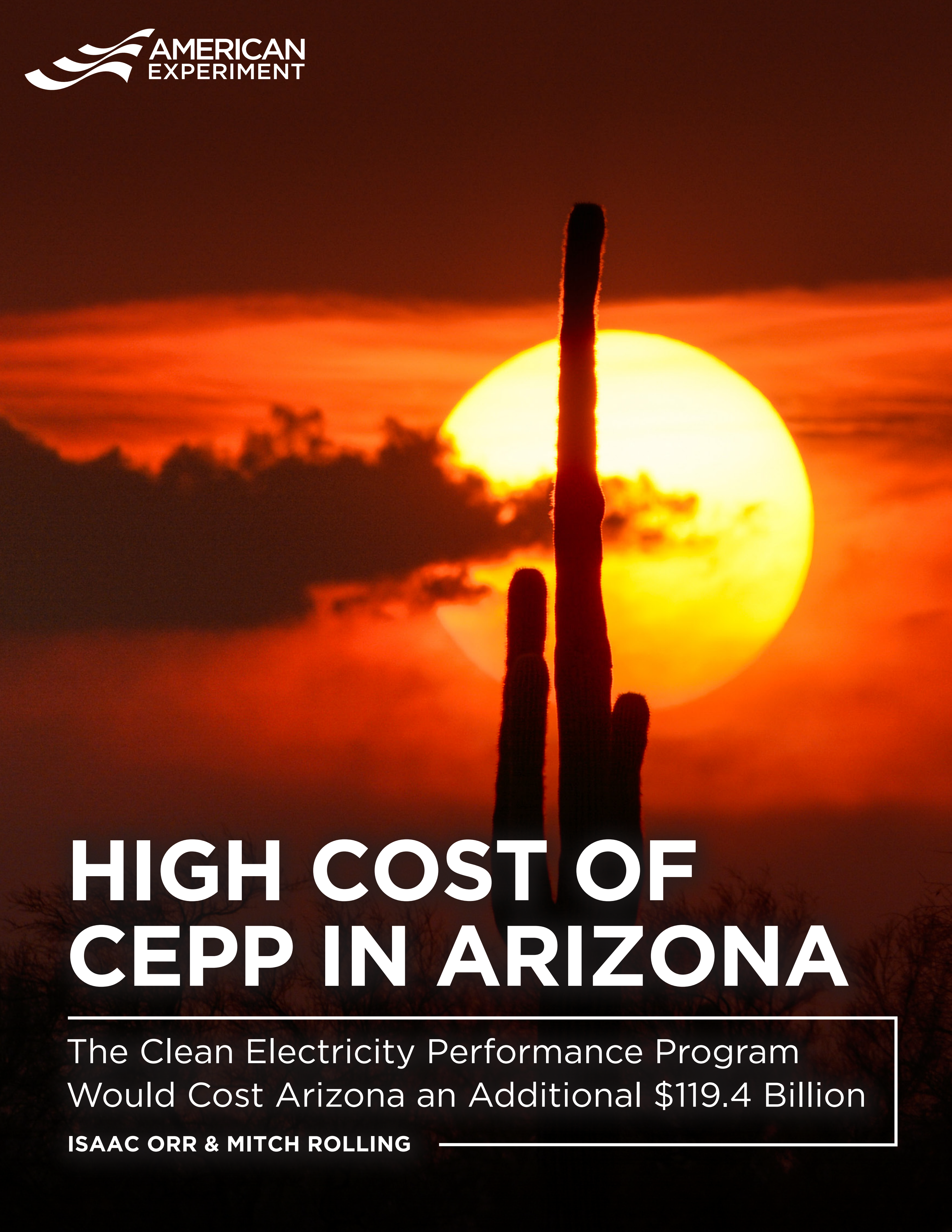

AMERICAN EXPERIMENT

HIGH COST OF CEPP IN ARIZONA

The Clean Electricity Performance Program Would Cost Arizona an Additional $119.4 Billion

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CONTENTS

Executive Summary

The Clean Electricity Performance Program (CEPP) advanced by Congressional Democrats as part of the proposed $3.5 trillion reconciliation package would require electricity providers to increase the amount of carbon-dioxide-free electricity sold on their systems by 4 percent every year or pay penalties.

Achieving this goal would cost an additional $119.4 billion (in constant 2021 dollars) in the state of Arizona, compared to operating the current electric grid.[1] This would result in a 45 percent increase in electricity prices by 2031, compared to 2019 rates. The cost of complying with the CEPP would increase to $246.9 billion if the Palo Verde nuclear power plant were to cease operations, which would raise electricity rates by nearly 90 percent from 2019 rates.

If borne by residential, commercial, and industrial electricity customers in Arizona, rather than federal taxpayers, the additional costs imposed by the CEPP would be more than $1,200 per customer, per year through 2052.[2]

Higher electricity prices would lead to higher costs for all Arizonans, but low-income households would be disproportionately hurt because these families spend a higher percentage of their income on energy bills relative to their more-affluent counterparts. ■

Introduction

Many people believe replacing coal and natural gas-fired power plants with wind turbines and solar panels will spur economic growth and that this transition will be easy to accomplish because wind and solar are "free" electricity sources.

However, these energy sources are not free. Moreover, maintaining a reliable electric grid becomes increasingly difficult—and expensive—as reliance on wind and solar power increases over time.[3]

Proponents of renewable energy mandates routinely ignore the large, up-front capital costs associated with building wind turbines, solar panels, and transmission lines. They also ignore the resulting cost increases in property taxes, utility profits, and load balancing—or providing electricity when the wind is not blowing or the sun is not shining, either with backup natural gas facilities or battery storage. These are all major expenses of maintaining a reliable electric grid with large amounts of wind and solar capacity.

"Proponents of renewable energy mandates routinely ignore the large, up-front capital costs..."

Our study accounts for each of these factors, and therefore provides a comprehensive and realistic picture of the cost of providing reliable electricity while implementing the CEPP.

Section I: What Is the CEPP?

The Clean Electricity Performance Program (CEPP) is one of the most sweeping energy proposals in American history.

This proposal—which is being advanced by Congressional Democrats as part of their proposed $3.5 trillion reconciliation package—would act as a de facto renewable energy mandate and carbon tax in the United States by requiring electricity providers to increase the amount of low-carbon electricity generated every year. If they do not comply, they will be subject to fines.

"The Clean Electricity Performance Program (CEPP) is one of the most sweeping energy proposals in American history."

