



The Stella Group, Ltd.



Scott Sklar is founder and President of The Stella Group, Ltd, since 2000, after running the Solar Energy Industries Association for 15 years, and in the US Senate as a military & energy aide for 10 years prior.

The Stella Group, Ltd.. is a global technology optimization and policy owners-rep 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. He teaches three unique interdisciplinary sustainable energy courses at The George Washington University (GWU) and serves as Sustainable 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.

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THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

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Sustainable Energy Director

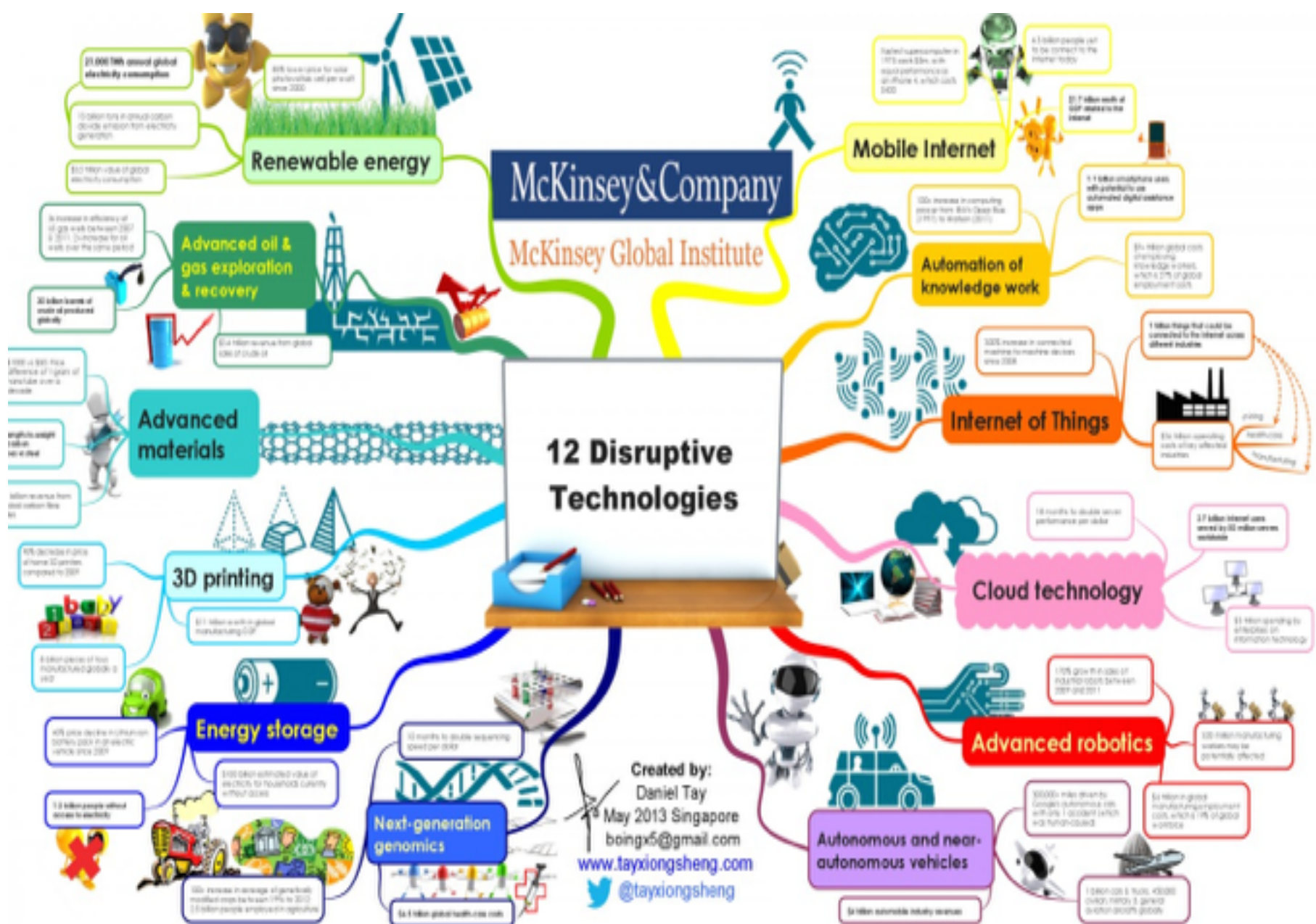
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Reforming the Energy Vision

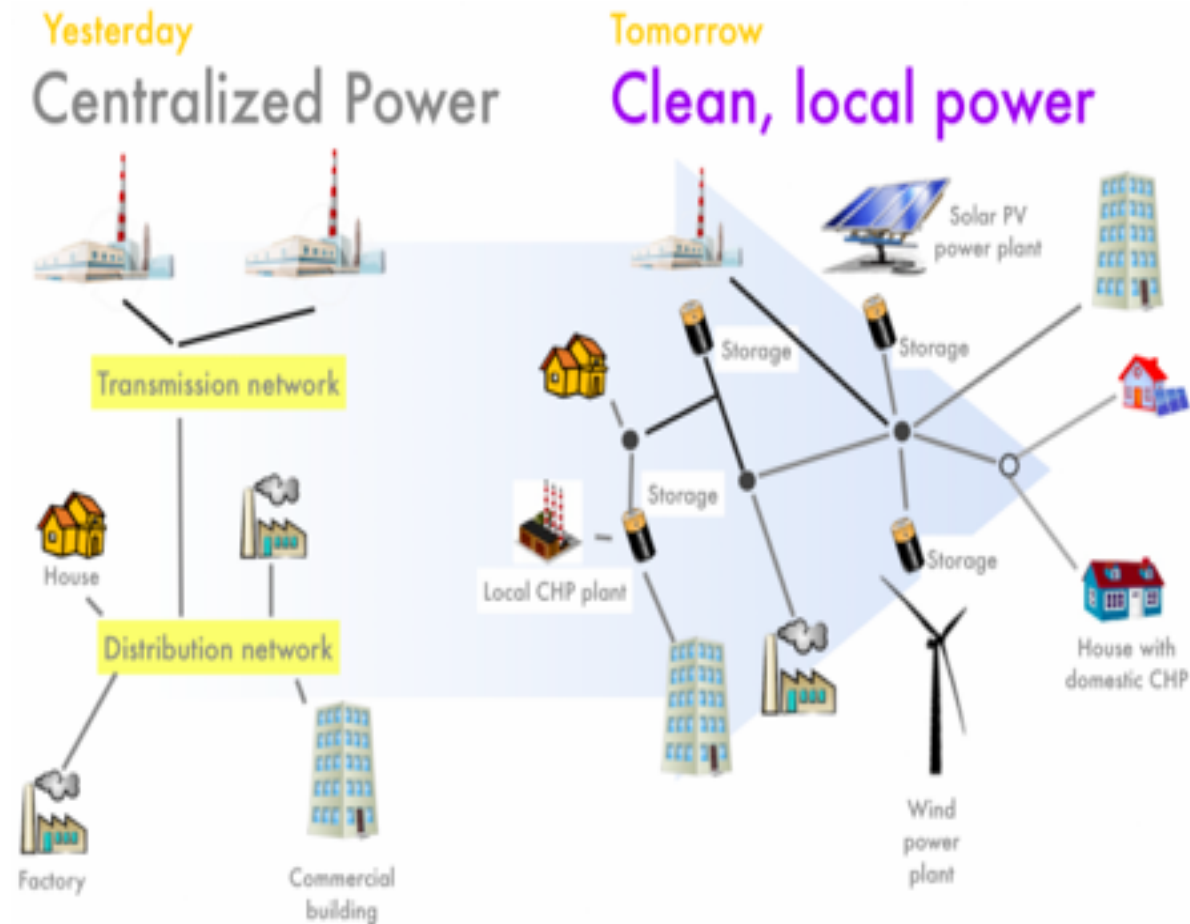
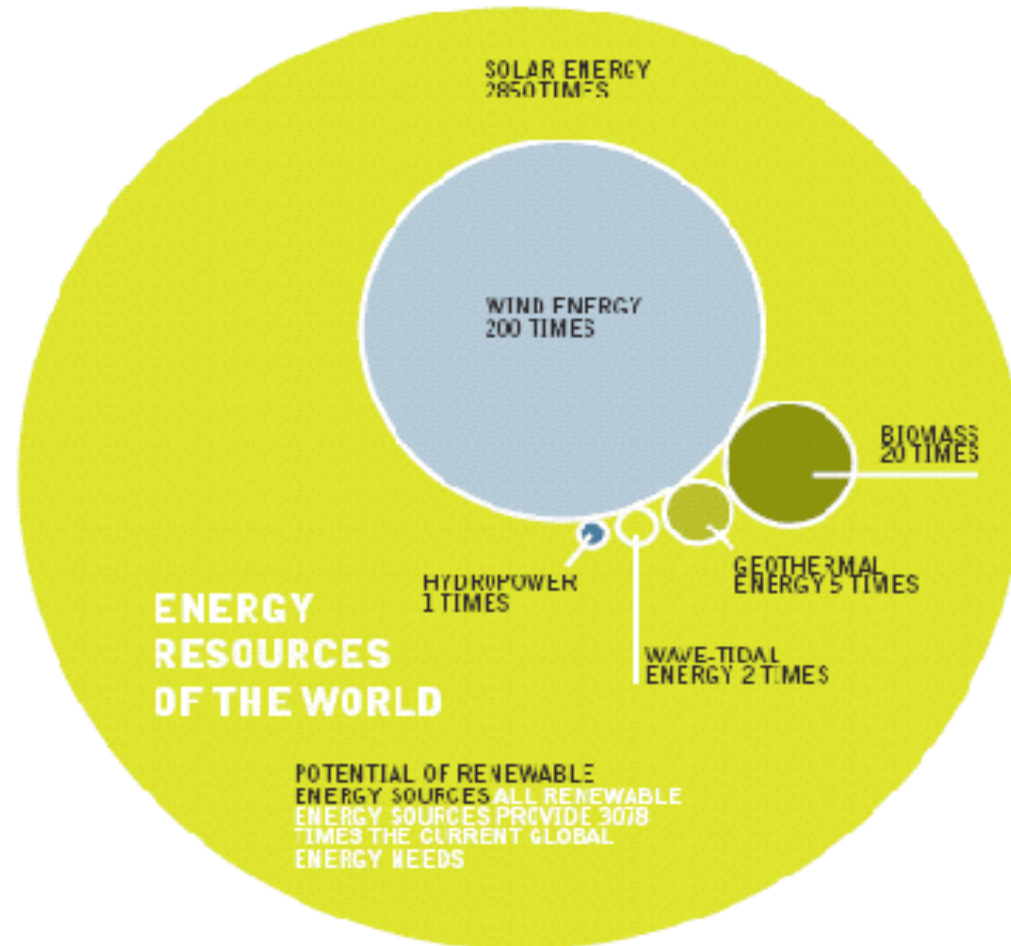


figure 30: energy resources of the world



source WBGU

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 GHG reductions in the time necessary to mitigate climate change without maximization of high-value energy efficiency in every single sector – buildings, industry, transportation, infrastructure, and 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)

