Climate Change and Rising Sea Level: What Can We do about it?

or

the Frog in Boiling Water Syndrome

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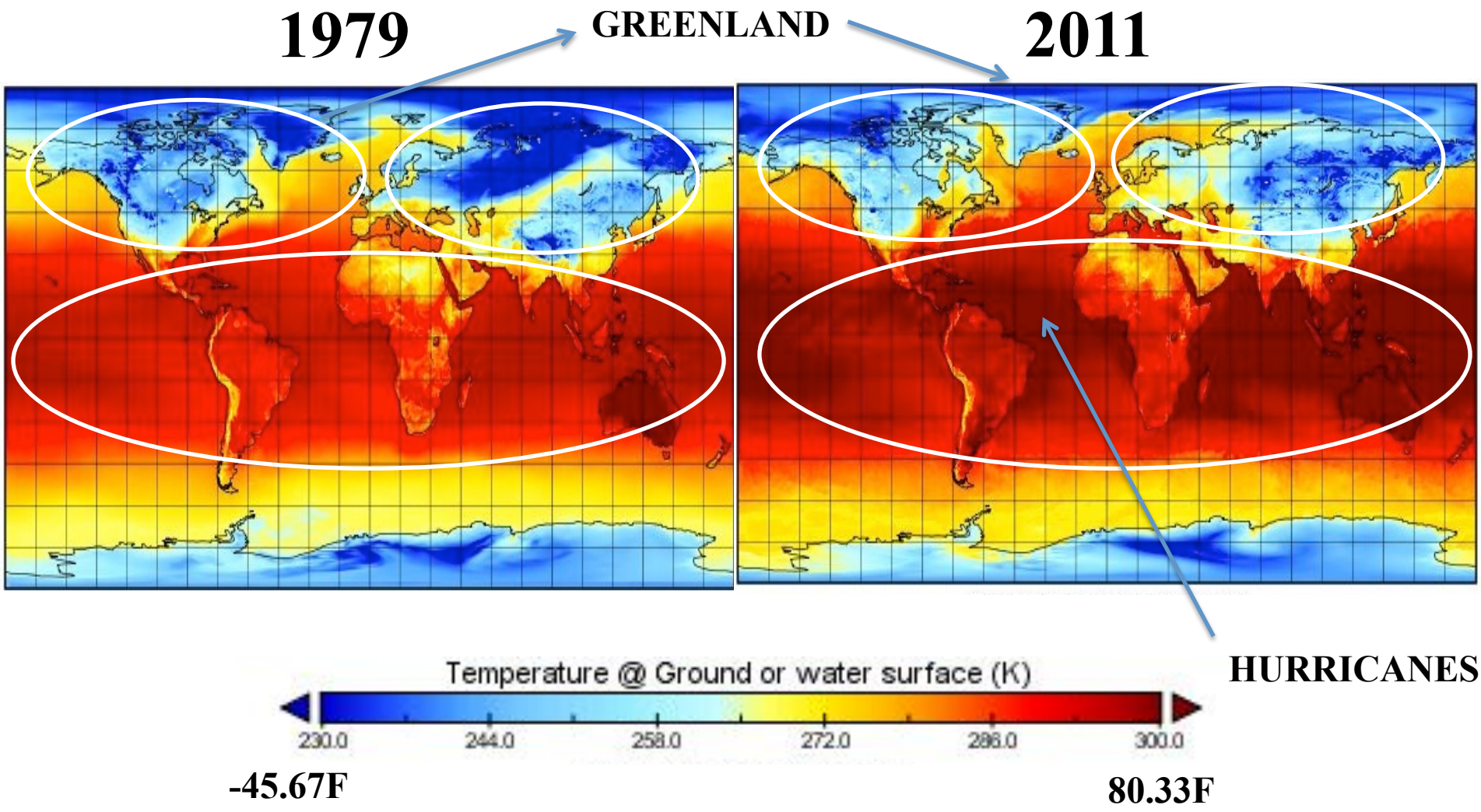
Anne Arundel South County Democratic Club Meeting, 1 June 2016

We are the *First* Generation to Understand what we have done to the Planet and the *Last* to not have to *Live with the Consequences*

1. **Raise your house to a first floor level about *10 to 12 ft. above MSL* if you live near the coast line;**
2. ***Minimize all New Development* within Coastal low lying areas & DO NOT provide government subsidized flood insurance to new developments (i.e. Newly revised FEMA 100 year flood zone (which now may be the 30 year flood zone);**
3. **Add ~ *40% Renewable SOLAR Energy* to the National Electric Power Grid and *use Natural Gas from Fracking UNTIL 2060* to power Fast Response Gas Turbine electric power ramp-up capacity to cover the Base Load at night, in the winter months, etc. & >*300,000 3MW* WIND TURBINES;**
4. **Add more Base Load *Nuclear Power plants* (with modern, safe design codes) to the Grid and find a way to dispose of the spent fuel rods;**
5. **Try to *Cap* Global Carbon Dioxide in the planet's atmosphere to ~ 500 to 550ppm and ~ 1.5 to 2 deg. C. global temp rise by electing a President, Senators and Congress men & women who will pass and enforce strict environmental laws and put pressure on all other nations (esp. China and India) to do the same with international treaty's.**
6. **SUPPORT *Research* on SMART GRID & New Battery Technology**
7. ***NEW BUSINESS MODELS* FOR POWER UTILITY SERVICE PROVIDERS?**

Temperature at Ground and Water Surface:
ONE GENERATION !



Data: NOAA National Operational Model Archive & Distribution System
Software: Panoply netCDF, HDF and GRIB Data Viewer

A Global Problem that Needs *Informed Leadership*
Major Political Climate Conferences

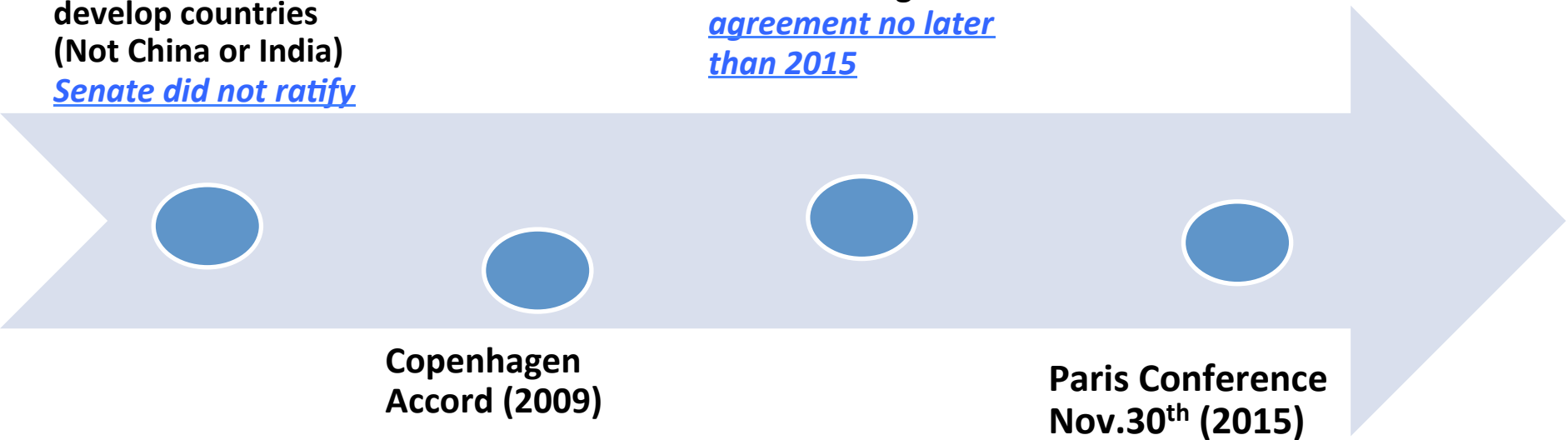
Kyoto Protocol (1997) *Cinton Adm.*

- First Greenhouse gas emissions reduction treaty
- Only included develop countries (Not China or India)

Senate did not ratify

Durban Conference (2011) *Oboma Adm.*

- Agreed to come up with universal legal climate change *agreement no later than 2015*



Copenhagen Accord (2009)

- *Bush/ Oboma Adm.*
- *Summit collapsed*

Paris Conference Nov.30th (2015) *Oboma Adm.*

- Agreed on a target of *2°C* of preindustrial temperatures

Information gathered from UN Framework Convention on Climate Change [6]