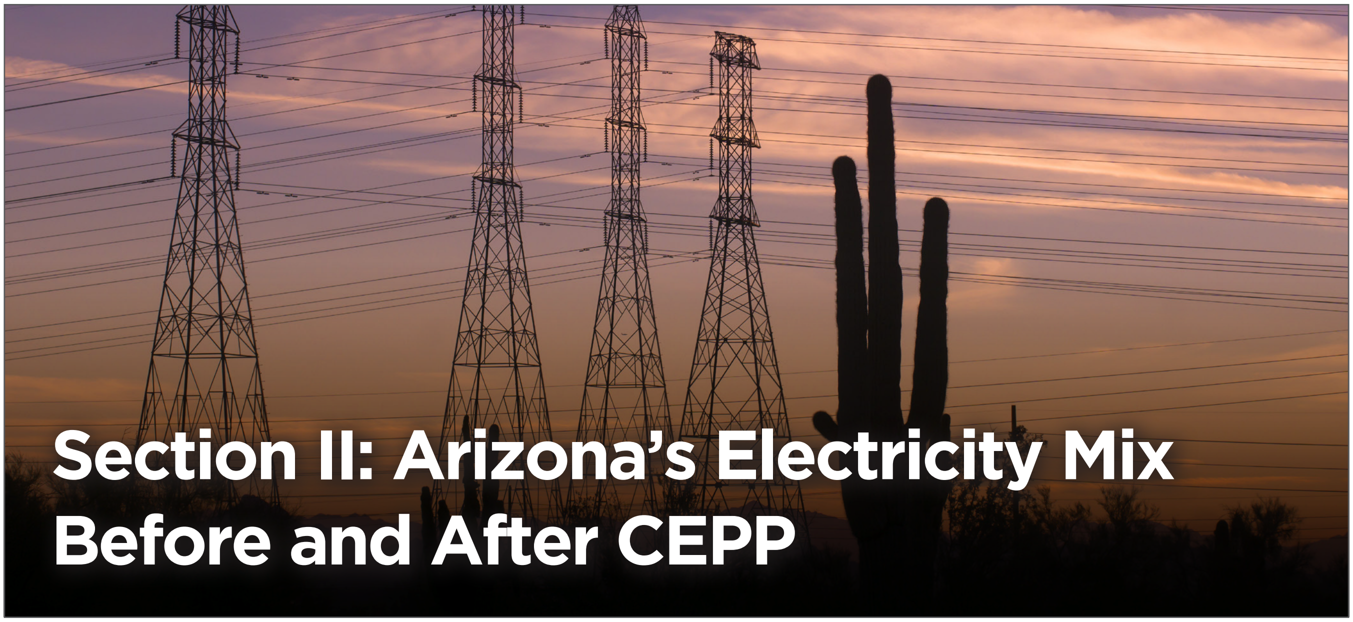
The CEPP requires that electric companies increase the amount of "clean" electricity, defined as energy sources producing less than 0.1 tons of carbon dioxide per megawatt hour (MWh) generated, by 4 percent each year, relative to the previous year.

Companies that achieve these goals will receive payments in the amount of $150 per MWh of clean electricity generated.[4] Companies that do not meet this target will face fines of $40 per MWh if they fail to increase the amount of carbon-free electricity generated by at least 1.5 percent each year.

Proponents of the CEPP claim the proposal will decrease the cost of electricity by shifting the cost of generating and maintaining electric infrastructure from ratepayers to federal taxpayers.

Rather than attempt to allocate CEPP compliance costs based on complicated federal formulas that are subject to change during the legislative process, this analysis calculates the complete cost of complying with the CEPP without factoring in federal subsidies for wind turbines or solar panels, or CEPP payments and penalties. We believe this methodology is appropriate because federal subsidies do not reduce the cost of complying with this proposal, they simply shift who pays for it.

The appendix explains the assumptions and factors taken into account by our model. ■



Section II: Arizona's Electricity Mix Before and After CEPP

In 2019, Arizona derived 41 percent of its electricity generation from natural gas, 28 percent from nuclear power plants, 20 percent from coal, 5 percent from hydroelectric plants, 5 percent from solar facilities, and 1 percent from wind installations located in the state (See Figure 1).[5]

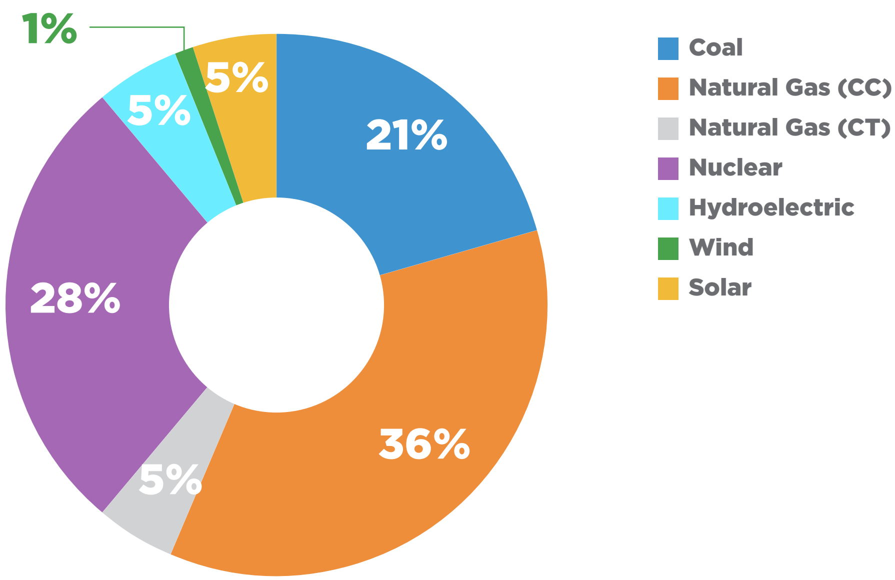
Combined, nuclear, hydroelectric, solar, and wind—which do not produce carbon-dioxide emissions—represented 39 percent of the electricity generated in Arizona in 2019.

Under the CEPP, the generation mix would shift to 38 percent utility solar, 28 percent nuclear, 20 percent natural gas (combined cycle and combustion turbine), 7 percent wind, 5 percent hydroelectric, 1 percent battery storage, and 1 percent thermal solar (See Figure 2). This would achieve a grid whose emissions are 80 percent carbon-dioxide-free by 2031.[6]

The changing electricity generation mix will have a profound impact on the cost of power for Arizona families and businesses.

