Igniting the Renewable Energy Revolution:

How U.S. Electric Utility Decarbonization Targets Compare with State Renewable and Clean Portfolio Standards

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Abstract

The energy transition underscores the importance of decarbonizing the electricity sector, and Renewable Portfolio Standards (RPS) are one of the primary policy tools being used to accomplish this. In recent U.S. history, the private sector has catalyzed changes in the energy system and the national electricity system has decarbonized faster than experts have anticipated. This raises the question of whether RPS policies are leading the push towards renewable electricity, or if companies are projected to outperform state ambition. To address this question, I compare state-level RPS goals and utility-level decarbonization targets aggregated to the state level. I have three key results: 1) utilities are similarly ambitious to their respective state targets, especially for standards with intermediate and net-zero goals; 2) in most states with expired RPS deadlines, the targets have been met or exceeded; and 3) if you take utility plans at their word, they suggest that the electricity system will be decarbonized by roughly 2060. If taken at face value, it seems as though utilities are broadly on track to meet state level targets but are nonetheless behind the Biden Administration target of decarbonizing by 2050.

Keywords: Decarbonization, Renewable Portfolio Standards, energy transition, electric utilities

Introduction

Energy transitions are by no means new: up until the 1930's, coal and wood were the primary sources of energy; since then, natural gas and oil have taken over. Since climate research has lambasted the negative effects of fossil fuel combustion, the ignition of a clean energy transition offers a brighter future (Black, 2018). The current transition requires electrification: we must replace what is powered from fossil fuels to what is powered by electricity, *but only electricity powered by renewable resources.* The clean energy transition has already begun – renewable energy as a share of US generating capacity has already risen from 12.8% to 23.1% over the past decade (Porter et al., 2020). Moreover, global demand for fossil fuels has gone from ~95% of primary energy in 1975 to 85% in 2020 (Cembalest, 2021). Between now and 2050, it is expected that this number continues to drop, but of course this depends on the commitments of electric utilities to a low-carbon future. In this paper I investigate utilities' planned decarbonization rates at the state-level, and ask: do these projections match state goals?

The International Energy Agency projects fossil fuels will comprise at least 70% of global primary energy consumption in 2040 (Teske, 2020). To move the needle faster, energy stakeholders across all sectors must allocate sizeable funds and resources to a reduced reliance on fossil energy. Considered low-hanging fruit, electricity is central to reducing carbon emissions as its power can be derived from a wide suite of energy technologies. In 2021, renewables were expected to have more capital spending than oil and gas together (Cembalest, 2021). What does this mean for companies responsible for providing electricity to homes and businesses in the United States? Eventually, all industries will have a role in significantly reducing emissions, but many will depend upon carbon-free electricity first.

Electricity is widely considered the easiest sector to decarbonize. In contrast to transportation and manufacturing sectors, electricity has the fewest number of point sources for pollution (Lawson, 2018). Already, there is an array of carbon free substitutes on the market, many of which are cost-competitive with new fossil fuel plants (Lawson, 2018). According to the International Energy Agency (IEA) in 2018, electricity constituted 21% of total world energy consumption, roughly 22 terawatt hours (Teske, 2020). Meeting the challenge of decarbonizing the economy will require that all electricity come from zero-carbon sources, including wind, solar, nuclear, and hydroelectric. In 2018, over 60% of electricity generation came from fossil fuels, and 35% was generated from renewable sources (Teske, 2020). To reduce emissions to zero in the coming decades, traditional electricity generation needs to adapt and evolve.

According to climate policy goals, electricity must be increasingly powered by renewable resources. There have been significant advances in renewable technology to date, made more powerful by changing policies on energy (Cembalest, 2021). Already, immediate deployment solutions are ready to be disposed. According to the World Energy Transitions Outlook, renewable energy (RE) plays a key role in decarbonizing and more than 90% of the solutions to reach low emissions pathways by 2050 demand RE development (IRENA, 2021). To deploy greater renewable generation, electricity will become the primary carrier for consumption—eventually generation must expand three-fold by 2050, powered at least 90% by renewable sources (IRENA, 2021). Consequently, installed renewable generation capacity must grow tenfold, from 2,500 GW to 27,700 GW by 2050. The IEA's Stated Policies Scenario sees fast growth in RE use, primarily supported by utility-scale solar and wind projects. Already, coal demand in advanced economies, including the U.S. has been almost cut in half from 2019 levels to 2030 (IEA, 2020). Finally, energy efficiency will be a driver helping to reduce total demand.

Carbon free electricity is complementary of goals to mitigate the effects of climate change. While the electrification of global industries paves a path to zero-GHG energy use, fossil fuels continue to provide most of our energy. In 2020, the electric power sector primary energy use was about 57% fossil fuel-powered (EIA, 2021). While this is down from 70% fossil fueled power in 2005, a significant portion of energy must be non-emitting by 2050 to meet popular goals, such as those laid out in the Paris agreement—that is to stay below a benchmark of 2 degrees Celsius warming from preindustrial levels (IEA, 2020). Moreover, the Biden administration intends to usher in net-zero carbon electricity by 2035, with commitments to spend over $16 trillion to wean off fossil fuels (Muyskens & Eilperin, 2020). Although electrification has the potential to enable zero-GHG energy consumption, there must be a big push to replace the two largest sources—natural gas and coal (Lawson, 2018). CO2 emissions from non-clean sources contribute to large public health burdens, aside from posing threats of climate change (Henneman et al 2019, Buonocore et al 2021). As such, understanding how the timing of electrification coincides with the timing of electricity decarbonization is relevant for evaluating the overall environmental impact of policy interventions and the potential for burden shifting.

The Catalyst: State Standards for Renewable Electricity

The U.S. does not yet have many federal policies or standards intended to spur renewable growth or decarbonize the electricity sector, but most states do. Renewable Portfolio Standards (RPS) are policies which require retail suppliers of electricity to sell a specified portion of the energy supply generated from renewable sources. First passed by Iowa in 1983, many other states have since adopted renewable standards, and the state-level variation is available through the National Conference of State Legislatures (NCSL), which has collected and organized state-level policies.

To date, 31 states and D.C. have passed standards, and four have passed goals to promote a diversified electricity mix and greater renewable adoption, although eleven have since expired (NCSL, 2021). RPS are enacted to increase and diversify the electricity mix with renewable energy and promote domestic energy production (Wiser et al., 2005). State standards impose numerical targets for retail electricity suppliers. RPS purchase requirements tend to increase with time and load-serving entities (LSEs) are monitored for compliance. These policies drive the U.S. $64 billion market for renewable energy sources, namely wind, solar, and hydroelectric (NCSL, 2021).

There are several ways entities can comply with renewable targets: (1) developing existing or new renewable energy facilities hosted by the LSE; (2) engaging in bilateral purchases of renewable electricity; and (3), in some jurisdictions, purchasing tradeable renewable energy certificates (RECs). The design of RPS largely influences its success. Policy design criteria suggest that RPS should have broad applicability, balanced supply-demand conditions, sufficient duration to comply, and well-defined and stable resource eligibility rules (Wiser et al. 2005). Moreover, the policies should consider and define the treatment of out-of-state energy resources, else the location of benefits be external to the state. RECs are traded at the incremental cost of the marginal renewable generator meets RPS requirements, allowing entities to produce renewable electricity at least-cost (Mack et al., 2011). Moreover, the RECs proffer additional revenue streams to RE developers by offering greater flexibility and more efficient allocation of resources. Because of state specific RPS specifications, the market for RECs is largely fragmented as regional markets are still being developed. Moreover, barriers are presented by in-state generation requirements. Finally, RPS should be attuned to a state's "adequate and accessible developable resource potential", dependent on renewable resource options, transmission constraints, and interconnection barriers (Wiser et al., 2005). There is a long way to go before RPS standards are the most efficient and cost-effective at encouraging renewable development.

While RPS are the conventional state policy, some states have passed Clean Energy Standards (CES). The distinction between RPS and CES is subject to how a state defines "renewable" versus "clean" sources of energy (NCSL, 2021). Where clean energy contains carbon free sources, including nuclear, renewable sources are non-emitting or lifetime neutral. Renewable sources include biomass, even though it produces some carbon emissions. In fact, for biofuel production and use to yield the intended environmental benefits, there must be significant advances in technology and policy (Lark et al., 2022). In many cases, a CES goal includes an RPS requirement as part of the policy. For example, California has a 100% CES goal by 2045 with an RPS of 60% renewable electricity by 2030 (NCSL, 2021). With wide variability in standard rules, it is important to consider the impact of the policy on cutting emissions and the applicability of the policy with respect to a state's existing capacity and infrastructure.

Iowa was the first state to enact an RPS policy in 1983, and since then over half the states have established targets for renewable electricity. 30 states and DC, and two U.S. territories, have active RPS/CES requirements, most with multiple year targets, and three states have voluntary renewable electricity goals (NCSL, 2021). There are two diverging trends in RPS goals: while some states are expanding or increasing their requirements, others have allowed theirs to lapse. Since 2018, 15 states and DC passed legislation to expand or renew their RPS/CES (See Table 1). On the other hand, seven states have allowed their policies to expire, with four targets expiring in 2021 (See Table 2).

States with current and updated RPS policies are generally more ambitious than states with expired policies. Most targets require at least 40% of energy from renewables, but in recent years, states have been pushing towards 100% clean or renewable energy requirements. As of now, 10 states and DC have set out to reach net-zero carbon electricity between 2030 and 2050. As the energy transition gains traction, this number is expected to rise.