TECHNOLOGY OPTIONS SURVEY

New Analysis Shows How Communities Can Locally Produce 100% Clean Energy:
Union of Concerned Scientists, by James Gignac, October 5, 2021

<https://cleantechnica.com/2021/10/05/new-analysis-shows-how-communities-can-locally-produce-100-clean-energy>
and

<https://www.ucsusa.org/about/news/communities-can-locally-produce-100-percent-clean-energy>

The Union of Concerned Scientists and the nonprofit Soulardarity have partnered to show how Highland Park, Michigan, can realize a vision of an equitable, reliable, and affordable clean energy system powered by locally-owned resources. The analysis found that 100 percent of Highland Park's electricity demand can be met with energy efficiency and clean energy generated locally by rooftop solar panels installed on homes and businesses, larger solar installations, and a community water and energy resource center that uses wastewater to generate electricity. The analysis, "Let Communities Choose: Clean Energy Sovereignty in Highland Park, Michigan," is a model that could also help other communities achieve their visions of energy sovereignty.

October 4, 2021. 9:01 AM EDT
REUTERS: All Britain's power to be green by
2035, PM Johnson says



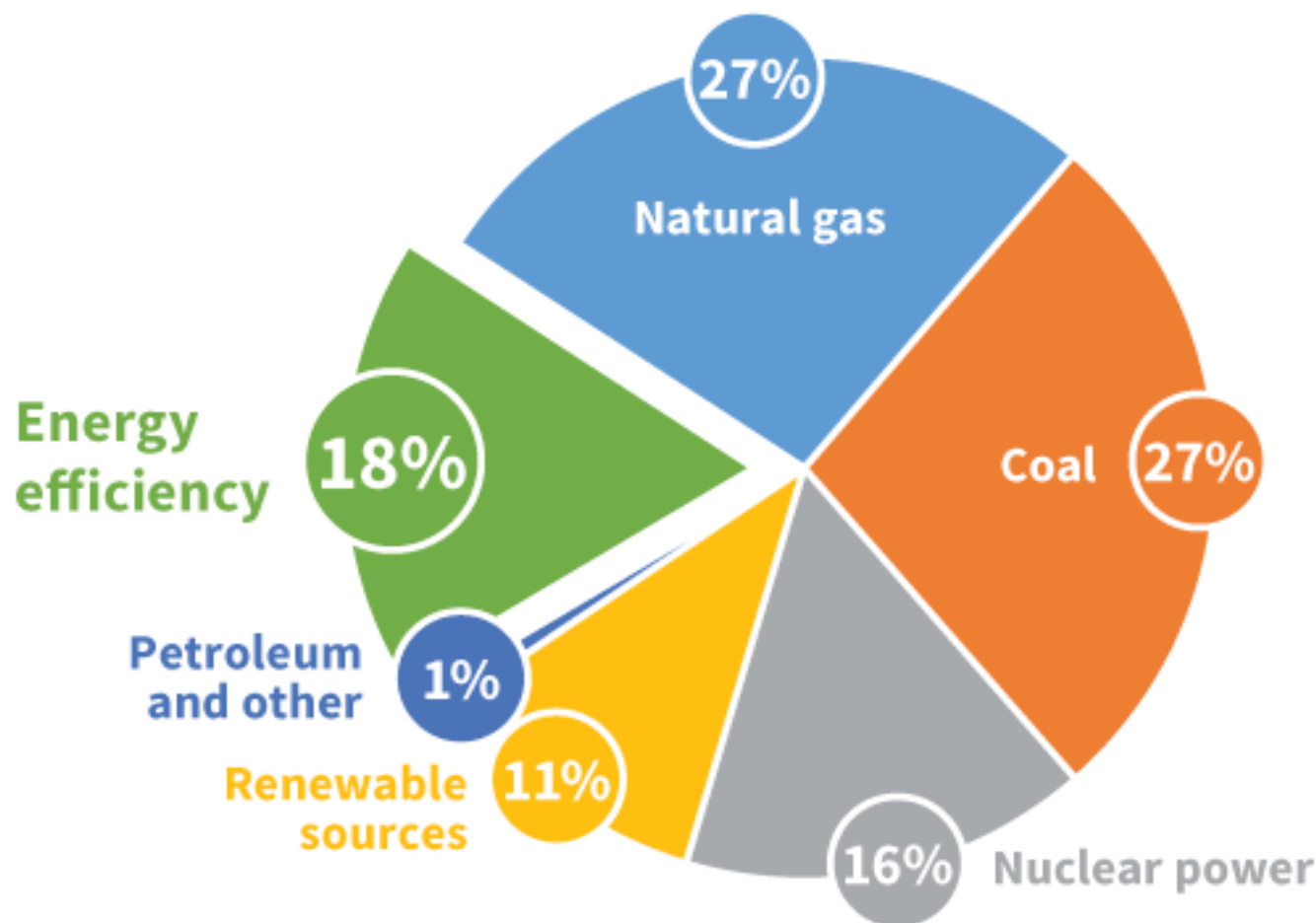
Prime Minister Boris Johnson says the U.K. is aiming to generate all of its energy from renewable sources by 2035. "Looking at the progress that we're making in wind power, where we lead the world now in offshore wind, looking at what we can do with other renewable sources, carbon capture and storage with hydrogen potentially, we think we can get to complete clean energy production by 2035," Johnson said.

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

<https://www.energymanagertoday.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).



FERC PROJECTS MASSIVE GROWTH FOR SOLAR AND WIND OVER NEXT THREE-YEARS - NEARLY 3.5x NATURAL GAS RENEWABLES ON TRACK TO EXCEED 30% OF U.S. CAPACITY BY 2025

For Release: Tuesday - February 9, 2021. Contact: Ken Bossong, 301-588-4741 or 301-270-6477 x.6

Washington DC – According to a review by the SUN DAY Campaign of data just released by the Federal Energy Regulatory Commission (FERC), renewable energy sources (i.e., biomass, geothermal, hydropower, solar, wind) strongly dominated new U.S. electrical generating capacity additions in 2020.

Combined, they accounted for or 22,451 megawatts (MW) or more than three-quarters (78.09%) of the 28,751 MW of new utility-scale capacity reported to have been added last year. Wind (13,626 MW) and solar (8,543 MW) each contributed more new generating capacity than did natural gas (6,259 MW). [1]

FERC's latest monthly "Energy Infrastructure Update" report (with data through December 31, 2020) also reveals that natural gas accounted for 21.77% of the total, with very small contributions by coal (30 MW), oil (6 MW), and "other" sources (5 MW) providing the balance. There were no new capacity additions by nuclear power or geothermal energy during the year.

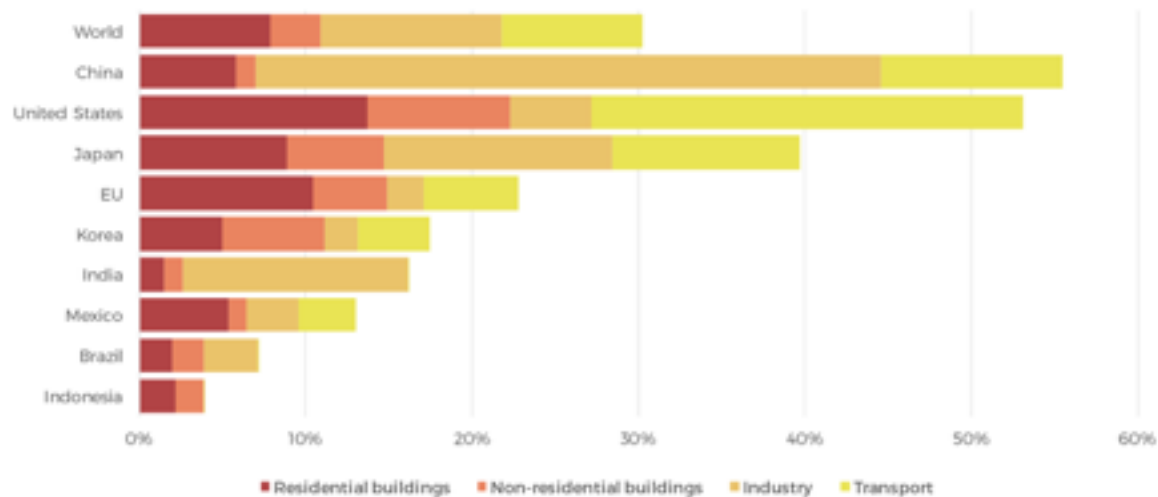
Sources:

FERC's 7-page "Energy Infrastructure Update for December 2020" released on February 8, 2021. It can be found at <https://www.ferc.gov>; open the link "Industries and Data," then follow to "FERC Staff Reports and Papers," and then to "Energy Infrastructure." For the information cited in this update, see the tables entitled "New Generation In-Service (New Build and Expansion)," "Total Available Installed Generating Capacity," and "Generation Capacity Additions and Retirements."

The U.S. Energy Information Administration issued its "Electric Power Monthly" report for calendar year 2019 on February 26, 2020. It may be found at: <https://www.eia.gov/electricity/monthly>

Follow the link to "previous issues" and then to "December 2019". The data cited in this update can be found at, or extrapolated from, Tables ES1.A and ES1.B.

