

The Stella Group, Ltd.

The Stella Group, Ltd.. is a strategic technology optimization and policy firm for clean distributed energy users and companies which include advanced batteries and controls, energy efficiency, fuel cells, geoexchange, heat engines, microhydropower (including tidal and wave), modular biomass, photovoltaics, small wind, and solar thermal (including CSP, daylighting, water heating, industrial preheat, building air-conditioning, and electric power generation). Scott Sklar serves on the national Boards of Directors of the non-profit Business Council for Sustainable Energy and The Solar Foundation. He teaches three unique interdisciplinary sustainable energy courses at The George Washington University (GWU) and serves as Energy Director of GWU's Environment & Energy Study Institute (EEMI). Scott Sklar was awarded the prestigious The Charles Greely Abbot Award by the American Solar Energy Society (ASES) and on April 26, 2014 was awarded the Green Patriot Award by George Mason University in Virginia. He was appointed to the US Department of Commerce (DOC) Renewable Energy & Energy Efficiency Advisory Committee (RE&EEAC), term ending 2020.

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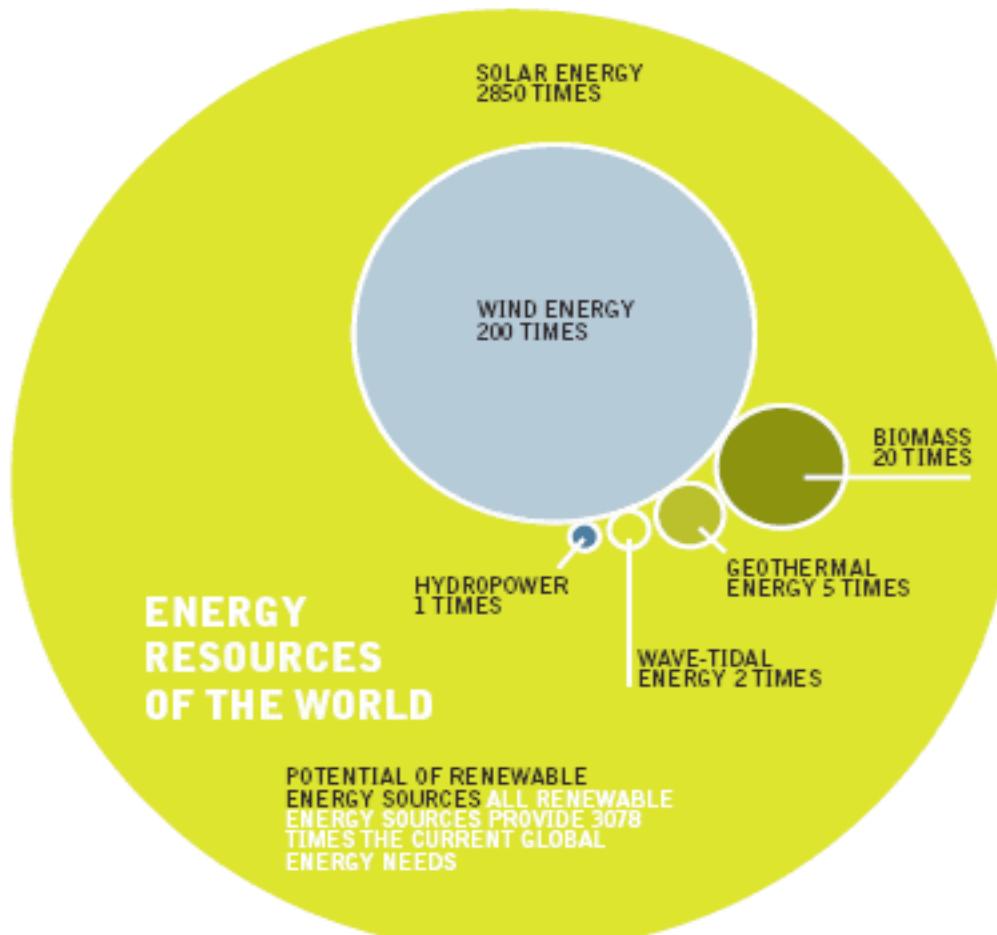


THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

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figure 30: energy resources of the world



source WBGU

Institute DLR, Institute of Technical Thermodynamics, Department of Systems Analysis and Technology Assessment, Stuttgart, Germany Ecofys BV, P.O. Box 8408, NL-3503 RK Utrecht, Kanaalweg 16-G

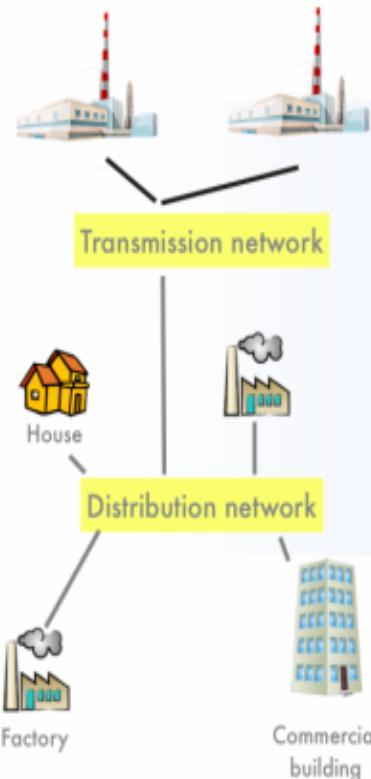


The source of information in this Mind Map comes from http://www.mckinsey.com/insights/business_technology/disruptive_technologies

Reforming the Energy Vision

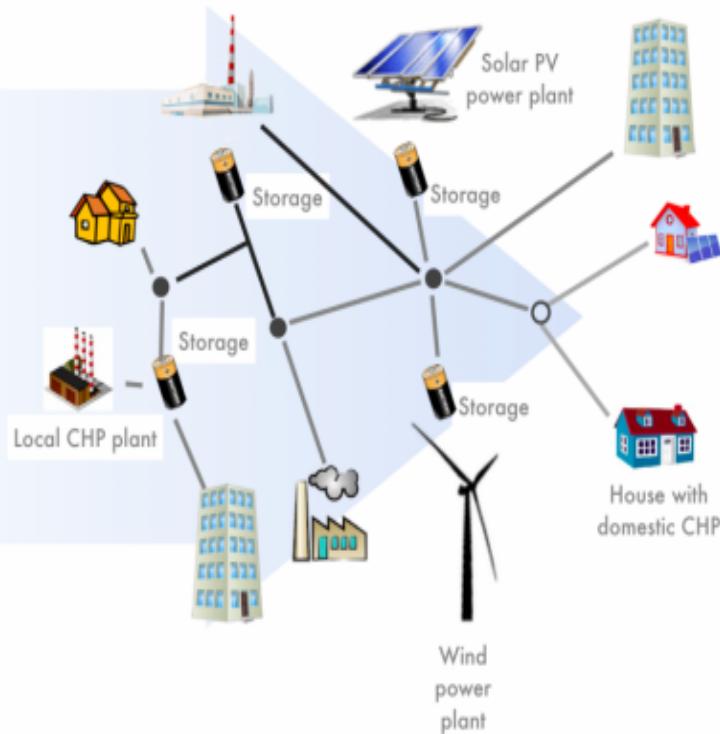
Yesterday

Centralized Power



Tomorrow

Clean, local power



I WILL BE REVIEWING WITH YOU MANY, MANY STUDIES THAT THE WORLD and THE USA CAN MEET ALL THE ENERGY NEEDS WITH ONLY THE CLEAN ENERGY TECHNOLOGIES WE HAVE TODAY FROM:

- the maximization of high-value energy efficiency
- the entire portfolio of renewable energy
- the utilization all energy storage and maximized use of advanced sensors, controls, software

MAXIMS:

1. No one or two renewable energy technologies can meet 100% energy, rather optimization of the complete portfolio of efficiency, renewables & storage
2. We, as a world, cannot meet achieve 100% renewables and in the time necessary to mitigate climate change, without the maximization of high-value energy efficiency in every single sector – buildings, industry, transportation, infrastructure, and energy production/generation
3. We, as a world, cannot meet the renewable energy and greenhouse gas mitigation goals without sustainable use of biomass, especially waste – human sewage, manures, food processing wastes, contaminated feedstuffs, etc. to intercept methane – a more potent greenhouse gas – over 25 times that of CO₂ (though only 300 years in the atmosphere)

ACEEE Report Says Efficiency Could Halve U.S. Energy Usage by 2050: Energy Manager Today, by Alyssa Danigelis, September 19, 2019