Renewable portfolio standard policies also vary widely on application, including targets, the applicable entities, and eligible resources to meet the requirements. Some also include cost caps (Mack et al., 2011). Standards are measured by the percentage of electricity sales, and Iowa and Texas have stipulated capacity requirements. Eligible resources of course vary, but the majority include solar, wind, biomass, geothermal, and select hydroelectric facilities. Many RPS are primarily applicable to investor-owned utilities (IOUs), but other states include municipalities (munis) and cooperative utilities (co-ops). Utilities then obtain renewable energy certificates or certificates (RECs) to represent compliance with the standard (NSCL, 2021). Finally, some RPS promote certain technologies and diversification by creating carve-outs or renewable energy multipliers, which encourage the deployment of certain technologies, such as wind and solar (Mack et al., 2011).

How have renewable portfolio standards been evaluated for promoting clean energy? RPS policies are unsurprisingly advantageous for the energy transition. They can drive a known quantity of new renewable development with known buyers. Research demonstrates that existing state RPS policies have the potential to stimulate large amounts of new capacity, with over 16,000 MW of new renewable capacity (solar and wind) in 2018 (NREL, 2020; Wiser et al., 2005). Furthermore, these policies lower the cost of development by giving LSEs flexibility in meeting purchase targets. If applied evenly, RPS are competition neutral, meaning they do not preclude participation of both public and private entities. RPS are applicable in both restructured and monopoly electricity markets and possess low administrative costs (Yin & Powers, 2010). However, RPS policies are also difficult to design and often include complex metrics. They are also not well-suited to supporting diversity among technologies because they encourage the development of least-cost renewable supply options, though some are designed with resource tiers (Yin & Powers, 2010). Ultimately, in the absence of federal mandates, RPS serve an important role in promoting clean energy alternatives among energy providers.

States have various reasons for adopting such policies, and it seems to be driven by economic incentives and market structures. In the model for a state's decision to adopt an RPS, several theories are tested in what drives a state's decision to adopt an RPS. Consistent with the private interest theory of regulation, states with renewable energy interests are more likely to adopt RPS, whereas states with coal, oil, and natural gas power producers are less likely to adopt policies. At the state level, Democrats tend to support standards for decarbonization more than Republicans (Marshall & Burgess, 2022). RPS adoption is most likely in states with significant potential for renewable development, states with restructured electricity markets, a smaller share of natural gas in the electricity fuel mix, and the presence of Democratic politicians in the state legislature (Lyon & Yin, 2010). The next step is to understand how the standards translate into utility-level action and pledges relative to decarbonization.

The Agents: Electric Utilities

If RPS/CES at the state level are catalysts to the energy transition, utility companies at all levels are agents at the front line of the renewable energy revolution. Across the industry, companies have explicitly laid out carbon reduction goals to reach net-zero between 2035 and 2050. The road map for utility decarbonization involves three cross-cutting themes: the phasing out of fossil fuels, the buildup of solar and wind capacity, and the improvement to infrastructure.

Electric utilities are responsible for generating and transmitting power for consumption in a geographic area, often large portions of municipalities and states (Willis & Philipson, 2018). Understanding how utilities plan to meet the challenges of the energy transition helps to estimate the rate at which states are poised to adopt clean energy, and whether utilities are projected to meet federal and state level goals. As of now, over 300 utilities are planning to meet a state's 100% carbon reduction goal, and 26 parent companies have voluntarily adopted a carbon-reduction target (SEPA, 2022). As utilities seek to lead the economy-wide transition to lower carbon energy sources, the assessment of utility-specific strategies and commitments on decarbonization is salient.

The fall of fossil fuels is the keystone of this transition and utilities are starting to phase out coal plants. We have witnessed a staggering decline in coal as a source of generation between 2010 and 2020, from 45% of utility scale generation to just 19% (Bohlin, 2021). In all energy pathways for reaching net-zero energy published by the Net Zero Alliance at Princeton, coal use must be eliminated completely by 2030, requiring the shut-down of over 700 coal mines and retirement of some 500 coal-fired power plants (Larson et al., 2020). Natural gas has captured coal's dominance as a power source, now approximately 40% of electricity generation (Larson et al., 2020). While natural gas is less carbon intensive than coal, eventually gas plants will need to be shut down in keeping with climate goals.

Infrastructural improvements will usher along the changing levels of fossil-fueled and renewable power. Accordingly, the rapid deployment and expansion of low-carbon technology must start now and accelerate. There are three main components to this: (1) increasing the adoption of wind and solar, electric vehicles, and heat pumps, (2) investing in complementary infrastructure, including chargers, transmission, and CO2 pipelines, and (3) maturing existing technology in line with innovation (Larson et al., 2020). Generating capacity for renewable and wind power, currently 10% of U.S. electricity needs to dramatically increase to supply half of electric use. Specifically, we will need to expand high-voltage transmission capacity by roughly 60% to transport renewable electricity (Larson et al., 2020). Additionally, as with new technology there will be improvements to existing renewable technologies. Investment will be required to make these solutions cheaper, scalable, and market-ready by 2030. Ultimately, electric producers, transmitters, investors, and entire communities are gearing up to support the massive changes to infrastructure that are indispensable to a successful energy transition.

In stride with retiring fossil fuel plants, the U.S. must bring more RE capacity online to comply with state-level climate targets. There has been a widespread market disruption by renewables in the last decade, experiencing growth, especially by wind and solar (IEA, 2020). The extension of tax credits, along with increasing acceptance by regulators to include renewable investment in the rate base, will help the utility industry to make significant investments in wind and solar in the coming years. Tax credits have been helpful to bolster renewable capacity. Solar projects have an ongoing investment tax credit (ITC) of 26% with construction before the end of 2022 (Bohlin, 2021). Projects initiated before 2022 for wind and other qualifying renewables (such as geothermal) has an ITC of 60% and ongoing offshore wind has a 30% ITC for production pre-2025. These credits are an important factor to encourage utilities to develop more wind and solar.

These tax incentives make investment in renewable capacity more attractive, but they are increasingly unnecessary: many onshore wind and solar projects have now become the cheapest source of generation. Along with inexpensive sources, in some locations the returns are attractive for RE even in the absence of subsidies (Bohlin, 2021). As more RE capacity gets built, carbon emissions will decline, but investments by power providers will continue to drive changes going forward.

There is an impetus to do more on the decarbonization front. In a Deloitte energy transition survey, the Power, Utilities, and Renewables (PUR) sector will be a leader, and more than half of respondents expressed executive-level commitments. Investor-owned utilities could have the greatest impact for decarbonization (Porter et al., 2020). Most IOUs surveyed had goals for emissions reduction: 38% share of retail electricity sales had goals for GHG emission reductions, 36% for net-zero carbon, and 13% for carbon-free electricity. Electrification offers the potential to eliminate the consumption of carbon-based energy, the timing of decarbonization remains to be important. Understanding the evolution of emissions for a given utility over the coming decades is useful to evaluate how we might intervene against climate change. Duke Energy, a large utility servicing states in the Southeast, underscores the need to increase action: according to Duke's sustainability report, "Achieving net zero, even with gas, will require an unprecedented and sustained pace of capacity additions" (Duke, 2020). The utility will need to add renewables at a pace more than double the rate at which it was added over the past three decades. The same will be said for many other electric utilities across the U.S.

In this paper, I explore to what extent utility goals are positioned to comply with state-level RPS/CES legislation. Specifically, are utilities projected to meet the demands of states' energy legislation? Who is at the cutting edge of the energy transition—states or utilities?

Methods

To understand which entity–states or electric utilities–is at the cutting edge of the energy transition, I collect, analyze, and compare data in each state about the top energy providers by market share and energy sales to see which industry players have the most comparative power. Ultimately, I seek to understand the potential timelines of utility decarbonization at the state level and the incremental amounts of energy that will need to be decarbonized.

In general, RE includes hydroelectric, solar photovoltaic, wind, biomass, and geothermal, all depending on the designation in each standard. For example, Indiana, includes nuclear generation in its Clean Energy Standard, while many other states do not. These observations provide the renewable portfolio baselines, assuming there will be a future surge in renewable capacity. To be sure, observations to date do not always show increasing trends in renewable capacity. In line with experts, I assume that many states will experience positive growth to renewable capacity and sales (Bohlin, 2021; Larson et al., 2020; Yin & Powers, 2010).

There are three channels of data. (1) I access two EIA datasets for MW capacity and MWh sales—these measures deviate with peak demand levels and electric rates. Schedules EIA-906, EIA-920, and EIA-923 provided Net Generation by State by Type of Producer by Energy Source annually to 2020. I filter by producer-type in line with policy specifics—namely Independent Power Producers (IPPs), Investor-Owned Utilities (IOUs), and Total Electric Power. (2) I access EIA-961 schedules 4A and 4D and EIA-861S for 2020 bundled sales to final customers at the utility level (EIA Table 10 – Excel file), organized by states where utilities operate to use when collecting utility-level data and eventually aggregating to the state level. (3) I research the parent company for all applicable IOUs or other relevant utility companies (e.g., Xcel, Southern Company, Consolidated Edison).

Initially I use a dataset of 1,670 load-serving entities (LSEs), indicating for each utility the state(s) of operation, sales in megawatt hours (MWh), customer count, and revenue. Using the sales and respective states, I generate a data column to evaluate the top electric providers by state, representing electricity market share. With a target of reaching a certain level of market share in each state, I aggregate percentage share by sales for each of the top 5 energy providers or 70% market share—whichever comes first. Next, I collect data on each state's RPS and baseline years (See Appendix). Finally, I assess sustainability reports of each states' major utilities to compare utility level commitments to state policies, if available. I started with three hypotheses regarding what energy transition plans look like in each state:

1. **De jure**: Utilities are meeting their renewable portfolio standards and are on track to reach future goals. This is most likely, assuming the passage of RPS is adequately ambitious.
2. **Policy-led**: States are more ambitious than their utilities regarding renewable generation expectations, but only states with stated policy as they have expressed motivation to enact science-based targets. Utilities will need to increase their ambitions to stay on track.
3. **Free market-led**: Utilities with the biggest market share, or those serving more than one state, are more ambitious than their state policies. This could be due to utilities being subject to more variation in policy, having economies of scale, and serving customers and stakeholders who may prioritize sustainability.

