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Advancing America's Climate Leadership

Policy Options That Most Effectively Put Renewable Energy to Work

ACORE
AMERICAN COUNCIL ON RENEWABLE ENERGY

Acknowledgements

In developing the recommendations contained in this paper, ACORE consulted more than 50 prominent players in the renewable energy sector, including the pan-renewable collection of developers, manufacturers, financial institutions, electric utilities and major corporate electricity consumers participating in our Partnership for Renewable Integration and Market Expansion (PRIME) and Partnership for Renewable Energy Finance (PREF) executive programs. While this paper enjoys broad support among our members, not all ACORE members necessarily endorse every recommendation.

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About ACORE

The American Council on Renewable Energy (ACORE) is a national nonprofit organization that unites finance, policy and technology to accelerate the transition to a renewable energy economy. Founded in 2001, ACORE is the focal point for collaborative advocacy across the renewable energy sector, supported by members spanning renewable energy technologies and constituencies.

For more information, please visit www.acore.org.

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Executive Summary

Policymakers have a variety of tools at their disposal to help mitigate climate change and drive the deployment of emissions-free, renewable power. This paper examines notable climate policy approaches for their impact on renewable energy growth and investment, including a federal high-penetration renewable energy standard or clean energy standard, a technology-neutral tax credit, and carbon pricing regimes. To help lay the groundwork for implementation, we also offer policy design recommendations and identify complementary measures to ready the electric grid for the higher levels of renewable energy penetration necessary to achieve ambitious greenhouse gas (GHG) emission reductions.

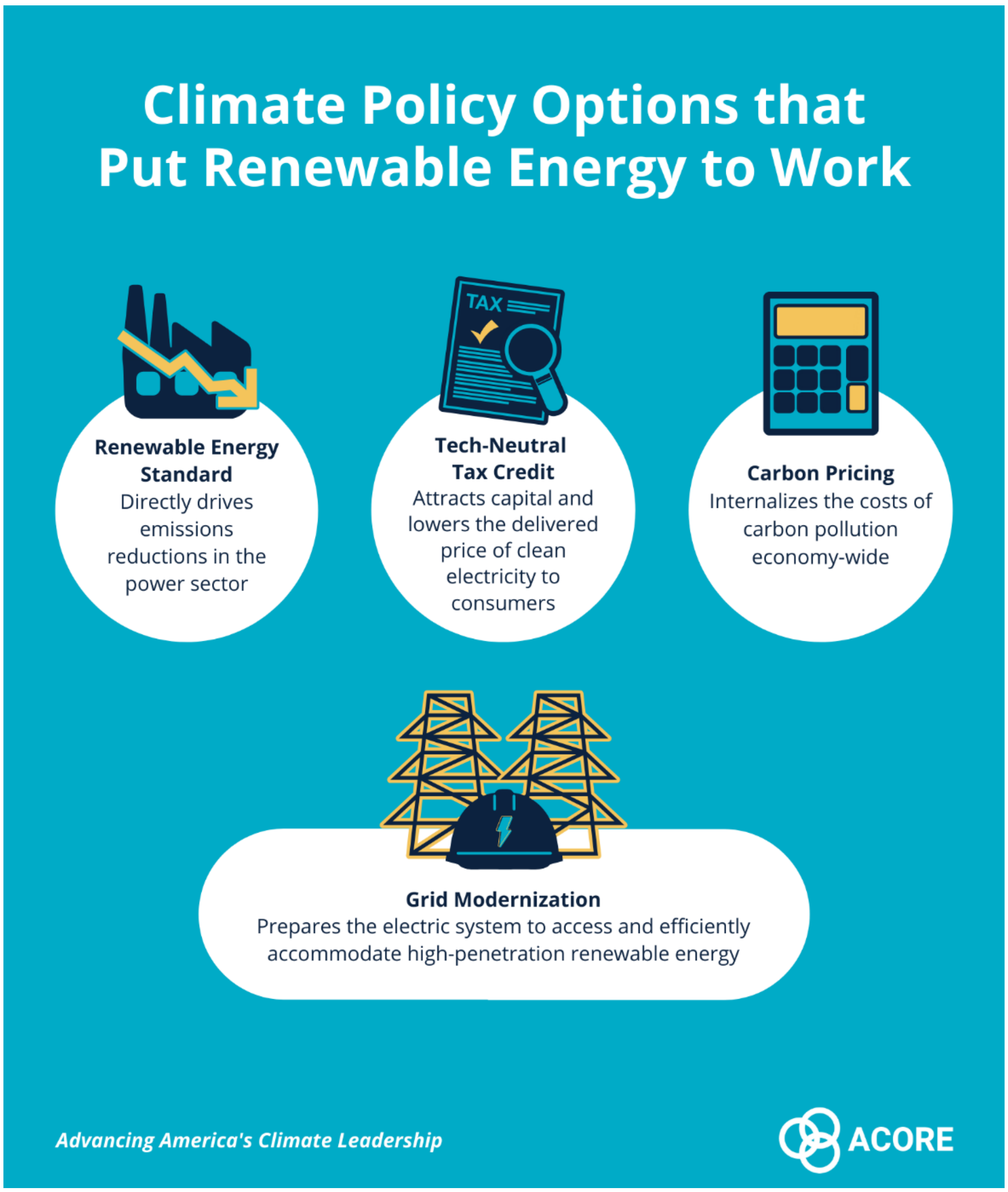
- A **federal high-penetration renewable energy standard (RES) or clean energy standard (CES)** would require a minimum percentage of renewable or zero-carbon energy in electricity supply companies' electricity sales, generating capacity or electricity purchases. A federal high-penetration RES or CES represents a direct and reliable way to ensure scientifically driven emissions reductions in the electricity sector. The history of successful state renewable energy standards indicates that the long-term market certainty provided by an RES can catalyze renewable energy investment and deployment. An effective program should respect ambitious state programs already in place, and carefully incentivize progress in states with limited renewable energy resources or deployment.

- A **technology-neutral tax credit for zero or low-carbon electricity generation** would simplify the tax code and incentivize the market to produce cost-effective climate outcomes, rather than technology-specific inputs. This approach could lower the delivered cost of clean energy to consumers, which could be especially useful in states with higher initial RES compliance costs, and help attract capital to renewable energy investment after the currently scheduled phasedown of existing wind and solar tax credits. A technology-neutral tax credit could also address the continued need for long-term parity in the tax code with fossil fuel generation by displacing the range of permanent incentives for emitting resources, which otherwise would work at cross-purposes with the policy goals of the new credit. The efficiency and impact of the credit can be enhanced through transferability or refundability.

- **Carbon pricing** internalizes the costs of carbon pollution and sends a powerful market signal to drive low- and zero-carbon solutions across the economy. The economy-wide reach of carbon pricing is essential for avoiding carbon leakage and associated price distortions. It also addresses the reality that more than two-thirds of U.S. carbon pollution comes from outside the electricity sector. However, if the goal of carbon pricing is to drive deployment of pollution-free renewable power to help meet mid-century climate goals, policymakers should take care to design a carbon pricing system that accomplishes that objective and avoids incentivizing the creation of new natural gas infrastructure that could become the next generation of stranded assets.

- Finally, we must **modernize our antiquated electrical grid** to better accommodate the growth of clean energy spurred by these climate policy options through improved transmission planning, enhanced transmission incentives, streamlined siting and permitting for renewable energy generation facilities, improved power markets, and increased measures to foster the growth of energy storage and advanced grid technologies.

In the end, the most effective scenario for transitioning to a renewable energy economy and achieving scientifically based reductions in GHG emissions will likely require a combination of these policy approaches. The national RES or CES provides the greatest certainty to investors and developers, and is fundamental to ensuring the rapid acceleration of renewable deployment called for by climate scientists. A technology-neutral tax credit levels the playing field in the tax code, helps attract needed investment and facilitates compliance with ambitious RES or CES targets by lowering the delivered price of renewable power. The economy-wide reach of effective carbon pricing is important to address the more than two-thirds of greenhouse gas pollution outside the electricity sector and guard against "carbon leakage" and other pricing distortions that could result from a single sector approach. And grid modernization – including expanded transmission capacity and the deployment of advanced grid technologies (especially energy storage) – will be necessary to access and accommodate high levels of renewable penetration at the lowest possible cost.



I. Introduction

The Intergovernmental Panel on Climate Change (IPCC) estimates that the global temperature is currently on track to rise 2.5-10⁰ Celsius (C) over the next century. Limiting global temperature rise to no more than 1.5⁰ C by mid-century is critical to avoid the worst impacts of climate change.[1] Achieving this objective is going to require dramatic reductions in total global greenhouse gas (GHG) emissions and rapid decarbonization of the world's electricity sector. The U.S. accounts for 15% of the world's total GHG emissions, making it the world's second largest emitter.[2] While only 28% of U.S. GHG emissions are attributable to the electricity sector,[3] the good news is that renewable energy and enabling grid technologies can deliver the emissions reductions science requires, while providing American businesses and consumers the abundant, affordable and reliable pollution-free power they want and deserve.

Today, 22% of America's 1,047.6 gigawatt (GW) utility-scale, electric generation capacity is renewable, while 67% of our electrical capacity produces GHG emissions.[4] In 2050, the U.S. Energy Information Administration projects that 60% of the generation mix will still produce GHG emissions. Replacing this projected emitting capacity with pollution-free renewable power will require nearly 30 GW of additional renewable capacity each year between 2020 and 2050, a roughly 50% increase above the current growth rate of U.S. renewables.[5]

This paper is designed to highlight the combination of smart, forward-looking policy tools that can achieve this goal in the fastest time frame, with the least disruption, at the lowest cost.

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[1] Intergovernmental Panel on Climate Change. "Impacts of 1.5ºC Global Warming on Natural and Human Systems." Accessed November 18, 2019 from https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf.

[2] U.S. Environmental Protection Agency. "Emissions by Country." Accessed November 1, 2019 from https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data#Country.

[3] U.S. Environmental Protection Agency. "Sources of Greenhouse Gas Emissions." Accessed November 1, 2019 from https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

[4] U.S. Energy Information Administration. "Annual Energy Outlook 2019." Accessed November 13, 2019 from https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf.

[5] The U.S. Energy Information Administration's 2019 Annual Energy Outlook projects an electric generation capacity of 1,475.3 GW in 2050 with 892.7 GW from emitting sources. The Outlook also projects continued double digit annual growth of renewable energy, including assumptions of renewable capacity retirements. 29.76 GW of additional annual renewable capacity construction is needed between 2020 and 2050 to replace EIA's 2050 projected emitting generation. This figure is conservative because it does not account for further potential policy changes that would favor non-emitting generation nor increased electric demand resulting from significant economy-wide electrification. It also assumes future renewable capacity factors on par with fossil generation as modern hybrid renewable-plus-storage power plants exhibit such characteristics. Accessed November 1, 2019 from https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf.

