

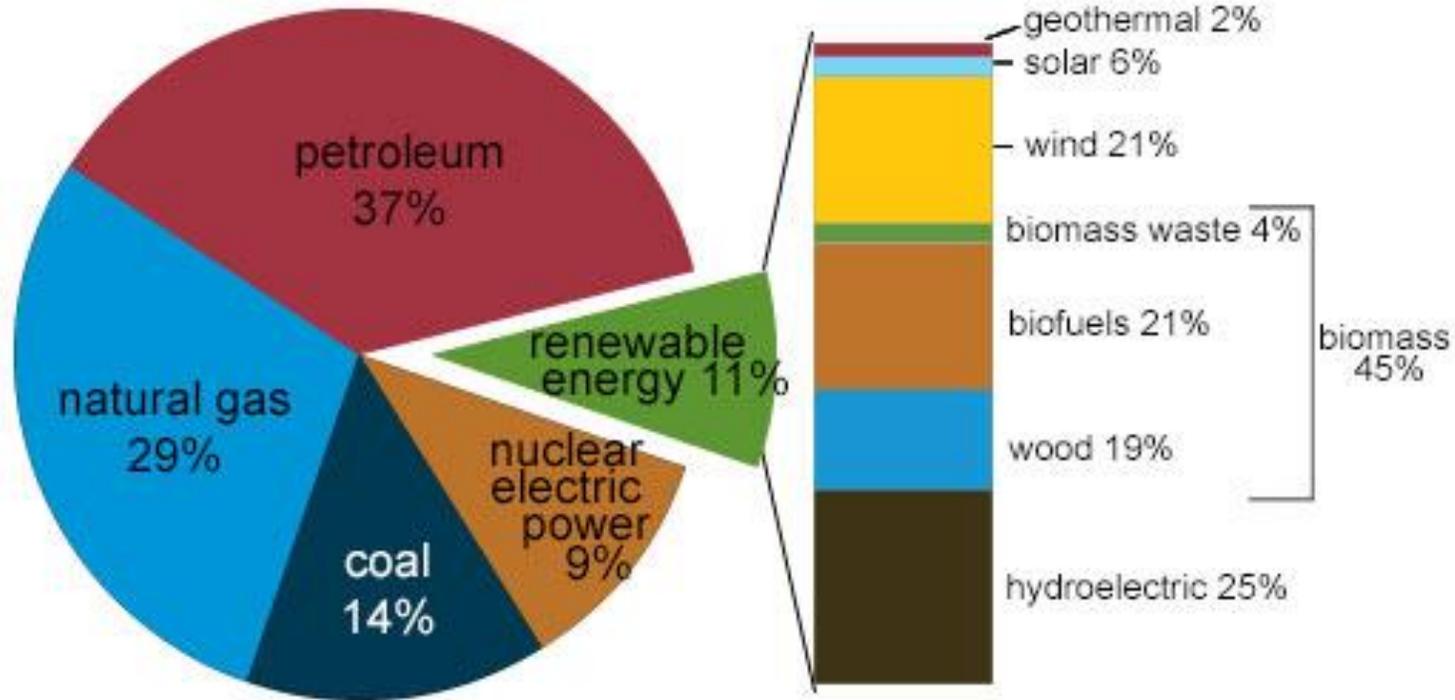
MUNI
FSS

Renewables, Climate Policy

Martin Jirušek, PhD.

U.S. energy consumption by energy source, 2017

Total = 97.7 quadrillion
British thermal units (Btu)

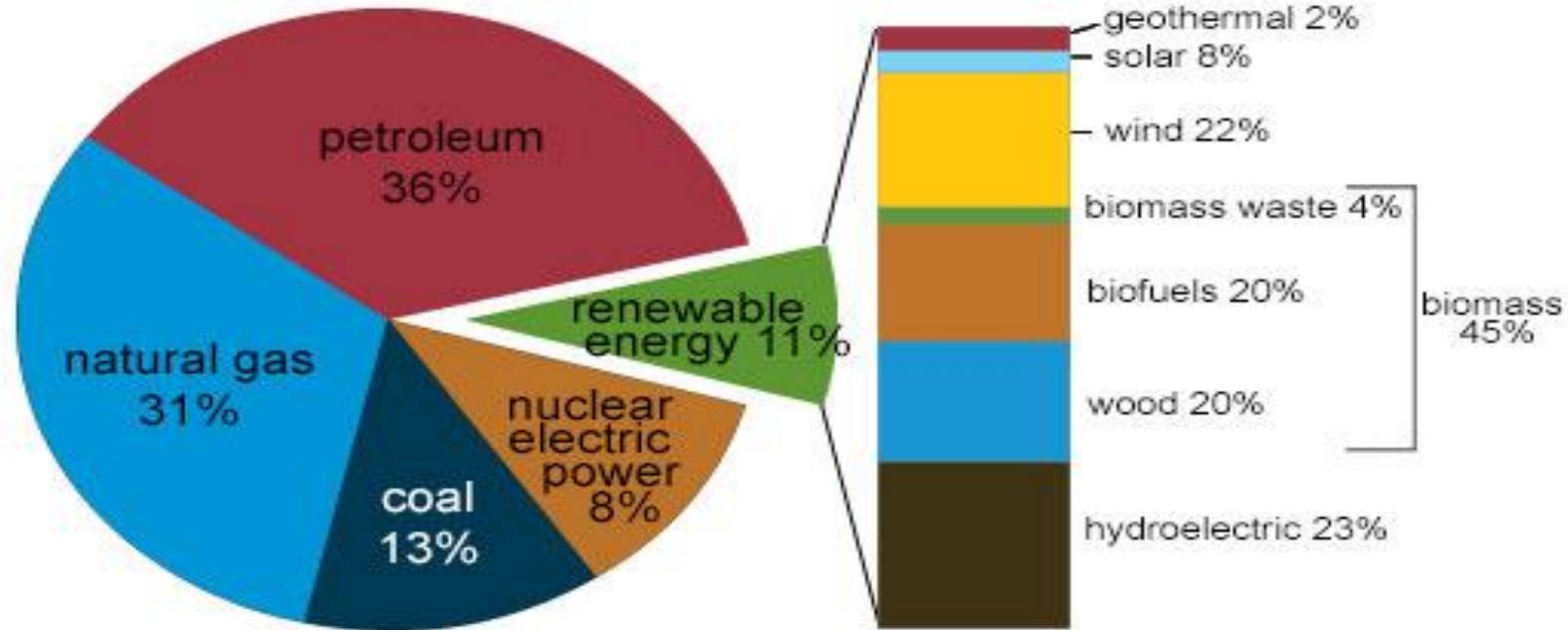


Note: Sum of components may not equal 100% because of independent rounding.
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2018, preliminary data



U.S. energy consumption by energy source, 2018

Total = 101.3 quadrillion
British thermal units (Btu)

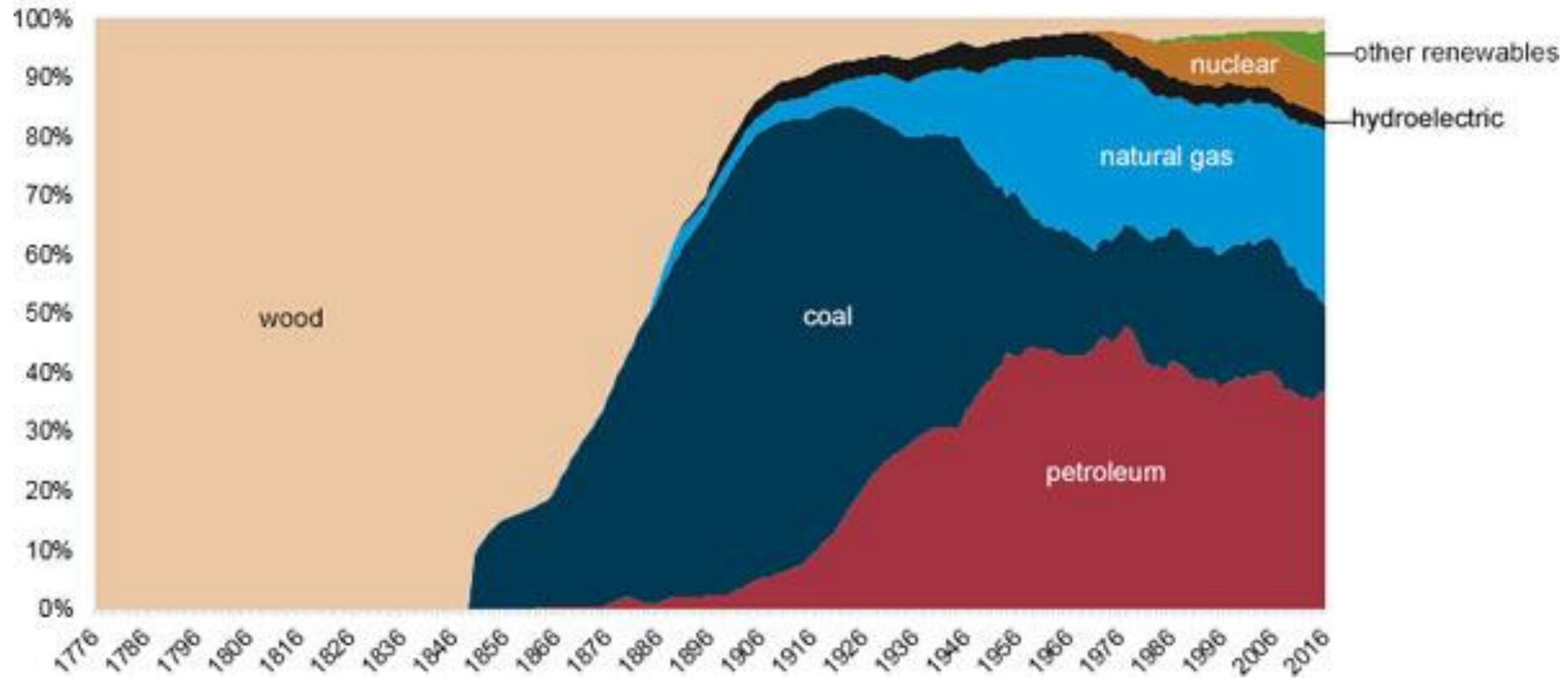


Note: Sum of components may not equal total because of independent rounding.
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2019, preliminary data