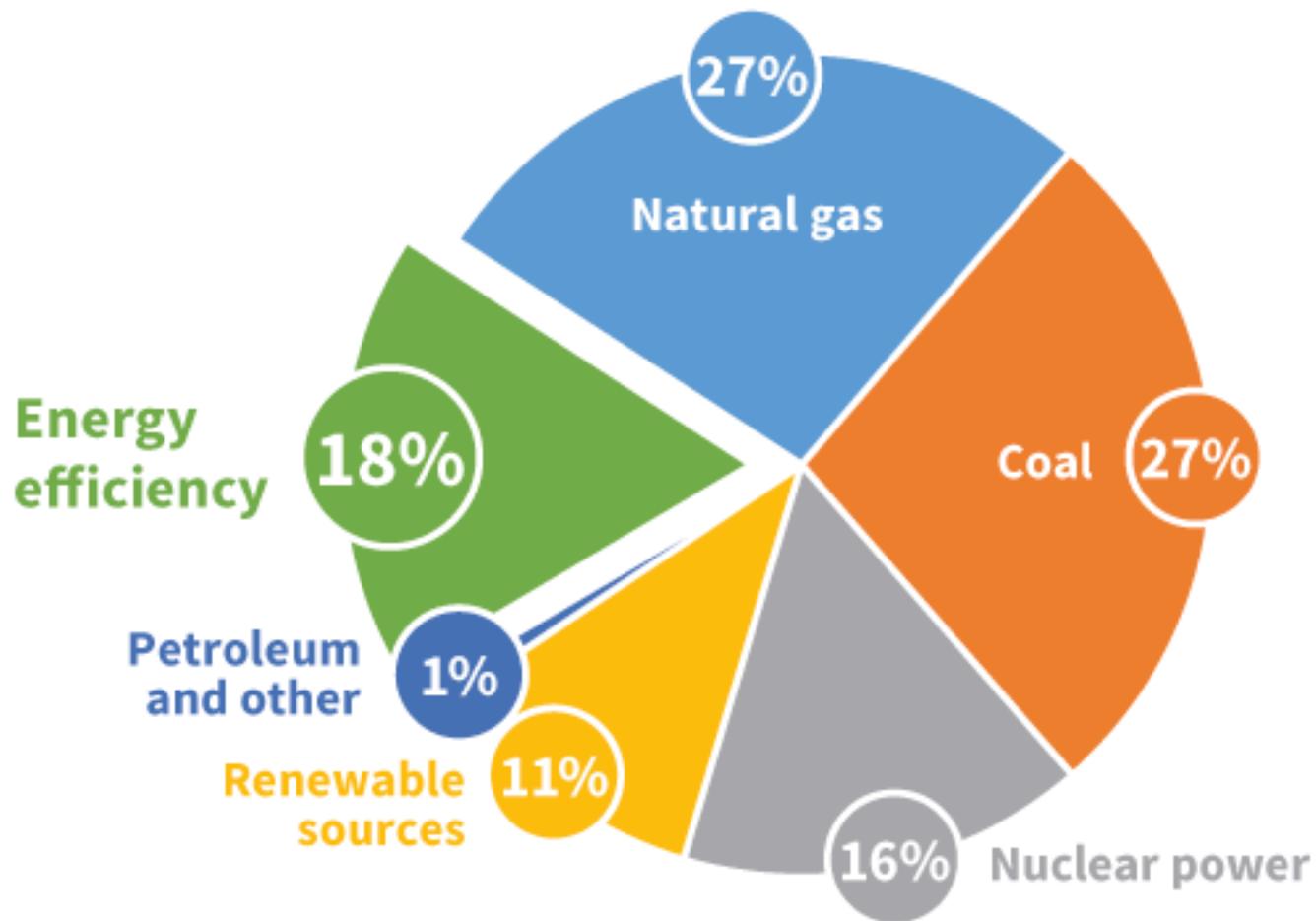
<https://www.energymagertoday.com/aceee-energy-efficiency-2050-0184387>

and

<https://aceee.org/press/2019/09/energy-efficiency-can-slash>

A new report from the American Council for an Energy-Efficient Economy concludes that energy efficiency could cut US energy use and greenhouse gas emissions by 50% by 2050. The report, "Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050," builds on previous studies including ones from the International Energy Agency and the Natural Resources Defense Council. It identified 11 ambitious but cost-effective and technically possible measures that would avert emissions of nearly 2,500 million metric tons of heat-trapping carbon dioxide — equivalent to all emissions from cars, trucks, homes, and commercial buildings in 2050. For example, new homes and commercial buildings could cut their emissions by 70% with efficient design and use of cleaner electricity.

Share of US electricity generation by resource in 2015



Source: EIA for all except energy efficiency, which is based on ACEEE estimates. EIA data source is May 2016 Monthly Energy Review, Table 7.2a Electricity Net Generation: Total (All Sectors).



Berkeley Lab Turns Out Comprehensive Estimate of Efficiency

Cost - and It's Cheap:

UtilityDive.com, by Robert Walton, July 7, 2018

<https://www.utilitydive.com/news/berkeley-lab-turns-out-comprehensive-estimate-of-efficiency-cost-and-its/527263>

Research by the Lawrence Berkeley National Laboratory looked at efficiency programs funded by customers of investor-owned utilities. Some 30 states and the District of Columbia have adopted efficiency policies, including two dozen that adopted an energy efficiency resource standard. While the figure is highly variable, depending on geography and demographics, on average it costs \$0.025 to save a kilowatt-hour of electricity. Costs were lower in the Midwest, where utilities have less experience with efficiency programs and more low-hanging fruit; in the Northeast, the cost reached \$0.033/kWh, on average, because the region has several states with more developed efficiency programs.

Renewables Bring 72% of New Global Power Capacity in 2019:

Renewables Now, April 6, 2020

<https://renewablesnow.com/news/renewables-bring-72-of-new-global-power-capacity-in-2019-693872>

and

<https://solarindustrymag.com/renewable-energy-accounts-for-majority-of-new-capacity-in-2019>

and

<https://www.hydroreview.com/2020/04/06/nearly-three-quarters-of-global-generating-capacity-added-in-2029-came-from-renewables>

According to the International Renewable Energy Agency (IRENA), the world installed 176 GW of renewable power capacity in 2019, 90% of which came from solar and wind farms.

The share of renewables in net power generation capacity additions was 72% globally. The only regions in which that share was below 70% were Africa and the Middle East. There, renewables projects represented 52% and 26%, respectively, of net new capacity. Renewables accounted for 34.7% of installed global power capacity at the end of 2019, up from a share of 33.3% in 2018. The 2019 renewable capacity additions were slightly below the 2018 total of 179 GW. Last year, the total renewable power growth outpaced fossil fuel growth by a factor of 2.6. Asia, the Middle East and Africa recorded net growth in non-renewable capacity additions, while Europe and North America decommissioned more than they added.

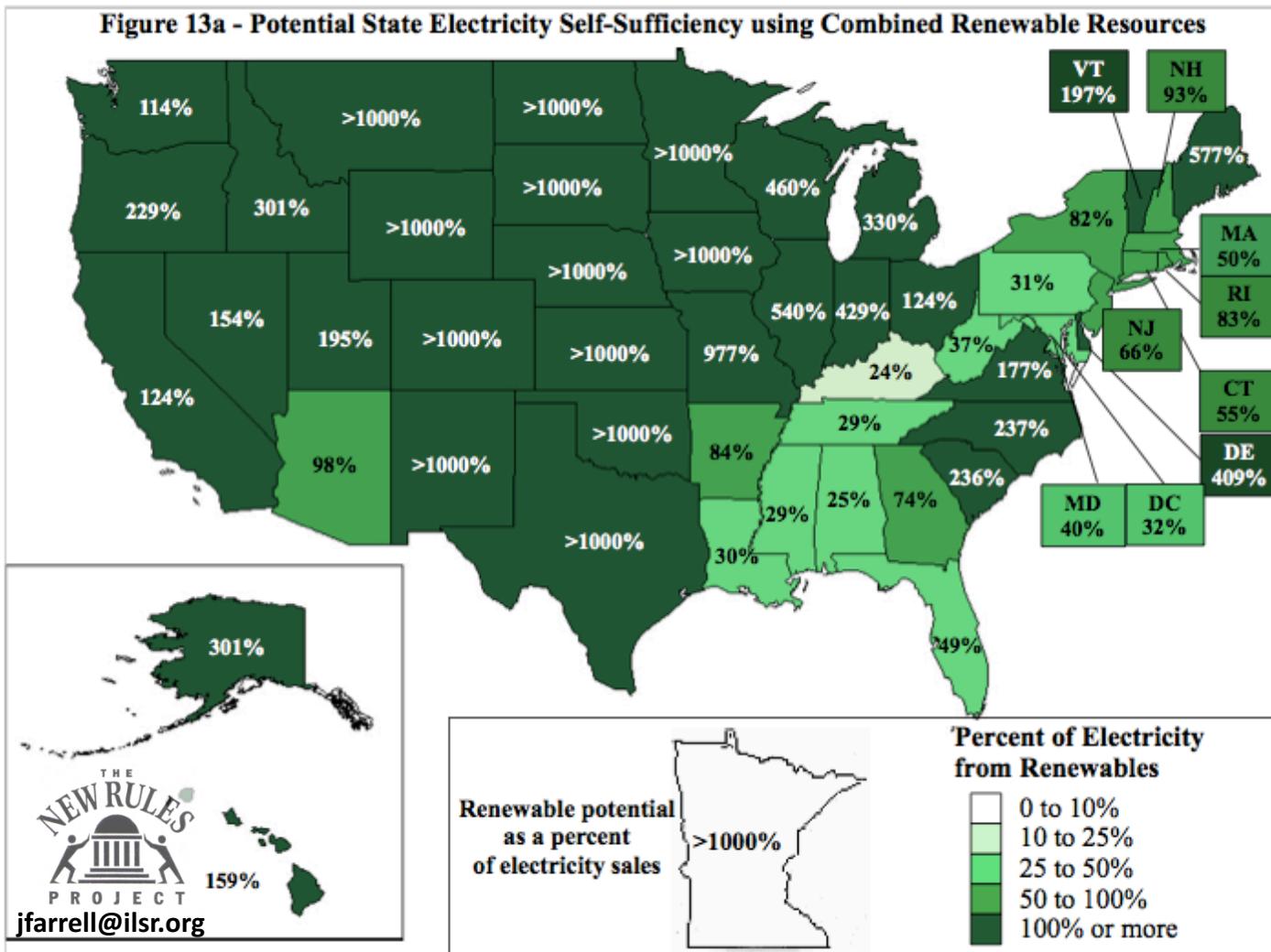
Advanced Energy Hit Record \$1.6 Trillion Worldwide in 2018; U.S. Revenue Grew Nearly 4 Times as Fast as GDP:

