U.S. POLICY

CLEAN ENERGY STANDARDS: STATE AND FEDERAL POLICY OPTIONS AND CONSIDERATIONS

C2ES CENTER FOR CLIMATE AND ENERGY SOLUTIONS

Center for Climate and Energy Solutions

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FOREWORD

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The power sector of the United States is transitioning to cleaner electricity sources. Accelerating this transition is an important policy goal with numerous benefits—reductions in harmful greenhouse gases and other pollutants, diversification of energy supply, and the growth of new clean energy industries. Cleaner electricity is also a necessary predicate to decarbonizing a large majority of other energy uses, such as transportation and building energy use. In the eight years since C2ES last examined a clean energy standard (CES), the urgency for federal policy to expedite the energy transition has only grown.

A CES is one approach to increase the proportion of our electricity generated by clean sources and has recently been adopted by several states. States continue to be policy innovators in this area, enacting and strengthening both renewable and clean energy portfolio standards and goals. Additionally, there is renewed interest in developing a federal level CES, a market-based, sector-specific policy that may be more attractive as an initial step than other economywide options. Several years ago, there was bipartisan support at the federal level with Republican senators sponsoring some CES proposals, and President Obama endorsing a federal CES in his 2011 State of the Union address.

This report brings important insights from our experience working with a wide range of stakeholders. The authors explore the concept of a CES, explaining how it works, the benefits that a CES can deliver, and federal and subnational options for CES policies. Also considered in this update is the potential to integrate a CES with greenhouse gas reduction programs in other sectors. Additionally, this report examines some of the nuances of CES policy design and the implications of different design choices. This discussion and the conclusions reached aim to help policymakers, regulators, and other stakeholders decide whether a CES is an appealing option and to help such stakeholders understand the potential impacts of a CES.

The report points out that absent significant new policies to promote clean generation, the share of total electricity obtained from clean energy sources will likely not increase fast enough over the next 30 years for the United States to become carbon neutral or achieve net-zero emissions by mid-century. Such a reality will mean the United States would forgo substantial important benefits, including growth of new industries and mitigating climate change. Furthermore, recent reports from the United Nation's Intergovernmental Panel on Climate Change (IPCC) and the multi-U.S. agency Fourth National Climate Assessment tell us that our time to act and avoid the worst effects of climate change is limited. We need to accelerate the effort to transition our economy away from carbon emissions. A CES warrants consideration by policymakers at all levels as a potential tool for accelerating the many benefits of a clean energy transition.

EXECUTIVE SUMMARY

A transition from conventional fossil fueled electricity generation to clean electricity offers several benefits—particularly a reduction of greenhouse gases (and other types of pollution), diversification of electricity supply and growth of new clean energy industries and related jobs.

The current status of clean energy generation depends on how one defines clean electricity. While there is no universally agreed upon definition, various stakeholders endorse some or all of the following as at least partially clean options: natural gas, renewable electricity, savings from energy efficiency and conservation; fossil fuel use coupled with carbon capture utilization and storage (CCUS); and nuclear power. These clean and partially clean generation sources provide more than two-thirds of U.S. electricity today. While market dynamics and current state and federal policies have led to recent growth in clean energy generation—such as the growth in renewable generation driven in part by state renewable electricity portfolio standards and federal tax incentives—projections for the power sector indicate that, absent significant new policies to promote clean generation, the pace of transition to cleaner power generation, needed to meet our climate change challenge, will be insufficient.

Given the imperative of transitioning to cleaner electricity, policymakers have redoubled their attention to a number of significant, climate-focused proposals, including the idea of a clean energy standard (CES) that prioritizes performance and outcome rather than particular technologies. A CES is a type of electricity portfolio standard that sets aggregate targets for the amount of clean electricity that electric utilities (and other retail providers) are required to sell. Program flexibility is provided by: (1) defining clean electricity more broadly than just renewables, and (2) allowing market-based credit trading to facilitate lower-cost compliance.

As a concept, a CES builds on the successful experience of the majority of states that have implemented renewable and alternative energy portfolio standards and draws on a history of federal policy deliberation regarding national electricity portfolio standards. State CES programs can and have been a complement to existing state renewable portfolio standards and may be a promising option in states that are looking to increase low-carbon ambition beyond what may be feasible with renewables alone, as well as in states where more narrowly defined renewable electricity policies have less political appeal. A handful of states including: California, Colorado, Connecticut, Illinois, Indiana, Massachusetts, Nevada, New Mexico, New Jersey, New York, Pennsylvania and Washington have already enacted electricity portfolio standards that have attributes of a CES.

The federal government could also enact a national CES. Senator Tina Smith (D-Minn.) and Representative Ben Ray Luján (D-N.M.) introduced a federal CES bill earlier this year. Between 2008 and 2012, federal CES proposals received bipartisan support with sponsorship from several Republican senators, and former President Obama endorsed a federal CES in his 2011 State of the Union address. While the prospects for near-term enactment of a federal CES are uncertain, a federal CES has received substantial attention and warrants close consideration by stakeholders.

While typically thought of as policy for the electricity sector, since a CES is basically a performance standard for utility generators, it is possible to expand and connect this type of policy to other sectors (e.g., industrial, transportation). In fact, the province of Alberta has implemented a multi-sectoral performance standard approach to reduce greenhouse gases.

This report explains how a CES works, describes the benefits that a CES can deliver, and explores federal and subnational options for CES policies. In addition, it examines some nuances of CES policy design, how a CES might integrate into economywide market-based solutions, and the implications of different design choices. This discussion can assist state and federal policymakers, utility regulators, and other stakeholders in deciding whether a CES is an appealing policy option.

Key insights include the following:

- Absent significant new policies to promote clean energy, the share of total U.S. electricity generation obtained from clean energy sources will likely not increase fast enough to achieve mid-century climate goals.
- Substantial increases in clean energy generation can offer important benefits, including:
  - Mitigation of environmental and public health impacts from electricity generation—including criteria and hazardous air pollutants and greenhouse gas emissions that contribute to climate change;
  - Diversification of energy supply to limit electric utilities' and ratepayers' exposure to fuel price volatility and regulatory risk associated with particular energy sources. Moreover, pursuing multiple avenues improves the probability of meeting decarbonization and emission goals;
  - Growth of new clean energy industries and associated jobs—e.g., wind turbine manufacturing, solar panel installation, and nuclear power plant construction;
  - Cleaner end-use electrification in other sectors (e.g., transportation, buildings, and many industrial sub-sectors).
- In general, the more flexibility that utilities have for meeting clean targets (e.g., the more broadly clean electricity is defined), the more cost-effective a CES program will be.
  - A CES program can build upon the success and expand the ambition of existing electricity portfolio standards that many states have already implemented (i.e., a renewable portfolio standard), provided that the targets are increased in proportion to the potential of newly eligible resources. If additional clean energy resources are allowed to qualify for an existing portfolio standard without increasing the targets, the mix of resources used to meet the standard and the resulting compliance costs may change, but the total amount of clean energy generation will not increase and the goals of the policy may not be furthered.
- A CES can be an effective market-based policy if clean electricity credit trading between participants is allowed. Allowing compliance flexibility through credit trading can lower potential cost impacts on electricity consumers. Program flexibility is also increased by broadly defining what counts as clean electricity. Policymakers have several options for providing electric utilities with temporal compliance flexibility under a CES (e.g., banking and borrowing of credits).
- Since utilities tend to comply with electricity portfolio standards by deploying the lowest-cost qualified resources, policymakers may need to include special provisions in a CES (or develop additional targeted innovation policies outside of a CES) if they hope to provide a meaningful incentive for less commercially mature and higher-cost technologies. In fact, several state efforts actively employ this concept to ensure renewables (e.g., offshore wind) and nuclear resources are deployed.
- Certain policy design options (e.g., exemptions for certain utilities and alternative compliance payments) can have the effect of reducing a CES program's effective target for incremental clean electricity deployment.
- How policymakers set CES targets, treat new vs. existing clean electricity generators, and define qualified clean electricity sources determine how the effects of a CES program vary among different utilities, power generators, or customers.
- Designing a CES that enables integration with additional sectors provides a larger economy-wide platform for reducing carbon dioxide emissions, and may accelerate power sector decarbonization efforts.

I. INTRODUCTION

This report is intended to inform debate and deliberation among policymakers and stakeholders regarding state and federal clean energy standards (CES) for the electric power sector. A CES is a policy option for increasing the role of "clean" generation in the power sector—beyond a traditional renewable portfolio standard. This report updates our 2011 C2ES report; it explores what a CES is and how policymakers might best design such a policy to reduce greenhouse gas emissions and other societal goals.

A word is in order regarding use of the word "clean," both in this report and in the larger debate. There is no commonly accepted definition of "clean" energy. Indeed, one person's definition of "clean" can differ dramatically from another's if their objectives for energy policy differ. Renewable electricity, nuclear power, natural gas or coal with carbon capture and sequestration (CCS), and energy efficiency all have supporters, who define these sources as clean. Unless otherwise noted, this report will use the term "clean" to refer to these options listed above and "conventional" to refer to all other electricity generation (e.g., fossil fuel generation without CCS). When referring to the share of total electricity obtained from clean sources, this report will, unless otherwise noted, count only renewable or zero-carbon emitting (or zero-emission) generation. This report does not choose what options should be considered clean. Rather, this report explores issues pertaining to clean electricity broadly and looks at the specifics of a policy mechanism (i.e., a clean energy standard) whose workings and implications are largely separate from the choice of how to define clean.

This report is organized as follows. Chapter II explains what a CES is. Chapters III and IV describe the current status of and outlook for clean energy absent new policies and the significance and benefits of expanding clean energy generation through new policies. Chapter V highlights advantages and disadvantages of a CES policy compared to alternative means for promoting clean energy. Chapters VI and VII provide an overview of recent proposals for a national CES, relevant state experience with CES-like programs, and options for new state or multi-state CES programs. Chapter VIII takes an in-depth look at the particular policy design elements of a CES and the implications of different design choices. Finally, Chapter IX offers conclusions.

II. WHAT IS A CLEAN ENERGY STANDARD (CES)?

A CES is a flexible, market-based policy designed to increase the share of electricity sales met via clean energy sources (and perhaps electricity savings from energy efficiency). Typically, a CES sets a target for electricity sales for a state, a region, or the entire country (depending on the scope of the program)—e.g., by 2030, 50 percent of electricity sales must be met via clean electricity sources. Allowing a broad range of clean energy sources to qualify provides flexibility and allows more ambitious clean energy targets to be achieved sooner. Additionally, a CES may permit "trading" such that if one utility generates more clean electricity than it needs to comply with the standard, it can sell the excess (called a clean energy credit) to other participants. The ability to trade credits puts a value on those credits and creates a market incentive for producing clean energy. Providing longer-term certainty about policy also helps guide the decisions of electric utilities, merchant generators, regulators, and other entities about investments in new generation, retirements, retrofits, utilization, and energy efficiency programs. The market signal under a CES directs participants to seek the cleanest least-cost approach for achieving the policy's aggregate goal for clean electricity.

A CES can be a standalone policy or it can be configured in conjunction with other electricity requirements like a renewable portfolio standard (RPS) or even a direct price on carbon emissions. A few states have enacted programs that, when considered in-aggregate, could be viewed as a CES. For example, New Jersey, New York, and Illinois have RPS which aim to increase the share of renewable electricity consumed by the state. Additionally, each state has established a zero-emission credit (ZEC) program for preserving in-state, zero-emission nuclear power, which further diversifies the set of clean electricity sources. Taken together, an RPS and a ZEC program can dramatically expand the quantity of electricity sales from clean sources within a state. Since the ZEC programs operate independently from (and do not directly compete with) other electricity requirements, the nuclear component of the CES is fixed (i.e., not growing, not tradable), while the renewable component is flexible (i.e., growing, tradable). Notably, no state attempts to quantify a specific clean energy target (e.g., 25 percent of electricity sales from nuclear power through 2050) from its ZEC program.

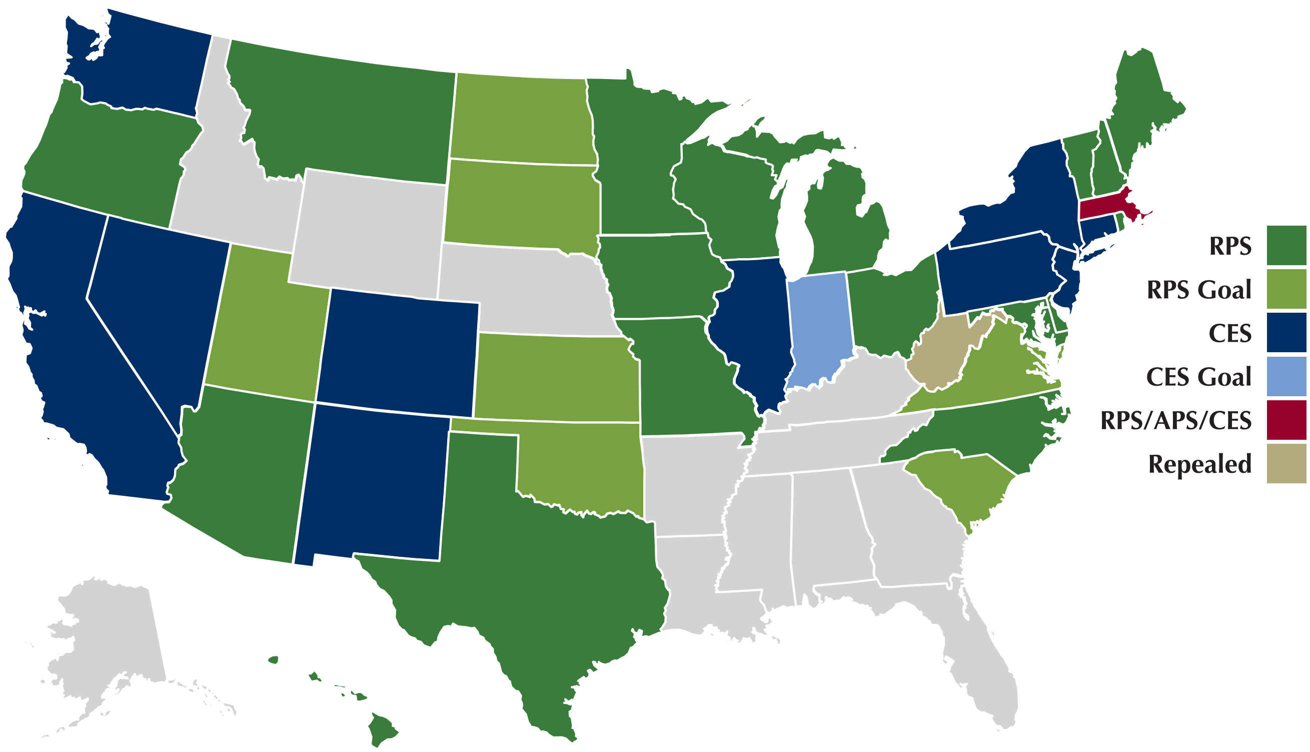
Similarly, electricity generators in Connecticut, New York, Massachusetts, and now New Jersey also face a direct price on carbon as part of the Regional Greenhouse Gas Initiative (RGGI), a cap and trade program for the electricity sector operating in nine northeastern states. Electricity portfolio standards dictate the quantity of clean electricity desired, while the carbon price makes visible the cost of putting greenhouse gas emissions into the atmosphere. Because the requirement for clean electricity is fixed in a CES, implementing these policies together tends to result in lower carbon prices in RGGI. While examining the interaction of differing policy options is a worthwhile endeavor, this report focuses exclusively on the CES. It examines the issues relevant to a CES implemented in a single state, as a multistate program, and as a national program. In addition, while a CES is typically only discussed in relation to the performance of electricity generation, depending on how it is structured, it is not difficult to envision how it could be applied to other sectors, providing an economy-wide mechanism for reducing carbon dioxide emissions.

ELECTRICITY PORTFOLIO STANDARDS

Electricity portfolio standards dictate the mix of electricity offered to consumers. They can be fixed and mandate a limited set of specific sources or flexible, allowing the goal to be met by a number of qualified energy resources like solar, wind, nuclear or fossil energy with carbon capture and storage. A majority of states have already enacted some type of electricity portfolio standard focused on pulling more renewables into the electricity mix but few have extended this standard beyond renewable generation (see **Figure 1**).

As with the definition of "clean," electricity portfolio standards go by different names, in large part depending on what types of energy resources count toward the requirements. Typically, an electricity portfolio

FIGURE 1: U.S. Electricity Portfolio Standards



Twenty-nine states and the District of Columbia require electric utilities to deliver a certain amount of electricity from renewable or other clean energy sources. Five states have adopted a mandatory clean energy standard requirement while one state has adopted a clean energy standard goal. Note that APS denotes alternative energy portfolio standard.

Source: Center for Climate and Energy Solutions 2019b.

standard that sets a requirement only (or primarily) for renewable electricity is called a renewable portfolio standard (RPS) or renewable electricity standard (RES). The nomenclature gets more complicated when electricity portfolio standards allow for non-renewable electric generation or savings from energy efficiency measures to qualify toward compliance with the policies' requirements. Policymakers have referred to such policies as "alternative," "advanced," "diverse," and "clean" energy (portfolio) standards. Moreover, there is no clear distinction between an RPS/RES and these other types of electricity portfolio standards since some policies that are called an RPS/RES—because they primarily require an increase in renewable electricity—also allow for at least some limited compliance via nonrenewable electricity generation or energy efficiency.[1]

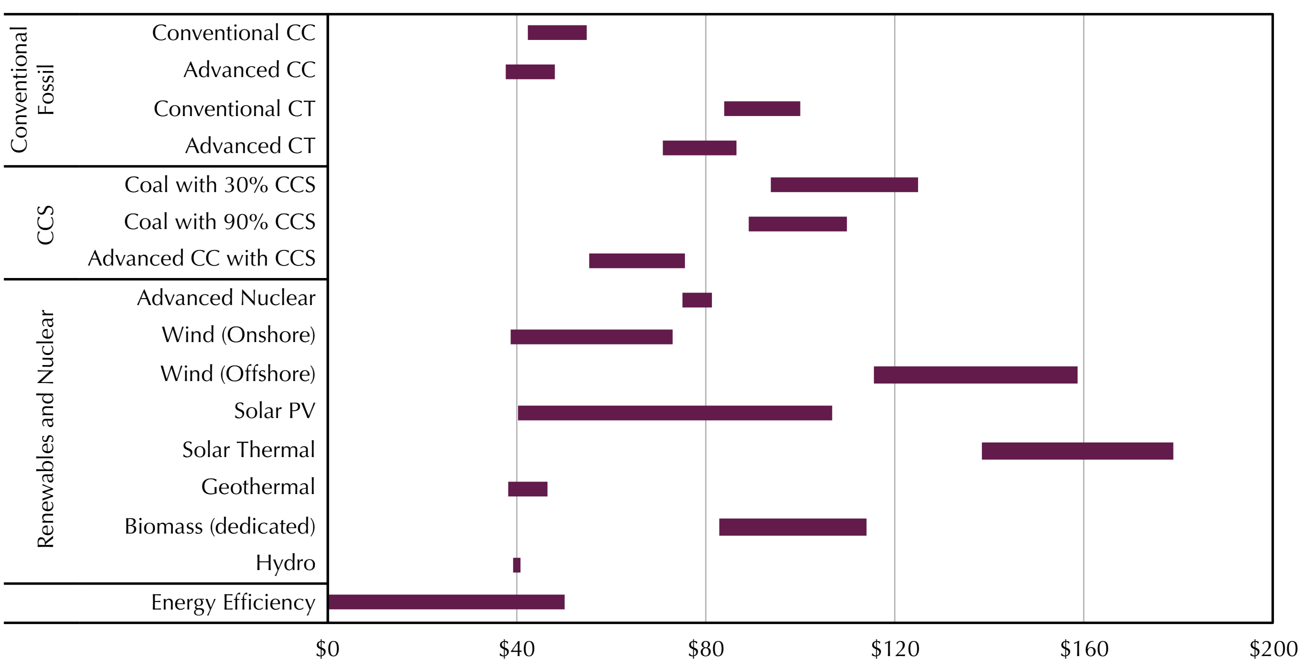
For the purposes of this report, the term clean energy standard or CES will refer to an electricity portfolio standard that sets a requirement for the amount of electricity sales to be met via qualified resources beyond a typical RPS, i.e., where qualified resources include at least some low- or non-carbon emitting, non-renewable electric generation technologies. Again, rather than specifying which technologies should be considered "clean" (i.e., low- or zero-carbon emitting), the authors assume that policymakers will determine for themselves which technologies should qualify. But for illustrative purposes, a number of technologies that have been defined as "clean" in actual state laws or proposed federal laws are used throughout this report (e.g., nuclear power, fossil fuel use coupled with CCS, energy efficiency, etc.).

HOW DOES A CES WORK?

Subject to regulatory and policy constraints, utilities generally choose to obtain new capacity from the resource with the lowest cost (**Figure 2**), including all environmental compliance costs, costs of integration, incremental transmission costs, etc. In today's market, the lowest cost sources vary by region (**Figure 3**). In some regions, renewable resources could be least cost and in others fossil generation will be the lowest cost option. Environmental objectives and diversity of fuel sources, however, are often regional goals beyond cost objectives and policies that specify a requirement for certain types or portfolios of generation can be used to help meet these goals. An additional consideration for utilities includes the levelized avoided cost of electricity (LACE), which captures the value (i.e., the market revenue that the new capacity will generate) of the generation resource to the grid.[2]

As a type of electricity portfolio standard, a CES works much like the electricity portfolio standards already in place in a majority of states and the District of Columbia. Under a CES, an electric utility faces a requirement to supply a certain fraction of its electricity sales to end-use customers from qualified clean energy sources (potentially including electricity savings from energy efficiency).[3] Electric utilities demonstrate compliance with the CES requirement by either owning or contracting for delivery from clean energy generating assets, or by purchasing tradable credits (if that design option is chosen/available). Each clean energy credit (CEC) represents one unit of clean energy generation (or potentially electricity savings from energy efficiency). For example, one CEC might correspond to one megawatt-hour (MWh) of output from a qualified clean energy facility (e.g., a wind farm or a nuclear power plant) or one MWh of energy savings. Thus, if a utility sells 1 million MWh of electricity to retail customers in a given year, and its CES obligation is 50 percent, it must somehow obtain 500,000 CECs and surrender

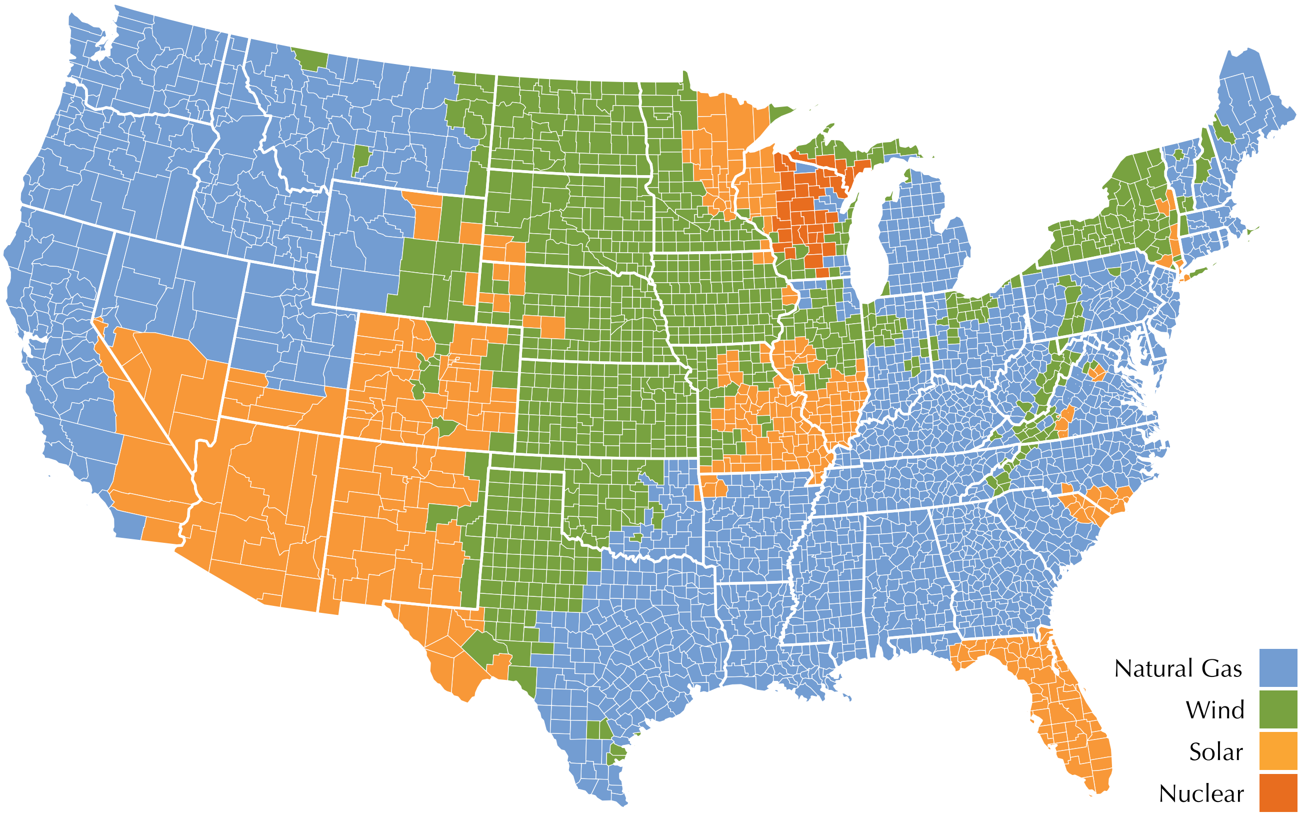
FIGURE 2: Regional variation in levelized cost of electricity for new generation resources entering service in 2023



This figure shows the most recent estimates for the total levelized cost of electricity (LCOE) from EIA's *Annual Energy Outlook 2019* for new entry of various power generation technologies (as well as electricity savings from energy efficiency). Importantly, the values shown do not reflect various incentives including state or federal tax credits that may be available. The total system LCOE estimates include levelized capital, fixed operation & maintenance (O&M), variable O&M (including fuel), and transmission investment costs. Note, the LCOE estimate for electricity savings from energy efficiency is not from *AEO2019* but rather based on Paul, Palmer, Woerman (2011), which finds that electricity savings of 1–3 percent are available at a marginal cost of $50/MWh. CC and CT refer to natural gas combined cycle and combustion turbine plants, respectively. CCS refers to carbon capture and storage.