What A Leading Republican Senator Believes About Climate Change

- **"To my knowledge, nobody has uttered the term 'global warming' since 2009. It's been completely refuted in most areas. … Those people who really believe that the world's coming to an end because of global warming and that's all due to manmade, anthropogenic gases, we call those people alarmists. … I really believe it's the greatest hoax ever perpetrated on the American people."[Politico, 8/1/12]**
  - **- Sen.Jim Inhofe (R Okla..)**
    - **Chair of the Senate Environment Committee**

This is also a State Government Problem

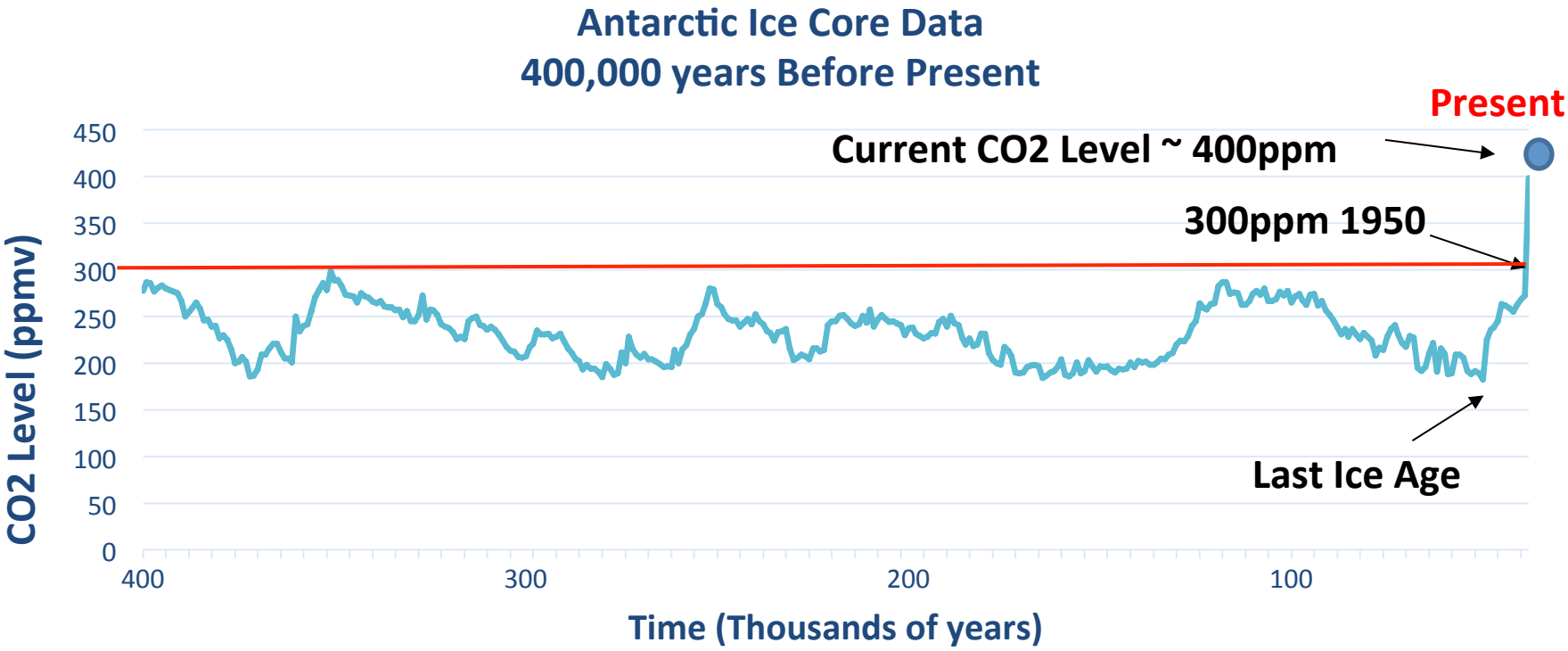
Thinkprogress.org May, 2016

This Will Become a Supreme Court Issue in the Next Presidential Term

- *76% Americans* **believe Global Climate Change is Occurring**
  - **59% of Republicans agree**
- **24 State Governors and 27 Attorneys general *are suing the EPA* to negate the Clean Power Plan - With a Total *of $98 Million* in Campaign Contributions:**
  - **Governors and Attorneys General Deniers $24M**
  - **House Deniers $40M**
  - **Senate Deniers $34M**
- *174 million America Citizens* **are represented by a Senator, Congressman, Gov. or AG *Opposing the EPA Clean Power Plan***
- **Many Republican Politicians will take the Position:**
  - ***" I do not know, I am not a Scientist {or Engineer}"***
- **Gov. Hogan accepts the science but does not believe that MD can make a difference**
  - **Signed 40% Greenhouse Gas Emissions Reduction Act in April**
  - **Vetoed Clean Energy Jobs Bill in May**
  - **Does NOT support Att. Gen. Brian Frosh defense of the EPA plan**

CO2 Levels from 400,000 Years Ago - Present

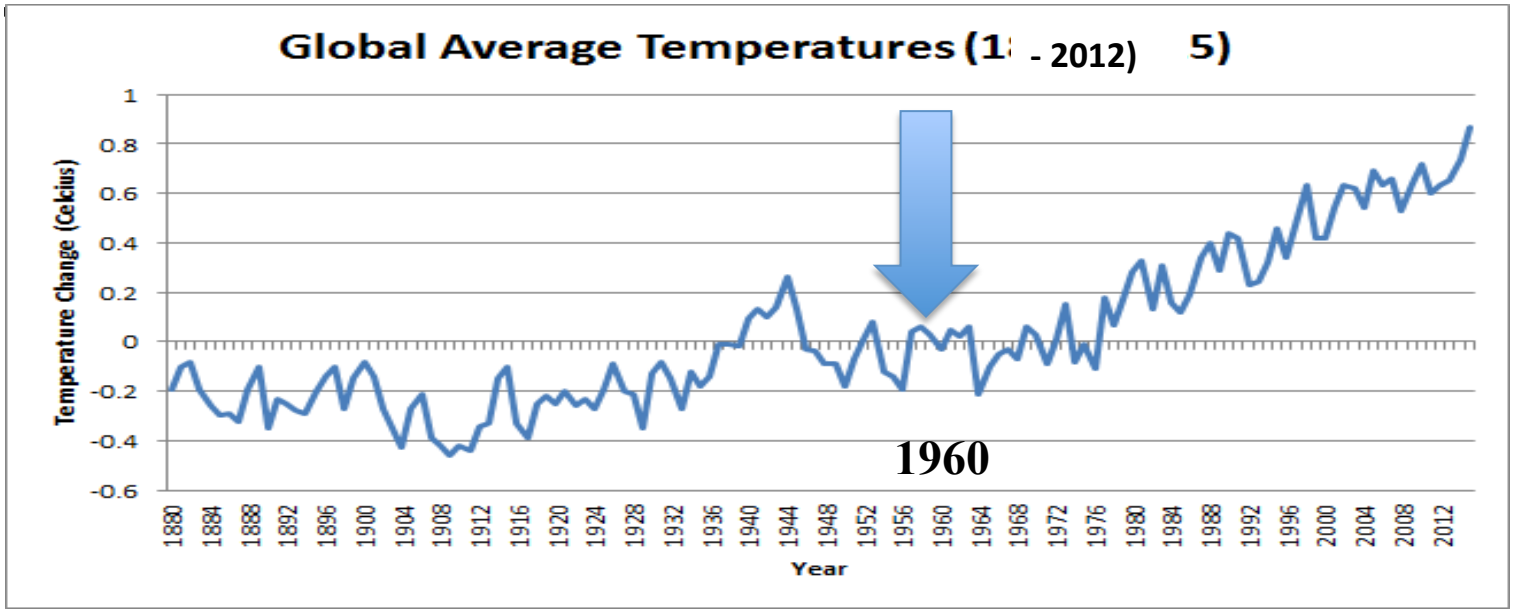
Sea Level has risen ~ *400 ft.* with a Global Temperature rise of *only 5 deg. C*. since the last Ice Age 20,000 years ago *(180ppm CO2*)



TIPPING POINT FEAR AT 500ppm BY 2060 !!!