Share of total final energy consumption covered by mandatory energy efficiency policies



Energy Efficiency Market Report 2016



<https://www.iea.org/newsroom/news/2017/may/commentary-the-untapped-potential-of-energy-efficiency-.html>

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.

Study Argues 100% Global Energy System Feasible:
PV Magazine, by Sandra Enkhardt, May 18, 2018

<https://www.pv-magazine.com/2018/05/18/study-100-global-energy-system-feasible>

Several scientists have gathered hundreds of studies on energy systems regarding the feasibility of a global transition to sustainable energy. Their analysis, "Response to 'Burden of proof: A comprehensive review of the feasibility of 100% renewable-electricity systems,'" was published in the academic journal "Renewable and Sustainable Energy Review." The conclusion: there are neither fundamental technical nor financial barriers on the path to a 100% renewable energy system. Scientists of the Karlsruhe Institute of Technology, the South African Council for Scientific and Industrial Research, Lappeenranta University of Technology, Delft University of Technology and the University of Aalborg contributed to the paper.

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-2019-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.

BLOOMBERG NEW ENERGY FINNACE (BNEF):
World may add up to 209 GW of solar this year

The world stands to add at least 160 gigawatts of new installed solar capacity this year, but that figure could climb as high as 209 GW, depending on deployment activity in international markets like India and China, according to Bloomberg NEF. The industry will continue to surge in 2022 and 2023, but BNEF reports there's no need to worry about supply constraints. New manufacturing facilities and partnerships are lining up to facilitate growth of the energy source.

Full Story: [PV Magazine \(Germany\)](https://www.pv-tech.org/up-to-209gw-of-solar-pv-to-be-installed-in-2021-bloombergnef-forecasts/) (2/23/21)
<https://www.pv-tech.org/up-to-209gw-of-solar-pv-to-be-installed-in-2021-bloombergnef-forecasts/>

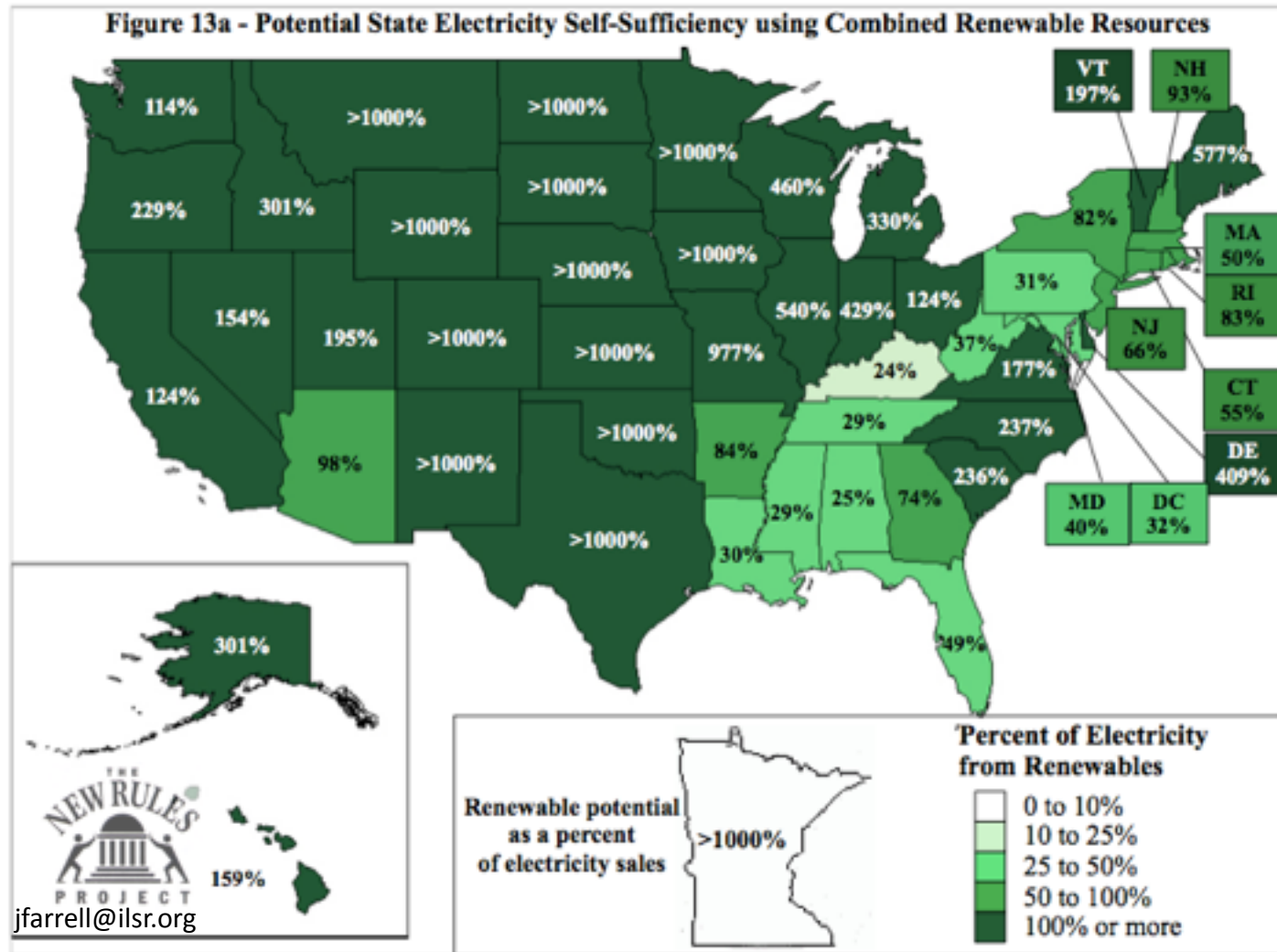
Advanced Energy Hit Record \$1.6 Trillion Worldwide in 2018; U.S. Revenue Grew Nearly 4 Times as Fast as GDP:

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

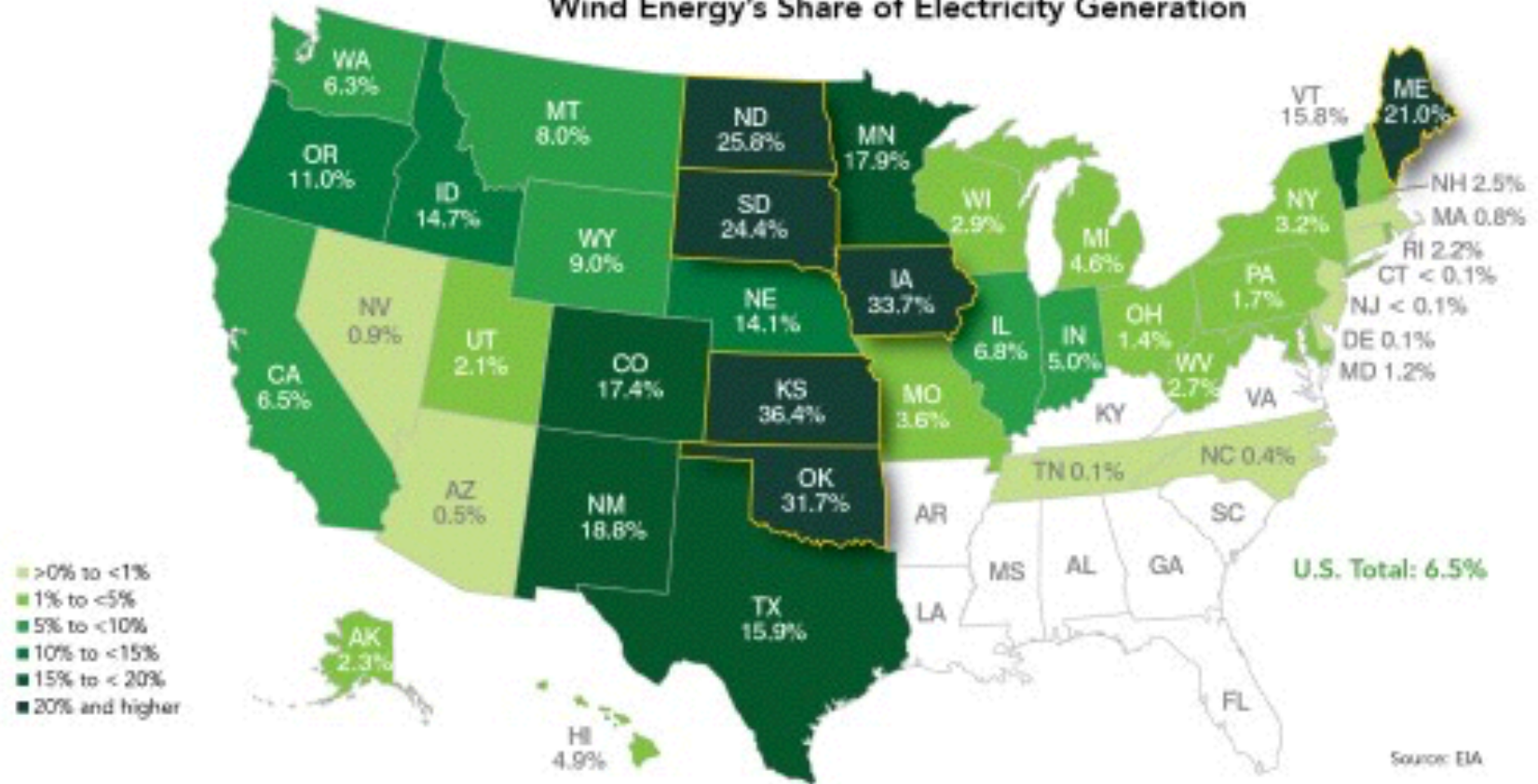


Report Concludes Most States Could Rely on Local Renewables:
Institute for Local Self-Reliance, by John Farrell & Maria McCoy, September 10, 2020

<https://ilsr.org/report-energy-self-reliant-states-2020>

Forty-seven states could meet 100% of their electricity needs using in-state renewables, according to a new analysis, “Energy Self-Reliant States,” by the Institute for Local Self-Reliance. Moreover, advances in technology have allowed 47 states to dramatically increase their overall renewable generation potential, with a median increase of 439% over the past decade. This means that not only can most states meet all of their current electricity needs with in-state, renewable resources, most could achieve it several times over. Among the factors driving the trend toward in-state renewable energy across the U.S. are improved technologies in the renewable energy sector and increased commitments to renewables at the city and state level. In addition, the 20-year average cost of solar electricity has declined from around \$0.200 per kilowatt-hour for small scale projects to \$0.091 per kilowatt-hour. Wind energy costs have declined by significant margins, as well, from around \$0.13 to \$0.04 per kilowatt-hour.