- Solar (mainly PVs) and wind marked the biggest additions among RES

Share of U.S. energy consumption by major sources, 1776–2016



Source: U.S. Energy Information Administration, *Monthly Energy Review*, April 2017, preliminary data for 2016



US electricity generation by source

2013 - 2015

- Coal 39%
- Natural gas 27%
- Nuclear 19%
- Hydropower 6%
- Biomass 1.7%
- Geothermal 0.4%
- Solar 0.4%
- Wind 4.4%
- Petroleum 1%
- Other gases <1%

2017

- Natural gas 32%
- Coal 30.4%
- Nuclear 20%
- Hydropower 7.5%
- Wind 6.3%
- Biomass 1.6%
- Solar 1.3%
- Geothermal 0.4%
- Petroleum 0.5%
- Other gases 0.3%

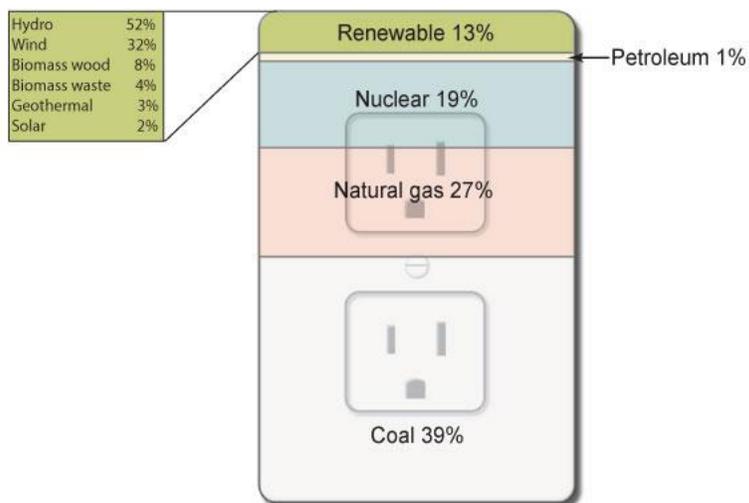
2018

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- Coal 27.4%
- Nuclear 19,3%
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- Biomass 1.5%
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- Geothermal 0.4%
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- Other gases 0.3%

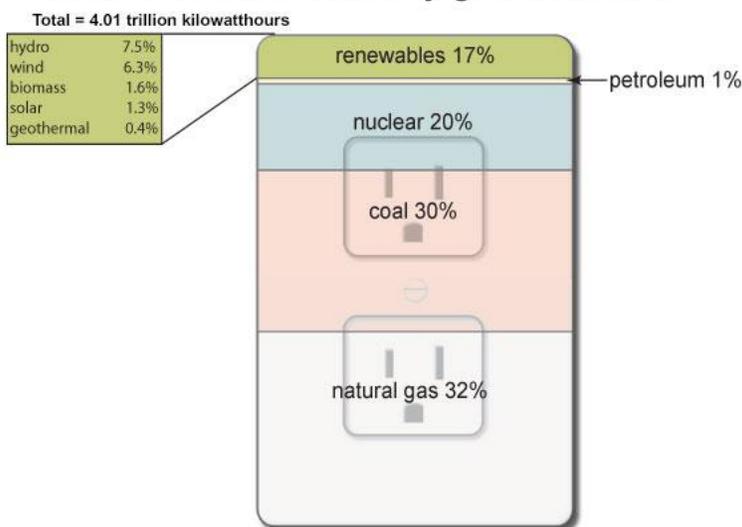
RES – share on total production

- Total installed capacity 163 GW (2x as much compared to 2000)
- Biggest sources of RES electricity – hydro (1/2), wind (1/3)
- 4. world's biggest producer of hydropower

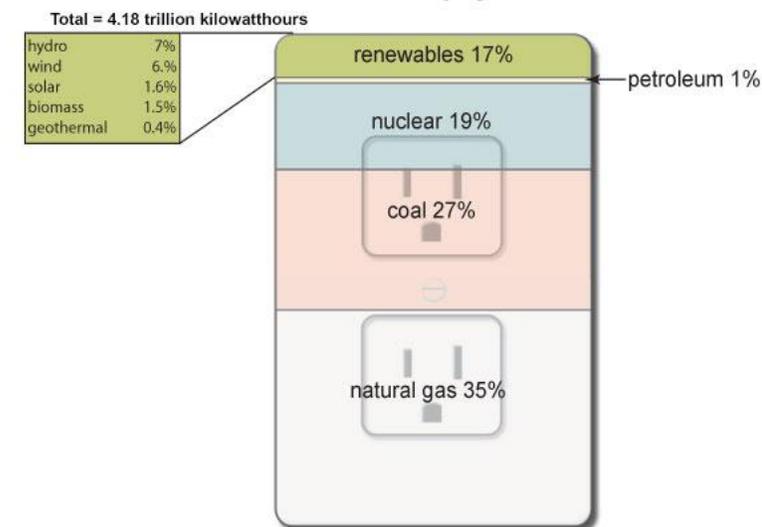
Sources of U.S. electricity generation, 2013



Sources of U.S. electricity generation, 2017



Sources of U.S. electricity generation, 2018



Source: U.S. Energy Information Administration, *Electricity Power Monthly* (February 2014). Percentages based on Table 1.1 and 1.1a; preliminary data for 2013.

Note: Electricity generation from utility-scale facilities.

Source: U.S. Energy Information Administration, *Electric Power Monthly*, February 2018, preliminary data

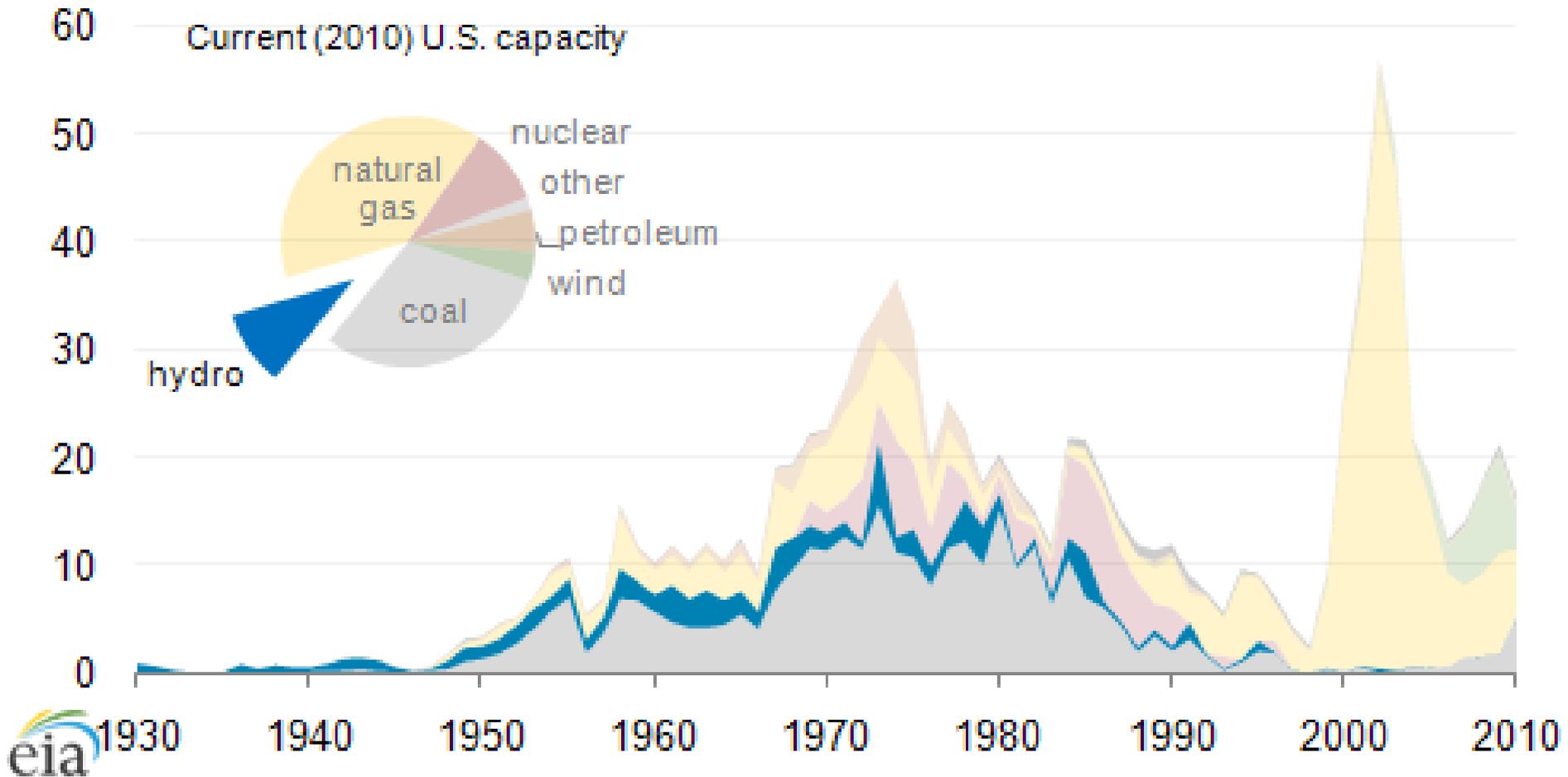
Note: Electricity generation from utility-scale facilities.

Source: U.S. Energy Information Administration, *Electric Power Monthly*, February 2019, preliminary data



Note: Sum of components may not equal 100% due to independent rounding.