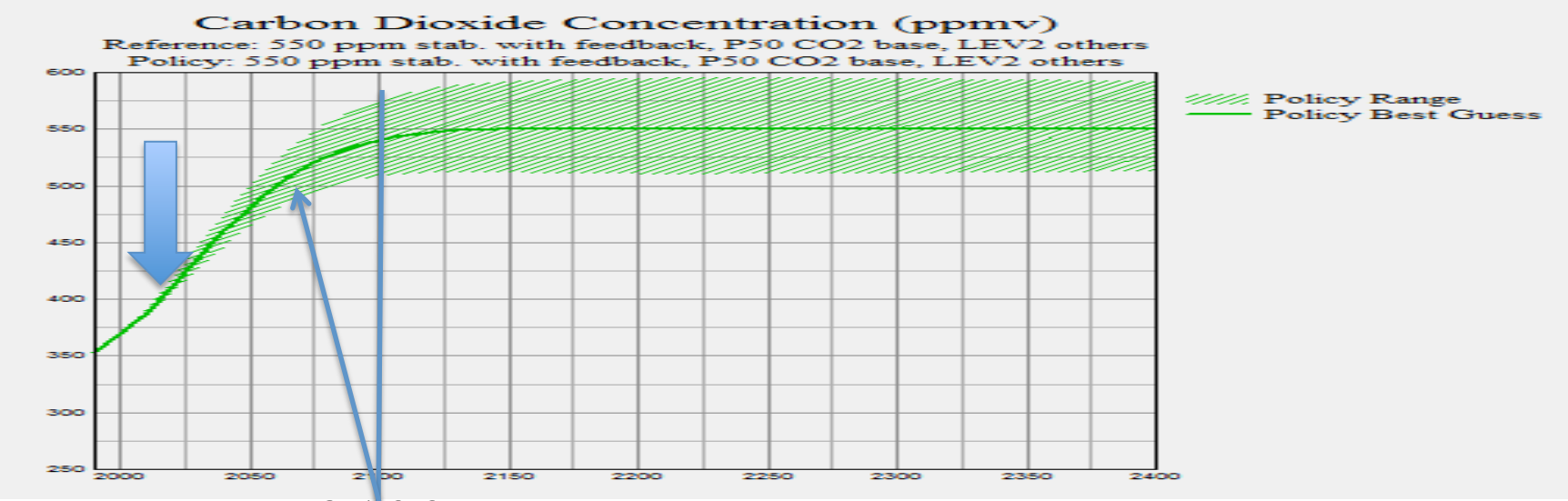
Data collected from NOAA [6]

Rising Global Temperature: The "Hockey Stick" Curve is Real

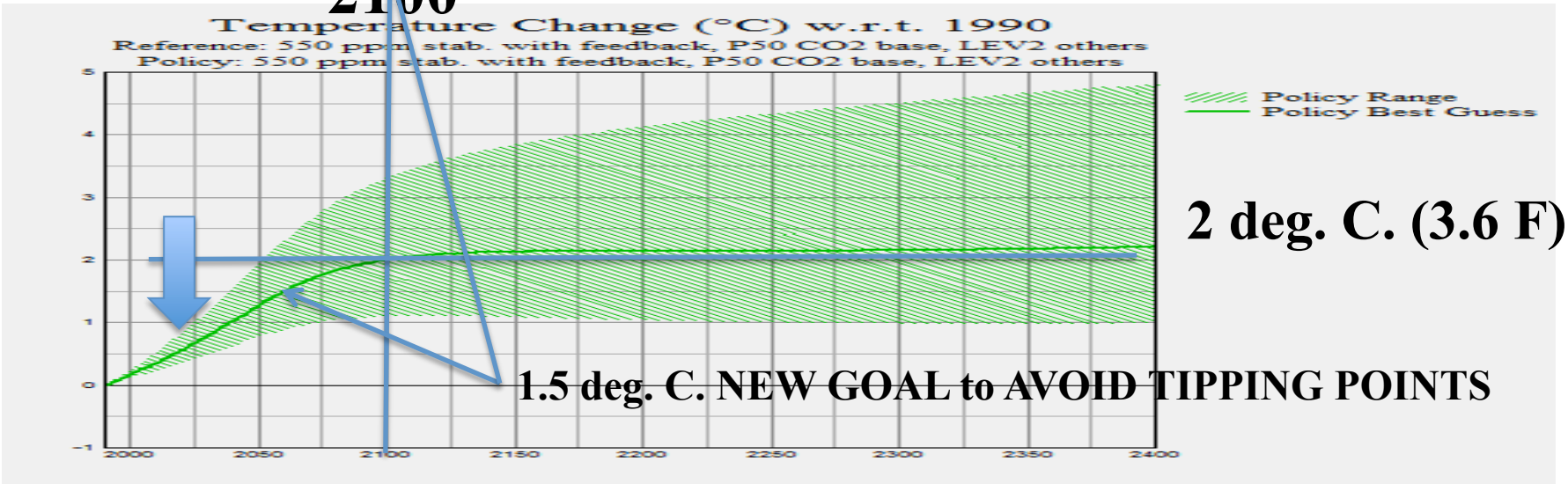
- **In the past 100 years (3 Generations) the global average temperature has risen + 0.7° C (1.3 F) and the Global average Temperature is predicted to rise to +2 (3.6) to +4 (7.2) degrees Celsius over the Next 3 Generations!!!**
- ***Fourteen of the Fifteen HOTTEST YEARS ON RECORD occurred the first fifteen years of the 21st century!***
- 

Data source: NASA's Goddard Institute for Space Studies (GISS)

Optimistic Model Prediction of Carbon Dioxide (550ppm) & Temp. Growth over the next 10 Generations – If We Start NOW!



2100



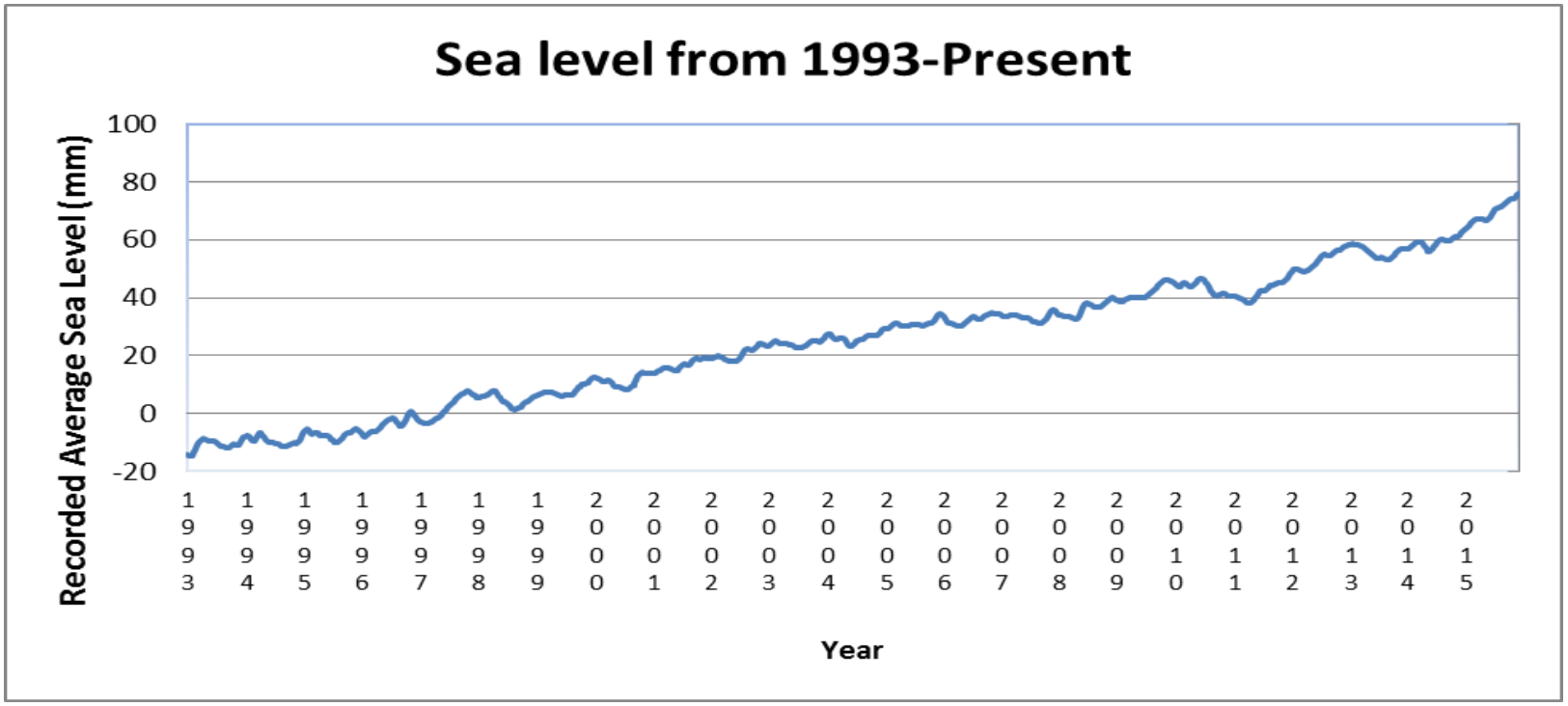
2 deg. C. (3.6 F)