Source: U.S. Energy Information Administration 2019e

FIGURE 3: Lowest Cost of Electricity by Geography



This map shows the lowest cost electricity source by county, assuming a 5 percent discount rate. All other assumptions can be found at: University of Texas (2019).

those credits to the CES program administrator to demonstrate compliance.

Qualified clean electricity generators earn credits in proportion to their output and may earn these credits at different rates. In other words, the owner of a qualified clean energy facility will earn some number of CECs for each MWh generated and this number of CECs may vary depending on the type of clean energy facility (i.e., partial credit could be awarded for cleaner, but not zero-emission, electricity like coal with CCS). Importantly, the tradable credits are "unbundled" from the clean electricity to which they correspond—i.e., they can be sold separately. This means that a generator may sell the electricity to one party and the CEC to another.[4] By allowing this kind of trading, the CES is an inherently flexible way to promote clean electricity.

Electric utilities that own qualified clean energy facilities receive the CECs associated with their generation. Electric utilities can also buy CECs from qualified generators or other electric utilities. The reliance on unbundled credits means that some utilities might deliver more clean electricity than specified by the standard and others might deliver less. The CEC market price provides a financial incentive for deployment of clean electricity technology. **Appendix C** discusses how a CES works in traditionally regulated and competitive electricity markets.

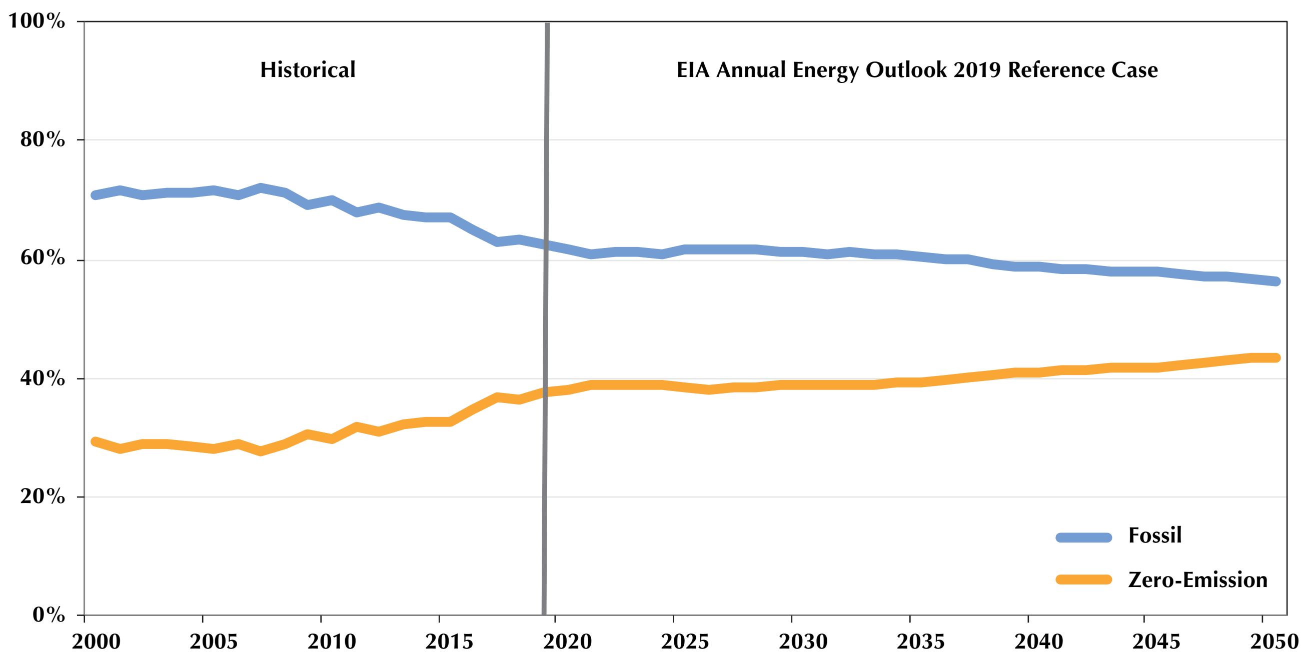
III. STATUS AND OUTLOOK FOR CLEAN ENERGY

Some context regarding the status and outlook for clean energy in the power sector can help inform the discussion of a clean energy standard (CES). Since 2005, carbon dioxide emissions from the power sector have fallen by nearly 28 percent.[5] Still, the United States obtains nearly 63 percent of its electricity from carbon-emitting (i.e., coal, natural gas, and to a much less extent petroleum), fossil fuel-fired electric power plants (**Figure 4** and **Figure 5**).

Natural gas has dominated new capacity additions in the power sector over the past three decades, and renewables, particularly wind power, have seen strong growth in the last decade (**Figure 6**). Conversely, nearly 18 percent (55 GW) of coal-fired power plant capacity has been retired over the past decade. And since 2012, five percent (5.4 GW) of the existing nuclear fleet has been prematurely retired with respect to their operating licenses. In the last decade, low natural gas prices have driven growth in natural gas-fired power generation. However, low wholesale electricity prices resulting from low natural gas prices, excess power generation capacity, declining renewable electricity costs (from federal and state policies, corporate support, technology learning and advancement), and low growth in electricity demand are the main drivers of coal and nuclear plant retirements.

The latest business-as-usual projection from the U.S. Energy Information Administration (EIA) Reference Case (i.e., no new policies) for the power sector (from EIA's

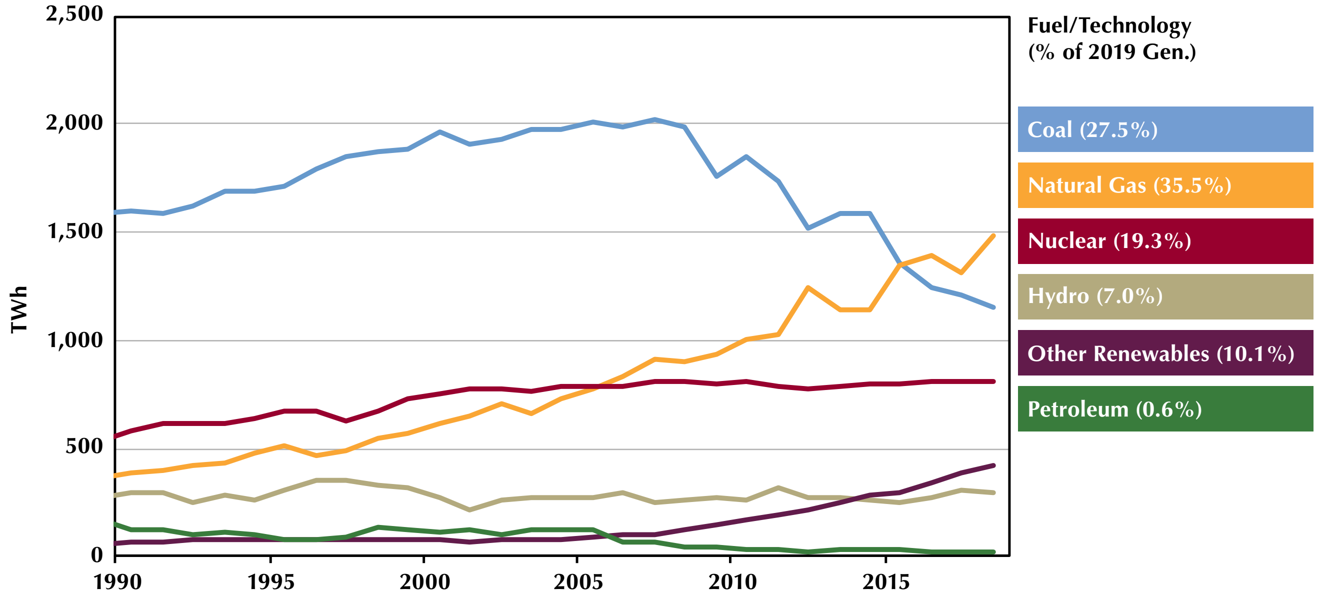
FIGURE 4: Projected Fossil and Zero-Emission Electric Power Sector Generation from AEO2018 Reference Case



Reference case electricity mix in 2050: Coal (17.2 percent), natural gas (38.8), nuclear (12.3 percent), and renewables (31.1 percent); total electric power generation is expected to be 30 percent larger than in 2018.

Source: U.S. Energy Information Administration 2019a.

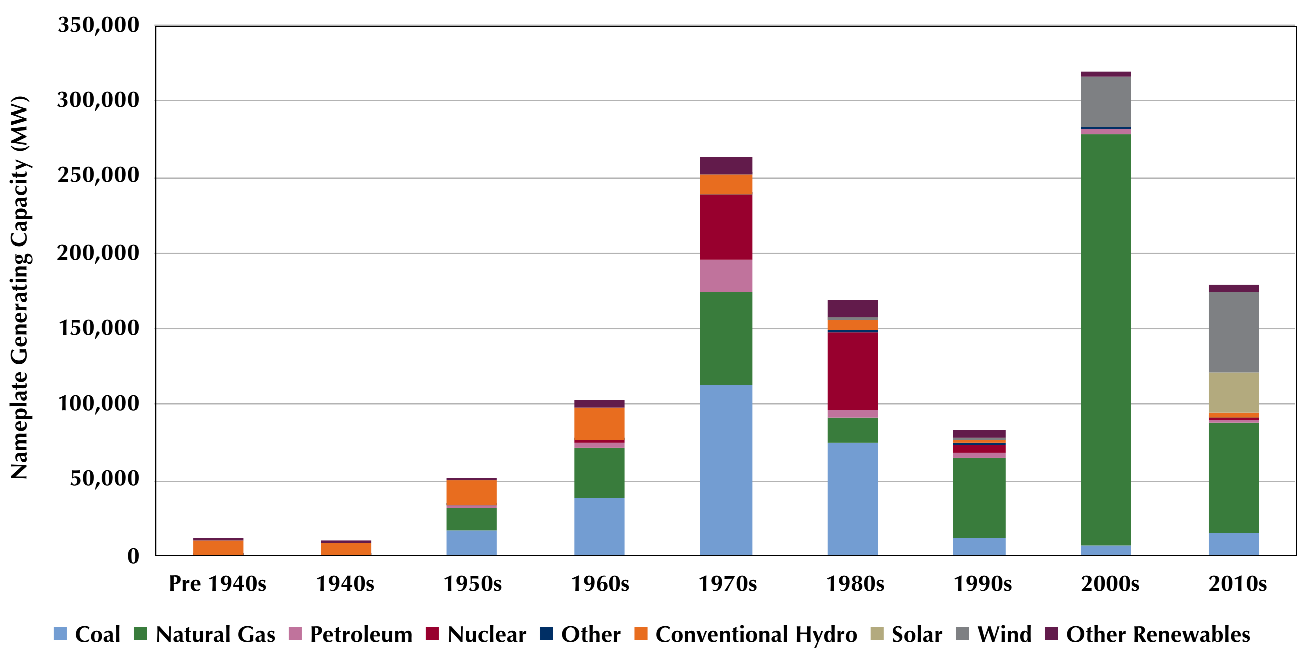
FIGURE 5: Electric Power Sector Net Generation, 1990–2018



In 2016, natural gas overtook coal to become the largest source of electricity.

Source: U.S. Energy Information Administration 2019b.

FIGURE 6: U.S. Electric Generation Capacity by In-Service Decade and Fuel/Technology



Excludes industrial and commercial generators reported in EIA-860.

Source: U.S. Energy Information Administration 2018c.

Annual Energy Outlook 2019, AEO2019) suggest that the share of total U.S. electricity generation obtained from several zero-emitting sources is unlikely to increase by more than a few percentage points over the next 30 years.

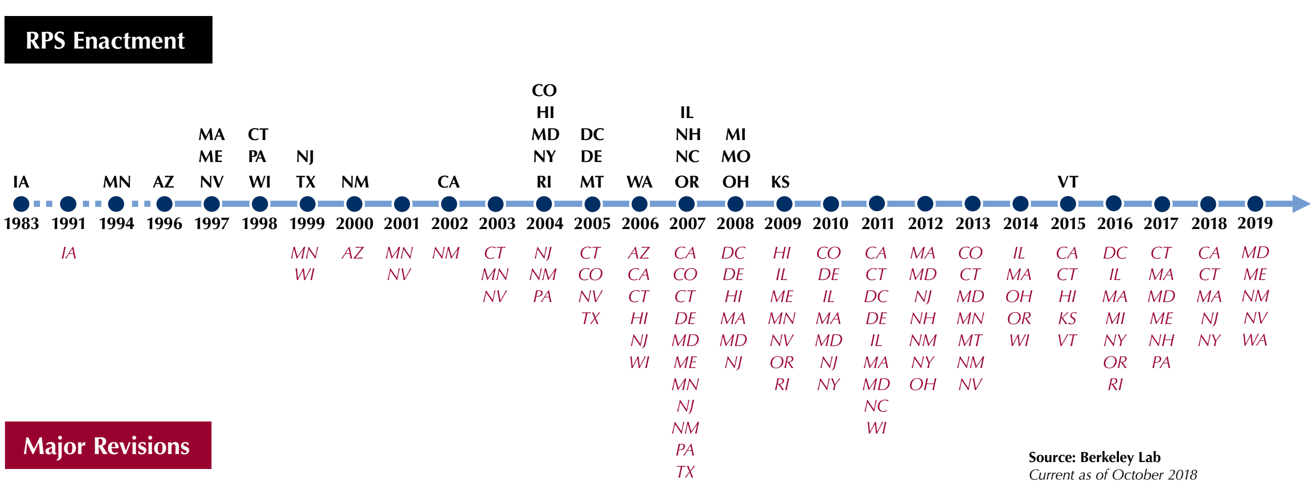
Absent new energy policy, solar, wind and natural gas are projected to be the dominant technology choices for new electricity generation.[6] Though solar deployments are expected to increase 10-fold and wind capacity is expected to nearly double, fossil fueled generation is still expected to comprise 57 percent of the 2050 electricity mix (see **Figure 4**).

An additional challenge is the early retirement of nuclear power plants. Currently, nuclear supplies 20 percent of U.S. electricity and more than 50 percent of its zero-emission generation. An examination of plant retirements to date shows that nuclear generation is largely being replaced by natural gas-fired generation, resulting in emissions backsliding.[7] An additional 12 reactors are scheduled to close by 2025 unless market reform measures or policy actions are implemented to value nuclear's zero-emission attribute. A few states (i.e., New York, Illinois and New Jersey) have adopted zero-emission credit (ZEC) programs to compensate at-risk nuclear power plants for their environmental benefit. Connecticut is allowing nuclear plants to participate in its zero-carbon auction. So far, these policies have averted the closure of 13.1 GW of nuclear power across 13 reactors (i.e., 8 plants).[8]

A majority of states have adopted binding renewable and alternative energy portfolio standards to drive increases in clean energy generation (**Figure 1**). As target dates approach, some states are increasing the ambition of their portfolio standards (**Figure 7**). New York, Illinois and Massachusetts have adopted clean energy standards, and other states like Pennsylvania and Indiana, have policies that augment qualifying clean technologies beyond wind, solar, small hydro and energy efficiency.

In many areas of the United States, new clean energy technologies (i.e., wind and solar) are becoming cost-competitive with new natural gas combined cycle power plants, the least costly and cleanest fossil fuel technology for new capacity additions (**Figure 3**). However, current policies and market forces are not expected to increase the quantity of deployed clean energy technologies (including renewables, battery storage, advanced nuclear and carbon capture and storage) as rapidly as necessary to avoid the worst impacts of climate change. Specific challenges related to clean energy deployment are discussed in **Appendix A**. The observations above suggest that, absent significant new policies to accelerate clean energy deployments, the United States will not deploy as much clean energy as necessary.

FIGURE 7: Timeline of State Renewable Portfolio Standard Adoption



In 2019, portfolio standards in Colorado, Maine, Maryland, New Mexco, Nevada, and Washington were increased, extended or new requirements were added through legislative or administrative means. Half of all RPS states will reach their RPS target year by 2021. Seven states now have extended their target year beyond 2030.

Sources: Barbose (2018) and C2ES analysis.

IV. SIGNIFICANCE AND BENEFIT OF EXPANDING CLEAN ENERGY

Growing the share of electricity provided by clean energy sources can provide a range of important benefits—chief among them reducing greenhouse gases and other types of pollution, which can improve public health. Additionally, clean energy sources help diversify the energy supply mix and foster clean energy industries and jobs. A clean energy standard (CES) designed to maximize only one of these benefits, however, might not maximize another and thus it is important to consider the overall policy objectives. This chapter discusses the range of benefits. Chapter VIII discusses how the particular design elements of a CES might be more productive in achieving one benefit than another.

PROTECTING THE ENVIRONMENT AND PUBLIC HEALTH

A 2018 report from the Intergovernmental Panel on Climate Change (IPCC) warns that we may be as little as a dozen years away from crossing a critical threshold—seeing a global temperature rise of 1.5°C above pre-industrial levels, increasing the risk of dangerous climate change.[9] That report and others highlight the grave nature of climate change. Increased concentrations of greenhouse gases are anticipated to lead to more excessive heat days, heavy precipitation events, intense droughts, major crop damage, sea level rise and so on.

Each economic sector contributes greenhouse gas emissions. Globally, electricity and heat production are the largest contributors of greenhouse gases.[10] As the largest cumulative carbon dioxide emitter since 1750 (and currently the second largest emitting country), the United States can play a significant climate change leadership role by decarbonizing its economy.

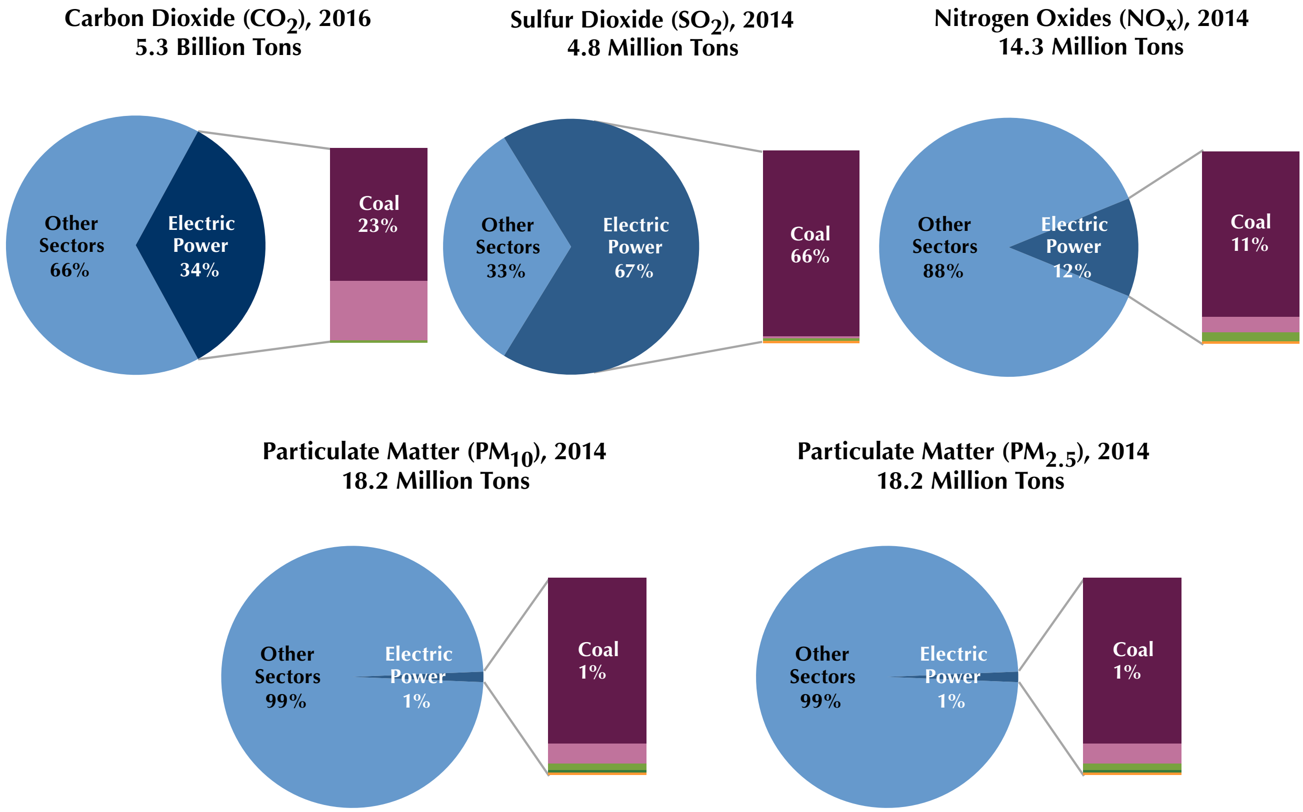
Nearly all renewable energy technologies either do not emit greenhouse gases at all (while generating electricity), or only emit greenhouse gases that would eventually be released to the atmosphere anyway.[11] Nuclear power is the largest non-emitting electricity source, and energy efficiency reduces emissions by avoiding electricity generation. Additionally, there are nearly two dozen commercial-scale carbon capture projects in the industrial and power sector operating around the world, with 22 more in development, which have a significantly smaller carbon footprint than conventional (i.e., without CCS) coal- and natural gas-fired power plants.

