

# Energy Self-Reliant States 2020

Third Edition

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By Maria McCoy and John Farrell  
September 2020

**IISR** INSTITUTE FOR  
Local Self-Reliance

## About the Institute for Local Self-Reliance

The Institute for Local Self-Reliance (ILSR) is a national nonprofit research and educational organization founded in 1974. ILSR has a vision of thriving, diverse, equitable communities. To reach this vision, we build local power to fight corporate control. We believe that democracy can only thrive when economic and political power is widely dispersed. Whether it's fighting back against the outsize power of monopolies like Amazon or advocating to keep local renewable energy in the community that produced it, ILSR advocates for solutions that harness the power of citizens and communities. More at [www.ilsr.org](http://www.ilsr.org).

## About the Authors

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## Related publications from ILSR's Energy Democracy Initiative:

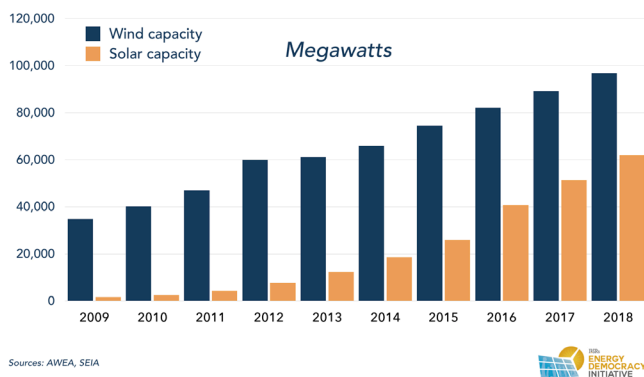
- **New Power Generation Quarterly:** see how new renewable generation potential stacks up against new fossil generation in this quarterly update.
- **Community Power Map:** our map that shows where communities are taking charge of their energy future and which states give communities the most power to tap their renewable energy potential.
- **Coal Plant Communities Seek a Just Economic Transition:** Communities reliant on coal power plants for tax revenue and jobs are at risk when the plants go under. In this post, we ask whether clean energy opportunities can replace what's been lost (2020).
- **Why it's Short-Sighted to do Centralized Planning in a Decentralizing Electricity Grid:** With financial rewards tied to building big, utilities overlook distributed energy resources like rooftop solar. This essay has implications for utility resource planning nationwide (2020).
- **Reverse Power Flow:** a report detailing how solar and batteries shift electric grid decision making from utilities to consumers (2018).
- **Energy Self-Reliant States, Second Edition:** the first national overview of state renewable electricity potential (2010).

# Introduction

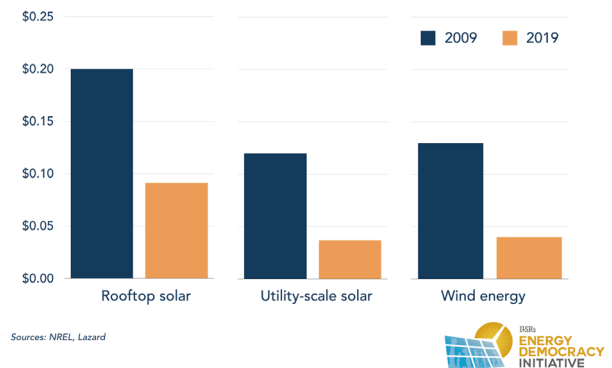
If each U.S. state took full advantage of its renewable resources, how much electricity would it produce? How much of its own electricity consumption could renewable energy fulfill? Would in-state renewable generation be enough to charge electric vehicles and power electric heating, too? In 2010, ILSR published the first national overview of state renewable electricity potential with the **second edition** of Energy Self-Reliant States (ESRS). At the time, most states were setting ambitious goals to attain 25 percent renewable electricity.

Now, several states and over 100 U.S. cities have made truly ambitious commitments to 100 percent renewable power. Fortunately, this third edition finds a better technical outlook and a brighter economic picture than a decade ago. States have much better renewable energy resources than they thought. Also, the costs of renewable electricity sources, like wind and solar, have declined precipitously. The 20-year average cost (often called the “levelized cost”) of solar electricity has declined from around \$0.200 per kilowatt-hour for small scale projects to \$0.091 per kilowatt-hour.<sup>1</sup> The decline is even more dramatic for utility-scale solar, with the levelized cost falling from \$0.120 to about \$0.037 per kilowatt-hour. Wind energy costs have declined by significant margins, as well, from around \$0.13 to \$0.04 per kilowatt-hour.<sup>2</sup>

### A DECADE OF RENEWABLE ENERGY GROWTH



### A DECADE OF COST DECLINES IN RENEWABLE ENERGY GENERATION



Clean energy is not only affordable, it is a big contributor to the U.S. economy. At the start of 2020, the clean energy industry employed 3.3 million people – that’s **40 percent of America’s energy workforce**. The clean energy sector is strong and growing stronger; the U.S. Bureau of Labor Statistics predicts that **solar installers and wind technicians will be the fastest growing occupations** in the next decade.

A nation of renewable-powered, job-generating, self-reliant states is within reach – and necessary. The fossil fuel industry harms human health, especially the historically marginalized communities who are **disproportionately likely to live near a toxin-emitting power plant**. Fossil fuel combustion releases nitrogen oxides, sulfur dioxide, and particulate matter, which all contribute to heart attacks, asthma, and **respiratory diseases**. Before the fuels are even combusted, oil and gas leaks contaminate air, water, and soil **at an alarming rate**. Gas combustion and leaks in the home also **contribute to asthma**. By displacing fossil fuel-fired plants and infrastructure with renewable power, communities reduce these dangers for all.

1. 2010 data from <https://www.nrel.gov/docs/fy12osti/51847.pdf>. 2019 data generated using the NREL System Advisor Model 2018.11.11 (PVWatts) for Jacksonville, Fla., with property tax removed, 10 year loan term instead of 25 years, 5% interest rate, real discount rate of 2.5%. \$2.70 per Watt installed cost. Both figures include the 30% federal tax credit for comparison.

2. <https://www.lazard.com/perspective/lcoe2019>

Renewable energy also makes cities more resilient. Extreme weather events, driven by climate change, have catastrophic impacts on fossil fuel infrastructure and centralized power grids. Renewable energy technologies are more conducive to a distributed system, including rooftop solar paired with batteries, that can help communities bounce back faster.

Several cities – including **Burlington, Vt.** and **Georgetown, Tex.** – already source 100 percent of their electricity from renewable resources. Local and state policy tools like rooftop solar mandates and **community choice energy**, covered in separate publications from the Institute for Local Self-Reliance, can help communities tap the potential illustrated in this report. These innovative cities already know what this report tells decision makers in every state; not only can most states meet all of their current and future electricity needs with in-state, renewable resources, most could do it several times over.<sup>3</sup>

**The following maps illustrate nationwide renewable electricity potential from a wide variety of sources.**

Some exciting energy sources considered in the second edition never saw significant commercial development. Accordingly, we dropped enhanced geothermal and combined heat and power from the analysis. Although they are slow-growing, small hydro and conventional geothermal remain in this edition. Offshore wind is on the cusp of major development and we've updated its estimated potential and the related map. Rooftop solar also remains. Utility-scale solar is not mapped – every state has sufficient undeveloped land area to produce 100 percent of its annual electricity use from solar alone. Another useful resource, energy storage, wasn't considered at all – but it could fundamentally change the conventional wisdom that massive investments in transmission, or even gas backup power, would be required to tap the full potential in each state.

