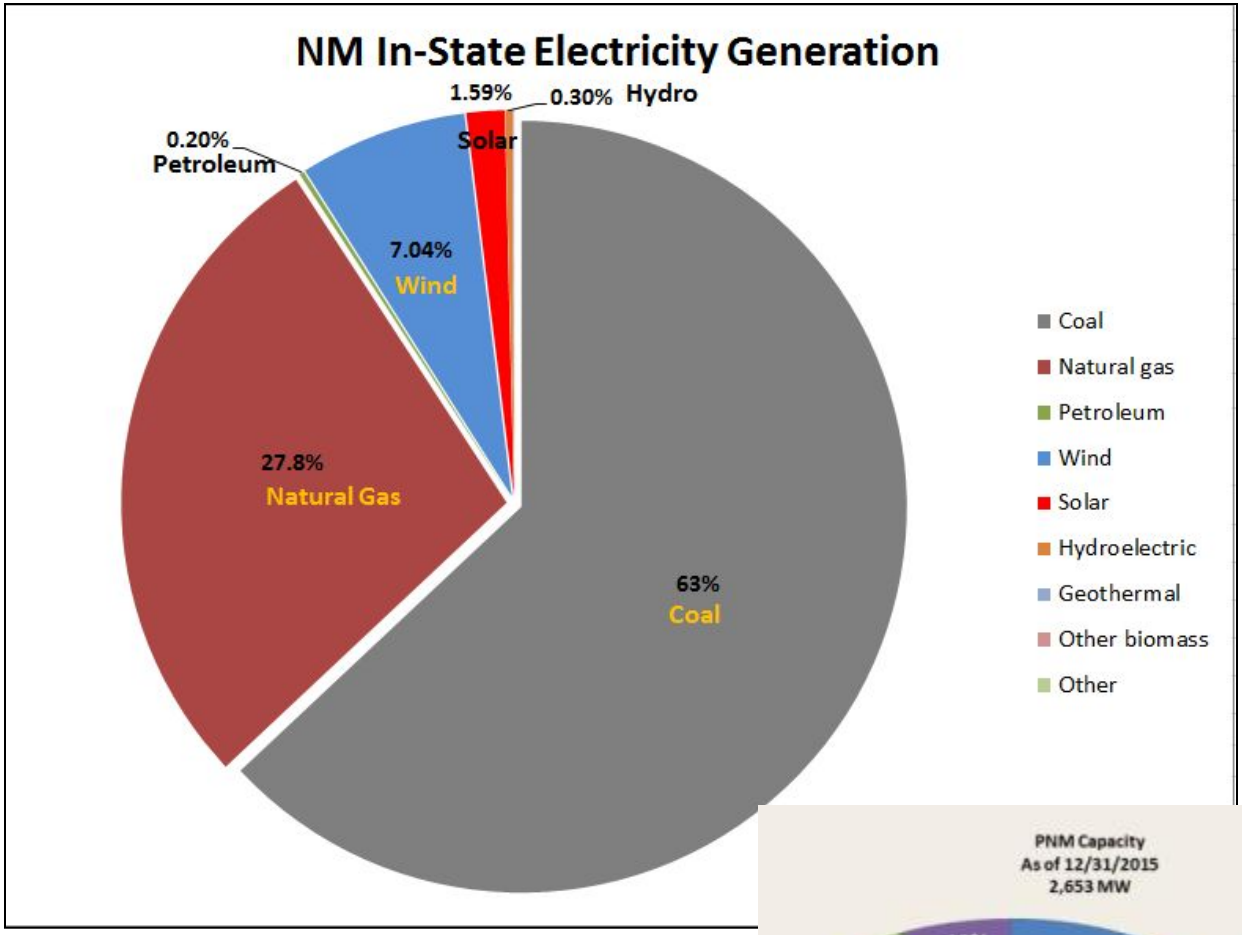
Link: https://energy.gov/eere/geothermal/geothermal-faqs#cost_to_develop_geothermal_power_plant