Moreover, electric power plants (particularly older, less-efficient coal plants that lack a full suite of modern pollution controls) are major sources of conventional air pollutants that have significant negative effects on public health and the environment. According to the U.S. Environmental Protection Agency (EPA), more than 111 million Americans live in areas with unhealthy levels of air pollution.[12] Replacing conventional fossil fueled electricity generation with new clean energy generation can reduce pollution and protect public health and the environment. Carbon capture also reduces conventional air pollution because the exhaust must be cleaned before its carbon can be captured.

Based on 2014 data, the latest analyzed by EPA in its National Emissions Inventory, electric power plants are the leading U.S. source of emissions of sulfur dioxide. The electricity sector also ranks third among all U.S. sources of nitrogen oxide emissions and fourth in emissions of fine particulates.[13] As shown in **Figure 8**, the vast majority of the emissions in this sector in 2014 were associated with coal-fired power plants. Sulfur dioxide and nitrogen oxides contribute to acid rain and irritate the human respiratory system, exacerbating and contributing to the development of a range of medical conditions.[14]

Most renewable energy technologies, as well as nuclear power and energy efficiency, do not release any of the kinds of air pollutants that most often cause immediate and direct public health impacts: criteria air pollutants such as fine particulates, sulfur dioxide, and nitrogen oxides, as well as hazardous air pollutants (HAPs) such as mercury, other metals, and acid gases. Analysis by NREL concluded that in 2013, new renewable electricity deployed to satisfy RPS obligations (displacing fossil generation) reduced emissions of sulfur dioxide by 77,400 metric tons, emissions of

FIGURE 8: Power Sector Contribution to Greenhouse Gas and Other Types of Air Pollution



Coal-fired power plants make up the vast majority of power sector air emissions. "Other Sectors" includes transportation, other mobile sources, and industrial sources.

Source: U.S. Environmental Protection Agency 2018a and U.S. Environmental Protection Agency 2018c.

nitrogen oxides by 43,900 metric tons, and emissions of particulate matter (i.e., $PM_{2.5}$) by 4,800 metric tons.[15] Natural gas combined cycle (NGCC) generation emits less particulate matter than conventional coal-fired generation, virtually no sulfur dioxide or metals, but does emit significant amounts of carbon dioxide and nitrogen oxides, as it supplies 35 percent of U.S. electricity (**Appendix B**). In comparison to coal combustion, natural gas combustion emits about half the carbon dioxide per MWh of electricity generated.

Over the longer-term, in order to improve air quality, address pollution-related public health problems, and mitigate climate change, regulation of emissions and air pollution will likely increase. Utilities and state regulators are likely to find that in some cases it is cheaper in the long run to replace older carbon-emitting power plants with new clean energy generation (including new fossil generation with carbon capture) than it is to retrofit the pollution control equipment that will be necessary to comply with updated regulations and standards. In addition, states such as Illnios, New Jersey, and New York have determined that it is more cost effective to preserve existing zero-emission resources than replace them with new zero emission resources or risk having them replaced with polluting fossil fuel resources.

DIVERSIFYING ENERGY SUPPLY

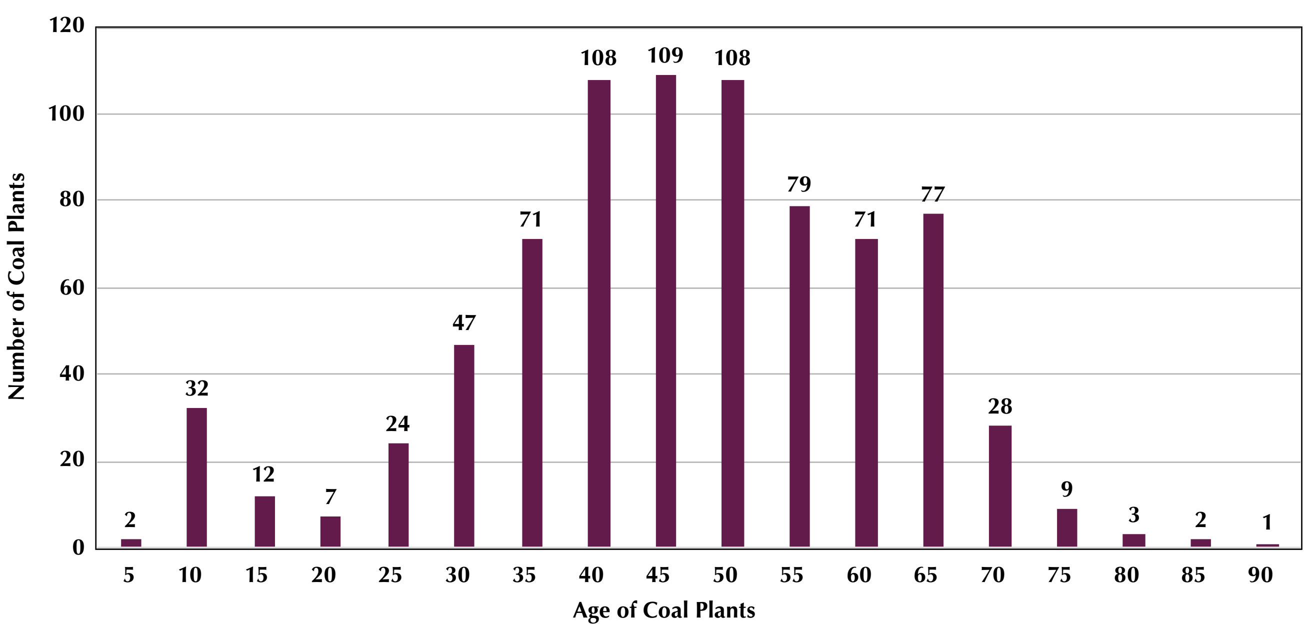
Since the 1990s, more natural gas-fired power plants have been constructed than any other type (**Figure 6**). Selected for their short construction times and low capital costs, natural gas plants represented 81 percent of new electric capacity added between 1990 and 2010.[16] Widespread deployment of new technologies to extract natural gas in the late 2000s, led to a significant and sustained price decline of the resource, which further increased the attractiveness of building natural gas power plants.[17] However, in the past several years, flat electricity demand, electricity oversupply, and lower wholesale electricity market prices have led to a slowdown in new capacity construction in general. Additionally, incentives and cost declines for renewable energy have helped grow the share of wind and solar capacity. Between 2010 and 2017, natural gas accounted for only 40 percent, wind made up 30 percent, and solar made up 15 percent of new capacity additions.[18]

Construction of so many new natural gas electricity plants over the past three decades raises concerns about the possible overreliance on a single fuel source. Nationally, natural gas accounts for about 32 percent of the electricity mix, up from only 16 percent in 2000. However, in a half dozen states more than two-thirds of electricity generation is now sourced from natural gas, and natural gas growth is continuing. While the long-term availability of supply does not appear to be in doubt, delivering natural gas to power plants via pipeline has risks. As use of the pipeline network increases, capacity constraints can (and do) emerge particularly during high demand periods, e.g., cold winter days when demand for power and residential heating from natural gas are elevated. Note too that in most jurisdictions residential customers get preference over power plants for natural gas delivery. So, natural gas supply for electric power plants is not necessarily certain. Along with delivery risk comes associated price swings. Historically, natural gas prices have displayed volatility; there were a few large price spikes during the early 2000s and several smaller, more short-lived spikes since 2010, which have resulted mostly from cold weather outbreaks, but also from heat waves.[19] With greater reliance on a single fuel, delivery risk and the associated price volatility are only magnified.

Some states, however, are very reliant on coal. According to EIA, about 18 states obtained the majority of their electricity from coal—12 states get more than 50 percent of their electricity from coal.[20] And many of these facilities are quite old. As shown in **Figure 9**, about 90 percent of all U.S. coal-fired power plants are at least 30 years old and about 47 percent are at least 50 years old. The implementation of new safety, health or environmental standards pertaining to coal may have significant impacts on electricity prices in areas that are heavily reliant on coal.

These facts raise questions about the extent to which the United States is vulnerable or could become vulnerable to price shocks and supply disruptions due

FIGURE 9: Age Distribution of U.S. Coal-Fired Power Plants



Source: U.S. Energy Information Administration 2018c.

to overreliance on any given energy source. A CES could be designed to address these concerns by diversifying the nation's energy supply by explicitly requiring greater use of other technologies, none of which are currently producing as much electricity in the United States as coal or natural gas. One of the benefits of a more diverse generation portfolio is that it could lessen the country's vulnerability to temporary fossil fuel supply disruptions (e.g., weather related) and associated price spikes, skilled labor stoppages or shortages, and problems in quickly obtaining needed equipment or replacement parts.[21]

FOSTERING NEW CLEAN ENERGY INDUSTRIES

In response to the climate challenge, countries are promoting activities to stimulate clean energy growth and deployment. At the 2015 Paris climate conference, more than 20 nations and the European Union launched Mission Innovation—an initiative that aims to significantly expand public sector research and development in clean energy.

Under the Paris agreement, each nation, including the United States, committed to an emissions target (a nationally determined contribution or NDC). While the Trump Administration expressed its intention to withdraw from the Paris Agreement by 2020, 23 states and Puerto Rico formed the U.S. Climate Alliance to continue to try to meet the U.S. pledge.[22] Additionally, through the *We Are Still In* pledge, more than 3,500 businesses, universities, cities, and investors also expressed support for the goals of the Paris Agreement.

The IPCC *Special Report on Global Warming of 1.5 Degrees* concluded that annual investment of $2.4 trillion will be needed between 2016 and 2035 to stave off the worst impacts of climate change.[23] Though it has quintupled since 2004, global clean energy investment still falls far short of what is necessary. A recent report puts global clean energy finance and investment above $300 billion in 2018 for the fifth year in a row, reaching $332.1 billion.[24] Looking at the previous year, investment in renewable and nuclear energy in 2017 represented more than 70 percent of investment in electric generation, which is a promising change from less than ten years ago, when it represented less than 50 percent.[25]

The United States had been leading the world in clean energy investment until 2009, when it was surpassed by China. Between 2011 and 2015, Asia surpassed Europe as the number one region for new clean energy investment. By 2018, China's investments in clean energy equaled $100.1 billion, or 30 percent of the global total compared to $74.5 billion for Europe and $64.2 billion for the U.S.[26]

New policies to promote clean energy in the United States would stimulate research, development, and investment and accelerate clean technology deployment at scale—by accelerating "learning by doing," innovation, competition, and increased rationalization of emerging supply chains—allowing the United States to keep pace with global competitors. Policies that create a predictable, steadily growing demand for clean energy provide motivation and reduce uncertainty for investors, financiers, merchant power companies, and regulated utilities. As demand for clean energy grows, innovation and competition follow, and these factors lead to significant reductions in cost per kilowatt-hour (kWh).

History supports these assertions. A 2018 analysis by the National Renewable Energy Laboratory (NREL) found that about half of the increase in non-hydropower renewable energy generation and capacity additions since 2000 was required by RPS policies.[27] Over the same period, analyses by Lawrence Berkeley National Laboratory (and others) show that the cost per kWh of various renewable energy technologies has decreased, steadily and significantly.[28] In particular, the unsubsidized cost of utility-scale solar energy has fallen 88 percent since 2009 and wind energy has fallen 69 percent.[29] Furthermore, under current policies NREL projects that demand for non-hydropower renewable electricity from RPS policies will increase by 80 percent by 2030.[30] Additional large-scale deployment is expected to continue to drive costs down, expanding the geography where consumers, businesses, and utilities can choose clean energy as an unsubsidized, cost-saving alternative to conventional electricity generation.

CREATING NEW CLEAN ENERGY JOBS

Clean energy standards can be flexible and drive innovation across the entire clean energy portfolio. They can also be tailored to incentivize the development of specific zero-carbon resources in a given region, or state. Furthermore, they can help the United States maintain global leadership in clean energy innovation, which enables the export of cleaner, cheaper energy technologies to help other nations decrease their emission profiles. Moreover, increasing the level of electricity supplied by clean energy sources could stimulate domestic job growth in clean energy industries.[31]

Clean energy jobs represent a small but growing fraction of U.S. employment. In 2016, more than 620,000 people worked in non-emitting electricity jobs (**Table 1**), and more than 2 million were employed in energy efficiency. Overall, solar employment has grown by more than 300 percent (four-fold) since 2010, while wind employment recorded an increase of 32 percent from 2015 to 2016.[32]

Substantial increases in clean energy generation could spur growth in U.S. clean energy technology manufacturing jobs (e.g., wind turbine and solar panel manufacturing, and large manufactured components in advanced technology (CCS or nuclear) power plants) and in non-manufacturing jobs related to clean energy technologies (e.g., construction, installation, operation and maintenance). State experience with electricity portfolio standards suggests that such standards can lead to economic growth in clean energy technology manufacturing. For example, a 2011 report from Michigan's Public Service Commission found that the state's RPS, enacted in 2008, led to the first in-state production of utility-scale wind turbines.[33] However, supply chains for wind and solar face competition from overseas manufacturers and the potential for reduced

TABLE 1: Generation and Fuels Job Numbers by Sub-Technology (2016)

	ELECTRIC POWER GENERATION	FUELS	TOTAL
Solar	373,807	-	373,807
Wind	101,738	-	101,738
Geothermal	5,768	-	5,768
Bioenergy/CHP	26,014	104,663	130,677
Corn Ethanol	-	28,613	28,613
Other Ethanol/Non-Woody Biomass, incl. Biodiesel		23,088	23,088
Woody Biomass Fuel for Energy and Cellulosic Biofuels		30,458	30,458
Other Biofuels	-	22,504	22,504
Low Impact Hydroelectric Generation	9,295	-	9,295
Traditional Hydropower	56,259	-	56,259
Nuclear	68,176	8,595	76,771
Coal	86,035	74,084	160,119
Natural Gas	52,125	309,993	362,118
Oil/Petroleum	12,840	502,678	515,518
Advanced Gas	36,117	-	36,117
Other Generation/Other Fuels	32,695	82,736	115,431
Totals	**860,869**	**1,187,412**	**2,048,281**

Non-emitting power generation includes: solar, wind, geothermal, hydropower, and nuclear. In 2016, total employment from these sources was 623,638.

Source: U.S. Department of Energy 2017.

demand after the phase-out of U.S. federal tax credits over the next five years.[34] Other industries, like solar energy, are adopting automated technologies and creating efficiencies in panel and component design that reduce the demand for labor in manufacturing.[35]

Electricity portfolio standards can be particularly effective at promoting the creation of local well-paying construction and operations and maintenance jobs – a valuable ancillary benefit of clean electricity deployment. NREL concluded that in 2013, renewable electricity generated to satisfy RPS obligations contributed more than $20 billion to gross domestic product, resulting in nearly 200,000 jobs with an average salary of $60,000 per year. As many as 170,000 of these jobs involved construction (mostly for solar PV installation), while over 30,000 jobs involved operations and maintenance (mostly for wind energy facilities). In 2013, California had the most onsite jobs in renewable energy because it experienced the largest expansion of renewable energy capacity and generation as a result of RPS obligations.[36] Moreover, with U.S. solar deployments expected to increase 10-fold and wind capacity expected to nearly double by mid-century, non-manufacturing clean energy jobs are forecast to experience strong growth. In fact, the Bureau of Labor Statistics projects that solar PV installer and wind turbine technician will be among the fastest growing jobs in the next 10 years.[37] Note that gains in clean electricity employment (including for carbon capture) would be offset to some extent by likely job losses from carbon-emitting electricity sources (e.g., coal-fired generation and coal mining).

V. ADVANTAGES AND DISADVANTAGES OF A CES

A CES offers advantages and disadvantages compared both to other types of policies for increasing clean energy generation and to the policy status quo.

ADVANTAGES OF A CES

A Flexible, Market-based Policy

A CES sets a target for clean energy. Those that meet and exceed the target are often allowed to generate credits which can be sold to other generators that face a higher cost of compliance. The market for these credits results in a market signal (i.e., the credit trading price) which provides an incentive for electric utilities, merchant generators, regulators, and other entities to invest in new cleaner generation, retirements, retrofits, utilization, and energy efficiency programs. The market signal under a CES directs these actors to seek the least-cost approach for achieving the policy's aggregate goal for clean energy.

The use of tradable credits to demonstrate compliance gives electric utilities compliance flexibility and helps to keeps costs low since no electric utility needs to generate or deliver any specific quantity of clean energy by itself. Rather, electric utilities can generate or deliver more or less clean energy themselves and sell or buy credits accordingly depending on whether they have relatively more or less access to low-cost clean energy sources. Beyond this basic degree of compliance flexibility, a CES can also include other forms of flexibility such as a broad array of qualifying energy sources, temporal compliance flexibility (banking and borrowing of credits), and various policy options for keeping costs manageable (see Chapter VIII below for more details on the flexibility mechanisms).

Investment Guidance for Utilities and Other Power Generators

A CES policy can also create a more predictable regulatory future for power generators. In today's policy environment, utilities and merchant generators are in a bind. For the most part, there is an expectation that future regulatory requirements will demand a transition to clean energy and much lower emissions of air pollutants in coming decades. EPA air pollution regulations, state and regional greenhouse gas cap and trade programs like the Regional Greenhouse Gas Initiative (RGGI) in northeastern states, and state RPS policies are already pushing in this direction. New state, regional, and federal programs will likely require even greater emission reductions and clean energy generation than these policies; however, the total amount of clean energy required and the schedule on which it is needed is mostly unknown. The same can be said for the stringency of future air pollution requirements.

All of this uncertainty makes it difficult, and risky, to determine when and how much to invest in clean energy, pollution controls, or conventional fossil fueled power plants. On the one hand, utilities cannot be certain that regulators will allow them to recover the costs of clean energy investments (i.e., if it is not a least-cost investment or legislative mandate) if investment decisions are based purely on speculation about future requirements, and merchants that invest too much or too soon could lose a lot of money. Merchants may also find that their access to capital is reduced because of regulatory uncertainty.[38] On the other hand, delaying action until the policy issues become resolved has its own risks, financial and otherwise, and in some cases isn't even an option. Some utilities need to make decisions about capacity additions, power plant retirements, or pollution controls immediately or in the very near term. These decisions frequently come with a price tag of tens or hundreds of millions of dollars, or even billions, and deciding what is best requires the utility and the regulator to make assumptions about future regulatory requirements. If those assumptions turn out to be wrong, somebody—shareholders, ratepayers, or both—will pay the price.

One of the underappreciated effects of regulatory uncertainty is that it can, over time, create capacity and reliability problems. If regulatory uncertainty makes utilities and merchants unwilling or unable to invest in new power plants or pollution controls, or continue to invest in preserving existing zero carbon resources that would not be profitable without a value on clean electricity, demand growth may eventually put pressure on existing capacity. This phenomenon was experienced in some parts of the country in the 1990s, when uncertainty about the deregulation of electricity markets caused a slow-down in new power plant construction.

With a long-term CES policy in place, utilities would likely have a much better sense of what is expected of them, and they could make investment decisions that regulators are likely to view as necessary, prudent, and in the public interest. Similarly, merchant generators would have the knowledge about supply and demand that they need to make investment decisions that are best for their bottom line. It is important that polices encourage both utilities and merchant generators to invest in clean electricity to provide the most benefit to consumers.

Broad Political Appeal

State and federal policymakers have enacted or at least considered a variety of policies other than a CES that would have the effect of increasing clean energy generation. Other key policy options include renewable portfolio standards, cap-and-trade programs, and traditional emission performance standards (see **Appendix D** for a comparison of a CES to these other policy options).

A CES policy may offer the promise of a way forward on a long-term policy for promoting clean energy and reducing pollution from the power sector that minimizes regional disparities and may be less politically charged or controversial than many alternatives. This is borne out by the fact that a substantial majority of U.S. states have enacted renewable or alternative energy portfolio standards already under the leadership of both major political parties.

If renewable and alternative energy portfolio standards have proven popular among the states, there is reason to think a CES could also be popular. Many of the states that have thus far eschewed renewable portfolio standards policies are fossil fuel exporters and may view renewable energy as a threat to those industries. However, some of these states may be more receptive to policies that also encourage cleaner fossil fuel use with CCUS, and preserve and grow nuclear power.

For example, in terms of the percentage of electric generation fueled by coal in each state, the top five states are West Virginia, Wyoming, Missouri, Kentucky and Indiana. Four of these states (all but Missouri) also rank in the top 10 states for coal production, producing nearly two-thirds of U.S. coal. Indiana, Kentucky, West Virginia, and Wyoming do not currently have a mandatory RPS policy. West Virginia, which ranks number one in coal generation percentage and number two in coal production, repealed its Renewable and Alternative Energy Standard in 2015, which (when passed in 2009) provided credit to a wide range of energy sources—including renewables, natural gas, and advanced coal technologies. In 2011, Indiana enacted a voluntary clean energy goal that recognizes natural gas and nuclear power. The Indiana example demonstrates that a broadly defined CES may appeal to a state that might not be receptive to renewable energy standards. This appeal might also hold at the federal level.[39]

The CES is a relatively new idea, attempted by a few states and currently reattracting federal attention, but it may offer a politically palatable way for states that already have an RPS as well as those that do not to spur clean energy deployment and for federal policymakers to find common ground to establish national goals for clean energy.

DISADVANTAGES OF A CES

Any given policy, including a CES, may also have its disadvantages. Several disadvantages are worth mentioning and deserve further exploration. For example, a key challenge is defining “clean energy,” for which there is no universal definition. One person’s preferred CES may not promote the technologies preferred by another person. Determining what technologies qualify as “clean” under a CES has implications for achieving the policy objectives, and for the cost-effectiveness of the program. Another challenge is that the diversity of state electricity portfolio standards—with different clean energy definitions and target goals—may complicate efforts to harmonize the state standards or to create harmony between a federal standard and state standards. This could lead to higher CEC prices than under a harmonized approach and raise administrative and compliance costs. Furthermore, any increases in electric bills will impact lower income households the hardest, and since there is no revenue being generated from a CES, there’s no clear-cut way to address any potential regressivity of the program as there would be for a carbon price.

Another disadvantage is the (local and regional) employment and economic impacts around retiring conventional fossil-fuel power generation. Large, rural (and other) power plants contribute significantly to the local tax base and often provide a large percentage of community employment. Again, since there is no revenue generated from a CES, support for retraining workers and providing economic assistance to rural communities could be challenging.

For those who view reducing pollution as a key objective of a CES, one disadvantage of a CES may be that it increases the portion of generated electricity that is clean but does not guarantee an absolute level of pollution reduction. Given that the amount of electricity generated by each facility varies with supply and demand, it would not be practical for policymakers to use a CES to guarantee a specific absolute level of pollution reduction.

Also, since a CES is a power-sector-specific policy whose tradable credits are likely denominated in units of clean electricity generation instead of absolute pollution reduction, it is more difficult (but not impossible) to link and expand the CES to programs focused on other sectors (like transportation or manufacturing).The advantages and disadvantages of specific design aspects of a CES are further examined in Chapter VIII.

VI. FEDERAL CES PROPOSALS

The idea for a federal clean energy standard (CES) has recently reemerged from policymakers. Congress last considered a CES proposal in 2012. Since then, the U.S. electricity sector has transformed significantly. CES proposals introduced in 2019 reflect these changes. This chapter briefly summarizes elements of past congressional CES proposals and compares them with recent proposals introduced in 2019. **Table 2** contains more detail on these proposals.