II. Establishing a Federal High-Penetration Renewable Energy Standard

A federal high-penetration renewable energy standard (RES),[6] or clean energy standard (CES),[7] is a direct way to drive the deployment of carbon-free electricity and provide market certainty for a low-carbon resource mix.

Existing state renewable mandates have been highly effective in promoting renewable energy investment and development.[8] A federal high-penetration RES or CES should respect effective state measures and could be structured to require states to develop and implement their own approaches to address state and regional resource and market differences. In states with lower existing deployment or fewer renewable resources, targets could be flexibly set consistent with needed emissions reductions to achieve climate objectives.

A. Federal Renewable and Clean Energy Standard Efforts

Federal RES legislation has been approved, on separate occasions, in both the U.S. House of Representatives and the U.S. Senate over the course of the past two decades.[9] Appendix A contains a comparison of recent national renewable and clean energy standard proposals.

A total of 29 states and the District of Columbia now have legally binding renewable or clean energy standards, and the level of ambition for state programs has accelerated dramatically in recent years.[10] In fact, 14 states and the District of Columbia now have 100% renewable or carbon-free energy mandates or goals (see Figure 1 below).

"A total of 29 states and the District of Columbia now have legally-binding renewable or clean energy standards, and the level of ambition for state programs has accelerated dramatically in recent years."

[6] A high-penetration RES is generally considered to be at or above 50% renewable energy.

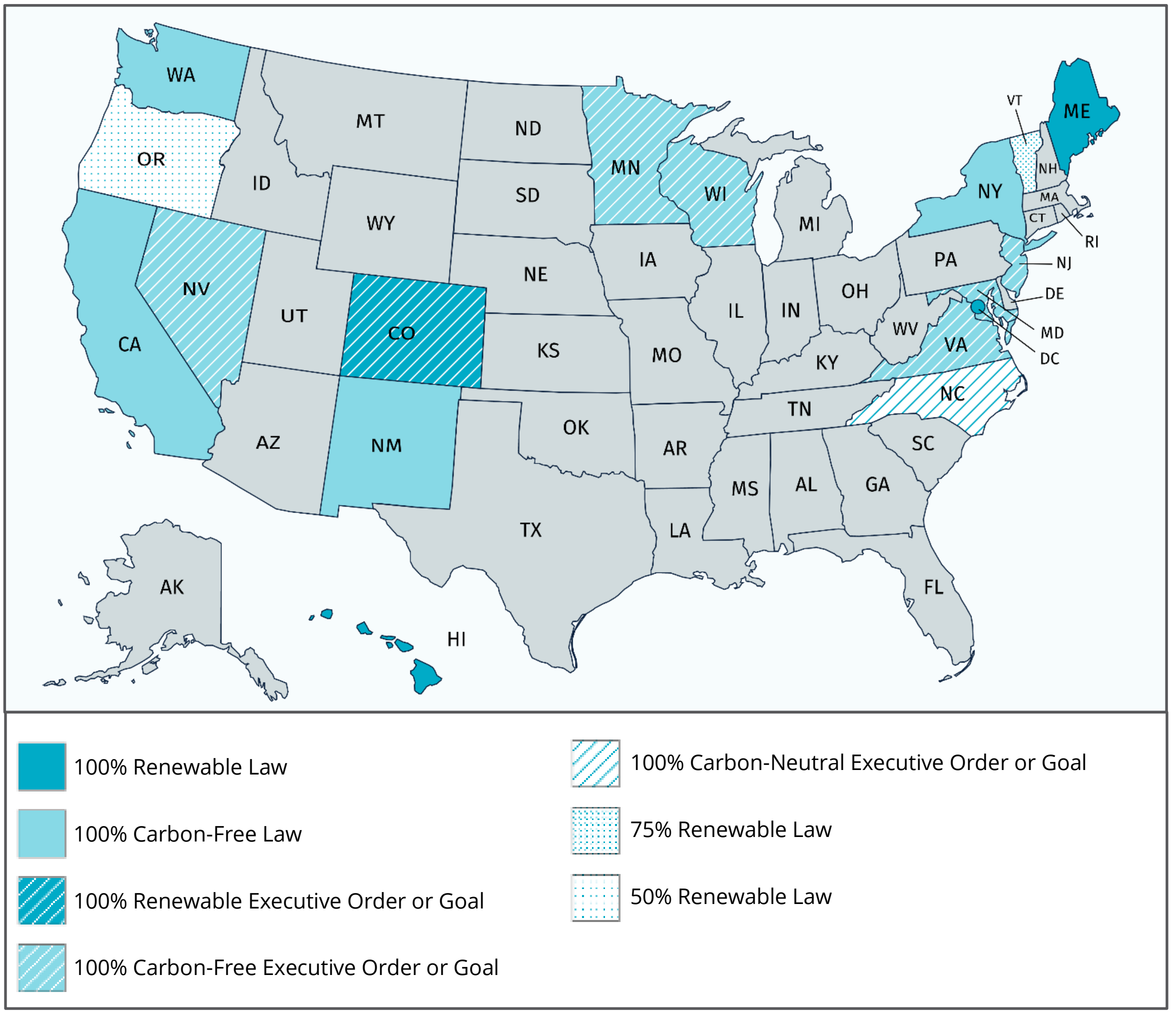
[7] Compared to a high-penetration RES, a high-penetration CES generally includes all technologies that meet specified carbon emissions or carbon intensity criteria, at or above 50% of total electricity generation.

[8] Wiser, R. et al. "A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards." National Renewable Energy Laboratory and Lawrence Berkeley National Laboratory. January 2016. https://www.nrel.gov/docs/fy16osti/65005.pdf

[9] *See* H.R. 4 – Energy Policy Act of 2002, 107th Cong. (as amended and passed by Senate, April 25, 2002); H.R. 6 – Energy Policy Act of 2005, 109th Cong. (as amended and passed by Senate, June 28, 2005); H.R. 2454 – American Clean Energy and Security Act of 2009, 111th Cong. (as passed by House, June 26, 2009)

[10] N.C. Clean Energy Technology Center. "Renewable Portfolio Standards and Clean Energy Standards." Accessed November 10, 2019 from https://www.dsireusa.org/resources/detailed-summary-maps/.

Figure 1: State High-Penetration Renewable and Clean Energy Standards[11]



B. Federal High-Penetration Renewable Energy Standard Key Considerations

A federal high-penetration renewable or clean energy standard may set annual benchmark targets for renewables as a proportion of the generation mix across the nation. However, an approach that does not consider the unique starting points of different states may disproportionately burden states with fewer renewable resources or lower renewable penetrations, which are likely to encounter higher initial costs of compliance. Conversely, it is important to also consider the possibility that compliance costs may increase as renewable penetration levels approach 100%. These cost dynamics will have to be equitably calibrated in any optimized RES or CES. To address these dynamics, a hybrid approach can set annual per-state renewable energy requirements that consider available renewable resources. These requirements can be keyed to a single national target and then taper the rate of annual increase as penetration levels approach 100%.

[11] Figure created by ACORE using MapChart.net on January 3, 2020. https://mapchart.net/usa.html

C. Federal High-Penetration Renewable Energy Standard Recommendations

The following are important features of any federal high-penetration RES or CES:

- Qualifying technologies should include wind, solar, hydropower, ocean, tidal, hydrokinetic, geothermal energy, and other zero-carbon renewable resources[12]
- The required percentage of compliant electricity should be at least 50%, on a timeline consistent with climate commitments, recommendations from scientific experts, and other policy goals[13]
- Annual RES state requirements should take into account differences in available renewable resources, starting deployment levels, and initial compliance costs
- Alternative Compliance Payments (ACPs) and penalties should be sufficient to achieve RES objectives
- A federal high-penetration RES should recognize, build upon, and not preempt successful state renewable energy standards[14,15]

[12] For high-penetration renewable energy standards, qualifying technologies should include existing zero-carbon renewable resources.

[13] Compliance obligations are typically placed on the suppliers of electricity.

[14] For further analysis and discussion on policy considerations for RES design, please see the October 2019 ACORE-Wilson Sonsini Goodrich & Rosati white paper *Enacting a Federal High-Penetration Renewable Energy Standard: Building on Proposals to Date and Addressing Important Additional Considerations*. Available at https://acore.org/acore-wsgr-res/.

[15] One potential RES or CES compliance mechanism is a forward clean energy market (FCEM) for clean electricity attributes, similar and complementary to existing markets for energy, capacity and ancillary services. Proposed in a white paper developed by the Brattle Group for NRG, a FCEM is a competitive wholesale market that allows interested purchasers of clean energy to fulfill their zero-carbon obligations with a market-based framework. White paper available at https://brattlefiles.blob.core.windows.net/files/17063_how_states_cities_and_customers_can_harness_competitive_markets_to_meet_ambitious_carbon_goals_-_through_a_forward_market_for_clean_energy_attributes.pdf.

III. Enacting a Technology-Neutral Tax Credit

A technology-neutral tax credit based on carbon emissions could complement a federal high-penetration RES or CES by attracting increased capital investment, accelerating renewable energy deployment and lowering the delivered price of clean energy to consumers. While renewable energy is a competitive source of power generation across the country, the ability of a technology-neutral tax credit to bring down consumer costs could be especially useful in states with fewer renewable resources or lower levels of initial deployment. Moreover, a technology-neutral credit could help level the playing field in the federal tax code, given that renewable tax credits are phasing down and out even as there are permanent law tax incentives for fossil fuel generation.

A. Previous and Proposed Key Renewable Energy Tax Incentives

The federal Production Tax Credit (PTC) and Investment Tax Credit (ITC) have been critical drivers in the financing and widespread deployment of wind and solar power. Indeed, renewables now comprise over 22% of total U.S. electric capacity and accounted for more than one-third of all newly built generating capacity in 2018.[16] However, absent any change in current policy, the PTC will phase out completely after 2020, and the ITC will phase out for residential uses and phase down to a permanent 10% rate for commercial and utility-scale projects after 2021.