Wind Energy's Share of Electricity Generation



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

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.

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 \$60/MWh and \$143/MWh. The levelized cost of utility-scale solar is between \$36/MWh and \$46/MWh.

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.

For Release: Wednesday - January 15, 2020 SUN DAY CAMPAIGN sun-day-campaign@hotmail.com

Pumped Hydro Storage to Exceed \$350 Billion by 2024:

Power Engineering, September 18, 2017

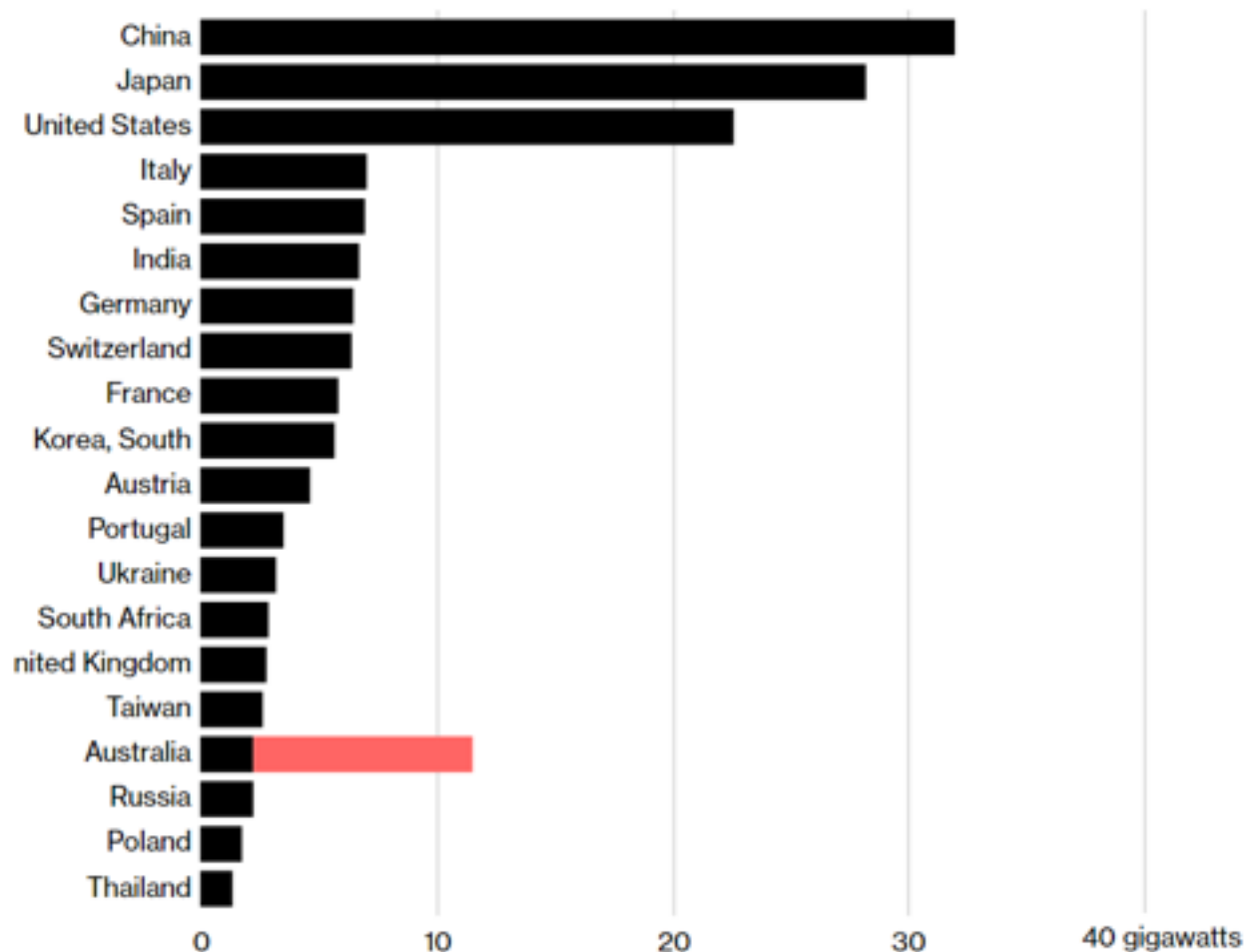
<http://www.pennenergy.com/articles/pe/2017/09/pumped-hydro-storage-to-exceed-350-billion-by-2024.html><http://www.pennenergy.com/articles/pe/2017/09/pumped-hydro-storage-to-exceed-350-billion-by-2024.html>

Utilities will continue to embrace pumped hydro storage, with the total worldwide market expected to exceed \$350 billion by 2024, according to a new study by Global Market Insights. Favorable regulations and growing adoption of renewable energy will drive pumped hydro adoption, as well as a lack of efficient monitoring systems and frequent supply outages in developing countries. The expansion of microgrids following the development of distributed generation technology will also make hydro storage more attractive, as well as the desire to lower carbon emissions. In the U.S., pumped hydro use will grow as grid infrastructure becomes upgraded and refurbished with advanced grid support systems. Open loop systems account for over 90 percent of pumped hydro storage systems, with three open-loop projects announced or under construction in the U.S.