PAST CONGRESSIONAL PROPOSALS

Past congresses have seen proposals for a national electricity portfolio standard. Congress has several times debated a federal renewable electricity standard (and the House and Senate have even separately passed such standards). The 111th Congress (2009–2010) saw passage in the House of Representatives of a federal renewable electricity standard as part of a comprehensive climate and energy bill (the Waxman-Markey American Clean Energy and Security Act of 2009). The Senate saw the introduction of three proposals for federal electricity portfolio standards in 2010—one renewable electricity standard by Sen. Jeff Bingaman (D-N.M.), and two CES proposals by Sens. Richard Lugar (R-Ind.) and Lindsey Graham (R-S.C.). In the 112th Congress (2011–2012), Sens. Bingaman and Lisa Murkowski (R-Alaska) released a CES white paper in 2011 that solicited feedback from stakeholders on the design of a federal CES.[40] Based on stakeholder feedback, Senator Jeff Bingaman introduced his clean energy standard in 2012.[41]

RECENT CONGRESSIONAL PROPOSALS

After a seven year hiatus, there is a new CES proposal in Congress. Since that time, the U.S. electricity system has changed significantly; natural gas has overtaken coal to become the largest source of electricity generation, the cost of renewables have fallen significantly, and a number of nuclear plants have closed before their planned retirement date.

In 2019, Sen. Tina Smith (D-Minn.) and Rep. Ben Ray Luján (D-N.M.) introduced a CES proposal (Smith-Luján) that would require at least 90 percent of U.S. electricity to come from clean energy sources by 2050. The plan would fully count (i.e., full credit) all zero-emission sources, but any generator with a lower carbon intensity than that of the current average of the U.S. electricity grid (i.e., 882 pounds or 0.4 metric tons of CO2 per megawatt-hour) would still be able to count in a partial way (i.e., partial credit). The proposal also acknowledges that states and utilities have achieved different levels of clean energy in their electricity mixes. Utilities with less than 60 percent clean energy would be required to increase their clean energy at a greater rate than those that have hit the 60 percent clean energy mark. The plan is viewed as a minimum or floor; states can work to decrease their carbon intensity more quickly if they wish.

Table 2 summarizes the last three Senate proposals for a federal clean energy standard. It highlights several important differences that point out the range of potential objectives and designs for a CES. Among other things, the CES proposals differed in terms of how they defined clean energy, how they treated energy efficiency, how they limited the cost impacts of the policy, and how much incremental clean energy generation they would require beyond "business as usual."

TABLE 2: Comparison of Senate Federal Electricity Standard Proposals

	CLEAN ENERGY STANDARD ACT OF 2010 (S.20)	CLEAN ENERGY STANDARD OF 2012 (S.2146)	CLEAN ENERGY STANDARD ACT OF 2019 (S.1359)
Sponsor	Sen. Lindsey Graham (R-S.C.)	Sen. Jeff Bingaman (D-N.M.)	Sen. Tina Smith (D-Minn.)
Policy	CES	CES	CES
*Point of Regulation**	Electric utilities	Electric utilities	Electric utilities
Qualified Energy Sources	Non-hydro renewables, incremental hydropower, coal with CCS, incremental nuclear power.	Renewables, nuclear power, fossil fuel use with CCS, and efficient combined cycle natural gas plants (partial credit), qualified biomass, qualified CHP	Renewables, nuclear power, qualified CCS, qualified biomass, qualified CHP, and qualified energy storage.
Coverage	Retail electric utilities with sales of less than 4 million MWh per year are not covered.	Retail electric utilities with sales of less than 2 million MWh per year are not covered. The sales threshold decreases 100,000 MWh per year until the threshold reaches 1 million MWh.	Large retail electric utilities (with sales of at least 2 million MWh per year) and small retail electric utilities (with sales between 20 MWh and 2 million MWh per year).
Targets (% of Base Quantity of Electricity Sales to Come from Qualified Energy Sources or Efficiency)	2013–2014 13.0% 2015–2019 15.0% 2020–2024 20.0% 2025–2029 25.0% 2030–2034 30.0% 2035–2039 35.0% 2040–2044 40.0% 2045–2049 45.0% 2050 50.0%	2015 24% 2020 39% 2025 54% 2030 69% 2035 84%	Large retail electric utilities have a target that increases 2.75% annually until reaching 60 percent, at which point the target increases 1.75% annually. Small retail electric utilities have a target that increases 1.5% annually. All retail electric utilities will have a maximum clean energy target of 90% until 2040, at which point the target increases 1% annually until reaching 100% in 2050.
Exclusions from Base Quantity of Electricity Sales	Existing hydropower and MSW.	Nuclear or hydropower placed in service before 1992.	None specified.
Energy Efficiency	Credits for electricity savings from efficiency can be used for up to 25% of compliance.	Credits at least for industrial CHP.	Credits for qualified CHP.
Alternative Compliance Payment	$35/MWh	$30/MWh, and increasing 5 percent annually annually.	$30/MWh, and increasing annually 3% above inflation until 2030 and then increasing annually 5% above inflation.
Other Notable Provisions	Credits for early retirement of coal plants and generator-side efficiency improvements.	Unlimited banking.	Initially, credits can be banked for three years until 2040, credits can be banked for two years from 2040 to 2050, and credits can be banked for one year after 2050.

* Each of the bills summarized in uses the definition of "electric utility" from the Public Utility Regulatory Policies Act of 1978 (PURPA), 16 U.S.C § 2602(4)—i.e., any person, state agency, or federal agency, which sells electric energy—and applies the portfolio standard requirement to electricity sales to consumers for purposes other than resale.

VII. STATE AND REGIONAL CES OPTIONS

As of August 2019, 29 states and the District of Columbia have adopted some form of mandatory RPS policy through legislation, regulation, or public utility commission order (**Figure 1**). Another seven states have adopted non-mandatory renewable portfolio goals. Also, 12 states (California, Colorado, Connecticut, Illinois, Indiana, Massachusetts, Nevada, New Mexico, New Jersey, New York, Pennsylvania, and Washington) have either expanded their portfolio standard or adopted complementary clean energy policies that when considered in aggregate could constitute a clean energy standard. In addition, 23 states and the District of Columbia have established mandatory long-term energy savings targets through an Energy Efficiency Resource Standard (EERS), with six other states having a non-mandatory energy savings goal.[42] In some of these cases, the state RPS policy is combined or linked to the EERS policy.

Some of the lessons learned from these state policies are summarized in this chapter. Based on these lessons, this report also considers some fundamental questions about how to transition from dozens of individualized state RPS policies into a more consistent set of regional or national CES policies.

LESSONS LEARNED FROM STATE ELECTRICITY PORTFOLIO STANDARDS

Perhaps the most important lesson to be learned from state RPS programs is that they succeed in accelerating the deployment of renewable resources. Since 2000, 52 percent of the 140 GW of renewable capacity was at least partially motivated by RPS policies.[43] Another clear (and expected) lesson is that state RPS policies tend to result in the deployment of the least expensive available renewable energy options. In most states, this has meant utility-scale wind power projects, but solar projects have come on strong in recent years too. State RPS policies are given a good deal of the credit for establishing a viable wind turbine supply chain in the United States, along with training and credential programs and some domestic manufacturing facilities. A third key lesson is that the impact of RPS policies on electricity rates is difficult to isolate from other factors that influence prices. Another lesson is that the impact depends on geographic location. In the Northeast, Mid-Atlantic, and West, RPS has been a larger driver. In Texas, the Midwest, and Southeast, the RPS impact has been less.[44] The RPS has been achieved in Texas, and in the southeast, renewable energy growth is primarily due to the Public Utility Regulatory Policies Act and utility procurement. Overall, the share of RPS driven new renewable energy projects has declined, from 60 percent from 2008–2014 to 34 percent in 2017.[45] An additional lesson is that even states with voluntary goals can spur renewable energy development. In South Carolina, renewable energy projects increased from just 5 MW in July 2015 to 470 MW in July 2018 after adoption of a renewables goal in 2014.[46]

While these broad lessons about RPS policies are useful, a few states have adopted more expansive policies, which credit non-renewable, non- and lower-emitting fossil, and other electricity sources to expand their clean energy resources. Some states refer to their expanded programs as clean energy standards (e.g., New York and Massachusetts), while others use names like Alternative Energy Portfolio Standard. There are currently 12 states (California, Colorado, Connecticut, Illinois, Indiana, Massachusetts, Nevada, New Mexico, New Jersey, New York, Pennsylvania, and Washington) that have either expanded their portfolio standard or adopted complementary clean energy policies that when considered in aggregate could constitute a clean energy standard.[47] These ancillary (or complementary) policies function either as tiers or carveouts (discussed in greater detail in Chapter VIII) to electricity portfolio standards and create a parallel systems of credits (e.g., zero-emission credits or ZECs). Note that Indiana's 2025 and Nevada's 2050 targets are goals, not requirements. **Table 3** highlights some of the features of these state programs and the next subsection examines a subset of these states in greater detail.

TABLE 3: Summary of Clean Energy States

STATE	POLICY ACTION	COMMENT
California	In 2018, California expanded its RPS with the following targets: • 60 percent renewables by 2030, • 100 percent renewables and zero-carbon energy by 2045.	With regard to the final 40 percent of clean energy, California has left the door open for all non-carbon emitting sources, including nuclear power, large hydropower, and fossil fuel electricity with CCS.
Colorado	In 2019, Colorado enacted a broad overhaul of state utility regulation, which requires power companies to consider the social costs of carbon when submitting resource plans, and to include in those plans roadmaps for reducing their emissions 80 percent by 2030 and 100 percent by 2050 from 2005 levels.	
Connecticut	Connecticut procures its zero-carbon electricity through an auction administered by the Department of Energy and Environmental Protection (DEEP). In late 2017 after the governor signed legislation, nuclear power plants became eligible to participate in the auction. In its most recent auction, it accepted bids from two nuclear plants.	Led to the signing of a 10-year PPA with in-state Millstone Nuclear Power Station. Additionally, a bid was accepted from the Seabrook Nuclear Power Station in New Hampshire. Owners of both plants had signaled that these facilities were economically challenged and could close prematurely.
Illinois	In late 2016, Illinois passed the Future Energy Job Act, which, among other things, established a zero-emission credit (ZEC) program for eligible, in-state nuclear power plants (see details below).	Effectively, Illinois provides parallel credits. The ZEC program in conjuction with the state's RPS supports maintaining and developing a substantial quantity of clean electricity. The Act was supported by broad collection of Illinois stakeholders that included consumer, environmental justice, renewable developers and nuclear operators.
Indiana	Indiana has a voluntary clean energy portfolio standard. And up to 30 percent of its goal may be met with non-renewable and cleaner electricity sources like, nuclear energy, combined heat and power, and natural gas that displaces electricity from coal (see details below).*	By expanding the definition of clean electricity, a state is able to achieve its goal sooner, send an important low-carbon innovation signal, and lay the groundwork for increasing clean electricity ambition over time.
Massachusetts	Massachusetts adopted a clean energy standard in 2017 (see details below).	
Nevada	In 2019, Nevada increased the ambition of its RPS to require 50 percent renewable electricity by 2030, and a goal of 100 percent of total electricity sales from zero carbon dioxide emission resources by 2050.	Nevada allows up to 50 percent of its 2050 clean electricity goal to be met by non-renewable, non-emitting resources.

STATE	POLICY ACTION	COMMENT
New Mexico	In 2019, New Mexico expanded its RPS, with the following interim renewable energy targets for its public utility's total retail sales: • by Jan 1, 2020, 20 percent renewables • by Jan 1, 2025, 40 percent renewables • by Jan 1, 2030, 50 percent renewables • by Jan 1, 2040, 80 percent renewables • by Jan 1, 2045, zero-carbon resources shall supply one hundred percent of all retail sales of electricity in New Mexico.	Similar to California, New Mexico allows zero-carbon resources to meet the last 20 percent of its goal. Zero carbon resources include resources that do not emit carbon dioxide into the atmosphere, or that reduce methane emitted into the atmosphere in an amount equal to no less than one-tenth of the tons of carbon dioxide emitted in atmosphere, as a result of electricity production.
New Jersey	In 2018, New Jersey adopted a ZEC program as part of a comprehensive Clean Energy program through the legislative process.	New Jersey provides parallel credits. Similar to Illinois and New York, the ZEC program in conjuction with the state's ambitious RPS supports maintaining and developing a substantial quantity of clean electricity.
New York	In 2016, New York adopted a clean energy standard which is composed of a renewable energy standard and a zero emission credit requirement (see details below).	New York's clean energy standard provides parallel crediting. The renewable energy standard requires load serving entities to procure 50 percent of their electricity from renewable sources by 2030. Load serving entities are also required to procure zero emission credits from nuclear power.
Pennsylvania	Alongside renewable electricity, Pennsylvania's alternative energy portfolio standard allows coal mine methane, waste coal, and coal integrated gasification combined cycle to count toward its target (see details below).	
Washington	In 2019, Washington passed legislation to source 100 percent carbon-neutral electricity by 2030. Notably, 80 percent of the state's power must come from non-emitting electric generation and electricity from renewable resources.	Similar to other states in this list, Washington has expanded the definition of clean electricity to achieve its target far more quickly than any other state.

** Indiana General Assembly 2019 Session, "Chaper 37. Voluntary Clean Energy Portfolio Standard Program," accessed June 14, 2019, http://iga.in.gov/documents/8850f79f.*

Illinois

In 2016, Illinois updated its renewable portfolio standard, requiring 25 percent of electricity sales to come from renewable energy sources by 2025. For electric utilities, 75 percent of renewable energy procured must come from wind. For alternative retail electric suppliers, 60 percent of renewable energy procured must come from wind and 6 percent must come from solar. Other electricity sources that qualify include biomass, anaerobic digestion, and biodiesel.

Although the state's renewable portfolio standard does not include nuclear power as a qualifying resource, a complementary policy called the Future Energy Jobs Act was passed to create a zero emissions standard for nuclear assets.[48] The Illinois Power Agency procures ZECs to meet an annual volume requirement of approximately 20,100,00 credits. The price of a ZEC considers the social cost of carbon and the Illinois Commerce Commission determines whether ZECs are cost-effective.[49] Similar to New York, the ZEC program is a means of preserving a state's nuclear fleet.[50] Though it is not branded as a clean energy standard, the Future Energy Jobs Act is a complementary policy to a renewables portfolio standard that can maximize environmental benefits by sourcing energy from a broader range of zero- and low-emitting resources.

Indiana

Indiana enacted its Voluntary Clean Energy Portfolio Standard in May 2011. The law creates clean energy incentives (described below) rather than requirements for public utilities. In order to receive incentives, a utility must apply for the program and be approved by the Indiana Utility Regulatory Commission. To be approved, the utility must demonstrate to the commission's satisfaction that in the year 2025 the utility has a reasonable expectation of obtaining from qualified energy resources an amount of electricity equal to 10 percent of its total base year (2010) retail sales. There are also two multi-year interim targets that the utility must meet in order to maintain eligibility for incentives: in the years from 2013 through 2018, the annual average percentage from qualified resources must equal four percent of base year sales, and from 2019 through 2024 the annual average must equal seven percent of base year sales.

In addition to a typical list of qualifying renewable resources, Indiana's voluntary program recognizes electric generation or savings from energy efficiency and other demand-side management programs; energy storage systems; distributed generation; coal bed methane; CHP and waste heat recovery; nuclear power; and natural gas from a facility constructed in Indiana after July 1, 2011, which displaces electricity generation from an existing coal fired generation facility.

The law is very specific about the incentives that the commission is authorized to provide to participating utilities. If a participating utility can attain the stated clean energy goals, the commission has discretion to award shareholder incentives in the form of an increased overall rate of return on equity, not to exceed 50 basis points over the utility's authorized rate of return. The number of additional basis points authorized by the commission may be different for each of the goal periods, as the commission determines appropriate, and may also be based on the extent to which the participating utility met its goal using renewable resources. Participants are also assured of cost recovery through a periodic rate adjustment mechanism.

Massachusetts

Massachusetts has a renewable portfolio standard, an alternative portfolio standard, and a clean energy standard. In 2008, Massachusetts updated its renewable portfolio standard, requiring 15 percent of electricity sales to come from new renewable sources (installed after 1997) by 2020 and increase 1 percent annually thereafter.[51] Qualifying new renewable sources (Class I) include: solar, wind, small hydropower, landfill gas, marine or hydrokinetic, geothermal, and eligible biomass.[52] The renewable portfolio standard also requires a certain amount of electricity sales to come from existing renewable sources (operating before 1998). The annual percentage varies annually per a formula in the regulation. Qualifying existing renewable sources (Class II) include: solar, wind, small hydropower, landfill gas, marine or hydrokinetic, geothermal, eligible biomass, fuel cells using renewable fuels, and waste to energy.[53]

Complementing the commonwealth's renewable portfolio standard is its 2009 alternative portfolio standard, requiring 5 percent of electricity sales to come from alternative energy generation by 2020 and increasing 0.25 percent annually indefinitely.[54] Qualifying alternative energy generation include: combined heat and power, flywheel storage, and efficient steam storage.

Massachusetts adopted a clean energy standard in 2017, requiring 80 percent of electricity sales to come from clean energy sources by 2050.[55] The clean energy requirement is in addition to the renewable portfolio Class I requirements, though compliance with renewable portfolio Class I counts towards the CES. Qualifying clean energy technologies include: Class I renewable sources, and energy technologies that have a net lifecycle greenhouse gas emissions of at least 50 percent below a combined-cycle natural gas plant over a 20 year life cycle. Additionally, technologies must have begun operation after December 31, 2010 and be located either in ISO New England or in an adjacent control area using new transmission capacity. The CES is intended to be complementary to the RPS, since the CES requirements are on top of the RPS Class I regulations. However, a key difference is that the CES uses an emissions-based performance standard to identify eligible resources, while the RPS does not.

It is expected that credits for energy technologies that demonstrate a greenhouse gas footprint of at least 50 percent below a combined cycle natural gas plant will not be available until 2020. Since the first compliance deadline is not until the middle of 2019, no reports on the CES are available at the time of this report's publication.

New York

New York adopted a CES in 2016, requiring 50 percent of the electricity consumed in the state to come from renewable energy sources by 2030.[56] The CES is divided into two parts. The first is the Renewable Energy Standard (RES), a continuation of the Renewable Portfolio Standard. Qualifying renewable resources include: biogas, biomass, liquid biofuel, fuel cells, hydroelectric, solar, ocean or tidal power, and wind. The second part of the standard is the Zero-Emission Credit (ZEC) program, which was created in order to preserve existing nuclear assets as the premature closure of nuclear power plants is expected to lead to an increased reliance on fossil fuel power plants.[57] In-state, qualified nuclear power plants are currently receiving ZEC payments.

New York's CES is notable because renewables and nuclear are segregated into different categories. And while the RES portion of the CES specifies the percentage of electricity sales to be derived from qualifying renewables (i.e., like a typical RPS), the ZEC portion does not. Separately, the ZEC policy addresses the wholesale market's failure to compensate nuclear plants for their environmental (i.e., zero-emitting) characteristics. Thus far, New York's ZEC program has withstood legal scrutiny.[58] A complementary approach that the state is currently working toward will incorporate a carbon price directly into the wholesale power market (i.e., NY ISO), which will affect all generating technologies equally.[59]

In 2019, New York enacted the Climate Leadership and Community Protection Act. The CLCPA requires the State to achieve a carbon free electricity system by 2040 and reduce greenhouse gas emissions economy-wide 85 percent below 1990 levels by 2050, setting a new standard for states and the nation to expedite the transition to a clean energy economy.

Pennsylvania

Pennsylvania's electricity portfolio standard (called the Alternative Energy Portfolio Standard) was adopted in 2004. It requires utilities to increase their use of clean energy resources each year, with a final target of generating eight percent of all electricity from "Tier I" energy resources and ten percent from "Tier II" energy resources in 2021. Tier I sources include solar photovoltaic and thermal, low-impact hydro, biomass, coal-mine methane, biologically derived methane gas, and fuel cell resources. Tier II includes demand side management and energy efficiency measures, waste coal, coal gasification, coal-mine methane and distributed generation.[60] As of April 2019, Pennsylvania is considering adding nuclear power as a qualifying resource to its standard.

HOW MIGHT EXISTING STATE RPSS BE EXPANDED TO/COMPLEMENTED BY CES?

Regardless of the existence of a federal CES, states that already have an RPS policy could certainly choose to expand the list of resources that qualify for their own standards. If states wish to increase both renewable and non-renewable clean energy, the early results from some of the first experiments with a CES suggest that the targets and schedule would need to be adjusted accordingly to ensure that the policy change does not result in a substitution of one for the other. In other words, a state that currently has a 25 percent by 2025 RPS will not promote additional clean energy deployment if it switches to a 25 percent by 2025 CES that includes natural gas, though it may reduce compliance costs for utilities. Instead the state should consider higher targets and/or a more aggressive schedule when it expands from an RPS to a CES.

If a federal CES policy is adopted, depending on its ambition, states might simply choose to comply with the federal standard in lieu of the state standard, enjoying the environmental and economic efficiency benefits and administrative simplicity of a national program. For example, they could take advantage of the flexibility to trade clean electricity credits with other states. Many states are acting to fill the federal vacuum, and if that vacuum is filled rationally by a national policy, states may no longer need additional state portfolio policies. Other states may wish to retain their RPS or other portfolio policies if they want to ensure (and control) the amount of clean electricity that is in their supply mix or express local preferences about which clean electricity resources are most valued. One way to allow state RPS policies to operate concurrently with a federal CES policy would be to develop tracking systems that assign multiple distinct credits to each unit of clean energy generation. For example, a megawatt-hour of generation that is considered "clean" under both laws would receive one federal CES credit and one state RPS credit. The owner of the credit would separately retire the federal CES credit for federal compliance purposes and the RPS credit for compliance in any one state where the credit would qualify for RPS compliance purposes (see Chapter VIII: Keeping State and Federal Programs Distinct and Separate.[61]

POTENTIAL FOR REGIONAL COORDINATION AND MULTI-STATE PROGRAMS

As previously noted, in the absence of a federal CES policy states could expand their RPS policies to become CES policies. Another option would be for states to pursue coordinated and harmonized multi-state or regional policies. These regional programs could be along the lines of a traditional RPS, or a CES.

Some regional coordination has already occurred with respect to RPS credit tracking systems, and many state policies allow the use of credits from generation in other states, particularly when the state is contiguous or part of the same wholesale power market. What has not happened, however, is a more systematic effort to harmonize across states the types of eligible resources, the targets and schedule, or other requirements. To the extent that common definitions of "clean" are adopted across jurisdictions, credit trading programs and tracking systems can be much simpler. Most regional transmission operators (RTO) have an environmental attribute tracking system, such as PJM's GATS that can be used to track and confirm state compliance with regional programs.[62]

The Regional Greenhouse Gas Initiative (RGGI) may provide a useful example of how states collaborated on a regional policy affecting the electricity sector. Although differences do exist in the policies of each state, they all fit into a single regional framework for achieving a regional greenhouse gas reduction target. In addition, the states worked with three different regional power pools to coordinate consistent tracking systems. The same thinking could be applied to achieving a regional clean energy target.

VIII. CES POLICY DESIGN OPTIONS AND IMPLICATIONS

This chapter describes the options for key clean energy standard (CES) policy design parameters and the implications of different choices. As described in Chapter III, increasing the share of electricity provided by clean sources can advance a range of important objectives—including improving the environmental and public health profile of electricity generation, diversifying the generation supply, and fostering clean energy industries and jobs. Choosing one policy design over another, however, may have the effect of favoring one objective over another.

Design choices may also be evaluated in light of additional criteria, including:

- Effectiveness—what is the magnitude of the policy's desired impacts?
- Affordability—does the policy balance the benefits associated with increased clean power generation against the cost impacts of the policy?
- Cost-effectiveness—how efficiently does the policy achieve its intended aims?
- Fairness—does the policy unfairly burden particular groups or lead to any undue burdens or unearned windfalls for particular utilities, power generators, or customers?
- Interoperability with emission reduction programs in other sectors – how can the policy be expanded to increase emission reduction opportunities?

Design choices may be further evaluated with **Equations 1 and 2** below, which highlight the difference between the "nominal" amount of clean energy required under a CES and the actual amount of clean energy generated. They also help explain one of the most important and least understood facets of CES design: the impact of defining "base quantity of electricity sales."

