Bill Savings in a Clean Energy Future, Part 2

Clean Power Plan Final Rule Update

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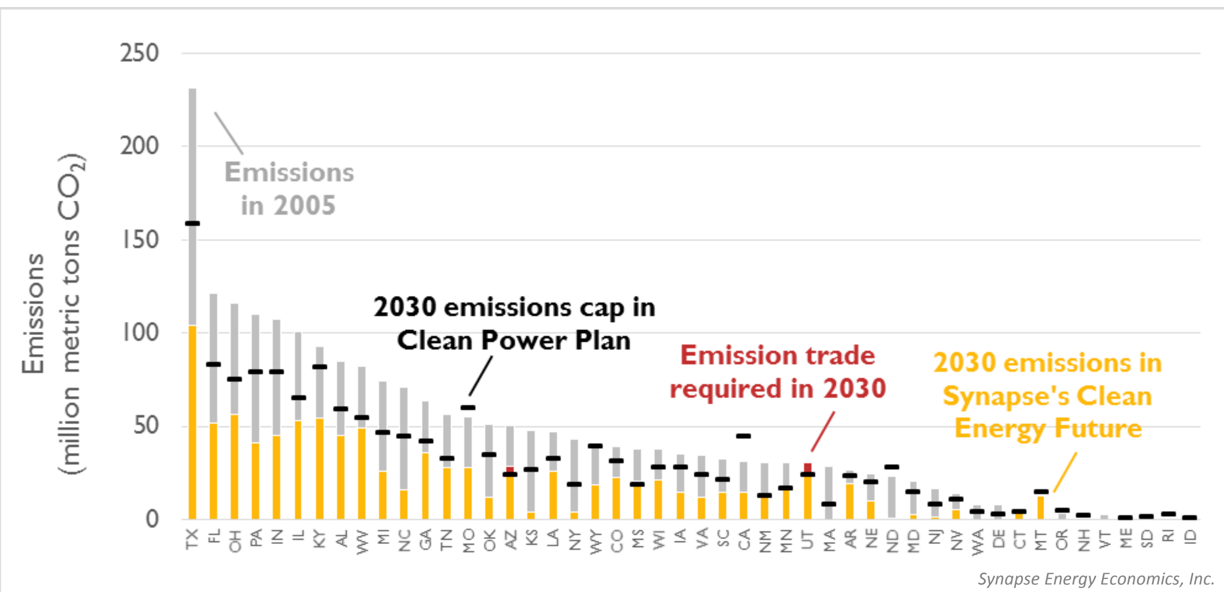
EXECUTIVE SUMMARY

On August 3, 2015, the U.S. Environmental Protection Agency (EPA) released its final Clean Power Plan under Section 111(d) of the Clean Air Act. The Clean Power Plan aims to reduce emissions of carbon dioxide (CO_2) from existing fossil fuel-fired power plants by approximately 32 percent below 2005 levels by 2030. These targets are based on a conservative set of assumptions for what is technologically and economically achievable. As a point of comparison, Synapse Energy Economics, Inc. (Synapse) developed and analyzed a scenario designed primarily to push the limits of emission reductions that are available at little or no net cost to society. The "Clean Energy Future" scenario models what would happen if each state invested heavily in energy efficiency and renewable energy.

Updating our July 2015 analysis to accurately represent the final Clean Power Plan after its release confirmed our original conclusions. The Clean Energy Future pathway over-complies with the Clean Power Plan's CO_2 emission reduction targets, and has the added benefit of lowering electricity costs over the long term compared to existing practices and policies. In fact, in many states, electricity bills will actually decline from 2012 levels. Depending on the level of participation in ratepayer-funded energy efficiency programs under this scenario, 2030 bills are expected to be $35 per month lower than in a business-as-usual ("Reference") scenario and, on average, $13 per month cheaper than residential bills were in 2012.

As reported in Figure ES-1, in 2030, the vast majority of states in the lower 48 have far lower CO_2 emissions than their target levels under the Clean Power Plan. Nationally, the Clean Energy Future would produce a 58 percent reduction in CO_2 emissions, nearly double the reductions called for in the Clean Power Plan.

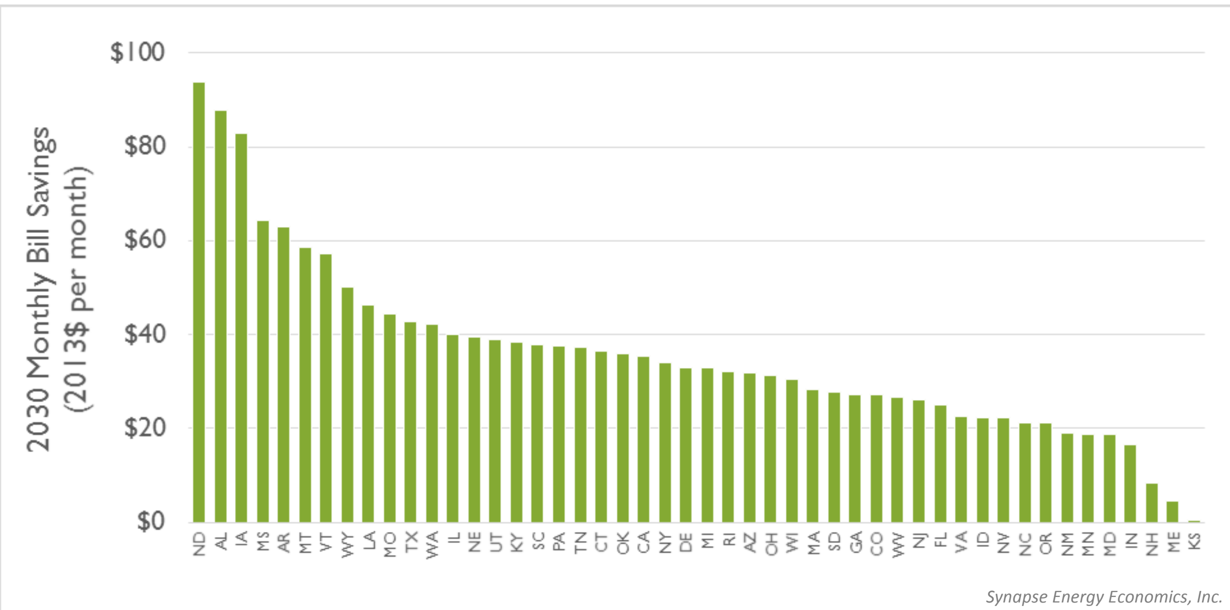
Figure ES-1. CO_2 emissions (Clean Power Plan target and Clean Energy Future result) in 2030 compared to 2005



In Synapse's Clean Energy Future scenario, most electric-sector investments are in renewables and efficiency, and all states achieve Clean Power Plan compliance. Even after accounting for households' share of the cost of energy efficiency, this Clean Power Plan strategy saves consumers money on their electric bills in 2030. Monthly bill savings for households with strong participation in energy efficiency programs range from $0.45 in Kansas up to $94 in North Dakota, as reported in Figure ES-2. The Clean Energy Future energy efficiency investments are aggressive, but realistic: they are based on levels already achieved in several states.

Electricity customers in the Clean Energy Future scenario save the most in states that are "first movers," meaning their states invest in new renewable energy sources early on. Their electricity costs decline even after incorporating the integration costs for wind and solar to account for variability and capacity factors. First-mover states are able to export clean power in later years to those states that continue to depend heavily on existing fossil fuel plants, which must eventually be retired. Those states that exceed Clean Power Plan compliance are also able to sell compliance allowances to states that miss their targets, although these allowances are expected to cost very little. In the interim period, all but 15 states will be in compliance and add to an abundance of supply that will drive down allowances prices.

Figure ES-2. 2030 residential monthly bill savings for energy efficiency participants in the Clean Energy Future



An overview of this analysis can be found in the brief accompanying this report, *How Clean Power Will Save Us Money in the Long Run*, available at www.synapse-energy.com/clean-power-will-save-money.