Current (2010) capacity by initial year of operation and fuel type gigawatts



Biggest Producers of Renewable Energy

World

- China
- India
- USA
- Brazil

US (excl. hydro)

- Texas
- California
- Iowa
- Oklahoma

RES – distribution



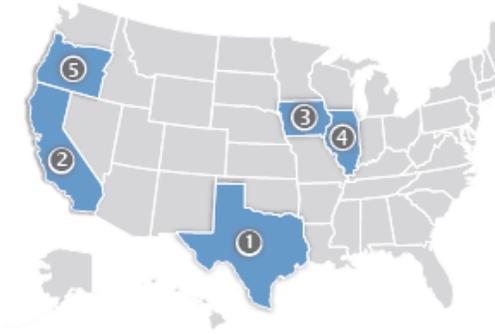
Solar PV	
1	California
2	Arizona
3	New Jersey
4	Nevada
5	Colorado



CSP	
1	California
2	Florida
3	Nevada
4	Colorado
5	New Mexico



Biomass	
1	California
2	Florida
3	Maine
4	Georgia
5	Virginia



Wind	
1	Texas
2	California
3	Iowa
4	Illinois
5	Oregon

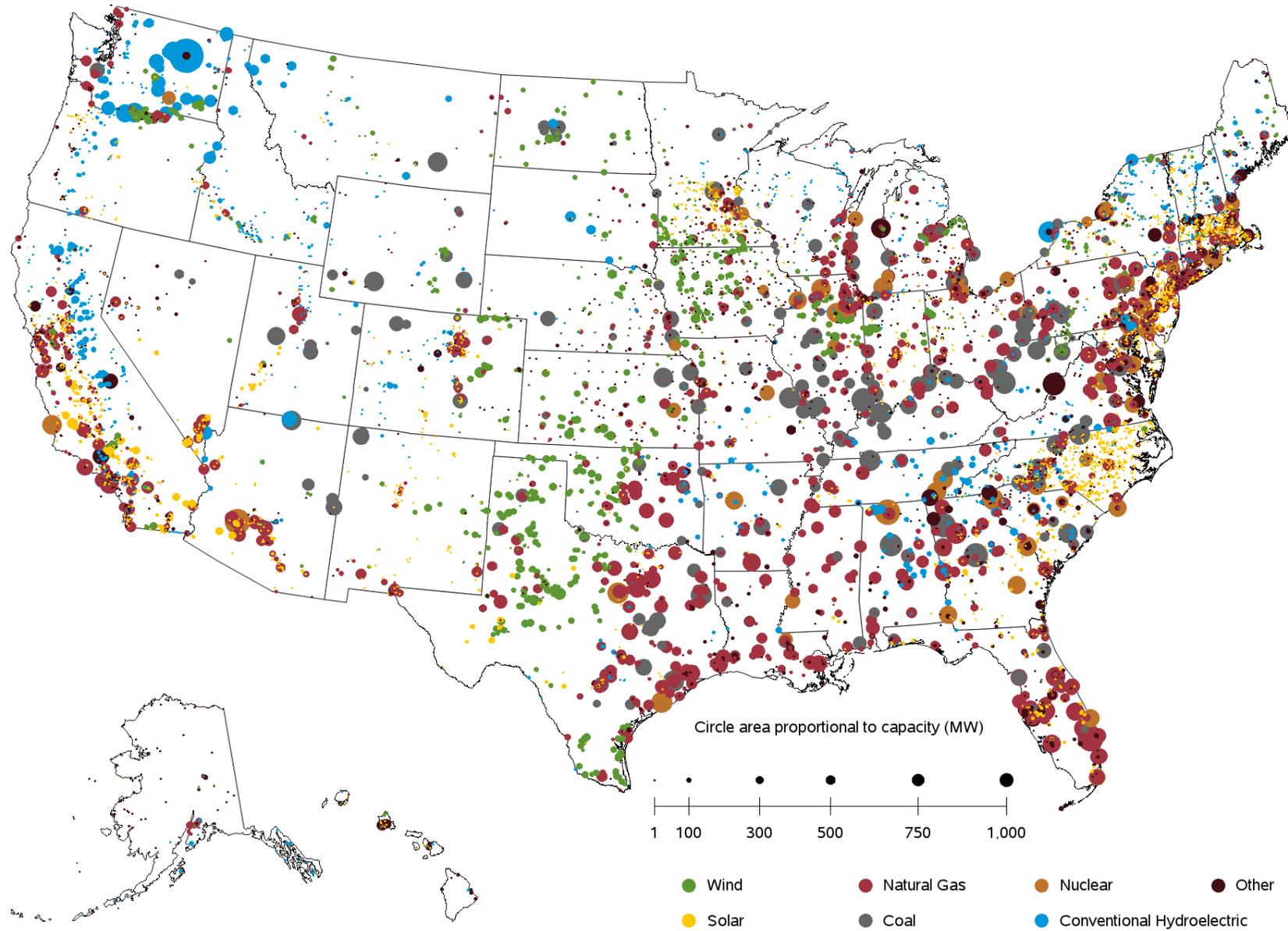


Geothermal	
1	California
2	Nevada
3	Utah
4	Hawaii
5	Oregon



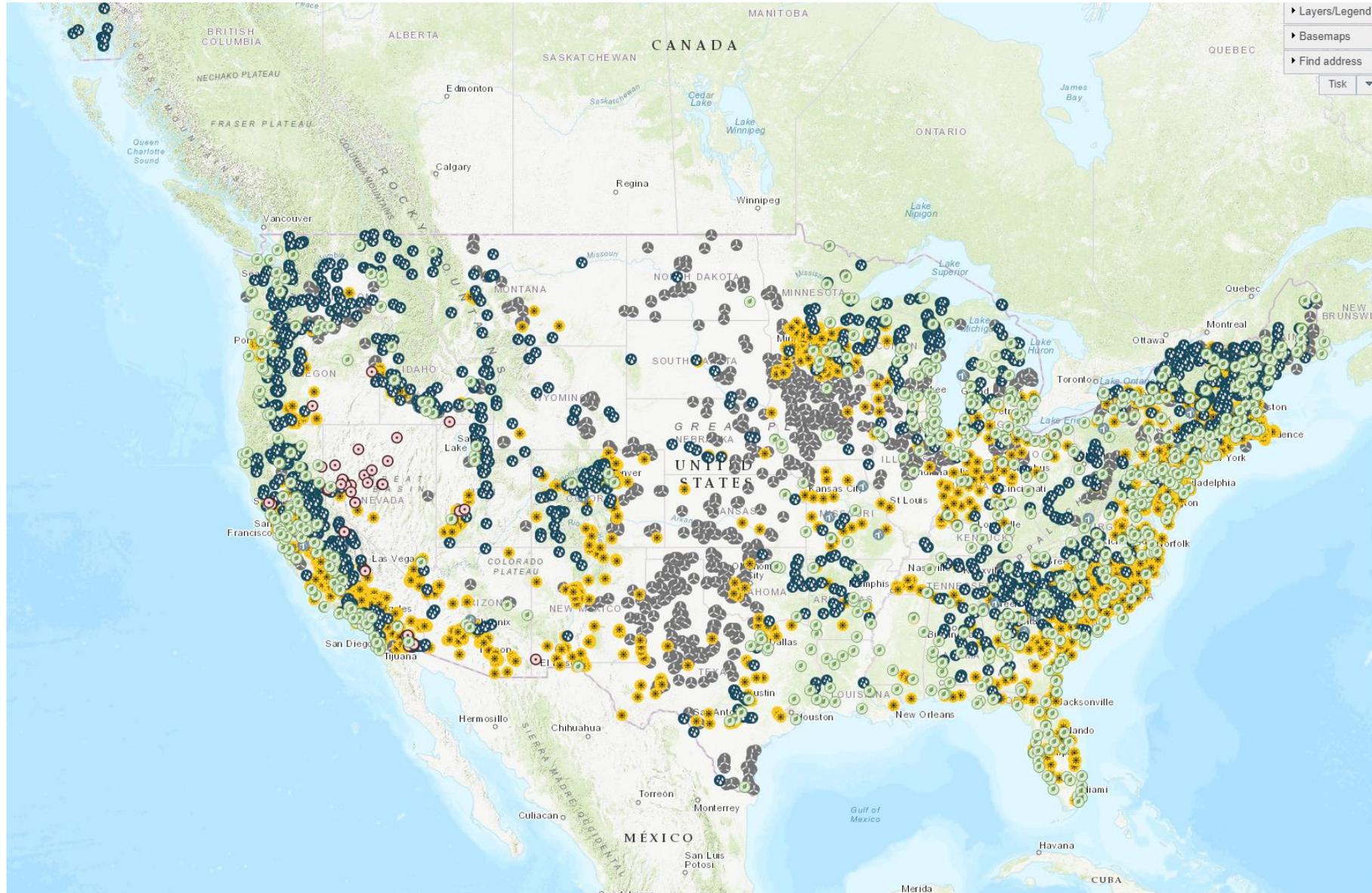
Hydropower	
1	Washington
2	California
3	Oregon
4	New York
5	Alabama