Water for Batteries

Countries with the most pumped hydro capacity

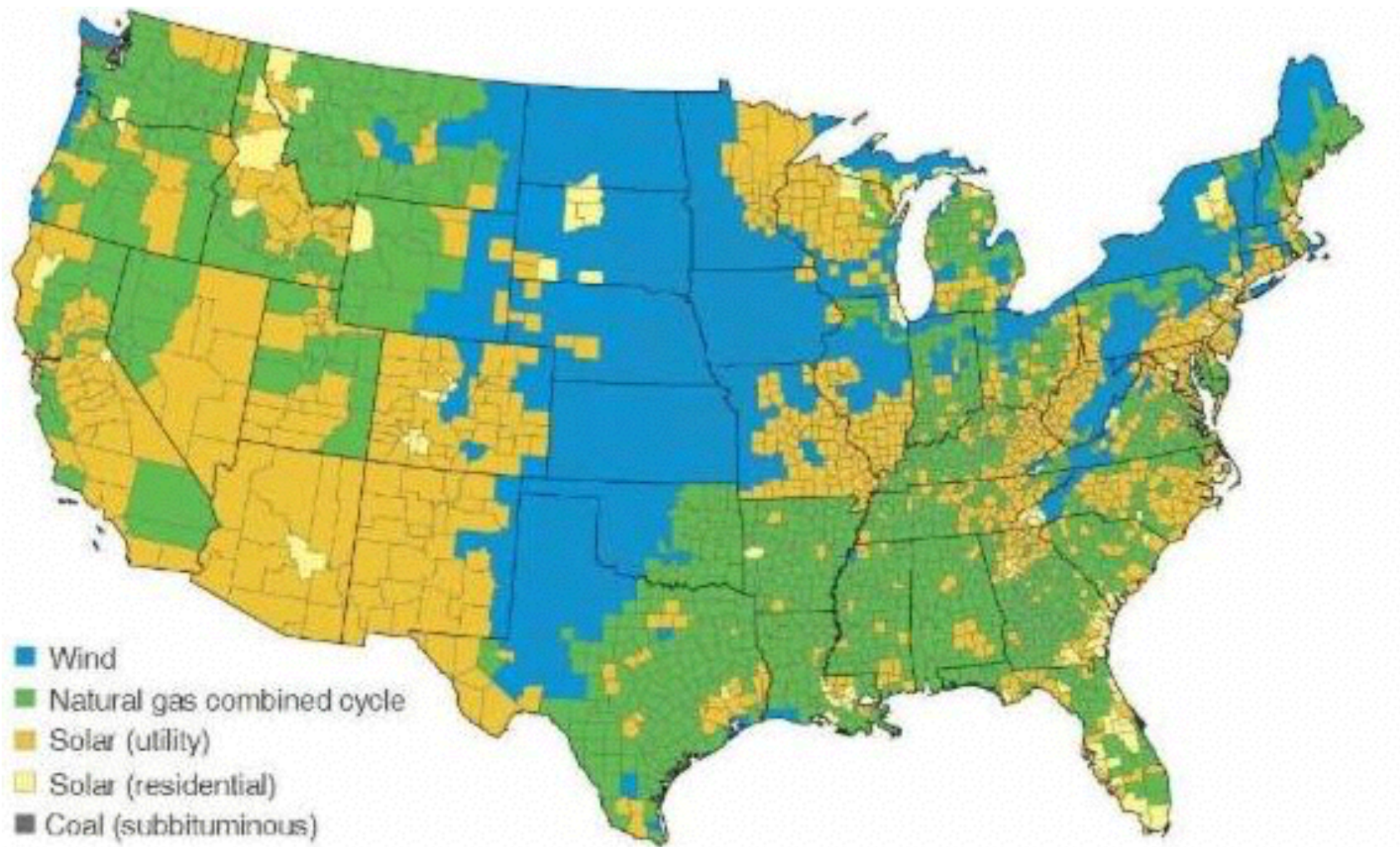
■ Operational ■ Proposed

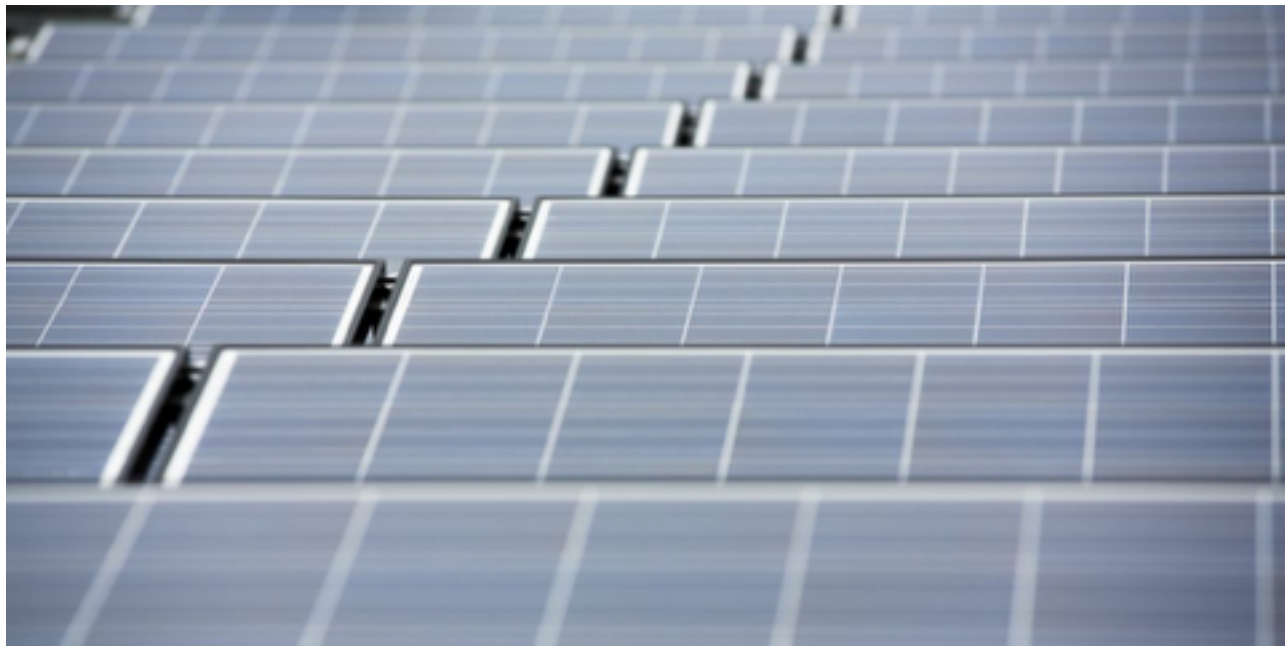


Bloomberg New Energy Finance

Source: DOE Global Energy Storage Database

The least expensive method for generating electricity in the US, by region





Abu Dhabi's 1.5 GW tender draws world record low solar bid of \$0.0135/kWh

By Emiliano Bellini on Apr 29 2020, 3:11pm

The tariff is around \$0.0021 lower than the \$0.0156/kWh French oil giant Total and Japanese conglomerate Marubeni Corp offered in Qatar's 800 MW tender in late January. French energy company EDF and Chinese solar company JinkoPower reportedly submitted the record bid in the UAE exercise.

https://pv-magazine-usa.com/2020/04/29/abu-dhabis-1-5-gw-tender-draws-world-record-low-solar-bid-of-0-0135-kwh/?utm_source=pv+magazine+USA&utm_campaign=816e2fd796-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_80e0d17bb8-816e2fd796-158716569

Los Angeles solicits record solar + storage deal at 1.997/1.3-cents kWh
8Minute Energy beat its record for U.S. solar contracts, previously held by the 2.376 cents per kWh project being developed for NV Energy.



The Los Angeles Department of Water and Power (LADWP) is preparing a potentially world record-setting power purchase agreement (PPA) for solar + storage at 1.997 cents and 1.3 cents per kWh, respectively. LADWP presented the 400 MW solar, 800 MWh storage project to the city's Board of Power and Water Commissioners on June 18, previewing its planned July 23 submission for approval. The solar + storage contract would beat out the previous U.S. record, a 2.376 cents per kWh solar project proposed by NV Energy in June 2018, with both the Nevada and California projects under developer 8Minute Energy. 8/2019

https://www.utilitydive.com/news/los-angeles-solicits-record-solar-storage-deal-at-199713-cents-kwh/558018/?utm_source=Sailthru&utm_medium=email&utm_campaign=Issue:%202019-07-11%20Utility%20Dive%20Renewable%20Energy%20%5Bissue:21850%5D&utm_term=Utility%20Dive:%20Renewable%20Energy

Solar-plus-Storage Is 'Chasing Gas Off the Grid':
Energy Storage News, by John Parnell, May 1, 2019

<https://www.energy-storage.news/news/solar-and-storage-plants-chasing-down-gas-generators>

A study by Fluence and a group of MBA candidates at the Tepper School of Business at Carnegie Mellon University has found that building new mid-merit gas plants was no longer the best value option for utilities. Solar plus storage (S+S) can compete – operationally and financially – with mid-merit NGCC plants in many regions of the U.S. today. For example, in the California Independent System Operator service territory, the net levelized cost of energy (NGCC) for S+S runs from \$39 to \$48, with a mid-point of \$43.20. A comparable mid-merit NGCC would have a net LCOE of \$60-\$116. The study's authors note that tracking the ability of solar and storage to compete with mid-merit natural gas is the first part of a much larger question – how fast can we replace all natural gas – and even baseload – generation with renewables and storage?

Energy Storage 2020 - It's Not Just About Lithium-Ion Batteries Any More:
CleanTechnica.com, by Steve Hanley, January 5, 2020

<https://cleantechnica.com/2020/01/05/energy-storage-2020-its-not-just-about-lithium-ion-batteries-any-more>

Many of us think lithium-ion batteries are the beginning, middle, and end of the energy storage discussion. Yet there are other types of storage solutions, many of which will begin to share the spotlight with lithium-ion batteries in 2020. The US Department of Energy's Advanced Research Projects Agency (ARPA-E) is funding research by 10 organizations with one common goal - creating long term energy storage systems that cost \$0.05 per kilowatt hour or less. Five of the projects are scheduled for completion in 2020 and the rest in 2021. The research falls into several general categories including Sulfur Flow Batteries, Electricity to Hydrogen, Zinc-Bromine Flow Batteries, Thermovoltaics, Electricity to Magnesium Manganese, Electricity to Heat, Pressurizing Water Underground, and Liquid Air Energy Storage. After the research projects are complete, ARPA-E plans to fund small scale field trials to determine which are commercially viable.

36 STUDIES ON GOING TO 100% RENEWABLES

“a subset of efficiency & renewables”

Clean Energy Reports

1. **GREENPEACE/DLR**

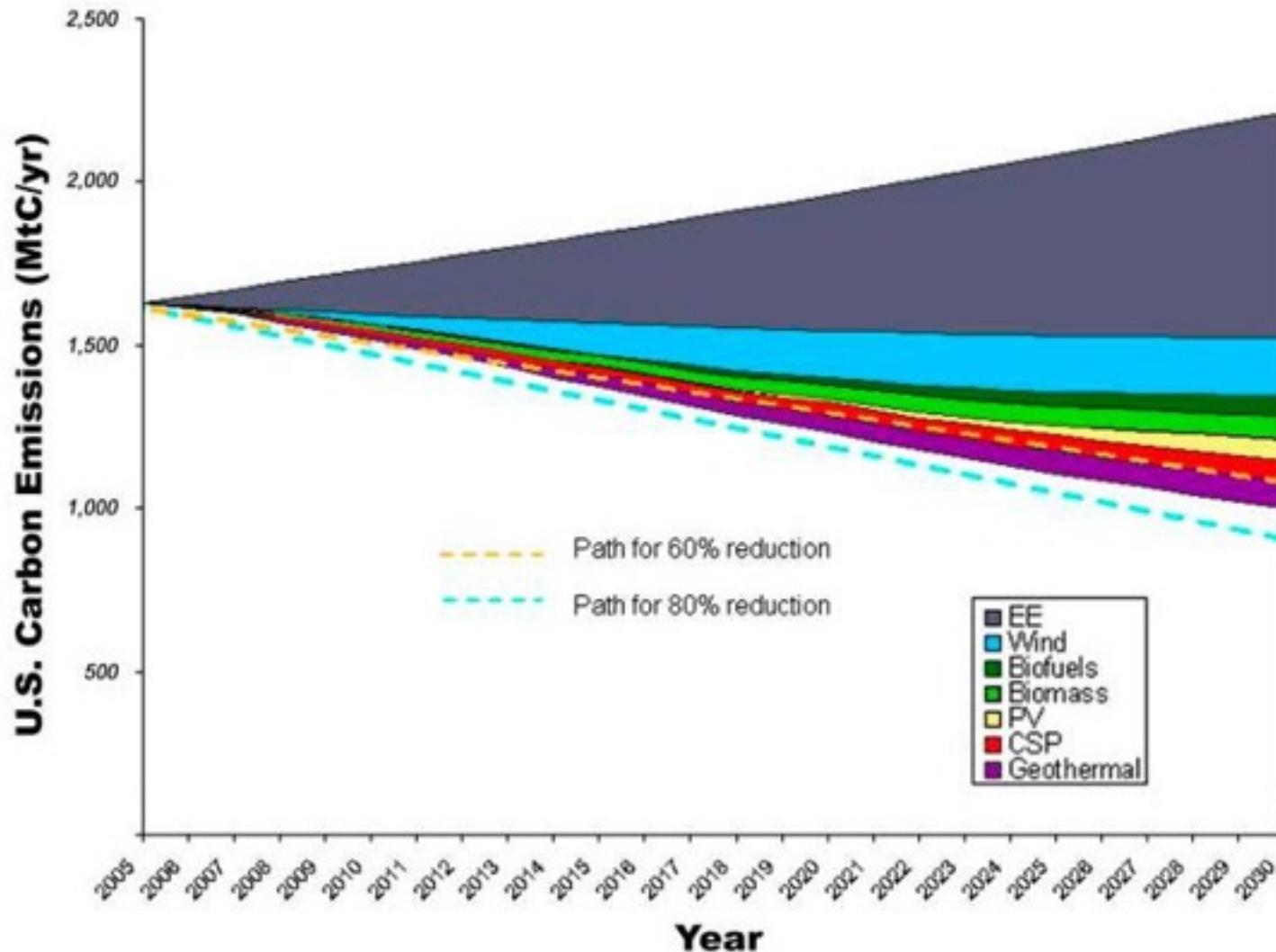
The world could eliminate fossil fuel use by 2090 by spending trillions of dollars on a renewable energy revolution, the European Renewable Energy Council (EREC) and environmental group Greenpeace said. The 210-page study is one of few reports -- even by lobby groups -- to look in detail at how energy 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