FIGURE 1

Arizona Electricity Generation by Source in 2019

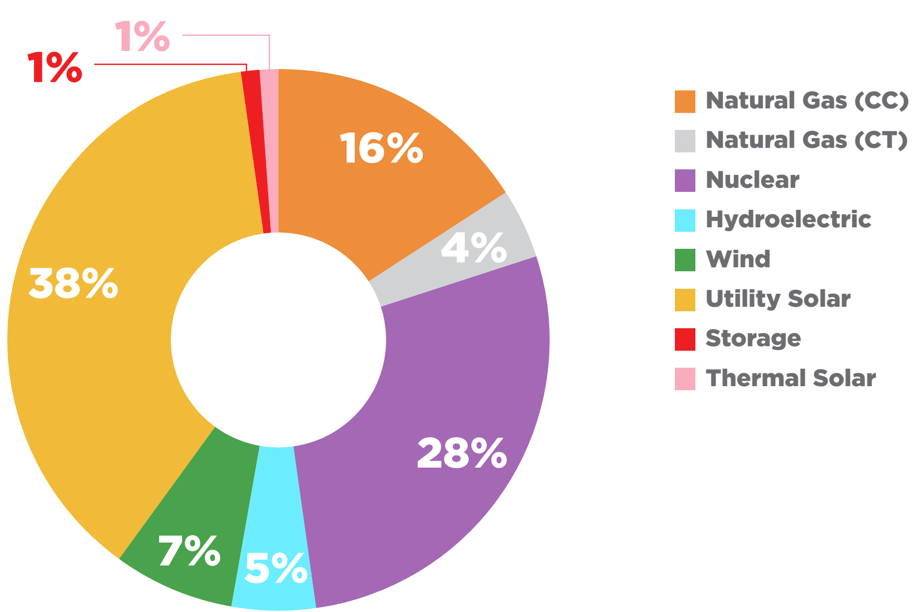


SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION

FIGURE 2

2031 Generation by Energy Source

Under the CEPP, Arizona electricity generation shifts from a grid that is primarily powered by natural gas, to one that is primarily powered by solar.



SOURCE: AMERICAN EXPERIMENT MODELING, SEE APPENDIX

Section III: The Cost of the CEPP

Implementing the CEPP would cost an additional $119.4 billion in the state of Arizona, compared to operating the current electric grid. This would result in a 45 percent increase in electricity prices by 2031, compared to 2019 rates.

This translates into an average increase in electricity costs of more than $1,200 per customer, per year in the state of Arizona. Industrial companies in Arizona, as large users of electricity, would be hit hard, with electricity bills increasing by more than $35,000 per year on average through 2052.

CEPP compliance costs are driven by the need to build enough solar panels, wind turbines, battery storage facilities, and transmission lines to meet the carbon-dioxide-free electricity requirements in the program.

Other factors that increase costs include increasing property taxes, utility returns, and maintaining the reliable power plants needed to provide electricity when the sun is not shining and the wind is not blowing. These are referred to as "load balancing" costs and they are often ignored.

This analysis assumes electricity generation in Arizona will remain constant at approximately 114 million MWhs from 2021 through 2052.[7,8] This assumption is conservative because proponents of the CEPP also promote the widespread adoption of electric vehicles and the broader electrification of the energy sector. These actions would require large increases in the amount of electricity generated every year.

This study does not quantify the additional costs associated with rising levels of electrification because it is designed to show the difference in cost to serve the same amount of electricity demand as the current grid, providing an apples-to-apples comparison of the cost of electricity in Arizona with, and without, the CEPP.

Increasing Electricity Generation Capacity

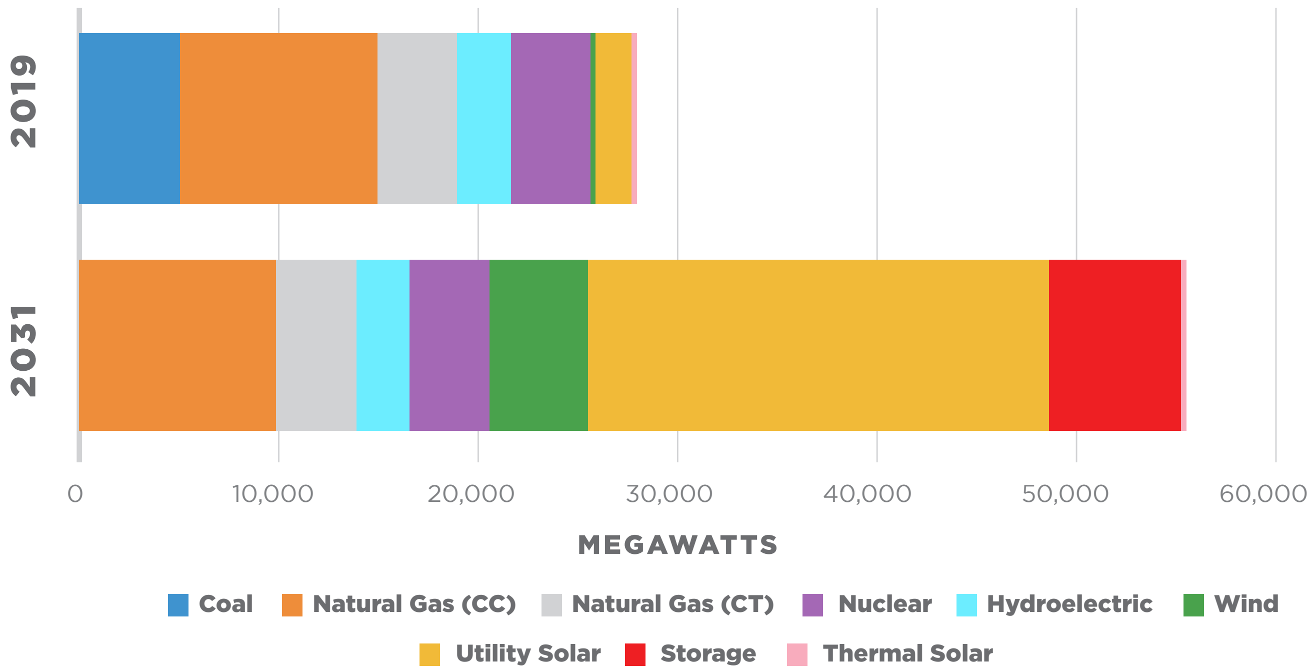
The CEPP would greatly increase the amount of electricity generation capacity on the Arizona electric grid. Figure 3 shows Arizona had roughly 28,000 MW of capacity on the grid in 2019; under the CEPP, the amount of installed capacity would nearly double, growing to more than 55,000 MW. While that may sound like a good thing, increasing capacity merely to meet mandates, rather than meeting demand, is an unnecessary cost that will harm Arizona families and the state's economy.