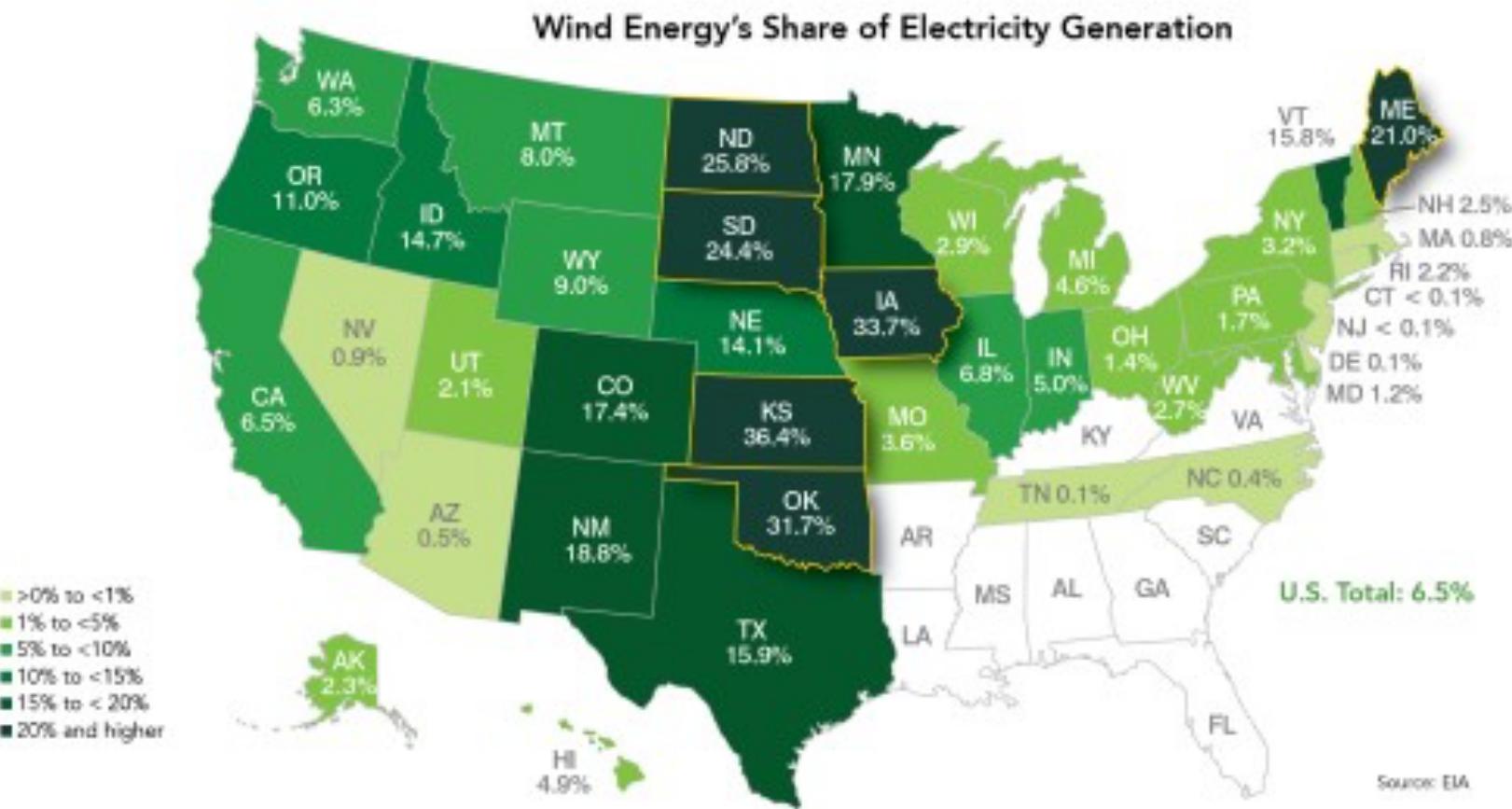
Advanced Energy Economy, by Monique Hanis, April 25, 2019

<https://www.aee.net/articles/report-advanced-energy-hit-record-1.6t-worldwide-in-2018-u.s.-revenue-grew-nearly-4-times-as-fast-as-gdp>

Total revenue for advanced energy worldwide was a record \$1.6 trillion in 2018, making the industry equal to global tourism, bigger than pharmaceuticals, and twice the size of airlines worldwide according to the "Advanced Energy Now 2019 Market Report" produced by Navigant Research for AEE. The U.S. advanced energy market hit \$238 billion after growing 11% in 2018 – nearly four times as fast as U.S. GDP. Advanced energy is now nearly equal in revenue to aerospace manufacturing, and twice the revenue of the biotech industry. Of the \$25 billion overall increase in U.S. advanced energy revenue over 2017, the bulk came in three segments: Advanced Transportation (\$7.9 billion), led by explosive growth in revenue from plug-in electric vehicles; Building Efficiency (\$7.8 billion), a steady source of growth since 2011; and Advanced Fuel Production (\$5.4 billion), marked by a rebound in ethanol and biodiesel revenue.

32 States can be Self-Sufficient





According to a new report from the American Wind Energy Association, the U.S. wind power industry emerged from 2018 stronger than ever, now able to power 30 million American homes after 8% capacity growth last year. The annual report reveals that U.S. wind power supports a record 114,000 American jobs, over 500 domestic factories, and more than \$1 billion a year in revenue for states and communities that host wind farm.

Report: https://www.awea.org/2018-market-report_us-wind-power-grew-8-percent-in-2018

Renewable Energy Continues to Be Cheaper Than Natural Gas and Coal:

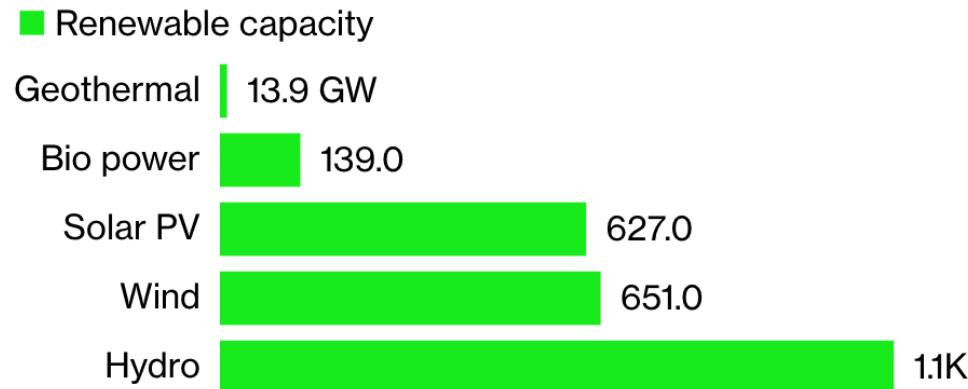
Navigant Research, by Jesse Broehl, January 2, 2019

<https://www.navigantresearch.com/news-and-views/renewable-energy-continues-to-be-cheaper-than-natural-gas-and-coal>

Lazard's latest annual comparative assessment of levelized cost of energy (LCOE) shows that the cost of generating energy from utility-scale solar PV and onshore wind technologies continues to decline. The LCOE of utility-scale PV technologies is down approximately 13% from 2017 and the mean LCOE of onshore wind has declined close to 7%. More impressive are the long-term declines in cost of energy; over the last 9 years, unsubsidized wind has declined by 69% and unsubsidized utility-scale solar PV has declined by 88%. These figures are all in current dollars, so price differences between years would be even more impressive if adjusted for inflation. The latest unsubsidized cost figures show the levelized cost of onshore wind-generated energy is between \$29/MWh and \$56/MWh, whereas coal is between \$60MWh and \$143/MWh. The levelized cost of utility-scale solar is between \$36/MWh and \$46/MWh.