The design of my research consists of homogenizing utilities' stated decarbonization goals across the U.S., weighted based on the utility's service to the state using market share. Ultimately, I source such commitments from sustainability reports and webpages for roughly 170 utilities and parent companies. Sustainability, corporate responsibility, and environmental reports contain numeric decarbonization targets for the future with baseline levels, and other relevant information at the utility level. The rate of decarbonization is proximal to the rate at which utilities rely on renewable technologies for electric production. I use the percentage of emissions each utility aspires to cut to determine the incremental reliance on renewables per year. Many utilities set objectives to reach net-zero between 2035 and 2055.

I build a utility master spreadsheet from EIA 2020 Utility Bundled Sales report. In this Excel spreadsheet, I analyze a list of utilities (denoted 'Entity') by state, MWh sales, ownership type, sustainability report link, decarbonization rate, year to reach that goal, baseline year, renewable portfolios in baseline, and any other related details. It is important to note that a multitude of utilities with goals operate in numerous states. To fill in the data gaps approximately even by state, I calculate the percentage generation in each state by utility, according to the total sales listed for each state denoted in the column labeled Percent State Covered. With a goal to reach minimum 70 percent coverage across the United States for each state, I sort the columns by state and percentage coverage to focus on the largest energy providers. For states with highly fragmented electric generation, I rely on the biggest players and track at least five utilities. Figure 1 exhibits utilities serving Arizona, where approximately 90% of the state's electricity for 2020 are captured in decarbonization rates found in respective sustainability reports.

Entity	% State Covered
Salt River Project	37.26%
Arizona Public Service Co	35.84%
Tucson Electric Power Co	11.13%
Morenci Water and Electric	3.26%
UNS Electric, Inc	2.21%

Figure 1. An example in the Excel file of different utilities and the percentage of electricity sales they provide to the state.

The big players for investor-owned utilities are cross-referenced against individual utilities owned by larger companies using a benchmarking report compiled of the 100 largest power producers (MJ Bradley, 2021). The report contains emissions and generation data for the top 100 largest electric power producers in the U.S. for 2019. Roughly 10% of electric generation is renewable, including wind and solar (382.6 million MWh), 7% is hydroelectric (288.8 million MWh), and 19.6% is nuclear. In the past 10 years, utilities have been trending towards greater renewable generation: since 2008, renewable generation by the top 100 utilities has seen greater than a four-fold increase (MJ Bradley, 2021). If this trend is perceptible at a national level, my methods uncover trends at the utility-level.

The previous step helped me to identify the parent companies of many of the investor-owned utilities. My research identifies and isolates larger companies that own or generate power for utilities at the state level. In total, there are 769 utilities considered parent companies. Xcel Energy, for example, owns and operates four companies: Northern States Power Company Minnesota, Northern States Power Company Wisconsin, Public Service Company of Colorado, and Southwestern Public Service Company. These utilities service customers in Colorado, Minnesota, Michigan, North and South Dakota, Wisconsin, and Texas. I use sum based on synergies to determine total parent generation in MWh at the company level.

State Policies

I employ the historical data and future estimates as a proxy with which to measure progress in comparison to state standards and goals. States have passed legislation in the form of renewable portfolio standards to promote energy independence, diversify their energy mix, and encourage economic growth (Wiser et al., 2005). RPS policies have driven the U.S. market for wind, solar, and other renewables estimated at $64 billion (NCSL, 2021). About half the growth in U.S. renewable energy generation resulted from renewable standards since 2000. Clean energy standards are like renewable standards but include sources that are carbon non-emitting such as nuclear. For more information about each state's RPS status or goals, see the Appendix.

Historical Data: 1990-2020

The energy sources in the EIA datasets for sales and capacity are coal, geothermal, hydroelectric, natural gas, nuclear, wood-derived fuels, other biomass, petroleum, solar thermal and photovoltaic, wind, hydroelectric, and pumped storage. I amass one column for Renewable Capacity—geothermal, hydroelectric, other biomass, pumped storage, solar thermal, wind—for each state for each year since 1990.

I access EIA data on energy generation for electricity by state. Because states have different designations for what counts towards renewable policies, I sort according to what counts as renewable generation. Sometimes, policies stipulate specific measures to include specific technologies, but I am limited with my dataset, and I assume those technologies are mere fractions of total power provided.

Next, I sort the Producer Type to isolate the energy produced for electricity as a final stage. Consequently, I replicate this process to aggregate renewable sales in MWh for each state over the 30-year period—ultimately, most RPS measure renewable portions through electricity sales, but some measure with capacity.

Future Projections: Extrapolating to 2050

With the goal to see a tenable future renewable mix, I devise a strategy to understand the rate of state decarbonization in accordance with utility goals. Overall, I produce a series weighted averages of utility decarbonization rates at the state level, representing the percentage changes in favor of renewables year-to-year.

Importantly, utility goals are relative to a baseline, meaning that each decarbonization goal is subject to a baseline renewable capacity. After surveying sustainability reports and zero-carbon goals, I factor in the renewable portion of each utility's energy portfolio for the baseline year. If this information is unavailable, I impute state level data on renewables as a portion of energy generation as a proxy. In general, utilities vary in their presentation of goals, but most offer a goal in similar form —i.e., 100% carbon reduction by 2050 from 2005 levels. These scores are based on sustainability reports made publicly available accounting for missing data points, which are assumed to be zero.

Using a simple change equation to get the percentage per year needed to meet these goals, I construct a weighted score of each utility. This value can subsequently be taken to identify a state weighted average of utility goals. The calculations of decarbonization rates weighted by utility commitments for state required weighting utility-level scores based on the percentage provision in state sales.

Of course, this method for analyzing the timeline of the energy transition predicates on two core assumptions: 1) that energy use and efficiency will remain constant and 2), that renewable additions are brought online linearly.

It is important to note that utilities offer other strategies in addition to greater renewable capacities. Energy efficiency will likely improve between now and 2050 due to technological progress, but demand will also increase (Teske, 2020). Phasing out coal plants and investing in renewable energy generation is a central strategy, but there are additional elements that will be required for a transition to occur. According to my review of utility plans, utilities are focused on electrifying the transportation sector, increasing energy efficiency, implementing demand response principles, shaving peak power, and retiring coal power plants early.

In total of 1,670 electric utilities serving the United States, I collected data on future decarbonization goals for about 700 of the utilities, 200 of which included useful decarbonization information. The most ambitious utilities according to their respective sustainability scores included: Algonquin, Fortis, Unitil, Avangrid, AES, NextEra Energy Partners and Xcel. Many of the smaller local investor-owned utilities and cooperatives offered no sustainability information, so their scores were represented as zero.

In the interest of my argument, should we decarbonize the electricity sector primarily through transitioning generation technology, these rates represent the compulsory percentage of renewables added to eventually reach zero-carbon electricity generation. Other sources of power, especially natural gas, will continue to power the electricity sector for years to come.

Results

Overall results covering an average of three fourths of state electricity sales from utility decarbonization goals (shown in Figures 2 and 3) suggest that states are approximately on track to meet or exceed established RPS, with some caveats. Two analyses—one central to capacity proportions of renewables, and one based on MWh sales in each state, have similar results. Figure 2 displays renewable observations and projections for electric utilities and independent power producers in terms of net renewable capacity as a percentage of the portfolio. Figure 3 displays the results, but with MWh observations instead. The main difference here would be found in states that build out more renewable capacity than is used, or otherwise transfer renewable power as RECs to other states (Mack et al., 2011).

A quantitative analysis comparing implied utility targets and RPS goals suggests that about 70% of states are on track to meet or exceed their RPS and CES targets. Building from capacity using the incremental decarbonization rates, I find that six of eleven states with zero-carbon targets are on track to meet that goal. The same calculation with electricity sales as the base results with five states on track and six lagging. Using capacity, 15 states are projected to be on track for their intermediate goals, and seven already have achieved them. Four are behind and one (Maryland) fails its goal. Building from electricity sales, 17 are in line with their goals and four have achieved them. Four are behind and two (Maryland and Michigan) have failed. See Table 4 for numerical results.