1. INTRODUCTION

On August 3, 2015, the U.S. Environmental Protection Agency (EPA) released its final Clean Power Plan under Section 111(d) of the Clean Air Act. The Clean Power Plan aims to reduce emissions of carbon dioxide (CO_2) from existing fossil fuel-fired power plants by approximately 32 percent below 2005 levels by 2030.[1] Achieving this level of emissions reductions may require significant changes to the nation's electric system, but these changes need not come at an increased cost to consumers.

Synapse conducted an analysis of the impacts of intensive investment in renewables and efficiency on electric-sector emissions and costs, presented in the accompanying policy brief, *How Clean Power Will Save Us Money in the Long Run*.[2] This background report to the brief documents the data, assumptions, and results related to modeling the emissions reductions of two scenarios of the future U.S. electric system: a "Clean Energy Future" approach to Clean Power Plan compliance that emphasizes cost-effective energy efficiency and renewable energy investments, and a business-as-usual "Reference" scenario.

In contrast to a scenario that focuses solely on compliance with the Clean Power Plan, in Synapse's Clean Energy Future, we modeled the extent of emission reductions possible at little or no cost to society. The Clean Energy Future represents a substantial shift towards renewable generation as the costs of green technologies continue to fall and incentives are put in place to encourage their adoption. Aggressive energy efficiency policies reduce total demand by 22 percent as compared to the Reference scenario in 2030, even after accounting for the impacts that an expansion of electric vehicles would have on the electric sector.[3]

The Reference scenario is a "no new policy" scenario in which existing state renewable portfolio standards are met but not expanded. New load is met largely by new gas-fired generating capacity, and the existing fleets of coal-fired and nuclear plants are retrofit to continue operating.

The Clean Energy Future scenario meets or exceeds EPA targets in all states and obtains higher levels of total national emission reductions—58 percent below 2005 levels in 2030—compared to the 32 percent reduction achieved by EPA's Clean Power Plan. As demonstrated in Synapse's recent report on air emissions displacement, high levels of energy efficiency and renewables will take the place of fossil fuel

[1] Previous Synapse reports on the implications of the proposed Clean Power Plan and best practices for planning for Consumer advocates include Stanton, E. A., et al. 2014. *Final Report: Implications of EPA's Proposed Clean Power Plan,* available at http://synapse-energy.com/sites/default/files/Final%20Report%20-%20Implications%20of%20EPAs%20Proposed%20Clean%20Power%20Plan%2014-026.pdf and Wilson, R. et al. 2015. *Best Practices in Planning for Clean Power Plan Compliance,* available at http://synapse-energy.com/sites/default/files/NASUCA-Best-Practices-Report-15-025.pdf.

[2] Additional information can be found in previous briefs in this series, available at http://synapse-energy.com/project/consumer-costs-low-emissions-futures.

[3] By 2030, electric vehicles make up 1.9 percent of total electric load in the Clean Energy Future.

generation; as a result, substantial emissions are avoided.[4] Even with relatively large emission reductions, modeling showed that with participation in energy efficiency programs, the average household can save $35 per month on its electric bills in the Clean Energy Future in 2030 as compared to the high-emissions Reference scenario.

This report discusses the methodology used to calculate emissions and household bills under each scenario, along with the state-by-state results of Clean Power Plan compliance and household bill impacts in the Clean Energy Future scenario.

2. METHODOLOGY OVERVIEW

Synapse developed its Clean Energy Future and Reference scenarios using the following tools, together with publicly available data: Regional Energy Deployment System (ReEDS) from the National Renewable Energy Laboratory, Synapse's Coal Asset Valuation Tool (CAVT), EPA's energy efficiency savings tool (EE Savings Tool), Synapse's Clean Power Planning Tool (CP3T), and Synapse's ReEDS Postliminary Reporting Tool (RePRT). More information on this combination of models, referred to as the "Synapse CPP Toolkit" can be found online at http://synapse-energy.com/synapse-clean-power-plan-toolkit.

Using the Synapse CPP Toolkit, we analyzed compliance with EPA's Clean Power Plan and bill impacts in two scenarios: a compliance scenario featuring extensive investment in energy efficiency and renewable energy ("Clean Energy Future"), and a business-as–usual ("Reference") scenario with no new policies to meet EPA targets. See *Appendix A: Methodology* for more information on the methodology used in this analysis. For more detailed information on the development of these scenarios, see Synapse's July 2015 *Clean Energy Future Technical Review*.[5]

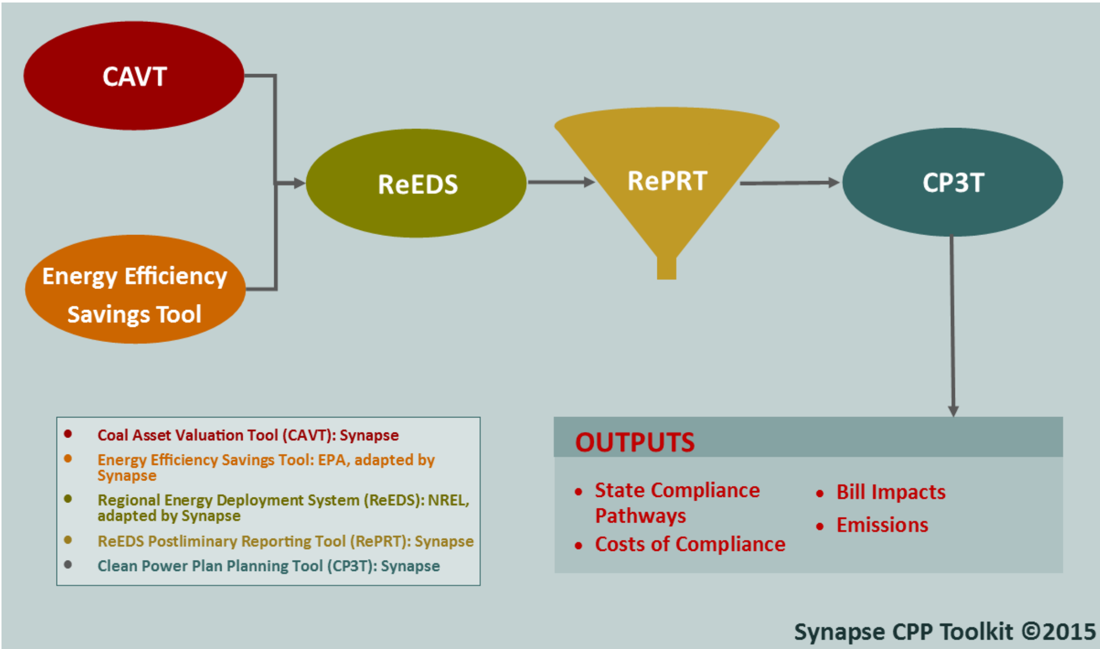
In this analysis, we compared Clean Energy Future to Reference scenario bill savings in 2030 (the final year of requirements under the Clean Power Plan), and 2030 emissions and bill savings to their near-current levels. Data availability lags behind the current day; the most recent year of data available for the particular data used by EPA is 2012. Some other electric-sector data (such as emissions, plant-level generation, and energy efficiency savings) are available for 2013 or 2014, but 2012 is the most recent year in which *all* required data are available. Furthermore, this is the same year that EPA uses in its Clean Power Plan baseline, making it a helpful reference point for comparisons.

[4] Biewald, B. et al. 2015. *Air Emissions Displacement by Energy Efficiency and Renewable Energy.* Available at http://www.synapse-energy.com/sites/default/files/Air-Emissions-Displacement-by-Energy-Efficiency-and-Renewable-Energy_0.pdf.

[5] Fields, S. et al. 2015. *Clean Energy Future Technical Review*. Available at http://www.synapse-energy.com/sites/default/files/Clean-Energy-2040-Technical-Review.pdf.

Figure 1 depicts the interrelations of the models used in the Synapse CPP Toolkit for this analysis.

Figure 1. Schematic of models used in Clean Energy Future analysis



While there are many different pathways states can take to meet Clean Power Plan compliance, in this analysis we considered a situation in which all states comply using the same pathway: mass-based compliance including emissions from new sources. In practice, it is possible that some states may choose different compliance pathways. However, as states segregate themselves into different pathways, they limit the number of eligible trading states and thereby reduce the cost-effectiveness of their compliance approach. In addition, while states may choose to follow a rate-based approach to compliance, the mass-based approach (including emissions from new sources called the "new source complements") may be simpler to administer from the states' perspectives.