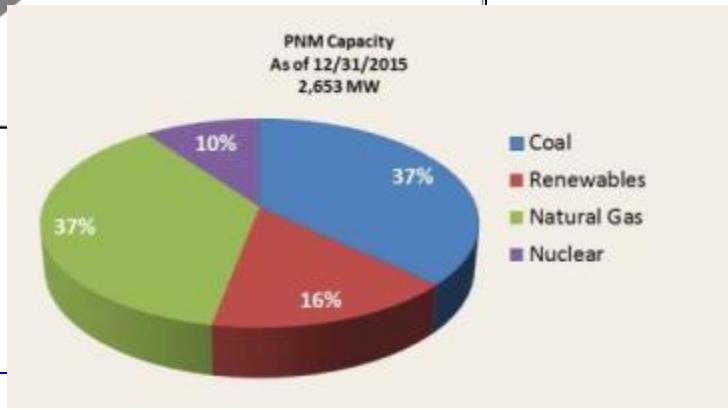
Calculating NM Fuel Costs

Information needed for these calculations:

- How much does NM spend on fossil fuel
- What is NM % generation by fuel source (coal, gas, nuclear, CRE)
- Costs per BTU for coal and nat gas

NM Electricity Generation by Source





- 63% coal, 28% gas.
- PNM also imports nuclear

How Much Is Spent on Coal & Gas for Electricity Generation in NM

Question: What did NM spend on fuel for in-state electricity sales in 2015?

Methodology

1. Total sales were 23.1M MWh per EIA-826. link
2. Subtract the sales from imported nuclear power from PNM's PVNGS. =268MW, per DVW. Convert MW to MWh and use 90% CF to get 2.1M MWh from imported nuclear energy.
3. So sales w/o PVNGS were 23.1-2.1= 21M MWh
4. Allocate that to 63% from coal and 28% from gas, using the %s from generation. The rest is from other sources, mostly Wind& Solar.
5. Use EIA values for cost of power plant fuel, ~$0.022/kWh Coal, $.033/kWh NatGas, and the % of power from coal and gas from item 4 above.
6. Calc spending on coal + nat. gas fuel = $482M

1

NM Sales 2015	MWh	Percent of total
NM total MWh	23,065,990	100%
PNM total (EIA-826)	8,986,090	39%
Adjustments	4,422,400	19%
IOU utilities	15,735,855	68%
Coop/Muni +Adjs	7,322,750	32%
Solar Bhind mtr	7,385	0%
NM total	23,065,990	
from EIA-826_2015b1.xls		
NM MWh w/o PVNGS	20,951,631	

3

2

MW imports from PVNGS	268
Capacity factor	90%
#hrs per year	8766
MWh from PVNGS	2,114,359

5

$ /kWh	Source
$0.022	Coal
$0.033	Nat. Gas

4

If we revise the MWh down, to match DvW's EIA 826 report on NM electricity			20,951,631					
NM SALES (not generation)	Generation (kWh)	kcf or short ton/kWh	Total Fuel consumed	Coal (S-tons)	Coal Price ($/S-ton)	NG Price ($/kCF)	Dollars	
Coal	13,201,290,471	1.0400	13,729,342,090	6,864,671	42.33		$290,581,525	63.01%
Natural Gas	5,821,005,599	0.0101	58,850,367			3.25	$191,263,691	27.78%
Total Cost							$481,845,217	**$482M** for sales

Electricity generation is per EIA. But includes exports
http://www.eia.gov/electricity/state/NewMexico/

6

Fuel Savings

Fuel spending has been $482M/yr (in 2014)