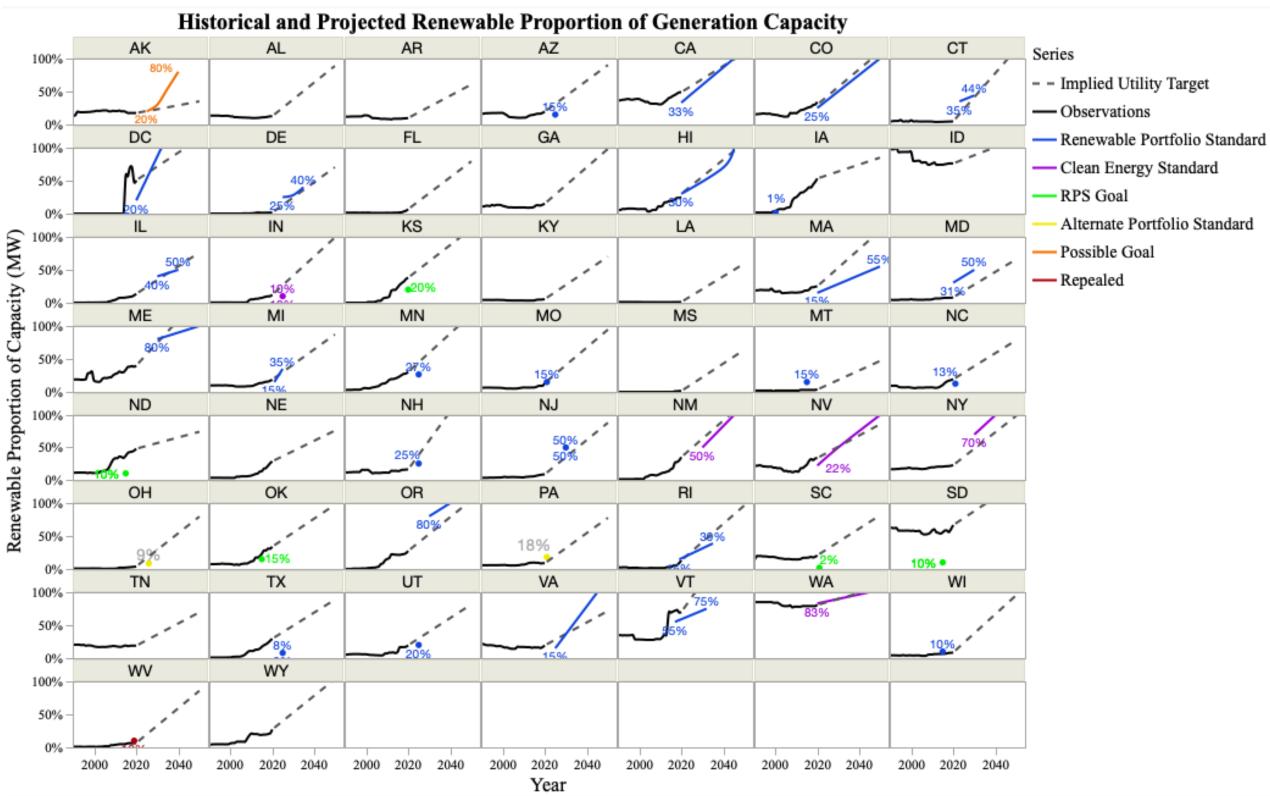

Figure 2. Projections from 2021-2050, with 1990-2020 data for renewables as capacity for electricity use. Some RPS are adjusted to account for large discrepancies between observations to account for contribution by large-scale hydro (Washington, Montana, Oregon). Data from Data from EIA-906, EIA-920, and EIA-923.

Most states have some sort of policy to promote clean energy, but policies do not promote the same level of ambition, and not all states have a net-zero goal. The majority have RPS, several have clean energy standards (CES), and some are voluntary targets. 13 states (including West Virginia, whose policy was repealed and Alaska, without real policy) do not have standards or goals for decarbonizing their electricity sector. Of the states with goals and standards, ten are since expired and have not been renewed (See Table 4). In accordance with capacity projections, all states except Montana succeeded in their timeline. Indeed, several have produced beyond the goal. When looking at electricity sales aggregated from MWh observations, four states out of ten failed to reach the goal—Kansas, Montana, Missouri, and Wisconsin. This suggests that states with expired goals had lacking ambition overall. Moreover, it seems that generation of renewables in these states exceeds electricity sales.

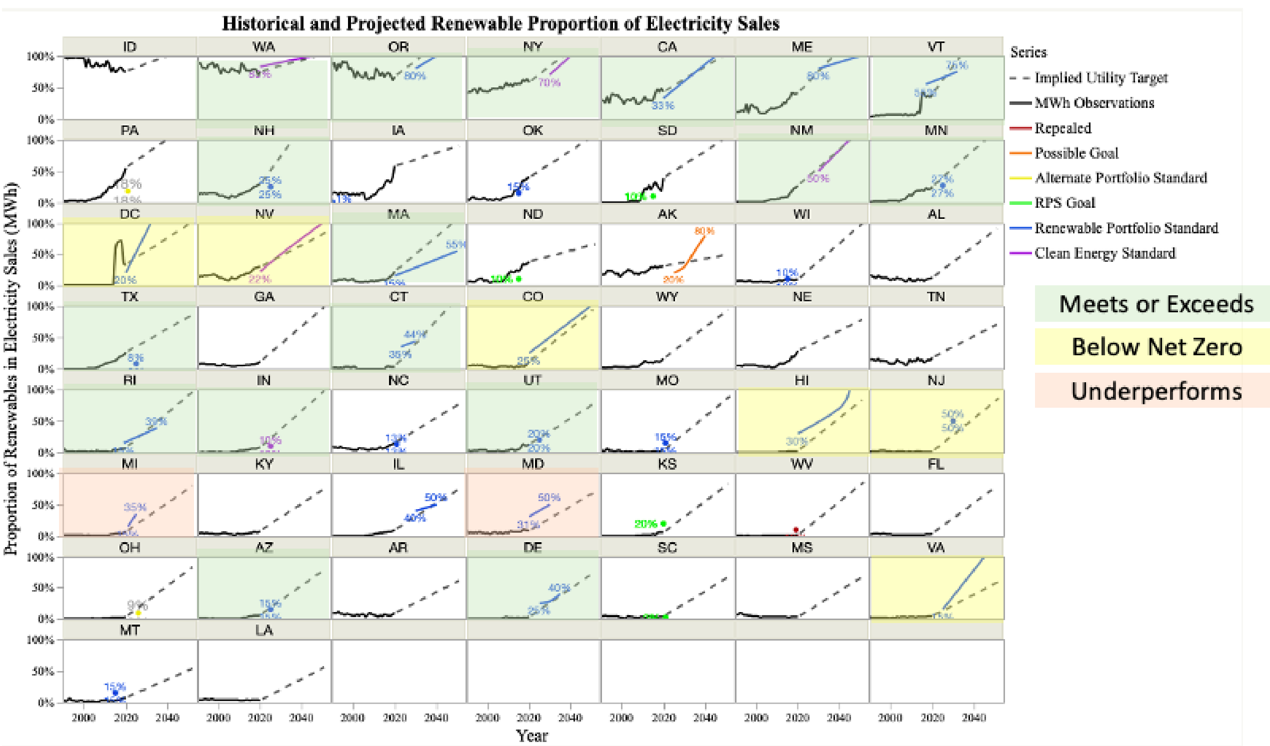

Figure 3. Projections for future electricity sales in each state from 2021-2050, with MWh data from 1990-2020. Data from Data from EIA-906, EIA-920, and EIA-923. Coloring indicates evaluated performance.

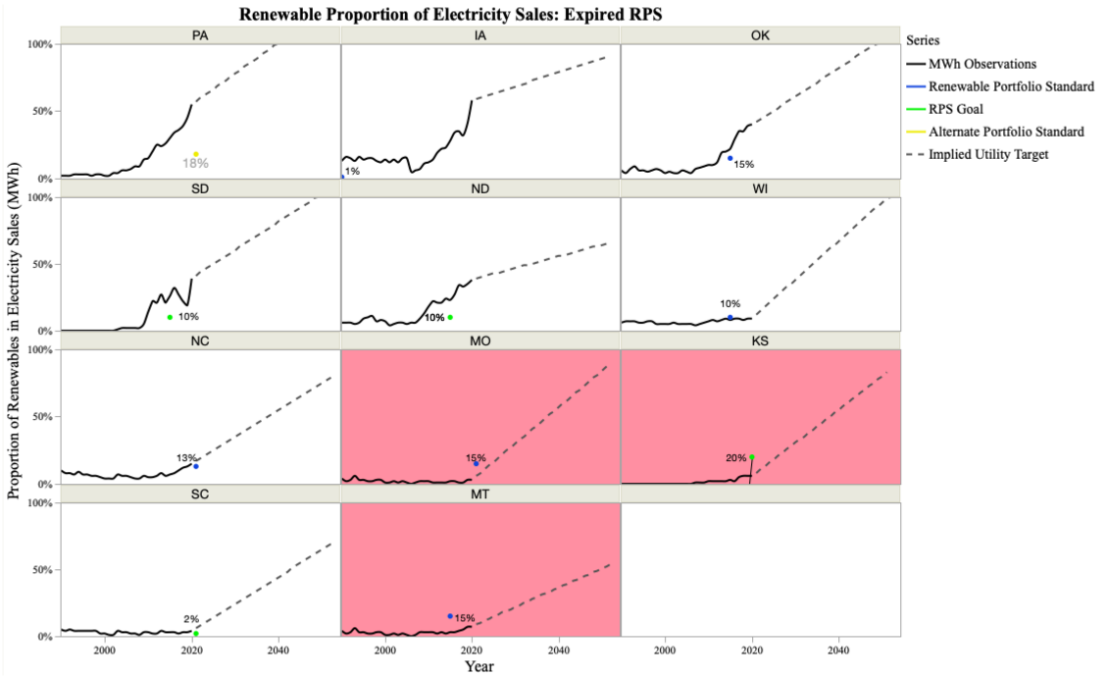

Figure 4. States with Expired RPS. States in red failed to comply.

All six renewable portfolio goals have succeeded (KS, ND, OK, SC, and SD) when aggregating based on capacity (Figure 2). Compared to many standards, portfolio goals assign relatively passive targets. However, comparing to MWh sales, which are more relevant to standards than capacity, all but Kansas have succeeded in their goal target. For Clean Energy Standards, most states are on track, as five of seven (CA, IL, NM, NV, and WA) have incremental rates close to the stipulated RSP/CES lines. New York underperforms but exhibits a similar predicted rate. Indiana has already met and exceeded its goal of 10% renewables. Alaska has not passed a goal but is projected to be on track for the potential 2025 goal, but unlikely to reach 80% by 2040. Meanwhile, about 14% (5 of 36) are projected to fail.

States with implied utility targets that are most synonymous to their CES/RPS tend to be Democratic leaning, with close to half of the state constituency identifying as Democrat or leaning Democrat. These states, as seen in Fig. 3, include California (49% Dem.), Colorado (44% Dem.), Hawaii (51% Dem.), Illinois (48% Dem.), Michigan (47% Dem.), New Mexico

(48% Dem.), Nevada (46% Dem.), and Washington (44% Dem.). Additionally, many of these states boast high proportions of renewables in 2020. States with Democrat-only sponsors disproportionately passed mandatory RPS and emissions standards (Marshall & Burgess, 2022). Clearly, there seems to be a relationship between a state's utility-level commitments and that state's political affiliation. Further research might investigate the boards for utilities with strong decarbonization plans.