One can think of a CES as defining a simple equation that electric utilities must balance:

EQUATION 1: Illustration of CES Requirement for an Electric Utility

$$\text{CES \% Requirement} = \frac{\text{Qualified Clean Energy Generation}}{\text{Base Quantity of Electricity Sales}}$$

Equation 1 highlights three of the most important policy design decisions for a CES, namely:

1. What is the nominal annual percentage requirement for electric utilities under the CES?
2. What receives credit under a CES as qualified clean energy generation?
3. To what base quantity of electricity sales does the CES percentage requirement apply?

The distinction between the nominal annual percentage requirement of a CES and the total amount of clean energy that is actually generated under the CES is illustrated by **Equation 2.**

Equation 2 illustrates the possibility that the nominal annual percentage requirement of a CES—the number by which the CES is known to most of the public—will not be the same as the amount of clean energy that will actually be generated under the CES. While policymakers may be familiar with the impact that the definition of qualified clean energy will have on the difference between the nominal requirement and the actual generation of clean energy, what is often less

EQUATION 2: Decomposition of Total Clean Energy Generation under a CES into Relevant Parts

$$\text{CES \% Requirement} = \frac{\text{Qualified Clean Energy Generation} + \text{Other Clean Generation}}{\text{Base Quantity of Electricity Sales} + \text{Other Electricity Sales}}$$

understood is the importance of defining the base quantity of electricity sales, as discussed throughout this chapter.

Specific design choices can have an outsized impact in tackling the climate challenge. For example, designing a CES that is compatible with other sectors (beyond electric power) is beneficial in a couple of important ways. First, expanding the market of covered emissions creates greater opportunities for emission reductions and credit creation, which increases the economic efficiency of the overall system. Additionally, over the next several decades, cleaner electricity will be increasingly incorporated in other sectors (as a climate solution), particularly electric vehicles in transportation, but also electric heat pumps in the buildings sector, among other things. The ability to integrate market-based mechanisms between sectors can facilitate that transition and provide a strategic advantage.

POINT OF REGULATION

The "point of regulation" refers to the entity upon which the compliance obligation is imposed under a CES. The choice for policymakers is between: 1) regulating electric utilities and making their CES compliance obligation a function of their electricity sales; and 2) regulating generators and making their CES compliance obligation a function of their electricity generation.[63] A majority of states already have renewable or alternative energy standards, and all of them have placed this obligation on electric utilities. To date, congressional renewable portfolio standard (RPS) and CES proposals also place the regulatory obligation on electric utilities.[64]

Historically, however, some have argued for reconsidering the point of regulation. In particular Joseph Aldy (2011) and Dallas Burtraw et al. (2011) have suggested that the obligation should be on electricity generators (i.e., at the facility level) rather than electric utilities.[65] Aldy proposes a national clean energy standard with a point of regulation on power generators rather than electric utilities for the purposes of administrative simplicity and to avoid creating an incentive for industry to adopt on-site fossil fuel generation to evade any potential electricity price increases associated with the CES. Burtraw argues that placing the obligation on electric utilities is a "blunt" instrument that treats large categories of existing facilities (e.g., all coal plants) as a homogeneous group, despite substantial variations in heat rates and CO_2 intensities. He also argues that putting the standard on utilities provides limited or no incentives for generators to improve their efficiencies. Nevertheless, he acknowledges, several reasons for placing an obligation on electric utilities; chiefly, through their regulated status, electric utilities are in a unique position with respect to promoting end-use energy efficiency and network efficiency (in terms of transmission and distribution).

Finally, there are two additional reasons for focusing the requirement on utilities. First, if a given generator (i.e., single facility) is made the point of regulation, that generator would have few compliance options.[66] Second, having the point of regulation at the utility level allows for the implementation of a complementary fleet-level performance standard (i.e., technology-based emission rates for emitting sources), which could be ratcheted down over time to achieve a long term target. Under a baseline-and-credit system, this would allow overachievers to earn credits (i.e., tons of CO_2), which could be more easily traded between sectors.

COVERAGE

The coverage of a CES refers to the set of entities at a particular point of regulation that are subject to a CES. Assuming the point of regulation is on electric utilities, two issues to address are whether small utilities should be exempt from requirements, and whether certain types of utilities should be exempt based on ownership structure.

EXEMPTIONS BASED ON UTILITY SIZE

Previous federal electricity portfolio standard proposals have included exemptions for smaller utilities (see Chapter VI). However, an exemption for small utilities can substantially weaken a CES's effective target and shift the responsibility for achieving a national goal for clean electricity generation to a subset of utilities and ratepayers. Policymakers should evaluate whether such an exemption is justified in light of the following considerations.

By its very nature as a market-based program, a CES does not impose disproportionately higher costs on smaller utilities simply as a function of their smaller scale. This is in contrast to command-and-control environmental regulations which require the installation of specific pollution controls on specific sources—requirements that have less impact on electricity costs (in $/kW of capacity) at larger plants because of economies of scale. For such pollution controls, smaller utilities that own or are supplied by smaller power plants, or that depend heavily on a few large plants, would likely face higher costs than larger utilities. Under a CES, all utilities—small and large—can determine the most cost-effective strategy for meeting the CES requirements through a combination of increased clean generation from self-owned facilities, purchase of clean energy credits (CECs), or some other compliance means allowed under the program.

Second, the current status of clean energy generation suggests that small utilities can successfully deploy clean energy technologies.[67] While exclusion of smaller utilities dramatically reduces the number of regulated entities (see **Appendix E**), based on the low administrative costs of market-based pollution control programs,[68] implementing a market-based CES program with a large number of regulated entities is unlikely to be a significant administrative burden.

EXEMPTIONS BASED ON OWNERSHIP STRUCTURE

Some state RPS laws only cover investor-owned utilities, with municipal utilities, public power marketers, and electric cooperatives exempted from all requirements. The theory underlying this policy choice in most cases appears to be that municipal governments, rather than state government, should establish policy for municipal utilities, while cooperatives should be governed by their members. However, not all states exempt these entities. Furthermore, such an approach if adopted in a federal CES would fail to cover roughly one third of the electric power sector and could contribute to exaggerated regional inequities. Investor-owned utilities in Missouri, for example, supply around two-thirds of all retail electricity sales while there are no investor-owned electric utilities in the entire state of Nebraska.

TARGETS AND TIMETABLES

The targets and timetable for a CES define the level of clean electricity generation required and thus the extent of clean energy technology deployment and the degrees to which associated benefits are realized (e.g., pollution mitigation). This subsection explores three issues relevant to CES targets and timetables.

NOMINAL VS. EFFECTIVE TARGETS

As illustrated earlier, electricity portfolio standards can specify aggregate nominal targets and timetables that can differ substantially from the actual effective aggregate requirements of the standards.

Two main design parameters determine the difference between the nominal targets and the actual effective targets. First, any exemptions from compliance (e.g., for small utilities) make the overall effective target (across all utilities) lower than the nominal target. Second, exclusions from the base quantity of electricity sales (i.e., the electricity sales to which the nominal target applies) can make the effective target lower or higher than the nominal target depending on what sort of electricity sales are excluded.[69]

Other provisions of a CES can also lower the effective target relative to the nominal target, including bonus credits for specific technologies (e.g., distributed renewable generation or carbon capture and sequestration (CCS)) and shut-down credits for early retirement of certain generators. These types of provisions and their effects are explained later in this report.

UNIFORM VS. DIFFERENTIATED TARGETS

A CES can have a uniform percentage requirement that applies to all covered electric utilities, or can set different targets for different electric utilities. The rationale for differentiated targets is that, at the time a CES is enacted, electric utilities may supply substantially different fractions of their demand from clean energy sources. This is especially the case if a CES is a multi-state, regional or federal program. For example, a CES proposal from Sen. Tina Smith (D-Minn.) recognizes that retail electricity suppliers have achieved different levels of clean electricity, requiring those that have exceeded 60 percent clean electricity sales to increase clean electricity by 1.75 percent per year and those that fall below that threshold must increase their clean electricity by 2.75 percent per year.[70] Setting targets that vary by individual electric utility, by state, or by region may promote more equitable distribution of costs under a CES (see Chapter VIII Defining the Base Quantity of Electricity Sales for more on this topic). An argument against differentiated targets is that they can disadvantage early adopters of clean energy, and create an un-level playing field for retail electricity providers that creates perverse incentives (e.g., for customers to switch away from early adopters) in states with retail competition.

TIMETABLE OPTIONS

A CES may have a primary nominal target tied to a particular year in the future (e.g., 80 percent clean energy by

2035) that summarizes the policy's overall level of ambition. The timetable refers to the set of interim requirements that define electric utilities' annual compliance obligations. Policymakers may take one of two approaches to defining a CES policy's timetable.

First, policymakers might simply set annual CES requirements that ramp up to a long-term target at a constant rate. This might be done linearly—with CES targets increasing by a small, constant amount each year—or in steps—e.g., with the CES requirement increasing by a fixed number of percentage points at five-year intervals. Policymakers may prefer this approach for its simplicity particularly if they think that the rate of increase is consistent with the rate of growth in clean energy that the industry can deliver cost-effectively and if the CES policy provides electric utilities with substantial compliance flexibility from credit trading and banking (and perhaps borrowing). Banking and borrowing concepts are explained later in this report.

A second approach is to define a CES timetable such that the CES percentage requirements begin modestly, increase slowly at first, and then increase at an accelerating rate. The appeal of this approach is that it gives the industry time to ramp up its investments in clean energy and allows some time for initial longer-lead projects (e.g., new nuclear reactors) to come online.

DEFINING THE BASE QUANTITY OF ELECTRICITY SALES

Perhaps the most important and least understood concept in the design of a CES is how the definition of the base quantity of electricity affects the difference between the nominal CES target and the actual amount of clean energy generated. The base quantity of electricity sales is the portion of an electric utility's annual electricity sales to which an electricity portfolio standard's percentage requirement applies. All else being equal, excluding some types of clean electricity sales (e.g., from existing clean energy sources) from the base quantity under a CES will increase the required level of new clean energy generation and raise a CES's effective target above its nominal target. Conversely, excluding electricity sales that are not clean (e.g., from small generators) from the base quantity will lower the required level of new clean energy generation and decrease a CES's effective target below its nominal target. Finally, the concept of base quantity helps explain why utilities could have a natural incentive to promote energy efficiency under a CES, even without additional incentives. Four example cases can illustrate this.

Case 1. First, consider a situation in which 40 percent of electricity is already provided by clean energy sources, and a CES is enacted with a nominal requirement that 50 percent of electricity come from clean energy sources. If the base quantity is defined as being equal to the total electricity supply (i.e., including the already-clean energy), another 10 percent of total electricity will have to come from new clean energy sources.

Case 2. Second, consider a situation, again with a 50 percent nominal CES, but in which the base quantity is defined as excluding the 40 percent of electricity that already comes from existing clean energy sources. In that case, the 50 percent nominal CES will apply to the 60 percent of electricity not already supplied by existing clean energy generators. Therefore, 30 percent (50 percent of the 60 percent) of total electricity will have to come from new clean energy sources. The actual percentage of total electricity generated from clean energy sources will be 70 percent—40 percent from existing clean energy sources plus 30 percent from new clean energy sources. Excluding some types of clean energy from the definition of base quantity raises a CES's effective target over its nominal target.

Case 3. Third, consider a situation with a 50 percent nominal CES in which existing clean energy sources are defined as being included in the base quantity, but small non-clean sources which generate 20 percent of total electricity are excluded from the program, and therefore from the base quantity. Because the CES will apply only to the 80 percent of sources that are large, the actual amount of clean energy generated will be 40 percent of total electricity (50 percent of the 80 percent). Excluding some types of non-clean energy from the definition of base quantity lowers a CES's effective target below its nominal target.

Case 4. Finally, consider a situation with a 50 percent nominal CES in which existing clean energy sources are included in the base quantity, and sources of all sizes are included in the program, but utilities must decide whether to launch projects to increase their customers' energy efficiency, which would decrease electricity demand by 10 percent. If the utilities launch the projects, the actual percentage of the originally-generated electricity (i.e., before the energy efficiency projects) generated by clean energy sources will be 45 percent (50 percent of the 90 percent). In other words, utilities will see their actual CES obligation decrease as a result of their energy efficiency projects. The concept of base quantity helps us understand why a CES would naturally create an incentive to increase energy efficiency, even if energy efficiency itself cannot directly earn clean energy credits.[71]

The above examples illustrate the effects of various definitions of base quantity on the power sector in the aggregate. A given definition of base quantity can also have importantly different impacts on different individual utilities, especially if other parameters, such as the nominal CES level and whether existing clean energy resources can be used to comply with the requirement, are also changed. (Note that whether existing clean energy is defined as part of the base quantity and whether existing clean energy can be used for compliance are two separate questions). It is beyond the scope of this report to discuss all the possible variations, but two more examples will illustrate the possibilities.

First, consider two utilities ("Coal Utility" and "Nuclear Utility") operating under the premise of case 2 above, with a 50 percent nominal CES, and in which the base quantity is defined as excluding electricity from existing clean energy sources, but also in which existing clean energy sources can be used to comply with the CES. Clean energy sources provide 16 percent of Coal Utility's electricity and 72 percent of Nuclear Utility's electricity. Coal Utility's base quantity of electricity will be 84 percent of its total electricity sales (100 percent minus 16 percent), therefore 42 percent (50 percent of the 84 percent) of Coal Utility's total electricity sales will have to come from clean energy sources, and therefore Coal Utility will have to add new clean energy or buy CECs for 26 percent of its total electricity sales (42 percent effective target minus 16 percent existing clean energy). Nuclear Utility's base quantity will be 28 percent (100 percent minus 72 percent), therefore 14 percent (50 percent of the 28 percent) of Nuclear Utility's total electricity sales will have to come from clean energy sources, and therefore Nuclear Utility will actually be able to sell CECs from 58 percent of its total electricity sales (72 percent existing clean energy minus 14 percent effective target). Some would view this as a windfall.

Second, consider the previous scenario, except with a 20 percent nominal CES (rather than 50 percent), and with existing clean energy sources not allowed to count towards compliance. As before, Coal Utility's base quantity will be 84 percent, though now only 16.8 percent (20 percent of the 84 percent) of Coal Utility's total electricity sales will have to come from clean energy sources. Also, as before, Nuclear Utility's base quantity will be 28 percent, though now 5.6 percent (20 percent of the 28 percent) of Nuclear Utility's sales total electricity sales will have to come from clean energy sources. Coal Utility will have to add more clean resources (16.8 percent) than Nuclear Utility (5.6 percent)—in other words, there will be an advantage to Nuclear Utility in having made the earlier clean energy investments—but there will be no windfall. This approach—a low nominal CES, with existing clean energy not included in the baseline and not counted towards compliance—has in fact been taken in some legislative proposals.

QUALIFIED ENERGY SOURCES

A CES must specify the types of electricity generation (potentially including "negawatt-hours" of electricity savings from efficiency) that qualify as clean and the rate at which qualified energy sources earn credits.

As mentioned above, policymakers and various stakeholders may have different opinions about what should count as clean under a CES. In deciding whether to include a particular fuel or technology as a qualifying clean energy source under a CES, policymakers might consider the extent to which a fuel or technology furthers the goals they have for a CES. (The same consideration holds for counting electricity savings from energy efficiency.) For example, does providing an incentive for a particular fuel or technology (or energy efficiency):

- Reduce the environmental and public health impacts from electricity generation?
- Diversify the power sector's energy supply?
- Promote the development and deployment of less mature, advanced clean energy technologies?
- Spur growth in clean energy industries and associated employment?

It is not always easy to measure or to agree upon the extent to which a given clean energy source promotes the objectives above; moreover, stakeholders may have different views about how to weigh the objectives above in deciding whether a particular fuel or technology should qualify as clean under a CES and whether it should receive full or partial credit as clean (and if partial, what fraction).

Natural gas generation is an important case in point. Some CES proposals have included at least partial credit for highly efficient natural gas combined cycle (NGCC) electricity generation as a qualified clean energy source. Such generation does offer benefits, particularly in terms of public health and environmental impacts, compared to older, less efficient, and more highly polluting electricity technologies. However, NGCC is a mature and established technology for generating electricity. Indeed, natural gas is the dominant choice for new electricity generating capacity and one objective of a CES may be fuel diversity away from a heavy reliance on natural gas. Further support for natural gas may draw away support for other resources that are not already cost-competitive.[72] Allowing credits from natural gas generation under a CES may, in effect, disincentivize other clean energy technologies, including technologies that are less commercially mature or have higher costs in the near term. As such, stakeholders may have different views about whether or to what extent a CES ought to count natural gas as a clean energy source, driven largely by the policy objectives they wish to advance.[73] Regardless, the long-term effectiveness of a CES will be negatively impacted if natural gas-fired sources are not deployed with CCS or developed as carbon-capture-ready facilities.

The possibility of retrofitting fossil fuel power plants with post-combustion CCS provides another case in point. When post-combustion CCS is added to an existing power plant, greenhouse gas emissions can decrease substantially. However, depending on the technology used, emissions of other air pollutants may not change. In addition, in many types of capture technology, some of the power generated by the plant must be used to operate the CCS equipment (sometimes referred to as parasitic load), meaning the amount available for sale decreases. In some cases the net result may be that for a given amount of net electrical generation leaving a power plant, the addition of CCS makes greenhouse gas emissions decrease but other air pollutant emissions increase. Deciding whether a post-combustion CCS retrofit should be considered clean could be somewhat complicated or site-specific, and may depend heavily on whether a higher priority is placed on reducing greenhouse gas emissions than reducing other air pollutants.

Given the above, in designing a CES policymakers may take different approaches to defining qualified clean energy sources and setting the rate at which they earn credit under the CES. Policymakers might simply enumerate a list of qualifying clean energy sources and assign each a rate at which it earns credits under the CES. A variety of considerations might inform this list and the assignment of full and partial credits.

Table 4 illustrates how a CES might simply list qualified clean energy technologies. This approach has the advantage of administrative simplicity, and allows for accommodation of different viewpoints since policymakers can negotiate which clean energy sources to include and the degree to which each receives full or partial credits. However, the simplicity of this approach can lead to less efficient incentives for achieving particular policy objectives.[74] This is perhaps most easily seen for the objective of reducing greenhouse gas emissions from power generation and the example in **Table 4**. In the example, the CES would provide power producers with no incentive to exceed thresholds for

TABLE 4: Illustration of Simple Approach to Crediting Clean Energy Generation under a CES

ELECTRICITY GENERATION TYPE	NUMBER OF CECS PER MWH OF GENERATION
Renewables	1
Nuclear	1
Coal with CCS (50-90% CO_2 capture)	0.5
Coal with CCS (90+% CO_2 capture)	1
Natural gas combined cycle (NGCC) (<800 lbs. CO_2/MWh)	0.5
NGCC with CCS (90+% CO_2 capture)	1

qualification—for example, by decreasing the heat rate of an NGCC plant or increasing the level of CO_2 capture at a facility employing CCS.

An alternative approach is for policymakers to define a set of performance criteria that clean energy sources must meet to qualify for credit under a CES, perhaps using a formula for determining eligibility and assigning credits to qualified clean energy sources. The benefit of this approach is that it is more precise and thus can create more efficient incentives for clean energy producers. The drawback of this approach is that it is most suitable and practical when policymakers can agree on a single primary objective for a CES. If policymakers believe the primary objective of a CES is to spur greenhouse gas (GHG) emission reductions in the power sector via expanded clean energy generation, they might adopt a formula like that in **Equation 3** for assigning credits to clean energy sources.

The fact that existing state policies differ in the resources that qualify for credit and in the amount of credits awarded to each resource complicates any effort to develop multi-jurisdictional trading and credit tracking systems. Although this is not an insurmountable problem, it could be minimized through greater harmonization of state CES policies, i.e., something that would occur if more states joined an existing program like RGGI.

The most important principle for policymakers to remember is that deciding what qualifies as clean goes hand in hand with deciding the CES targets. The wider the range of resources that qualify as clean, the easier and cheaper it is to meet any given percentage target. Since it is lower cost, it may also provide an opportunity to be more ambitious.

CREDITING CLEAN GENERATION FROM NEW AND EXISTING GENERATORS

A CES has to provide credit to generation from new clean energy facilities, since the main purpose of the policy is to spur deployment of clean energy technologies. Policymakers, however, have different options for treatment of generation from clean energy facilities that predate enactment of a CES (See **Table 2** in Chapter VI). The question of how a CES treats generation from such existing clean energy generators has very different implications for utilities with large existing clean energy sources than for those that do not. Some argue that providing credit for existing sources would create wealth transfers and windfall profits for those that have already invested and deployed clean energy. Others argue that doing so would reward early adopters of clean energy, encourage existing clean resources to maintain and not reduce their output, provide for less expensive compliance with a given nominal target, and tend to make the market for CECs more robust from the beginning. The implications are especially important for the five issues below.

Effect of Counting Existing Clean Resources on Target Setting

The level of incremental clean energy required by a given nominal CES target will vary depending on whether generation from existing facilities counts toward the target. Providing credits to all clean energy generation (new and existing) makes it simple to translate a target like supplying 50 percent of electricity from clean electricity sources by 2030 into a CES target, which converts directly to a requirement that utilities supply 50 percent of their annual sales from clean electricity sources in 2030. On the other hand, providing credits for only new or incremental clean energy generation means that, all else equal, the actual level of clean energy generation in a given year will be a function both of the percentage requirement set under the CES and the level of generation from existing clean energy sources that do not receive credits under the CES.[75] To meet an overall goal for total clean energy generation (e.g., 80 percent of total electricity supply by 2035) with a CES that sets a requirement only for new and incremental clean energy generation it may be necessary to revise periodically the CES requirements in light of changes to existing clean energy facilities for example, due to facility retirements.

EQUATION 3: Illustrative Formula for Awarding CECs to Clean Energy Sources

$$\text{CEC/MWh} = 1 - \frac{\text{Generator's GHG Intensity in tCO}_2\text{e/MWh}}{\text{GHG Intensity in tCO}_2\text{e/MWh of a New Coal Fueled Power Plant w/o CCS}}$$

Incentives for Incremental Output

To the extent that an additional financial incentive can lead to greater output from existing clean energy facilities, providing credits to at least incremental generation from existing clean energy facilities can increase clean energy generation and reduce emissions more cost-effectively. For example, if credits are not awarded to all existing clean energy generation, then awarding credits for incremental output from existing clean energy generators can provide an incentive for nuclear upgrades and higher utilization of existing natural gas combined cycle power plants. There are limits to this, of course—wind and nuclear generating units usually operate at full capacity already, and lower natural gas prices may lead to an already high dispatch of NGCC plants. Policymakers may wish to target the incentives, for example by assigning credits for output from capacity expansions or uprates at existing units.

Windfall Profits

Some argue that granting credits under a CES to existing facilities can create windfall profits for electricity generators. CECs are typically designed to be a tradable commodity with a market value. When an existing clean generation source is awarded CECs, it receives something of real economic value even though its operating costs and compliance obligations haven't changed. If this hypothetical generation source is owned by a vertically-integrated utility, the utility regulator will presumably strive to ensure that the credits are used to meet the utility's overall compliance obligations, or if the credits are sold that some or all of the proceeds are returned to ratepayers. But if the generation source is not owned by a utility, (depending on the terms of the contract) it is entirely possible that revenue from the sale of CECs goes straight to those who invested in the generator. These investors receive a windfall profit (i.e., something of value obtained at no additional cost to themselves) at the expense of the customers of the utility that purchased the credits.[76] The policymaker's desire to avoid or minimize this kind of windfall profit must be balanced with the desire to maximize generation from existing as well as new clean energy resources.