As before, we've considered energy efficiency, creating a version of our all-resources potential map that considers the difference if all states could match their energy intensity to a state like New York (a decrease in energy use per dollar of GDP for most states). A new layer considers how renewables could meet the increased energy demand required for the electrification of vehicles and buildings. Finally, we present an all-resources potential map that imagines a state of both lower energy intensity and high electrification, where the state taps its renewable electricity potential to power more of the total economy.

**The bottom line is that improved renewable electricity technology would allow nearly every state to produce 100 percent of its electricity needs from local renewable resources.**

Neither energy efficiency nor the ambitious electrification scenario significantly impact the potential of state electricity self-reliance. Without further ado, the maps await...

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3. Note: this report examines the ability of in-state renewable electricity generation to meet electricity needs on an annual basis, and does not address short- or long-term variations in weather that impact renewable energy generation nor power flow analysis to match supply and demand at various time increments. These technical issues are under consideration in the work of many we admire, including Vibrant Clean Energy, the National Renewable Energy Laboratory, Rocky Mountain Institute, and others.

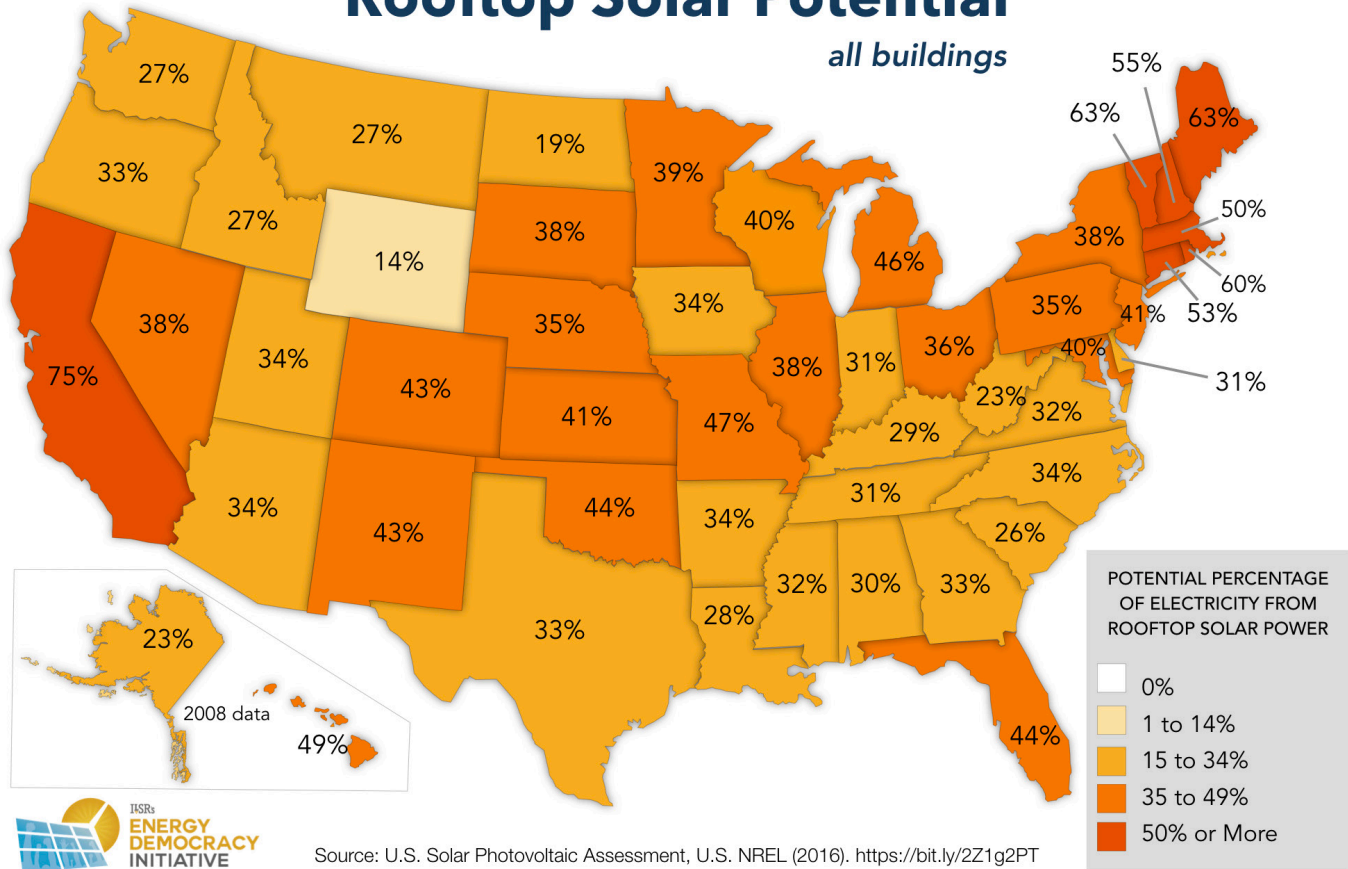
# Rooftop Solar:

In the last decade, the cost of solar PV has **dropped by 70 percent** and small-scale solar projects have grown seven-fold. New technology coupling **solar with battery storage** has also transformed the industry.

No state is estimated to provide all of its electricity use through rooftop solar alone, but six states could provide half or more. Geographically, though Florida and California are known for their sunshine, rooftop solar potential is also strong in the Northeast and Midwest. 43 states have increased their rooftop solar potential since our **2010 ESRS** report. Rooftop solar potential in these states increased between one percent (Wyoming) and 49 percent (Vermont), with an average of 16 percent more rooftop solar potential in 2020 than shown in the 2010 edition.