In total, 75% of states with goals or standards are on track or set to exceed their standards. Some state goals are more ambitious than others, but there is a positive trend towards decarbonized electricity generation in the United States.

About 13 states of those with at least two standards in place are on track to meet the targets, and almost all have a similar rate of incremental renewable capacity additions. These results imply that large investor-owned utilities are developing renewable strategies to match or exceed portfolio standards. We can observe how the incremental renewable additions factored with current renewable fuel mixes map against RPS policies at the state level.

While most states are on track, several are projected to underperform their standards—specifically Alaska, DC, Maryland, New York, Oregon, and Virginia. This implies that some states might have passed RPS that are ambitious, especially if they aim for net-zero before year 2050. For example, Virginia is already exceeding its 2025 goal for 15% renewable electricity, but the projected decarbonization rate of 1.7% puts the state at just 63% renewable capacity by 2045, falling below the aspirational 100%. Fortunately, utilities may adopt clean technologies at a faster rate and catch up in the long run. Many states are predicted to reach net-zero electricity by 2050 and only a couple states are projected to be far from attaining full renewable power (Alaska, Arkansas, Kentucky, Louisiana, and Mississippi).

Aggregated weighted utility targets for sustainability are between a 0.5 and 5% increase of renewable reliance per year. On average, utilities seek to reach a 2.3% decarbonization rate, meaning that a state with 10% renewable generation in 2020 and a 2.3% rate would reach 12.3% electric generation from renewables by 2021. Fig 3 illustrates these target utility rates at the state level, accounting for roughly three fourths on average of the state's electricity generation.

The top states for incremental percentage adoption include Vermont (4.5%), New Hampshire (4.5%), Connecticut (3.7%), Maine (3.5%), and Minnesota (2.9%). Contrary to conjecture that the most colloquially "sustainable" states would have the highest scores, recall that the scores incorporate the base year renewable proportion. Many of the utilities in those states (such as California and Washington) started with a larger proportion of renewables and therefore do not require the highest rates to be on track. California, as an example, has a 2% rate but is on track to reach zero-carbon by roughly 2042. Washington also scores low at 1%, but hydroelectric has accounted for about 80% of the state's electric power. State averaged utility rates assess utility plans and the overall potential for spurring decarbonized electricity generation.

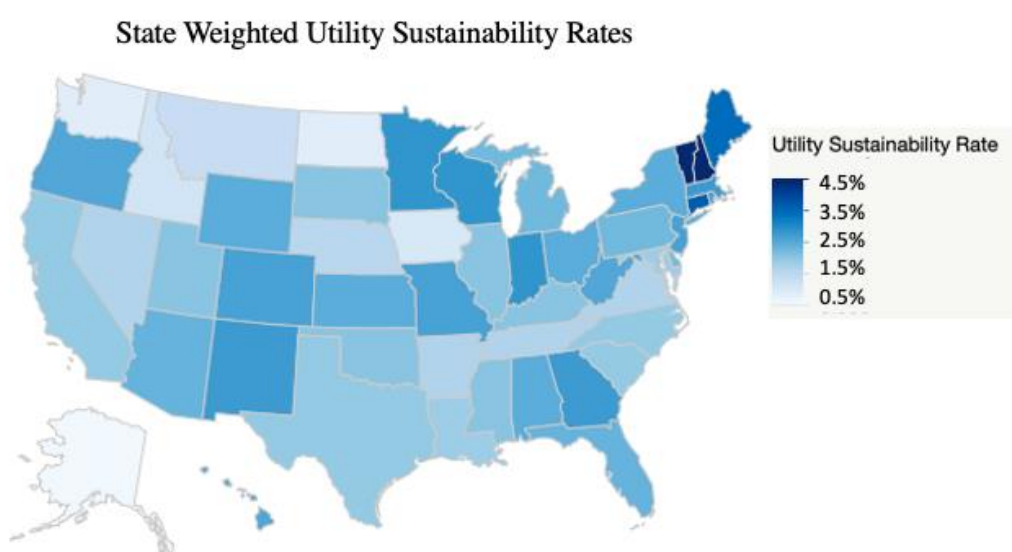

Figure 5. Predicted utility rates based on aggregated data at the utility-level from most recent sustainability reports

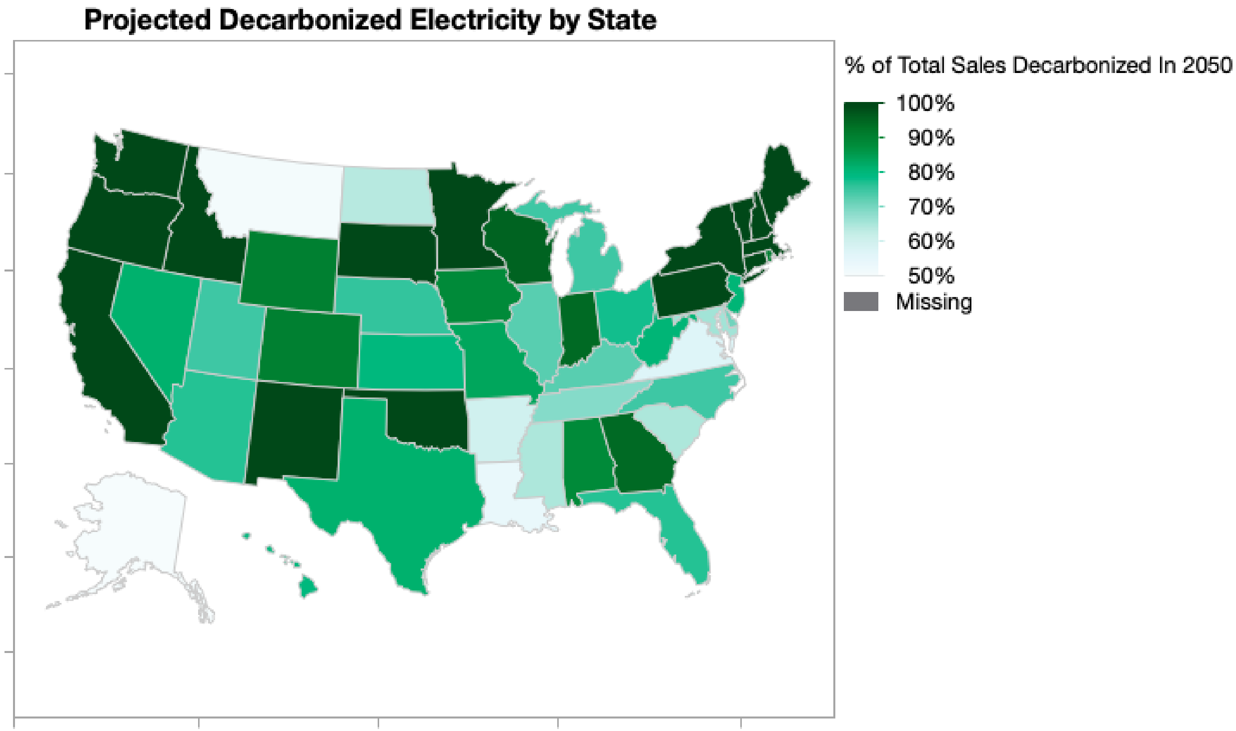

Figure 6. Forecasted fraction of a state's total electric power generated from renewable sources in 2050, based on the decarbonization rates of utilities aggregated to the state level and tacked on to existing renewable proportions.

Figure 5 is a map visualization of the weighted decarbonization rates I rederived from utility decarbonization commitments with baseline renewable capacity factored in. Lighter states generally have a lower rate, and sometimes this is because the baseline presence of renewable capacity was already comparably higher than other states. In Figure 6, I estimate a plausible future scenario of renewable generation should utilities increasingly produce using RE resources. This represents prospective portfolios for renewable capacity from IPPs and IOUs, visualizing optimistic future as far as the energy transition goes. In total, 32 states and DC are projected to reach at least 85% of sales from renewable and clean energy by 2050.

Based on aggregated utility sustainability rates for each state, weighted by utility state generation, the U.S. decarbonization rate is projected to be around 2.2% per year. With current renewable capacity at about 24%, primarily wind (~10%), solar (~4%), and hydroelectric (~7%), the U.S. is projected to reach net-zero electricity generation by 2060. Figure 7 displays this rate added yearly to the existing renewable capacity. The same figure shows the incremental rate aggregated with electricity sales, which would project the U.S. to reach zero-carbon electricity use in roughly 2057. Between 1990 and 2020, renewable capacity has only increased 1% as a proportion of electricity generation. However, excluding hydroelectric illustrates more promising growth: renewables have increased from 3 to 8% since 2000, and have grown about 160% in total.

Between 2011 and 2020, the average incremental increase in renewable sales was about 0.9%. For my estimate to hold, this rate would have to more than double. Assuming utilities are indeed committed to an energy transition, it is plausible that a ~2.2% yearly rate will take place, on average, for the next decades. Experts also see Biden's plan as targeting sources of carbon directly, and with trillions of dollars ushering in a change, efforts might yield promising results (Muyskens & Eilperin, 2020).