Unintended Incentives

Because existing clean energy facilities (e.g., nuclear plants and hydroelectric dams) face very low variable production costs, they are unlikely to reduce their output if they do not receive credits under a CES in the near and medium run. However, to the extent that owners of existing clean energy facilities will eventually need to make investments to continue producing clean energy, they may ultimately choose to retire facilities rather than extend their lives if they do not receive credits for their clean energy output under a CES. This issue is relevant, in particular, to decisions by nuclear reactor owners regarding whether to pursue relicensing or committing to a premature shutdown versus continuing to operate.

In addition, providing credit to only incremental output from existing natural gas power plants (under a CES that provided any credit for natural gas) might introduce competition between new and existing natural gas generation; to the extent that generation from a new NGCC plant simply displaces generation from an existing NGCC plant in order to earn credits.[77] Such competition would create CES compliance credits but no additional clean energy generation, on net.

Further analysis can determine the extent to which the unintended consequences noted above such as the premature retirement of clean electricity facilities may be material rather than just theoretical concerns. A CES could include provisions to address those unintended consequences that are expected to be material.[78]

Regional Impacts

Granting credits to non-incremental generation from existing clean generators has implications for how the impacts of a CES are distributed among different utilities and among states and regions under a multistate or federal program. For example, assuming uniform percentage requirements for all utilities, providing credits for non-incremental generation from existing clean energy facilities makes utilities that, at the time of enactment of a CES, have relatively low levels of clean energy generation net buyers of CECs from utilities that start out with relatively high shares of electricity from clean energy sources. Some object to this approach, arguing that this would lead to large credit transfers and associated wealth transfers from utilities (and possibly states and regions) that are relatively more carbon-intensive to those that are relatively less carbon-intensive that are disproportionate to the level of incremental clean energy generation required by the CES. Others argue that similar wealth transfers are ubiquitous and may be seen, for example, when a region is discovered to be a new source of natural gas that other regions will buy.

CREDITS FOR ENERGY EFFICIENCY AND CONSERVATION

Many analyses find that energy efficiency and conservation can provide large multi-pollutant emission reductions via avoided electricity generation at a relatively low cost. Several states have allowed utilities to meet a portion of their compliance obligation under an electricity portfolio standard via demonstrated electricity savings from energy efficiency, as have recent congressional electricity portfolio standard proposals.[79] Sen. Smith's CES proposal does not include end-use energy efficiency and conservation, but does allow for credits for combined heat and power systems and waste-heat recovery.[80]

In addition, 23 states have established mandatory long-term energy savings targets through an Energy Efficiency Resource Standard (EERS), with two other states having a non-mandatory energy savings goal.[81] An EERS is similar in concept to an electricity portfolio standard in that it requires utilities to achieve annual energy savings equal to a specified amount, most commonly expressed as a percentage of retail sales. There are a variety of ways an EERS policy can be implemented. In some of these cases, the state RPS policy is combined with or linked to the EERS policy.

However, measuring electricity savings from energy efficiency is more challenging than measuring generation from qualified clean energy sources. In addition to this basic challenge, at least three interrelated issues arise when credits are awarded for electricity savings:

- Measuring electricity savings for a multistate or federal CES may prove administratively difficult and contentious, particularly since states already measure electricity savings from energy efficiency but not all in the same way. Some of the differences may be related to differences in climate and other objective factors between states.
- Awarding credits to utilities for electricity savings that are already factored into "business-as-usual" projections for electricity demand lessens the impact that a CES has on clean energy technology deployment and associated benefits.
- Historically, certain states and utilities have been more aggressive in pursuing energy efficiency than others. With substantial efficiency programs and requirements already in place, such states and utilities may object to any requirement under a CES that credits only be awarded for electricity savings from energy efficiency beyond "business as usual."

If credits are awarded for electricity savings from energy efficiency and conservation, policymakers must decide how many credits to award for each unit of electricity savings. Unlike clean energy technologies, each unit of electricity savings from energy efficiency and conservation reduces the base quantity of electricity sales. Policymakers can treat one unit of electricity savings as equivalent to one unit of clean generation by providing partial credits for each unit of electricity savings, with the partial credit for electricity savings declining as the CES percentage requirement increases over time.

In considering whether and to what extent to credit electricity savings from energy efficiency, policymakers might consider how energy efficiency aligns with the objectives they hope to achieve through a CES.[82] Crediting energy efficiency can reduce air pollution from electricity generation but will also limit the impact of a CES on deploying clean energy generation technologies.

As **Figure 2** (in Chapter II above) illustrates, energy efficiency may be substantially less expensive than clean energy generation. If a CES does credit electricity savings from energy efficiency, policymakers might limit the degree to which an electric utility can comply with the CES via energy efficiency so as to still incentivize the development of other desired technologies.[83]

SHUT-DOWN CREDITS FOR COAL PLANT RETIREMENTS

In addition to crediting qualified clean energy generation, a CES might also provide credits for avoided generation from highly polluting generating units (e.g., coal plants lacking modern pollution controls) that retire earlier than they otherwise would. A CES might offer such shut-down credits in order to spur the early retirement of coal plants facing retrofit requirements to comply with new air, water, and waste regulations.[84]

Under a CES, providing credits for avoided generation from retired coal plants lowers the CES's effective target (because the CES is granting credits both for avoided generation from retired units and for whatever incremental clean energy generation replaces this avoided generation, thereby increasing the supply of clean energy certificates and reducing the incentive to deploy other technologies). However, the magnitude of the actual impact on the level of incremental clean energy generation might be small if the shut-down credits are limited in number (e.g., granted for a short duration) or if the CES has a relatively low alternative compliance payment. Policymakers could also adjust a CES's target to take into account the effect of providing shut-down credits for coal plant retirements. A key decision for policymakers is: for how many years should shut-down credits be offered?

Shut-down credits might appeal to policymakers as a means to accelerate the turnover of the existing fleet's generating units and speed the transition to cleaner energy sources. In particular, providing a financial incentive in the form of shut-down credits can deter some coal plant owners from making pollution control retrofit investments that, in the long run, might prove suboptimal compared to investments in clean energy. Shut-down credits might have additional appeal under a CES that does not provide any credit for natural gas generation. Under such a CES, incremental clean energy generation might displace some new natural gas generation and older coal-fueled generation without differentiation even though the former is typically much cleaner than the latter. A CES program could provide shut-down credits only for the relatively more polluting coal plants.

PROVISIONS FOR SPECIFIC TECHNOLOGIES (TIERS, CARVE-OUTS, AND BONUS CREDITS)

A CES that is technology-neutral—one that provides credits in proportion to qualified clean energy production from all qualified facilities without any limits or special treatment of any technologies—will likely promote some clean energy technologies, namely the most mature and least costly, more than others. Policymakers, however, may want to ensure that a CES spurs deployment of specific clean energy technologies in order to promote improvements and cost reduction in that technology (e.g., by moving the technology further down its learning curve) or to promote energy supply diversification.

Figure 2 (in Chapter II above) shows the most recent estimates for the total system levelized cost of electricity (LCOE) from EIA's Annual Energy Outlook 2018 for various power generation options.[85] While power generators' decisions about investing in new generation capacity involve much more than LCOE, **Figure 2** does suggest that a uniform financial premium for clean energy might lead to substantially more deployment of some clean energy technologies compared to others. For example, **Figure 2** suggests that natural gas combined cycle plants, onshore wind, and energy efficiency are substantially less expensive than many other clean energy options.

The following subsections discuss four CES policy design options that can achieve the goal of promoting a role for certain technologies that would not necessarily be developed or deployed under a simple, technology-neutral CES.

Tiers

Tiers typically define sets of eligible clean energy sources. State electricity portfolio standards provide precedents for including tiers for particular classes of technologies. Pennsylvania and New York both have standards with tiers. Pennsylvania has separate tiers for renewable and non-renewable, alternative energy sources. New York established tiers for new renewables, maintaining existing renewables and maintaining existing nuclear energy resources. New York issues renewable energy credits (RECs) and parallel credits called zero-emission credits (ZECs) for nuclear generation to promote clean electricity. New York has made a determination that the two crediting systems are independent and cannot be combined.

Carve-Outs

In an electricity portfolio standard, a carve-out is a requirement that a specific technology provide a specified minimum fraction of compliance with the overall target. Several state RPS programs include carve-outs for solar power. For example, New Jersey has an RPS that requires that 50 percent of electricity comes from qualified renewable generation by 2030 with a carve-out that requires that at least 5.1 percent of electricity come from solar power by 2021. Similarly, policymakers could establish one or more carve-outs under a CES for technologies for which they wanted to ensure at least a minimum role.

Bonus Credits

A CES can offer extra incentive for the deployment of specific technologies (e.g., less mature and more costly technologies) by awarding bonus credits for each unit of output from such facilities. In other words, provide more than one credit per unit of clean energy. For example, policymakers might use bonus credits to promote solar power, next generation nuclear power, distributed generation, or first mover CCS projects—clean energy sources that might not see substantial deployment under a purely technology-neutral CES.[86]

Providing bonus credits for specific technologies will lower the effective target of a CES relative to its nominal target. If large numbers of bonus credits are provided for specific technologies, policymakers can maintain a desired effective CES target by increasing the nominal target to reflect the number of bonus credits.[87]

Limits on Compliance via Particular Clean Energy Sources

While the options described above provide incentives for or set minimum requirements for certain subsets of qualified clean energy sources, policymakers could also put limits on the degree to which utilities could comply with CES requirements via particular clean energy sources.[88] For example, policymakers might set maximum levels for compliance via credits earned for electricity savings from energy efficiency or new natural gas generation. Such limits can ensure that a CES provides substantial incentive for less mature clean energy technologies to further particular CES policy objectives—e.g., energy diversification and technology advancement.

Constructing provisions for specific technologies can create challenges for expanding CES programs to similar programs outside of a region. The greater the specificity in terms of carve-outs, tiers or bonus credits beyond the less complicated approach that provides credits in proportion to qualified clean energy production from all qualified facilities, the more complicated it becomes to link. Firms trading credits would need to ensure that what is being traded fit the needed definition in other programs.

ADDITIONAL COMPLIANCE FLEXIBILITY

As explained in Chapter II above, a CES is a market-oriented policy whose broadly defined set of eligible clean energy sources and reliance on tradable credits to demonstrate compliance inherently provide electric utilities with substantial compliance flexibility and keep the cost of transitioning to cleaner energy sources lower.

Beyond the flexibility and cost-effectiveness inherent in the basic design of a CES, three particular policy design options (described in the subsections below) can provide additional compliance flexibility under a CES and help ensure that the cost of complying with the CES is manageable.

Banking and Borrowing

Credit banking and borrowing lowers the cost of meeting clean energy targets by giving regulated entities compliance flexibility in terms of timing without affecting the ultimate level of clean energy generation or the achievement of associated policy objectives. Such flexibility can smooth out the price trajectory for credits and reduce price jumps over time.

Banking simply refers to saving CECs earned or purchased in one period to use for demonstrating compliance in a later period. Allowing banking can help avoid CEC price volatility and creates incentives for early deployment of clean energy and the associated environmental benefits.[89] All recent federal electricity portfolio standard proposals have all allowed for credit banking—with restrictions in some cases—but little to no borrowing. The 2019 CES proposal from Sen. Smith limited banking of credits to two years from the year of issuance; however, the CES proposals from Sens. Lugar and Graham placed no such time limits on banking. Sen. Graham's proposal alone allowed for credit borrowing in cases where a utility could submit an approved plan demonstrating future over-compliance sufficient to warrant near-term borrowing against future credits.

Borrowing is the mirror image of banking and an additional means of providing regulated entities with temporal compliance flexibility. Allowing for borrowing does, though, raise some implementation challenges regarding enforcement of repayment and the risk that firms will rely excessively on borrowing credits from the future (thereby deferring the required clean energy deployment into the future) thus creating pressure for policymakers to lower future clean energy targets. This "debt forgiveness" dynamic may jeopardize the overall clean energy deployment goal and increase regulatory uncertainty for firms.

In light of these issues, policymakers might allow for limited borrowing of credits under a CES, perhaps tied to projected output from specific clean energy facilities that are reasonably anticipated to come online in the future. For example, if a utility owns or has a power purchase agreement with a new nuclear unit under construction, a CES could allow that utility to borrow against that plant's future stream of CECs with the obligation to repay all borrowed CECs.

Offsets

Offsets are tradable compliance credits issued for actions taken by entities that are not subject to a particular market-based regulatory requirement. The concept is based on long-standing air pollution control rules that were developed to prevent increases in criteria pollutant emissions when new factories and power plants were built.[90]

The inclusion of offsets in a CES could draw upon the same principles and policy specifics associated with the use of offsets under other market-oriented regulations. Most importantly, offset provisions under other policies generally require that offset credits be real, surplus (or additional), verifiable, permanent, and enforceable.

Offsets could offer the same compliance flexibility under a CES as they do in air pollution control programs. Including offsets in a CES is most obviously aligned with the policy objective of reducing greenhouse gas emissions, but could certainly be done in a way that addresses other air pollutants. However, while including offsets in a CES would yield equivalent net greenhouse gas emission reductions, it could also yield less clean energy deployment in the power sector depending on what qualifies as an offset.

Offsets, while not currently used in a CES, could provide a flexible compliance mechanism under an economywide expansion (see Expanding a CES beyond the Power Sector for more details).

Alternative Compliance Payments and Cost Off-ramps

Without cost containment provisions, a CES sets a known target for clean energy but has uncertain costs. While sophisticated and extensive policy analysis can estimate the costs of achieving a given CES target, the future policy costs are innately uncertain especially over long timeframes —they may be higher or lower than projected. While a CES is an inherently flexible, market-based policy that can achieve clean energy goals cost-effectively, policymakers may choose to include cost containment provisions to keep the cost impacts of a CES within a particular range—i.e., to provide some certainty about the maximum cost of the policy. Two such options are alternative compliance payments (ACPs) and cost off-ramps. Designing cost containment provisions for a CES requires balancing the desire to protect ratepayers from excessive costs and the goal of not undermining the aims of the CES policy.

Electric utilities demonstrate compliance with CES requirements by submitting clean energy credits equivalent to the required level of clean energy generation (e.g., where one CEC equals one MWh of qualified clean energy generation). An ACP provision under a CES allows an electric utility to make payments to the CES program administrator of a specified value in lieu of submitting CECs.[91] An ACP acts as a limit on the cost of compliance with a CES—i.e., a CEC price ceiling. Electric utilities will increase their levels of clean energy delivery until the incremental cost of such energy exceeds the ACP value. Policymakers have three options in determining the value of an ACP: one that is fixed (nominally); one that increases at the rate of inflation but remains constant in real terms; and one that increases in real terms over time as the CES target becomes more ambitious.

All recent congressional electricity portfolio standards have included ACPs (see **Table 2**). ACPs are common in state electricity portfolio standards as well. A 2008 survey of electricity portfolio standards in 25 states and the District of Columbia found that nine states had an ACP for capping the maximum cost of compliance.[92]

When including an ACP in a CES, policymakers must decide how to use the revenue raised when utilities opt to pay the ACP in lieu of supplying qualified energy. Policymakers might require that ACP revenue be used to further the goals of the CES, for example by funding clean energy deployment or research and development. Under a multi-state CES, ACP revenue might be returned to the states whose utilities paid it to further those respective states' CES program goals, or other energy goals such as ameliorating any negative cost impacts on energy-intensive, trade-exposed industries and household consumers.

The value of any ACP (including its rate of increase if any) is a crucial policy design decision. A low value for the ACP can undermine the ability of a CES program to drive clean energy research and development and incremental clean energy deployment and deliver the associated benefits.[93] Policymakers might calibrate the ACP value to protect against excessive costs without substantially limiting the deployment of clean energy.

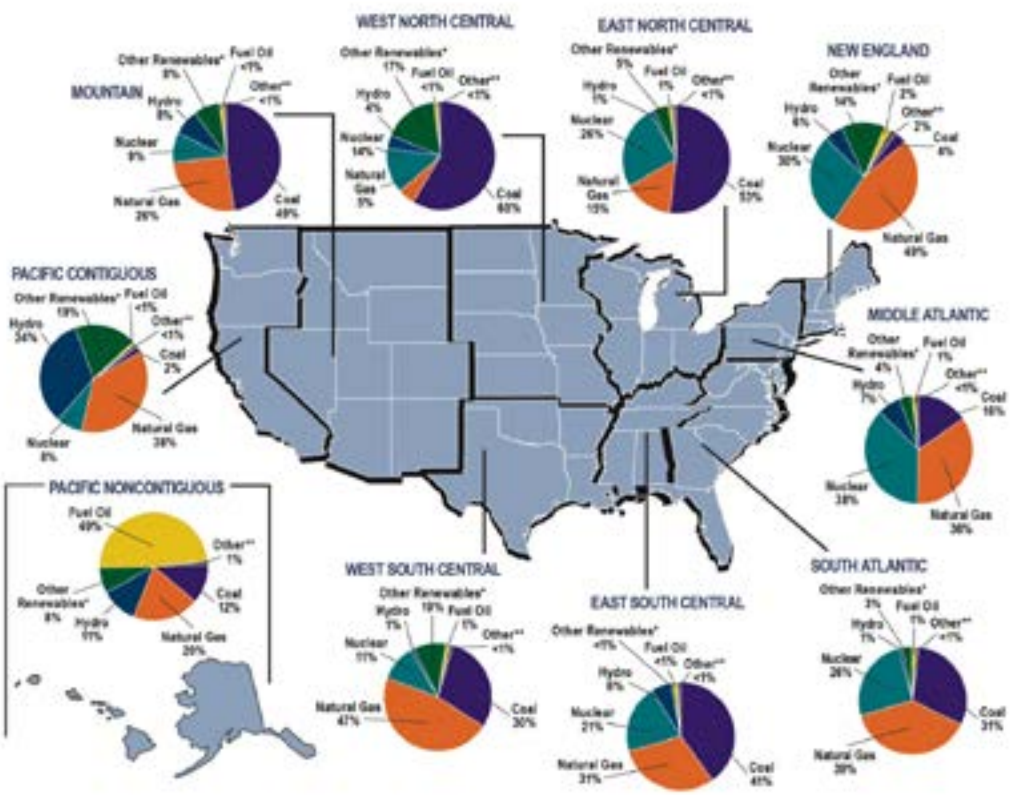
Another cost containment option is a cost off-ramp. Cost off-ramp provisions can take a variety of forms, but such provisions effectively limit the cost of compliance under a CES. For example, a cost off-ramp might set a maximum percentage rate impact for CES compliance such that, if an electric utility can demonstrate that full compliance with the CES would lead to compliance costs in excess of the off-ramp level, then the CES program administrator can limit the utility's compliance obligation to a level of clean energy that does not exceed the maximum rate increase. Some federal CES proposals have included cost off-ramps.[94] Cost off-ramps are also common features of existing state electricity portfolio standards. A 2008 survey of electricity portfolio standards in 25 states and the District of Columbia found that most states that did not have ACPs had some type of cost off-ramp provision.[95] However, whereas an ACP provides a direct signal (in terms of $/MWh) to investors regarding a reasonable level of new technology deployment, a cost off-ramp does not. Therefore, cost off-ramps may impact the CES policy's cost-effectiveness.

PROMOTING EQUITABLE IMPACTS UNDER A CES

For a variety of reasons, the percentages of electricity supply that come from clean energy sources vary significantly among different states and regions (see **Figure 10**) and even among electric utilities in the same state. In addition, the availability and economics of certain clean energy sources, and historical state clean energy policies, vary among electric utilities, states, and regions. For example, Plains states have more wind and Southwest states have more solar than others.

While there may be differences among electric utilities in a single state in terms of their electricity supply mixes, ensuring equitable impacts from a CES is likely to be of particular concern for policymakers in the case of a multi-state or federal CES. These factors suggest that, depending on policy specifics, a multi-state or federal CES might have different cost and electricity price impacts in different states and regions. Policymakers and other stakeholders may seek to minimize any such disparities to promote fairness. Policymakers can adjust several CES design parameters in order to promote such fairness. These policy parameters are reviewed in the sections above, and **Table 5** summarizes the implications for state/regional impacts of several of these primary policy parameters.

FIGURE 10: Regional Electricity Generation Mix



Source: Edison Electric Institute (2017).

One can make qualitative predictions about how certain policy designs will impact states and regions. However, given the number of potential variations and combinations of these policy parameters and the often complex dynamics of the power sector, substantially more sophisticated power sector modeling analysis is needed to inform policymakers and other stakeholders about the best ways to promote fairness alongside other CES policy goals.

EXPANDING A CES BEYOND THE POWER SECTOR

A CES as described in this report would only comprise the power sector, which in 2018 was responsible for one-third of U.S. energy-related carbon dioxide emissions. Due to the serious and time-sensitive nature of climate change, it would be advantageous to link emission reduction programs in other sectors to maximize and expedite the potential for emissions reductions.[96] The broad contours of how such a program might function, including how credits would be generated and traded are discussed below.

When considering the interoperability of a CES with emission reduction programs in other sectors, a challenge is developing a linking mechanism (i.e., a "decoder ring"), which connects programs with tradeable units between the sectors. Note that trading is the key assumption to linking the sectors. And while one CEC in a CES represents one zero-emission MWh, other sector programs use mass- or rate-based metrics (e.g., short or metric ton of CO_2, or emissions per unit of output or production).

One option is to focus on tons of avoided CO_2 emissions from a CES, but there are a couple of issues to consider. When a CES program is implemented, utilities' portfolios of clean electricity begin to grow, and carbon emissions decline. However, since each utility starts with a unique electricity portfolio, the quantity of reductions (i.e., tons of CO_2) that result from becoming one percent cleaner vary. Furthermore, the specific actions that a utility takes to become one percent cleaner also impact the quantity of emissions reduction (see **Appendix F** for calculations).

Therefore, the process for determining a utility's emission reductions in a consistent manner requires the development of a parallel accounting system, which focuses on the emitting sources of electricity generation in its portfolio, not the level of clean electricity (e.g., 30 percent clean) in its portfolio. A baseline or emissions cap (i.e., measured in tons of CO_2) can be determined for each utility (or each emitting facility) either based on average emissions over a specific time period or on a performance standard for a specific technology like emissions from a combined cycle natural gas facility.[97]

Then, a timetable or schedule can be developed out to mid-century or other reference date, which ratchets the emissions cap down to zero or nearly-zero. In a given year, if a utility emits less than its scheduled cap it would receive surplus credits.[98] If a utility's emissions are

TABLE 5: CES Design Parameters and Implications for State/Regional Impacts

CES PARAMETER	OPTIONS AND IMPLICATIONS FOR STATE/REGIONAL IMPACTS
Percentage Requirement	A CES could include percentage requirements that are differentiated by region, state, or individual utility.
Qualified Clean Energy Sources	The broader the set of energy sources that qualify for credits under a CES, the more options electric utilities in different states/regions have for compliance and the less likely utilities are to find themselves overly reliant on buying credits from others.
Credits for Existing Clean Energy Facilities	By not awarding credits for non-incremental generation from clean energy facilities, a CES can mitigate state/regional disparities.
Base Quantity of Electricity	Excluding non-incremental generation from existing clean energy facilities from the base quantity of electricity sales can lessen the burden on states/regions that already have substantial clean energy generation.

EQUATION 4: Emission Cap for a Generic Facility

$$\text{Emissions Cap} = \sum_{(i=1)}^{n} [\text{Performance Standard} \left(\frac{tCO_2e}{unit\ i}\right) \text{ x Production } (units\ i)]$$

greater than the cap, the utility could buy credits from a federally-established market at the market price, submit surplus credits from a previous year, pay a fee (e.g., $40 per ton of carbon dioxide), or submit eligible offset credits in order to comply.