Operable utility-scale generating units as of August 2019

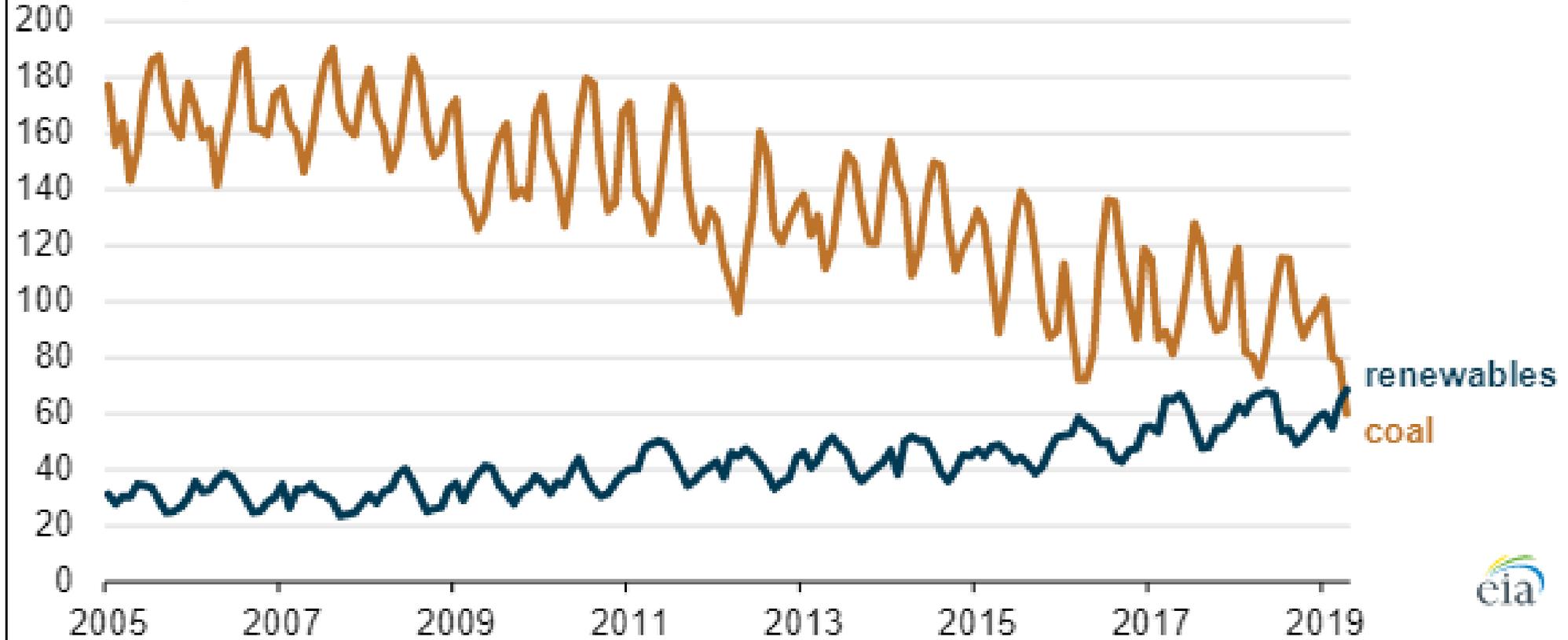


Sources: U.S. Energy Information Administration, Form EIA-860, 'Annual Electric Generator Report' and Form EIA-860M, 'Monthly Update to the Annual Electric Generator Report.'

RES-based Electricity Generation

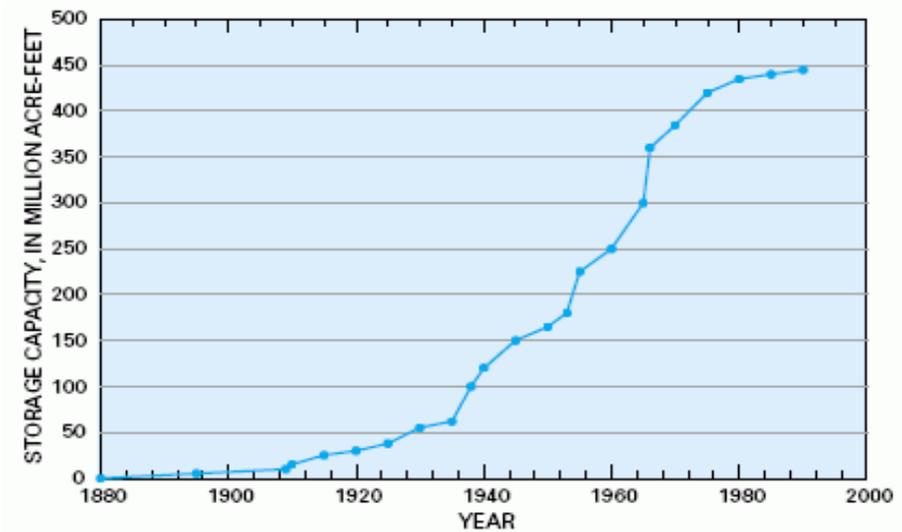
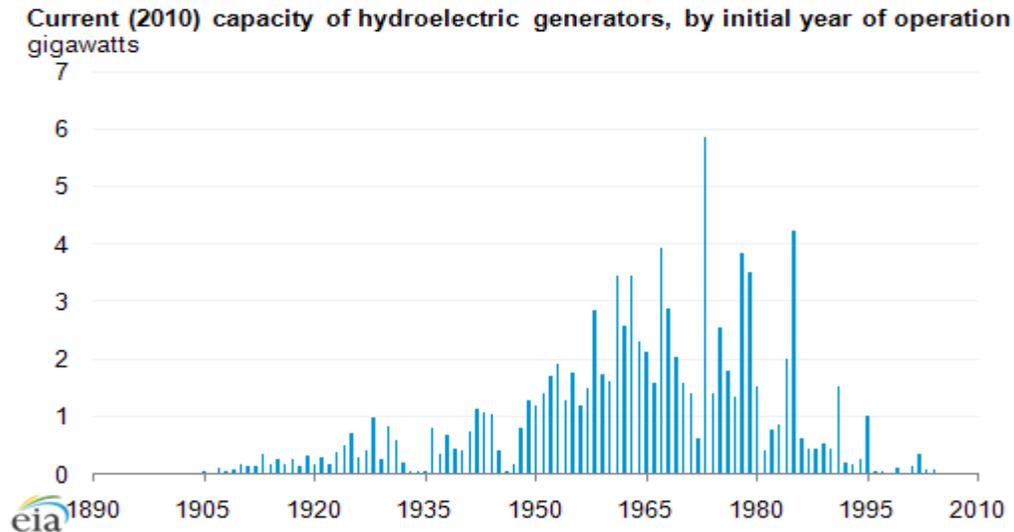


U.S. monthly electricity generation from selected sources (Jan 2005-Apr 2019)
million megawatthours



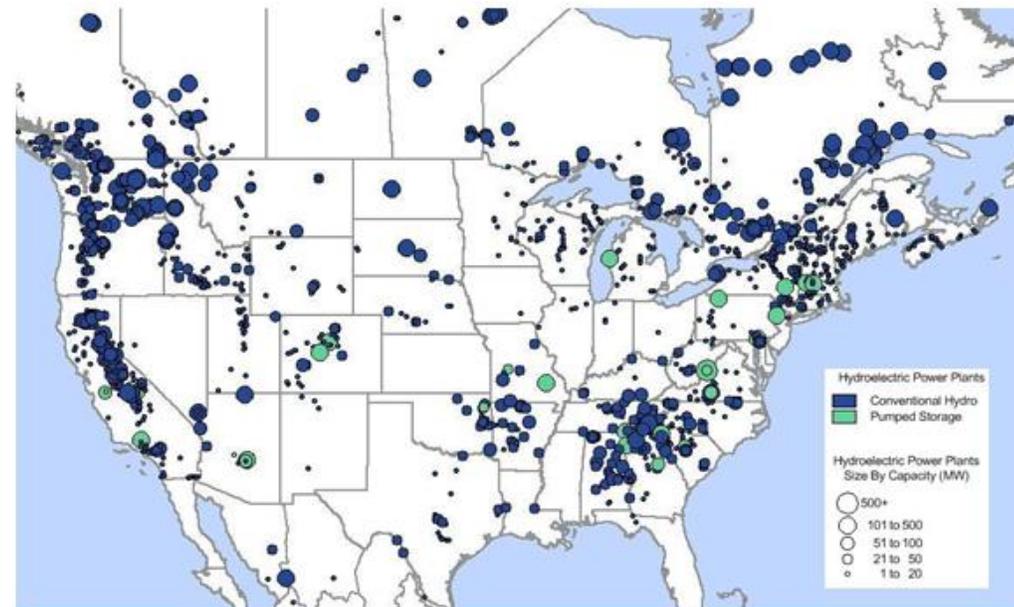
RES - development

- Different kinds of RES came online in different times/situations
- Hydropower – the oldest of RES – increase of installed capacity/production until 1970s
 - biggest capacity (in RES)
 - Federal activity – majority owned/operated by governmental agencies
 - Important source in times of urbanization
 - In decline since 1980s – exhausted potential, aging
 - Only smaller, private-owned sources are currently being installed