Renewable World

Global capacity for renewable power is dominated by hydro, wind and solar



Source: REN21
Figures include data through 2019

World Now Has 583.5 GW of Operational PV

PV-Magazine.com, by Emiliano Bellini, April 6, 2020

<https://www.pv-magazine.com/2020/04/06/world-now-has-583-5-gw-of-operational-pv>

Global grid-connected solar capacity reached 580.1 GW at the end of 2019, along with 3.4 GW of offgrid PV, according to the International Renewable Energy Agency. Solar installations, including PV and concentrated solar power (CSP), continue to lag slightly behind wind, with a cumulative installed capacity of 586.4 GW. CSP represented 6.27 GW of the total, while grid-connected PV accounted for 580.1 GW. Asia is the part of the world with the largest share of PV capacity, at 330.1 GW of cumulative installed capacity. In North America, total grid-connected PV capacity reached 68.2 GW at the end of December. About 60.5 GW was installed in the United States, followed by 4.8 GW in Mexico and 3.3 GW in Canada. Total installed renewables capacity globally hit a remarkable 2,563.8 GW, with hydropower remaining the dominant source at 1,310.9 GW, followed by wind at 622.7 GW.

FERC's latest monthly "Energy Infrastructure Update" report (with data through November 30, 2019) reveals renewable sources (i.e. biomass, geothermal, hydropower, solar, wind) accounted for 8,784 MW of new generating capacity through the end of November . [1] That is 8% more than that of natural gas (7,819 MW), nuclear (155 MW), oil (77 MW), and coal (62 MW) combined. Combined, renewables provided 52% of new generating capacity through the first eleven months of 2019 and seem poised to increase their share once the final December numbers are released.

Renewables have now also surpassed 22% (i.e., 22.03%) of the nation's total available installed generating capacity - further expanding their lead over coal capacity (20.92%). Among renewables, wind can boast the largest installed electrical generating capacity - 8.52% of the U.S. total, followed by hydropower (8.43%), solar (3.43%) [2], biomass (1.33%), and geothermal (0.32%).

Moreover, FERC foresees renewables dramatically expanding their lead over fossil fuels and nuclear power in terms of new capacity additions during the coming three years (i.e., December 2019 - November 2022). Net generating capacity additions (i.e., "proposed additions under construction" minus "proposed retirements") for renewable sources total 49,926 MW: wind - 28,856 MW, solar - 19,156 MW, hydropower - 1,463 MW, biomass - 238 MW, and geothermal - 213 MW.

By comparison, net additions for natural gas total 23,233 MW while the installed capacities for coal, nuclear, and oil are projected to drop by 14,067 MW, 3,751 MW, and 2,751 MW respectively. Thus, net new renewable energy capacity will be 18.7 times greater than that of fossil fuels and nuclear power combined (49,926 MW vs. 2,664 MW). FERC's projections are consistent with new projections released just this week (1/15/2020) by the U.S. Energy Information Administration (EIA). [3] The agency expects solar and wind to represent 76% (or almost 32 GW) of new capacity additions in 2020.

36 STUDIES ON GOING TO 100% RENEWABLES

“a subset of efficiency & renewables”

Clean Energy Reports

I. GREENPEACE/DLR

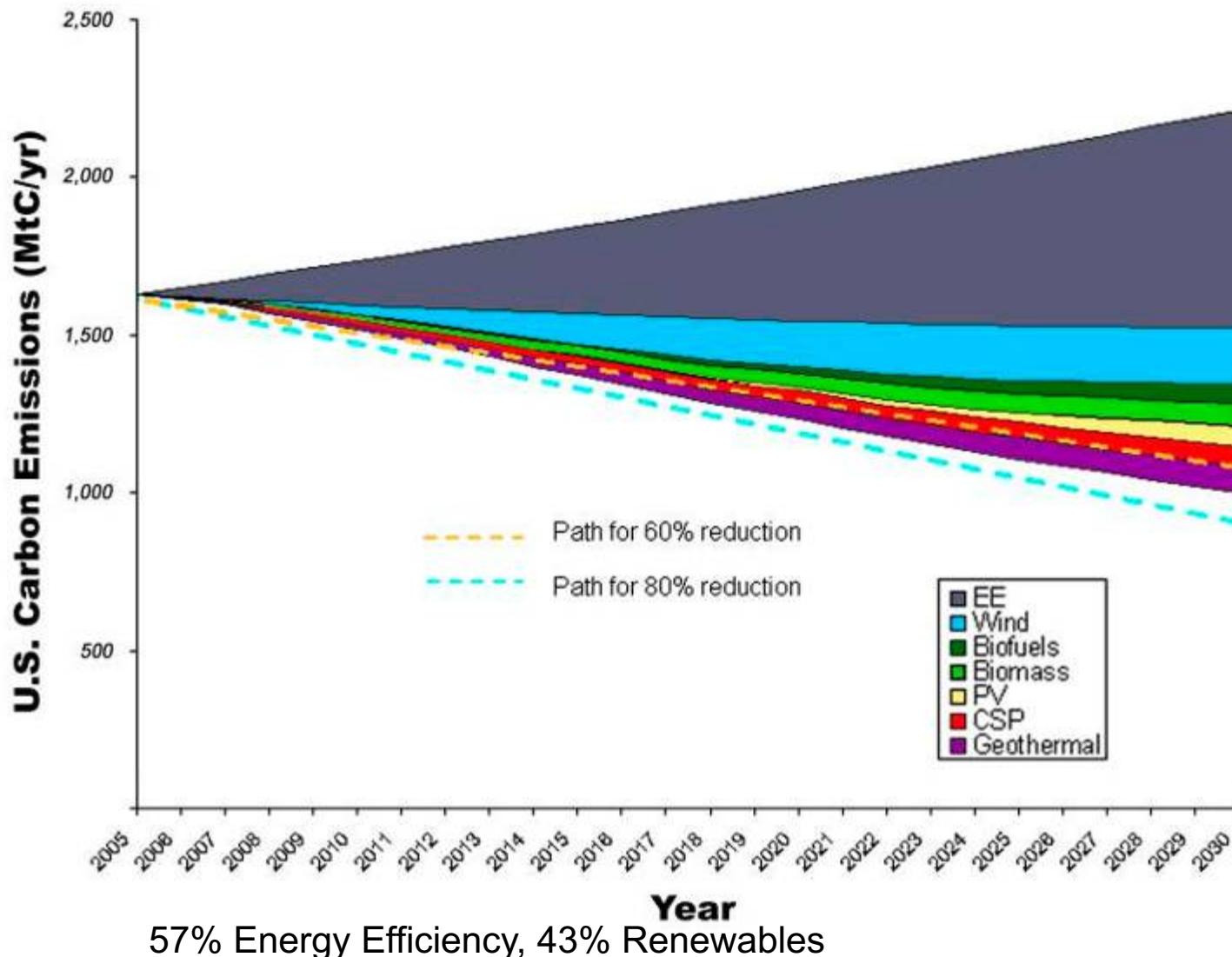
The world could eliminate fossil fuel use by 2090 by spending trillions of dollars on a renewable energy revolution, the European Renewable Energy Council (EREC) and environmental group Greenpeace said. The 210-page study is one of few reports -- even by lobby groups -- to look in detail at how energy use would have to be overhauled to meet the toughest scenarios for curbing greenhouse gases outlined by the U.N. a Climate Panel. "Renewable energy could provide all global energy needs by 2090," according to the study, entitled "Energy (R)evolution." EREC represents renewable energy industries and trade and research associations in Europe.

2. ASES/NREL U.S. Energy Experts Announce Way to Freeze Global Warming

On January 31, 2007 at a press conference in Washington, D.C., ASES unveiled a 200-page report, Tackling Climate Change in the U.S.: Potential Carbon Emissions Reductions from Energy Efficiency and Renewable Energy by 2030. The result of more than a year of study, the report illustrates how energy efficiency and renewable energy technologies can provide the emissions reductions required to address global warming. U.S. Carbon Emissions Displacement Potential from Energy Efficiency and Renewable Energy by 2030 - 57% Energy Efficiency, 43% Renewables

3. GOOGLE Google.org, the philanthropic arm of the search giant, has unveiled a plan to move the U.S. to a clean-energy future. The vision: In 2030, electricity will be generated not from coal or oil but from wind, solar, and geothermal power. Energy demand will be two-thirds what it is now, thanks to stringent energy-efficiency measures. Ninety percent of new vehicle sales will be plug-in hybrids. Carbon dioxide emissions will be down 48 percent. Getting there will cost \$4.4 trillion, says the plan -- but will recoup \$5.4 trillion in savings. The Clean Energy 2030 plan would require ambitious national policies, a huge boost to renewables, increased transmission capacity, a smart electricity grid, and much higher fuel-efficiency standards for vehicles.