States have flexibility in the timing of their compliance with the Clean Power Plan: we model all states complying with both a final compliance deadline in 2030 and an interim period average for 2022-2029. In the EPA's rule, this interim period is divided into a set of multi-year interim "steps." States are legally obligated to comply with both these steps and the interim period total itself, although they are mathematically equivalent. For simplicity's sake, our analysis models compliance only over the entire eight-year interim period and the final compliance year of 2030.

3. EMISSIONS RESULTS

In 2030 in the Clean Energy Future scenario, all states comply with EPA's mass-based (including the new source complements) targets for the Clean Power Plan.[6] Figure 2 illustrates U.S. total electric-sector CO_2 emissions in 2012, and compares emissions in the Clean Energy Future to EPA's targets in the rule for two time periods: an average for the 2022-2029 interim period and 2030. We modeled emission targets in the Clean Power Plan on a state-by-state basis as calculated by EPA. In the Synapse Clean Energy Future, aggregate national emissions are 37 percent lower than the 2030 target.

Figure 2. Emissions in 2012, 2022-2029, and 2030 for Clean Power Plan targets and the Clean Energy Future

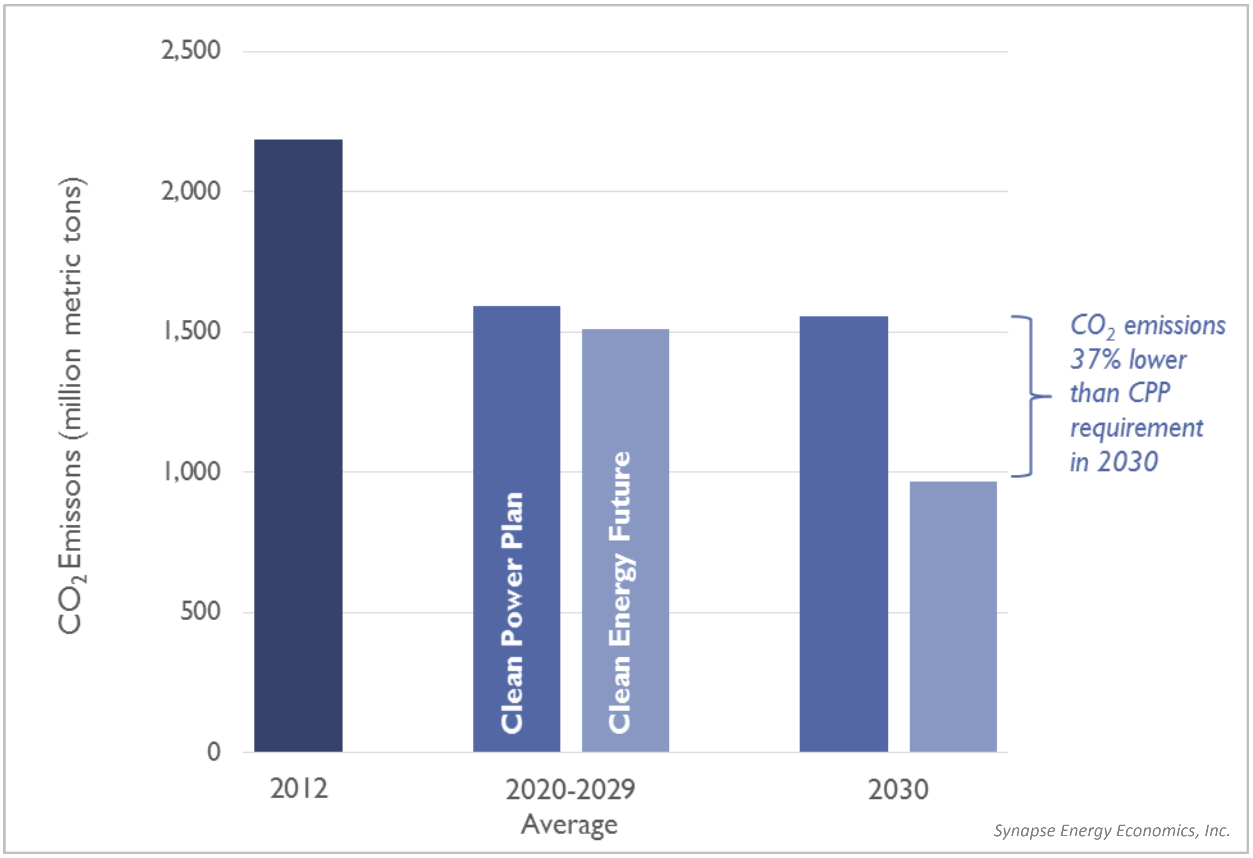
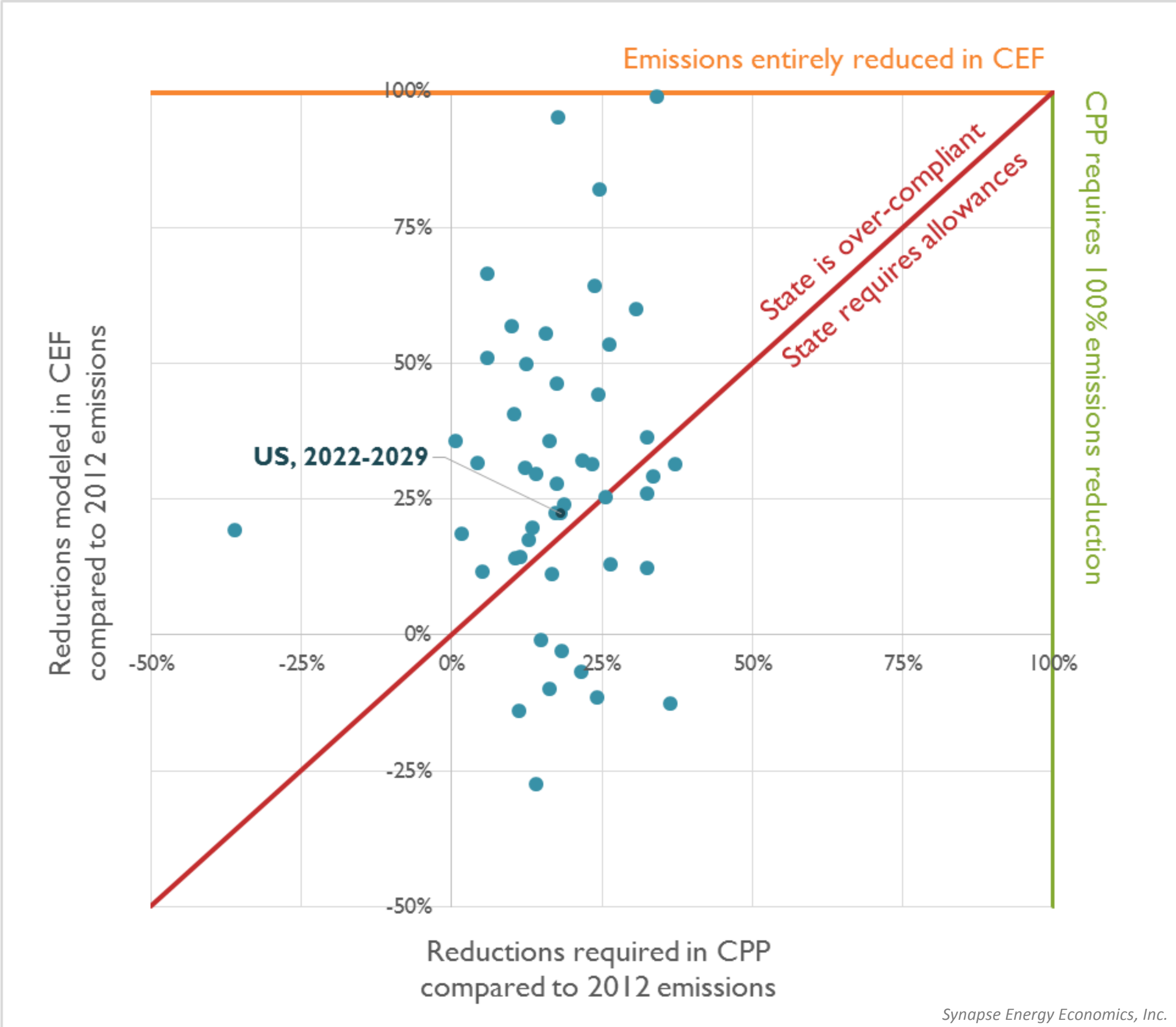


Figure 3 and Figure 4 compare states' Clean Energy Future emissions and Clean Power Plan targets in the 2022-2029 and 2030 periods, respectively. We assumed that states with emissions greater than their target purchase CO_2 allowances at low cost from states that over-comply with their targets. These figures show Clean Energy Future emissions using the Clean Power Plan formula but prior to any trade in allowances with other states.