## Rooftop Solar Potential

*all buildings*

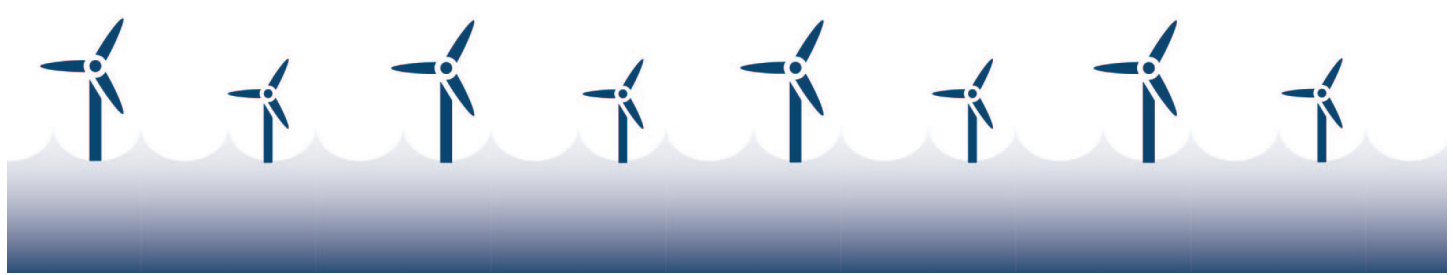
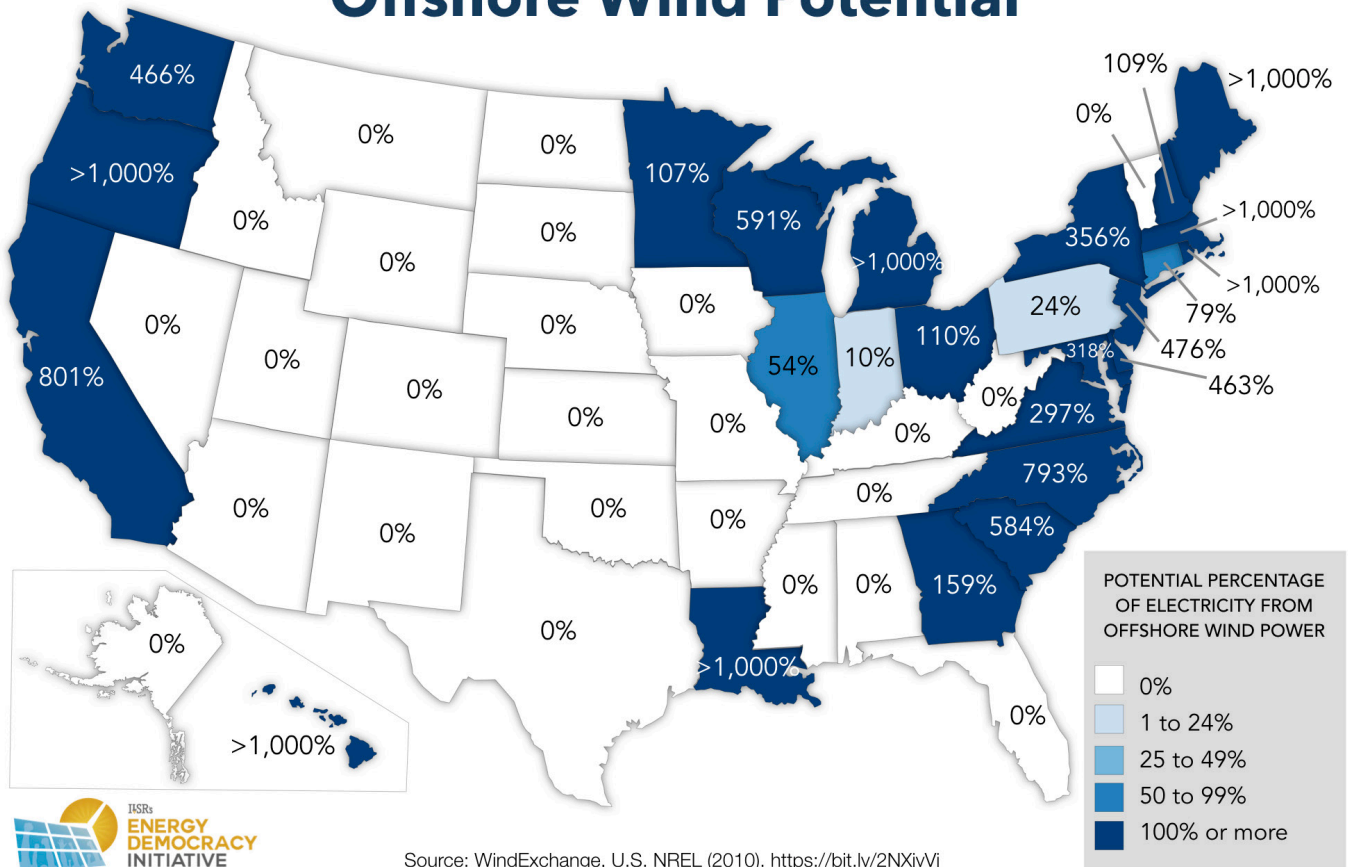


# Offshore Wind:

While the U.S. has seen little offshore wind development, nearly 30,000 megawatts of offshore wind projects have been built, mostly in Europe or China. Consistent wind speeds are a major benefit with offshore wind. While typical onshore wind projects produce 30 to 40% of their rated capacity on average each year, one offshore wind project in Europe reported **a 65 percent capacity factor in 2018**. Projects underway in the U.S. are predicted to see capacity factors of **47** and **45 percent**, and the National Renewable Energy Laboratory predicts a typical 40-50 percent capacity factor for this technology. Our map uses a conservative estimate of a 40 percent capacity factor.

25 states have the potential for offshore wind generation, be that over an ocean or a lake. Of these states, 21 could generate more than 100 percent of their electricity use with offshore wind alone. Compared to our **2010 ESRS** report, 25 states see increased potential in 2020, with a median *four-fold* increase.

## Offshore Wind Potential

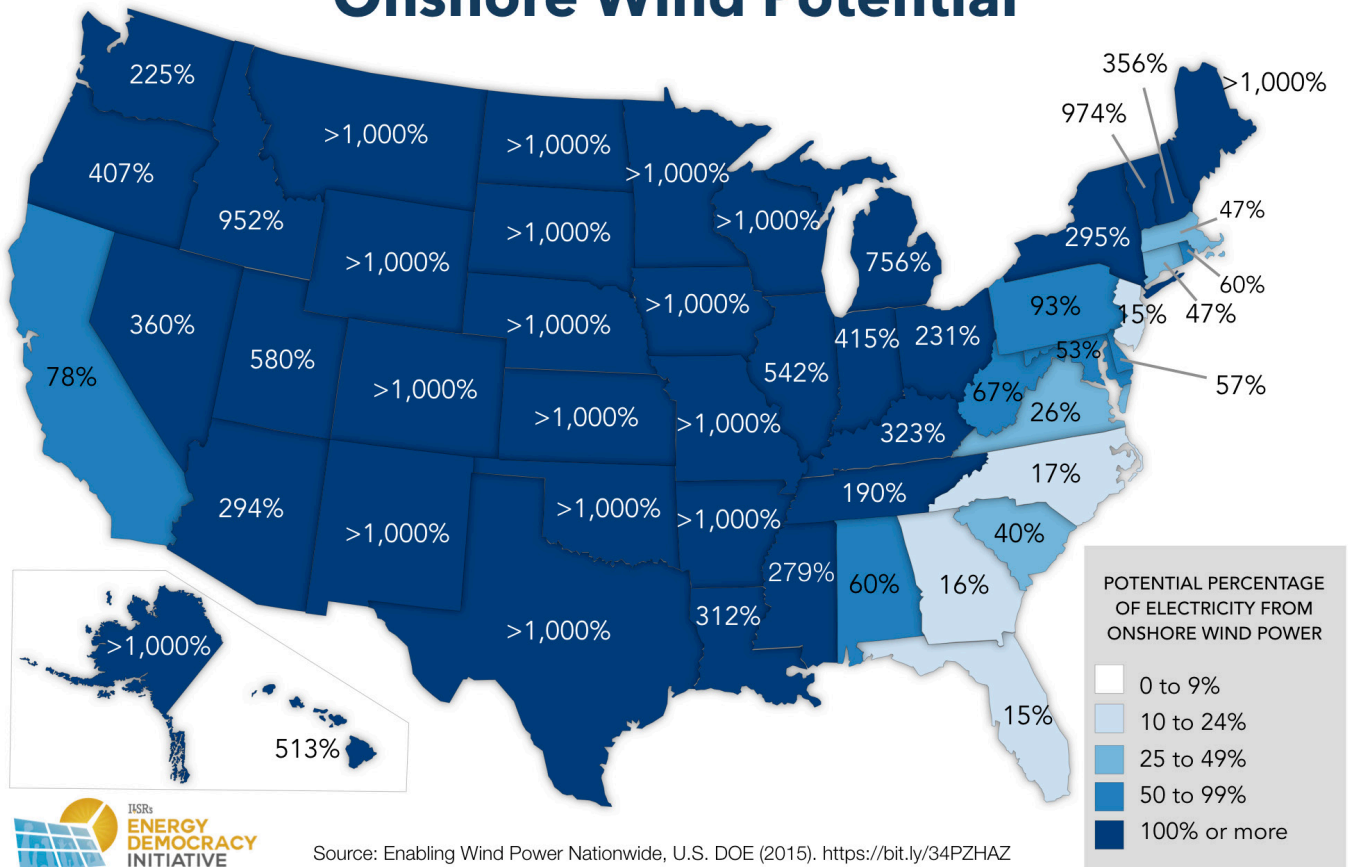


# Onshore Wind:

Onshore wind power has **tripled in the last decade** and now accounts for **7.3 percent of U.S. utility-scale energy generation**. Not all wind power is utility-scale: **more than one thousand megawatts** of distributed wind have been installed in the U.S. since 2003. Given its continued technological improvement, onshore wind outcompetes all renewable energy resources in its net generation potential.