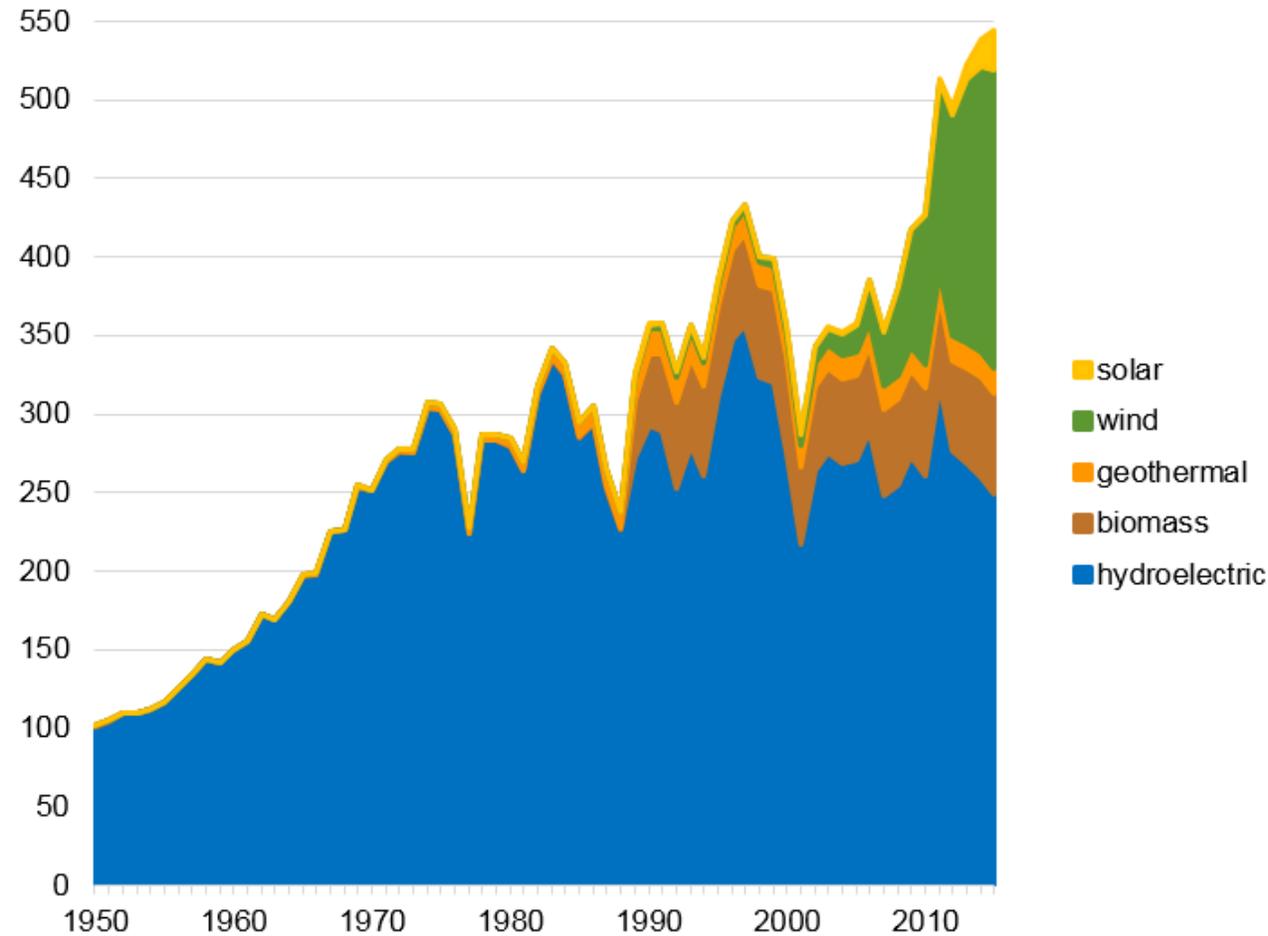
Hydro PPs

- Hydro PPS are unevenly distributed due to natural conditions
- Majority of electricity imported from Canada comes also from hydro PPs
- Biggest producers Washington (no. 1 in US – 70% from RES), Oregon, California (> 50% of total electricity production)
- Spring „oversupply“ – usually squeezes other sources from the grid
- Grid capacity issues
- In spring, hydro meets almost entire demand on NE
- NW with the biggest potential for new projects



U.S. electricity generation from renewable energy sources, 1950–2017

billion kilowatthours



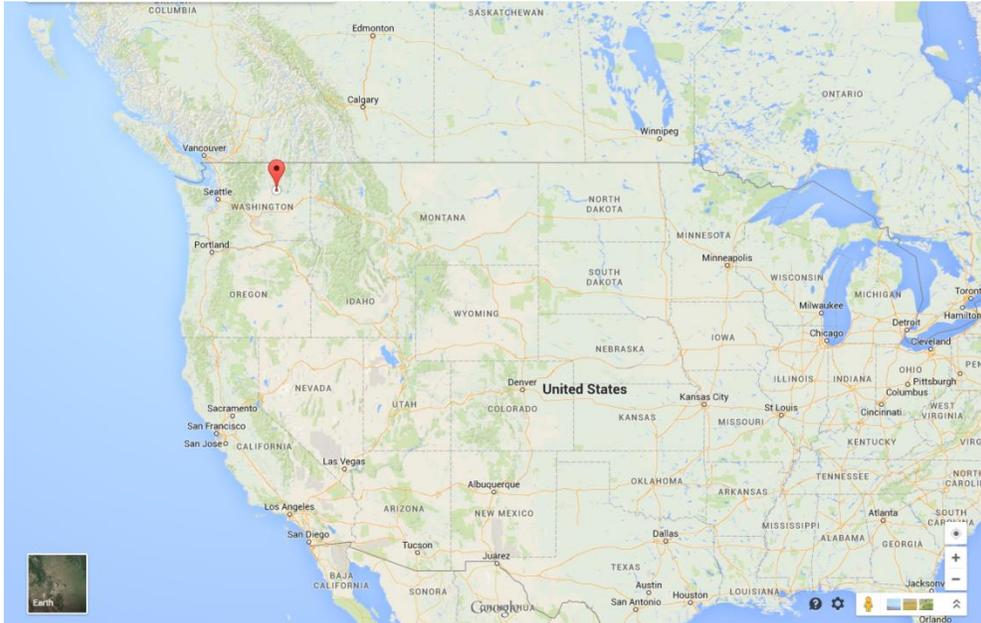
Note: Electricity generation from utility-scale facilities. Hydroelectric is conventional hydropower.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 7.2a, March 2018, preliminary data for 2017



Grand Coulee Dam, Washington

- Columbia River, Washington



- Capacity - 6800 MW





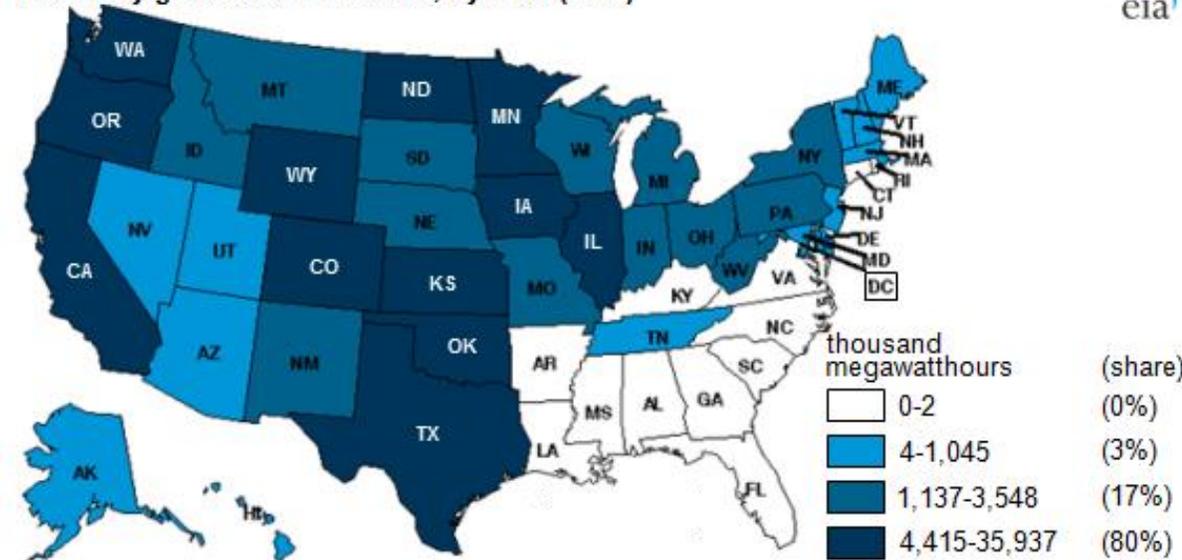
Hydro Power

- Dominance of gravity dams
- Limited amount of pumped hydro power plants
- High initial (fixed) costs
- Low variable (running) costs
- Stable production (X solar, wind)

Wind power

- Texas, Iowa, California, Oklahoma, Illinois, Kansas, Minnesota, Oregon, Colorado, Washington, North Dakota, Wyoming = 80% of US overall wind capacity
- W coast – oversupply of RES (hydro, wind, solar)
- Fastest growing RES along with solar power
- 23x since 2000

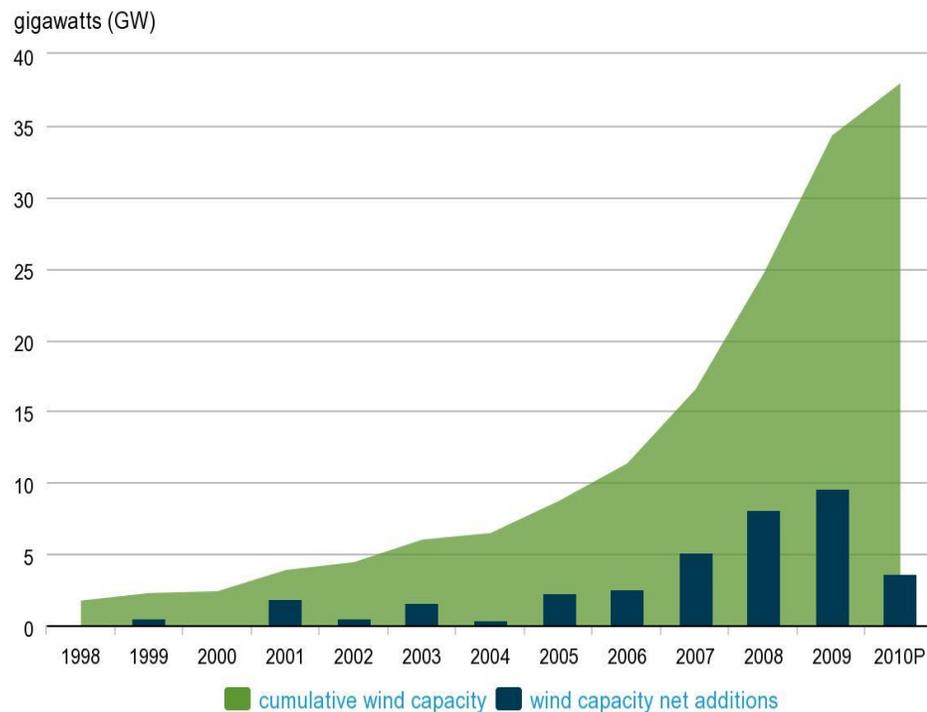
Electricity generation from wind, by state (2013)