Solar, wind, and battery storage capacity grow the most, while the amount of natural gas on the system remains the same to ensure there are

FIGURE 3

Capacity by Energy Source: 2019 v. 2031 (MW)

Total installed capacity would nearly double to meet the criteria established by the CEPP. Solar capacity would increase nearly 13-fold, from 1,812 MW in 2019 to 23,087 MW in 2031.



SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, AMERICAN EXPERIMENT MODELING

enough reliable power plants available to generate electricity during periods of low wind and solar output.[9] Building these solar panels, wind turbines, and battery facilities would cost $46.6 billion, $13.8 billion, and $15.3 billion, respectively.

Battery facilities are needed to comply with the CEPP because these facilities allow Arizona to store solar power generated during sunny periods for use later in the day when it is needed.

Figure 4 shows electricity generation from each resource during a hypothetical scenario when electricity demand peaks during the week of August 1, 2031 through August 7, 2031.[10]

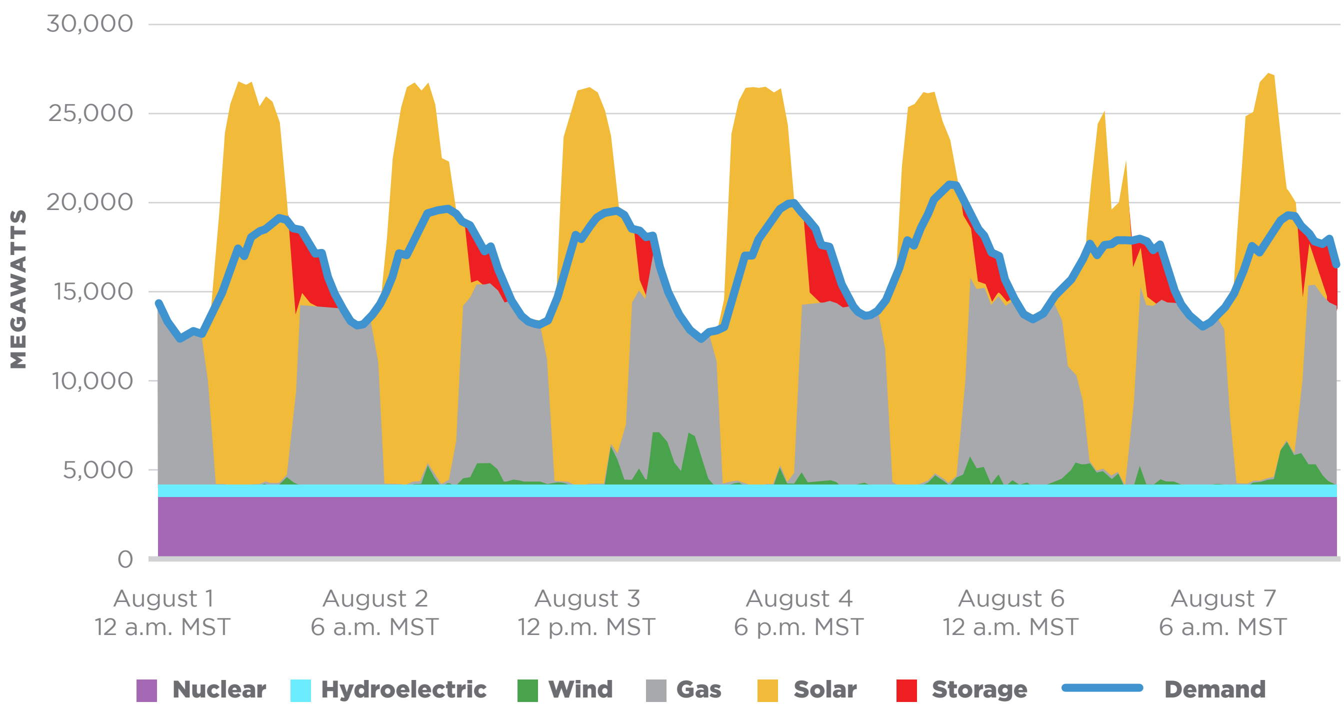
The blue line shows the demand for electricity during every hour of this week. Demand for electricity is highest during the mid-afternoon as temperatures increase, prompting the use of air conditioning. Demand remains high in the early evening as the sun begins to set but temperatures remain high.

Battery storage, shown in red, is used to provide electricity during the peak, limiting the use of natural gas as a peaking energy source, to comply with the requirements of the CEPP.

Solar generation, shown in yellow, exceeds the demand shown with the blue line because solar capacity must be "overbuilt" to comply with the CEPP. A portion of the extra solar power must be used to charge the batteries. Once the batteries are fully charged, any additional solar power that is

FIGURE 4
2031 Arizona Generation Mix Over a Week

Batteries are needed to store electricity generated from solar panels for later use. Solar and wind are used to help meet electricity demand and charge the battery storage.



SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, AMERICAN EXPERIMENT MODELING

generated is curtailed, or turned off. Curtailment is expected to become increasingly common as more wind and solar are placed into service on the grid.[11]

Transmission Costs

Transmission lines are important: It does no good to generate electricity if it cannot be transported to the homes and businesses that rely upon it. Implementing the CEPP in Arizona would require $3.3 billion in additional transmission spending compared to the current system.[12]