Every single state has onshore wind resources. 35 states can meet 100 percent of their energy demand with onshore wind generation. 45 states have seen increased potential since 2010. Much of this improvement is along the coasts, where many states had zero estimated potential in our last edition. The median increase in onshore wind potential is 225 percent.

## Onshore Wind Potential

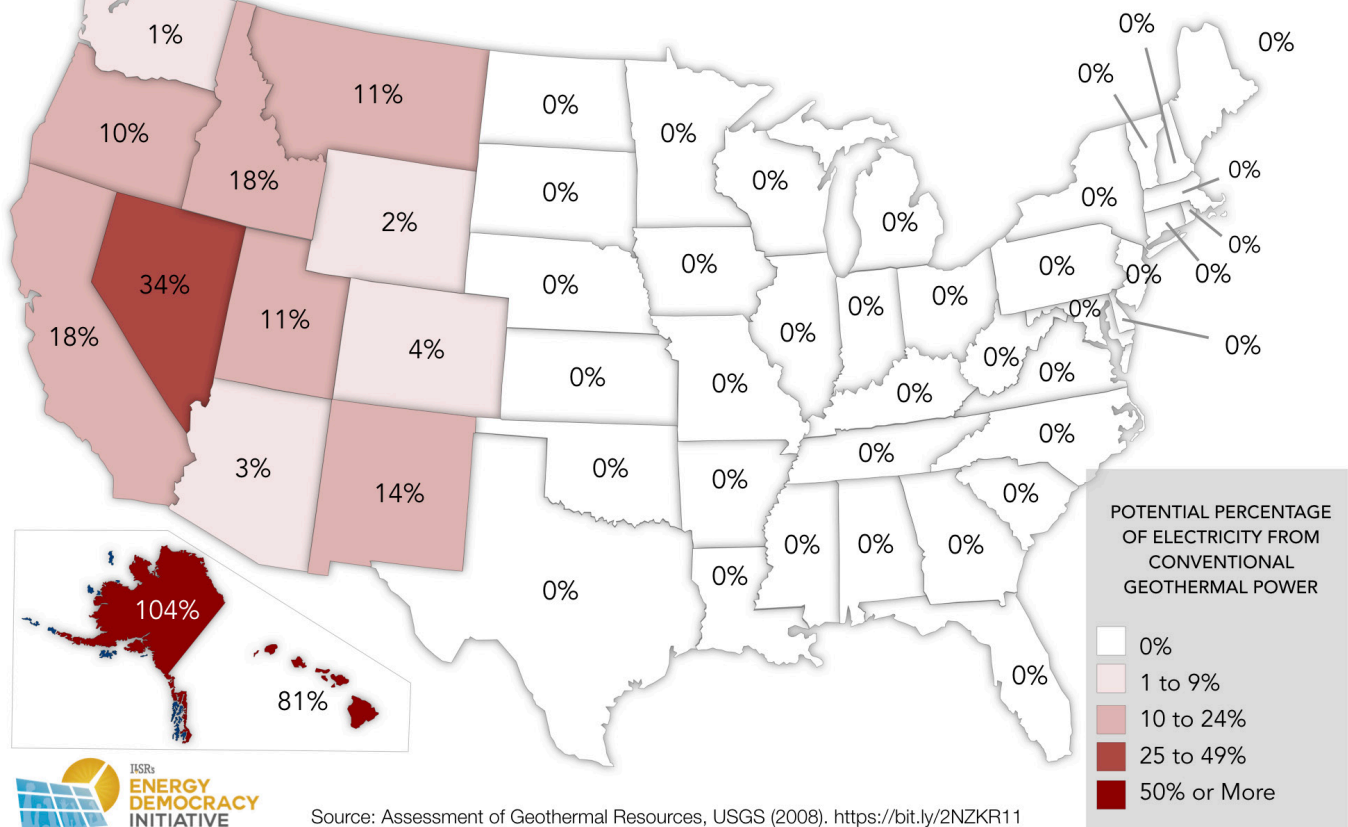


# Geothermal:

Geothermal power plants require high ground temperatures, generally at least 90°F. This explains why ground-source geothermal heating (requiring low temperatures) can be installed anywhere in the U.S., but geothermal power plants are geographically limited. Though heat pumps are a valuable carbon-free heating alternative, this report only considers geothermal electric generation.

Conventional geothermal potential is concentrated in the western United States, with the strongest potential in Alaska and Hawaii. The data is the same used for our **2010 ESRS** report, so geothermal potential has only changed where state electricity use changed. Hawaii, which decreased electricity use 7% between 2010 and 2017, has the most noticeable boost in geothermal potential (9%).