[6] EPA. 2015. *Clean Power Plan Final Rule Technical Documents Data File: New Source Complements Appendix.* Available at http://www.epa.gov/airquality/cpp/tsd-cpp-new-source-complements-appendix.xlsx.

Figure 3. Average 2022-2029 emissions as a percent of 2012 emissions for each state's Clean Power Plan compliance target compared to Clean Energy Future emissions



As shown in Figure 3, on average in the 2022-2029 interim period, prior to trading in CO_2 allowances with other states, 13 states have emissions greater than their targets. During this period, 34 states over-comply with the Clean Power Plan, resulting in three available allowances for every unmet emission reduction obligation over the course of the interim period.[7] Importantly, this does not include allowances received through the EPA's new Clean Energy Incentive Program, which could also create a number of allowances available to the states that need them during the interim compliance period.[8] The

[7] Note that Vermont is the only state in the lower 48 states represented in our models that is not obligated to meet a compliance target in the Clean Power Plan.

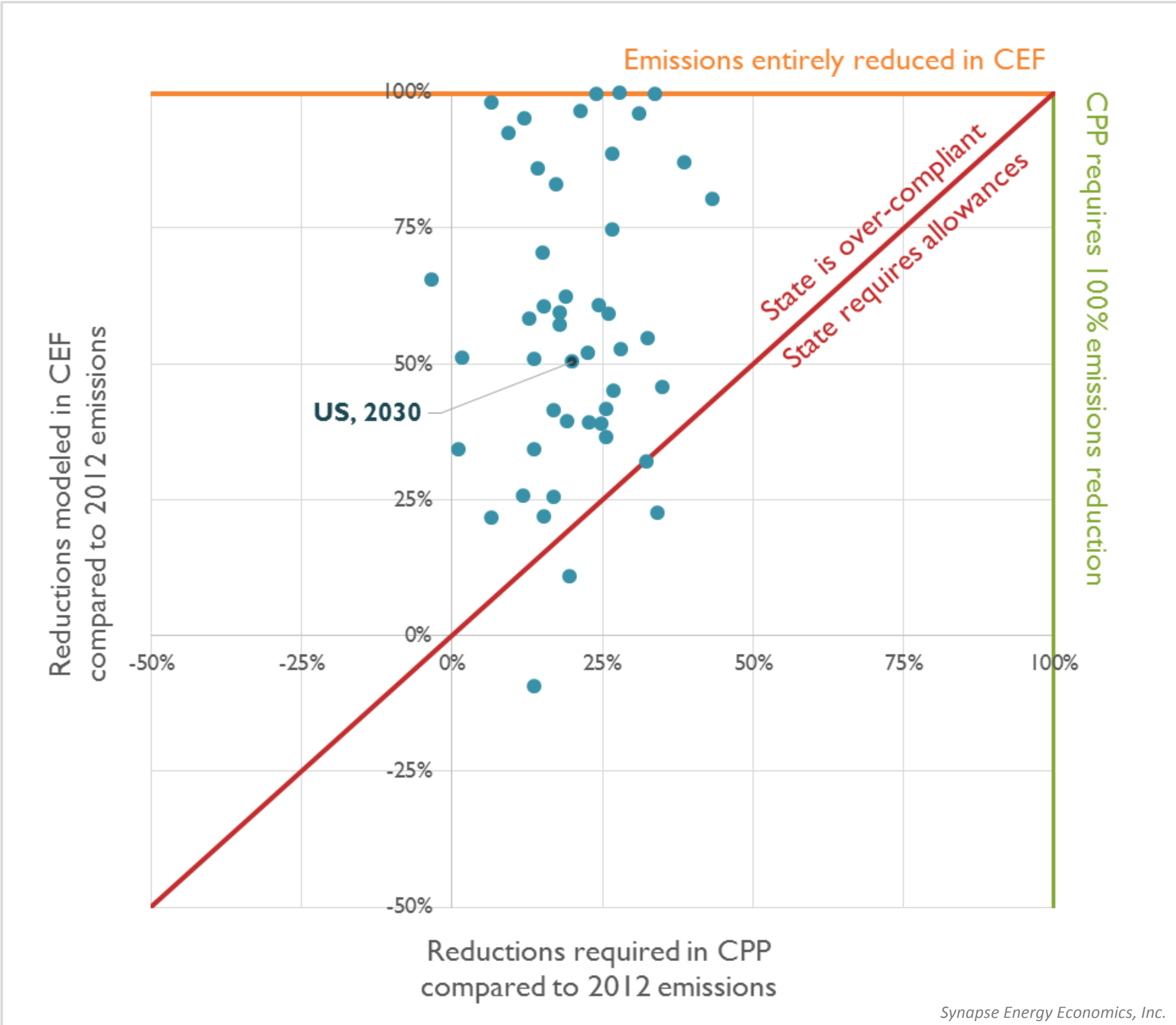
[8] The Clean Energy Incentive Program awards allowances to early-acting solar, wind, and low-income energy efficiency programs. Generation and savings from these resources are eligible to be awarded CO_2 allowances if they are online by September 2018 and produce or save energy during 2020 and 2021, two years before the first compliance period begins.

supply of allowances well exceeds demand, and, for this reason, the price associated with compliance allowances would be very low. We use a price of $1 per allowance to present this cost in our modeling.[9] Note that states shown near the top, orange edge of the chart have the highest emission reductions as a percent of their 2012 emissions. During this period Delaware, Oregon, and Washington have reduced their emissions compared to 2012 by over 75 percent.

As shown in Figure 4, in 2030 in the Clean Energy Future, national average electric-sector emissions (labeled "US") are 50 percent lower than they were in 2012. In this year, five states (Montana, New Mexico, Tennessee, Utah, and West Virginia) emit CO_2 in excess of their targets and available allowances from over-complying states greatly exceed the number required: there are 43 available allowances for every unmet emission reduction obligation. In this year, 14 states' reductions from 2012 levels exceed 75 percent.

[9] Note that this $1 per allowance price is not the marginal cost of compliance with the Clean Power Plan. In the Clean Energy Future, states make the most economically efficient decisions and as a result, invest in clean electricity. Clean Power Plan compliance is a side benefit of this investment.