U.S. Carbon Emissions Displacement Potential from Energy Efficiency and Renewable Energy by 2030



MORE REPORTS - NRC and ILSR

4. National Research Council Renewables Report – June 09

Renewable energy resources in the U.S. are sufficient to meet a significant portion of the nation's electricity needs says a new report from the National Research Council. Press and link to report at:

<http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12619> or <http://tinyurl.com/neka69>

5. INSTITUTE FOR LOCAL SELF RELIANCE (October 2009) report by David Morris “SELF RELIANT STATES” -- Excerpted Executive Summary Conclusion:

"All 36 states with either renewable energy goals or renewable energy mandates could meet them by relying on in-state renewable fuels. Sixty-four percent could be self-sufficient in electricity from in-state renewables; another 14 percent could generate 75 percent of their electricity from homegrown fuels. Indeed, the nation may be able to achieve a significant degree of energy independence by harnessing the most decentralized of all renewable resources: solar energy. More than 40 states plus the District of Columbia could generate 25 percent of their electricity just with rooftop PV. In fact, these data may be conservative. The report does not, for example, estimate the potential for ground photovoltaic arrays – although it does estimate the amount of land needed in each state to be self-sufficient relying on solar – even though common sense suggests that this should dwarf the rooftop potential.... It is at the local level that new technologies like smart grids, electric vehicles, distributed storage, and rooftop solar will have their major impact."

Contact for David Morris at: cell 612-220-7649 or dmorris@ilsr.org

6. GEOTHERMAL USA STUDY – MIT Jan 22, 2007

MIT study: Get more energy from Earth's heat. Geothermal could meet 10 percent of U.S. needs by 2050.
Study: <http://energy.mit.edu/wp-content/uploads/2006/11/MITEI-The-Future-of-Geothermal-Energy.pdf>

7. CONCENTRATED SOLAR POWER - from Earth Policy Institute

An easy 15% of US Energy also see: SOLAR ENERGY COULD PROVIDE 8000+ MW OF CAPACITY IN WESTERN STATES
BY <http://www.nrel.gov/docs/fy13osti/56294.pdf>
<http://www.nrel.gov/docs/fy13osti/56294.pdf>

The National Renewable Energy Laboratory (NREL) results of detailed modeling suggest that the CSP technology could provide up to 16% of U.S. electricity generation if Energy Department cost targets are achieved. January 21, 2019

Detailed Modeling Shows CSP Costs of \$0.05/Kilowatt-Hour Could Lead to Broader Deployment. CSP plants use mirrors to concentrate sunlight and heat a heat-transfer fluid. The heated fluid can then be used to spin a turbine to generate electricity immediately or be held until needed, serving as a form of large-scale thermal energy storage .

Report: <https://www.nrel.gov/docs/fy19osti/71912.pdf> (this works)

Source: [https://www.nrel.gov/news/program/2019/csp-role-could-grow-with-cost targets.html?utm_source=NREL+News&utm_campaign=097a4f24e1-EMAIL_CAMPAIGN_2018_12_04_07_35_COPY_01&utm_medium=email&utm_term=0_807f77e7f4-097a4f24e1-282468141](https://www.nrel.gov/news/program/2019/csp-role-could-grow-with-cost-targets.html?utm_source=NREL+News&utm_campaign=097a4f24e1-EMAIL_CAMPAIGN_2018_12_04_07_35_COPY_01&utm_medium=email&utm_term=0_807f77e7f4-097a4f24e1-282468141)

11. NREL (2018), NAVIGANT / ENERGY FOUNDATION 2005 market study - technical potential of PV in the US. Using only roof space (per Census) and using average amounts of shading, tilt, etc., within the US, their estimate was maximum technical potential in the US of 1,037,519 MW_p , which would represent almost 1/3 of total electricity US usage MWh for MWh

http://www.geni.org/globalenergy/library/technical-articles/generation/solar/the-energy-foundation/rooftops-could-support-vast-us-market-for-solar-power/PV_pressrelease.pdf

And 2016: <https://www.nrel.gov/docs/fy16osti/65298.pdf>

-see next slide for 2nd rooftop study -

12. Continued –

U.S. May Have 320 GW of Non-Traditional, Untapped Rooftop Solar Potential:

CleanTechnica.com, May 24, 2018

<https://cleantechica.com/2018/05/24/320-gw-of-non-traditional-untapped-rooftop-solar-potential-in-usa>

Low- and middle-income Americans could represent a large untapped solar market in the U.S. In fact, there might be 320 GW of untapped solar potential on non-traditional solar applications, including multifamily and other commercial properties. A new report by the National Renewable Energy Laboratory says, in essence, solar needs to get out from the single-family-home model of solar development and into a more collective model like community solar. And a second new report from the Interstate Renewable Energy Council, "Expanding Solar Access: Pathways for Multifamily Housing," suggests shared solar, whether on-site or off-site, is the key.

13. WATER POWER - EESI, EPRI, NHA, OREC

http://www.eesi.org/060807_Hydropower

Several studies conclude that upgrading existing dam turbines, installing free-flow hydropower (no dams or diversions) tidal, wave and ocean currents and thermal could produce 10% of US energy.

<http://www.circleofblue.org/wp-content/uploads/2010/08/EPRI-Assessment-of-Waterpower-Potential-and-Development-Needs.pdf>

14. WASTE HEAT – COMBINED HEAT & POWER

ACEEE, EPA and DOE conclude that an easy 8 % of US electricity and probably more in displacing other thermal applications could be displaced by CHP.

<http://aceee.org/policy-brief/combined-heat-and-power-and-clean-distributed-energy-poli> and ORNL report
<http://aceee.org/policy-brief/combined-heat-and-power-and-clean-distributed-energy-poli>

NEW: <https://aceee.org/research-report/ie134>

<https://www2.aceee.org/l/310911/2018-03-06/wkkwp>

<https://aceee.org/sites/default/files/publications/researchreports/ie1501.pdf>

31. 100% RENEWABLE ENERGY - UCLA

139 countries could source all of their energy needs from renewables by 2050. On Nov. 29, 2015, Jacobson presented the plans -- which detail specific numbers of turbines, solar farms and other renewables -- to 195 national leaders at the UN climate talks in Paris. If approved, Jacobson said that plans would create 24 million construction jobs, 26.5 million operational jobs and prevent 3.3 million to 4.6 million premature deaths each year through 2050. Combined, the plans call for the use of 3.8 million turbines worldwide. Jacobson and [Delucchi](#), a research scientist at the University of California at Davis, presented their “100 percent renewables” construct to the public for the first time in a [2009 feature article](#) in *Scientific American*. It explained how the world could derive all of its power, including for transportation, from 1.7 billion rooftop solar systems, 40,000 photovoltaic power plants, 3.8 million wind turbines, 900 hydroelectric plants, 490,000 tidal turbines, etc. [ScientificAmerican.com](#) (11/15)

Source: <http://www.scientificamerican.com/article/139-countries-could-get-all-of-their-power-from-renewable-sources1/>

20. 100% RENEWABLE ELECTRICITY - A roadmap to 2050 for Europe and North Africa

Abstract: <http://pure.iiasa.ac.at/9383/>

Roadmap: <https://www.pwc.co.uk/assets/pdf/100-percent-renewable-electricity.pdf>

23. WORLD WILDLIFE FUND (WWF) report indicates how its vision of a 100 per cent **renewable** and sustainable energy supply could be realized. In 2050, ambitious energy saving ...

http://assets.worldwildlife.org/publications/384/files/original/The_Energy_Report.pdf?1345748859

24. THE UN INTERNATIONAL PANEL ON CLIMATE CHANGE said in a May 15, 2011 released report that the availability of renewable sources like the wind and sun was virtually unlimited, and could provide up to 77 percent of the world's energy needs by 2050 , but governments needed to adopt policies to take advantage of them.
and press release:

REPORT NEW: <https://www.ipcc.ch/report/renewable-energy-sources-and-climate-change-mitigation/>

25. NREL, the **[Renewable Electricity Futures Study](#)** (*RE Futures*), is an initial investigation of the extent to which renewable energy supply can meet the electricity demands of the continental United States over the next several decades. This study explores the implications and challenges of very high renewable electricity generation levels—from 30% up to 90%, focusing on 80%, of all U.S. electricity generation from renewable technologies—in 2050. At such high levels of renewable electricity generation, the unique characteristics of some renewable resources, specifically geographical distribution and variability and uncertainty in output, pose challenges to the operability of the nation’s electric system.

Renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the country. (4 volumes)

NEW: <https://www.nrel.gov/analysis/re-futures.html>

27. **Biogas:** A new report published by the Nicholas Institute for Environmental Policy Solutions at Duke University seeks to uncover under what conditions a substantial, decentralized domestic biogas market could develop in the United States by 2040. The report, titled “Biogas in the United States: An Assessment of Market Potential in a Carbon-Constrained Future,” determined that biogas could supply as much as 5 percent of the total natural gas market in 2040, when U.S. consumption of natural gas is expected to reach nearly 30 trillion cubic feet. (March 19, 2014)

<https://nicholasinstitute.duke.edu/environment/publications/biogas-united-states-assessment-market-potential-carbon-constrained-future>

Publication: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_r_14-02_full_pdf.pdf

35. Global Energy System Based on 100% Renewable Energy – Power Sector by Energy Watch Group (LUT)

Lappeenranta University of Technology

A global transition to 100 percent renewable electricity, far from being a long-term vision, is happening now, the study says. It is the work of Finland's [Lappeenranta University of Technology](#) (LUT) and the [Energy Watch Group](#) (EWG), and was published at the [UN climate change conference, COP23](#), which is meeting in Finland (11/08/17)

<http://energywatchgroup.org/wp-content/uploads/2017/11/Full-Study-100-Renewable-Energy-Worldwide-Power-Sector.pdf>

29. Waste Can Meet 12% of U.S. Electricity Needs : Columbia University Study

UtilityDive.com, by Claire Cameron, July 15, 2014

The U.S. could power 14 million homes and heat a further 10 million if it moved from landfill to waste to energy, according to a new study published by the American Chemistry Council (ACC).