## Conventional Geothermal Potential

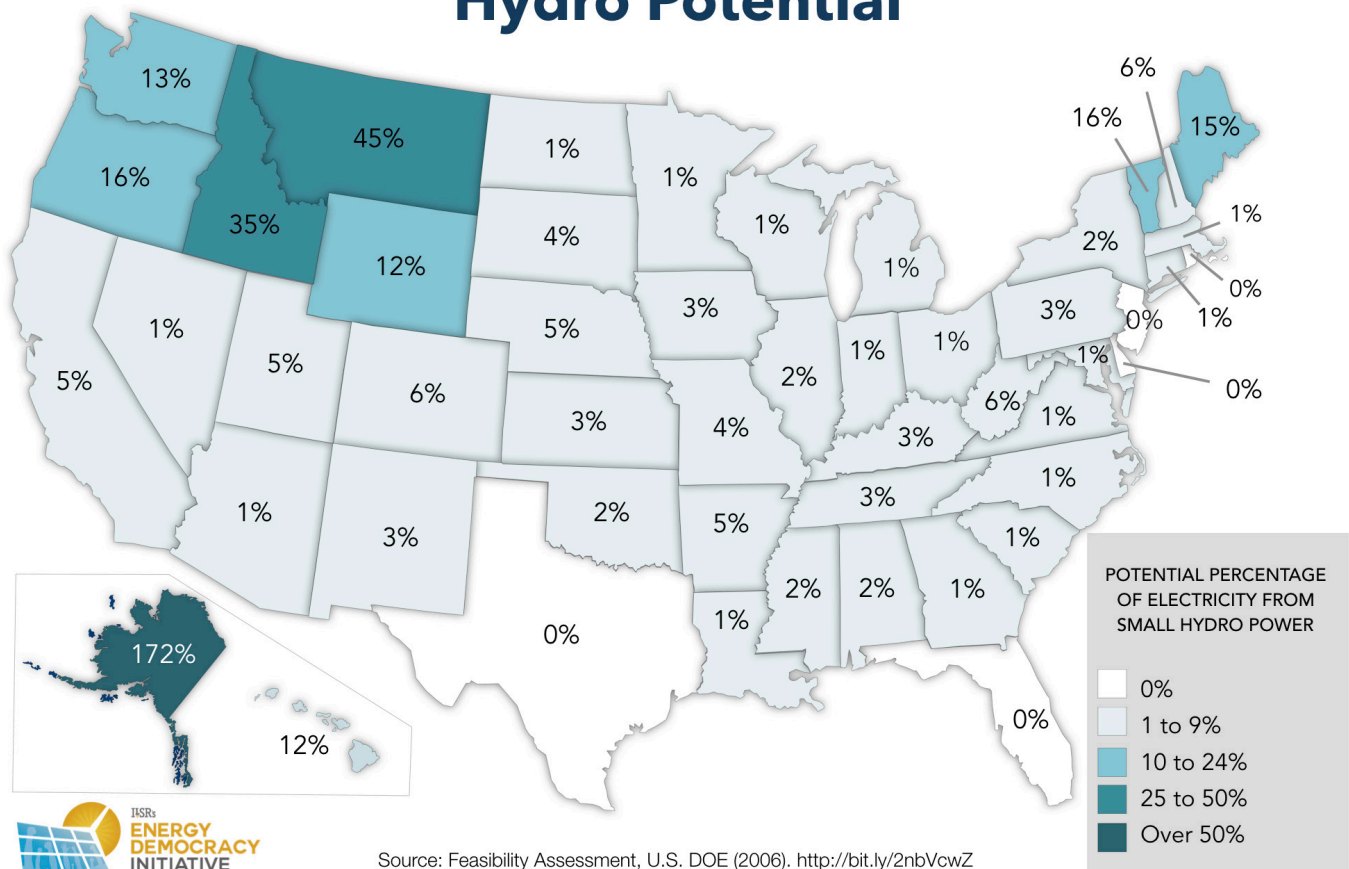


# Small Hydro:

Although hydro power is renewable, it is not a carbon-free resource. Related emissions, other environmental impacts, and land rights have made building dams contentious. Re-powering existing dams is possible, but not explored in this report. The map below reports new low-power and small hydroelectric opportunities that minimize disruption to a river ecosystem.

Alaska and the Northwest feature the strongest hydroelectric potential, but every state has some potential (map values are rounded). Hydroelectric potential changed only where state electricity use changed, as we used the same dataset as in our **2010 ESRS** report.

## Hydro Potential



Source: Feasibility Assessment, U.S. DOE (2006). <http://bit.ly/2nbVcwZ>

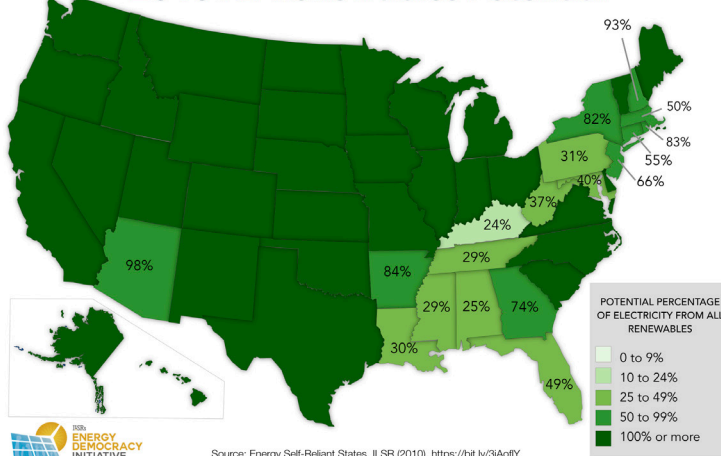


# All Renewables Potential:

Renewable technology, and the data on its potential, has improved dramatically since 2010. Now, 47 of 50 states have the opportunity to meet 100 percent of their electricity needs with in-state renewable resources, up from 32 states in our **2010 report** (even with the omission of utility-scale solar, a growing resource).

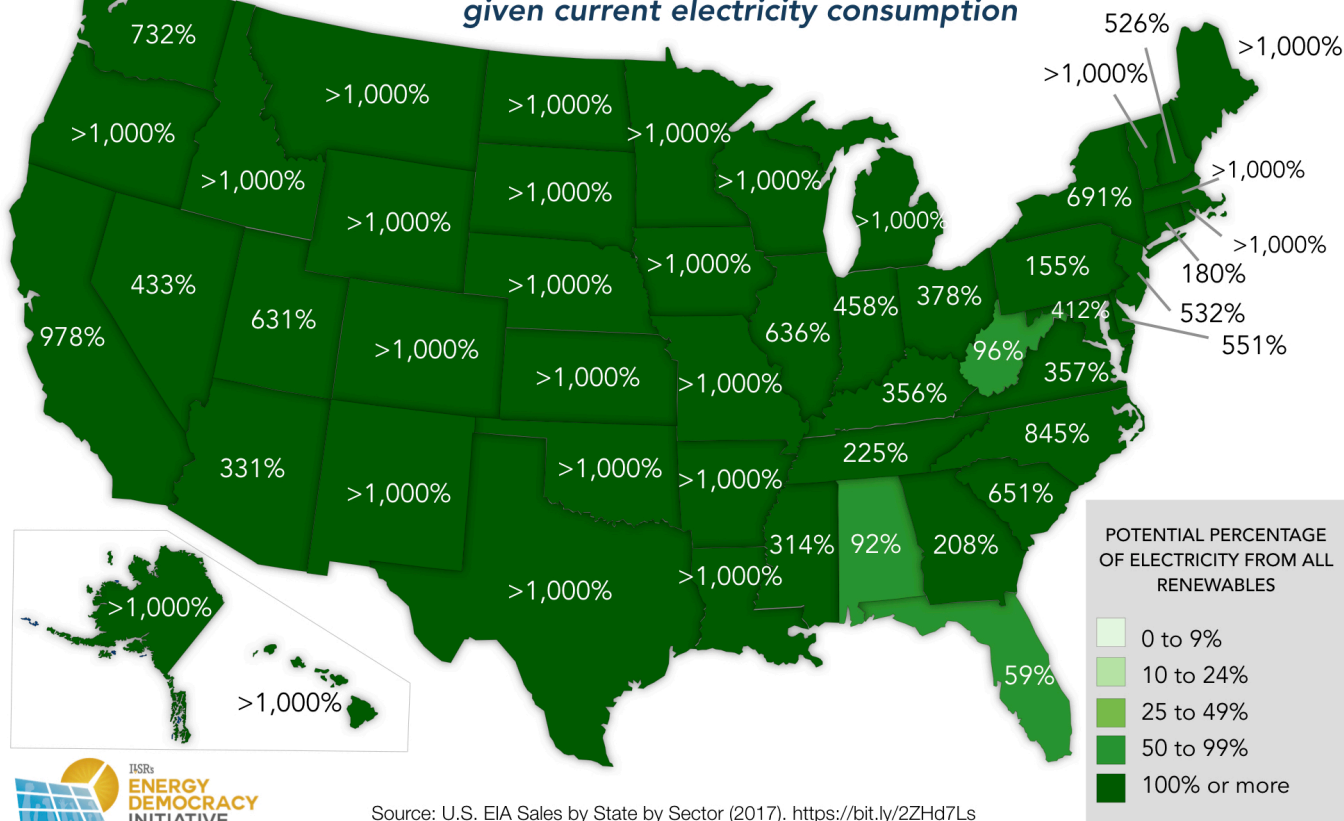
47 states have increased their overall renewable generation potential, with a median increase of 439 percent of their annual electricity sales.