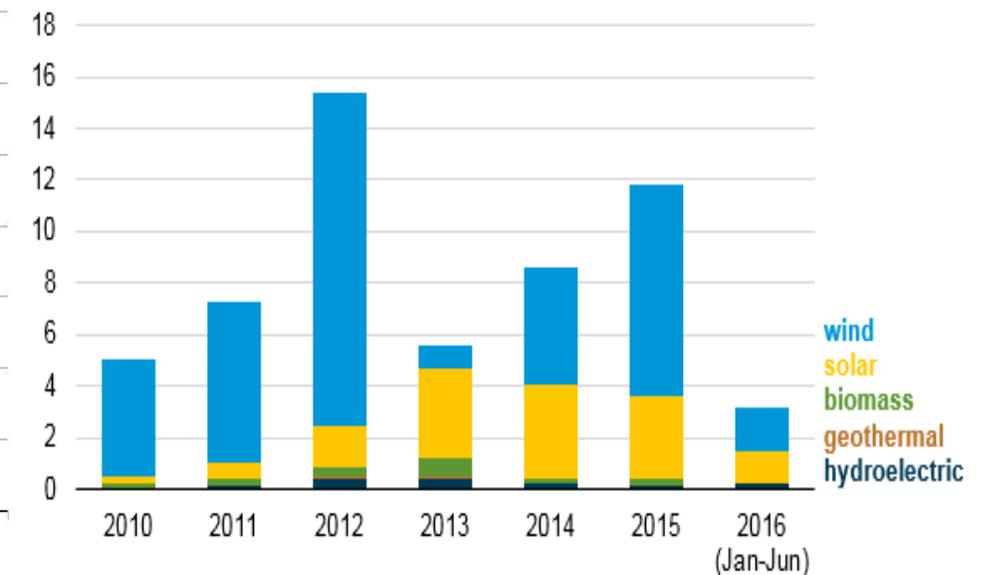
Wind Power

- Biggest addition to the overall RES capacity
- Massive increase also thanks to governmental support

Wind capacity and additions, 1998 - 2010

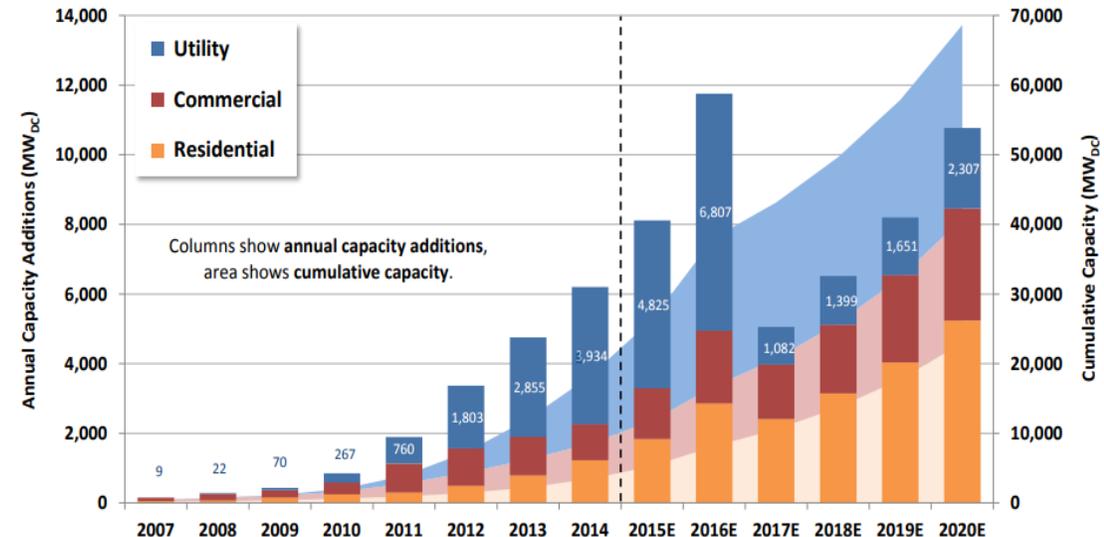


Capacity additions for utility-scale renewable technologies, 2010-16



Solar power

- Majority of sources are deconcentrated low-capacity sources (privately owned)
- California, Arizona, New Jersey, Nevada, Colorado
- Emission drop
 - E.g. Nevada 85% decrease between 2005-2015 (!), coal to phase out by 2023
- Decline of initial costs (production costs, economy of scale,...)
- Increase of incentives – tax credits
 - on the federal level + state support
- Influx of renewables changing pricing patterns
 - E.g. Solar PVs in Nevada are currently practically ‘worthless’
 - negative market price during the day (!)
 - Potential for ca. 10000 MW of solar power in Southern Nevada alone
 - Projects to concentrate solar power generation in larger clusters of 50 – 300 MW



Source: GTM/SEIA (2010-2015), Tracking the Sun Database

RES and New Dynamics in Electricity Production and Consumption

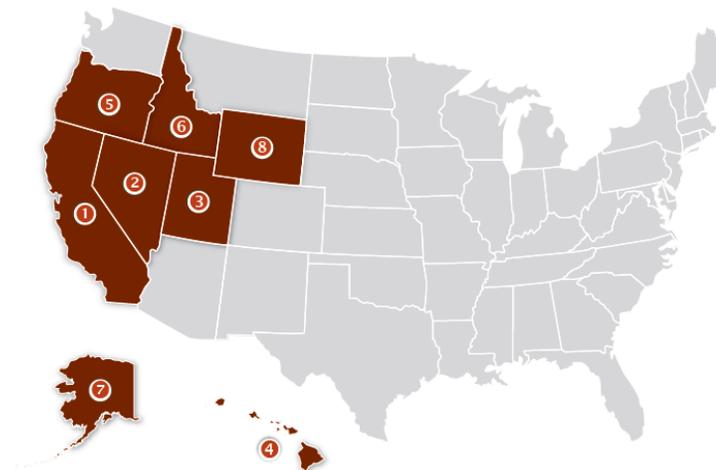
- Intermittent sources can be unpredictable
- Growing dynamics put a greater pressure on the grid, which needs to be more robust and larger/interconnected to balance demand/supply irregularities
- Utilities and distributors have to recognize the new reality
 - Irregularities in electricity production
 - Shifting peak demands (from mid-day to late afternoon) that need to align with peak production (during the day and until ca. 3 hrs after the sunset)
- Case in point - Pacific NW (WA, OR) – growing stability even with growing amount of RES

RES and New Dynamics in Electricity Production and Consumption

- Need for a more ‘communicative’ grids, responsive consumers – two-way/smart(er) grid
 - Former consumers may now sell domestically generated electricity to the grid – so far only solar
 - ‘Prosumers’
 - Falling prices of electricity storage – pumped hydro, batteries
 - E.g. New water heaters must be equipped with a connection to the grid so they can be remotely shut off to levelize demand peaks
 - New related issues – e.g. Privacy – legal restriction on data collecting

Other RES

- **Biomass** – local use, not important on federal level
 - utilization of waste or in related facilities (sawmills, paper mills,...)
- **Geothermal**
 - US – the world’s leader in installed geothermal capacity – 3,4 GW
 - big potential, slower growth than wind and solar
 - used also for heating and cooling
- **Influencing factors**
 - costs
 - technology
 - limited availability
 - grid inadequacy – remote areas
 - time-consuming construction
 - overall uncertainty



Total Installed Capacity (MW)	
1 California	2,732.2
2 Nevada	517.5
3 Utah	48.1
4 Hawaii	38.0
5 Oregon	33.3
6 Idaho	15.8
7 Alaska	0.7
8 Wyoming	0.3



RES - support

- Aimed on private owners/operators
- Push to implement market-based tools
- Predominantly on state level
- Compulsory standards for RES share in electricity mix for utilities
- Non-binding goals (for the future)
- 3 ways to meet the RES share standards
 - RES-based production
 - purchase of certificates (REC)
 - Purchase of RES-based electricity
- Offsets

RES - support

– Federal level

- Efficiency standards, grant programs, educational programs

– State level

- Loans supporting installation, (personal) tax credits and rebates
- Renewable Portfolio Standards (RPS) or Renewable Portfolio Goals (RPG)
 - RPS – real impact on consumers, may include tax credits
 - RPG – rather a declaratory effect (a more far-fetched goal), do not include tax credits
- Preferential grid access

RES - conclusion

- US faces similar issues as Europe
- Problematic economy of „traditional“ base-load sources
 - support for RES
- Relatively low initial costs in RES, deconcentrated production (except for hydro)
 - clash of principles – short-term economic logic vs. long-term planning

Climate Policy

- An uneasy development
- Rising awareness in 1960s and 1970s
- EPA established in 1970
- Conservative backlash and denialism in 1980 (Reagan's administrations)
 - Global Climate Coalition – pro-industry lobbying group against GHG mitigation
- Recognition of the issue in 1990s (1992 Rio de Janeiro Summit)
- US reluctance under G. Bush Sr.
 - series of rather declaratory or modest policies
 - Non-ratification of the Kyoto Protocol
 - Climate changes not seen as a 'winning issue'

Climate Policy

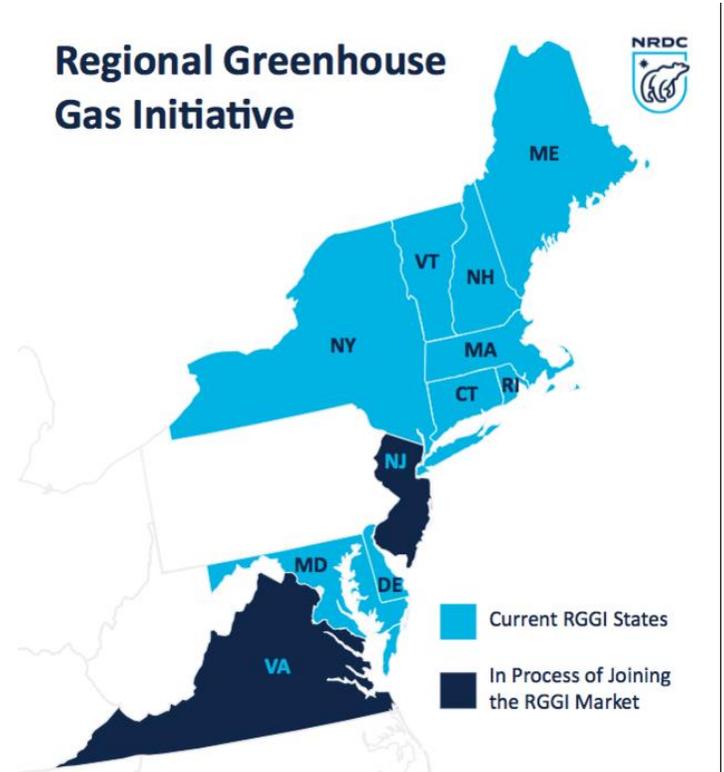
- Clinton's administration (with VP Gore) more receptive to environmental issues, however, their actions remained limited (political unwillingness, Congress dominated by Republicans,...)
 - Rather minor policies focused on efficiency and savings
 - Persistent (mostly conservative/GOP) efforts to point out the costs of related policies and effect on economy
- Environmental topics gained more traction during 2000s, especially during democratic administration of B. Obama
- Clean Power Plan (2015) – to reduce emissions in power generation by 32% below 2005 levels by 2030

Climate Policy

- G.W. Bush
- "Some of the scientists, I believe, haven't they been changing their opinion a little bit on global warming? There's a lot of differing opinions and before we react I think it's best to have the full accounting, full understanding of what's taking place."
- Barack Obama
- "We risk consigning future generations to an irreversible catastrophe... The security and stability of each nation and all peoples - our prosperity, our health, and our safety - are in jeopardy, and the time we have to reverse this tide is running out."
- Donald Trump
- "I'm not a believer in man-made global warming. It could be warming, and it's going to start to cool at some point. And you know, in the early, in the 1920s, people talked about global cooling...They thought the Earth was cooling. Now, it's global warming...But the problem we have, and if you look at our energy costs, and all of the things that we're doing to solve a problem that I don't think in any major fashion exists."