In an effort to streamline the tax code and focus federal clean energy tax incentives on climate outcomes rather than technology-specific inputs, Sen. Ron Wyden (D-OR) has proposed a new technology-neutral tax credit based on carbon emissions.[17] The electricity title of the Clean Energy for America Act (S. 1288) would provide a minimum credit to any clean electricity facility that is at least 35 percent cleaner than the national average, with zero-emissions facilities receiving a production tax credit of up to 2.4 cents per kWh or an investment tax credit of up to 30%, at the election of the taxpayer. The PTC would be available for ten years after the facility is placed in service, and the credit in its entirety would phase out when emissions from the electricity sector fall to 50% below 2019 levels. Additionally, the Clean Energy for America Act would repeal a range of existing preferential incentives for fossil fuel companies, including the expensing of intangible drilling costs, percentage depletion, deductions for tertiary injectants, and credits for enhanced oil recovery and marginal oil wells.

[16] U.S. Energy Information Administration, *Preliminary Monthly Electric Generator Inventory*, May 2018. https://www.eia.gov/todayinenergy/detail.php?id=36092

[17] *See* S.1288 - Clean Energy for America Act. Available at https://www.congress.gov/bill/116th-congress/senate-bill/1288/

B. Technology-Neutral Tax Credit Recommendations

The Clean Energy for America Act is just one example of how a technology-neutral credit might be structured. The following are key features for any future technology-neutral tax credit:

- Qualifying technologies should include all current and future resources that meet emissions criteria, including enabling technologies like energy storage and expanded interstate, high-voltage transmission that accesses clean energy resources
- Emissions criteria and credit value should be established and allocated to achieve science-based climate outcomes
- Project developers should be given the choice of taking the credit as either a PTC or an ITC
- The credit should be permanent, or sunset only after policy objectives are achieved
- The credit should be transferable or refundable to enhance efficiency, utilization and impact
- Permanent law incentives for emitting resources should be eliminated so as not to work at cross-purposes with the policy goals of the new credit

IV. Pricing Carbon

By internalizing the costs of carbon pollution, carbon pricing can send a powerful market signal to drive low- and zero-carbon solutions across the entire economy. Key parameters for an effective carbon pricing regime include both the level of carbon price and its rate of increase.

The economy-wide reach of pricing carbon (and other GHGs) is especially important for addressing the more than two-thirds of GHG pollution that comes from outside the electricity sector, e.g., transportation, industry, commercial and residential, and agriculture.[18] An economy-wide application also helps avoid "carbon leakage" and its associated pricing distortions. For example, if carbon pricing were limited to the electricity sector, and did not include the transportation sector, the cost of charging electric vehicles would be increased to reflect the internalized cost of carbon in the electricity sector even as the absence of carbon pricing in the transportation sector would leave the cost of operating gasoline-fueled vehicles unaffected.

"Carbon pricing can send a powerful market signal to drive low- and zero-carbon solutions across the entire economy."

Not all carbon pricing proposals are created equal. Outcomes can vary depending on the initial carbon price and its annual rate of increase. Importantly, different prices and price trajectories can send market signals that could incentivize near-term activity whose long term impacts are not necessarily compatible with the original objectives of achieving long-term GHG emission reductions.

If the goal of carbon pricing is to accelerate the deployment of pollution-free renewable power to help meet mid-century emissions reduction targets, policymakers must take care to design a system that accomplishes that objective rather than, for example, simply prompting near-term fuel-switching from coal to natural gas. In the absence of other complementary climate policies that mitigate such an outcome, there is a risk that the wrong price structure could incentivize investment in new natural gas infrastructure that could become the next generation of stranded assets as we approach more ambitious carbon reduction goals post-2030.

A. Current Carbon Pricing Initiatives

Putting a price on carbon is not a new idea. As of October 2019, 57 carbon pricing initiatives covering 46 jurisdictions and 30 subnational jurisdictions, representing roughly 20% of global GHG emissions, have been implemented or are scheduled for implementation.[19] In the U.S, ten states, representing a quarter of the American population and one-third of GDP, currently have carbon pricing programs.[20] Over 3,500 economists

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[18] U.S. Environmental Protection Agency. "Sources of Greenhouse Gas Emissions." Accessed November 1, 2019 from https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

[19] World Bank. "Carbon Pricing Dashboard." Accessed November 1, 2019 from https://carbonpricingdashboard.worldbank.org/map_data.

[20] Center for Climate and Energy Solutions. "U.S. State Carbon Pricing Policies." Accessed November 1, 2019 from https://www.c2es.org/document/us-state-carbon-pricing-policies/.

recently endorsed carbon pricing as "the most effecive lever to reduce carbon emissions at the scale and speed that is necessary."[21]

A review of current and proposed carbon pricing systems reveals three basic approaches:

- **Carbon taxes** are direct taxes or fees levied on carbon emissions with the intent of discouraging such emissions and incentivizing lower- or zero-carbon alternatives. Carbon taxes can be economy-wide or sector-specific, and rates usually rise over time with the goal of achieving specific emissions reduction targets.
- **Cap and trade** programs work by capping allowable carbon emissions, which are represented by a fixed number of carbon allowances. Compliance obligations generally fall on a wide range of emitting sources above a defined threshold. Covered parties meet their compliance obligations by surrendering a number of allowances equal to their annual emissions in a given year, and are permitted to sell surplus allowances they do not need or buy extra allowances if they do. Caps generally decrease over time until emissions reduction goals are reached.
- **Cap and dividend** programs work by capping allowable carbon emissions, which are represented by a fixed number of carbon allowances. Compliance obligations often fall on a relatively limited number of upstream first sellers of fossil fuels into the marketplace. Covered parties meet their compliance obligations by purchasing a number of allowances equal to their annual sales (or emissions impact) of covered fuels, and are permitted to sell surplus allowances they do not need or buy extra allowances if they do. Caps generally decrease over time until emissions reduction goals are reached, and revenue from allowance sales is returned to citizens in the form of a pro-rata carbon "dividend."

Appendix B contains a comparison of carbon pricing proposals, including recent federal proposals and enacted state laws.

B. Carbon Pricing Levels

Increased penetrations of natural gas and renewables have already reduced GHG emissions in the electricity sector.[22] With carbon pricing, those reductions would be expected to accelerate. Where, by how much and for how long will depend on the carbon price selected.

The University of Texas at Austin's Energy Institute provides a new generation cost calculator with accommodations for carbon pricing.[23] Using the calculator, Figure 2 below displays estimates of least-cost new construction electricity generation for every U.S. county at four ascending levels of carbon pricing.[24]

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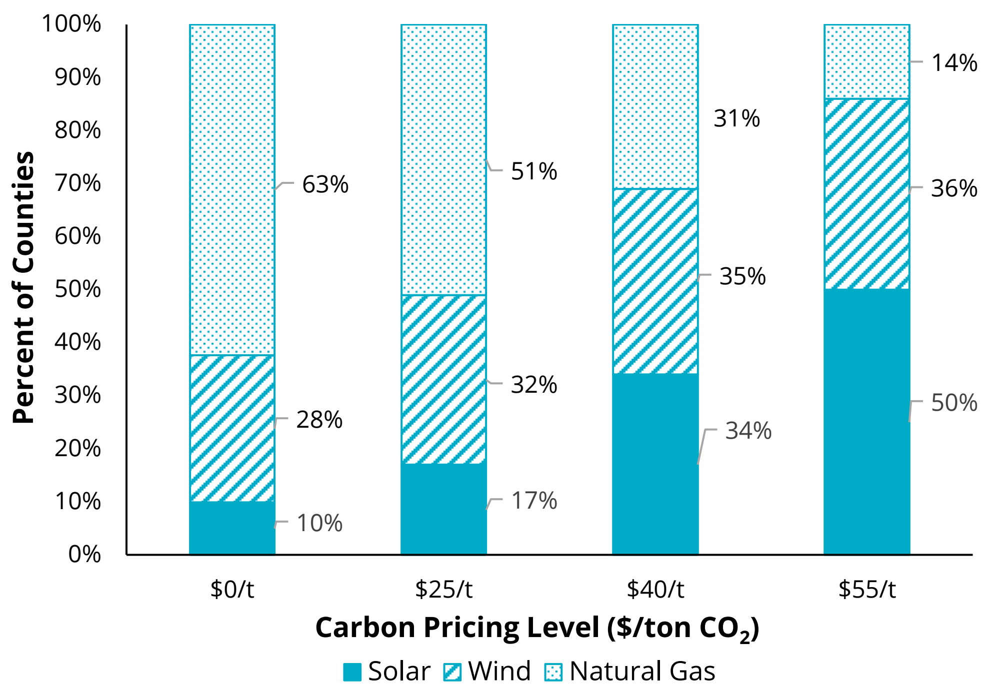
[21] Wall Street Journal. "Economists' Statement on Carbon Dividends." January 16, 2019. https://www.wsj.com/articles/economists-statement-on-carbon-dividends-11547682910

[22] U.S. Energy Information Administration. "Carbon dioxide emissions from the U.S. power sector have declined 28% since 2005." October 29, 2018. https://www.eia.gov/todayinenergy/detail.php?id=37392

[23] The University of Texas at Austin Energy Institute. "Levelized Cost of Electricity Map." Accessed November 2, 2019 from https://energy.utexas.edu/policy/fce/calculators.

[24] Note that these graphics use the assumptions in Rhodes et al., "A geographically resolved method to estimate levelized power plant costs with environmental externalities." March 2017. Monthly fuel costs (2007-2014) for coal and natural gas were taken from the U.S. Energy Information Administration's Form 923. Fuel costs for nuclear plants were taken constant across all regions at $0.70/GJ. Additionally, the

Figure 2: Least-Cost Energy Sources by Percent of U.S. Counties at Varying Carbon Pricing Levels[25]



Source: Created by ACORE using data from the University of Texas at Austin's Energy Institute "Levelized Cost of Electricity Map"

Under a business-as-usual baseline scenario at $0/ton CO_2, natural gas is the cheapest new generation source in 63% of counties, with renewables (wind or solar) least expensive in 38%. At $25/t CO_2, natural gas remains the cheapest resource in 51% of counties, with renewables (wind or solar) least expensive in 49%. At $40/t CO_2, wind or solar are the cheapest resource in 69% of counties, with natural gas still least expensive in 31%. Finally, at a carbon price of $55/t CO_2, natural gas is the least expensive new resource in 14% of counties, with renewables least costly in the remaining 86%. Appendix C contains a comparison of carbon pricing impact models by geography.