1.5 deg. C. NEW GOAL to AVOID TIPPING POINTS

Rising Sea Levels

Correlate with Rising Carbon Dioxide and Temperature

- Sea Level ~ Constant for last 6,000 years {*All of Recorded History*}
- Global Average sea level has risen 178mm (7in) in the past 100 years[2]
- CB Rising at a rate of ~ 75mm (3 in.) per Decade (2002 to 2011) [9]
- Recent Data Indicate this Level MAY INCREASE SIGNIFICANTLY



Data source: Coastal tide gauge records

Chesapeake Bay Mean Sea Level Rise *2 to 3 Times* Worse than Global Averages

Measurements and Predictions [1,9]

- **Measurements: 1900 to 2000 ~ +1 ft.**
- **CB Predictions above 1992 level:**
  - **2050 ~ + 1.4 ft. (+2.1 high Est.)**
  - **2100 ~ + 3.7 ft. (+5.7 high Est.)**
  - **Causes not Well Included in Global Models:**
    - **Ocean Thermal Expansion best estimated**
    - **Antarctica Melting**
    - **Greenland Melting**
    - **Other Glaciers Melting**
    - **Gulf stream Changes**
    - **Sinking land**

HIGH Water More Critical than Averages: Current Mid-Latitude Tidal Range

- Typical Design value + / - ~1 ft.
- Annual Super Tides can be twice this amount
- Storm surge can add 8 to 12 ft. to a high tide
- FEMA's flood risk Maps:
  - Do Not Reflect Current Projections
  - Inadequate for Long Term Planning

Storm Surge Is a Big Part of the future Danger

Extremes are Rising Faster than the Mean

- **Hurricanes are natures way of cooling the oceans and sending energy back into space**
- **Warmer oceans imply "Perhaps more Frequent" and Certainly More Violent Hurricanes**
  - **9 of the 10 most damaging storms (1900-2010) have occurred in the last decade**
- **Hurricanes produce Heavy Rainfall and Storm Surge of *Many feet Above Average Sea Level*:**
  - **Hurricane Isabel (Sept. 18,2003) $6B damage (+11 Ft. Storm Surge Washington DC, *+8 Ft. AA So. Co*.)**
  - **Tropical Storm Hanna (Sept. 6, 2008) major flooding E. shore**
  - **Hurricane Irene (Aug. 27, 2011) $16B damage**
  - **Hurricane Sandy (Oct 29, 2012) $71B damage**

Coastal Insurance Rates

- **Organization for Economic Coop. & Dev. (OECD) 2007 report on 136 major port cities infrastructure, worldwide**
  - **34 Member Countries**
  - **2070 scenario at +1.4 ft.**
  - **2070 scenario estimated potential of $*35 trillion* dollars of damage due to climate change and rising SL**
- **US Nat. Flood Insur. Prog. (NFIP) is More than *$20 Billion* in debt to US Treasury**
  - **5.6 million policies covering *$10.6 Trillion* in Asset Risk**
  - **Worst East Coast Risk for repetitive coastal flood loss are:**
    - **Boston MA, NY Manhattan, New Jersey, N. Carolina, S. Carolina, S. Florida, Virginia**

US Sea Wall Examples

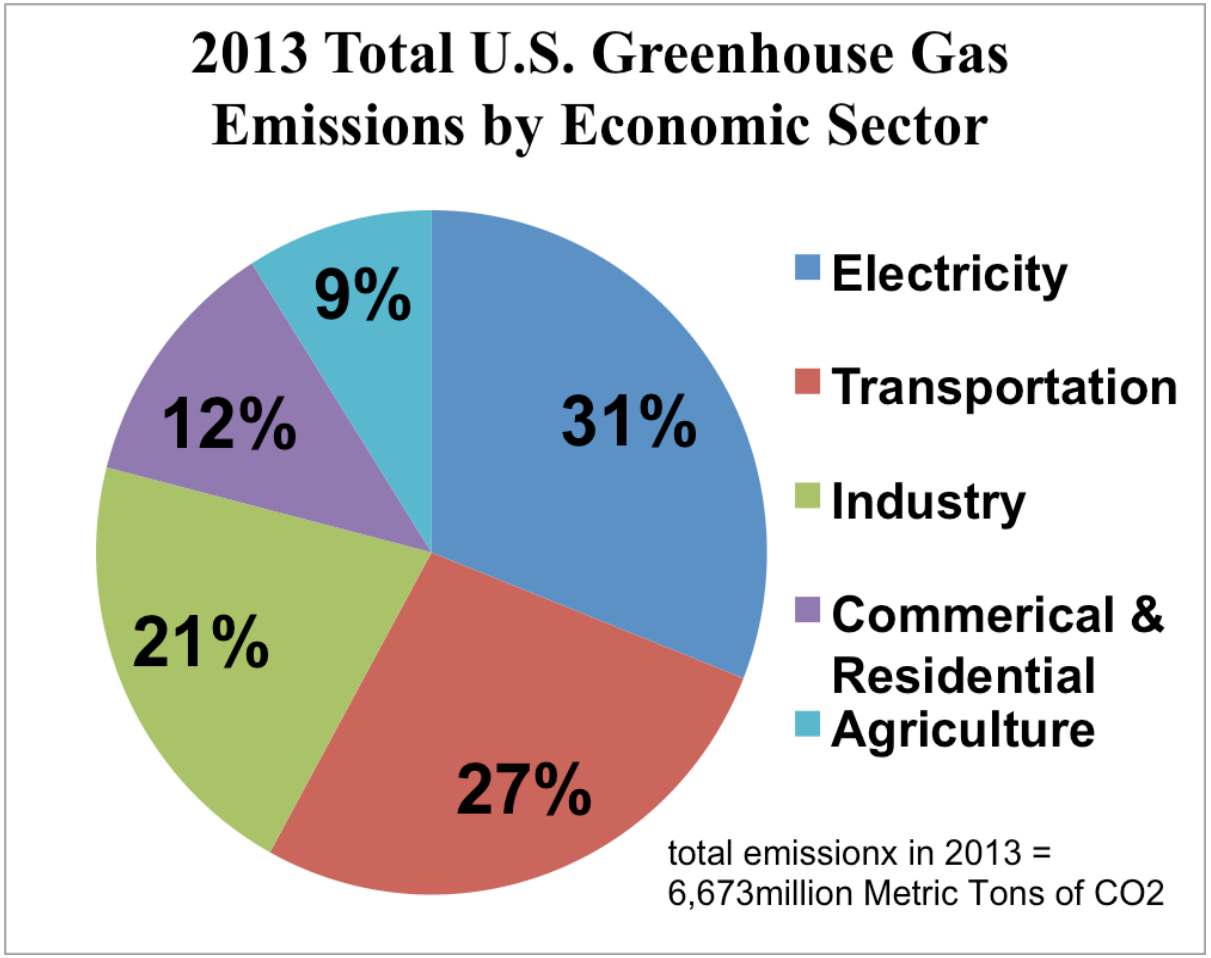
- **Galveston TX 17 ft. X 10 miles**
- **White House is only ~ +10 ft. above SL**
  - **Storm Surge Barriers being Installed**
- **NY city may need +30 ft. sea barriers**
- **Miami Dade Co. only +4 ft. above SL,expects 1 to 2 ft. SL rise by 2060**
- **Boston considering a massive storm surge barrier similar to Netherlands**
- ***ANNAPOLIS & USNA Tidal and Storm Surge Barriers*** **need to be designed and installed**

97% of all Climate Experts Agree that Global Climate Change is Driven by Human Activity

- **The largest CURRENT contributors to CO2 emissions are: China (28%), the *US (16%)* and India(6%)**
- **The largest industrial contributor to CO2 in the US is *electric power generation @ 31%***
  - **Transportation is second at 27%**
- ***Coal fired Power Plants* are the Second largest single source of electric power in the US**
- **Availability of Reliable Electric Power over a National Grid has grown for over 100 years & *Taken for Granted***
- **Conversion of electric power plants to Renewable Energy is a very large, difficult and expensive engineering enterprise.**