Climate Policy – Current Trends

- Changes to the climate policy under Donald Trump
- Apparent reverse of the trend set by previous administration(s)
- ‘Trickle-down’ effect on governmental bodies (incl. EPA)
 - support for greater use and extraction of hydrocarbons (e.g. Keystone XL)
 - bid to repeal Obama’s Clean Power Plan (32% cut in carbon emissions from power plants by 2030)
 - weakened version likely to be enacted
 - announced Paris Agreement withdrawal
 - Controversial picks for DoE and EPA (Rick Perry, Scott Pruitt, Andrew Wheeler)
- Decrease of carbon emissions thanks to changes in power generation (gas+RES vs. coal)
 - so far, market beats the government’s policies (incl. the ‘revival’ of coal)
- States and cities have been spearheading the policy-related activities; no comprehensive federal policy
 - State-level GHG reduction goals and carbon markets
 - 100+ cities and counties committed to 100% clean energy

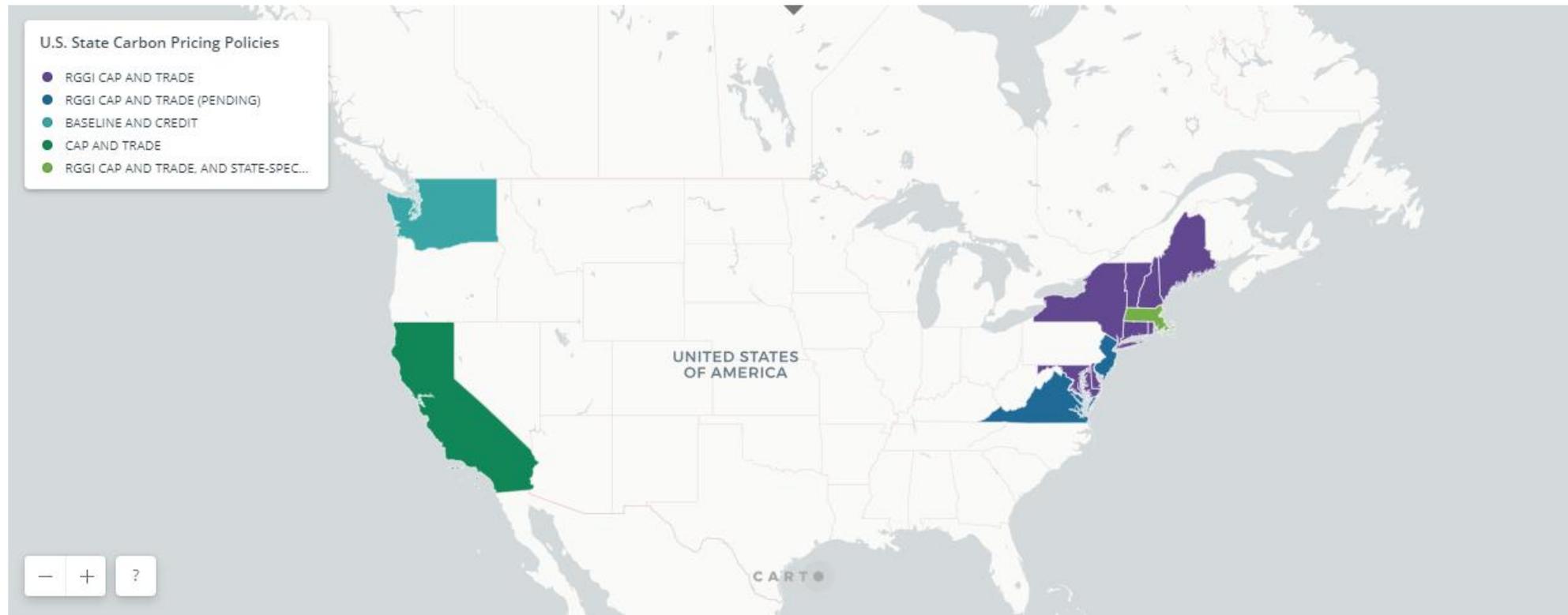


Climate Policy – Current Trends

- 2 cap-and-trade systems
 - Regional greenhouse Gas Initiative (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont) – electricity generation
 - Western Climate Initiative (California, Québec, Nova Scotia) – all fossil fuels-generated emissions
- +1 (de facto) defunct
 - Midwestern Regional Greenhouse Gas Reduction Accord (Minnesota, Wisconsin, Illinois, Iowa, Michigan, Kansas, Manitoba + observers)
- However, CO2 reductions mainly from efficiency and clean policies in power generation, not the C&T mechanism or other polluting sectors
 - Effect of coal-gas swap
- Both systems need to be stricter (excess capacity of allowances)
- Regional initiatives (transportation – TCI – New England and neighbours, etc.)

Climate Policy – Current Trends

- Two cap and trade systems
 - Regional Greenhouse Gas Initiative
 - Western Climate Initiative

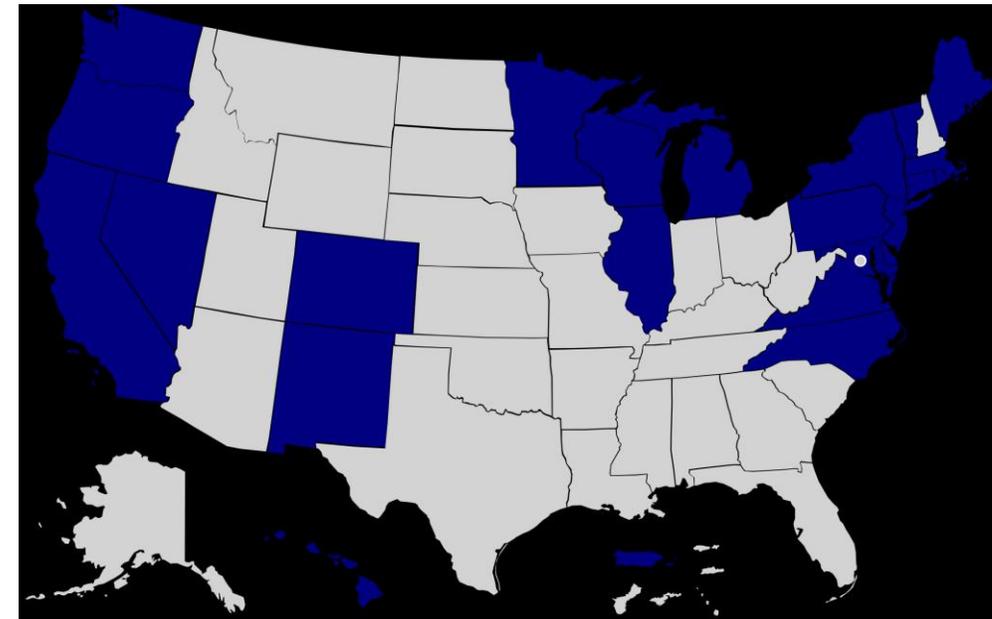


Climate Policy – Current Trends

- Great polarization on the issue of (man-made) climate changes
 - Party-dependent attitudes – (Reps. Vs. Dems.)
- Trump's administration has repealed a lot of previous policies
 - withdrawal from the Paris agreement
 - Clean Power Plan – criticized by Trump's administration for harming the industry - repealed and replaced by (much milder) Affordable Clean Energy rule
 - softened vehicle efficiency standards (light, medium and also heavy-duty)
 - Relaxed restrictions on methane (O&G producers to regulate themselves)
- Trump did so using executive orders
- Many states decided to pursue even stricter goals that had been prescribed even before
 - incl e.g. Pipelines
- Ironically, thanks to the administrative's reserved attitude towards the issue, it became much more debated

Climate Policy – Current Trends

- Climate policies are now very much state-based rather than government-induced, states lead the way
- Climate Alliance – bipartisan (!) group of the most progressive states committed to GHG reduction, following the Paris Agreement regardless the federal government's stance
 - California, Colorado, Connecticut, Delaware, Hawaii, Maryland, Massachusetts, Minnesota, New Jersey, New York, North Carolina, Oregon, Puerto Rico, Rhode Island, Vermont, Virginia, Washington
 - Massive GHG reduction targets 75%+ comp. to 1990 by 2045-2050 (or even net zero), up to 100 % RPS by 2045
 - Economy-wise would be 3rd country in the world
- 24 states (3/4 of the population) still subscribe to the Paris climate goals
- Regional cap and trade systems