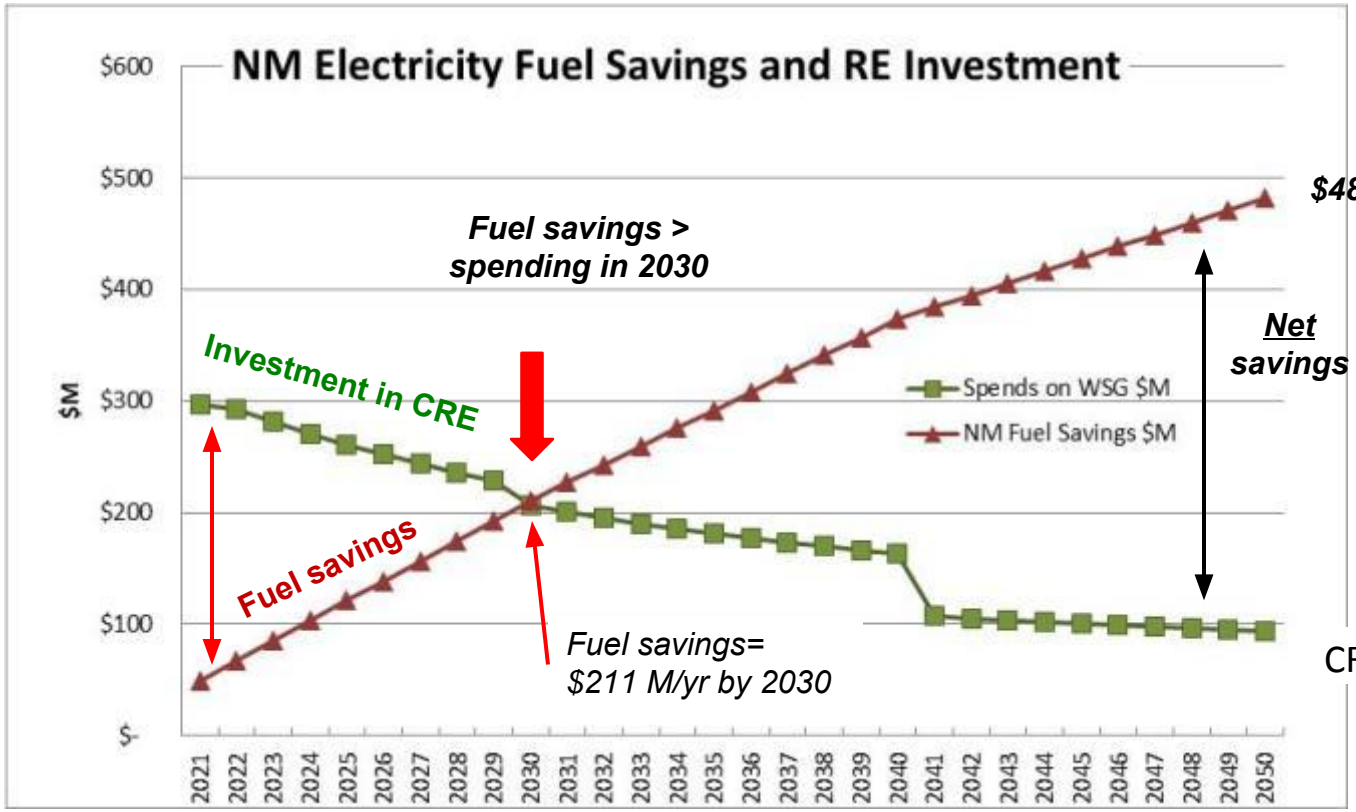
Fuel savings per year are relative to 2014. They grow as RPS % increases.

Fuel savings reach $211/yr in 2030 and more than pay for all future investments.