CAPEX and fuel price inputs are adjusted by regional multipliers as seen in the supplementary material of Rhodes et al. https://www.sciencedirect.com/science/article/pii/S0301421516306875 and U.S. Energy Information Administration. "*Form EIA-923 Detailed Data with Previous Form Data (EIA-906/920).*" https://www.eia.gov/electricity/data/eia923/

Technology	*Final Overnight Cost Assumption*	*Lifetime Assumption*	*Fuel Price Assumption*
Natural Gas	$820-2080/kW	35 years	$5.07/MMBtu
Coal	$4600-6000/kW	40 years	$2.16-3.17/MMBtu
Nuclear	$8000/kW	50 years	$0.70/MMBtu
Solar	$1100-7200/kW	25-30 years	N/A
Wind	$1520/kW	25 years	N/A

[25] Graphed using data from the University of Texas at Austin Energy Institute's "Levelized Cost of Electricity Map." Accessed November 2, 2019 from https://energy.utexas.edu/policy/fce/calculators.

It bears noting that the results of this analysis are based on comparing four separate carbon price points for a single hypothetical year. They therefore do not incorporate the starting price and annual rates of increase one would expect to find in any multi-year carbon pricing program. Additionally, the analysis does not consider the likelihood of cost changes for analyzed technologies over time, or the possibility that future transmission build-out could help move more cheap renewable power from where it is generated to the population load centers where it is consumed. Nevertheless, this analysis clearly underscores that the ability of carbon pricing to deliver on a policy goal of accelerating renewable energy deployment depends on the level of price, even as the price required to accelerate renewable energy deployment varies regionally.

Not surprisingly, the level of the carbon price and its annual rate of increase also affects the amount and timing of expected emissions reductions. Figure 3 below, graphed with data calculated by Resources for the Future's (RFF) Carbon Pricing Calculator,[26] compares projected emissions reductions from eight federal carbon pricing proposals against a business-as-usual scenario based on the U.S. Energy Information Administration's 2019 *Annual Energy Outlook* (AEO).[27] First-year carbon prices in these analyzed proposals range from \$15 to \$55, with annual rates of increase spanning <1% to 100%.

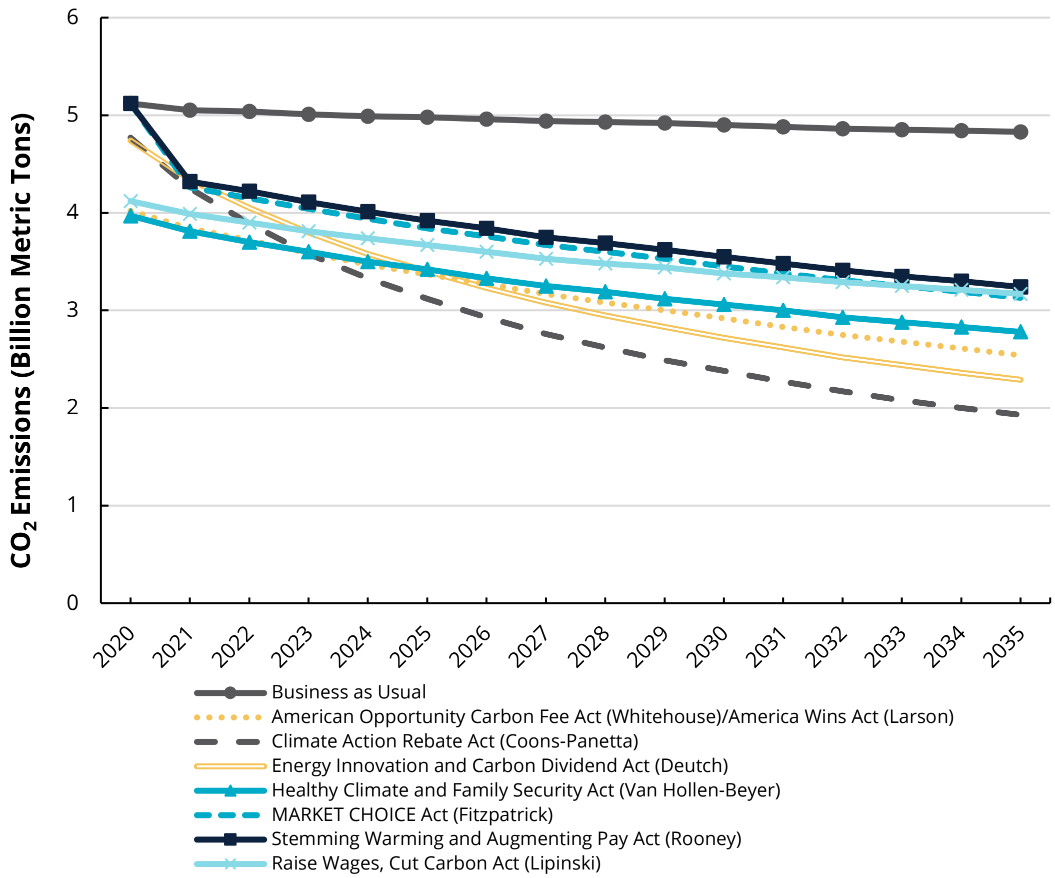
"While the initial carbon price can drive immediate and significant emissions reductions, a proposal's annual rate of increase can be the more important factor for driving long-term emissions reductions over time."

Virtually all compared proposals reduce carbon emissions over the next 15 years by more than 20%. With the highest starting price of \$55/t CO_2 and scheduled annual increases of 6%, the Healthy Climate and Family Security Act achieves the highest level of initial emissions reduction. However, the highest *total* emissions reduction over the modeled period goes to the Climate Action Rebate Act, which starts its carbon price at \$15/t CO_2 and increases it by \$15/year. While the initial carbon price can drive immediate and significant emissions reductions, a proposal's annual rate of increase can be the more important factor for driving long-term emissions reductions over time.

[26] Resources for the Future. "Carbon Pricing Calculator." https://www.rff.org/cpc/. The projections are based on the Goulder-Hafstead Energy-Environment-Economy E3 CGE Model, which utilizes 2013 benchmark data and solves for impacts at one-year intervals beginning in 2013. Carbon prices are imposed on all fossil fuels combusted within the U.S. and are based on the carbon content of these fuels. This model does not include non-CO_2 GHG emissions, non-energy-related CO_2 emissions, border adjustments, or changes in existing regulations although some proposals include such characteristics. RFF makes this material available under an Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) license. https://creativecommons.org/licenses/by-nc-nd/4.0

[27] U.S. Energy Information Administration. "2019 Annual Energy Outlook." https://www.eia.gov/outlooks/aeo/

Figure 3: Projected CO_2 Emissions by Select Carbon Pricing Legislation[28]



Source: Created by ACORE using data from Resources for the Future's "Carbon Pricing Calculator"

C. Carbon Pricing Considerations

Since energy is an unavoidable expense, putting a price on carbon could also, at least initially, have a disparate impact on lower-income households. To prevent that outcome, any equitable carbon pricing program should be designed to avoid economic regressivity. One possible solution is to return revenue from carbon pricing to citizens in the form of a pro-rata carbon "dividend."

Additionally, domestic carbon pricing, in the absence of a broader international agreement, could disadvantage American companies relative to their foreign competition operating in countries that do not price carbon. For that reason, any effective carbon pricing system should include border adjustment provisions to ensure American companies can continue to compete fairly in the global marketplace.

[28] Graphed using data from Resources for the Future's "Carbon Pricing Calculator." https://www.rff.org/cpc/. RFF makes this material available under an Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) license. https://creativecommons.org/licenses/by-nc-nd/4.0

D. Carbon Pricing and Stranded Assets

As we have seen, the effect that carbon pricing can be expected to have on the nation's resource mix will vary depending on the level of price. For that reason, any future carbon pricing program will need to be purpose-built for the policy outcome it is intended to achieve. If the goal of a carbon pricing program is to accelerate the deployment of pollution-free renewable power in order to meet scientifically-driven, mid-century climate targets, the level and trajectory of price in that program must take care to avoid sending price signals that primarily prompt near-term fuel-switching from coal to natural gas. While such fuel-switching could produce emissions reductions in the early going, it incentivizes the construction of new natural gas infrastructure whose continued emissions could undermine out-year reduction targets over time. These same natural gas facilities would therefore become the next generation of "stranded assets" that ratepayers could have to pay for twice.[29]

E. Carbon Pricing Recommendations

ACORE recommends the following principles for designing a durable, equitable and effective carbon pricing system:

- Carbon pricing should be economy-wide to drive maximum emission reductions, while avoiding "carbon leakage" and cross-subsidizing price distortions between sectors
- Carbon prices should be initially set and regularly adjusted on a predictable schedule consistent with scientifically-driven climate mitigation objectives to provide certainty for all stakeholders
- Carbon prices should be set at levels designed to encourage fuel switching from emitting resources to zero-emission resources, without incentivizing the creation of a new generation of stranded natural gas assets
- Carbon pricing policy should be politically sustainable, avoid regressivity, and include a border adjustment to maintain American companies' international competitiveness
- Federal carbon pricing policy should protect and build upon effective state renewable energy policies

[29] Utilities may have remaining years under a fossil fuel power purchase agreement for which they are responsible or must otherwise face a termination payment. These remaining amounts owed to investors, lenders and power plant owners in connection with uneconomic fossil fuel generation represent potential "stranded costs" that regulated utilities may seek to recover through retail customer rates, effectively causing consumers to pay twice for the same generating capacity. For more detailed analysis and discussion of stranded assets and their disposition, please see the October 2019 ACORE-Wilson Sonsini Goodrich & Rosati white paper *Enacting a Federal High-Penetration Renewable Energy Standard: Building on Proposals to Date and Addressing Important Additional Considerations*. https://acore.org/acore-wsgr-res/

V. Readying the Grid

While a federal high-penetration RES or CES, technology-neutral tax credit and carbon pricing can all be valuable policy tools for effectively addressing the climate crisis, no climate policy – or combination of policies – can be fully optimized without modernizing our antiquated electric grid. In order to transition to a 21st century clean energy economy, we need to significantly enhance transmission planning, overhaul transmission incentives, streamline siting and permitting for renewable generation facilities, improve power markets (including measures to foster the growth of energy storage), and implement new grid capabilities.

"No climate policy – or combination of policies – can be fully optimized without modernizing our antiquated electric grid."

