The Impacts of EPA's Clean Power Plan on Electricity Generation and Water Use in Texas

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Abstract

The U.S. Environmental Protection Agency (EPA) has proposed a new rule under the Clean Air Act—the Clean Power Plan (CPP)—to control carbon dioxide (CO_2) emissions from existing stationary electric power plants. In order to better understand the potential impacts of the rule for water consumption and withdrawals in Texas, a state that is experiencing on-going drought, we apply a power generation policy model to evaluate water use along with other economic and environmental indicators. We explore two scenarios: a Baseline scenario and the implementation of the CPP. We find that the state will save water under the CPP be able to meet the final and interim targets with modest incremental effort.

Executive Summary

To determine how Texas could be affected by the U.S. Environmental Protection Agency's (EPA's) Clean Power Plan (CPP), we applied CNA's Electricity-Water-Climate power sector model to evaluate the potential impacts. We find that under the CPP, the state will save water and reduce levels of conventional air pollutants. In addition, the state will be able to meet the policy's targets with modest incremental effort even though electricity demand is expected to increase by 25 percent.

We summarize our main findings:

1. Under the CPP, water consumption by the Texas power sector could be cut by more than 20 percent compared with water consumed in 2012. This is about 88,000 acre-feet per year.

2. The Texas power sector is already moving to cut the carbon dioxide (CO_2) intensity of its economy—the objective of the CPP—by shifting away from coal and toward natural gas and wind power.

3. The demand-side energy efficiency gains proposed by EPA would reduce the need for new power generating capacity in Texas. As a result, Texas would avoid increased water use and would significantly reduce conventional air pollution and CO_2 emissions.

4. Under the CPP, the cost per unit of electricity produced would increase by 5 percent, but total system costs would decrease by 2 percent.

Contents

List of Figures

List of Tables

Glossary

ac-ft	Acre-feet
AEO	Annual Energy Outlook
CCS	Carbon capture and sequestration
CPP	Clean Power Plan
CO_2	Carbon dioxide
EE	Energy efficiency
eGRID	Emissions & Generation Resource Integrated Database
EGU	Electric generating unit
EIA	U.S. Energy Information Administration
ERCOT	Electric Reliability Council of Texas
gal	Gallons
GHG	Greenhouse gas emissions
GWh	Gigawatt-hour
HG	Mercury
IGCC	Integrated gasification combined cycle plant
lbs	Pounds
mmBTU	Million British thermal units
MW	Megawatt
MWh	Megawatt-hour
NGCC	Natural gas combined cycle plant
NO_x	Nitrogen oxide
O&M	Operation and maintenance
PM	Particulate matter
PV	Photovoltaic
EPA	U.S. Environmental Protection Agency
SO_2	Sulfur dioxide
yr	Year

Background

Drought in Texas

Texas is periodically subject to severe drought. In 2011, the state experienced the worst single-year drought in its recorded history. [1]. Demand for electricity was at an all-time high because of the heat, and the water needed to cool the state's coal, nuclear, and gas power plants was in short supply. In some places, water levels had dropped below intake pipes; in others, the available water was too hot to provide effective cooling. Texans were warned that rolling blackouts were possible, as power plants that could not be properly cooled would have to shut down [2].

The drought has become less severe since then, but as of August 25, 2014, 59 percent of the state was still under moderate to extreme drought [3]. Reservoirs were about two-thirds full for that time of year, about 20 percentage points below the long-term median [4].

With high population and economic growth, the impact of water stress on the economy is a high priority for the state. The Texas Water Development Board believes that water resources are insufficient to meet projected needs during a drought [5]. In 2005, the largest source of water withdrawals in Texas was for cooling thermoelectric power generation. At 10.9 million acre-feet (ac-ft)[1] per year, this use accounted for about 40 percent of total freshwater withdrawals [6]. The power sector's dependence on water is a source of vulnerability [7].

As Texas grapples with this problem, decision-makers in the state must also consider a new federal policy, one which is aimed at producing a major shift in how electricity is produced in the United States. A key concern for Texas is how the policy will affect water use in the power sector. This report is intended to address that question.

[1] An acre-foot (325,851 gallons or 1,233 cubic meters) is the amount of water that would fill a volume one foot deep over one acre.