<https://waste-management-world.com/a/acc-study-waste-to-energy-could-meet-12-of-u-s-electrical-demand>
ACC: <https://www.americanchemistry.com/Media/PressReleasesTranscripts/ACC-news-releases/Study-Municipal-Solid-Waste-Could-Contribute-Significant-Supply-of-Alternative-Energy.html>

About 3.8 billion tons of waste was processed by U.S. waste-to-energy generation facilities in the U.S. between 2008 and 2011. However, a new study by the Earth Engineering Center at Columbia University has found that redirecting Municipal Solid Waste from landfill to fuel energy generation could produce enough electricity to meet 12% of U.S. electricity needs. It would also save an estimated 123 million tons of greenhouse gas emissions from entering the atmosphere. The study also pointed out that if all of the non-recycled plastic waste were converted to oil, it would produce 6 billion gallons of gasoline over the course of a year.

36. New Report Concludes Solar Could Meet Approximately 68% of Global Energy Demand by 2050:

PV Magazine, by Emiliano Bellini, April 12, 2019

<https://www.pv-magazine.com/2019/04/12/getting-almost-all-our-energy-from-the-sun-by-2050>

According to a new European report, as a result of massive electrification of energy and transport – and the constantly declining costs of renewable energy technologies – solar is expected to be able to meet around two-thirds of energy demand by 2050, with wind having an 18% share, followed by biomass and waste (6%), hydropower (3%) and geothermal energy (2%). That would mean renewables meeting almost all the world's primary energy demand, up from only 22% four years ago. A 100% renewable energy system could also create 22 million solar jobs by 2050 – but keeping global warming below 1.5 degrees C, though, would require FITs for projects up to 40 MW in capacity, auctions for bigger systems, removing fossil fuel and nuclear subsidies and providing more education and R&D and less red tape.

http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf

34. 100% Renewable Energy for 139 Nations Detailed in New Stanford Report:

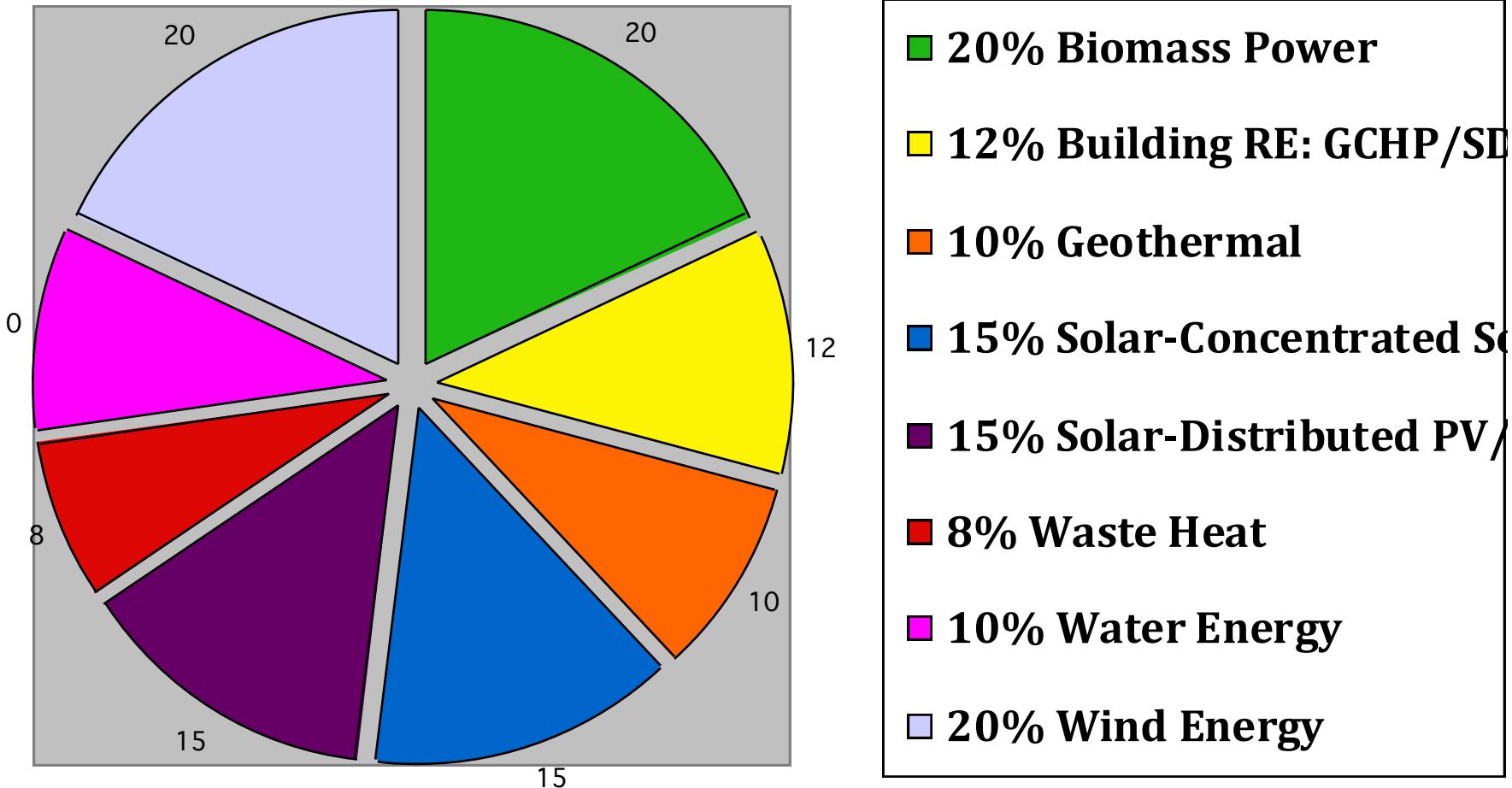
CleanTechnica.com, by Steve Hanley, August 23, 2017

<https://cleantechica.com/2017/08/23/100-renewable-energy-job-growth-139-nations-detailed-new-stanford-report>

<https://cleantechica.com/2017/08/23/100-renewable-energy-job-growth-139-nations-detailed-new-stanford-report>

Mark Z. Jacobson, a professor at the Stanford School of Earth, Energy, and Environmental Sciences, and 26 of his colleagues have compiled a report that shows how 139 nations could transition to 100% renewable energy by 2050 without throwing millions of people out of work. In fact, they contend that the changeover would actually spur job growth while dramatically reducing carbon emissions. Jacobson's group developed roadmaps that assess the renewable energy resources available to each country; the number of wind, water, and solar energy generators needed to get to 80% renewable energy by 2030 and 100% by 2050; how much land and how many rooftops these power sources would require; and how the proposals for each country would reduce energy demand and cost when compared to a business-as-usual scenario. The analysis revealed that those countries with lots of available land will find the transition to renewable energy the easiest.

Percentage of Clean Energy in 21st Century



Orlando City Commission Commits to 100% Renewable Energy by 2050:

Sierra Club, August 8, 2017

<http://content.sierraclub.org/press-releases/2017/08/orlando-city-commission-commits-100-renewable-energy-2050>
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The Orlando City Commission has unanimously approved a resolution establishing a goal to move Orlando to 100 percent clean and renewable energy by 2050. Orlando is now the largest city in Florida to make such a commitment and joins a growing movement of more than three dozen cities nationwide that have committed to a 100 percent clean energy future. Orlando represents the 40th city in the U.S. to commit to move to 100 percent clean and renewable energy. Other Florida cities that have committed to transition to 100 percent clean and renewable energy include St. Petersburg and Sarasota.

Colorado City to Become One of the First in U.S. to Run Completely on Renewable Energy:

The Hill, by Justin Wise, May 29, 2019

<https://thehill.com/policy/energy-environment/446065-colorado-city-to-become-one-of-the-first-in-the-country-run-on-100>

Glenwood Springs, Colorado is set to become the latest U.S. city to run entirely on renewable energy. The move to 100 percent renewable energy comes after the city inked a deal with its wholesale power supplier. The Glenwood Springs City Council in April approved a resolution to buy all of Glenwood Springs Electric's electricity from wind power supplied by Municipal Energy Agency of Nebraska. Glenwood Springs will join six other cities that are already running on 100 percent renewable energy. The cities include Aspen, Colorado, Burlington, Vermont.; Georgetown, Texas; Greensburg, Kansas; Rock Port, Missouri; and Kodiak Island, Alaska.