A. Enhance Transmission Planning

FERC Order No. 1000 requires transmission providers to produce regional and interregional transmission development plans.[30] However, implementation efforts too often do not allow for the use of advanced technologies and grid optimization methods that could benefit the build-out of clean energy resources by increasing capacity at a lower cost. Current procedures also disincentivize transmission interconnection[31] and ignore benefits such as lowered delivered energy costs through new renewable integration.[32] FERC should revise Order No. 1000 to incentivize a more robust and efficient transmission system.[33] Additionally, Congress should clarify federal backstop siting authority by restoring Congressional intent of the Energy Policy Act of 2005, which would encourage and accelerate investment and development of needed transmission infrastructure when that infrastructure is in the national interest and advances the objectives of a comprehensive climate plan.[34]

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[30] FERC. *Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities*, Order No. 1000-A, Docket No. RM10-23-001 (Fed. Energy Reg. Comm'n). May 17, 2012

[31] For example, FERC Order No. 1000 requires interregional projects to be separately selected in the planning process for each RTO plus a joint RTO planning process. Projects which do not have clear benefits within a single RTO may not be selected in that RTO's planning process despite benefiting the nation as a whole. This issue is known as the "triple hurdle" problem of interregional transmission planning.

[32] ACORE. Comments on *Inquiry Regarding the Commission's Electric Transmission Incentives Policy*, Docket No. PL19-3-000 (Fed. Energy Reg. Comm'n). June 25, 2019

[33] This can be accomplished by incorporating advanced technologies and grid optimization in the planning process, ensuring more standard and broad cost allocation in light of regional benefits, and harmonizing cross-regional planning processes to increase inter-RTO transfer capability. Furthermore, FERC can designate a single point of contact for each project to accelerate review and decision-making. If planning and cost-sharing challenges can be overcome, studies have shown that greater grid interconnections – at least connecting the Eastern Interconnection and the Western Interconnection – will enable higher renewable penetration, lower consumer costs and enhance grid reliability. Nat'l Renewable Energy Lab., *Interconnection Seams Study Presentation*. July 2018. https://register.extension.iastate.edu/images/events/transgridx/TransGrid-X-pre-Symposium-document-from-NREL---web.pdf

[34] A National Priority Transmission Plan to integrate carbon-free resources in a timely and cost-effective manner is one option. Proactive regional and interregional planning with national climate awareness can augment existing planning processes to ensure that transmission access is not an impediment to zero-carbon resource penetration. Texas' Competitive Renewable Energy Zone, which brought abundant,

A 2016 Nature Climate Change study found that a large transmission network would be the most effective way for the nation to reach a wind and solar penetration of approximately 55%,[35] and a 2019 Brattle Group analysis concluded that "building transmission to access high quality but distant renewable resources is often more cost effective than making use of more local, but lower quality resources."[36] Models suggest that significantly expanded transmission in the form of high-voltage direct current (HVDC) transmission connecting optimal areas of wind and solar generation with areas of demand could reduce greenhouse gas emissions from the grid by 80 percent from 1990 levels without increasing consumer costs.[37] Beyond enabling new renewable resources to supply the grid, increased transmission capacity also improves the viability of repowering existing renewable facilities. These findings underscore how building out regional and interregional transmission can complement other climate policies by enabling greater, and more cost-effective, renewable energy penetration.[38]

B. Overhaul Transmission Incentives

The Energy Policy Act of 2005 required FERC to establish incentives for transmission that 1) promote cost-effective investment in reliability-improving transmission infrastructure, 2) provide a sufficient financial return to incent investment, 3) encourage the deployment of transmission technology enhancements, and 4) allow the recovery of prudently incurred costs by transmission providers. In response, FERC started awarding incentives on the basis of special risks or challenges incurred by a project. To stimulate private-sector investment with minimal regulatory reform, FERC should shift from a risks and challenges framework, which encourages costly and risky projects, to a benefits framework, which would incentivize projects in line with their consumer value.

C. Streamline Siting and Permitting for Renewable Energy Generation Facilities

To supply a modern grid with renewable energy at levels able to meet climate mandates, siting and permitting regulations for renewable generation facilities need to be streamlined. The development of renewable energy generation facilities on both public and private lands is frequently subject to extensive delays and cost

low-cost wind power from West Texas to load centers in East Texas, is one successful model. While existing stakeholders would continue shouldering most of the cost, the National Priority Transmission Plan should include an appropriation of federal funds for national priority transmission infrastructure projects that advance climate objectives.

[35] A. MacDonald et al., *Future cost-competitive electricity systems and their impact on US CO_2 emissions*, Nature Climate Change. January 2016. https://www.nature.com/articles/nclimate2921

[36] WIRES, *The Coming Electrification of the North American Economy: Why We Need a Robust Transmission Grid* 13-14. March 2019. https://wiresgroup.com/wp-content/uploads/2019/03/Electrification_BrattleReport_WIRES_FINAL_03062019.pdf

[37] A. MacDonald et al., *Future cost-competitive electricity systems and their impact on US CO_2 emissions*, Nature Climate Change. January 2016. https://www.nature.com/articles/nclimate2921

[38] Moreover, well-designed transmission provides large and diverse additional benefits, including more competitive and cost-effective electricity markets, heightened grid resilience and increased grid reliability.

increases stemming from the federal approval process.[39] With that in mind, federal policymakers should consider the following siting and permitting improvements:

- Ensure that multi-agency environmental reviews and authorizations are performed in a manner that is concurrent, synchronized, timely and efficient, and use optimal interagency coordination
- Better facilitate agency use of environmental studies, analysis, and decisions in prior federal, state, tribal or local National Environmental Policy Act (NEPA) actions
- Ensure that NEPA actions are performed in a timely manner and that timelines are enforced in a way that provides an adequate level of certainty for renewable energy investors and developers
- Ensure that impacts on GHG emissions are considered as part of siting and permitting, including under NEPA
- Improve predictability and transparency in NEPA reviews and authorizations

D. Improve Power Markets

"Allowing climate externalities to escape inclusion in pricing constitutes an out-of-market subsidy for emitting resources paid for by Americans at large."

FERC regulates the wholesale energy markets serving two thirds of Americans, and Congress has directed FERC to enforce "just and reasonable rates" for energy in these markets through the Federal Power Act. For rates to be just and reasonable, they must internalize the real costs of generation, including the cost of emissions.[40] Allowing climate externalities to escape inclusion in pricing constitutes an out-of-market subsidy for emitting resources paid for by Americans at large.[41] FERC should also improve wholesale energy market rules to enable

[39] For example, projects on private lands, based on their location, may trigger review and planning processes under the Endangered Species Act (ESA) that would be subject to National Environmental Policy Act (NEPA) compliance. Delays caused by the protracted NEPA process in issuing Incidental Take Permits under the ESA can slow or halt the development of renewable projects or force completed projects to operate at a fraction of total capacity to remain in compliance, thereby reducing the overall contribution of renewable energy into the nation's electrical grid. Larger-scale land management planning, such as the creation of the Desert Renewable Energy Conservation Plan, also triggers NEPA review and delays that can be costly for numerous potential projects. Whether it be the installation of an individual generation facility or broader regional planning, improving efficiencies in the NEPA process can have a significant impact on renewable energy and infrastructure investments nationally. A lack of certainty and lengthy periods or delays in the NEPA process can greatly increase overall costs and can even prevent viable projects from reaching fruition. Improvements in process efficiency reduce project costs and uncertainty, encouraging private development.

[40] These policies have a significant influence on the direction of the nation's generation mix and can be effective tools to drive emissions reductions in the power sector.

[41] FERC should approve climate-aware market designs administered by wholesale energy market operators. For example, energy markets may file for FERC approval of carbon adders in their markets, an electricity-specific form of carbon pricing that factors the negative climate externalities of carbon-intensive generation into market price signals. Most recently, the New York Independent System Operator (NYISO) has considered such a proposal. Implementing climate-aware market designs would promote competitive low-cost emissions reductions consistent with existing markets and consumer interests. Conversely, FERC should reject market designs that negate state climate initiatives. For example, FERC recently approved a proposal from the PJM market to modify its capacity auction rules, raising the price of certain resources, all zero-carbon, on the basis of alleged state support for their operation. The Commission's majority claims this decision levels the capacity auction playing field for non-subsidized, polluting resources, but it in fact recreates economic externalities that states appropriately price.

greater deployment of multi-renewable, renewable-plus-storage, and standalone storage sources, as power producers are increasingly interested in deploying projects that combine the unique benefits of multiple forms of generation and increase project capacity factors.[42]

E. Implement New Grid Capabilities

New grid capabilities that enhance capacity and increase reliability can be unlocked with pilot programs, Department of Energy (DOE) and National Laboratory studies, and other mechanisms designed to enable more efficient interaction among resources at the transmission and distribution system levels. For example, simplified participation of distribution system operators, demand response aggregators, or customers in the overall power system may help to counter variability in transmission system-level renewable generation.[43] While distribution-level management is historically outside the federal government's purview, a comprehensive federal climate plan could nevertheless prove an appropriate vehicle for encouraging DOE or others to start studying and testing the possibilities of such a system.

[42] To fill the gap between FERC Order No. 841 (energy storage participation in markets) and Order No. 845 (project interconnection to the grid), the Commission should clarify the ability of storage to join operating renewable projects and projects in interconnection queues without causing those projects to exceed their studied power injection limits or lose their queue positions.

[43] L. Kristov, P. De Martini, and J. Taft, *A Tale of Two Visions: Designing a Decentralized Transactive Electric System*, IEEE Power and Energy Magazine, Volume: 14, Issue: 3, May-June 2016

VI. Conclusion

While climate policy measures should be realistically crafted with the legislative and political landscape in mind, we urge lawmakers and climate advocates to consider the recommendations contained in this paper when determining the contours of efforts to reduce GHG emissions. The policy approaches discussed here – a federal high-penetration RES or CES, a technology-neutral tax credit, effective carbon pricing and measures to modernize and expand America's electrical grid – all have potentially important roles to play in the transition to a renewable energy economy that lies at the heart of any effective climate response.

Policy development is a dynamic process, and we welcome further input on the contours of these and other important climate policy options. As a focal point for thought leadership across the renewable sector, ACORE strives to provide the analysis, information and commentary needed to realize renewable energy's critical role in solving the climate crisis.