The Clean Power Plan (CPP)

The U.S. Environmental Protection Agency (EPA) released the Clean Power Plan (CPP) on June 2, 2014 [8].[2] Under the plan, the Obama Administration hopes to reduce carbon dioxide (CO_2) emissions from the power sector by 30 percent across the country relative to CO_2 emission levels in 2005. The CPP defines state-specific CO_2 intensity rates—i.e., the number of pounds of CO_2 that can be emitted per megawatt-hour (MWh) of power produced. This rate is determined by dividing total CO_2 emissions from the power sector in a given state by total power generation in that state (excluding most of the nuclear power but including renewables) plus demand-side energy efficiency gains. All CO_2 emissions from the power sector are under a single state bubble; EPA is not proposing limits for individual power plants, as it does under other rules for conventional air pollutants. EPA's use of CO_2 intensity rates is intended to provide flexibility to state regulatory agencies. In addition, by including demand-side energy efficiency as part of the equation to reduce CO_2 emissions, EPA is attempting to provide further flexibility to regulators and to incentivize energy efficiency (EE) programs [10]. EE programs tend to be a low-cost approach to reducing emissions.

EPA specifies two intensity rates: (1) the final rate, a single-year rate that must be achieved by 2029 and (2) the interim rate, which is the average rate between 2020, when the CPP is to come into force, and 2029, the last year of the plan. The rates for each state are determined by EPA analysis [10].

EPA outlines four "building blocks" that states can use to achieve interim and final intensity rates. We list them below:

1. Reduce the CO_2 intensity of generation at individual coal-fired power plants through efficiency improvements;

2. Switch generation from coal-fired power plants to natural gas combined cycle plants (NGCC);

3. Employ zero-emission renewable energy and some nuclear power;[3] and

4. Reduce emissions by cutting growth in power demand through the use of demand-side energy efficiency. [10]

[2] EPA issued the proposal under the authority of the Clean Air Act, section 111(d) [9].

[3] Only nuclear generators that are considered "at risk" or under construction are counted. There is currently about 35 gigawatt-hours (GWh) per year of nuclear generation in Texas. Of this amount, EPA counts 2.3GWh.

Texas and the CPP

The government of the state of Texas is concerned that the CPP requirements may adversely affect its power sector and economy. Using the Electricity-Water-Climate power sector model developed by CNA, we estimate how Texas will fare under the new policy.

We find that the state will be able to meet the final and interim targets with modest incremental effort. What is more, under the CPP, the state will save water and reduce levels of conventional air pollutants. And, we find that this can be attained at a savings or small cost. In the remainder of this paper, we discuss the model and how we arrived at these results.

Synergies between CO_2 mitigation, water conservation, and cost

The model we use to evaluate how Texas will fare under the CPP was created by CNA researchers and has been used in other case studies—in China, France, India, and the Electric Reliability Council of Texas (ERCOT) region [7].

The model accounts for conventional indicators such as CO_2 emissions, power generation, fuel mix, conventional air pollutants, and total, fixed, and variable costs, as well as for water withdrawals and consumption.[4] Because the model accounts for all of these factors, we are able to identify synergies between CO_2 mitigation, water conservation, and cost. That is, we can see how changes made in the power sector to reduce CO_2 emissions will affect water consumption and costs.

Table 1 shows cost and environmental performance data for a subset of options available in the model to provide supply or cut demand. We see several cost-effective options for meeting growing electricity demand, while conserving water, reducing conventional air pollutants, and cutting greenhouse gas emissions (GHGs). The least expensive option is to slow demand growth through greater efficiency. Not only is efficiency the cheapest approach because it avoids the need for new capacity altogether, but it also eliminates cooling water needs and emissions.

[4] Withdrawal is "water removed from the ground or diverted from a surface-water source for use." Consumption is"[t]he part [portion] of water withdrawn that is evaporated, transpired…or otherwise removed from the immediate water environment" [11].