MOVING FORWARD TO 100 PERCENT

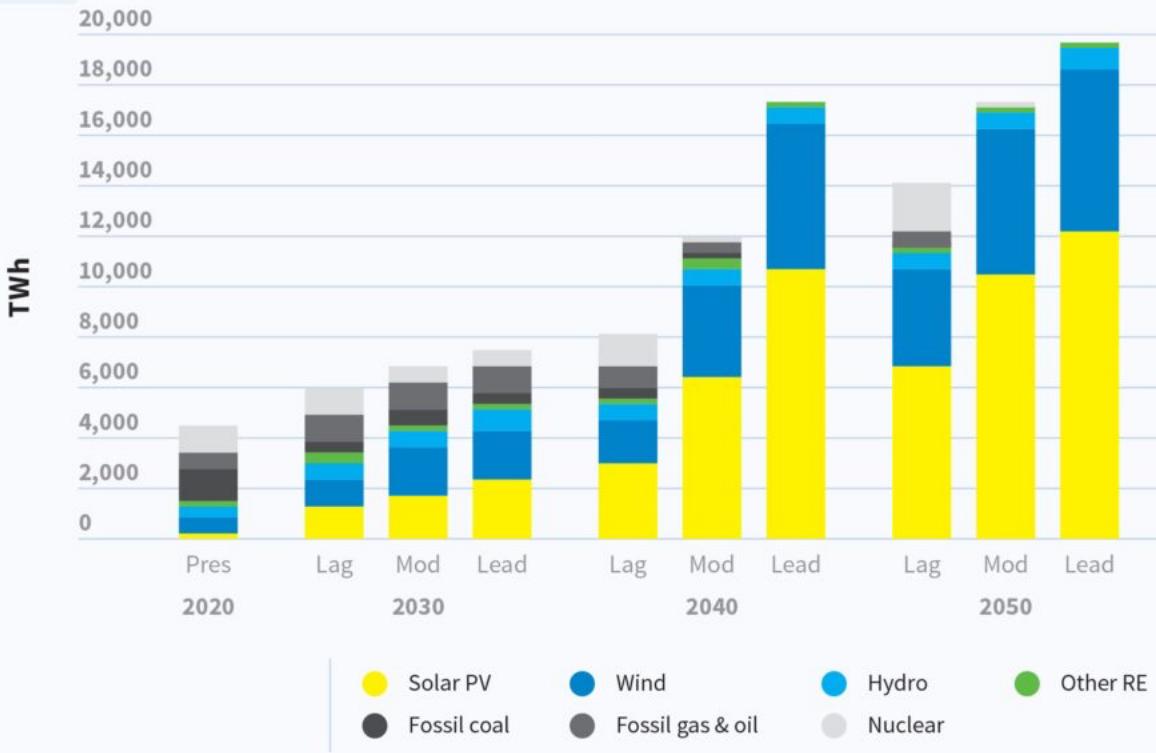
States Hold Fast to Clean Energy Growth Plans:

Pew Charitable Trusts, May 19, 2020

<https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2020/05/19/clean-energy-has-taken-a-hit-will-it-rebound>

Members of the 100% Clean Energy Collaborative, which include 14 states and Washington, DC, say they remain committed to their 100% clean energy goals, despite the pandemic. That commitment is possibly a surprise, given the battering the clean energy industry has taken over the past two months. The pandemic has slashed state budgets, devastated the clean energy workforce and set back many projects. But leaders from California to New York to Washington say the disruption is just a speed bump. In the states that have set firm clean energy targets, utilities, investors and developers have been preparing to meet the demand created by state mandates, and that work isn't stopping. Moreover, many state officials think investments in clean energy could play a huge part in the country's economic recovery. They point to the 2009 stimulus package passed during the last recession, which provided \$90 billion for the industry. That investment paved the way for the rapidly growing, increasingly affordable renewable energy being provided today

ELECTRICITY GENERATION



Source: SolarPower Europe. © SOLARPOWER EUROPE 2020

A study by Solarpower Europe and LUT: Three different cases for the transformation of the European energy system were examined in this study. The more ambitious scenario with 100% renewable energy and a high proportion of PV might be cheaper than less ambitious paths to a green Europe.

https://pv-magazine-usa.com/2020/04/15/a-climate-neutral-europe-powered-60-by-solar-is-possible-before-2050/?utm_source=pv+magazine+USA&utm_campaign=95bef00442-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_80e0d17bb8-95bef00442-158716569

RENEWABLE ENERGY

Germany Exceeds 50% Renewable Energy Use Milestone

Deutsche Welle

Apr. 03, 2020 02:48PM EST

In Germany's Hunsrück village of Schorbach, numerous photovoltaic systems are installed on house roofs, on Sept. 19, 2019. Thomas Frey / Picture Alliance via Getty Images

Germany's target for renewable energy sources to deliver 65% of its consumed electricity by 2030 seemed on track Wednesday, with 52% of electricity coming from renewables in 2020's first quarter. Renewable energy advocates, however, warned the trend is imperiled by slowdowns in building new wind and solar plants. The federal BDEW energy and water federation and Baden-Württemberg state's ZSW solar and hydro research center observed a 7% percent renewables jump from 44.4% in the same period last year, in comparison to fossil fuel consumption.

Wind, especially offshore wind turbines, solar panels and other sources generated 77 billion kilowatt-hours (kWh) compared to 67 kWh in the first quarter of 2019. Using the standard EU's electricity consumption measurement, Germany's total, also from conventional coal, gas and nuclear plants, amounted to 148 billion kWh. The 7% jump in renewables came despite conventional plant closures and pandemic impacts on industry, officials said, while also noting "special effects" such as record winds in February and plentiful sun in March that benefited turbines and voltaic panels.

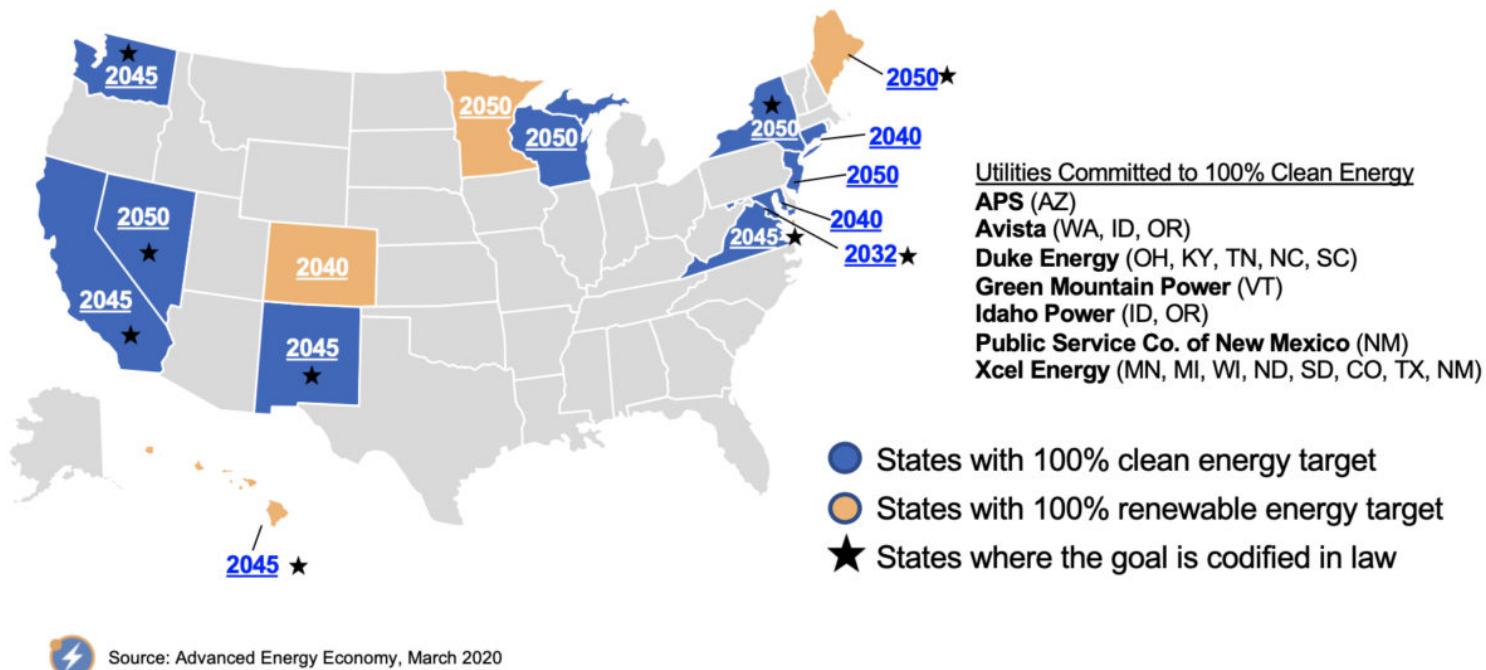
SOURCE: <https://www.ecowatch.com/germany-renewable-energy-2645629058.html>