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 MWp , 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://cleantechnica.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:

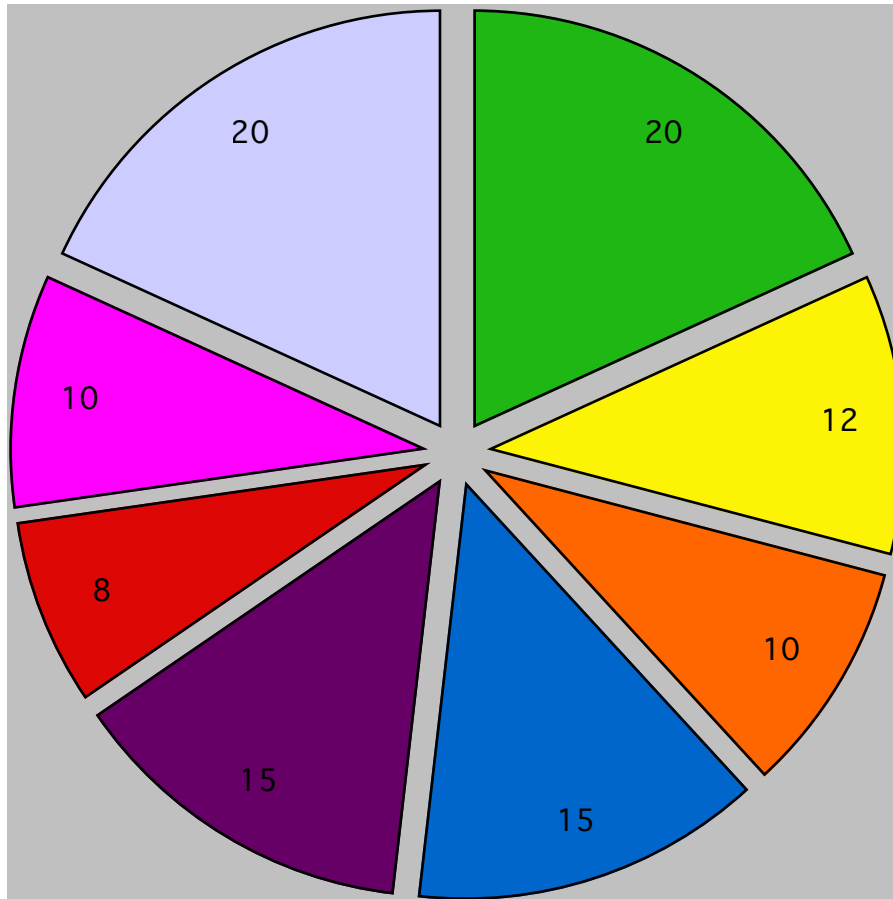
CleanTechnica.com, by Steve Hanley, August 23, 2017

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

<https://cleantechnica.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



- 20% Biomass Power
- 12% Building RE: GCHP/SDL
- 10% Geothermal
- 15% Solar-Concentrated Solar
- 15% Solar-Distributed PV/ST
- 8% Waste Heat
- 10% Water Energy
- 20% Wind Energy

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><http://content.sierraclub.org/press-releases/2017/08/orlando-city-commission-commits-100-renewable-energy-2050>

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 JustinWise, 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.

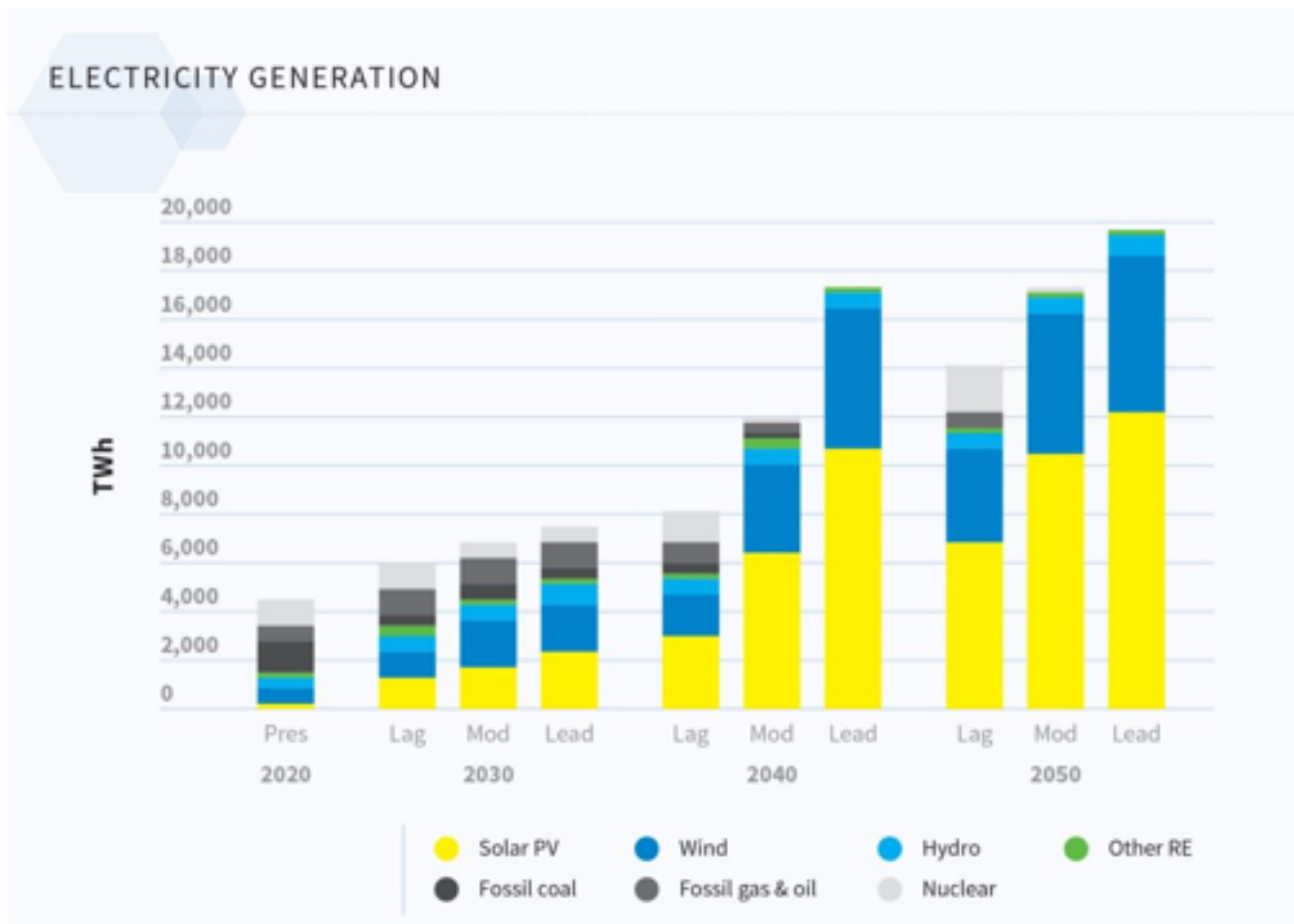
MOVING FORWARD TO 100 PERCENT

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



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

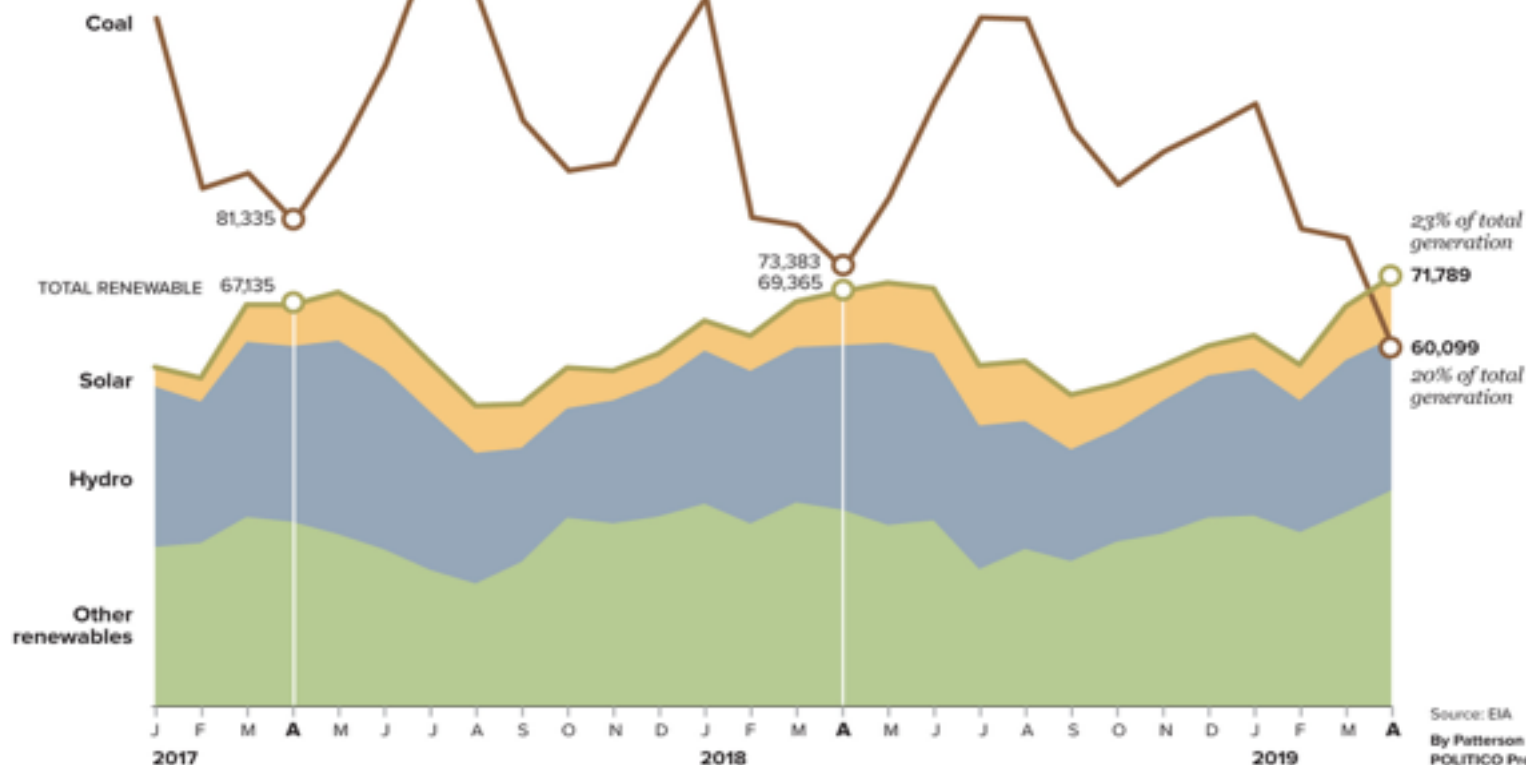
June 26, 2019

Renewable energy surpasses coal for the first time in the U.S.