Climate policy

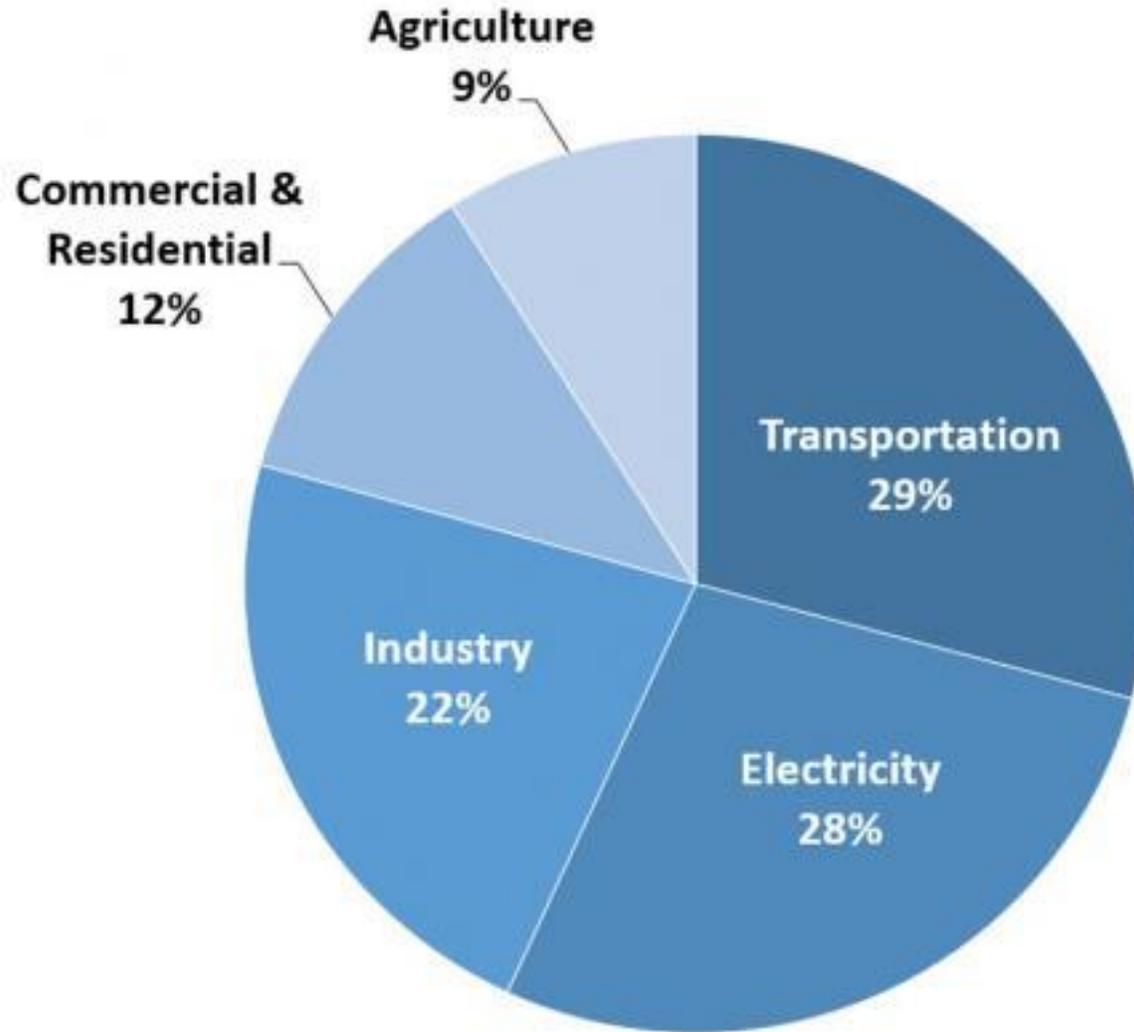
- ❑ Current changes often rather contradictory to environmentally favourable approach (crisis of NPPs, cheap gas, relatively cheap coal, ...)
- ❑ BUT... increase of deconcentrated RES
- ❑ Climate policy is more efficient on state level – „Petri dish“ of new policies
- ❑ Voluntary initiatives (e.g. Energy Star)
 - ❑ Started as a federal light-saving policy
 - ❑ Emerged into a federal certification program of efficiency measures
 - ❑ ICT, home appliances, buildings, industry
 - ❑ Applied internationally (CAN, JPN, SUI, TAI); EU (expired 2018)
 - ❑ Certification for products subscribing to Energy Star measures, intended also for US market
 - ❑ Cut of federal funding?



The Green New Deal

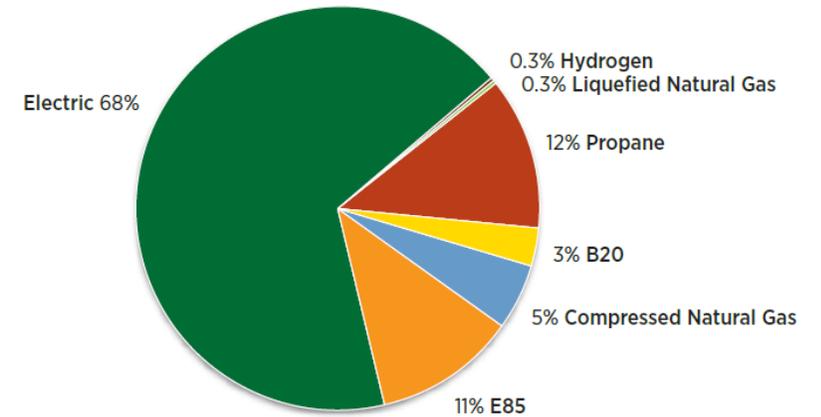
- Dems. sponsored policy comprehensive proposal package addressing the issue of climate change and sustainability
- No full-fledged act, no concrete policy, rather a set of ambitious goals
 - Net-zero GHG emission scheme
 - Infrastructural investments
 - RES
 - Smart grids
 - Building upgrades
 - Curbing agricultural emissions
- Highly divisive issue (GOP vs. Dems) – criticized fore being ‘ socialist’, expensive, unrealistic and wasteful, ...
- Resolution rejected in 3/2019
- Remains as a policy driver for like-minded politicians and a ‘punching bag’ for opponents

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2017



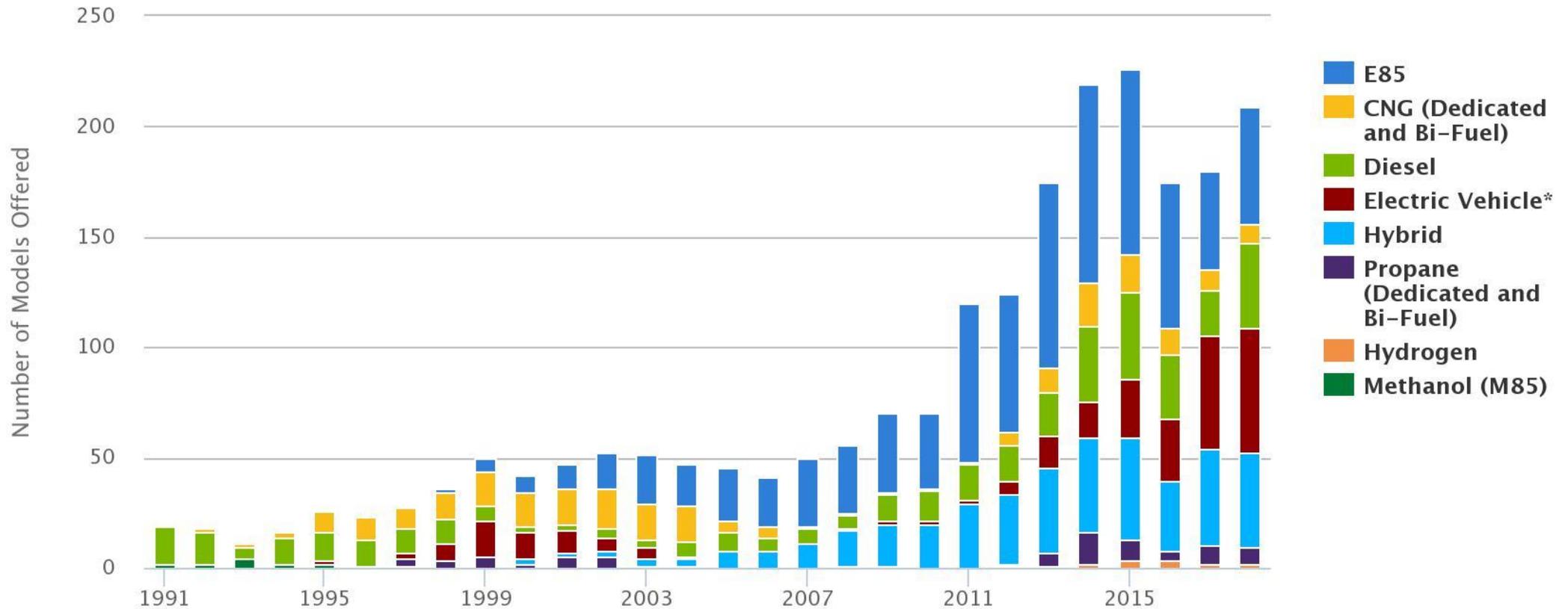
Alternative fuels

- Seemingly high number
- US as the leading world producer of ethanol
- Local and state projects to support electromobility (California)
- Electromobility and higher efficiency in transportation (issue of single-occupancy vehicles – almost 1/2 of all vehicles in big cities)
- City emissions – mainly transportation-related
 - Target of local policies (e.g. WA aims to exchange 50% of state fleet for EVs)



Alternative fuels

Light-Duty AFV, HEV, and Diesel Model Offerings, by Fuel Type



Last updated: January 2019
 Printed on: August 1

Alternative fuels

- Alternative fuels/sources of mobility still rather marginal
- FlexFuel as the most viable solution
- Alternative fuels keep failing to offset rise of fuel sells globally
- Biodiesel is more expensive than gasoline - lower EROEI than gasoline
- Brasil as the top producer/consumer of biofuels – aims at exports to US
- Clearly no will to repeal high import taxes on bofuels – that would be a support for foreign farmers at the expense of domestic production – politically unacceptable

Electromobility

- Regression of policies on the federal level under the Trump's administration
- Federal incentives for EVs and PHEVs are being repealed
- Car efficiency measures are being softened even beyond what manufacturers demanded
- States lead the way in implementing incentives for alternative fuels, efficiency and saving measures
- <http://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx>
- VW settlement money partly invested into EV infrastructure
 - Environmental Mitigation Trust
 - Vehicle buyback