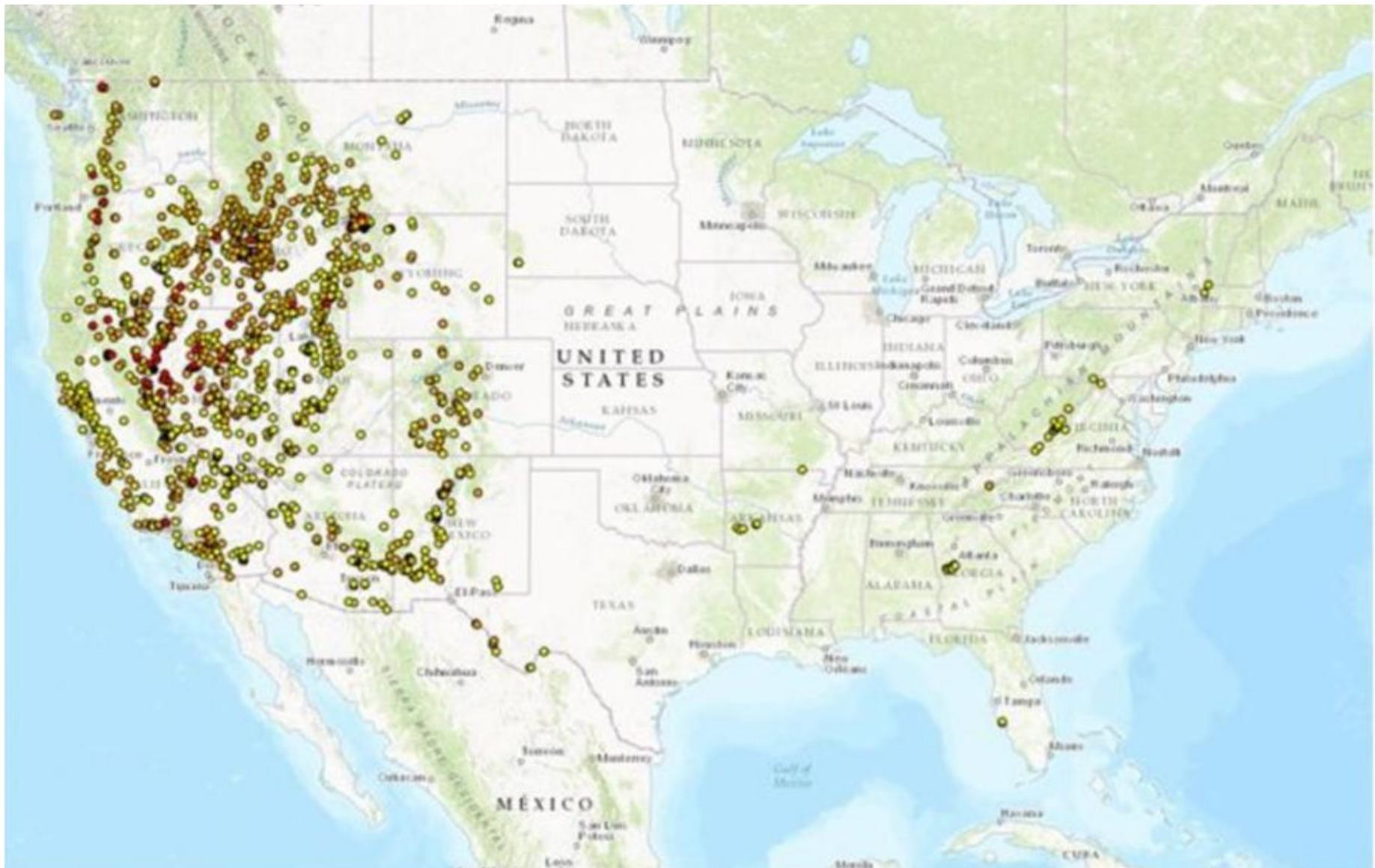
Hydrogen and ‘direct air carbon capture’ enter the policy conversation

By Jean Haggerty on May 5 2020, 6:00pm

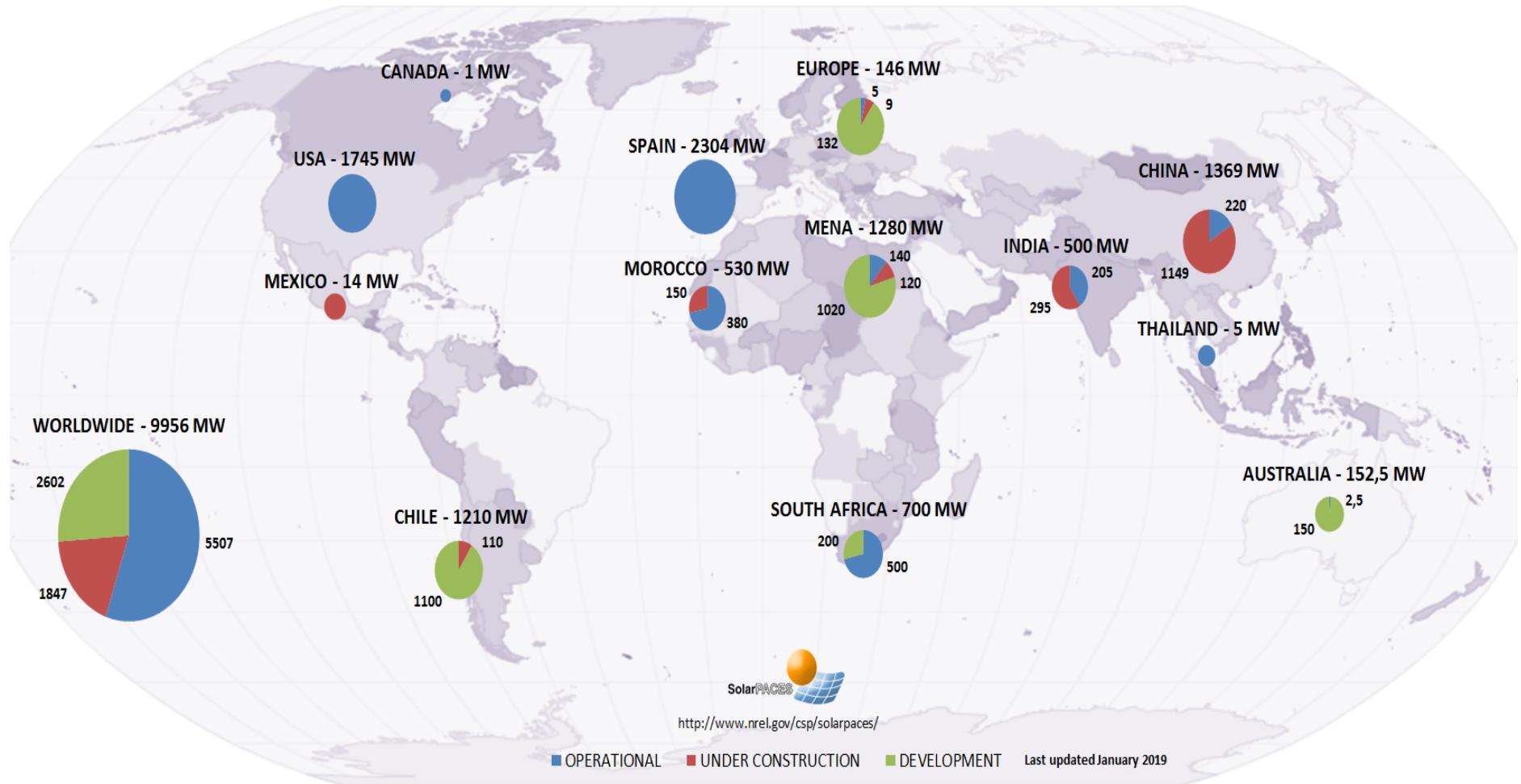
While utilities, municipalities and states across the U.S. struggle to find a cost-effective way to get to 100% carbon-free power, some companies, like Wärtsilä North America, think that the answer is closer than we realize. Power-to-hydrogen pathway’s biggest advantage over a power-to-methane pathway is that it is carbon-free; its exhaust is water. Also, when produced using excess solar or wind, electrolysis can be produced almost anywhere. Hydrogen’s drawback is that even though hydrogen is inexpensive to produce, it can’t be used in a power system without a complete overhaul of the entire gas-fuel infrastructure. According to Ferrari, this is because the current utility infrastructure can only handle 15-30% hydrogen by volume.

“The biggest advantage that [renewable power-to-methane] has over hydrogen is that the entire United States is crisscrossed with gas pipelines, compressors and storage systems, that can all be used today with renewable synthetic methane. None of this infrastructure can be used as-is for 100% hydrogen, and there are no thermal power plants that can burn 100% hydrogen today,” Ferrari said. The cost to build a 100MW thermal plant that uses hydrogen should be in the same price and performance range as a natural gas plant, he noted.





The US has 2.5 gigawatts of operating geothermal capacity, about half of which came online in the 1980s. Most geothermal capacity is in the western US (*insert*).



<https://www.solarpaces.org/csp-technologies/csp-projects-around-the-world/>



Good planets are hard to find.