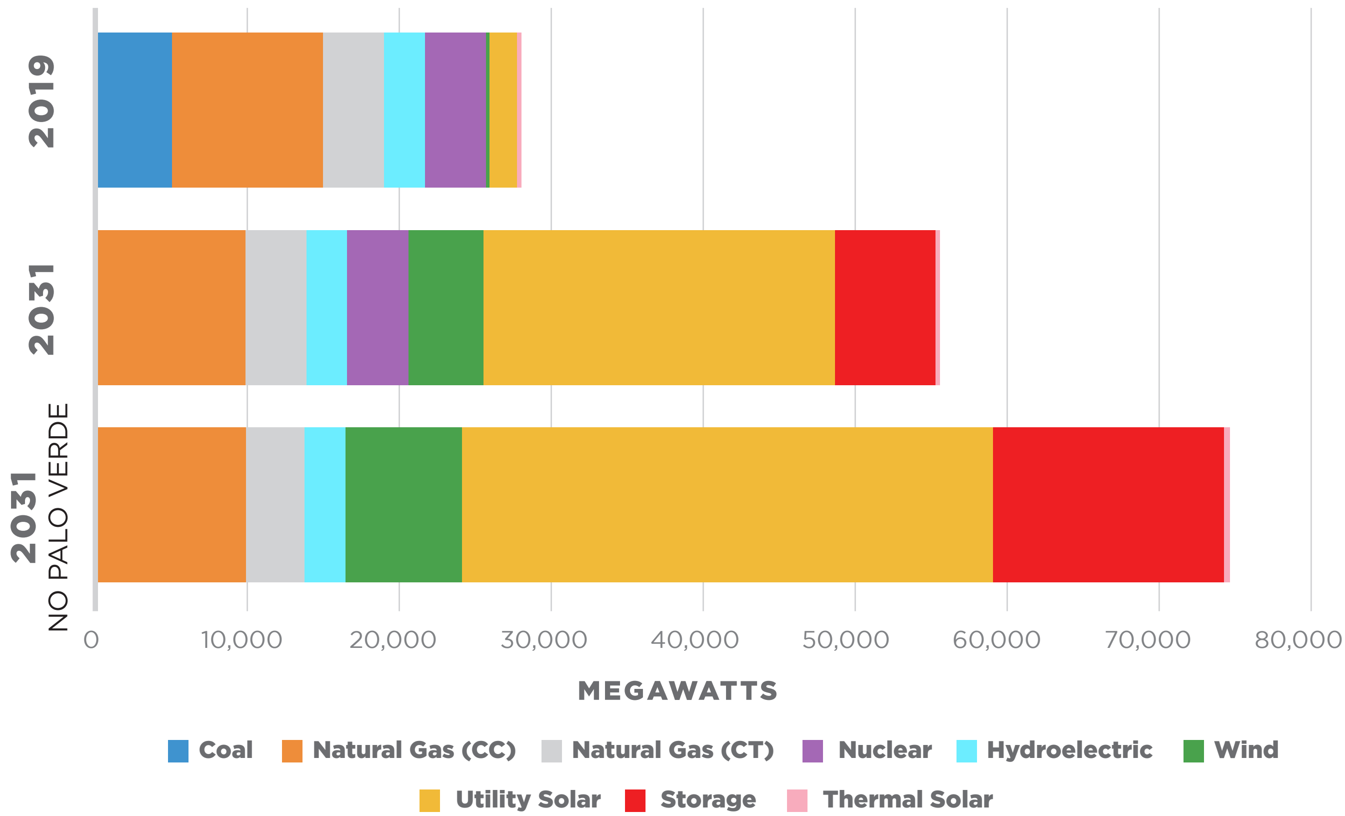
The National Renewable Energy Laboratory (NREL) estimates that achieving a grid powered by 50 percent solar and wind in the United States would require the construction of approximately 40 million MW miles of transmission lines, which is about 20 percent of the total quantity of transmission lines installed nationally.[13] Assuming similar increases in transmission lines would be needed for each state, Arizona's grid—which would be powered by 47 percent solar and wind under the CEPP—would require an approximately 20 percent increase in transmission lines.

According to the U.S. Department of Energy, Arizona has 2,268 miles of transmission lines that are 345 kilovolts (kV) or larger, and 1,906 miles of transmission lines that are less than 230 kV.[14] According to our assumptions based on NREL estimates, Arizona would require 454 miles of new 345 kV lines, and 381 miles of new 115 kV trans-

FIGURE 5

Capacity Needed for CEPP - No Palo Verde

Meeting CEPP objectives without the Palo Verde nuclear plant (purple bar) would require 74,363 MW of capacity, compared to the approximately 28,000 MW used to meet Arizona's electricity needs in 2019.



SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, AMERICAN EXPERIMENT MODELING

mission lines, to accommodate more wind and solar power.

Transmission lines routinely cost between $2.5 million per mile for 115 kV lines and $5.2 million per mile for 345 kV lines.[15] As a result, building enough transmission lines to comply with the CEPP would cost $3.3 billion.

Utility Returns

Because investor-owned utilities (IOUs) such as Arizona Public Service, Tucson Electric Power, and Morenci Water and Electric are regulated monopolies in Arizona, their profits are capped by utility commissions.

Instead, they are guaranteed a 8.7 percent profit when they spend money on capital assets such as power plants, transmission lines, and even new corporate offices, and earn a smaller return on debt incurred.[16]

The CEPP would require utilities to spend billions of dollars on new infrastructure. Our analysis assumes all new capacity is built by investor-owned utilities and subject to utility returns and concludes that utility returns would cost $54 billion under the CEPP.

Property Taxes

Property taxes increase under the CEPP because compared to the current grid, there is much more property to tax. While the property taxes assessed on power plants are often a crucial revenue stream for local communities that host power plants, these taxes also effectively increase the cost of producing and providing electricity for everyone.

Additional property tax payments under the CEPP were calculated to be $53.6 billion.[17]

The Value of Arizona's Nuclear Power Plant

Compliance costs for the CEPP would increase to $246.9 billion if Arizona's Palo Verde nuclear power plant were to cease operation. Palo Verde produced 28 percent of the electricity generated in Arizona in 2019 and could continue to do so for many years.[18]

The closure of this plant would greatly increase the cost of CEPP compliance by necessitating a large buildout of solar and battery storage capacity to replace the more than 3,900 MW of firm, –dioxide-free capacity.[19]

Figure 5 shows generating enough carbon-dioxide-free electricity without the Palo Verde plant would necessitate the construction of 34,398 MW of solar panels, 7,620 MW of wind turbines, and 14,965 MW of battery storage to meet CEPP objectives.

Policymakers should understand that reliable nuclear power plants play an important role in delivering electricity to the grid. Replacing the 3,900 MW Palo Verde nuclear plant with an additional 22,839 MW of wind, solar, and battery storage would be unnecessarily costly and impose enormous hardships on Arizona families and businesses. ■

Section IV: High Energy Costs Harm Arizona Families and the Economy

Proponents of the CEPP argue that increasing the use of wind and solar power will benefit the nation's economy. They are wrong. Increasing the cost of electricity does not grow the economy, it simply transfers into the electricity sector money that would have been spent elsewhere.