Separately, the federal government would establish a system for quantifying reductions in other economic sectors. In the case of the industrial sector, a subsector-wide (e.g., chemical manufacturing, iron and steel, paper and pulp, or cement) performance standard (i.e., measured in tons of CO_2 per unit of production) could be determined for an individual facility based on the performance of best-in-class facilities around the world. A baseline, emission limit or cap (i.e., measured in tons of CO_2) can be determined for a facility based on the average of several years of production data from the facility (i.e., a quantity) multiplied by the facility's assigned performance standard (i.e., tons of CO_2 per unit of output); a timetable or schedule for the facility could be developed by increasing the stringency of the performance standard over time (**Equation 4**). In a given year, if a facility emits less than its emission limit it would receive surplus credits. If a facility's emissions are greater than the limit, the facility could buy credits from a federally-established market at the market price, submit surplus credits from a previous year, pay a fee (e.g., $40 per ton of carbon dioxide), or submit eligible offset credits in order to comply.

In this manner, multiple sectors could participate in a much larger emissions reduction program. Initially, since emission reductions are likely easier to achieve in the power sector, the industrial sector might become a large purchaser of credits in a federally-established credit market, which could help to increase the value of credits and expedite power sector emission reductions. Ultimately however, this policy would drive emission reductions (e.g., new technology deployment, substitution) across all participating sectors.

An additional challenge with this approach is developing sub-sector performance standards in a consistent and equitable manner; Canada and the European Union have developed emission-based performance standards for many economic sub-sector facility types. Further study of the suggested approach and viable alternatives should be pursued, including the breadth of emissions coverage that could be achieved.

TREATMENT OF STATE PROGRAMS UNDER A MULTI-STATE OR FEDERAL CES

If a multi-state or federal CES were to be adopted, it would immediately raise questions about how to treat existing and future state electricity portfolio standards (see also Chapter VII: How Might Existing State RPSs Be Expanded to/Complemented by CES?).

Preempting State Programs with a Federal CES

One option for dealing with existing state renewable and alternative energy portfolio standards would be to preempt them with a federal standard. This could be acceptable to states if the environmental and economic benefits are large enough. However, it could run counter to the wishes of state officials who would likely prefer to retain their prerogative to set requirements for clean power that might be more stringent than a federal CES or that might require compliance via in-state clean power generation.[99] Sen. Smith's CES proposal allows states to advance clean electricity from any starting point. The rate of improvement (i.e., either 1.75 or 2.75 percent cleaner per year) in the bill sets a floor for action and states are free to do even more if they desire.

One argument—and perhaps the primary one—for preempting state programs is to avoid a patchwork of state programs in addition to a federal standard. However, compliance with distinct state and federal electricity standards is unlikely to prove onerous for utilities compared to compliance with only a federal CES.

Keeping State and Federal Programs Distinct and Separate

The first issue to address is that of overlapping requirements, and the most obvious solution is for a federal CES (for example) to be distinct from existing and future state programs. Under this approach, covered utilities would need to comply with the federal CES via federally issued CECs that are different from and not fungible with credits issued under state programs (e.g., state renewable electricity credits, RECs).[100] For example, a geothermal plant might get one federal CEC and one state REC for each unit of generation, but only the federal CEC could be used to demonstrate federal compliance and the state REC could be used to demonstrate state compliance.

In this case, some existing state portfolio standards would likely prove less stringent than the federal CES and thus effectively non-binding on utilities—i.e., in the process of meeting their federal obligation, utilities would obtain more than enough state credits to meet their state obligations. Consequently, state RECs in this example would trade at or near a price of zero.

On the other hand, some states might have or set more stringent clean energy requirements than a federal CES. Regulated entities in the state must go beyond the requirements of the federal CES, meaning that regulated entities outside of the state face a less stringent compliance obligation since the CES applies to national aggregate electricity generation or sales. Overall, such an approach may have no effect on the level of aggregate clean energy generation across the country, since the federal program would determine the aggregate total. A state program more ambitious than the federal program would simply change how clean energy generation is distributed among the states, with a disproportionate share of the national total coming from the states with ambitious standards.

State policymakers interested in promoting more clean generation than required by a federal CES may have options for ensuring that a stringent state standard leads to additional aggregate clean energy generation. One method is to require that, when a MWh of generation qualifies for both a state REC and a federal CEC, the REC and CEC be bundled and sold or transferred together. This constraint assures that even though a utility subject to the more stringent state standard will have excess federal CECs, it will not be able to trade the excess CECs to a utility in another state because the CECs are bundled with the RECs needed for compliance with the state standard.

Another way to allow state RPS policies to operate concurrently with a federal CES policy would be to allow states to opt their utilites out of the federal program if their state programs are deemed equivalent to the federal program (e.g., a model for this type of opt-out provision can be found in EPA's Clean Power Plan). In this case, each clean generator would only participate in one program (either state or federal), register with the appropriate REC tracking system, and generate one type of RPS or CES credit, and each utility would face only one RPS/CES compliance regime (either state or federal).

Allowing States to Define Clean Energy

Another issue to address is that of conflicting definitions of clean energy. One option for treating state electricity portfolio standards under a federal CES is to allow states discretion in defining qualified clean energy sources by allowing energy sources in a particular state that qualify for credit under that state's electricity portfolio standard to also qualify for credit under the federal CES. In this case, federal policymakers would forgo their ability to define qualified clean energy themselves; although, they might set certain minimum criteria that energy sources would need to meet to qualify for credit under the federal CES based on their inclusion in state electricity portfolio standards. Notably, this could be a significant hurdle for interstate credit trading.

INTERACTION OF STATE/REGIONAL GREENHOUSE GAS CAP-AND-TRADE PROGRAMS AND A CES

Many states with electricity portfolio standards also are participating in separate and distinct regional greenhouse gas programs, such as RGGI's power-sector CO2 cap-and-trade programs, or have implemented their own state-based greenhouse gas program, such as in California. Similarly, past and current congressional electricity portfolio standard proposals would create programs separate and distinct from any existing state or regional greenhouse gas cap-and-trade programs or any proposed federal greenhouse gas cap-and-trade program. As with state electricity portfolio standards, any future CES programs might adopt the approach of treating a CES program as entirely distinct and separate from any greenhouse gas cap-and-trade programs. The main purpose of a greenhouse gas cap-and-trade program is to reduce greenhouse gas emissions. While this is one of the benefits of a CES and a CES could be expanded to additional sectors, a CES may have other goals like deploying more solar or nuclear power, as discussed earlier.

The interaction of a CES and greenhouse gas cap-and-trade program has not been thoroughly modeled. Nonetheless, qualitative observations can be made about the potential interaction of a CES with a greenhouse gas cap-and-trade program. Factors that would likely affect the outcomes of the implementation of both a greenhouse gas cap-and-trade program and a CES include the relative stringencies of the programs' targets, the scope of coverage of the cap-and-trade program, and the electricity market structure (i.e., competitive vs. traditionally regulated).

Under a greenhouse gas cap-and-trade program that extends beyond the power sector, a CES might lead to lower power-sector greenhouse gas emissions than the cap-and-trade program alone and thus higher emissions outside the power sector than under the cap-and-trade program alone.

A CES might lead to lower allowances prices in a greenhouse gas cap-and-trade programs since the CES will lead to emission reductions and thus lower the level of emission reductions that must be driven by the cap-and-trade allowance price.[101]

If a greenhouse gas cap-and-trade program leads to more clean energy generation than a CES alone would, then CEC prices will be lower than they would be in the absence of the greenhouse gas cap-and-trade program.

INTERNATIONAL COORDINATION

With respect to a CES, policymakers might consider issues of international coordination in the context of regional climate and energy policies that cross national boundaries and the potential to link a federal CES with market-oriented programs for clean energy deployment and environmental benefit in other countries.

U.S. regional greenhouse gas emission reduction programs might span multiple countries. The Western Climate Initiative (WCI) includes Canadian provinces as members and Mexican states as observers.[102] In the case of a regional greenhouse gas cap-and-trade program that included trading among U.S. and international jurisdictions, a CES that covered only domestic electric utilities might lead to lower greenhouse gas emissions from U.S. power generators covered by the cap-and-trade program and higher greenhouse gas emissions from covered power generators in international jurisdictions than would occur in the absence of the CES.

None of the recent congressional proposals for federal electricity portfolio standards have explicitly included provisions for international linkage. However, a CES could be linked to similar market-oriented programs outside the United States such that U.S. CECs could be exchanged for tradable credits in other countries' programs and vice versa. To enable such international coordination, policymakers would need to define criteria for determining whether an international program could be linked to and establish some means for setting an exchange rate between U.S. CECs and tradable credits from other countries' programs. Already, several U.S. utilities trade clean electricity (i.e., hydropower) with Canadian entities.

IX. CONCLUSIONS

A transition from conventional fossil-fueled electricity generation to clean energy offers several benefits—particularly a decrease in greenhouse gas emissions, the growth of new clean energy industries and associated jobs, diversification of energy supply, acceleration of development and deployment of clean energy technologies, and reductions in the public health and environmental damages associated with conventional electricity generation. The current outlook for the power sector suggests, however, that absent significant new policies to promote clean energy the status quo in terms of power generation improvement will be insufficient to meet the mid-century goals we now know are needed.

A clean energy standard (CES) holds promise as a policy for preserving existing and spurring growth in clean generation. As a concept, a CES builds on the successful experience of the majority of states that have implemented renewable and alternative energy portfolio standards and draws on a history of federal policy deliberation regarding national electricity portfolio standards. There are real opportunities to consider a CES that can be integrated with ambitious performance standards in other sectors such as industry, transportation and buildings. This has the potential to further enhance the economic efficiency of a CES and create new strategic opportunities for intersector coordination.

The net effects of a CES policy are a function of interrelated policy design decisions. Policymakers and stakeholders should understand CES policy design options and their interactions and implications. Policymakers and stakeholders might usefully evaluate a CES in terms of key criteria—effectiveness, affordability, cost-effectiveness, fairness and interoperability—and think about implications of different policy design decisions in light of these criteria. At a time when Congress is increasingly looking for potential climate solutions and market-based approaches are known to be more economically efficient, a CES provides a viable, attractive alternative to more politically difficult market-based solutions.

LIST OF ABBREVIATIONS

ACP	Alternative Compliance Payment
AEO	Annual Energy Outlook
AEPS	Alternative Energy Portfolio Standard
CCUS	Carbon Capture Utilization and Storage
CEC	Clean Energy Credit
CES	Clean Energy Standard
CHP	Combined Heat and Power
DES	Diverse Energy Standard
EERS	Energy Efficiency Resource Standard
EIA	Energy Information Administration
GHG	Greenhouse Gas
HAP	Hazardous Air Pollutant
LCOE	Levelized Cost of Electricity
MSW	Municipal Solid Waste
MWh	Megawatt-hour
NGCC	Natural Gas Combined Cycle
NGCT	Natural Gas Combustion Turbine
RES	Renewable Electricity Standard
RGGI	Regional Greenhouse Gas Initiative
RPS	Renewable Portfolio Standard
ZEC	Zero Emission Credit

APPENDIX A: CHALLENGES FACING CLEAN ELECTRICITY TECHNOLOGIES

Clean energy technologies face numerous challenges to more widespread deployment, as summarized in **Figure A-1**.

Other challenges include the need for federal financial support for clean energy technology research, development, and demonstration and various other market failures and regulatory and institutional barriers.

In many parts of the United States, the water-energy nexus is a significant area of concern, both because of the amount of energy used to provide clean water to residents, businesses, and agriculture, and because of water withdrawals and water consumption by the power and oil and gas sectors. Renewable energy generation typically uses less water than fossil-fuel based sources of electricity generation. NREL concluded that in 2013 renewable electricity generation used to satisfy RPS obligations decreased water consumption by 27 billion gallons and water withdrawal by 830 billion gallons.[103] As concerns about access to clean water increase due to changing precipitation patterns and increased drought caused by climate change, the water-saving benefits of clean energy are likely to become a growing area of focus.

While a CES can partially resolve the current failure of power markets to reflect all societal costs and benefits, less mature and more costly clean energy technologies face additional challenges. Existing federal policies address some of these challenges to some extent, but these challenges might warrant additional policies.

Less mature and more costly clean energy technologies generally suffer from an underinvestment in research, development, and demonstration. Both because of the lack of a comprehensive financial incentive to shift to cleaner power generation and the spillover benefits from clean energy technology research and development (R&D), private firms under-invest in R&D given the returns such investments yield for society as a whole. This is the classic rationale for government financial support for clean energy R&D. In addition to clean energy R&D, the initial deployment of less mature clean energy technologies also provides spillover benefits (e.g., demonstrated success and real-world cost and performance data that reduce uncertainty and cost, and performance improvements from "learning by doing"). Failure to reward initial deployment of these technologies for such spillover benefits leads to lower levels of deployment than are socially optimal. The aforementioned spillover benefits from clean energy R&D and initial deployment are particularly relevant to more costly and less mature technologies such as solar power, CCS, offshore wind, and next-generation nuclear power plants. Federal support for R&D and demonstration projects can improve the cost and performance of clean energy technologies and reduce market risk and uncertainty regarding first-of-a-kind clean energy projects.

Other market failures and regulatory and institutional challenges also hold back particular clean energy technologies. A comprehensive description of all such challenges is beyond the scope of this discussion.

FIGURE A-1: Challenges Facing Clean Electricity Technologies

Renewables	Cost, variability, transmission, siting
Nuclear	Financing first-movers, spent fuel management, safety
Natural Gas	Price volatility, fracking concerns, lifecycle emissions
Fossil Fuel + CCS	Cost, commercial-scale demos
Energy Efficiency	Utility incentives, information

APPENDIX B: AIR EMISSIONS FROM FOSSIL FUEL-FIRED ELECTRICITY GENERATION

Table B-1 shows air emission rates in 2016 for three key pollutants from electricity generation from average coal-, natural gas-, and oil-fired power plants. Substituting natural gas generation for coal generation has led to a substantial reduction in carbon dioxide and sulfur dioxide emissions from the power sector, but carbon dioxide and nitrogen oxide emissions from natural gas-fired power plants are non-trivial; carbon dioxide emissions from U.S. natural gas-fired power plants have increased by more than 70 percent since 2005, and nitrogen oxide emissions have doubled over the same period.[104] Less than one percent of U.S. electricity is sourced from oil-fired generation.

TABLE B-1: Average Emission Rates from Fossil Fuel-Fired Electricity Generation (lbs/MWh)

GENERATION FUEL TYPE	CARBON DIOXIDE	SULFUR DIOXIDE	NITROGEN OXIDES
Coal	2,180	2.371	1.606
Natural Gas	897.6	0.039	0.395
Oil	1,369	2.376	3.076

Source: U.S. Environmental Protection Agency 2019a.

APPENDIX C: A CES IN TRADITIONALLY REGULATED AND COMPETITIVE ELECTRICITY MARKETS

In traditionally regulated electricity markets, vertically integrated electric utilities own electricity generation assets and sell power to retail customers. In competitive electricity markets, electric utilities buy power from competitive generators for sale to retail customers. Electricity portfolio standards generally, and a CES in particular, can apply to either type of electricity market, but the standards' impacts will differ depending on the electricity market regulatory structure.

In a traditionally regulated market, a vertically integrated electric utility under a clean energy standard (CES) will accrue clean energy creditrs (CECs) for the output from its own qualified clean energy facilities. It may also purchase CECs from other entities or sell excess CECs that it has accrued. The vertically integrated utility will seek the least-cost approach to complying with the CES. It will invest in new clean energy generation assets and increase the utilization of existing clean energy facilities where possible—earning credits itself for the output from these facilities—when doing so is cost-effective. The electric utility will also determine the extent to which its least-cost approach is to rely to some extent on buying credits from the credit market or generating more clean energy than it needs to comply with the CES and selling its excess credit to the credit market. Under the oversight of utility regulators, the electric utility will pass on to its ratepayers cost changes associated with increasing its own clean energy generation, buying credits from the credit market, and making alternative compliance payments (ACP)s. The utility regulators will also ensure that any revenue realized from selling excess CECs will pass through to electricity consumers.

The perspective of an electric utility in a competitive electricity market is different. Generally, the electric utility owns no clean energy generators and must purchase tradable credits from the credit market to cover its entire CES compliance obligation and will pass on the cost of purchasing these credits to its retail customers. Competitive clean energy generators will earn a premium for their output as they realize revenue both from selling electricity and CECs, and a CES will impact competitive electricity prices as the premium for clean energy induces new entrants and increased clean energy generation. For example, as the share of clean electricity sources increases in wholesale power markets, prices will continue to decline, adversely impacting the revenue stream and future viability of zero-emitting sources.

APPENDIX D: COMPARISON OF A CES TO OTHER POLICY OPTIONS

The table below compares a clean energy standard (CES) to other policies that can achieve many of the same policy goals via different means. These policies are renewable portfolio standards, cap-and-trade programs, and emission performance standards (both traditional and tradable standards).

TABLE D-1: Comparison of CES to Other Clean Energy and Air Emission Reduction Policies

		COMPARISON TO A CES	
POLICY	**DESCRIPTION**	**KEY SIMILARITIES**	**KEY DIFFERENCES**
Renewable Portfolio Standard (RPS)	Requirement for electric utilities to supply specified percentages of their sales from qualified renewable sources with compliance via tradable credits	Both policies focus on spurring deployment of clean energy technology. A CES and RPS can be nearly identical save for the set of fuels / technologies that qualify for credit under the policies.	A CES allows for compliance via a broader set of clean energy technologies that includes lower- and non-emitting technologies that are not renewable. A CES islikely to be less costly to achieve the same carbon performance.
Cap-and-Trade Program	Absolute, aggregate limit (cap) placed on emissions implemented via tradable allowances surrendered by covered entities	Both policies are market-oriented and rely on tradable instruments. Both policies can spur clean technology deployment and reductions in air emissions.	Cap and trade directly regulates pollution while a CES sets a performance standard for clean energy technology deployment. Cap and trade ensures a specified aggregate level of emissions whereas a CES target implies a certain level of aggregate emissions intensity. The point of regulation in a cap and trade program may differ from that of a CES. Cap and trade programs typically regulate emitters in the power sector (i.e., generators) whereas a CES typically regulates electric distribution utilities, which are often different entities than generators. Whereas cap and trade requires covered entities to hold allowances to cover all emissions, a CES requires electric utilities to surrender credits just for clean electricity sales. Cap and trade requires government distribution of emission allowances; under a CES, entities earn credits for qualified clean energy generation or electricity savings from efficiency.

POLICY	DESCRIPTION	COMPARISON TO A CES KEY SIMILARITIES	KEY DIFFERENCES
Carbon Tax (on emissions or product)	A carbon tax sets a price on each unit of pollution. A carbon tax can include mechanism(s) to ensure environmental objecrtives are met.	Both policies are market-oriented. Both policies can spur clean technology deployment and reductions in air emissions.	A carbon tax directly regulates pollution while a CES sets a performance standard for clean energy technology deployment. A carbon tax could provide some certainty in the levels of emission reductions whereas a CES target implies a certain level of aggregate emissions intensity. The point of regulation under a carbon tax may differ from that of a CES. A carbon tax could regulate emitters upstream whereas a CES typically regulates electric distribution utilities, which are often different entities than upstream. A carbon tax would require covered entities to pay for emissions, a CES requires electric utilities to surrender credits just for clean electricity sales. A carbon tax could offer credits or refunds for sequestered or embedded emissions; under a CES, entities earn credits for qualified clean energy generation or electricity savings from efficiency.
Tradable Performance Standards	Aggregate emissions intensity standard (e.g., lbs. / MWh) implemented via tradable permits / allowances surrendered by covered entities.	CES and tradable performance standard could be market-oriented and rely on tradable instruments. Both policies effectively require a certain aggregate emissions intensity level. These policies can be effectively nearly identical depending on how they are designed.	A tradable performance standard program explicitly sets a requirement for the emissions intensity of generation rather than a target for clean energy generation. A tradable performance standard program may apply to emitters rather than electric utilities.
Traditional Emission Performance Standards	Standards for maximum permissible emissions per unit of input or output (e.g., lbs. / MWh) that apply to emitting facilities; maximum emission rates may be facility- or technology/fuel- specific. Emission performance standards may be binding directly on facilities or may govern electric utilities' ability to contract for power from facilities.	Both policies can spur deployment of clean technology and reduce GHG emissions. Traditional emission performance standards alone are not tradable, but they could be made tradable with a baseline-and-credit system.	A CES is a market-oriented policy in contrast to traditional, non-market-oriented emission performance standards. Whereas traditional emission performance standards focus on limiting emissions, a CES focuses on increasing clean energy generation. There is no provision for continuous improvement. Performance standards typically apply to each emitting facility rather than to electric utilities. Traditional performance standards have an uncertain impact on aggregate emissions. Emission performance standards are enforced by environmental regulators, whereas a CES is normally enforced by utility regulators.

APPENDIX E: ELECTRIC UTILITY SIZE THRESHOLD UNDER A FEDERAL CES

TABLE E-1: Covered electricity sales under different thresholds

THRESHOLD (MWHS)	TOTAL COVERED ELECTRICITY SALES (MWHS)	TOTAL POTENTIAL REGULATED ENTITIES	PERCENT OF TOTAL 2017 SALES	PERCENT OF TOTAL ENTITIES
4,000,000	2,926,900,377	181	68%	5%
1,000,000	3,689,341,238	534	86%	16%
500,000	3,949,575,487	906	92%	27%
0	4,295,568,799	3411	100%	100%

Source: EIA form 861 2019: https://www.eia.gov/electricity/data/eia861/zip/f8612017.zip

APPENDIX F: INTEROPERABILITY WITH EMISSION REDUCTION PROGRAMS IN OTHER SECTORS

The calculations in the subsections below illustrate two points. First, two utilities can each increase their quantity of clean electricity by an equal percentage, yet the quantity of emission reductions that occur can be quite different. Second, a single utility can undertake two different action plans that result in the same overall increase in clean electricity, yet the quantity of emission reductions from each plan can be quite different.

TWO UNIQUE UTILITIES INCREASE THEIR QUANTITY OF CLEAN ELECTRICITY BY AN EQUAL PERCENTAGE

Utility A and Utility B each have a unique electricity portfolio (**Tables F-1 and F-2**). Therefore, the quantity of emission reductions that result from taking actions to become cleaner vary. To illustrate this point, the descriptions and tables below compare efforts to become 1.75 percent cleaner (i.e., a rate proposed in Senator Smith's federal CES) over one calendar year by hypothetical Utility A and Utility B.

TABLE F-1: Hypothetical utility A, 10.6 percent clean in year 1

	MW	CAPACITY FACTOR	MWH	PERCENT	EMISSION RATE (LB CO_2/MWH)	EMISSION RATE (MT CO_2/ MWH)	CLEAN STANDARD (MT CO_2/ MWH)	CECS	PERCENT CLEAN
Year 1									
Wind	980	0.35	3,004,680	3.0%	0	0.00	0.45	3,004,680	
Hydro	1,900	0.42	6,990,480	7.0%	0	0.00	0.45	6,990,480	
Coal	15,000	0.6	78,840,000	78.9%	2100	0.95	0.45		
Natural Gas	2,100	0.6	11,037,600	11.1%	950	0.43	0.45	551,834	
Total	19,980		99,872,760					10,546,994	10.56%
Year 2									
Wind	980	0.35	3,004,680	3.0%	0	0.00	0.45	3,004,680	
Hydro	2,015	0.42	7,413,588	7.4%	0	0.00	0.45	7,413,588	
Coal	14,155	0.6	74,400,000	74.2%	2100	0.95	0.45		
Natural Gas	2,950	0.6	15,505,200	15.5%	875	0.40	0.45	1,938,090	
Total	20,100		100,323,468					12,356,358	12.32%

Assumes that all zero-emission electricity earns a full credit. Natural gas earns partial credit because the carbon intensity of the utility's fleet is below the clean standard of 0.45 Mt CO2/MWh.

Source: C2ES Analysis

UTILITY A

In year 1, the portfolio of Utility A is 10.56 percent clean (**Table F-1**). The utility undertakes the following actions: brings a new 850 MW natural gas combined cycle unit on-line (which lowers the emission rate of its natural gas fleet), retires 845 MW of coal generation, and completes a turbine upgrade at a hydropower facility that adds 115 MW of capacity. Therefore in year 2, the utility is 12.32 percent clean. Looking at its emitting electricity sources (i.e., coal and natural gas), the utility emits 2.83 million metric tons of CO_2 less in year 2.