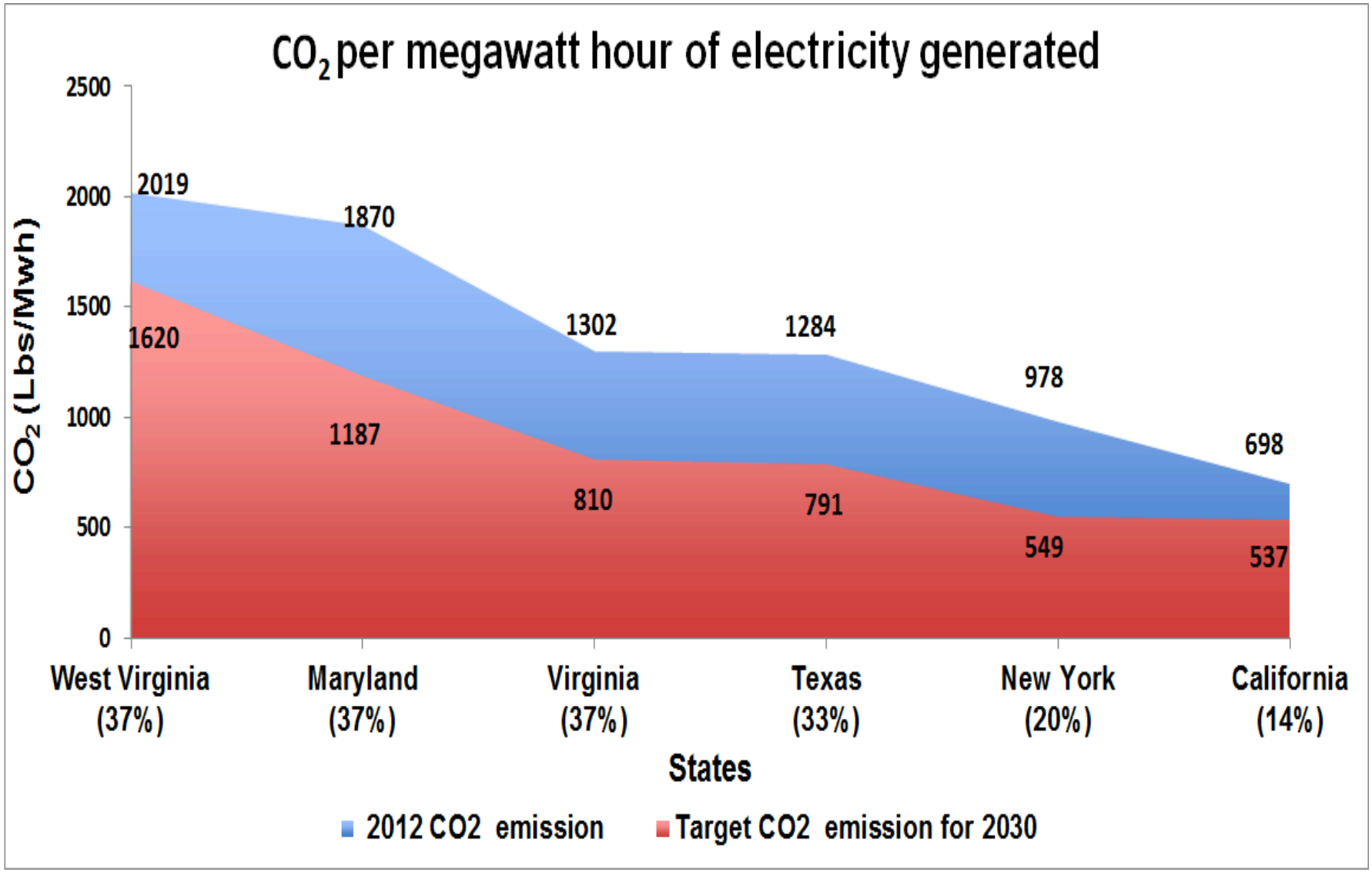
Electric Power and Transportation Dominate Carbon Dioxide Production in the US

- *CO2* has been identified as a primary catalyst to climate change.
- The *U.S. is the second highest* contributor to CO2 emissions.
- 73% of U.S. total energy was supplied by fossil fuels in 2015.
- PV cells and Wind Turbines (Tech. near *Max. Theo.* Effic.): 1.4% S + 6.4% W



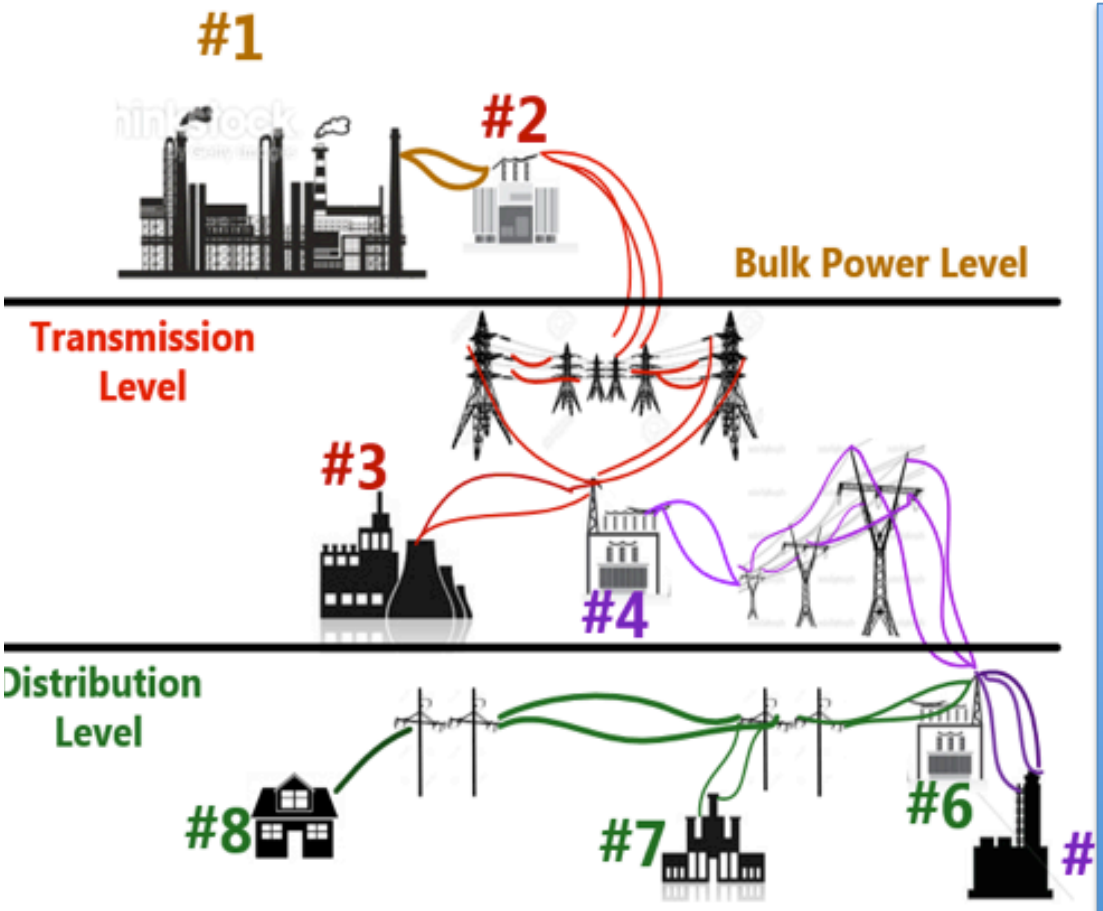
[1]

Maryland has Pledged to Reduce CO2 Production by 40%



The Modern Electric Power Grid (>100 GW): Generation – Transmission – Distribution

Where Do We Insert the Renewables?