In April, renewable energy sources generated more electricity in the U.S. than power generated from coal, according to the Energy Information Administration. Reflecting both long-term and seasonal trends, the shift happened in the spring when coal use — which is in general decline — was typically at its lowest, the time of year when generation from burgeoning renewable energy sources tends to peak.

Net generation by energy source

THOUSAND MEGAWATT HOURS, ALL SECTORS



RENEWABLE ENERGY

Germany Exceeds 50% Renewable Energy Use Milestone

_Deutsche Welle

Apr. 03, 2020 02:48PM ESTRENEWABLE ENERGY

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>

Biomass – the fourth largest energy source after coal, oil and natural gas - is the largest and most important renewable energy option at present and can be used to produce different forms of energy. As a result, it is, together with the other renewable energy options, capable of providing all the energy services required in a modern society, both locally and in most parts of the world. Renewability and versatility are, among many other aspects, important advantages of biomass as an energy source. Moreover, compared to other renewables, biomass resources are common and widespread across the globe. The sustainability potential of global biomass for energy is widely

The annual global primary production of biomass is equivalent to the 4,500 EJ of solar energy captured each year. The potential of global biomass as a sustainable energy source is widely recognized. Thus, at present, a bioenergy supply of 270 EJ, possible on a sustainable basis, can cover almost 50% of the world's total primary energy demand. Moreover, this amount of bioenergy can be achieved by only 6% of the annual global primary production of biomass. The potential for energy from biomass depends in part on land availability. Currently, the amount of land devoted to growing energy crops for biomass fuels is only 0.19% of the world's total land area and only 0.5-1.7% of global agricultural land. A mere 10% increase in the efficiency of biomass production through irrigation, manuring, fertilizing and/or improved management through the cultivation of idle land, would create energy equivalent to the total current global energy demand.

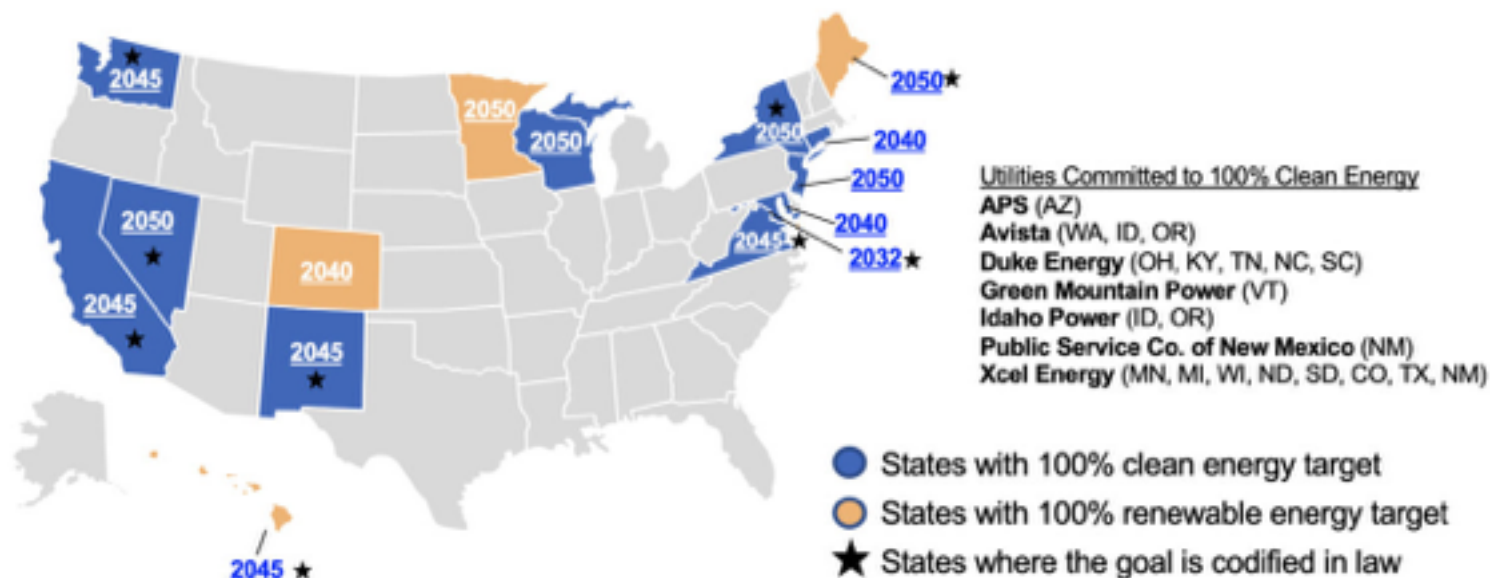
https://worldbioenergy.org/uploads/WBA_Global%20Potential.pdf

Hydrogen and 'direct air carbon capture' enter the policy conversation

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

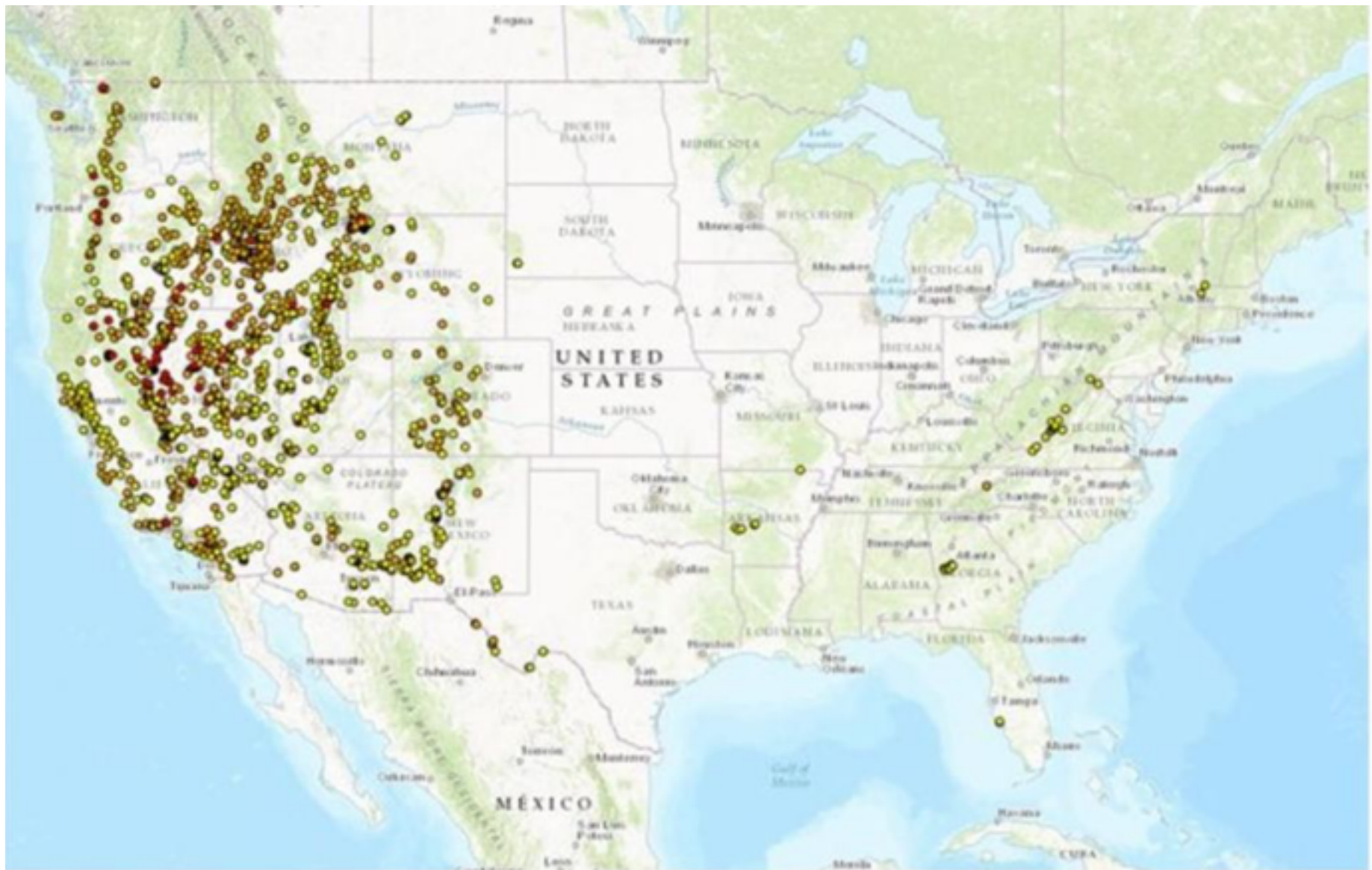
While utilities, municipalities and states across the U.S. struggle to find a cost-effective way to get to 100% carbon-free power, some companies, like Wärtsilä North America, think that the answer is closer than we realize. Power-to-hydrogen pathway's biggest advantage over a power-to-methane pathway 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.