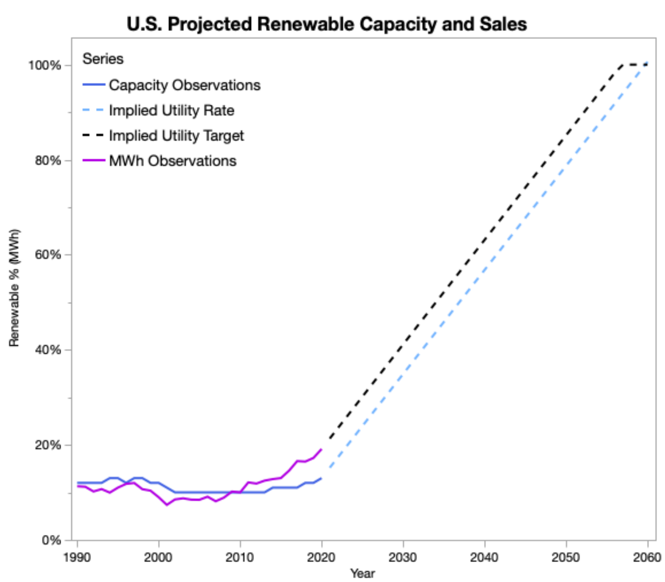

Figure 7. When the United States is predicted to reach 100% carbon-free electricity, based on capacity & sales data to date.

There are 17 states which are projected to reach 100% renewables based on their incremental decarbonization rate (See Table 5). Of these states, only two had no RPS goal (Idaho and Wyoming), and these states have high portfolios of renewables. For these states to reach net zero capacity for electric utilities and independent power producers, the utilities in those states would have to rapidly scale renewables. Importantly, states with preexisting portfolios with high proportions of renewable generation are better poised to reach net-zero. However, 27 states reach electric renewable portfolio mixes of greater than 95% by 2050 if commitments are fulfilled.

Based on percent of sales in the state that is renewable for 2020, 12 states have accomplished their renewable portfolio standards (New Hampshire, Oregon, Iowa, Pennsylvania, South Carolina, Maine, Montana, South Dakota, North Dakota, Vermont, Massachusetts, and Washington). Using the same comparison, but with megawatts of utility generation, 7 states have fulfilled their standard: Iowa, Wyoming, South Carolina, Montana, South Dakota, Vermont, and North Dakota.

Discussion

In this study, I compare utility rates of decarbonization to state RPS. The research explores several key questions. Which entity is on the cutting edge of the energy transition: states with RPS or utilities? What is the overall rate at which we can expect each state to depend increasingly on renewable energy based on stipulated targets? Which states are and are not on track based on these results?

If you take utilities at their word, they are broadly on pace with stated goals. Largely, they are also on pace to achieve carbon free electricity by 2060. Of 20 states with electric RPS, eight are expected to exceed these targets based on projections; eight are approximately on track; five are slow.

Intuitively, results hinge on the assumption that utilities will decarbonize by procuring and building renewable capacity accompanied by the phase out of carbon-intensive fuels, as well as improved infrastructure to transmit new power. Between 1990-2020, developments in renewable capacity have been slight or negligible. Taking utility companies at their word, many implementing net-zero carbon electricity targets, the cumulative capacity of renewables will need to rise dramatically to replace fossil fuels. According to calculations factoring in each utility's base year renewable fuel mix and desired decarbonization, many states are on track for a tremendous energy transition.

Strengths and Limitations

Quite a few assumptions and imputations have informed estimates of utility compliance and aspirational decarbonization. The premise of my argument assumes that renewable output as a fraction of electricity generation will increase over time. Therefore, each incremental decarbonization rate informs the aspirational renewable production as the "implied utility target" in the future. For my projections to transpire, renewable capacity production which will need to replace and overtake fossil-fuel electricity production. While this is plausible to eventually reach net-zero electricity production, there are several other strategies in place.

Perhaps the most important caveat of this study, the analysis takes utility sustainability reports as they are written. To make create projections, we hinge on what the utilities *say* they aim to do, which remains unknown. The analysis excludes cross checking of planned capacity based on integrative resource plans (IRPs) or commitments to spending on increased capacity. I simply look at when a utility plans to decarbonize from an established base year. Should utilities greenwash their company for the sake of appeasing stakeholders or customers, perhaps utility portfolios will not see a great change. Another possibility lies in the technical aspects of decarbonization: for example, utilities continue to expand natural gas capacity, which is not renewable, but is less carbon intensive. Overall, utilities have options external to renewable growth to meet their goals, at least in the near-term.

There are several reasons utilities would exaggerate their plans to decarbonize. A growing number of utilities have set ambitious goals to be a part of the energy transition, but several will fall short. As of April 2021, over 73 U.S. utilities serving over 70% of customer accounts had goals to reduce emissions, and 51 had net zero emissions goals (Trabish, 2021). According to a Smart Electric Power Alliance (SEPA) initiative on the topic, of the utilities surveyed only 18% of these utilities had reliable renewable resources in stock to contribute to these goals. SEPA Chief Strategy Officer Sharon Allan expressed doubts, noting that "utilities can make any public commitment" but transformation is only feasible if utilities make the necessary investments in people, technologies, and processes that will "build a modern foundation for carbon reductions" (Trabish, 2021). Moreover, electric sector analysts from the Sierra Club lament that utility operators continue to plan with room for fossil fuels, in spite of climate science.

The efforts to gather information across every state for all utilities is limited by the ability to find and access information on decarbonization and renewable capacity goals. This means that for companies without information provided, their decarbonization rates are imputed as zero. In other words, I suppose that the contents of their portfolios will remain constant. Due to the high count of lower extremes pulling state averages down, my incremental utility rates do not overstate the impact of utility commitments. Finally, and perhaps this provides greater assurance of the trends, the results are conservative in nature.

According to an extensive analysis of utility sustainability and corporate social responsibility reports, there are other strategies to accomplish carbon reduction goals. These avenues advocate for a reduced reliance on energy via improved energy efficiency campaigns. Some utilities suggest investing into new technologies and have proposed future wind and solar projects that may go online but are not guaranteed. As far as these development projects, the decarbonization of the electricity sector will not be linear, but stepwise. There will be millions of megawatts of capacity needed to be replaced by carbon-free sources, which is land-intensive and logistically challenging.

The project would have been unreasonable to take on if it included every megawatt of electricity produced, proposed future capacity, and expected retirement of existing coal and other fossil-based generation facilities. Further, with this information, I would have to understand which states the projects would be built in and where the power would be sent, which would muddle the state percentages. Hence, decarbonization rates are an important proxy to estimate renewable generation on a state-by-state basis.

A tertiary limitation of this research is whether renewable portfolio standards are considered an adequate benchmark for progress. While some standards promote net zero goals, others are characteristically unambitious. There is no determination for whether the standards inspire action in the long run, and the analysis stops short of full analysis of a state's renewable energy specifics and anecdotes. For example, I was unable to include additional information on the utilities' carbon intensity of electricity or total emissions by state. Because I focused on portfolio standards, my results do not explain which policies are best and which have been the most successful in reducing electricity-sourced emissions in terms of aggregate power. It would be useful to continue this research to project which states are making the most aspirational policies to reduce emissions.

Moreover, the composition of actual RPS omit “utility-scale” hydroelectric capacity and nuclear and include biomass. For example, in Oregon’s RPS, contributions to eligible power include new hydroelectric projects and efficiency upgrades. Several states with high proportions of hydroelectric express similar policies or only permit small hydropower, such as Delaware limiting to 30 MW capacity facilities. Conversely, in 2020 there were roughly 100,900 MW of nuclear capacity powering the electric industry with just 94 generators. Perhaps if the results could be reconstructed with the inclusion of nuclear and hydroelectric resources, there would be higher confidence in reaching net zero goals. Alas, because this analysis focuses on a comparison with RPS/CES as they are written, I was constrained to complete my calculations in line with state definitions of renewable energy.

Finally, this research is limited in data collection confidence. A large portion of the research relies on data and spreadsheets published by the U.S. Energy Information Administration (EIA). While the EIA is a reputable organization for energy, the process of manipulating, comparing, and aggregating thousands of rows of data while ensuring that calculations matched with the variations in policy specifics was tedious. Without more time devoted to this process, I cannot claim certainty that electricity company data are entirely accurate.

In most states, renewables have been largely constant, or slowly increasing between 1990 and 2020. Assuming that the energy revolution is bound to accelerate, these projections are conceivable. However, these projections are unlikely to occur incrementally, and there may be stepwise contributions depending on a state’s capacity additions.

Recommendations for Future Research

Given the limitations of my research, the climate research community should assess the plans of electric utilities, both by monitoring progress in real-time and suggesting additional strategies to help utilities meet their goals. It is important that utilities are committing to decarbonization goals and planning to enhance their sustainability, there must be science-based targets and tracking of progress from external sources to hold these entities accountable. SEPA is engaged in a holistic study of utilities to track decarbonization commitments and provide periodic survey data, which has reached over 80 million customer accounts and over 63% of U.S. customer accounts. This year, it surveyed over 130 investor-owned, public, and cooperative utilities of all sizes and regions. Through the study, SEPA analysts hope to develop and encourage strategies that will contribute to an effective and timely energy transition (SEPA, 2022).

The International Energy Agency purports that investment in net-zero technology will have to increase by 4.21 times and see a $1.6 trillion investment by 2030. Companies are encouraged to build up wind capacity on and offshore, deploy solar and hydrogen, modernize hydropower, and expand nuclear power. Financiers are encouraged to invest in innovation, increase investment in renewable and clean electricity technology, and develop financial tools to unlock private capital. Based on my review of hundreds of utility sustainability plans, I believe further research could unlock planned investment at the utility level to see plausible futures for renewable development (IEA: WEO 2020, 2020). For example, there may be pressure from stakeholders and customers to have a green portfolio. Because most utilities have a plan, it has likely become a mainstay publication to report. However, to effectively make strides towards net carbon, utility companies may have to require external consultants or have an internal team to make sure they are striving to comply with future targets.

On the other hand, there are several key drivers pointing to a fast energy transition. Key technologies of renewable energy are becoming more effective and increasingly adopted. In 2020, the U.S. solar market installed a record 19.2 GW of solar capacity. New capacity additions in the U.S. are disproportionately renewable: solar and wind together accounted for 63% of new generating capacity (SEIA, 2021). Forecasts by reputable entities, such as the IEA, have been infamously wrong and solar has grown far faster even in the first year of the forecasted period than most forecasts project for 25 years later, illustrated in Auke Hoekstra's analysis (Beetz & Enkhardt, 2018).