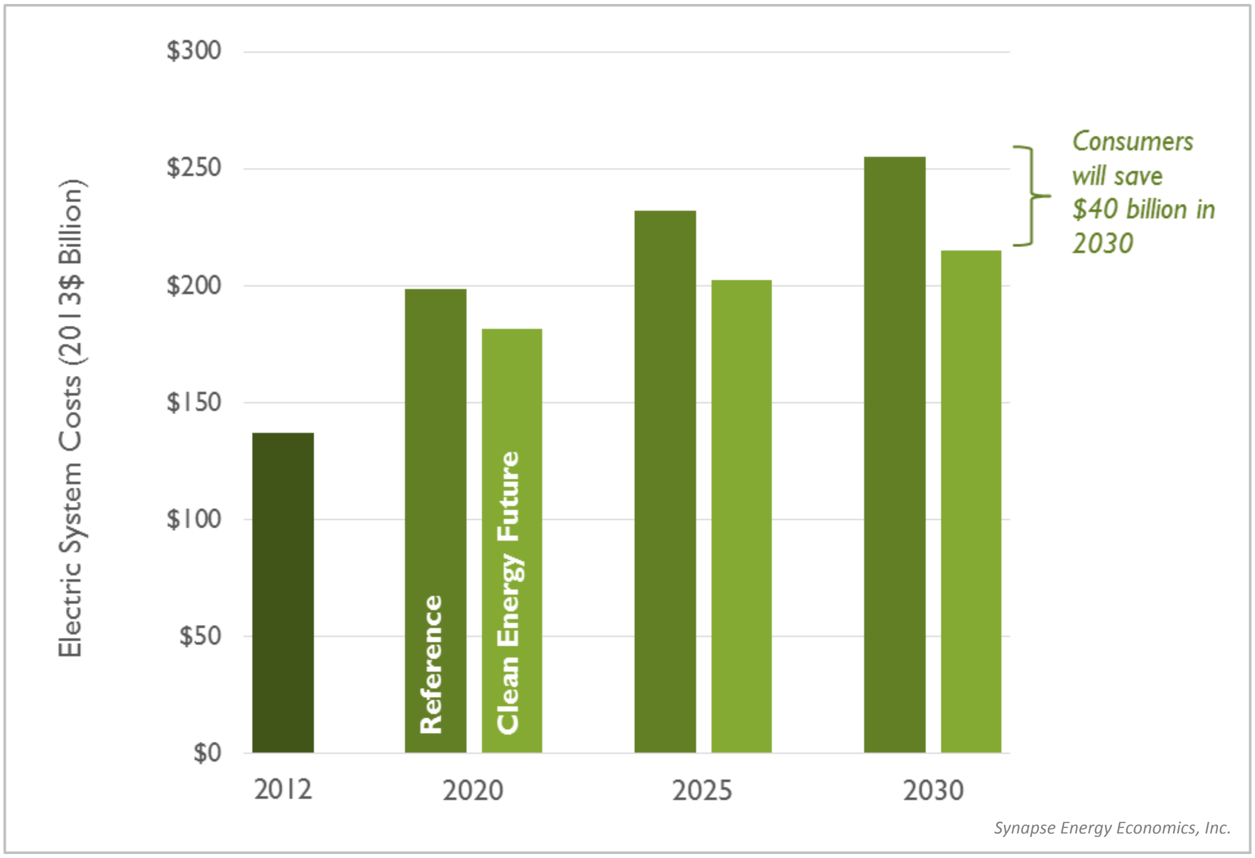
Figure 4. 2030 emissions as a percent of 2012 emissions for each state's Clean Power Plan compliance target compared to Clean Energy Future emissions



4. Cost and Bill Results

Even in a scenario in which states meet or exceed their EPA targets and CO_2 emissions are dramatically lower than the levels required in the Clean Power Plan, costs to consumers need not rise. In 2030, investments in high levels of energy efficiency and renewables result in $40 billion of savings in total U.S. electric-system costs (see Figure 5).

Figure 5. Estimated electric system costs in 2020, 2025, and 2030 in the Reference and Clean Energy Future scenarios

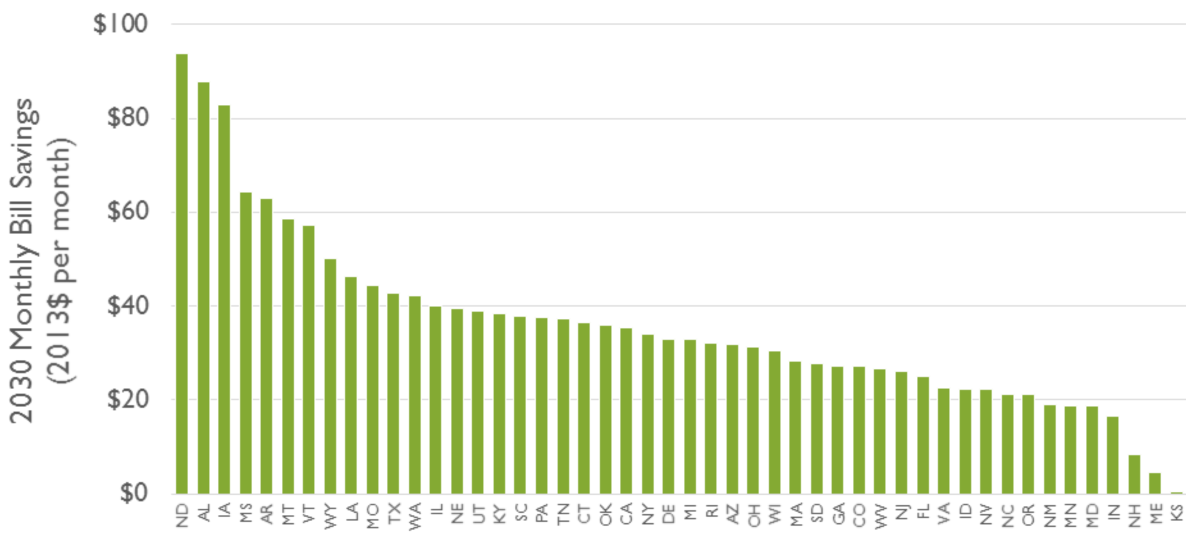


Over time, electric system costs are expected to decrease as a result of the falling costs of renewables, steady costs of energy efficiency, and increasing costs of conventional generation caused by higher fuel prices and expensive environmental controls unrelated to the Clean Power Plan. See Appendix B for state-level detail on bill impacts and renewable addition assumptions.

These cost savings are passed on to electricity consumers. In the Reference scenario, we estimated that on average across the United States, residential bills would be $126 per month in 2030. In the Clean Energy Future, however, consumers who actively take advantage of energy efficiency measures would save $35 per month in comparison to the Reference scenario, paying only $91, and would pay $13 less per month than in 2012. While we assume that about two-thirds of households have strong participation in energy efficiency programs in the Clean Energy Future, even those with very little participation in efficiency programs will see only minimal impacts on their electric bills, on average just $4 more than in the Reference scenario. For a discussion of the impacts of various levels of participation in energy efficiency programs on overall bill savings, see Section 4.1 of this report.

Figure 6 reports the range of monthly bill savings for residential consumers in 2030 in the Clean Energy Future. In eight states, more than 90 percent of households have strong participation in efficiency programs. Compared to the Reference scenario, households with strong participation save on bills, with monthly savings ranging from $0.45 in Kansas up to $94 dollars in North Dakota. Note that even the bills of households with minimal participation in efficiency programs fall in 16 states; on average, non-participant household see bills that are just $4 higher in the Clean Energy Future than in the Reference scenario.

Figure 6. 2030 residential monthly bill savings for households with strong energy efficiency participation in the Clean Energy Future



Synapse Energy Economics, Inc.

In this analysis, we did not make any assumptions about which households do and do not participate in energy efficiency programs, or what specific programs lower energy usage. Instead we assumed program participants avoid 30 percent of their electric consumption based on current-day Massachusetts program data.[10] The number of program participants was an output given total state efficiency savings and assumed household savings.

States that see large bill savings typically build renewable generation capacity early on and become net exporters of electricity. These first movers save money compared to states that continue operating fossil fuel generation well into the future and become electricity importers once these plants retire. This pattern is likely to be accentuated by the Clean Energy Incentive Program, which awards allowances to renewable energy and low-income energy efficiency programs that can then be sold to fossil generators to meet compliance requirements.

As described in Appendix A, inputs into our bills calculation included the variable costs of fuel and operations, levelized capital costs of new investments in generation and transmission, energy efficiency

[10] Note that there are many different options for energy efficiency program design, including programs that ensure savings are made available to those in low-income communities. With the exception of our assumption on energy efficiency costs (which are based on a wide survey of costs of implementing actual energy efficiency programs of various kinds), our analysis does not make any assumptions about the types of energy efficiency measures or programs being deployed.

and solar rooftop program costs, the costs of purchasing power from other states (or the revenues from selling power), the costs (or revenues) of CO_2 compliance trading, the sunk costs of previous investments (whether still in use or not), the cost of environmental retrofits, and the cost of distributing electricity to customers).