VII. Appendices

A. Renewable and Clean Energy Standard Proposals Compared

	Qualifying Technologies	Required Percentage of Compliant Electricity	Trading/ Banking/ Borrowing	Alternative Compliance Payments (ACPs)	Penalties	Interaction with State Programs
The American Clean Energy and Security Act of 2009 (Waxman-Markey)	Combined efficiency and renewable electricity standard. Qualifying technologies include wind, solar, geothermal, qualifying renewable biomass, biogas from renewable biomass, biofuel from renewable biomass, qualified hydropower, marine and hydrokinetic renewable energy, landfill gas, wastewater treatment gas, coal mine methane, and qualified waste-to-energy.	Retail electricity suppliers required to achieve 6% renewable energy in 2012, which gradually increases to 20% in 2021 and thereafter. Energy efficiency can constitute up to 25% of total annual requirement, or up to 40% of total annual requirement upon an approved request from a state. While one (1) Federal renewable energy credit (REC) is issued for each megawatt hour of qualifying renewable energy generation, distributed renewable energy generation facilities receive three (3) Federal RECs for each megawatt hour generated.	Trading of Federal RECs is permitted. Federal RECs can be banked for up to three (3) years.	$25/megawatt hour, adjusted annually for inflation. ACPs sent back to states in proportion to where they were generated and required to be used for deploying technologies that generate electricity from renewable sources and implementing cost-effective energy efficiency programs.	Failure by an electric utility to comply with its annual RES requirement or make an applicable ACP results in a penalty equal to its requirement shortfall multiplied by 200% of the ACP.	No preemption of State laws regarding renewable electricity, energy efficiency, or any other law, including environmental and licensing requirements. Additionally, States retain the authority to adopt renewable energy incentives. When implementing the Federal program, FERC is directed to incorporate best practices of State programs, rely on State and regional tracking systems, and coordinate with States to minimize burden and costs to retail electricity suppliers.
The Clean Energy Standard Act of 2010 (Graham)	Combined clean energy and energy efficiency standard. Qualifying technologies include solar, wind, geothermal, ocean, qualified biomass, landfill gas, qualified hydropower, marine, hydrokinetic, incremental geothermal, coal-mined methane, qualified waste-to-energy, qualified nuclear, advanced coal generation, eligible retired fossil fuel generation, and other clean energy technologies as determined by the Secretary of Energy.	Retail electricity suppliers required to achieve 13% clean energy in 2013-2014, 15% from 2015-2019, 20% from 2020-2024, 25% from 2025-2029, 30% from 2030-2034, 35% from 2035-2039, 40% from 2040-2044, 45% from 2045-2049 and 50% in 2050. Energy efficiency can be used to meet up to 25% of annual requirements. CECs are issued for each kWh of clean energy generated. Multiple credits are awarded for clean energy generated on Indian land, distributed clean energy generation, and the first five (5) advanced or retrofitted coal generation facilities.	Trading of Federal Clean Energy Credits (CECs) is permitted. Federal CECs can be banked without limitation. Federal CECs can be borrowed for up to three (3) years, with approval from the Secretary of Energy.	$35/megawatt hour, adjusted annually for inflation, subject to utility waiver petitions. ACPs are sent to back to states in proportion to the retail suppliers' base quantity of electricity in each state to increase clean energy production, promote the deployment and use of electric vehicles, and offset consumer costs through direct grants or energy efficiency investments.	Failure by an electric utility to comply with its annual CES requirement or make an applicable ACP results in a penalty equal to its requirement shortfall multiplied by 200% of the ACP. Federal penalties are reduced by amounts paid for failure to comply with State law, if the State requirement is more stringent than the Federal requirement. Federal penalties may be reduced to limit rate impact on consumers. Federal penalties may be waived if compliance failure was outside of utility's reasonable control.	No preemption of State laws regarding clean energy, energy efficiency, or the regulation of electric utilities. The Secretary of Energy is directed to promulgate regulations such that a utility's compliance with a state RES or CES would generate corresponding Federal CECs in an amount equal to the quantity of clean energy generated. The Secretary of Energy is directed to facilitate coordination between the Federal program and State clean energy and energy efficiency programs to the maximum extent practicable.

	Qualifying Technologies	Required Percentage of Compliant Electricity	Trading/ Banking/ Borrowing	Alternative Compliance Payments (ACPs)	Penalties	Interaction with State Programs
		Partial CECs are awarded for eligible retired fossil fuel generation.				
The Clean Energy Standard Act of 2012 (Bingaman)	For facilities placed in service after December 31, 1991, qualifying technologies include solar, wind, ocean, current, wave, tidal, geothermal, qualified renewable biomass, natural gas (excluding landfill methane and biogas), hydropower, nuclear and qualified waste-to-energy. For facilities placed in service after date of enactment, additional qualifying technologies include qualified combined heat and power, qualified efficiency improvements or capacity additions, carbon capture and sequestration, and any source of energy (other than biomass) with a carbon intensity of less than .82 MTC02e per megawatt-hour.	Retail electricity suppliers required to achieve 24% clean energy in 2015, with a three (3) percentage point annual increase each year thereafter, until 84% clean energy is reached in 2035. CECs are issued to utilities based on number of megawatt hours sold with a carbon intensity of .82 MTC02e or less. A utility that sells electricity from hydropower or nuclear power placed in service before December 31, 1991 may reduce their applicable clean energy requirement by the amount of electricity so generated.	Trading of Federal CECs is permitted. Federal CECs can be banked without limitation.	$30/megawatt hour, increased by 5% each year starting no later than 2016, and also adjusted annually for inflation, as deemed necessary by the Secretary of Energy. ACPs used to fund a State Energy Efficiency Program. Without further appropriation or fiscal year limitation, 75% of ACPs returned to States in proportion to amounts collected from each State for implementation of State energy efficiency plans.	Failure by an electric utility to comply with its annual CES requirement or make an applicable ACP results in a penalty equal to its requirement shortfall multiplied by 200% of the ACP. Penalties used to fund a State Energy Efficiency Program. Without further appropriation, 75% of penalty funds returned to States in proportion to amounts collected from each State for implementation of State energy efficiency plans. Federal penalties are reduced by amounts paid for failure to comply with State law, if the State requirement is more stringent than the applicable Federal requirement.	No preemption of state laws regarding clean or renewable energy, or the regulation of electric utilities. The Secretary of Energy is directed to facilitate coordination between the Federal clean energy program and relevant State and clean and renewable energy programs to the maximum extent practicable.
The Clean Energy Standard Act of 2019 (Smith-Luján)	Qualifying technologies include solar, wind, ocean, current, wave, tidal, geothermal, qualified renewable biomass, hydropower, nuclear, qualified waste-to-energy, qualified low-carbon fuels, qualified combined heat and power systems, qualified carbon capture and storage, and any other source of electricity that does not exceed .4 MTC02e per megawatt-hour.	Retail electricity suppliers over 2 million MWh required to increase clean electricity by 2.75% annually until clean energy delivered to customers hits 60%, 1.75% annually until clean energy delivered to customers hits 90%, and, starting in 2040, 1% annually until clean energy delivered to customers hits a maximum of 100%. Retail suppliers under 2 million MWh required to increase clean electricity 1.5% annually. Annual clean energy percentage increase requirement may vary within 0.5% depending on price of Alternative	Federal CECs can be banked for up to two (2) years after the CEC is issued. After 2040, banking is permitted for only one year after the year of issue. After 2050, Federal CECs are only valid for their year of issue.	$30/megawatt hour, increased by 3% annually through 2029 and then by 5 percent annually, and adjusted annually for inflation, as deemed necessary by the Secretary of Energy. ACPs are directed to a State energy efficiency, clean energy deployment and electric consumer bill program. Without further appropriation or fiscal year limitation, 75% of ACP funds are used to implement State energy efficiency plans, conduct State clean energy programs and carry out incentives to reduce electricity bills for households below	Failure by an electric utility to comply with its annual CES requirement or make an applicable ACP results in a penalty equal to its requirement shortfall multiplied by 200% of the ACP. Penalties are directed to a State energy efficiency, clean energy deployment and electric consumer bill program. Without further appropriation or fiscal year limitation, 75% of penalty funds are used to implement State energy efficiency plans, conduct State clean energy programs and carry out incentives to reduce electricity bills	No preemption of state laws regarding clean or renewable energy, or the regulation of any retail electricity supplier. The Secretary of Energy is directed to facilitate to coordination between the Federal clean energy program and relevant State clean and renewable energy programs to the maximum extent practicable.

	Qualifying Technologies	Required Percentage of Compliant Electricity	Trading/ Banking/ Borrowing	Alternative Compliance Payments (ACPs)	Penalties	Interaction with State Programs
		Compliance Payments and Clean Energy Credits. While one Federal CEC is issued for each megawatt-hour of clean energy generation, multiple credits are awarded for qualified dispatchable low- and zero-emission technologies. Emitting resources can receive partial credit based on carbon intensity.		300 percent of the poverty line.	for households below 300 percent of the poverty line. Federal penalties are reduced by amounts paid for failure to comply with State law, if the State requirement is more stringent than the Federal requirement. Federal penalties may be waived if compliance failure was outside the retail electricity supplier's reasonable control.	
The National Renewable Electricity Standard Act of 2019 (Udall)	Qualifying technologies include solar, wind, ocean, tidal, geothermal, renewable biomass, landfill gas, incremental hydropower, and hydrokinetic energy.	Retail electricity suppliers over 1 million MWh required to increase their base quantity of electricity generated by renewable energy by 1.5% in 2020, 2% annually from 2021-2029, and 2.5% annually from 2030-2035. Retail electricity suppliers that sell under 1 million MWh required to increase their base quantity of electricity generated by half the annual increase above. While one (1) Federal REC is awarded for each new kWh of electricity generated from a renewable resource, two (2) Federal RECs are issued per kWh of new renewable electricity generated on Indian Land or in impacted communities.	Trading of Federal RECs is permitted, unless the Federal REC was issued as a result of having complied with a more stringent State program. Federal RECs can be banked for up to three (3) years. Federal RECs can be borrowed for up to three (3) years, with approval from the Secretary of Energy.	$30/megawatt hour, adjusted annually for inflation, or 200 percent of the average market value of Federal RECs for the applicable compliance period. ACPs are deposited into a State renewable energy account and, subject to appropriations, used to provide grants to State agencies responsible for promoting renewable energy generation or State energy conservation plans.	No provision.	States may opt-out if more than 60% of their electricity is generated from new or existing renewable resources, or if the annual percentage increase requirement for renewable energy and the mechanisms needed to enforce the requirement are at least as stringent as the federal RES. Retail electricity suppliers in States that have opted out may not receive federal program RECs. Payments made to comply with State RESs count towards Federal compliance based on the quantity of electricity generated from renewable resources. No preemption of state laws regarding renewable energy that do not conflict with the Federal RES. The Secretary of Energy is directed to preserve the integrity of State programs and facilitate coordination between the Federal program and State programs.