## 2010 All Renewables Potential



## All Renewables Potential

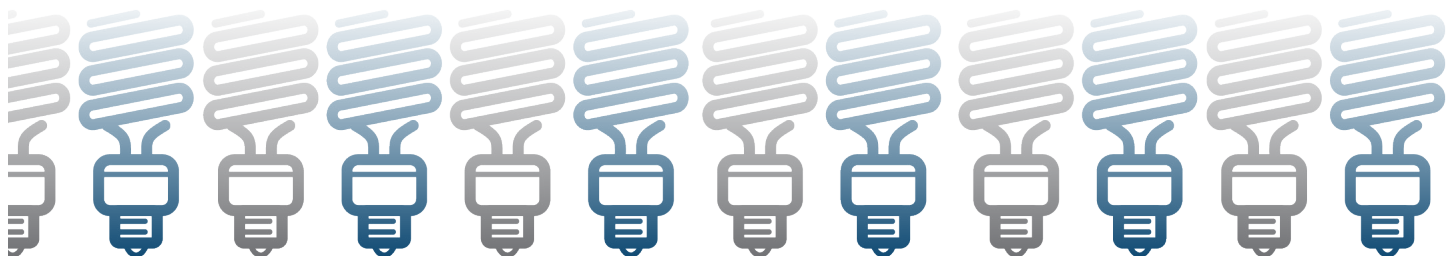
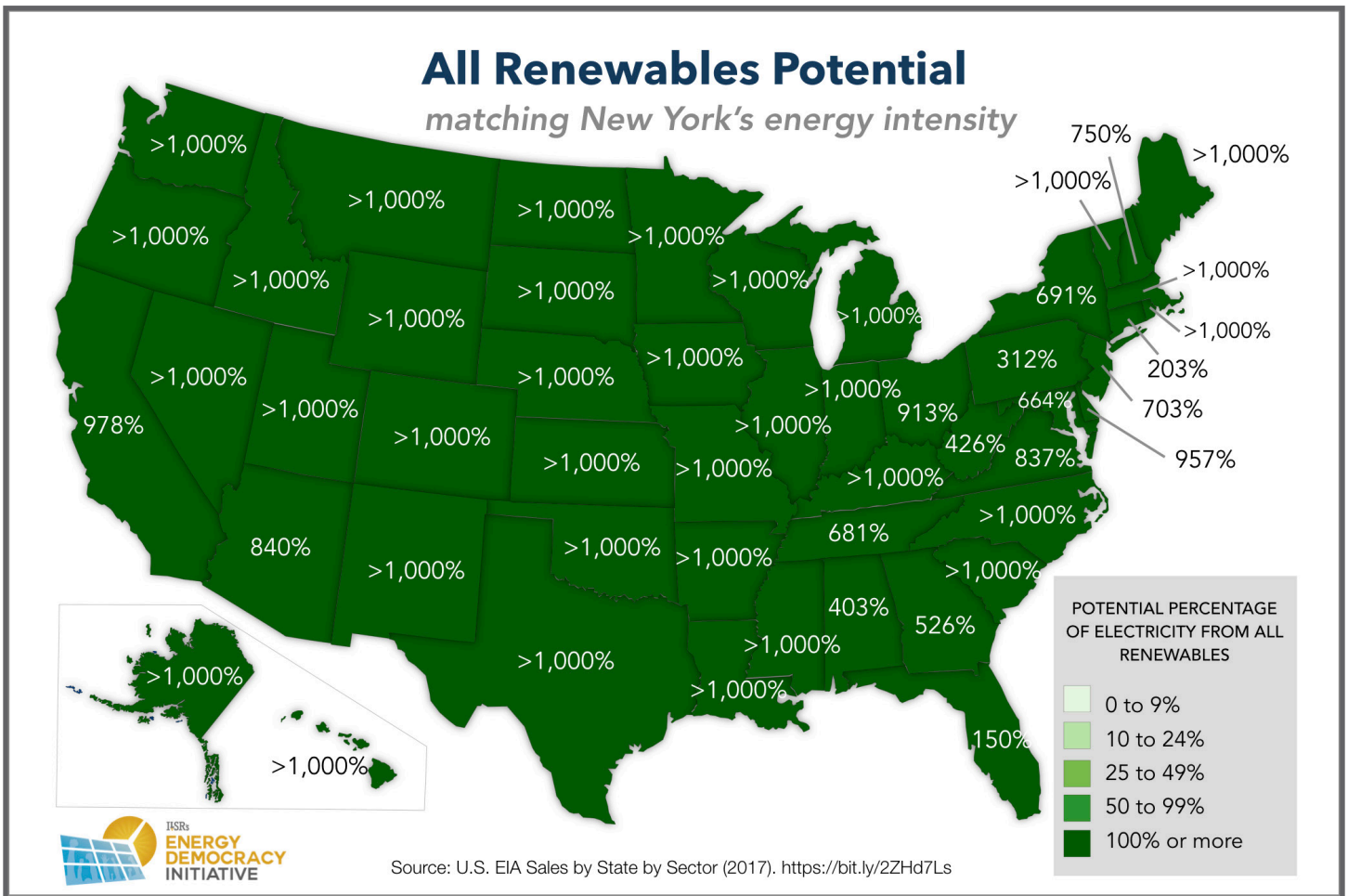
given current electricity consumption



# Energy Intensity:

States can improve their energy intensity, which would lower total electricity use. In the last update, we calculated the electricity use of each state if they matched the energy intensity of California. For this update, we used the energy intensity of New York as the benchmark because its climate mimics the impacts of weather on energy use better than California (although the two states have similar energy intensity scores, due to strong energy efficiency policies).

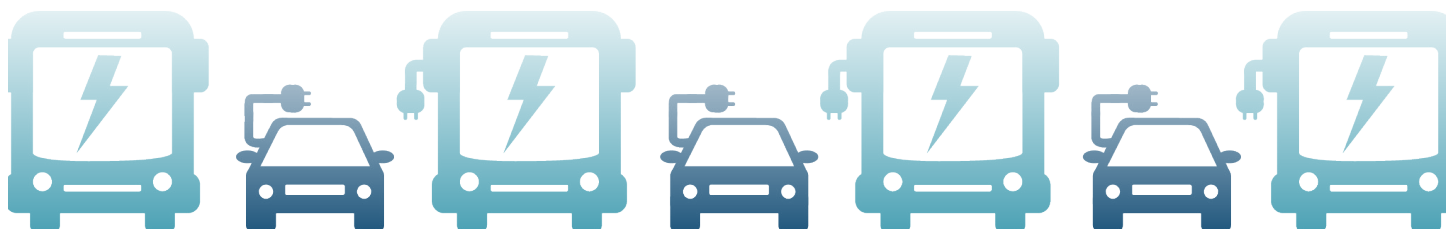
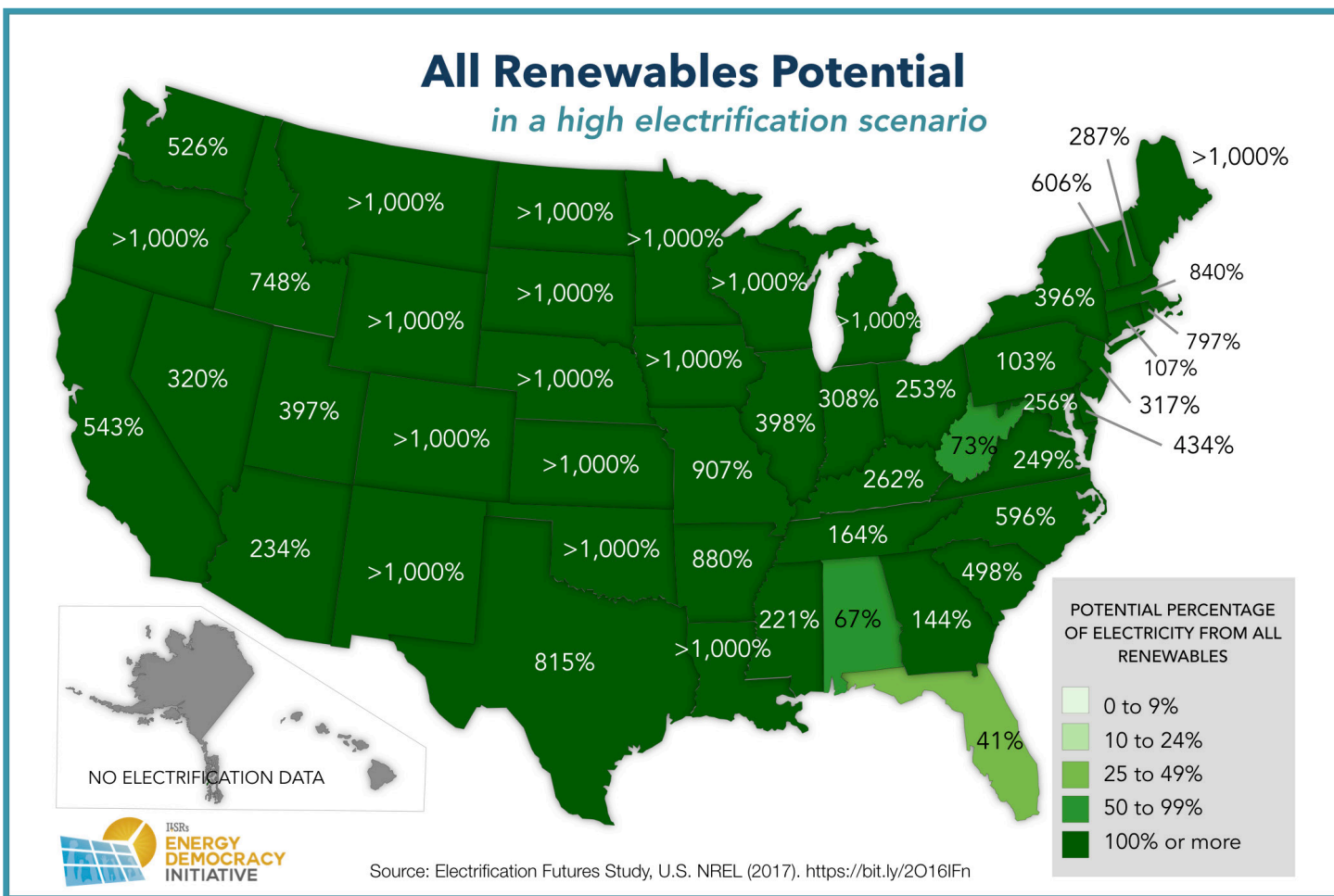
Although nearly every state could already meet its electricity needs with in-state resources, improvements in energy efficiency would raise the figure to 50 out of 50.