4.1. Energy efficiency participation

In states with active energy efficiency programs today, participation is widespread but uneven. Some efficiency measures, such as state building codes or marked-down LED lightbulbs sold at retail locations, benefit nearly all households in these states. Some federal efficiency measures, such as federal appliance standards, benefit a large share of households nationwide. Even households that do not take advantages of measures that require an upfront investment (such as deep energy retrofits and renovations) are still participating in energy efficiency programs at a lower level. As a result, in any energy efficiency program, the number of actual non-participants who see zero savings is likely to be quite low.

The bill savings presented are representative of households with strong participation in energy efficiency programs. Assuming 30 percent savings on electricity usage, two-thirds of residential customers have these strong participation levels and their savings reach $35 per month in 2030. However, given that the total amount of aggregate efficiency savings in megawatt-hours per state is held constant, energy efficiency savings would be lower for each household if all residential consumers were to participate equally in efficiency programs.

We tested the sensitivity of our modeling results to variations in the share of households with strong participation in efficiency programs. As participation is spread more equally, total savings are shared across more customers and the efficiency savings that each individual household sees on its monthly bill declines. If every household participates in efficiency programs, average savings would be $21 per month as compared to the Reference scenario, and bills would rise by less than a dollar per month compared to 2012.

We also tested other sensitivities in between the assumed levels of participation in efficiency programs presented in the Clean Energy Future (64 percent) and a scenario with 100 percent participation by households, as shown in Table 1. These sensitivities demonstrate a trend in which savings for each actively participating household fall as savings are spread more equally across ratepayers.

Table 1. Monthly bill savings comparisons in Clean Energy Future sensitivities

Energy Efficiency Participation Rate	Reference Scenario, 2030	2012
Clean Energy Future level (64%)	$35	$13
75%	$29	$8
80%	$27	$6
85%	$25	$4
90%	$24	$2
95%	$22	$1
100%	$21	($1)

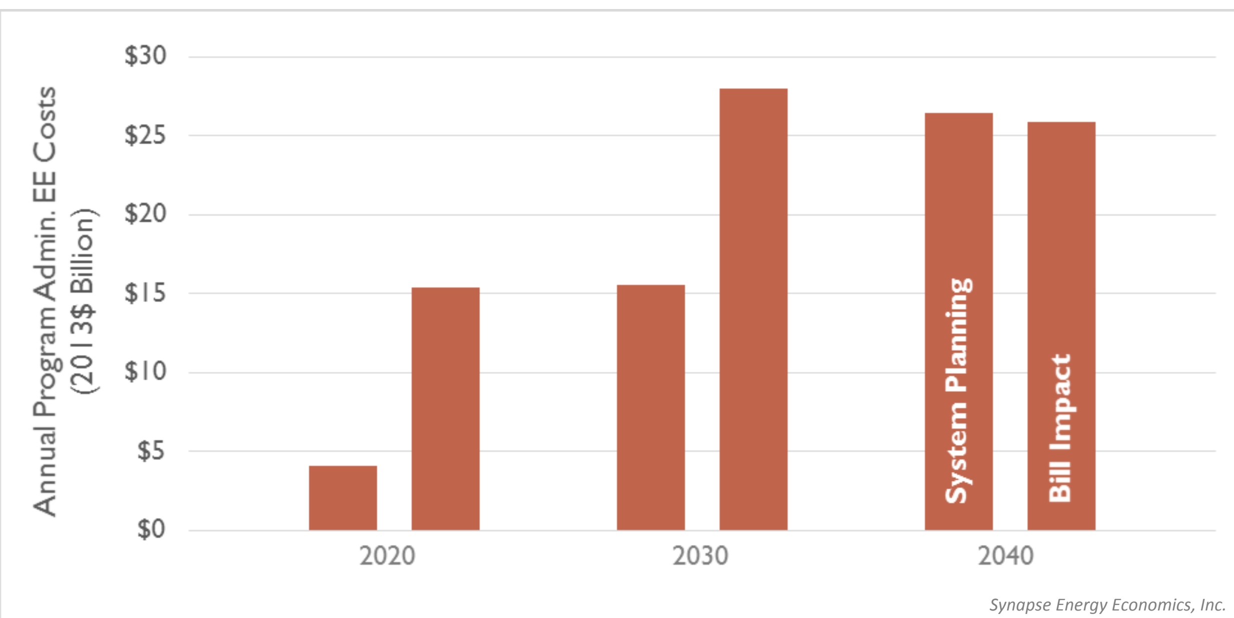
4.2. Stranded costs

In both the Reference and the Clean Energy Future scenarios, all of the capital costs of existing fossil plants that are currently included in the rates payed by consumers remain in these rates in the future. In other words, we assume that "stranded costs"—or investments already made in retiring fossil fuel units and still being paid off—are paid 100 percent by ratepayers in both scenarios. In reality, stranded costs may be paid in their entirety by generators or utilities, or split between ratepayers and utilities. To the extent that ratepayers do not pay for stranded costs, bill savings will be greater.

4.3. Upfront efficiency costs

The future costs to program administrators of energy efficiency measures were estimated in two different ways for two distinct styles of economic analysis: system planning and bill impact assessment. The distribution of these costs over time differs depending on the type of analysis (see Figure 7).

Figure 7. Comparison of program administrator costs under system planning and bill impact approaches



System planning

In the system planning approach to modeling energy efficiency program costs, first-year costs are spread over the entire lifetime of savings in order to facilitate comparisons between investments in supply- and demand-side resources. (First-year costs are the actual measure cost in the year it is implemented. Efficiency measures are implemented in one year but provide savings for many years to come. Supply-side measures are typically modeled with their costs spread across the lifetime of the technology using terms similar to the actual financing arrangements for these capital expenses.) We levelized first-year program administrator costs at a 3 percent discount rate equivalent to $19 per MWh in 2030.

This approach is standard in integrated resource planning and other long-range electric-sector modeling, and was the approach taken in Synapse's 2015 report *Clean Energy Future Technical Review* and the first brief in this series, *Lower Electric Costs in a Low-Emission Future*.[11] When we refer to savings to states of $40 billion in 2030 in the Clean Energy Future, it is in terms of a system planning approach to energy efficiency cost estimation.

Bill impact analysis

Bill impact analysis, however, must be conducted differently. While efficiency program costs are levelized for system planning and comparison to supply-side resources, financing of efficiency investments is uncommon—a reality that undoubtedly has some effect on utilities' investment choices.

To estimate the effect of program administrators' energy efficiency investments on consumers' bills, we instead assumed that all energy efficiency costs are paid for in their first year of savings and not spread over each measure's savings lifetime. By 2030 for bill impact estimates, we assumed a total first-year cost of energy efficiency of about $770 per MWh based on a Synapse literature review of the cost of electric generation avoided by efficiency measures.[12] Program administrator, or utility, costs were assumed to be 50 percent of total costs, resulting in a cost to the system in the first year of $385 per MWh.[13]

These two approaches yield approximately equal results by 2040, as depicted in Figure 7.

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[11] See http://www.synapse-energy.com/project/consumer-costs-low-emissions-futures.

[12] For a more detailed explanation see Stanton, E. A., S. Jackson, B. Biewald, and M. Whited. Nov. 2014. *Final Report: Implications of EPA's Proposed "Clean Power Plan."* Synapse Energy Economics for the National Association of State Utility Consumer Advocates.

[13] As a comparison to traditional supply-side resources, note that when levelized at a 3 percent discount rate this first-year program administrator cost is equivalent to $19 per MWh in 2030.

Appendix A: Methodology

In order to analyze the Clean Power Plan compliance and bill impacts of the Clean Energy Future and Reference scenarios, we used five different, interrelated models in our Synapse CPP Toolkit (see Figure 1 above for a schematic). This appendix details the analysis performed in each model, and how the inputs and outputs from each model interact.