Fuel Savings				Coal+NatGas only		without RPS	
	68%	32%	2014 FFuel $M/yr=	$ 482	$ 542		
Year	% RPS - IOUtil	% RPS - Co-ops	Weighted RPS	Fossil Fuel Spending $M	Spends on WSG $M	Net WSG cost after Fuel Savings $M	NM Fuel Savings $M
				$ 54			
2014	14%	5%	11%	$ 482			$ -
2015	15%	5%	12%	$ 478			$ 4
2016	16%	6%	13%	$ 473			$ 9
2017	17%	7%	14%	$ 467			$ 15
2018	18%	8%	15%	$ 462			$ 20
2019	19%	9%	16%	$ 457			$ 25
2020	20%	10%	17%	$ 451			$ 31
2021	23%	14%	20%	$ 433	$ 296	$ 248	$ 49
2022	26%	18%	23%	$ 415	$ 292	$ 225	$ 67
2023	29%	22%	27%	$ 397	$ 281	$ 196	$ 85
2024	32%	26%	30%	$ 379	$ 271	$ 168	$ 103
2025	35%	30%	33%	$ 361	$ 261	$ 140	$ 121
2026	38%	34%	37%	$ 343	$ 252	$ 113	$ 139
2027	41%	38%	40%	$ 325	$ 243	$ 87	$ 157
2028	44%	42%	43%	$ 307	$ 235	$ 61	$ 175
2029	47%	46%	47%	$ 289	$ 229	$ 36	$ 193
2030	50%	50%	50%	$ 271	$ 206	$ (5)	$ 211
2031	53%	53%	53%	$ 255	$ 200	$ (27)	$ 227
2032	56%	56%	56%	$ 239	$ 195	$ (48)	$ 243
2033	59%	59%	59%	$ 222	$ 190	$ (70)	$ 260
2034	62%	62%	62%	$ 206	$ 185	$ (91)	$ 276
2035	65%	65%	65%	$ 190	$ 181	$ (111)	$ 292
2036	68%	68%	68%	$ 174	$ 177	$ (132)	$ 308
2037	71%	71%	71%	$ 157	$ 173	$ (152)	$ 325
2038	74%	74%	74%	$ 141	$ 169	$ (171)	$ 341
2039	77%	77%	77%	$ 125	$ 166	$ (191)	$ 357
2040	80%	80%	80%	$ 109	$ 163	$ (210)	$ 373
2041	82%	82%	82%	$ 98	$ 107	$ (277)	$ 384
2042	84%	84%	84%	$ 87	$ 105	$ (290)	$ 395
2043	86%	86%	86%	$ 76	$ 103	$ (303)	$ 406
2044	88%	88%	88%	$ 65	$ 102	$ (315)	$ 417
2045	90%	90%	90%	$ 54	$ 100	$ (327)	$ 428
2046	92%	92%	92%	$ 44	$ 99	$ (340)	$ 438
2047	94%	94%	94%	$ 33	$ 97	$ (352)	$ 449
2048	96%	96%	96%	$ 22	$ 96	$ (364)	$ 460
2049	98%	98%	98%	$ 11	$ 95	$ (376)	$ 471
2050	100%	100%	100%	$ 0	$ 94	$ (388)	$ 482
					$ 5,365		$ 8,630

link

NM Fuel Savings Pay for Investment



Net CRE costs avg $127M thru 2030.

But consider: the SJGS maintenance budget in 2013 was $40M. Plus $10 /yr for capex. Plus costs of pollution controls, etc

- New Mexico spends $482M/year on coal & gas **fuel** to generate electricity
- For every **10%** we add to CR Energy, we'll **save another $48M**/year on fuel.
- **Fuel savings pay for all investment after 2030.** Until then, net CRE investments average $127M/yr. And savings increase every year.
- So after we reach 50% by 2030, fuel savings pay for all new RE investment.

**WSG= wind, solar & geothermal*

7% of NM Gas Used for Electricity

This 7% is for NM electricity generation, and some NM generated power is exported.
Thus less than 7% of produced gas is used to generate just the electricity consumed within NM.

7% of NM natural gas production was consumed in-state to generate electricity in 2014 (per EIA)

This would be the approx impact on NM gas revenue and jobs of converting to 100% CR electricity

All data is from 2014 per the US Energy Information Agency (US EIA)