Cost reductions in renewables have opened the door wide for the energy transition. Until recently, electricity from fossil fuels was far cheaper than electricity from renewables, but now they are rapidly catching up. For instance, the learning curve represents the efficiency gains of technology overtime, which yields lower costs to produce energy—with each doubling of installed capacity, the price declines by the same fraction (Roser, 2020). As such, between 2009 and 2019, the price of electricity from solar fell by 89%, onshore wind by 70%, and offshore wind by 10% (Roser, 2020). For example, solar photovoltaic is now the cheapest source of electricity with capacity set to triple by 2030 under current and proposed policies and potential to grow even faster (IEA – WEO, 2020). Additionally, there have been greater trends towards investment from both public and private sectors.

We have seen how utilities are steadily progressing towards stated targets today, but given the growth in technological advancements, it is possible that states will increase their targets. Moreover, utilities typically publish sustainability reports each year, so there is a possibility that utilities will adapt to such advancements and economic opportunities by committing to more ambitious targets.

If utilities nationwide are committed to net-zero, the pathway there requires a significant capacity build. According to the Princeton Net Zero Alliance Interim Report, to reach stated goals by 2050, wind would need to be ~2.5-3x current capacity) and utility-scale solar would need to reach ~4 x current capacity all installed before 2030 (Larson et al, 2020). In all pathways, the deployment of renewables remains a central component around reaching climate goals.

Conclusion

In this paper, I have focused on the rate at which we can expect states to comply with renewable and clean energy portfolio standards based on utility company stated decarbonization plans. I presented results demonstrating how many states are expected to be in line with their standards and goals. Overall, of 30 U.S. states and D.C. with RPS/CES, a majority are on track to meet their goals if we take utilities at their word. Several states have allowed their standards to expire without renewal, but most standards were met or exceeded, and many others have expanded or passed additional legislation. Based on sales data aggregations, roughly 15 states will be on track to reach net-zero electricity designation before 2050.

Second, and not unrelated to electric sales, the U.S. incremental utility target score was estimated at ~2.2%, which would forecast net-zero compliance by energy producers by 2060. Of course, these results depend on utilities to uphold their targets and innovate at faster rates. Despite reasons why utilities would fail to uphold their own decarbonization commitments, macro trends within the electric sector espouse a revolution. Already, renewable technology is increasingly cost effective and positioned for deployment, public and private investment is pouring in, and renewable capacity is being developed at an unprecedented rate. Continued research into planned capacity of utilities remains a key area for future research, as it is easy to commit to a date, but a carbon-free electric sector requires significant collaboration, planning, investment, and infrastructure. While we are not projected to be on track with the Biden Administration plan to eliminate carbon emissions from the electric sector by 2035, these results spell optimism for the future of a net zero electric system.

Appendix

Adapted from NCSL State Renewable Portfolio Standards and Goals, updated August 2021

Alaska –

- 30% by 2030, 80% by 2040*

  *Alaska does not currently have a standard or target (NCSL). However, House Bill 301 and Senate Bill 179, yet to be formally passed, may indict Alaska as a state holding policies to promote energy independence and long-term cost reductions.

Arizona – *RPS est. in 2006*

- 15% by 2025
- Applicable to IOUs, retail supplier
- Qualifying renewable resources include biogas, hydropower, fuel cells that use only renewable fuels, geothermal, hybrid wind and solar, landfill gas, solar, and wind.
- Enabling Statute: Ariz. Admin. Code §14-2-1801 et seq.

California – *RPS est. in 2002*

- 100% by 2045 (NCSL 2021), 44% by 2024, 52% by 2027, and 60% by 2030.
- Applicable to both investor-owned and municipal utilities
- Enabling Statute: Cal. Public Utilities Codes §399.11 et seq.; §25740 et seq.; Assembly Bill 327 (2013); Senate Bill 350 (2015); Senate Bill 100 (2018)

Colorado – *RPS est. in 2004*

- 100% by 2050, 30% for IOUs by 2020 / 10-20% for munis and coops by 2020
- Applicable to IOUs, municipal utilities, and cooperatives
- Enabling Statute: Colo. Rev. Stat. §40-2-124; Senate Bill 252 (2013); Senate Bill 263 (2019)

Connecticut – *RPS est. in 1998*

- 44% by 2030
- Class I renewables include distributed generation, such as wind and solar, and Class II including biomass, waste-to-energy, and some hydropower projects.
- Enabling Statute: Conn. Gen. Stat. §16-245a et seq.; §16-1; Senate Bill 9 (2018)

Delaware – *RPS est. in 2005*

- 40% by 2035, 28% by 2030, and 25% by 2025
- Applicable to IOUs, government, and retail suppliers
- Eligible renewables include solar, wind, new sustainable biomass, landfill gas, fuel cells, geothermal, landfill methane gas, thermal electric direct energy conversion
- Enabling Statute: Del. Code Ann. 26 §351 et seq.; Senate Bill 33 (2021).

Hawaii – *RPS est. in 2001*

- 30% by 2020, 40% by 2030, 70% by 2040, and 100% by 2045
- Applicable to investor-owned utilities
- Enabling Statute: Hawaii Rev. Stat. §269-91 et seq.; House Bill 623 (2015).

Iowa – *RPS est. in 1983*

- Calls for the production 105 MW of alternative energy generating capacity from IOUs by 1990.
- Expired
- Enabling Statute: Iowa Code §476.41 et seq.

Illinois – *RPS est. in 2007 (Target in 2001)*

- 25% between 2025 and 2026
- Includes solar, wind, new sustainable biomass, landfill gas, fuel cells, geothermal, landfill methane gas, and thermal electric direct energy conversion
- Enabling Statute: Ill. Rev. Stat. Ch. 20 §688 (2001); Ill. Rev. Stat. ch. 20 §3855/1-75 (2007); Senate Bill 2814 (2016).

***Indiana** – CES est. in 2011*
- 10% by 2025
- Applicable to IOUs, municipal utilities, cooperatives, and retail suppliers
- Includes generation met with clean coal technology and nuclear
- Enabling Statute: Ind. Code §8-1-37.

***Kansas** – RPS est. in 2009 turned Voluntary goal est. in 2015*
- 20% of a utility's peak demand by 2025
- Enabling Statute: Kan Stat. Ann. §66-1256 et seq.; Goal: Senate Bill 91.

***Maine** – RPS est. 1999 and updated in 2019*
- 100% by 2050, 80% by 2030
- Includes a 40% requirement for renewable sources in Class IA and 30% for Class II resources
- Sets goal 2,000 MW of installed wind capacity by 2020.
- Enabling Statute: Me. Rev. Statutes Ann. 35-A §3210 et seq.; §3401 et seq. (wind energy); Senate File 457 (2019).

***Maryland** – RPS est. in 2004*
- 30.5% by 2020, 50% by 2030
- Increased RPS solar requirements from 2.5% to 6% in 2020, passed in 2019.
- Enabling Statute: Md. Public Utilities Code Ann. §7-701 et seq.; Senate Bill 516 (2019).

***Massachusetts** – RPS est. in 1997*
- 35% by 2030, with increases of 1% each year thereafter
- Massachusetts would reach 100% renewable generation by 2095 by this approach
- Enabling Statute: Mass. Gen. Laws Ann. Ch. 25A §11F; House Bill 4857 (2018).

***Michigan** – RPS est. in 2008, updated in 2016*
- 15% by 2021, 35% by 2025
- Includes provisions for energy efficiency and demand reduction
- Eligible renewables include biomass, solar photovoltaics and solar thermal energy, wind energy, hydroelectric power, geothermal energy, and energy generated from landfill gas capture.
- Enabling Statute: Mich. Comp. Laws §460.1001 et seq.; Senate Bill 438 (2016).

***Minnesota** – RPS est. in 2007*
- IOUs to reach 26.5% by 2025, and 25% for all other utilities
- Separate requirement for Xcel has mandated 31.5% by 2020
- Renewables include solar, wind, small hydroelectric power plants, hydrogen generated from renewable resources, and biomass.
- Enabling Statute: Minn. Stat. §216B.1691

***Missouri** – RPS est. in 2007*
- 15% by 2021, with 2% for a solar carve-out.
- Applicable to IOUs
- Enabling Statute: Mo. Rev. Stat. §393.1020 et seq.

***Montana** – RPS est. in 2005*

- 15% by 2015
- Applicable to IOUs and retail suppliers
- Renewables include wind, solar, pumped storage, and waterpower. Large hydroelectric generation facilities are excluded from Montana's RPS
- Expired
- Enabling Statute: Mont. Code Ann. §69-3-2001 et seq.

Nevada *– RPS est. in 1997*

- 100% by 2050, 22% by 2020, 50% by 2030
- Applicable to providers of electric service
- Enabling Statute: Nev. Rev. Stat. §704.7801 et seq.; Senate Bill 358 (2019).

New Hampshire *– RPS est. in 2007*

- 25.2% by 2025
- Includes four classes: Class I energy sources are new renewables (wind, hydrogen, ocean thermal, wave, current, methane gas, eligible biomass technologies, combined heat & power), Class II is new solar, Class III is existing biomass/methane, and Class IV energy sources are existing small hydroelectric sources
- Enabling Statute: N.H. Rev. Stat. Ann. §362-F.

New Jersey *– RPS est. in 1991*

- 50% by 2030
- Applicable to IOUs, retail suppliers
- Includes two renewable energy carveouts for solar (2.21% by 2030) and offshore wind (at least 3,500 MW capacity by 2030)
- Enabling Statute: N.J. Rev. Stat. §48:3-49 et seq.; Assembly Bill 3723 (2018).