UTILITY B

In year 1, the portfolio of Utility B is 79.5 percent clean (**Table F-2**). The utility undertakes the following actions: brings a new 450 MW wind farm online, retires a 350 MW coal unit, and manages to lower electricity demand by around 0.46 percent through efficiency programs. Therefore, in year two the utlity is 81.26 percent clean. Looking at this utility's emitting electricity sources (i.e., coal and natural gas), it emits 1.75 million metric tons of CO_2 less in year 2.

> ***Each utility increases its percentage of clean electricity by 1.75 percent. However, utility A reduces its CO_2 emissions by 2.83 million metric tons—38 percent more than utility B.***

TABLE F-2: Hypothetical utility B, 79.5 percent clean in year 1

	MW	CAPACITY FACTOR	MWH	PERCENT	EMISSION RATE (LB CO_2/MWH)	EMISSION RATE (MT CO_2/ MWH)	CLEAN STANDARD (MT CO_2/ MWH)	CECS	PERCENT CLEAN
Year 1									
Wind	7,950	0.35	24,374,700	24.4%	0	0.00	0.45	24,374,700	
Hydro	14,900	0.42	54,820,080	54.8%	0	0.00	0.45	54,820,080	
Coal	2,900	0.6	15,242,400	15.2%	2100	0.95	0.45		
Natural Gas	1,050	0.6	5,518,800	5.5%	950	0.43	0.45	275,917	
Total	26,800		99,955,980					79,470,697	79.5%
Year 2									
Wind	8,400	0.35	25,754,400	25.9%	0	0.00	0.45	25,754,400	
Hydro	14,900	0.42	54,820,080	55.1%	0	0.00	0.45	54,820,080	
Coal	2,550	0.6	13,402,800	13.5%	2100	0.95	0.45		
Natural Gas	1,050	0.6	5,518,800	5.5%	950	0.43	0.45	275,917	
Total	26,900		99,496,080					80,850,397	81.26%

Assumes that all zero-emission electricity earns a full credit. Natural gas earns partial credit because the carbon intensity of the utility's fleet is below the clean standard of 0.45 Mt CO_2/MWh.

Source: C2ES Analysis

COMPARING TWO SETS OF ACTIONS BY A SINGLE UTILITY TO BECOME CLEANER

There are many actions a utility can take to achieve a cleaner portfolio. This section looks at two different plans by a single utility to become 1.75 percent cleaner, and the effect that each plan has on its total emission reductions.

Initially, the electricity portfolio of Utility C is 32 percent clean. Plan A to become 1.75 percent cleaner, shown in **Table F-3**, involves the following actions: bring a new 318 MW wind farm on-line, run its coal facilities less often (i.e., decrease the capacity factor), and run its natural gas assets more often (i.e., increase the capacity factor). Therefore in year 2, the utility is 33.75 percent clean. Looking at its emitting electricity sources (i.e., coal and natural gas) under Plan A, the utility emits 2.61 million metric tons of CO_2 less in year 2.

Plan B to become 1.75 percent cleaner, shown in **Table F-4**, involves the following actions: complete a 132 MW uprate on a nuclear reactor, run its coal facilities less often (i.e., decrease the capacity factor), run its natural gas assets more often (i.e., increase the capacity factor), and reduce electricity demand by 0.22 percent through efficiency programs. Therefore in year 2, the utility is 33.75 percent clean. Looking at its emitting electricity sources (i.e., coal and natural gas) under Plan B, the utility emits 5.60 million metric tons of CO_2 less in year 2.

Under each plan, utility C increases its percentage of clean electricity by 1.75 percent. However, Plan B reduces its CO_2 emissions by 5.60 million metric tons—2.15 times the quantity in plan A.

TABLE F-3: Utility C, Plan A for Cleaner Electricity

	MW	CAPACITY FACTOR	MWH	PERCENT	EMISSION RATE (LB CO_2/MWH)	EMISSION RATE (MT CO_2/ MWH)	CLEAN STANDARD (MT CO_2/ MWH)	CECS	PERCENT CLEAN
Year 1									
Wind	3,262	0.35	10,000,000	10.0%	0	0.00	0.45	10,000,000	
Hydro	2,537	0.9	20,000,000	20.0%	0	0.00	0.45	20,000,000	
Coal	5,708	0.6	30,000,000	30.0%	2100	0.95	0.45		
Natural Gas	7,610	0.6	40,000,000	40.0%	950	0.43	0.45	1,999,832	
Total	19,116		100,000,000					31,999,832	32.0%
Year 2									
Wind	3,580	0.35	10,976,280	11.0%	0	0.00	0.45	10,976,280	
Hydro	2,537	0.93	20,666,667	20.7%	0	0.00	0.45	20,666,667	
Coal	5,708	0.53	26,350,000	26.4%	2100	0.95	0.45		
Natural Gas	7,610	0.63	42,000,000	42.0%	950	0.43	0.45	2,099,824	
Total	19,435		99,992,947					33,742,771	33.75%

Assumes that all zero-emission electricity earns a full credit. Natural gas earns partial credit because the carbon intensity of the utility's fleet is below the clean standard of 0.45 Mt CO_2/MWh.

Source: C2ES Analysis

TABLE F-4: Utility C, Plan B for Cleaner Electricity

	MW	CAPACITY FACTOR	MWH	PERCENT	EMISSION RATE (LB CO_2/MWH)	EMISSION RATE (MT CO_2/ MWH)	CLEAN STANDARD (MT CO_2/ MWH)	CECS	PERCENT CLEAN
Year 1									
Wind	3,262	0.35	10,000,000	10.0%	0	0.00	0.45	10,000,000	
Hydro	2,537	0.9	20,000,000	20.0%	0	0.00	0.45	20,000,000	
Coal	5,708	0.6	30,000,000	30.0%	2100	0.95	0.45		
Natural Gas	7,610	0.6	40,000,000	40.0%	950	0.43	0.45	1,999,832	
Total	19,116		100,000,000					31,999,832	32.0%
Year 2									
Wind	3,262	0.35	10,000,000	10.0%	0	0.00	0.45	10,000,000	
Hydro	2,669	0.91	21,276,200	21.3%	0	0.00	0.45	21,276,200	
Coal	5,708	0.41	20,500,000	20.5%	2100	0.95	0.45		
Natural Gas	7,610	0.72	48,000,000	48.1%	950	0.43	0.45	2,399,799	
Total	19,249		99,776,200					33,675,999	33.75%

Assumes that all zero-emission electricity earns a full credit. Natural gas earns partial credit because the carbon intensity of the utility's fleet is below the clean standard of 0.45 Mt CO_2/MWh.

Source: C2ES Analysis

Under each plan, utility C increases its percentage of clean electricity by 1.75 percent. However, Plan B reduces its CO_2 emissions by 5.60 million metric tons – 2.15 times the quantity in plan A.

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ENDNOTES

1 Some states have also adopted energy efficiency resource standards (EERS). An EERS can be similar to an electricity portfolio standard except that only electricity savings from energy efficiency count toward compliance with an EERS. This paper does not consider an EERS in isolation as a form of electricity portfolio standard, but does allow for the possibility of a CES that treats energy efficiency savings as one type of qualifying resource.

2 U.S. Energy Information Administration 2018b.

3 In this paper, the term "electric utility" will generally be used to refer to any entity that sells electric energy at retail to end-use customers. Where references are made to specific state laws or specific federal laws that have been proposed, the term "utility" may in some cases be defined more narrowly in the applicable statute or bill, for example to include investor-owned utilities but not electric cooperatives. Chapter VIII explains how a CES specifies what fraction of sales must come from clean energy sources.

4 For a more thorough explanation of the unbundling of electricity attributes into different commodities such as the megawatt-hour (MWh) energy commodity and CECs, see Holt 2003.

5 See "Table 12.6 Electric power sector" in U.S. Energy Information Administration 2019c.

6 See "Table 7.2b Electric power sector" in U.S. Energy Information Administration 2019b.

7 Vine 2018b.

8 Vine 2018a.

9 Intergovernmental Panel on Climate Change 2018.

10 U.S. Environmental Protection Agency 2017.

11 Biomass and landfill gas technologies, for example, release GHG during the combustion process that would ultimately be released anyway as methane inevitably escapes the landfill or is flared releasing CO2, or as biomass decomposes in nature.

12 U.S. Environmental Protection Agency 2018b.

13 U.S. Environmental Protection Agency 2018a.

14 U.S. Environmental Protection Agency 2016, and U.S. Environmental Protection Agency 2019b.

15 Wiser et al. 2016.

16 U.S. Energy Information Administration 2011.

17 Crooks 2015.

18 U.S. Energy Information Administration 2018c.

19 U.S. Energy Information Administration 2019d and Baker 2019.

20 U.S. Energy Information Administration 2018a

21 Under very cold weather conditions, most electricity sources can face challenges. For example, frozen coal piles can disrupt plant supply; natural gas pipeline capacity can become constrained (as competition for supply from residential and commercial buildings for heat and electric power plants increases), resulting in forced power plant outages; ice can

block intake water for nuclear power plants, requiring an orderly shutdown; electric energy storage batteries and solar panels suffer from degraded performance under very cold temperatures; and wind turbines need to be turned off during very cold events or extremely high winds to prevent turbine damage.

22 United States Climate Alliance, n.d.

23 Intergovernmental Panel on Climate Change 2018.

24 Bloomberg New Energy Finance 2019. *Clean Energy Investment Trends 2018*.

25 International Energy Agency 2018. *World Energy Investment 2018*.

26 Bloomberg New Energy Finance 2019. *Clean Energy Investment Trends 2018*.

27 Barbose 2018.

28 See, for example, Wiser and Bolinger 2017; Stehly et al. 2018; and Bolinger and Seel 2018.

29 Lazard 2018.

30 Stehly et al. 2018.

31 Bureau of Labor Statistics 2019a and Bureau of Labor Statistics 2019b.

32 See U.S. Department of Energy 2017, and Business Council for Sustainable Energy 2018.

33 Michigan Public Service Commission 2011.

34 Wiser and Bolinger 2017, 12.

35 Eckhouse 2019.

36 Wiser et al. 2016.

37 Bureau of Labor Statistics 2019a and Bureau of Labor Statistics 2019b.

38 Merchants are independent electricity producers. Typically, they receive revenue from power markets and bilateral contracts. Therefore, their business model is more speculative than a traditional utility.

39 Part of the dilemma faced by coal-producing states is that most of them have relatively small populations and electric load. They are fuel exporters. RPS policies established in other states, over which the coal producing states have no control, may eventually reduce coal's share of the generation mix. At the same time, sustained low natural gas prices, EPA regulations (e.g., Mercury Rule), and the expectation of future EPA regulations on carbon pollution are having a dramatic effect, given the impacts of coal on air and water quality. It's unclear how much further these factors might substantially reduce the future demand for coal. So, it is not inconceivable to think that a federal CES policy could stimulate research, development, and deployment of lower-emitting coal-based technologies like CCS that would otherwise be cost-prohibitive, and thereby provide an "insurance policy" for coal-producing states.

40 Center for Climate and Energy Solutions 2011b.

41 Center for Climate and Energy Solutions 2012.

42 U.S. Energy Information Administration 2017. See also American Council for Energy-Efficient Economy 2019.

43 Barbose 2018.

44 By far, Texas has the largest installed wind capacity in the United States – more than three times Iowa, the number two state. See American Wind Energy Association n.d. Wind power has proliferated in Texas because the state has an excellent wind resource, a large amount of available land, and favorable transmission policy that delivers the electricity to in-state demand centers.

45 Barbose 2018.

46 Energy and Environmental Economics 2018. This growth was driven by several factors: utility goals set in Act 236 (2014), the Public Utility Regulatory Policies Act (which gives certain power plants special rates and regulatory treatments), federal and state renewable energy tax incentives, utility incentives, and the decreased costs of renewable energy (see South Carolina Energy Office n.d.).

47 Note that twelve states (i.e., a different set from the one listed in Table 3) and the District of Columbia include renewable thermal in their RPS (e.g., solar hot water heating, geothermal heat pumps, landfill gas) to qualify on an kWh-equivalent basis. Donalds 2018.

48 Vine 2018b.

49 Illinois Power Agency 2017.

50 Illinois has the most nuclear reactors in the U.S. with 11, see U.S. Energy Information Administration 2018c.

51 An Act Relative to Green Communities, 2008 Mass. Chapter 169 (approved July 2, 2008), *https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169*.

52 Renewable Energy Portfolio Standard - Class I, 2016 Mass. 225 CMR 14 (issued. July 12, 2016), *https://www.mass.gov/files/documents/2017/10/02/225cmr14.pdf*.

53 Renewable Energy Portfolio Standard - Class II, 2014 Mass. 225 CMR 15 (issued June 20, 2014), *https://www.mass.gov/files/documents/2017/10/02/225cmr15.pdf*.

54 Alternative Energy Portfolio Standard, 2017 Mass. 225 CMR 16 (issued April 19, 2019), *https://www.mass.gov/files/documents/2018/01/05/225cmr16.pdf*.

55 Massachusetts Department of Environmental Protection. 2018. 310 CMR 7.75: Clean Energy Standard Frequently Asked Questions (FAQ).

56 New York State Energy and Research Development Authority n.d. "Clean Energy Standard."

57 "Order Adopting a Clean Energy Standard," New York Department of Public Service, Case 15-E-0302 (effective August 1, 2016), *http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B44C5D5B8-14C3-4F32-8399-F5487D6D8FE8%7D*.

58 Thompson and Zenta 2018.

59 Vine 2018b.

60 Alternative Energy Portfolio Standards Act, No. 213, 2004, *https://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2004&sessInd=0&act=213*

61 In practice, this could require a fairly complicated national tracking system, especially if the definition of "clean" varies across jurisdictions, but the concept is not unprecedented and is certainly realistic. Some states already collaborate on tracking systems despite having different lists of qualifying RPS resources. The key points are to ensure that any one credit cannot be used where it is not eligible and cannot be used twice.

62 PJM Environmental Information Services.

63 This paper uses the term "electric utilities" to describe entities selling electric energy at retail to end use customers. This is in fact a gross simplification but it is sufficient for describing the concepts in this paper. In today's complex restructured electric power industry, the reality is that end use customers may be purchasing power from a distribution-only utility, a vertically-integrated utility that owns generation assets, an electric cooperative, a public power entity, or a competitive retail electric supplier. Some of these entities will not meet the legal definition of "utility" in every jurisdiction.

64 See Chapter VI.

65 Aldy 2011, and Burtraw 2011, 53–55.

66 Consider the case of a merchant coal plant. Under a CES with the point of regulation on electric utilities, this coal plant may earn some credits (e.g., via CCS retrofit) to sell to electric utilities or not earn any credits, but the coal plant will never have to pay for any credits or allowances to cover its emissions. Under Aldy's proposal though, the coal plant would eventually, if it did not retrofit with CCS, have to pay to buy credits to cover its emissions.

67 For example, the generation and transmission cooperatives that supply rural electric cooperatives with nearly half of their electricity have made significant investments in developing and deploying clean energy technologies. In April 2016, the National Rural Electric Cooperative Association (NRECA) reported that cooperatives are currently engaged in public-private partnerships to explore methods for capturing and utilizing carbon emissions from existing fossil power plants. In addition, NRECA reports that electric cooperatives are partial owners of operating nuclear plants in seven states.

68 "Administrative costs can be lower because regulators are relieved of responsibility for establishing specific targets on a facility-by-facility basis." California Market Advisory Committee 2007. In general, added complexity (e.g., offset programs, many tiers) can increase administrative costs and the burden on smaller utilities.

69 Excluding clean energy generation (e.g., from existing facilities) from the base quantity means a CES has an effective target for overall clean energy generation that is higher than its nominal target, all else equal. Excluding non-clean energy generation from the base quantity means a CES has an effective target for overall clean energy generation that is lower than its nominal target.

70 Clean Energy Standard Act of 2019, S.1359, 116th Congress (2019).

71 The fourth example is offered to illustrate how energy efficiency can change the base quantity of sales and thereby change the amount of actual clean generation needed to satisfy a CES. The authors do not intend to suggest that this "incentive" for energy efficiency is necessarily or in all cases sufficient to overcome other disincentives a utility might have for investing in efficiency.

72 In its AEO2019 Reference Case, EIA projects that natural gas-fired plants account for roughly half of capacity additions (e.g., NGCC and combustion turbine) from 2019 through 2050. See U.S. Energy Information Administration 2019a.

73 Combustible renewable fuels face a similar issue. Whereas biomass, biogas, and landfill gas can be viewed as neutral with respect to long-term emissions of GHG, the same is not true for non-GHG air pollutants. When burned, these fuels release criteria air pollutants (e.g., SO_X, NO_X, and particulate matter) and hazardous air pollutants, though usually in smaller quantities than the typical coal-fired power plants operating today. This point is illustrated in part by EPA's proposal to exempt natural gas power plants from new HAP emission regulations, based on EPA finding that the public health impacts from HAP emissions at those power plants are negligible. Nonetheless, if reducing non-GHG air pollutants is an important CES policy goal, policymakers might consider provisions to address the non-GHG pollutants from these renewable technologies.

74 Generally, it's challenging to create and assign generation technologies into credit categories that are equitable because of plant-to-plant as well as technology-by-technology variation in emission rates.

75 For example, if the baseline of existing clean energy generation was 40 percent before the policy is enacted, then a 40 percent CES that credits only new and incremental generation could be equivalent to an 80 percent CES that provides credit to existing, new, and incremental generation.

76 The issue of wealth transfers from consumers to producers is nuanced. In some competitive electricity markets, a CES might actually lower wholesale power prices during certain periods. In such cases, existing clean power facilities might be less profitable under a CES than they would otherwise have been which might be an argument for providing credits to existing facilities. See Appendix Cfor a discussion of a CES in traditionally regulated and competitive electricity markets.

77 McGuinness 2011.

78 For example, if analysis suggests that nuclear plant owners will not relicense their reactors without receiving credits under a CES (even when generation from such reactors receives indirect credit by its exclusion from the base quantity),

then policymakers might provide some amount of credits for generation from existing nuclear plants upon their relicensing.

79 See Table 2 in Chapter VI for details on the federal proposals.

80 See Clean Energy Standard Act of 2019, S.1359, 116th Congress (2019).

81 Center for Climate and Energy Solutions 2019a.

82 Policymakers could also consider an energy efficiency resource standard (EERS) as a complementary policy to a CES.

83 Table 2 in Chapter VI shows that two of the three federal electricity portfolio standards included limits on how much compliance could come from energy efficiency.

84 For example, Senator Graham's Clean Energy Standard Act of 2010 (S. 20 of the 111th Congress) would have provided credits for early retirement of carbon-intensive generating units (e.g., old coal plants), where early retirement was defined as retirement between enactment of the bill and the end of 2014. Under the proposal, eligible retired units received partial credits for their avoided generation during this period.

85 Note that the LCOE estimates do not reflect any state or federal tax or other financial incentives.

86 For example, Senator Tina Smith's Clean Energy Standard proposal from 2019 includes an innovation multiplier (i.e., greater than 1) for generation from the first new power plants to use qualified dispatchable low- and zero-emission technologies.

87 Using bonus credits to provide an extra incentive for deployment of particular technologies poses an additional challenge under a CES if such bonus credits are of a very large scale. For example, if a CES's nominal target is increased in order to maintain a certain effective target in light of substantial numbers of anticipated bonus credits for widespread CCS deployment, then the CES will turn out to be much more ambitious than intended if those anticipated CCS projects never materialize. One option for addressing this issue is to grant the bonus credits on a competitive basis (e.g., via a reverse auction); this approach would prevent policymakers from defining a rate for awarding bonus credits for CCS (e.g., double credits for first movers) only to find this rate insufficient to spur CCS projects, thus leaving the bonus credits unclaimed and the overall CES targets overly stringent.

88 Strictly speaking, by setting minimum requirements for certain clean energy sources, carve-outs and tiers also set maximum levels of compliance from all other clean energy sources.

89 One might argue that banking of credits should be limited under some electricity portfolio standard policies. For example, a renewable electricity standard that sets targets that are at or even below "business-as-usual" levels in the early years might warrant restrictions on banking since early over-compliance with very modest requirements might substantially undermine the longer-term deployment of renewables. However, a CES with clean energy targets that are significantly higher than "business as usual" projections may not face the same issue with regard to banking.

90 Offsets have been a key feature in GHG cap-and-trade programs and proposals—including RGGI, California's cap-and-trade program, and congressional GHG cap-and-trade bills. Under a GHG cap-and-trade program, entities who are not subject to an emissions cap (e.g., farmers and forest managers) could receive offset credits for quantified emission reductions or biological carbon sequestration (e.g., credits for carbon sequestered via reforestation) that they could sell to entities that are covered by the emissions cap for compliance with the cap on emissions. Such credits are called "offsets" because they allow an entity that does not have a compliance obligation to take some actions to offset the actions (e.g., GHG emissions) of entities that do face compliance obligations. For more information on offsets in the context of GHG cap-and-trade programs, see Center for Climate and Energy Solutions 2008.

91 An ACP may be specified in $/MWh. For example, if an electric utility had to demonstrate that it delivered 1,000

MWh of qualified clean electricity under a CES, it might submit CECs equivalent to 500 MWh of clean energy and pay the ACP for the remaining 500 MWh.

92 Wiser and Barbose 2008.

93 A study modeled a federal renewable standard with a target of 20 percent by 2020 both with and without the ACP ($25/MWh). Compared to "business as usual," this study projected that the policy scenario without an ACP led to the deployment of roughly 2.5 times as much incremental renewable generating capacity as did the policy scenario with an ACP through 2035. See Karen L. Palmer et al. 2011.

94 Senator Graham's Clean Energy Standard proposal (S.20 of the 111th Congress), for example, capped the program's rate impact at 4 percent per year per customer.

95 See Table 9 in Wiser and Barbose 2008.

96 In 2018, the transportation and industrial sectors were responsible for 36 and 19 percent of energy-related carbon dioxide emissions, respectively, see: U.S. Energy Information Administration 2019c.

97 This approach is similar to the Output-Based Pricing System developed in Canada. Government of Canada 2018.

98 Note that "surplus credits" are not the same as "clean energy credits (CECs)" as described throughout this report.

99 State laws that specifically require in-state generation have been challenged in court on constitutional grounds, with litigants asserting a violation of the interstate commerce clause. See, for example, *American Tradition Institute v. State of Colorado*. Although resolution of this legal question is important, it is beyond the scope of this paper.

100 Under this approach, policymakers may take two steps to promote the fair treatment of utilities subject to state standards in addition to the federal CES. First, utilities that have purchase agreements for state RECs at the time of enactment of a federal CES might be assured that they will receive any federal credits associated with the renewable electricity generation that creates those state RECs. Second, to the extent that regulated entities comply with state standards by making payments to state authorities, a federal CES could assign to utilities making such payments ownership of the federal credits associated with any clean power generation funded by such payments to states. Both of the above provisions should be accompanied by adequate steps to avoid any double-counting of clean power generation under the federal standard.

101 This interaction between an electricity portfolio standard and a GHG cap-and-trade program is illustrated by the modeling results in two studies from RFF that compared GHG cap-and-trade programs alone to cap-and-trade in combination with an RPS. See Palmer et al 2011 and Burtraw et al. 2005.

102 Western Climate Initiative. n.d.

103 Wiser et al. (2016).

104 See Table 3-9 and 3-11 in U.S. Environmental Protection Agency 2018c.

The Center for Climate and Energy Solutions (C2ES) is an independent, nonpartisan, nonprofit organization working to forge practical solutions to climate change. We advance strong policy and action to reduce greenhouse gas emissions, promote clean energy, and strengthen resilience to climate impacts.

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