# Decarbonization through Electrification:

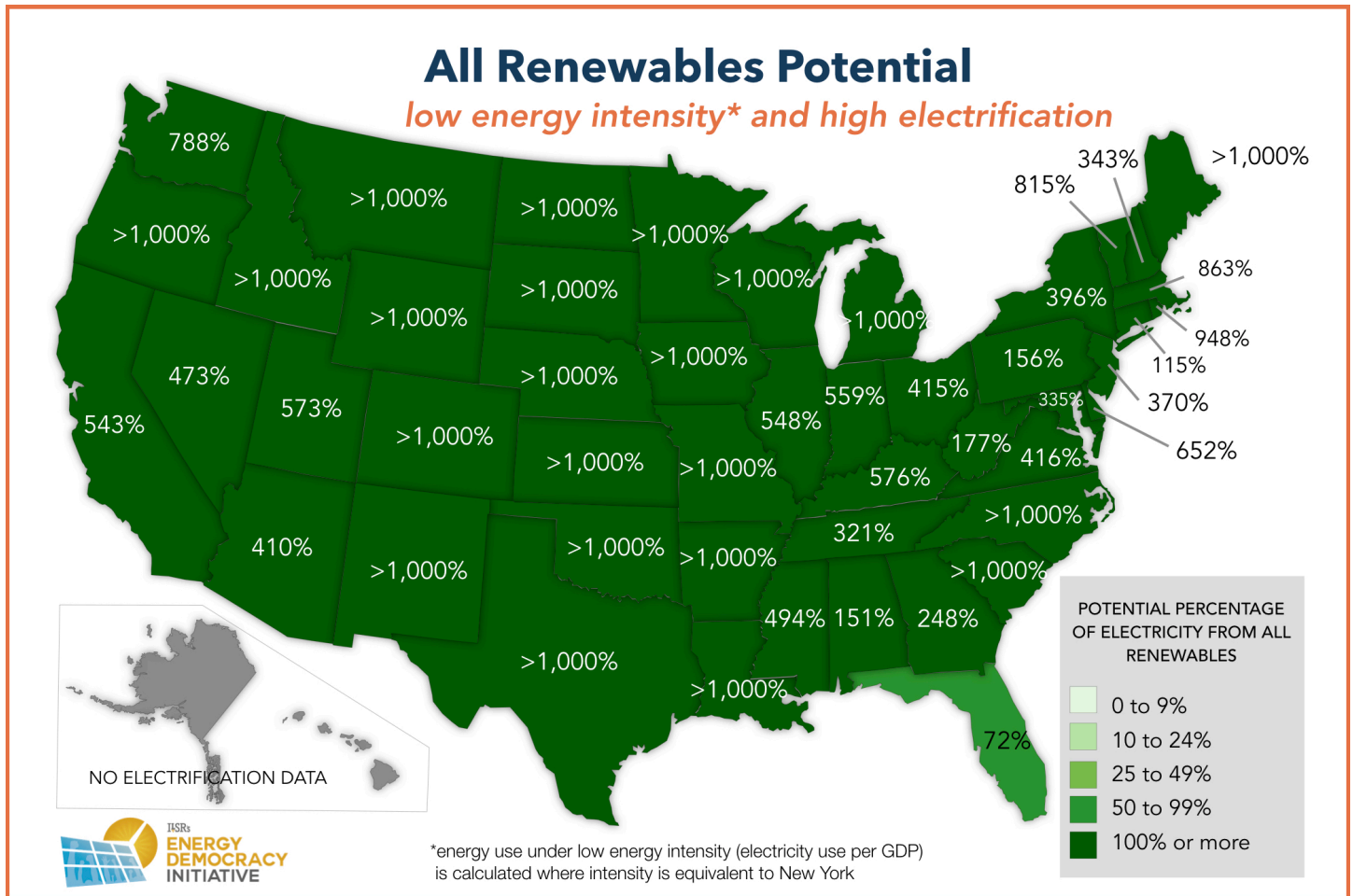
Cities and states around the country are making commitments to 100 percent or near 100 percent renewable energy, with many of these goals by 2050. To reach these ambitious goals, communities must go beyond switching to renewables for their electricity use. They will need to electrify and decarbonize transportation, industry, and building energy use.

Widespread electrification could dramatically increase electricity demand. Our calculations incorporate the state-by-state electricity demand increase predicted for 2050 by NREL's high electrification scenario, from the **Electrification Futures Study**, but we do not incorporate the predicted business-as-usual increase in demand by 2050 from NREL's reference scenario. Our method resulted in, on average, a 50% increase in electricity use by state. Despite this significant increase in electricity used to electrify buildings and transportation, the same 47 states could still meet the increased need with in-state renewable resources.



# Energy Intensity and Electrification:

Our final map combines the results of decreasing energy intensity and a high electrification scenario. It finds that the power of energy efficiency policy can offset much of the increased electricity demand from electrification. Only Florida would require utility-scale solar or imported renewable resources to meet its electricity needs.



# Appendix

Precise data for electricity use, electricity use under various scenarios, and generating potential for each renewable energy source by state is available for download on the report page: <https://ilsr.org/report-energy-self-reliant-states-2020>

The following sections explain the ILSR data presented in this report.