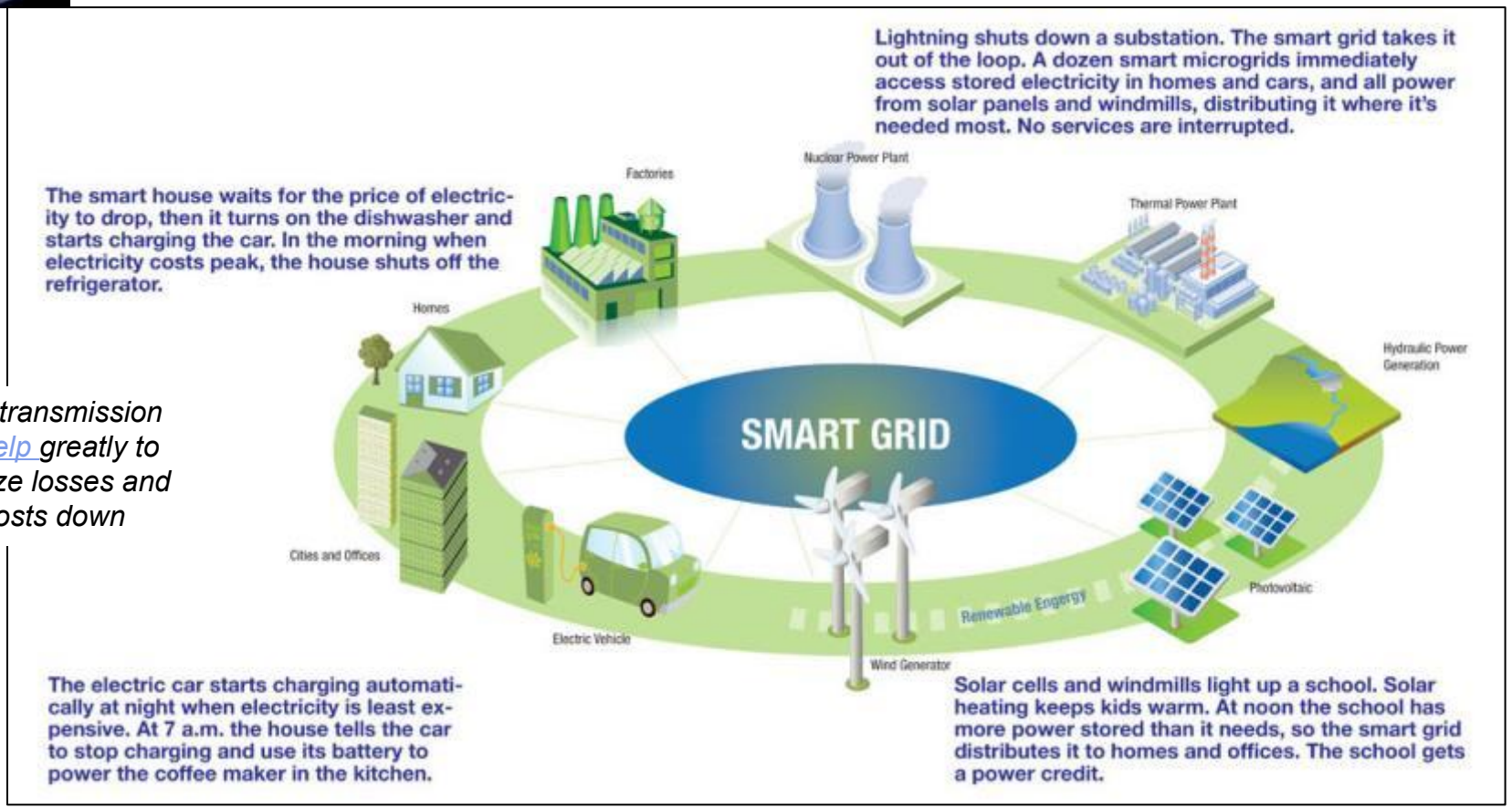
Calcs	Value	Comment	Link
A/1000	10,408	Btu/kWh, Power Plant Heat rate of Natural gas (US EIA)	Btu/kWh
A	10,408,000	Btu/**MWh**, Power Plant Heat rate of Natural gas	calc
B	8,975,656	MWh of electricity generated from natural gas in NM	MWh NG
C	1,355,000,000,000,000	Btu of natural gas produced in NM (1,355T Btu)	NG Prod
B*A	93,418,627,648,000	93T Btu of Natural Gas used to generate electricity in 2014	calc
(B*A)/C	**6.89%**	7% of NM NG production used in-state to generate electricity	calc

http://www.eia.gov/electricity/state/NewMexico/

What About Storage and Transmission?