B. Carbon Pricing Proposals Compared

Federal Proposals	Mechanism	Pricing Levels	Emissions Goals	Other Features
Energy Innovation and Carbon Dividend Act (Deutch - 2019)	Carbon fee on the sale or emitting use of crude oil, natural gas, coal or byproducts that release GHGs into the atmosphere. Fee refunds available for carbon verifiably captured and permanently sequestered. Exempts agriculture and the military.	Initial price of $15/ton based on the GHG content of covered fuel, with $10 annual increases adjusted for inflation and subject to further modification based on emissions reductions achieved.	90% below 2016 levels by 2050.Uses 2016 GHG emissions as baseline.	Does not preempt state law. Includes border adjustment. Separate fee on fluorinated GHGs. Suspends specified federal regulation of GHGs. Returns revenue to eligible individuals on a pro-rata basis every month in the form of a carbon dividend.
Baker-Shultz Carbon Dividends Plan (2018)	Carbon fee.	Initial price of $40/ton with annual increases of 5% above inflation.	50% below 2005 levels in 2035.	Includes border adjustment. Preempts all current and future federal stationary source carbon regulations so long as carbon fee is in effect. All net proceeds from carbon fee returned on an equal and quarterly basis in the form of carbon dividend.
Modernizing America with Rebuilding to Kickstart the Economy of the Twenty-first Century with a Historic Infrastructure-Centered Expansion (MARKET CHOICE) Act (Fitzpatrick - 2019)	Carbon tax on fossil fuels produced or imported into the United States based on CO2 equivalent of GHGs released from combustion. Exemptions for carbon capture and sequestration and non-combustible uses. Refunds for demonstrated reduction or elimination of emissions of a covered fuel over the lifetime of a product in which it was used. Credits given for GHG payments under state law.	Initial price of $35/ton, with annual increases of 5% above inflation. Additional $4/ton in the calendar year after an annual emissions goal is not met.	38% below 2005 levels in 2030.	Does not preempt state law. Includes border adjustment. Separate tax on GHG emissions from certain industrial processes and product uses. Moratorium on federal greenhouse gas regulation related to emissions covered under the Act. Moratorium lifted in 2033 if emissions reduction targets are not achieved. Eliminates federal motor vehicle and aviation fuel taxes. Modifies tax credits for advanced coal projects and CCS. Revenue allocated to federal highway trust fund, grants to low-income households and other specified energy, environmental, infrastructure and R&D priorities.

Federal Proposals	Mechanism	Pricing Levels	Emissions Goals	Other Features
Climate Action Rebate Act (Coons-Panetta - 2019)	Carbon fee on crude oil, natural gas, coal, solid biomass and byproducts that emit GHGs into the atmosphere. Exemptions for non-emitting use, and payments for qualified carbon capture.	Initial price of $15/ton based on the GHG content of the covered fuel, with annual increases of $15 (or $30 if emissions redution targets are not met).	90% below 2017 levels by 2050.	Does not preempt state law. Includes border adjustment. Separate fee for fluorinated GHGs. 70% of proceeds rebated back to eligible individuals every month on a pro-rata basis in the form of a carbon dividend. Dividend eligibility phases out for AGI over $130,000 for joint returns and AGI over $80,000 for individual returns. 30% of proceeds used for investment in infrastructure, energy innovation and assistance to workers in the transition to a clean energy economy.
Healthy Climate and Family Security Act (Van Hollen-Beyer - 2019)	Reqires the first sellers of crude oil, coal, natural gas and emitting byproducts to purchase carbon permits at quarterly auction corresponding to the MTCO2 contained in their covered fuel sold. Exemption for non-emitting use. One carbon permit awarded for each MTCO2 verifiably captured and sequestered.	Price of carbon permits determined at quarterly auction. Quantity of carbon permits made available at auction set by annual caps on total carbon emissions that decline every year. Trading carbon permits and banking carbon permits for future years is permitted under specific conditions. The Treasury is authorized to sell carbon permits from future years if necessary to stablize auction prices.	80% below 2005 levels by 2040.	Does not preempt state law. Includes border adjustment. Uses federal regulatory authority to reduce non-carbon GHGs Proceeds returned to eligible indiividuals on a pro rata basis in the form of a quarterly Healthy Climate Dividend, which are not included in gross income.
American Opportunity Carbon Fee Act (Whitehouse - 2019)	Carbon fee on coal, petroleum products and natural gas. Refunds available for carbon verifiably captured and disposed or utilized.	Initial price of $52/ton based on the C02 emitted by covered fuels. Price is adjusted by inflation in years after emissions reductions goals are met and by inflation plus 6% in years after emissions reductions goals are not met.	80% below 2005 levels.	Includes border adjustment. Separate fee on fluorinated GHGs and certain facilities that emit GHGs. Revenue returned to eligible individuals in the form of a Carbon Fee Offset Credit equal to the lesser of 6.2% of earned income or $900 (twice for joint returns). Provides grants to states to assist in transition to low-carbon economy.
Stemming Warming and Augmenting Pay (SWAP) Act (Rooney - 2019)	Carbon tax on coal, petroleum products and natural gas. Exemptions for noncombustive uses and carbon capture and storage. Credit given for GHG payments under state law. Credit for state payments phased out after four years.	Initial price of $30/ton of $MTCO_2e$, with annual increases of 5% over inflation, plus an extra $3/ton in the year folllowing any year where emissions goals are not met.	46% below 2005 levels by 2032.	Includes border adjustment. Separate tax for GHGs from certain industrial processes and product uses. Moratorium on federal greenhouse gas regulation related to emissions covered under the Act. Moratorium expires in 2034. 70% of revenue used to reduce payroll taxes.,10% for additional payments to Social Security beneficiaries, and 20% for state block grants to offset higher energy costs for low-income households, climate adaptation, energy efficiency, carbon sequestration and R&D.

Federal Proposals	Mechanism	Pricing Levels	Emissions Goals	Other Features
Raise Wages, Cut Carbon Act (Lipinski - 2019)	Carbon tax on taxable carbon substances including coal, petroleum products and natural gas. Refund for non-emitting use, carbon capture and sequestration, or if previously taxed	Initial price of $40/ton based on carbon emissions of a covered fuel. Price is adjusted by inflation in years after emissions reductions goals are met and by inflation plus 2.5% in years after emissions reductions goals are not met.	80% below 2005 levels	Includes border adjustment. Separate tax on fluorinated GHGs. Moratorium on federal greenhouse gas regulation related to emissions covered under the Act. Administrator may lift moratorium in 2030 if deemed necessary to bring GHG emissions at or below levels that would have occurred if the moratorium had never taken effect. Supermajority vote required to change revenue neutrality in bill. 84% of revenue for payroll tax offsets, 10% for SS beneficiary payments, 5% for LIHEAP and 1% for the Weatherization Assistance Program.
America Wins Act (Larson - 2019)	Carbon tax on taxable carbon substances including coal, petroleum and natural gas. Refund for non-emitting use, carbon capture and sequestration, and if previously taxed carbon substance is used to make another taxable carbon substance.	Initial price of $52/ton on the carbon dioxide content of the covered fuel, which increases by inflation plus 6% annually.	Not specified.	Includes border adjustment. Revenue goes to Build America Trust fund for investment in highways and transit, aviation, passenger rail, harbors and waterways, clean water, waste disposal, broadband deployment, educational infrastructure deployment, health care, housing, energy R&D and agricultural research. Funds are also used for payments to low-income households, and a refundable tax credit for households meeting specified income requirements.

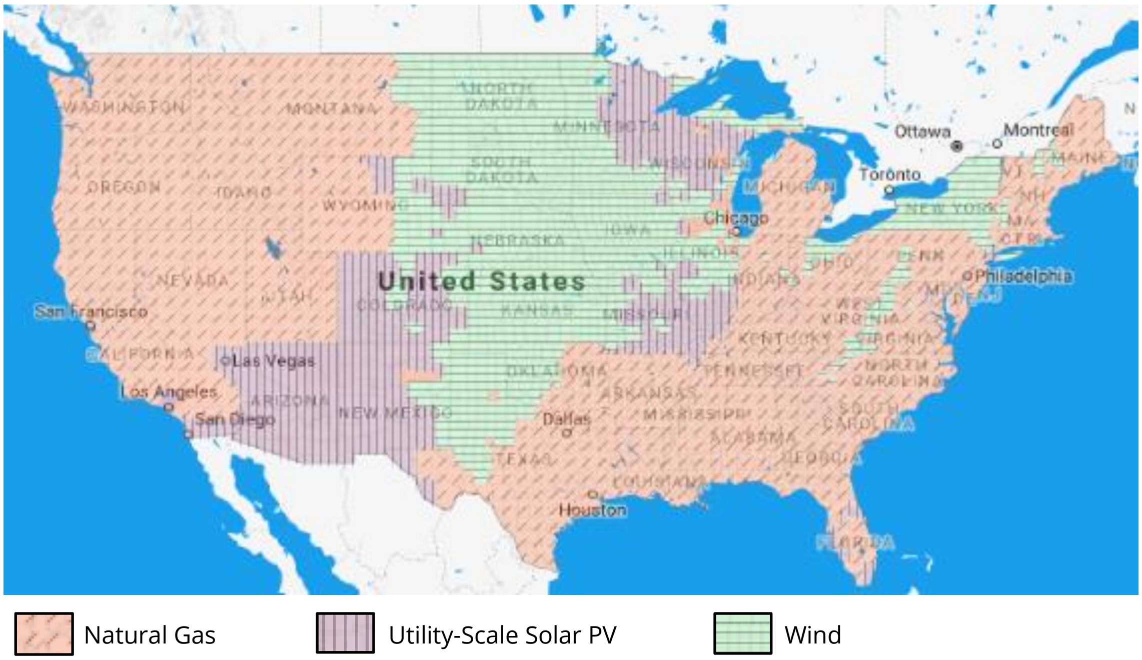
State Laws	Mechanism	Pricing Levels	Emissions Goals	Other Features
California Cap-and-Trade (2013)	Cap and trade program for 450 businesses responsible for 85% of California's total GHG emissions. Emissions allowances distributed by a mix of free allocation and quarterly auctions depending on the efficiency of each facility relative to industry benchmarks. Allowances allocated to electric utilities, industrial facilities and natural gas utilities (declining over time) based on output and sector-specific emissions intensity benchmark, rewarding efficient facilities. Investor-owned utilities must sell their free allowances at auction to benefit customers.	Emissions cap declines by 3% annually from 2015-2020 and at a faster, to-be-determined rate from 2021-2030. Minimum initial auction price of $10 and maximum initial auction price of $40 in 2012, both of which increase by inflation plus 5% annually. Hard price ceiling is set in 2021, with an unlimited supply of allowances offered at that price.	40% below 1990 levels by 2030.	Unlimited banking of allowances for covered entities, except that regulated utilities are restricted in the number of allowances they are permitted to hold at any one time based on allowance budget. Borrowing is not permitted. Offsets permitted, but become increasingly more restricted and targeted over time.