## State Electricity Consumption:

State electricity consumption data is for 2017. The data is from the **Energy Information Administration's** sales by sector, by state, by provider dataset. Electricity sales of residential, commercial, industrial, and transportation sectors are summed for an estimate of total state electricity consumption.

## Storage and Variability:

To achieve very high proportions of our electricity from variable renewable energy sources will require significant amounts of storage and/or a restructuring of our electricity system to meet electricity demand at all hours and in all seasons. The electricity storage sector has seen many technological and commercial developments in the past decade that improve its ability to meet the short-term needs of the grid. This report does not examine storage or other technologies for managing longer term variability (such as seasonal storage, transmission, or demand response).

## Onshore Wind:

Onshore wind generation potential data is from the U.S. Department of Energy's **Enabling Wind Power Nationwide** report (2015). We downloaded state-by-state data in 2015 that is no longer available, but our data uses the same hub height and capacity factor (110 meters, 35%).

In this edition, we chose an increased hub height and capacity factor as compared to the 2010 edition for several reasons. First, the average **turbine hub height has trended upward** for nearly two decades. Second, proposed wind projects are **projected to continue growing in height**. Finally, despite some practical challenges, increased hub height increases the efficiency of wind generation and allows for generation in areas with poor wind resources. 110 meter turbine hubs are the future of wind generation – a future that is not far off.

## Offshore Wind:

Data for offshore wind generating potential is from the National Renewable Energy Lab's 2010 **WINDEX-change dataset**. The NREL model's parameters include 90 meter turbines and wind speeds greater than 7 meters per second. From this eligible area, NREL assumes 5 megawatts of installed capacity per square kilometer of water. Their predictions are not reduced by environmental or human use considerations.

For our calculations, we assumed a 40 percent capacity factor, since the National Renewable Energy Laboratory predicts a 40-50% capacity factor for this technology. The 2010 edition of Energy Self-Reliant States generated offshore wind data with a 33 percent capacity factor.

## Rooftop Solar PV:

The data for rooftop solar generating potential is from the National Renewable Energy Lab's **2016 Rooftop Solar Photovoltaic Assessment**. The dataset is just for the continental United States. NREL provides state-by-state annual rooftop solar generation potential in terawatt hours per year, generated assuming a solar module efficiency of 16%. At that time, a solar photovoltaic efficiency of greater than 16% was only available in premium solar PV models. In 2018, the **median efficiency** of solar cells rose to 18.4%.

Since only rooftop solar potential is considered, our calculations provide a conservative estimate of total U.S. solar potential.

## Small Hydro:

The data for small hydro potential is from the U.S. Department Of Energy's **2006 feasibility assessment**. The DOE estimates have many environmental exclusions, making these estimates conservative. Data includes only projects less than 30 MW that draw power from a parallel penstock with limited length, where the project is:

- greater than 10 kW
- not in federally restricted area
- not in area with unfavorable zoning
- not near existing hydro plant
- within 1 mile of road
- within 1 mile of infrastructure or within typical distance

All in all, the study found the potential to double U.S. hydroelectric generation at the time.

## Geothermal:

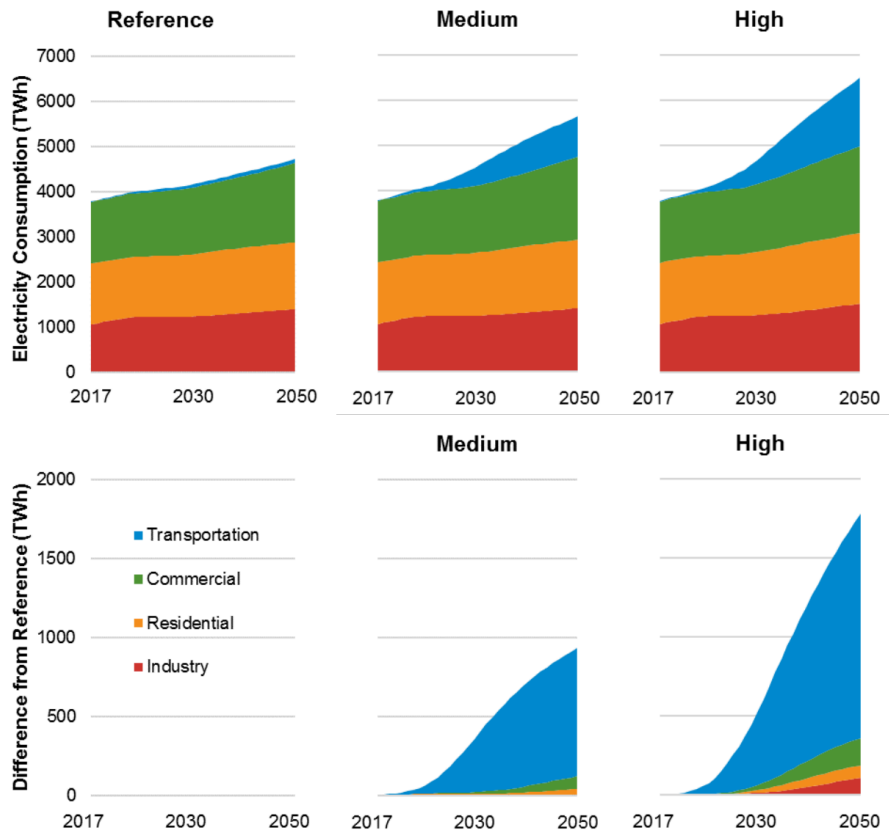
The data for conventional geothermal potential is from the **U.S. Geological Survey's** 2008 assessment. The estimated potential is in the F95 range, meaning there's a 95 percent chance that the actual resources exceed these estimates. For electricity generation, a 95 percent capacity factor was used. The assessment finds potential for geothermal power plants in 13 states and includes low, moderate, and high-temperature systems.

## Electricity Intensity:

For this analysis, we used one broad-brush measure of electricity intensity: electricity use per dollar of real GDP. Electricity sales figures came from the Energy Information Administration and are identical to the ones used throughout this report. GDP data is from the U.S. Bureau of Economic Analysis's annual gross domestic product by state, real GDP in chained dollars (SAGDP9), all industries, for 2017. In 2010's ESRS, state electricity intensities were benchmarked against California, since it is a leader in efficient use of energy. In this edition, state electricity intensity is benchmarked against New York. New York is similarly a leader in energy efficiency, without the advantage of a mild climate. The two states with better energy intensity than New York (California and Connecticut) were assumed to make no improvements. Thus, a state like Minnesota with an electricity intensity of 12,000 kWh per capita would reduce energy intensity by 61 percent, to 7,400 kWh per capita.

# Electrification:

Estimations of electricity use after electrification are based on the National Renewable Energy Laboratory’s **Electrification Futures Study**, demand-side scenarios. Illustrated in figure 7.4, the report estimates that, under a high electrification scenario, U.S. electricity demand in 2050 will increase by 38 percent relative to the reference scenario.



**Figure 7.1. Annual U.S. electricity consumption (top) and difference from Reference (bottom)**

Moderate technology advancement projections are shown.

This figure varies by state, with individual state electricity demand is estimated to increase anywhere from 20 to 50 percent. NREL provides this data down to the state level. NREL does not provide access to the modeling parameters of its reference scenario, but we approach models that predict increases in gross electricity consumption with skepticism given minimal increases in electricity consumption in the past decade. For the purposes of this report, we added NREL’s estimates for absolute energy consumption increase (relative to the reference scenario) to current state electricity consumption (2017).