- The 100% CRE model forecasts only the costs for generation. Does not include storage and transmission.
- We'll need a national smart grid
  - Cost of a USA Smart Grid was estimated by UMich at $476B, or $23.8B/yr for 20 years. Includes storage. Benefits = $2T
- Transmission
  - South Australia's Transgrid says transition to 100% is urgent, feasible. New transmission adds 4% to cost.

Cost of a US Smart Grid - $24B/yr



HVDC transmission lines help greatly to minimize losses and keep costs down

- Cost of a US Smart Grid was estimated at $476B, or $23.8 B for 20 years
- Benefits? $2T

http://www.engin.umich.edu/college/about/news/stories/2011/may/images/living-off-the-grid-smart-grids-are-current-technology-at-its-best/smartgrid-model-052211

2016 Revenues by Utility - NM

Source:
PRC web site compliance filings per rule 510, using the **New Mexico Jurisdictional Customer Info Form**

PRC Case Lookup
eDocket
http://164.64.85.108/

		2016 Retail Electric Revenue for NM Utilities (PRC filings) (w/o Muni's)				
Notes	#	Utility	2016 Revenue	%	total kWh	% of kWh
	A	PNM	$ 900,584,323	47.5%	8,951,425,000	42.3%
	B	El Paso Electric	$ 178,836,423	9.4%	1,653,465,000	7.8%
	C	Xcel Energy (SPS)	$ 345,726,851	18.2%	5,279,146,000	25.0%
		Subttl Investor Owned Utilities	$ 1,425,147,597	75.1%	15,884,036,000	75.1%
Tri-State	1	Central New Mexico Elec Coop	$ 32,842,651	1.7%	218,211,587	1.0%
Tri-State	2	Continental Divide	$ 58,960	0.003%	711,743,000	**3.4%**
Tri-State	3	Jemez Mountains	$ 47,184,047	2.5%	370,891,000	**1.8%**
Tri-State	4	Mora-San Miguel	$ 11,589,380	0.6%	69,984,149	0.3%
Tri-State	5	Otero County	$ 31,022,055	1.6%	183,982,000	0.9%
Tri-State	6	Sierra	$ 8,324,535	0.4%	63,192,850	0.3%
Tri-State	7	Springer	$ 21,308,523	1.1%	268,550,512	1.3%
West-Farm	8	Central Valley	$ 61,579,851	3.2%	765,864,795	**3.6%**
X-border	9	Duncan Valley	$ 387,053	0.020%	3,668,000	0.02%
	10	Kit Carson	$ 40,061,319	2.1%	265,801,775	1.3%
X-border	11	Navopache	$ 1,515,251	0.1%	9,936,000	0.05%
X-border	12	Rio Grande	$ 32,661,178	1.7%	271,325,000	1.3%
Tri-State	13	Socorro	$ 24,372,000	1.3%	177,300,000	0.8%
Tri-State	14	Columbus	$ 13,405,161	0.7%	97,674,000	0.5%
West-Farm	15	Farmers	$ 34,047,432	1.8%	358,615,000	1.7%
West-Farm	16	Lea County	$ 56,003,918	3.0%	796,682,000	**3.8%**
Tri-State	17	Northern Rio Arriba	$ 4,047,330	0.2%	24,345,000	0.1%
West-Farm	18	Roosevelt County	$ 15,183,835	0.8%	149,219,000	0.7%
Tri-State	19	Southwestern Elec Coop	$ 35,910,635	1.9%	451,088,000	**2.1%**
		Subtotal of 19 Co-ops	$ 471,505,114	24.9%	5,258,073,668	24.9%
		Total of 3 IOU's+19 Co-ops	**$ 1,896,652,711**	**100%**	21,142,109,668	100.0%
		2021 (max) req'd investmt in CRE	$ 296,401,944			
		% of 2016 retail elect revenue	15.6%			
		Avg 30yr req'd investmt in CRE	$ 178,836,070			
		% of 2016 retail elect revenue	9.4%			

For 3%/yr RPS