New Mexico *– RPS est. in 2002*

- 100% by 2045, 50% by 2030
- Applicable to IOUs and cooperatives
- Enabling Statute: N.M. Statutes Ann. §62-15-1 et seq.; §62-16-1 et seq.; Senate Bill 489 (2019).

New York *– RPS est. in 2004*

- 100% by 2040, 70% by 2030
- Applicable to IOUs, municipal utilities, cooperatives, and retail suppliers
- Est. by NY PSC Order Case 03-E-0188; 2015 New York State Energy Plan; SB 6599

North Carolina *– RPS est. in 2007*

- 12.5% by 2021
- Applicable to IOUs, municipal utilities, and cooperatives
- Est. by N.C. Gen. Stat. §62-133.8.

North Dakota *– RPS est. in 2007*

- 10% by 2015
- Applicable to IOUs, munis, and coops
- Est. by N.D. Cent. Code §49-02-24 et seq.

Ohio *– RPS est. in 2008*

- 8.5% by 2026, down from 12.5%
- Established by SB 310

Oklahoma *–RPS est. in 2010*

- 15% by 2015
- Applicable to IOUs, municipal utilities, and cooperatives

- Est. by Okla. Stat. tit. 17 §801.1 et seq.

Oregon *– RPS est. in 2007*

- 80% by 2030; 90% by 2035; and 100% by 2040
- Including qualifying sources, such as wind, solar or hydroelectric power. Also focuses on energy efficiency, demand responses resources, transmission, community-based renewable energy, and emissions reporting
- Applicable to IOUs, municipal utilities, cooperative utilities, and retail suppliers

Pennsylvania *– Alternative RPS est. in 2004*

- 18% by 2020-2021
- Tier I: 8% by 2020-2021 (includes photovoltaic); Tier II (includes waste coal, distributed generation, large-scale hydropower, and municipal solid waste) 10% by 2020-2021
- Applicable to IOUs and retail suppliers
- Est. by Pa. Cons. Stat. tit. 66 §2814.

Rhode Island *–RPS est. in 2004*

- 14.5% by 2019, with increases of 1.5% each year until 38.5% by 2035
- Applicable to IOUs and retail suppliers
- Est. by R.I. Gen. Laws §39-26.1 et seq.; House Bill 7413a (2016).

South Carolina *– Voluntary RPS est. in 2014*

- 2% by 2021
- Applicable to IOUs, municipal utilities, and cooperatives
- Est. by House Bill 1189

South Dakota *– RPS est. in 2008*

- 10% by 2015
- Applicable to IOUs, municipal utilities, and cooperatives
- Includes geothermal, solar, wind, biomass, and hydroelectric.
- Enabling Statute: S.D. Codified Laws Ann. §49-34A-101 et seq.

Texas *– RPS est. in 1999*

- 5880 MW by 2015 and 10,000 MW by 2025
- 10% by 2015
- Applicable to IOUs and retail suppliers
- Enabling Statute: Tex. Utilities Code Ann. §39.904

Utah *– RPS est. in 2008*

- 20% by 2025
- Applicable to IOUs, municipal utilities, and cooperatives
- Enabling Statute: Utah Code Ann. §10-19-101 et seq.

Vermont *– RPS est. in 2015, Voluntary Target est. in 2005*

- 55% by 2017; 75% by 2032.
- Applicable to IOUs, municipal utilities, cooperatives, and retail suppliers
- Enabling Statute: Vt. Stat. Ann. Tit. 30 §8001et seq.; House Bill 40

Virginia *– RPS est. in 2020*

- 100% by 2045 for Phase II utilities and 2050 for Phase I utilities
- Applicable to all utilities: Phase I utilities are required to achieve 14% by 2025, 30% by 2030, 65% by 2040, and 100% by 2050; Phase II utilities have an accelerated requirement of 26% by 2025, 41% by 2030, and 100% by 2045
- Enabling Statute: Va. Code §56-585.2; Senate Bill 851

Washington *– RPS est. in 2006*
- 15% by 2020, 100% by 2045
- Applicable to IOUs, municipal utilities, and cooperatives, and all serving 25,000+ customers
- Includes geothermal, solar, wind, biomass, and hydroelectric.
- Enabling Statute: Wash. Rev. Codes §19.285; §480-109; §194-37; Senate Bill 5116

West Virginia *– RPS est. in 2009; Repealed in 2015*
- 10% by 2015-2019, 25% by 2025
- Applicable to IOUs
- Enabling Statute: W. Va. Code §24-2F; Repeal: House Bill 2001

Wisconsin *– RPS est. in 1998*
- 10% by 2015
- Applicable to IOUs, municipal utilities, and cooperatives
- Includes geothermal, solar, wind, biomass, and hydroelectric.
- Enabling Statute: Wisc. Stat. §196.378.

Washington, D.C. *– RPS est. in 2005*
- 20% by 2020, 100% by 2032
- Applicable to IOUs and retail supplier
- Enabling Statute: D.C. Code §34-1431 et seq., Bill 650; Bill 904

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Tables

Table 1

State Amendments to RPS/CES Since 2018 (NCSL)

State	New RPS/CES Target	By Years
California	100%	2045
Colorado	100%	2050
Connecticut	44%	2030
Delaware	40%	2030
Maine	100%	2050
Maryland	50%	2030
Massachusetts	35%	2030
Minnesota	26.5%	2030
Nevada	100%	2050
New Jersey	50%	2030
New Mexico	100%	2045
New York	70%	2030
Oregon	100%	2040
Virginia	100%	2045/2050
Washington	100%	2045
Washington D.C.	100%	2032
Guam	100%	2045
Puerto Rico	100%	2050

Note: This came from analysis by NCSL

Table 2

States with Expired RPS/CES Up to 2021 (NCSL)

State	New RPS/CES Target	By Years	Fulfilled Percentage	Status
Iowa	1% (105 MW)	1990	3.6% capacity	Passed
South Dakota	10%	2015	26% sales	Passed*
Oklahoma	15%	2015	22% sales	Passed
North Dakota	10%	2015	26% sales	Passed
Wisconsin	10%	2015	8% sales	Failed
Montana	15%	2015	3% sales	Failed
Kansas	20%	2020	38% capacity	Passed
South Carolina	2%	2021	4% sales	Passed
Pennsylvania	18%	2021	55% sales	Passed
North Carolina	13%	2021	15% sales	Passed
Missouri	15%	2021	6%* sales	Failed

*Use of Implied Utility Target as 2021 data is not yet available

Table 3

States with 100% RPS/CES and Assessed Performance

State	RPS/CES Target	By Years	Projected Percentage (MW)	Status	Projected Percentage (MWh)	Status
California	100%	2045	99%	In Line	93%	In Line
Colorado	100%	2050	100%	In Line	91%	In Line
D.C.	100%	2032	76%	Below	59%	Below
Hawaii	100%	2050	100%	In Line	80%	Below
Maine	100%	2050	100%	In Line	100%	In Line
New Mexico	100%	2045	100%	In Line	98%	In Line
Nevada	100%	2050	86%	Below	82%	Below
New York	100%	2040	74%	Below	100%	In Line
Oregon	100%	2040	79%	Below	100%	In Line
Virginia	100%	2045	63%	Below	57%	Below
Washington	100%	2045	100%	In Line	98%	In Line

Table 4

Intermediate State RPS/CES and Assessed Performance

State	RPS/CES Target	By Years	Projected Percentage (MW)	Status	Projected Percentage (MWh)	Status
Arizona	15%	2025	31.00%	In Line	18.00%	In Line
California	33%	2020	51.00%	Achieved	43.00%	*Achieved*
Colorado	25%	2020	33.00%	Achieved	11.00%	Behind
Connecticut	44%	2030	41.00%	In Line	40.00%	In Line
D.C.	20%	2020	53.00%	Achieved	34.00%	*Achieved*
Delaware	40%	2035	36.00%	In Line	37.00%	In Line
Hawaii	30%	2020	30.00%	In Line	5.00%	Behind
Illinois	40%	2030	35.00%	In Line	31.00%	In Line
Indiana	10%	2025	26.60%	In Line	23.00%	In Line
Massachusetts	15%	2020	25.00%	Achieved	22.00%	*Achieved*
Maryland	31%	2020	10.00%	Failed	9.00%	Failed
Maine	80%	2030	75.00%	In Line	76.00%	In Line
Michigan	15%	2021	21.00%	Achieved	9.00%	Failed
New Hampshire	25%	2025	39.00%	In Line	51.00%	In Line
New Jersey	50%	2030	35.00%	Behind	28.00%	Behind
New Mexico	50%	2030	66.00%	In Line	56.00%	In Line
Nevada	22%	2020	36%	Achieved	30.00%	*Achieved*
New York	70%	2030	48.00%	Behind	84.00%	In Line
Ohio	9%	2026	19.00%	In Line	18.00%	In Line
Oregon	80%	2030	53.00%	Behind	93.00%	In Line
Pennsylvania	18%	2021	11.00%	Behind	57.00%	*Achieved*
Rhode Island	39%	2035	55.00%	In line	49.00%	In Line
Texas	8%	2025	39.00%	In Line	35%	In Line
Utah	20%	2025	30.00%	In Line	23%	In Line
Virginia	15%	2025	28.00%	In Line	13%	In Line
Vermont	75%	2032	100.00%	In Line	93%	In Line
Washington	83%	2020	81.00%	Achieved	76%	In Line

Table 5

Projected Net-Zero States Time Frame for IOUs

State	Year Projected Net Zero for Utility Portfolios	Year Projected Net Zero Electricity Sales
Vermont	2027	2034
South Dakota	2036	2049
Maine	2038	2038
Idaho	2039	2040
New Hampshire	2039	2036
Washington	2042	2048
New Mexico	2043	2046
Minnesota	2044	2046
Kansas	2045	X
Colorado	2046	X
California	2046	2049
Connecticut	2046	2047
Massachusetts	2047	2048
Hawaii	2047	X
Oregon	2049	2033