If CEPP compliance costs are paid by Arizona ratepayers instead of federal taxpayers, the billions of dollars spent on new solar panels, wind turbines, battery storage facilities, and transmission lines would impose significant additional electricity costs on each Arizona electricity customer.[20]

Average additional costs would be more than $1,200 per customer per year through 2052.[21] If the Palo Verde plant ceases operation, CEPP compliance costs would increase to $2,500 per customer per year.

"Average additional costs would be more than $1,200 per customer per year through 2052."

Increasing electricity costs for by more than $1,200 every year means Arizonans would have less money for rent or mortgage payments, healthy food for their families, healthcare for their children, or saving for a rainy day.

Low-income households—many of whom are immigrant or minority households—would be most hurt by rising electricity costs, because they spend a higher percentage of their income on energy bills than more-affluent Arizona households.[22]

Data from the U.S. Department of Energy's Low-Income Energy Assistance Data (LEAD) program show a significant number of Arizona residents already spend between 6 and 10 percent of their income on energy (See Figure 6).[23]

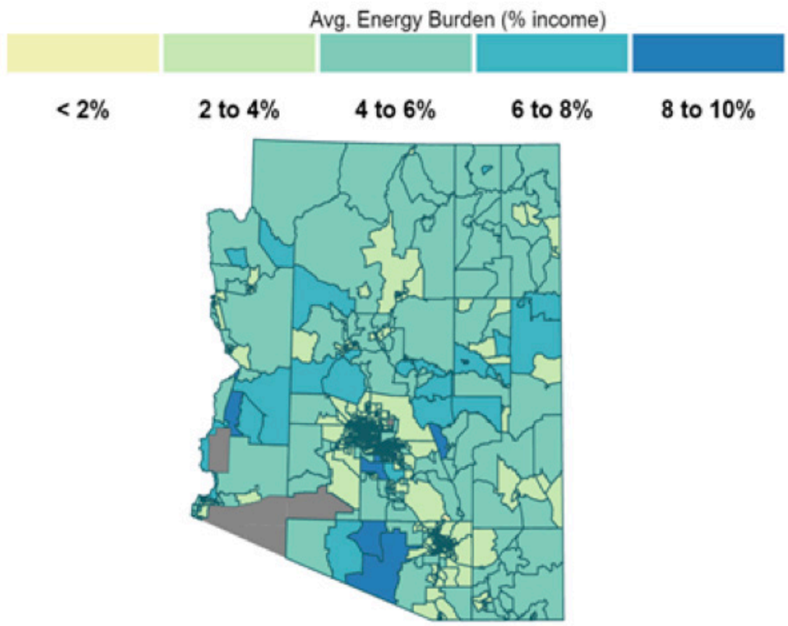
By increasing energy costs on Arizona consumers, the CEPP would increase the cost of essential services like refrigerating food and medicine, home heating, and air conditioning. The latter, in turn, could subject low-income families to higher temperatures and lead them to be more vulnerable to heat-related illnesses.

Research from Australia shows attempts to reduce energy demand by raising prices during heat waves or encouraging electricity conservation to reduce the chances of blackouts could increase health and wellbeing risks for some of the most vulnerable populations in society.[24] If similar measures are taken in the United States to reduce peak electricity consumption, similar results would likely follow.

FIGURE 6

Average Energy Burden as Percent of Income

Federal data show Arizona households living in several Census tracts already pay between 6 and 10 percent of their income for energy bills.



SOURCE: U.S. DEPARTMENT OF ENERGY

Broader Economic Impacts

Increasing the cost of electricity by $1200 per customer in Arizona would harm Arizona's economy in two primary ways. One, it would reduce the amount of household income available to families to spend on goods and services, therefore reducing demand in other sectors of the economy. For example, the extra money a family spends on electricity may mean fewer meals at local restaurants or delayed repairs to a home or automobile.

Two, it would increase the costs of healthcare, education, food, and durable goods, because electricity is the invisible ingredient in everything. Rising electricity costs force businesses to raise the prices of the goods and services they offer.

High electricity costs also jeopardize jobs in energy-intensive industries like manufacturing and mining, which compete in a global marketplace. Increasing electricity costs leave them at a competitive disadvantage relative to similar firms in other states and countries.

Manufacturing

Arizona's nearly $31 billion manufacturing industry accounts for approximately 8.4 percent of the state's gross domestic product, according to 2019 data from the Bureau of Economic Analysis (BEA).[25] This economic sector employs more than 191,000 Arizonans with average annual wages of $90,000, providing a high standard of living for Arizona workers.[26,27]

Mining

Data from the United States Geological Survey (USGS) show Arizona was the second-largest mining state in the nation in 2020, producing more than $7 billion in copper, rare earth metals, and other non-fuel minerals sold.[28] BEA data show Arizona's mining industry employed nearly 15,000 people in 2019 with average wages of $91,000.[29,30]

Arizona also produces 60 percent of the copper mined in the United States. Jeopardizing domestic producers by raising electricity prices would make the country more dependent on foreign sources of this essential metal.

While energy-intensive industries would be impacted most, all industries would be affected the CEPP-imposed higher electricity prices. For example, rising electricity prices would mean school districts would have less money to hire and retain teachers, which could lead to layoffs or rising taxes to fund education.

Section V: Emissions Reductions

The stated goal of the CEPP is to reduce carbon-dioxide emissions from the electricity sector. In Arizona, the program would reduce carbon-dioxide emissions by an average of 25.3 million metric tons per year through 2031.