Source: Advanced Energy Economy, March 2020

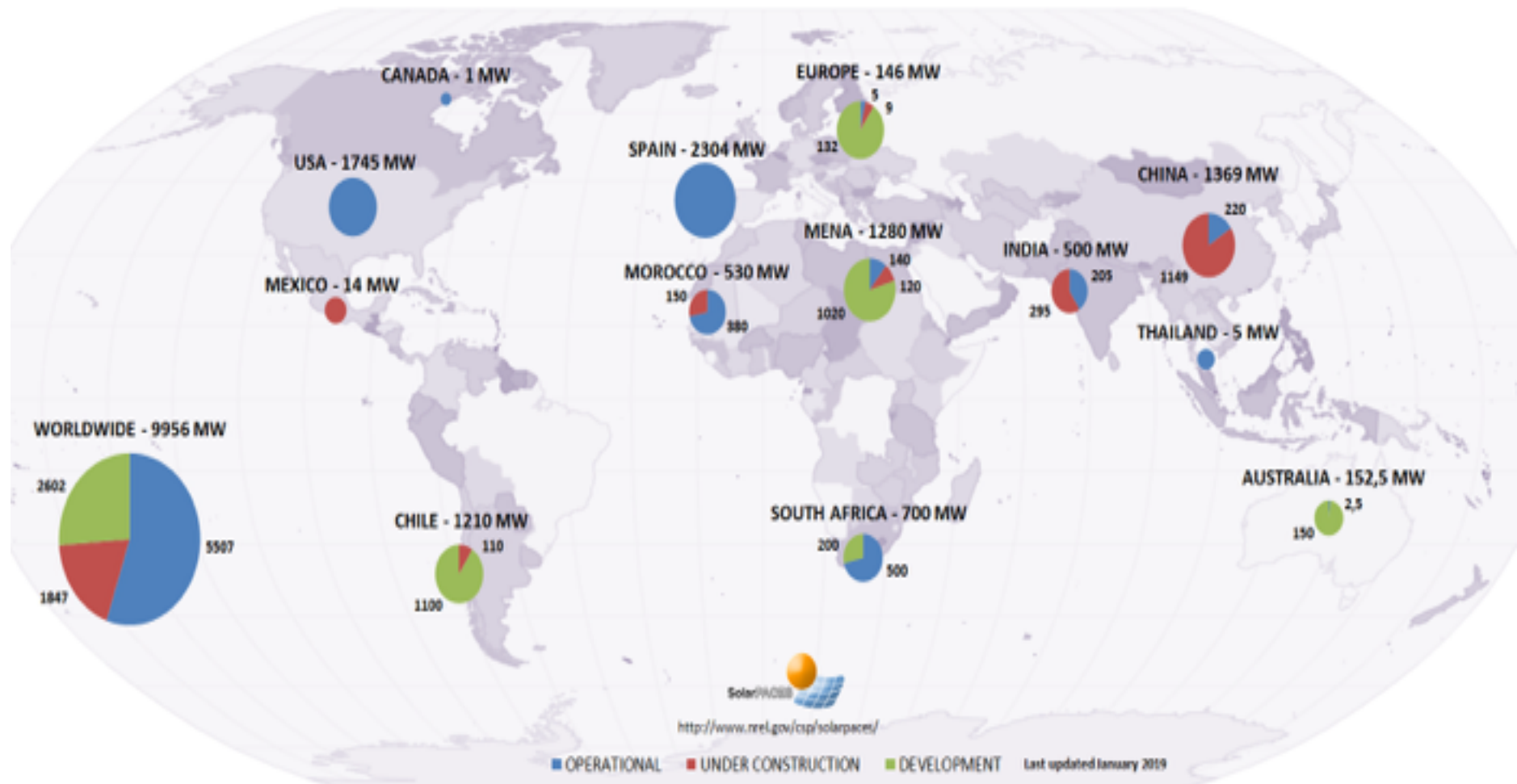
https://pv-magazine-usa.com/2020/05/05/hydrogen-and-dacc-enter-the-policy-conversation/?utm_source=pv+magazine+USA&utm_campaign=2eaff229b3-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_80e0d17bb8-2eaff229b3-158716569



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).

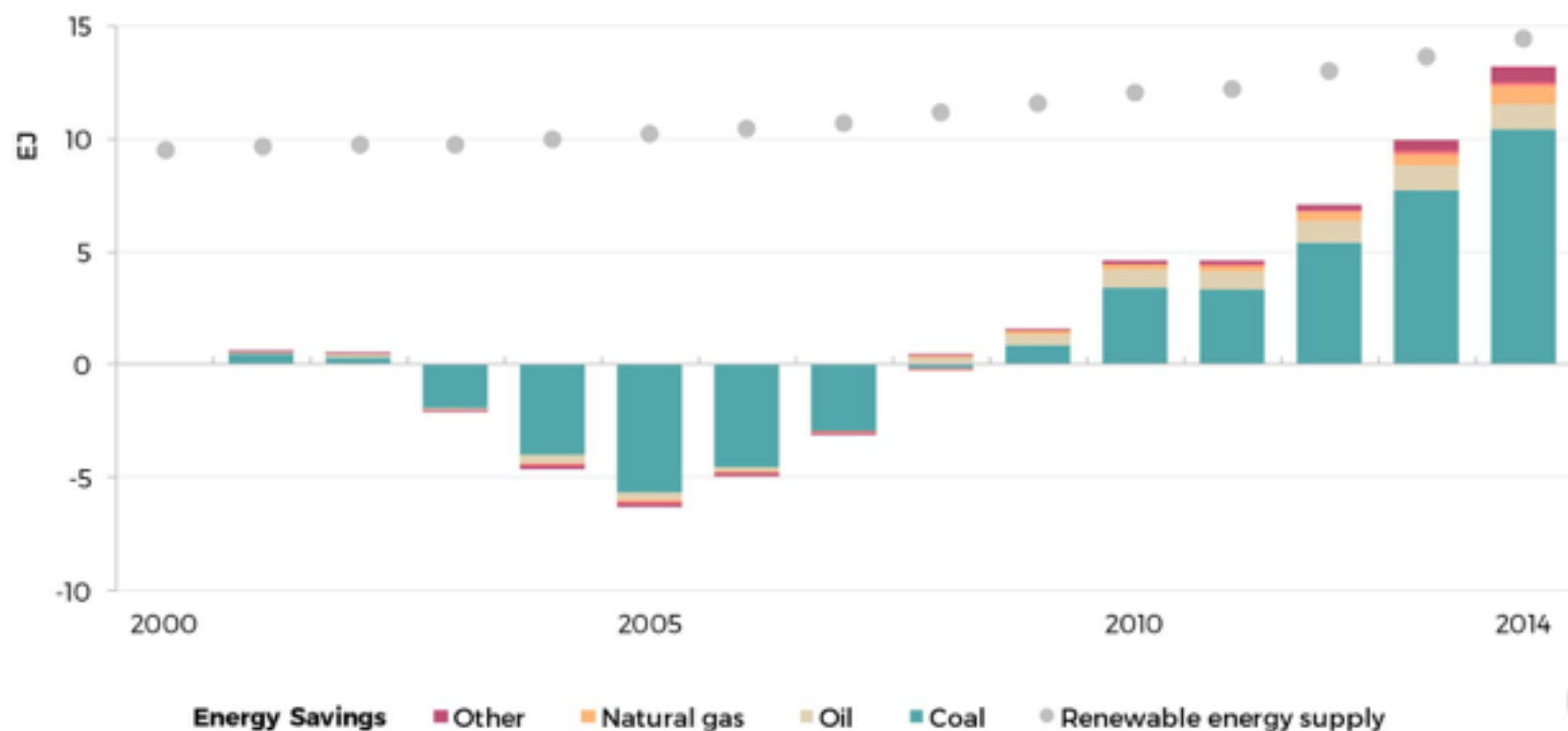
Operational Biogas Systems in the U.S. - Agricultural, Landfill, and Wastewater Systems Only





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

Primary energy savings from efficiency gains since 2000 and renewable energy supply in China



North America Has Retaken Role of World's Leader in Total Microgrid Capacity with 36% Market Share: Guidehouse Insights, April 23, 2020

<https://guidehouseinsights.com/news-and-views/north-america-has-retaken-role-of-worlds-leader-in-total-microgrid-capacity-with-36-market-share>
and
<https://microgridknowledge.com/microgrid-market-guidehouse>

According to a new report, “Microgrid Deployment Tracker 1Q20,” North America has retaken its role as the global microgrid leader over Asia Pacific, claiming 36.3% of global capacity. As of 1Q 2020, Guidehouse Insights has identified 6,610 microgrid projects representing 31,784.6 MW of planned and installed power capacity. Regionally, North America is the leading microgrid market in terms of total capacity and project count, followed by Asia Pacific and Latin America. North America’s push for the top spot is due to a large quantity of fossil-based commercial and industrial system additions for resiliency.

The Net-Zero Transition - What It Would Cost, What It Could Bring: McKinsey & Company, January 26, 2022

<https://www.mckinsey.com/business-functions/sustainability/our-insights/the-net-zero-transition-what-it-would-cost-what-it-could-bring>
and
<https://cleantechnica.com/2022/01/26/climate-change-how-much-will-it-cost-mckinsey-has-the-answer>
and
<https://cleantechnica.com/2022/01/27/reaction-to-the-mckinsey-climate-change-report>

A new McKinsey analysis of the net-zero transition suggests that it would be universal, significant, and front-loaded, with uneven effects on sectors, geographies, and communities, even as it creates growth opportunities. The transformation of the global economy needed to achieve net-zero emissions by 2050 would require \$9.2 trillion in annual average spending on physical assets, \$3.5 trillion more than today. To put it in comparable terms, that increase is equivalent to half of global corporate profits and one-quarter of total tax revenue in 2020. Spending over the next decade will be decisive—and the impact uneven across countries and sectors. However, the transition is rich in opportunity. It would prevent the buildup of physical climate risks and reduce the odds of initiating the most catastrophic impacts of climate change. It would also bring growth opportunities, as decarbonization creates efficiencies and opens markets for low-emissions products and services.



Good planets are hard to find.