NUCLEAR & NATURAL GAS TURBINES (INVESTOR OWNED UTILITIES)

WIND TURBINES & SOLAR/BAT. FARMS (INVESTOR OWNED UTILITIES)

SOLAR , ALL ELECTRIC VEHICLES, INSULATION & LOW ENERGY APPLIANCES

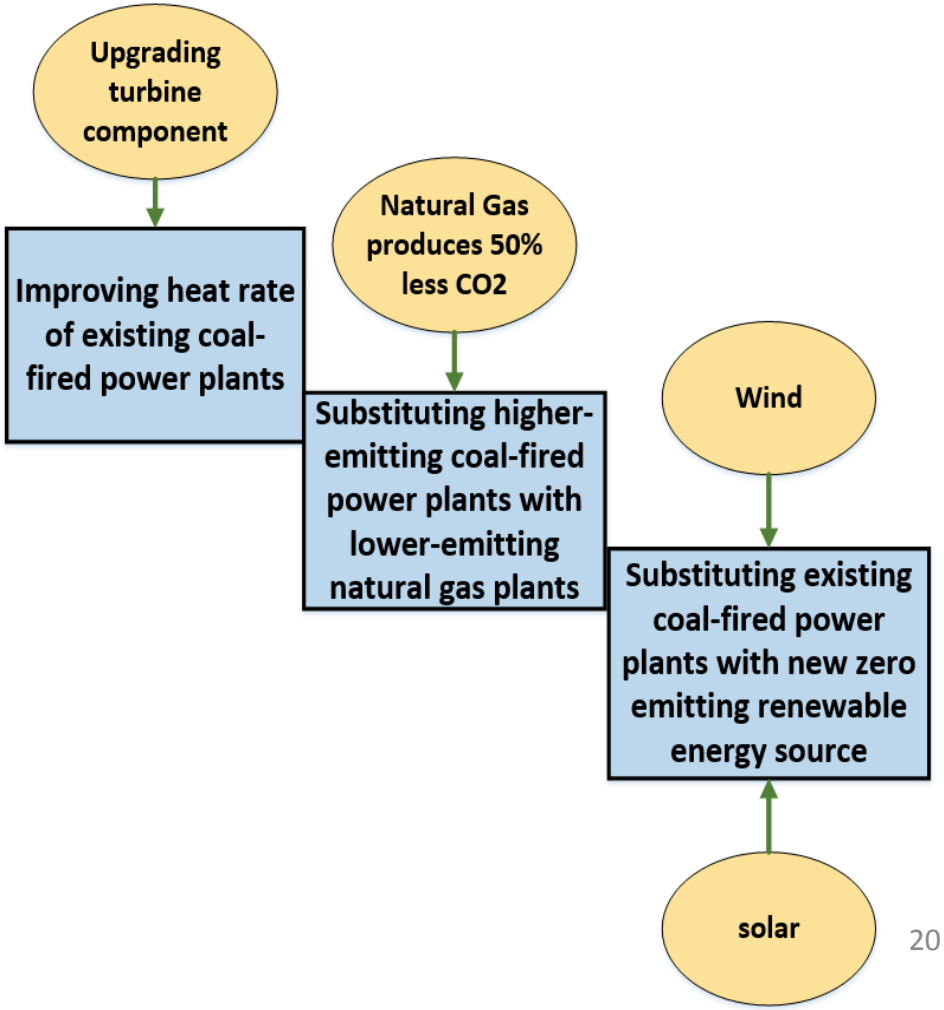
EPA's Clean Power Plan

EPA's *3 Building Blocks* to determine the *Best System Emission Reduction (BSER)*

On August 3, 2015, EPA finalized the Clean Power Plan to reduce CO_2 emission from the power sector by *32% below 2005* levels by *2030*.

EPA established interim and final CO_2 emission performance rates for:

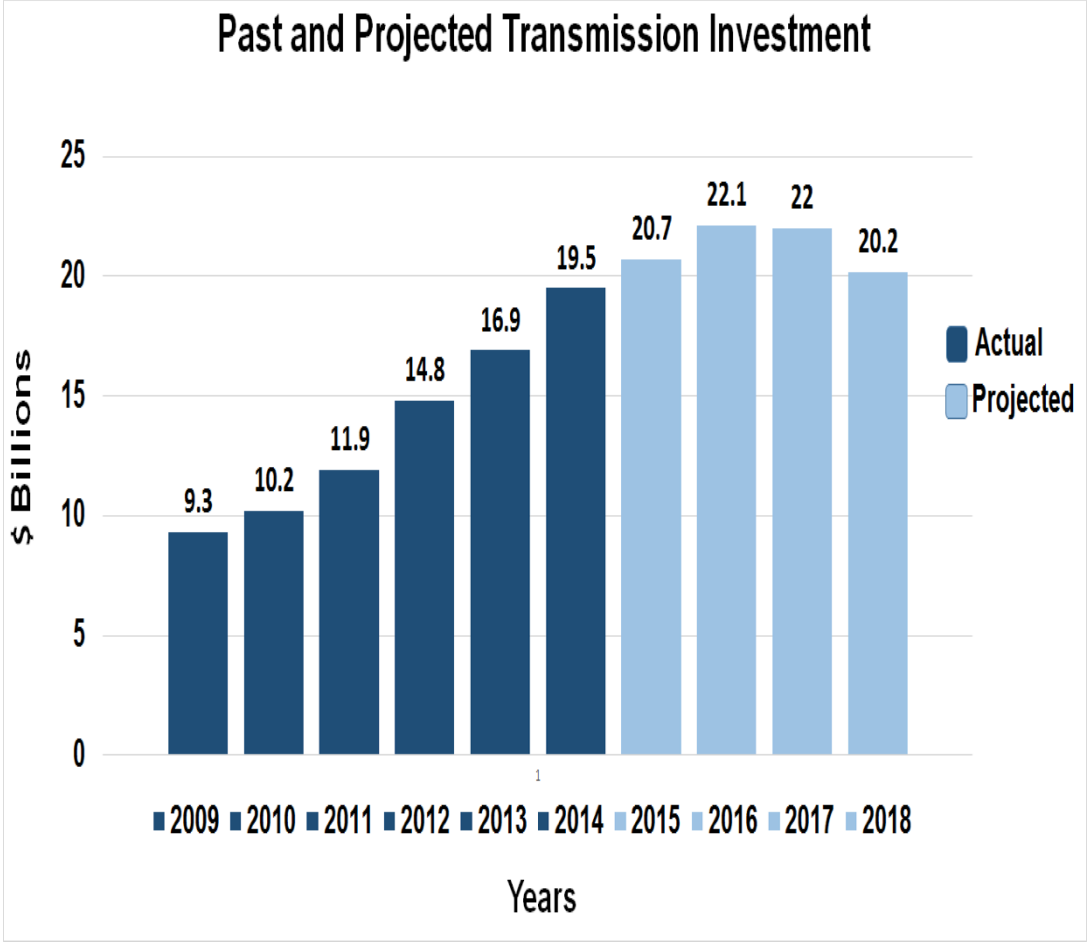
- **COAL fuel-fired power plants PHASED OUT [26% today]**
- ***Natural Gas-fired power plants FOR THE NEXT 50+ YEARS ??* [43% today]**



[2]

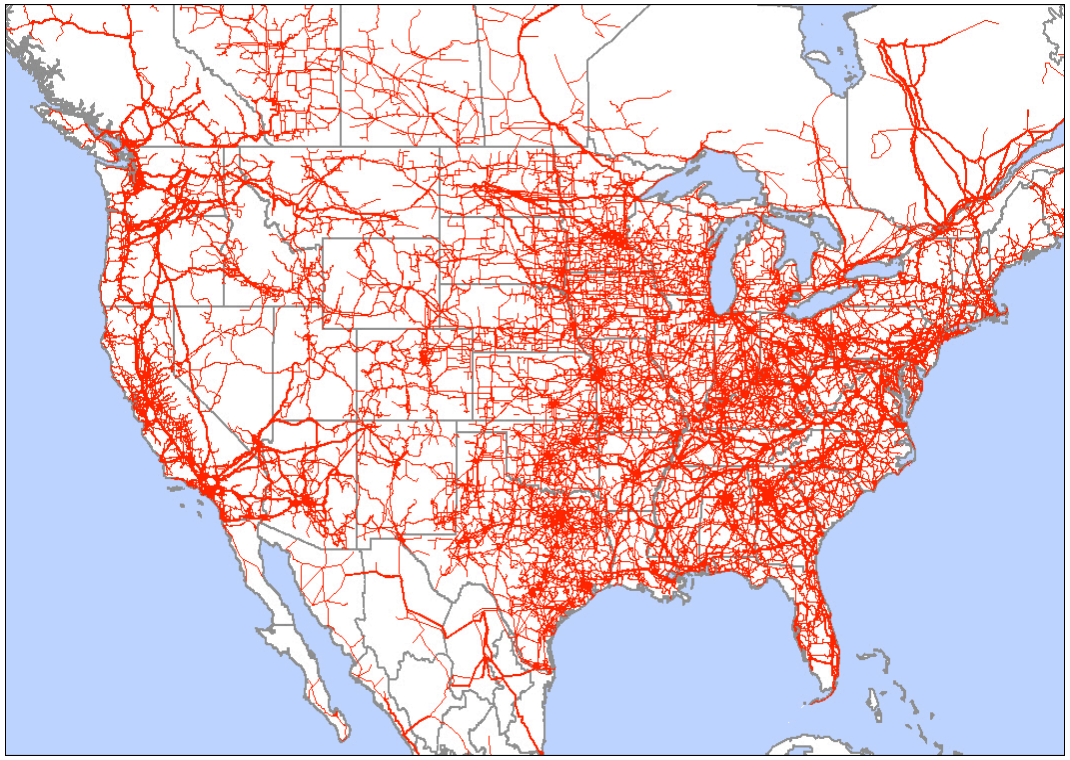
Aging Power Grid Infrastructure Requires *Significant New Investment Capital*