ReEDS

The Renewable Energy Development System (ReEDS) model is designed by the National Renewable Energy Laboratory (NREL) for long-term analysis of the development of the electric power sector.[14] ReEDS is a long-term capacity expansion and dispatch model of the electric power system in the lower 48 states. It has a high level of renewable resource detail with many wind and solar resource regions, each with availability by resource class and unique grid connection costs. Model outputs include generation, capacity, transmission expansion, capital and operating costs, and emissions of CO_2, sulfur dioxide (SO_2), nitrogen oxides (NO_X), and mercury. The model operates through 2050 in two-year steps, with each two-year period divided into 17 time slices representing morning, afternoon, evening, and night in each of the four seasons, plus an additional summer peak time slice. ReEDS includes data on the existing fossil fuel facilities in each of the model's 134 Power Control Areas (PCAs).[15]

Synapse uses a version of ReEDS that we have adapted in house to provide detailed costs by resource type and to include updated emission and heat rate assumptions for fossil fuel-based resources. Key input assumptions to ReEDS for the Clean Energy Future and Reference scenarios are reported in Table 2.[16]

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[14] Short et al. 2010. Regional Energy Deployment System (ReEDS). Available at: http://www.nrel.gov/docs/fy12osti/46534.pdf.

[15] These 134 PCAs are contiguous with the lower 48 states. States are made up of between one and 11 PCAs.

[16] Note that preliminary model runs resulted in residential consumer electric bill savings for every state in the lower 48 except for one: North Dakota. Upon further investigation of the causes of this anomaly, we found that coal plants were remaining in operation later in North Dakota than in nearby states, delaying North Dakota's adoption of renewables in the Clean Energy Future. By the time North Dakota's coal plants retire, other states' efficiency savings make abundant clean energy resources available for export; as a result, North Dakota purchases imported energy rather than building its own low-cost renewables. To mitigate this anomaly, we adjusted our inputs to assume that North Dakota, like its neighbors, is an early adopter of wind technology, and in this way avoids the cost of importing energy towards the end of the compliance period. See Fields, S. et al. 2015. *Clean Energy Future Technical Review*. Available at http://www.synapse-energy.com/sites/default/files/Clean-Energy-2040-Technical-Review.pdf.

Table 2. Key input assumptions in Reference and Clean Energy Future scenarios

Assumption	Reference	Clean Energy Future
Demand-Side Resources		
Energy Efficiency	AEO 2014 Reference Case	Ramping from near-term state-specific targets to 2% annual savings beginning in 2020
Demand Response	10% potential by 2040	15% potential by 2040
Distributed PV	EF Reference: 80% below Sunshot 50 costs and capacity additions	Adjusted Sunshot 75 scenario: 75% cost reduction with capacity additions redistributed across the scenario
Electric Vehicles	No electric vehicles integrated as electric-grid storage	25% of light vehicles by 2040 (45% of this load available for grid management)
Supply-Side Resources		
Coal Retirements	Only those announced by June 2015	All retired by 2040 or at 35 years old if built after 2005
Nuclear Lifetime	60 years	60 years
Renewable Target	Existing state RPS	70% National RPS

CAVT

Costs of retrofitting aging coal plants to meet federal environmental regulations other than the Clean Power Plan are modeled using Synapse's Coal Asset Valuation Tool (CAVT).[17] We use the mid-case for environmental retrofit assumptions from our 2015 report on forecasting coal unit competiveness to provide input on the forward-going costs of complying with EPA regulations other than the Clean Power Plan.[18]

EE Savings Tool

As part of its work with EPA, Synapse helped to develop an energy efficiency (EE) savings tool, attached as an appendix to the Clean Power Plan technical support documents.[19] This model allows users to specify an energy efficiency ramp rate, savings level target, measure life distribution, and first-year cost

[17] CAVT is freely available at http://synapse-energy.com/tools/coal-asset-valuation-tool-cavt.

[18] Knight, P. and J. Daniel. 2015. *Forecasting Coal Unit Competitiveness: Coal Retirement Assessment Using Synapse's Coal Asset Valuation Tool (CAVT).* Available at: http://synapse-energy.com/sites/default/files/Forecasting-Coal-Unit-Competitiveness-14-021.pdf.

[19] EPA. 2015. *Data File: GHG Abatement – Scenario 1 (XLS).* Available at http://www2.epa.gov/sites/production/files/2014-06/20140602tsd-ghg-abatement-measures-scenario1.xlsx. An updated version of this appendix which accompanies the final Clean Power Plan is available at http://epa.gov/airquality/cpp/df-cpp-demand-side-ee-at3.xlsx. This updated appendix was not used in this analysis.

of saved energy for each state. EE Savings Tool outputs—cumulative savings from energy efficiency and costs of achieving such savings—were used as inputs in the ReEDS and RePRT models in this analysis.

CP3T

ReEDS outputs on generation, costs, emissions, and other state-specific variables for each scenario are analyzed in Synapse's CP3T model.[20] CP3T, or the Clean Power Plan Planning Tool, is an Excel-based spreadsheet tool for performing first-pass planning of statewide compliance with EPA's Clean Power Plan. It is based on the unit-specific data assembled by EPA to create its "building blocks" for target-setting and compliance. CP3T users can:

- Adjust fossil unit capacity factors, renewable energy and energy efficiency projections, unit retirements, and 111(b) unit additions for each state,
- Compare differences in generation, capacity, emissions, emission rates, and costs across created scenarios and EPA's base case,
- Substitute the default assumptions in CP3T for user-selected inputs, including data from ReEDS runs, and
- Compare emissions in both the Clean Energy Future and Reference scenarios against Clean Power Plan requirements.

In this analysis, we use CP3T to determine whether states are compliant with the Clean Power Plan during the 2020-2029 and 2030 periods.

RePRT

State-level electric-system costs, rates, and bills are calculated in the Synapse-developed ReEDS Postliminary Reporting Tool (RePRT). RePRT translates ReEDS outputs into annualized total cost to the system by technology and PCA. For fixed operations and maintenance (O&M) charges and fuel costs, RePRT simply pulls outputs straight from ReEDS. For capital costs for new technologies, however, the tool calculates and adds interest during construction to the capital cost outputs from ReEDS, and then amortizes those costs over a technology-specific investment life.

We used RePRT to estimate the state-by-state bill impacts of both the Clean Energy Future and Reference scenarios. To do this, we relied on the following components, modeled in ReEDS at the PCA level:

[20] CP3T is freely available at www.cp3t.com. A new version of CP3T which facilitates analysis of the final Clean Power Plan is forthcoming in mid-September 2015.

- **Environmental retrofit costs:** Estimated in the CAVT model, these include the costs to comply with environmental regulations addressing SO_2, NO_X, mercury, and particulate emissions, as well as cooling water, effluent, and coal ash control standards.
- **Non-transmission system costs:** Derived from ReEDS and reported by PCA, these are the system costs associated with capital expenditures, fuel, and O&M for all resource types except transmission and energy efficiency.
- **Transmission costs:** Derived from ReEDS and reported by PCA, we reallocated these costs across all the PCAs in a single North American Electric Reliability Corporation (NERC) region in proportion to annual sales data to approximate the distribution these transmission costs across ratepayers.
- **Import/export costs and revenues:** Each PCA's net export or net import of electricity is estimated based on its generation and electric demand. These net imports (or exports) are multiplied by regional energy and capacity prices to estimate the cost of (or revenue from) supplying this additional electricity need.

Next, PCA-specific costs are aggregated by state and combined with the following cost components:

- **Energy efficiency program costs:** Program administrator costs, also known as utility costs, are calculated at the state level for the Clean Energy Future scenario. (The Reference scenario assumes no additional efficiency measures beyond those already implemented today.)
- **Clean Power Plan compliance allowance costs and revenues:** Depending on the year, some states require trading in order to comply with the Clean Power Plan's mass-based targets (that is, targets based on tons of CO_2 emissions); they emit more CO_2 than the EPA-specified cap allows.[21] As a result, some states pay to purchase allowances, while other states receive revenue for their sale of these allowances. In the Clean Energy Future, in any given year, there are far more states over-complying with the Clean Power Plan than there are states that require trading to comply. As a result, the price of allowances would be very low. In this analysis, we assumed a $1 per ton allowance price. Costs and revenues associated with Clean Power Plan allowances were not calculated in the Reference scenario.