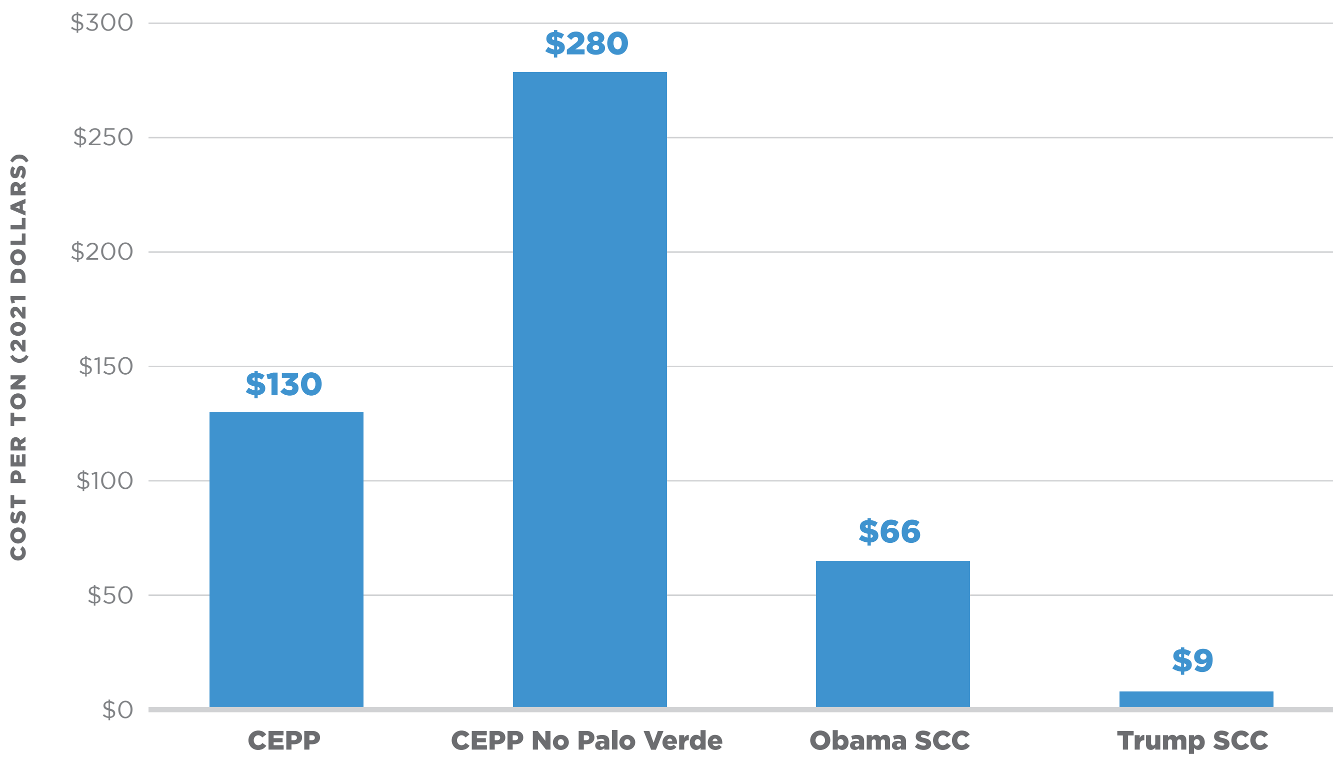
In Arizona, the cost of reducing carbon-dioxide emissions under the CEPP would be nearly $130 per metric ton in 2031. If the Palo Verde plant were to cease operations, this price would increase to $280 per ton.

The cost of reducing carbon-dioxide emissions in each of these scenarios exceeds the Social Cost of Carbon estimates for 2030 established by both the Obama and Trump administrations (See Figure 7). This means the cost of reducing carbon-dioxide emissions under the CEPP exceeds the benefits by a 2-1 margin using the Obama SCC estimates, and a 15-1 margin using the SCC estimates established by the Trump administration. The CEPP clearly fails to pass a cost-benefit analysis. ■

FIGURE 7

Cost of Carbon Dioxide Emissions Reductions Through 2031

The cost of reducing carbon dioxide emissions under the CEPP exceeds the estimated economic damages of each ton of carbon dioxide estimated by the Obama and Trump Administrations.



SOURCE: AMERICAN EXPERIMENT MODELING

Conclusion

Compliance with the CEPP in Arizona would cost at least $119.4 billion through 2052. This is the equivalent of $1,200 per electricity customer per year through this timeframe.

Costs are driven by a massive buildout of solar panels, wind turbines, battery storage facilities, and transmission lines, in addition to the costs associated with higher property taxes, utility profits, and the cost of maintaining reliable generators to provide power when the sun is not shining, or the wind is not blowing.

While proponents claim the CEPP is needed to reduce carbon-dioxide emissions, the costs of implementing the plan dramatically outweigh the benefits. The CEPP itself is more harmful to Arizona families and the state's economy than the carbon-dioxide emissions it aims to reduce.

Appendix

Use of State-Level Analysis

While the CEPP is a de facto renewable energy mandate for electricity providers nationwide, this analysis calculates the cost of each state increasing its share of "clean" energy by 4 percent each year. It does not capture interstate flows of electricity or quantify the costs incurred by individual utilities that may operate or own generation assets in other states.

Annual Average Additional Cost Per Customer

The annual average additional cost per customer was calculated by dividing the average annual cost of CEPP compliance by the number of electricity customers in Arizona.[31] This methodology is used because rising electricity prices increase the costs of all goods and services. Businesses will attempt to pass these additional costs on to consumers, effectively increasing the cost of everything. Therefore, this method helps convey the total cost of the CEPP for Arizona households in a way that is more representative than calculating the costs associated with higher residential electric bills.

Time Horizon Studied

This analysis studies the impact of the CEPP on electricity prices from 2021 to 2052. This time horizon was selected for two reasons.

One, power plants are large investments, like houses. Like a mortgage, electricity customers pay off the cost of the plant each year, meaning decisions made today will affect the cost of electricity for decades to come. Electricity prices would increase much more in the early years if the study did not allow for the gradual repayment of the solar panels, wind turbines, battery storage facilities, and transmission lines needed to comply with the CEPP.

Two, the study sought to show the cost of hitting the targets established by the CEPP and maintaining the amount of carbon-dioxide-free power on the electric grid into the future to prevent emissions from rising after the program expires in the early 2030s.

This assumption is very conservative because the CEPP seeks to achieve a grid that is, on average, only 80 percent carbon-free. The Biden administration has stated its desire to make the electricity sector 100 percent carbon-free by 2035, which would be exponentially more expensive based on today's technologies.[32,33]

Electricity Generation Assumptions

Electricity generation is kept constant at 2019 levels throughout the course of this model run. This assumption is made for two reasons. One, load-growth projections are subject to a wide variety of assumptions, such as energy efficiency measures that reduce electricity demand. Furthermore, electric vehicle adoption and the electrification of other sectors of the economy are difficult to accurately predict.

Two, this analysis is intended to show the difference in cost between operating the electric system in Arizona today compared to what it would cost to generate the same number of MWhs of electricity under the CEPP.

Plant Construction by Type

While the language of the CEPP is technically broad enough to incentivize the construction of a wide variety of low-carbon and no-carbon resources, such as carbon capture and sequestration equipment and new nuclear power facilities, in practice, the requirement for a 4 percent increase in annual "clean" electricity generation precludes these resources because there is no realistic timeline for these technologies to meet CEPP requirements.

Further, the CEPP does not allow for averaging of clean energy sources over the course of several years. This further disincentivizes the construction of large nuclear power plants and carbon capture units in favor of wind, solar, and battery technology, which are better suited to meet these incremental mandates.