- **Investor Owned Utilities (IOU) have spent more *than $91 Billion* over the last 30 Years.**
- **Estimated *~$300 Billion* transmission investment needed over the Next 20 Years between 2010-2030.**
- **Properly Structured *Carbon Tax* could help to Fund this massive Investment & movement to Renewable Energy**



[6],[7]

The Power Grid – A Significant National Infrastructure Capital Asset



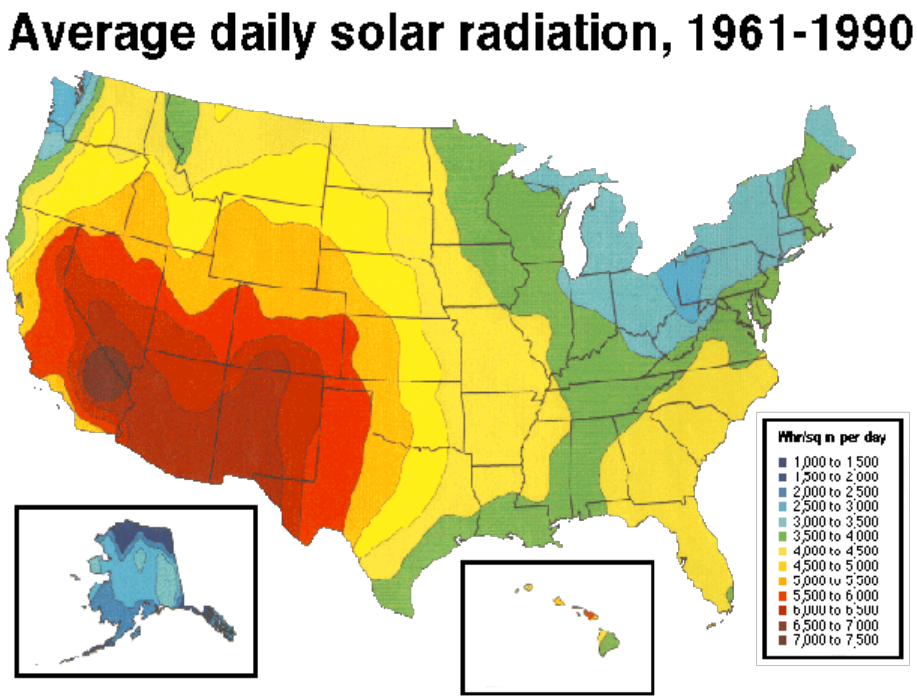
- 164,000 miles interconnected network linking over *1000 GW of Generation*
- 15,700 transmission substations in U.S.
- Estimated 6% Power is lost during trans & distribution
- Typical Home Rooftop PV output *<10KW*
- ~100 Million homes during the day??? What about THE *NIGHT??*
- ~ 300 Thousand 3MW Wind Turbines?

A Smart Grid is Needed to Manage Unpredictable *Energy Storage* for Nighttime (*Base*) Loads

[3],[4],[5]

We Get Renewables from Where the Sun Shines and the Wind Blows: @11 PM in MD, Solar from Calif. ? Wind from TX, WV, KS or Offshore ?

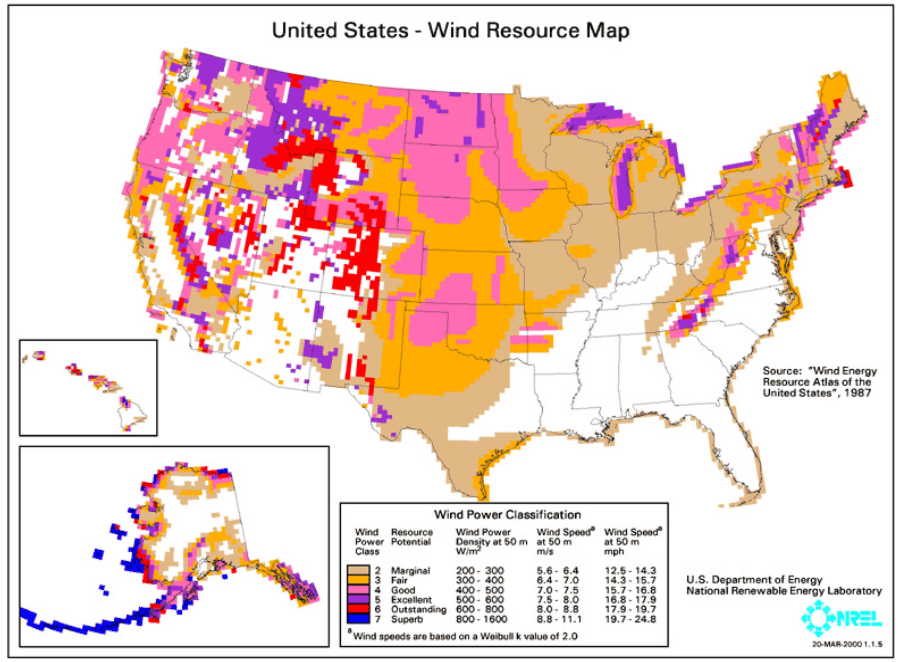
Solar Energy Map Of The U.S.



Energy from the sun on a surface directly facing the sun.

Special thanks to the National Renewable Energy Laboratory

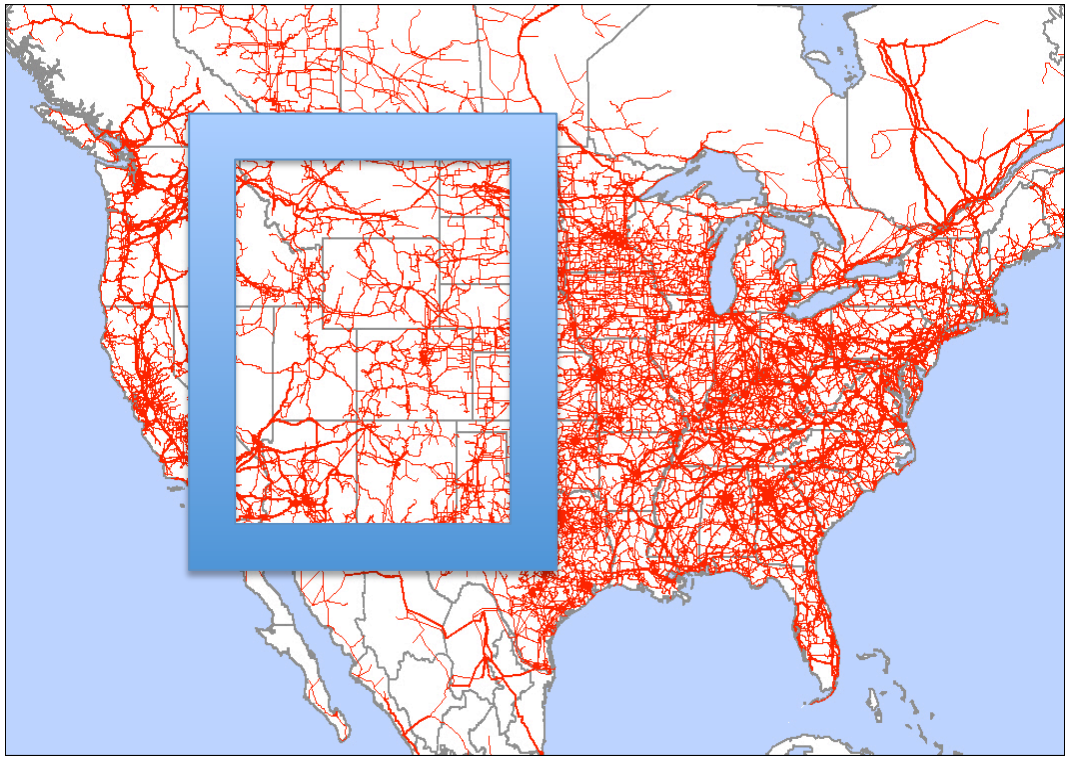
U.S.A. Wind Resource Map



Wind energy resources in the United States

U.S. state maps of wind resources are available at:
http://www.eere.energy.gov/windpoweringamerica/wpa/wind_maps.asp