State-specific costs were then divided by the kWh sales in a given year and scenario to derive the cost of supply. Costs of supply in a given year are added to a fixed, per-consumer bill component to estimate each state's residential electric rate.[22] Electric rates were then multiplied by forecasted monthly

[21] For a detailed discussion of Clean Power Plan compliance trading, see Synapse's modeling analysis of multi-state compliance with the proposed Clean Power Plan: Knight, P. et al. 2015. *Multi-State Compliance with the Clean Power Plan in CP3T.* Available at http://www.synapse-energy.com/project/clean-power-plan-reports-and-outreach-national-association-state-utility-consumer-advocates.

[22] The fixed, per-consumer component is typically made up of historical capital costs that have already been incorporated into electricity rates. It is certainly possible that this component will decrease in the future as the plants in this fixed component are depreciated, or if, as older plants retire, ratepayers are no longer obligated to pay some portion of investments that are no longer used and useful. We do not, however, assume a reduction in this bill component in this analysis. The fixed, per-

residential usage in each year to estimate monthly bills. For non-participants in energy efficiency programs, electric usage was based on average statewide usage in 2012.[23] Participants in energy efficiency programs see their usage reduced by 30 percent.[24]

consumer component is calculated by subtracting the cost of supply rate calculated for 2012 from the statewide residential electric rate reported in the EIA Form 861 for 2012. Actual electric rates can vary widely by utility, even within a single state.

23 Calculated using EIA Form 861 2012, available at http://www.eia.gov/electricity/data/eia861/index.html.

24 Savings level based on usage reduction achieved by Massachusetts energy efficiency programs in 2013 through 2015. See Massachusetts Program Administrators, "2013-2015 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan." November 2, 2012, see e.g., D.P.U. 12-107, Cape Light Compact, Exhibit 1.

APPENDIX B: STATE-LEVEL MODELING RESULTS

Table 3. Residential monthly bills

	2012	2030			2030 Delta
		Reference	*Clean Energy Future*		*Reference less*
			EE participant	EE non-participant	*CEF EE participant*
AL	$137	$184	$96	$138	$88
AR	$106	$141	$78	$111	$63
AZ	$122	$146	$114	$163	$32
CA	$89	$103	$68	$97	$35
CO	$82	$100	$72	$103	$27
CT	$99	$106	$70	$99	$36
DE	$127	$148	$115	$165	$33
FL	$125	$149	$124	$177	$25
GA	$125	$138	$110	$158	$27
IA	$96	$124	$41	$59	$83
ID	$89	$96	$73	$105	$22
IL	$80	$92	$52	$75	$40
IN	$107	$102	$85	$121	$17
KS	$108	$97	$97	$138	$0
KY	$108	$147	$109	$155	$39
LA	$107	$139	$93	$132	$46
MA	$88	$107	$79	$113	$28
MD	$112	$132	$113	$162	$19
ME	$40	$32	$28	$40	$4
MI	$97	$113	$80	$114	$33
MN	$91	$103	$85	$121	$19
MO	$109	$136	$92	$131	$44
MS	$124	$173	$108	$155	$64
MT	$86	$101	$43	$61	$59
NC	$119	$143	$122	$174	$21
ND	$100	$160	$66	$94	$94
NE	$102	$132	$92	$132	$39
NH	$99	$56	$47	$67	$8
NJ	$100	$116	$90	$129	$26
NM	$76	$96	$77	$110	$19
NV	$112	$117	$94	$135	$22
NY	$98	$114	$80	$114	$34
OH	$87	$106	$75	$107	$31
OK	$109	$145	$109	$155	$36
OR	$95	$101	$79	$114	$21
PA	$88	$124	$86	$123	$38
RI	$87	$122	$90	$129	$32
SC	$134	$151	$113	$162	$38
SD	$100	$100	$72	$103	$28
TN	$125	$144	$107	$152	$37
TX	$130	$159	$116	$165	$43
UT	$80	$112	$73	$104	$39
VA	$126	$150	$128	$183	$22
VT	$98	$137	$80	$114	$57
WA	$90	$113	$70	$101	$42
WI	$94	$114	$84	$120	$30
WV	$108	$120	$93	$133	$27
WY	$87	$111	$61	$87	$50
US Avg	**$105**	**$126**	**$91**	**$130**	**$35**

Note: All bills reported in 2013 dollars per month

Table 4. Renewable capacity additions in the Clean Energy Future scenario

	Solar			Wind		Other				Energy Efficiency
	Distributed PV	*Utility PV*	*Concentrating Solar*	*On-Shore*	*Off-Shore*	*Geothermal*	*Hydro*	*Storage*	*Demand Response*	*Incremental % achieved*
AL	0.5	1.2		1.1			3.9		2.0	2%
AR	0.2	1.2		3.8			2.4		1.1	2%
AZ	7.9	2.2	0.3	1.9			2.4		1.8	2%
CA	30.8	3.4	1.3	6.2		7.2	14.1		6.0	2%
CO	4.5	0.1	0.0	2.8		0.0	1.2		0.3	2%
CT	2.1	0.9		0.2	0.6		0.2		0.6	2%
DE	0.6	1.6		0.0			0.0		0.2	2%
FL	9.8	17.3	0.9				0.1		5.6	2%
GA	2.2	5.8		0.3			4.2		3.3	2%
IA	0.9	0.0		16.6			0.7		0.9	2%
ID	0.1			1.1		0.0	2.7			2%
IL	1.7	0.5		18.3			0.9	0.1	3.2	2%
IN	0.7	0.0		11.1			0.1	0.2	2.1	2%
KS	0.9	1.2		3.5			0.1		1.1	2%
KY	0.3	1.4		2.4			2.7		1.8	2%
LA	1.4	1.2		1.5			1.0		1.9	2%
MA	1.8	0.1		0.6	0.6		1.9		0.3	2%
MD	1.4	11.1		0.8			0.6		1.6	2%
ME	0.5			1.0			0.6			2%
MI	1.3	0.0		5.6			2.1		2.3	2%
MN	1.2	0.3		3.7		0.0	0.3	0.2	1.3	2%
MO	1.9	0.1		7.1			2.7		2.0	2%
MS	0.2	2.1		0.5			0.2		1.1	2%
MT	0.4			5.9			2.8		0.0	2%
NC	2.3	15.0		0.9	0.2		2.0		3.1	2%
ND	0.1	0.0		13.8		0.0	0.5	4.3	0.2	2%
NE	0.5			2.4			0.3		0.7	2%
NH	0.2	0.0		1.0			0.5			2%
NJ	2.6	5.1			0.6		0.4		1.9	2%
NM	1.2	0.2	0.2	1.5			0.1		0.5	2%
NV	3.5	0.4	0.2	0.2		0.8	0.8			2%
NY	6.2	0.1		5.3	0.4		6.1		2.5	2%
OH	0.9	1.5		14.6			0.3		3.1	2%
OK	1.1			5.2			1.4	0.2	1.5	2%
OR	0.6	0.0		3.7		0.1	6.7			2%
PA	3.2	2.9		8.4			3.8	3.0	2.8	2%
RI	0.7	0.8		0.0			0.0		0.1	2%
SC	0.7	0.1					4.1		1.8	2%
SD	0.3			1.8			1.6		0.2	2%
TN	1.0	0.0		1.8			4.2		2.2	2%
TX	14.1	9.5	0.1	41.1			0.9	0.5	9.5	2%
UT	0.8	0.0		0.6		1.4	0.3			2%
VA	1.6	2.4		1.0			4.1		2.6	2%
VT	0.2	0.0		1.1			0.3			2%
WA	2.0	0.0		7.6			21.9			2%
WI	1.3	0.0		2.8			0.5		1.4	2%
WV	0.2			2.6			0.4		0.6	2%
WY	0.2			4.8			0.3		0.1	2%
US Total	**119.0**	**89.8**	**3.0**	**217.8**	**2.4**	**9.7**	**109.3**	**8.7**	**75.0**	**-**

Note: Additions represent total incremental capacity in 2030 to 2015 capacity, in GW. In this table, "Hydro" includes both conventional hydro and pumped hydro and "Storage" includes storage both from batteries and compressed air.