Natural Gas Capacity Is Kept Online

Our model does not allow for load modification. Instead, combustion turbine natural gas capacity is maintained to provide enough firm, dispatchable capacity at all times. This includes redundant natural gas capacity to ensure reliable electricity supplies in the event that battery storage facilities are not entirely charged. This is consistent with the methodology used by the Analysis Group in its assessment of a Clean Energy Payment Program, which was one of the first analyses released supporting the CEPP.[34]

Maintaining enough natural gas capacity to cover installed battery capacity adds approximately $3 billion to the cost of CEPP compliance. This is a necessary insurance policy to help maintain grid reliability in the event that the batteries are not fully charged.

Transmission

Distance per mile costs were estimated from the 2021 Midcontinent Independent Systems Operator Transmission Cost Estimation Guide.[35] This analysis uses the MISO-wide average cost estimates of double circuit 115kv lines for any lines less than 230kv, and the MISO-wide average cost estimates for double circuit 345kv for any lines above 230kv.

Utility Returns

The amount of profit a utility makes on capital assets is called the Rate of Return (RoR) on the Rate Base. For the purposes of our study, the capital structure used is that of Arizona Public Service (APS): 44.2 percent debt and 55.8 percent equity, and a return on debt of 4.1 percent and return on equity of 8.7 percent.[36,37]

Property Taxes

Property tax payments for utilities were calculated to be 7.5 percent of the undepreciated cost of generation assets installed in each respective scenario, which is a midpoint of property tax expenditures or equivalents for the Salt River Project and Arizona Public Service.[38,39]

Unit Lifespans

Different power plant types have different useful lifespans. According to the National Renewable Energy Laboratory (NREL), wind turbines have a useful life of 20 years, and solar panels have a useful life of 25 to 40 years.[40] Our analysis uses a 25-year lifespan for solar because this is the typical warranty period for solar panels. Wind and solar facilities are rebuilt, or "repowered," in our model after reaching the end of their useful lifespans.

Nuclear power plants are assumed to have an 80-year useful life, based on the extension of the operating license for the Turkey Point nuclear power plant in Florida.[41] Natural gas and coal-fired power plants are assumed to have 60-year useful lifetimes.

Finally, battery storage facilities are assumed to have a useful lifespan of 20 years. This is likely a generous assumption. Depending on usage rates, battery storage facilities can require repowering as early as five to eight years after they are put into operation.[42] NREL used 15 years in its cost projections for battery storage. Our analysis uses a lifespan of 20 years to showcase a best-case scenario for storage facility life expectancies.

Hourly Peak Demand Assumptions

The peak demand for Arizona is estimated to be 21,000 MW based on 2019 Energy Information Administration (EIA) Form 861 Operational Data and assuming a concurrent peak load for all load-serving entities in the state.[43] These are the best available data for peak demand in the state of Arizona.

Solar Panel Degradation

Recent research has found that solar panels are degrading faster than previously anticipated.[44] This research found the degradation rate for utility-scale solar is 0.8 percent per year. Our study does not take this degradation into account.

Wind Turbine Degradation

Academic research from Lawrence Berkeley National Labs has found wind turbine performance declines smoothly with age until there is a large step-down in production after ten years.[45] This analysis does not incorporate declines in wind turbine performance.

Battery Storage Capacity Assumptions

Battery storage capacity was estimated based on the annual hourly load shape for the state of Arizona. The load shape was based on demand and generation data for 2019 through EIA's Hourly Electricity Grid Monitor for Arizona Public Service (APS), the Salt River Project (SRP), and Tucson Electric Power Company (TEPC). We extrapolated for the rest of Arizona based on generation load profiles for the Southwest electrical region.

These inputs were entered into a model provided by the Texas Public Policy Foundation to calculate storage capacity needs and the quantity of solar capacity needed to charge the batteries.

Capacity Factors

Initial annual capacity factors used for Arizona energy sources in 2021 are based on EIA's state electricity profile for Arizona.[46] These are the best representation of annual capacity factors in the state.

Capacity factors for baseline levelized cost of energy (LCOE) values for existing power plants were obtained through FERC Form 1 data on power plants owned by Arizona Public Service (APS), Tucson Electric Power Company (TEPC), and UNS Electric. Federal Regulatory Commission (FERC) Form 1 data for capacity factors were used because they are the best representation of the cost per megawatt-hour (MWh) for energy sources in Arizona. Annual capacity factors within the model are then used to calculate new LCOE values derived from the baseline LCOE values.

Hourly solar capacity factors used for Arizona's load shape were obtained from EIA's Hourly Electric Grid Monitor for SRP from August 1, 2019 through August 7, 2019.[47]

These data were used because they are the best available data for the state of Arizona on an hourly-load basis. Hourly wind capacity factors were obtained using data for TEPC[48] because they are the best available data.

Capital Costs

Total Overnight Capital cost estimates for new capacity for each generation technology are taken from Region 20 SRSG of the EIA's Electricity Market Module, Assumptions for the Annual Energy Outlook 2021.[49] National estimates are used for Variable Operations & Maintenance (O&M), Fixed O&M, and heat rates. These capital and operating costs are held constant throughout the model run.

Fuel Cost Assumptions

Fuel costs for existing natural gas, coal, and nuclear facilities were estimated using FERC Form 1 data for existing facilities for Arizona Public Service (APS), Tucson Electric Power Company (TEPC), and UNS Electric. All fuel costs were held constant throughout the model run.

Generation Costs for Existing Facilities

Generation costs for existing facilities were obtained using FERC Form 1 data. LCOE values were calculated for each energy source (coal, natural gas combined cycle, natural gas combustion turbine, nuclear, wind, solar, etc.) using costs and generation totals provided by FERC form 1 data for APS, TEPC, and UNS Electric. LCOE values are then used within the model and based on the annual capacity factors of each energy source.

Generation Costs for New Generation Facilities

Generation costs are based on LCOE values for new and existing energy sources in the state of Arizona during the duration of the model (2021-2052). Generation costs represent the additional generation costs incurred above present-day costs of operating the grid.

Acknowledgements

We thank Brent Bennett, Ph.D. of the Texas Public Policy Foundation for his assistance on this report, particularly with respect to determining the capacity of battery storage capacity necessary to meet CEPP requirements. We also thank Diane Bast for editing. ■

Endnotes

1 See "State Level Analysis," in the Appendix.

2 See "Annual Average Additional Cost Per Customer," in the Appendix

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