Solar and Wind are the Most Abundant Where the Grid and Political Support are the Weakest



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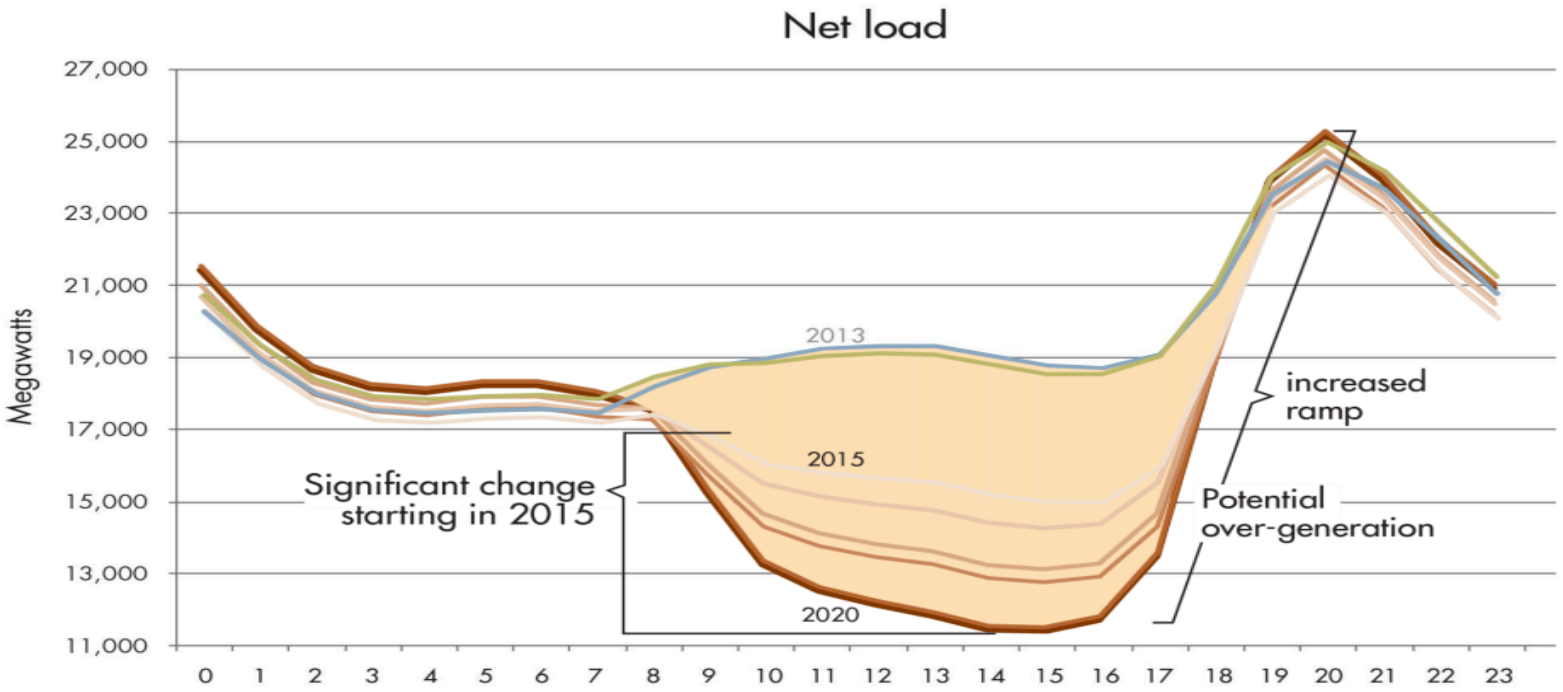
The *"Duck Curve"* – Base Load Ramp Up and Down Problem
California Power Grid



- **High levels of rooftop installation and isolated operations of PV renewables have proven to cause heavy imbalance between supply and demand**
  - ***~ 40% may be limit without NEW Battery Technology!***
- **Intermittent power production needs sophisticated power control and storage methods. *Natural Gas* fueled Turbines is a 2 Generation Solution. *Regulated Fracking Required* to Produce the Natural Gas Fuel.**
  - ***~ 300,000 3 MW Wind Turbines*** **[~50 story high Bld] are needed!**

[10]

Adding more Solar Renewables will make a Problematic "Duck" w/o *New Massive Energy Storage Technology*

- **Only about *40% of the Net Load* can be supplied by PV Renewables**
  - **Base Load from Nuclear, Natural Gas fired Gas Turbines and Hydroelectric?**
- **If the Duck's belly drops too low, that means PV Solar renewable sources are producing too much electricity, more than we can use.**
  - **So it gets wasted, or could damage the grid. And with a sagging duck belly, adding more Solar renewables won't do any good.**
- **When the Duck's peaks are high - its head and tail - there isn't enough electricity coming from renewable sources to meet the demand. So it has to come from elsewhere (i.e. Wind, Hydo, Nuc. And Smart Grid)**
  - **Because Non-Renewable power plants take a long time to Ramp Up and to Ramp Down, *the longer and steeper the duck's neck and tail, the harder it will be for utilities to provide power when the sun isn't shining and the wind isn't blowing***
  - ***Transitioning to All Electric Vehicles will put More NIGHTIME LOAD to recharge Car Batteries***
  - ***Natural Gas Turbines for the next 50+ years***

Energy Conservation and Efficiency is a MUST for reducing CO2 in the Atmosphere

- Emphasis on Renewable Sources of Energy can be ONLY PART of the Solution
- *Public Policy* on High Energy Use and Greenhouse Gas Producing/Absorbing Activities is a ***MUST*** for the future:
  - Automobile Efficiency Standards
    - *42mpg (35.5mpg fleet) avg by 2025* is a BIG DEAL
  - Low Energy Lighting
  - More Efficient Air Conditioning & Heating
    - Geothermal Heat Pumps
  - Better Insulated housing
  - Better Farming Policy

We are the *First* Generation to Understand what we have done to the Planet and the *Last* to not have to *Live with the Consequences*

- **Humanity has an insatiable desire for *ENERGY***
- **The damage we have done to the global climate over the last 3 Generations *is largely irreversible for the Next 10 Generations***
- **China, the US and India are the major national political entities that need to change (50% of global CO2 production)**
- **The Electric Power Grid is Central to CO2 production and to *National Political Policies* (even more so as surface transportation moves to *electric propulsion*)**
- **Base (or Net) Load Engineering Constraints *presents Limits to Renewable Energy Sources on the Power Grid with todays BATTERY technology & UTILITY BUS. MODELS***
- **We MUST STOP MAKING IT WORSE, BUT:**
  - ***PREPARE FOR RISING SEA LEVELS of up to 2 Ft. in AA Co. by 2050***
  - ***Restrict Low area NEW Development – NOT INSURABLE***
  - ***More Frequent Storm Surge is the Largest Risk to High Water Damage***

Sources of Data and Model Predictions

- **[1]*"Come High Water: Sea Level Rise and the Chesapeake Bay", Chesapeake Quarterly and Bay Journal, Oct. 2014, v. 13, n 2-3***
- **[2]Englander, John, "High Tide on Main Street: Rising Sea Level and the Coming Coastal Crisis, 2014 Ed.;**
- **[3]Pilkey, O.H. & R. Young, "The Rising Sea", 2009;**
- **[4]Fagan, B., "The Great Warming: Climate Change and the Rise and Fall of Civilizations", 2008**
- **[5]U Tube, Holland's Barriers to the Sea" 44 min.**
- **[6]Olibah, S., C. Ramirez, M. Dranbauer, R. Bhati, "Preliminary Design and Cost Estimate of a Large Scale Field Trial for Earth Albedo Modification with Sulfur Dioxide", SIED IEEE Conf. 29 April, 2016**
- **[7]Jenkins, T, T. Teklie, A. Alemayehu, T. Tablada, "Design and Cost Decentralizing Electric Power Grids to Achieve EPA CO2 Emission Standards", SYST 495 Final Report, April 2016.**
- **[8]*Overwhelming Risk: Rethinking Flood Insurance in a World of Rising Seas*, Union of Concerned Scientists, www.ucsusa.org/flood insurance, Feb. 2014**
- **[9] *Updating Maryland's Sea-Level Rise Projections*, Special Report of the Scientific and Technical Working Group to the Maryland Climate Change Commission, Univ. of Maryland Center for Environmental Science, June 26, 2013.**