State Laws	Mechanism	Pricing Levels	Emissions Goals	Other Features
Regional Greenhosue Gas Initiative (2009)	Cap and trade program between CT, DE, ME, MD, NH, NY, RI, and VT. New Jersey expected to join in 2020. Power sector only. Imposes CO_2 emissions limitations on electric power plants, issues CO_2 allowances and establishes participation in regional CO_2 allowance auctions.	Emissions cap declines 2.5% annually through 2019 and is scheduled to decline by an additional 30% between 2020-2030. Auction prices between 2009-2019 have ranged between $1.86-$7.50.	75% below 2005 levels by 2030.	In 2012, a Cost Containment Reserve (CCR) of 10 million allowances annually was introduced to keep allowances from exceeding a system-wide trigger price. The 2019 trigger price is $10.50. In 2021, the trigger price will be $13 and increase by 7% annually. In 2021, an Emissions Containment Reserve (ECR) will be introduced to enable states to withhold up to 10% of their budget if prices fall below $6, increased by 7% annually.

C. Carbon Pricing Models by Geography

The University of Texas at Austin's Energy Institute provides a new generation cost calculator with accommodations for carbon pricing. Using the calculator, the chart below displays estimates of least-cost new construction electricity generation for every U.S. county at four ascending levels of carbon pricing.[44, 45]

Figure A: $0/t CO_2 (Current Level)

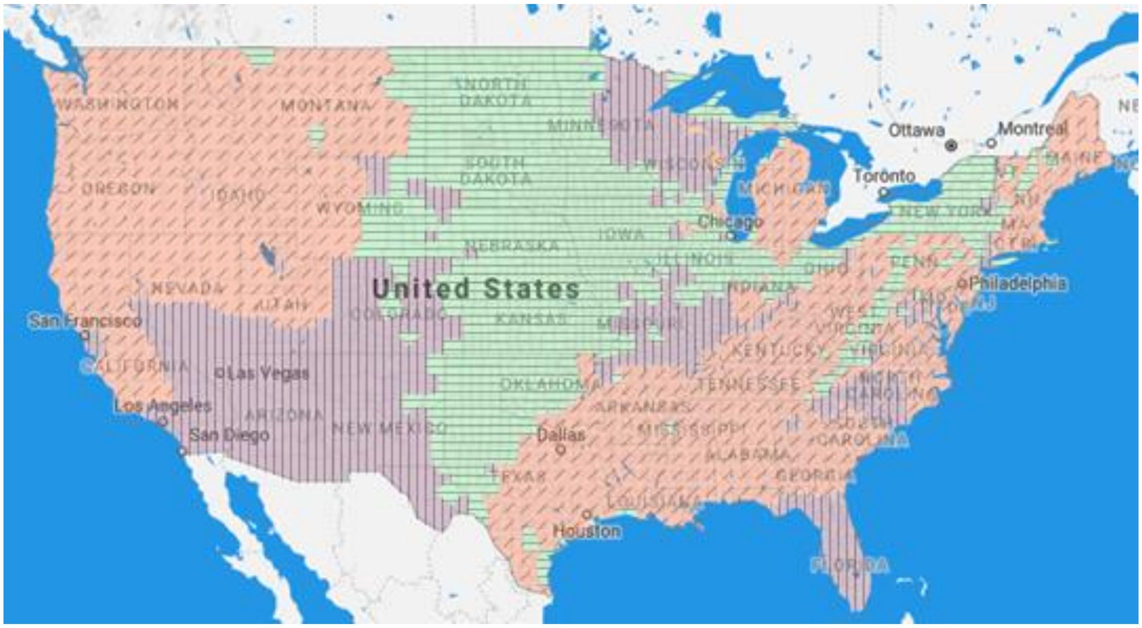


[44] The University of Texas at Austin Energy Institute. "Levelized Cost of Electricity Map." Accessed November 2, 2019 from https://energy.utexas.edu/policy/fce/calculators.

[45] Note that these graphics use the assumptions in Rhodes et al., "A geographically resolved method to estimate levelized power plant costs with environmental externalities." March 2017. Monthly fuel costs (2007-2014) for coal and natural gas were taken from the U.S. Energy Information Administration's Form 923. Fuel costs for nuclear plants were taken constant across all regions at $0.70/GJ. Additionally, the CAPEX and fuel price inputs are adjusted by regional multipliers as seen in the supplementary material of Rhodes et al. https://www.sciencedirect.com/science/article/pii/S0301421516306875 and U.S. Energy Information Administration. "*Form EIA-923 Detailed Data with Previous Form Data (EIA-906/920).*" https://www.eia.gov/electricity/data/eia923/

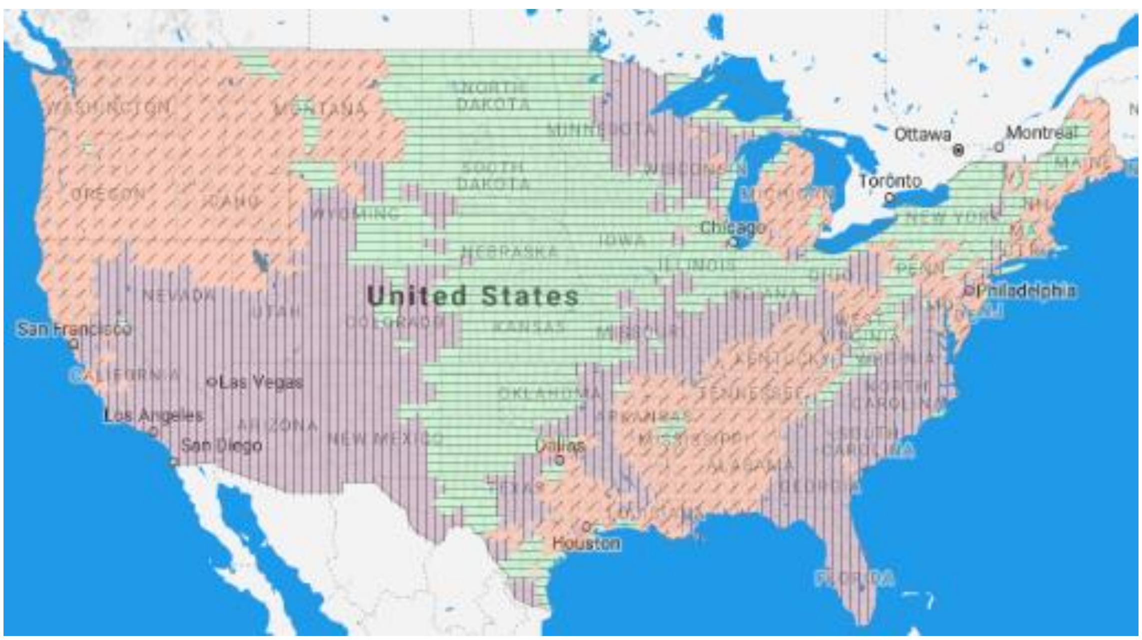
Technology	*Final Overnight Cost Assumption*	*Lifetime Assumption*	*Fuel Price Assumption*
Natural Gas	$820-2080/kW	35 years	$5.07/MMBtu
Coal	$4600-6000/kW	40 years	$2.16-3.17/MMBtu
Nuclear	$8000/kW	50 years	$0.70/MMBtu
Solar	$1100-7200/kW	25-30 years	N/A
Wind	$1520/kW	25 years	N/A

Figure B: $25/t CO_2



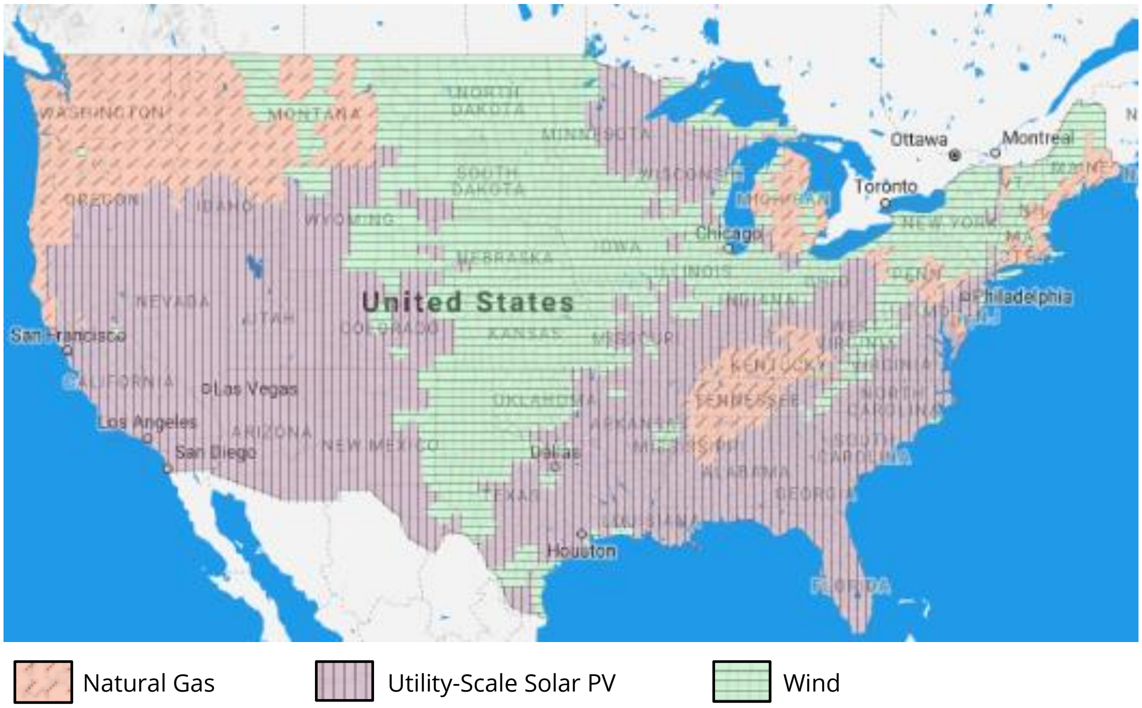
Natural Gas | Utility-Scale Solar PV | Wind

Figure C: $40/t CO_2



Natural Gas | Utility-Scale Solar PV | Wind

Figure D: $55/t CO_2



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