Table 1. Synergies exist between water conservation, cost, and environmental performance

Fuel Type	Median Water Use (gallons/MWh)[a]		Cost[b] (per MWh)	Air Pollutants (lbs/MWh)			
	Withdrawal	Consumption		PM	SO_2	NO_x	CO_2
Natural Gas[c]	264	198	$66	–	–	0.07	813
Wind	–	–	$80[e]	–	–	–	–
Nuclear	1,101	672	$96	–	–	–	–
Coal	531	471	$96	0.13	0.71	0.57	1,678
Coal w/CCS[d]	1,123	846	$122[f]	0.11	0.73	0.73	203
Solar Photovoltaic	28	28	$130	–	–	–	–
Energy Efficiency	–	–	$16-48[g]	–	–	–	–

Note: The numbers in this table are median values taken from the literature [12], [13], [14]. The actual numbers used in the model were adjusted during the calibration exercise.

a. This assumes tower/recirculating cooling.

b. This is the total system levelized cost of energy [12].

c. Natural gas combined cycle (NGCC)

d. CCS stands for carbon capture and sequestration.

e. Wind and photovoltaic (PV) costs are unsubsidized.

f. This figure was derived from EIA [12] and is based on the difference between IGCC and IGCC with CCS.

g. This figure is from Molina [13].

The least expensive option for new generation capacity is NGCC, which has significant benefits over coal. Water withdrawals and consumption are less than half that of coal for the same cooling technology. In addition, natural gas emits only negligible amounts of particulate matter (PM) or sulfur dioxide (SO_2), and nitrogen oxide emissions (NO_x) are 90 percent lower. Furthermore, natural gas produces less than half of the CO_2 emissions that coal produces.

The numbers in this table do not include water consumed for fuel during extraction, only combustion. Grubert et al. compared life-cycle water consumption by coal and natural gas-fired power plants in Texas and concluded that natural gas extraction consumes 3 gallons per million BTU while lignite extraction consumes 16 [15].

As we see in the table, unsubsidized wind power costs are currently lower than coal or nuclear, and they are continuing to drop as technology improves [16]. Wind does not require any cooling water and does not release any emissions. Solar photovoltaic (PV) also has positive environmental performance, and, although PV costs are relatively high, there was a 60 percent drop in price between 2011 and the end of 2013 [17].

Using the CNA Model to Understand How the CPP Will Affect the Power Sector in Texas

In the next few sections, we explain how we set up the two scenarios—the Baseline scenario and the CPP scenario—we use to identify the potential impacts of EPA's proposed policy. We then compare the two scenarios, providing and explaining indicators including CO_2 intensity, water use, conventional air pollutants, and costs.

Establishing the Baseline

The first step in our analysis was to establish a Baseline scenario for Texas so that we could compare it with the CPP scenario. The Baseline is intended to represent a continuation of current policy and trends under a reference case for prices.

We used the following steps to establish the baseline:

1. We extracted power sector data from EPA's Emissions & Generation Resource Integrated Database (eGRID) database [18] for Texas for those electric generating units (EGUs) that EPA expects to be covered under the CPP. From eGRID, we extracted data on generating capacity and total generation. We also extracted emissions data for conventional air pollutants and CO_2, as well as capacity factors for coal, gas, nuclear, wind, and other minor power sources.

2. We updated annual load growth for the power sector. ERCOT recently developed a new process to calculate long-term demand growth for its share of Texas, which is 1.3 percent per year compounded, which amounts to 25 percent growth over the period [19]. We assumed this number to apply to the

entire state. In our modeling, we only represent generation covered by the CPP, which is about 85 percent of all generation in Texas.[5]

3. We calibrated the model with the new data. This step forces the model to reproduce initial conditions including generation, generating capacity, capacity factors, CO_2 emissions and intensity rate, water consumption, and NO_x and SO_2 emissions, as determined from EPA technical documents, eGRID, the Texas Water Development Board, and other sources.

4. We updated cost data from the Energy Information Administration's (EIA's) 2014 Annual Energy Outlook reference (AEO) case [20]. The key data we updated were the fuel price projection for coal and natural gas, which showed (1) steam coal prices rising from $2.40 per ton to $2.93 between 2010 and 2030 and (2) natural gas prices increasing from $3.80[6] per million Btu (MMBtu) to $6.49 per MMBtu [21].

Although coal and natural gas prices are expected to increase, wind prices are expected to decline [22]. We assume an increase in the capacity factor although capital, and fixed and variable operation and maintenance (O&M) costs are held constant. This produces a decline in the overall cost of wind power. Although not shown, demand-side energy efficiency is the cheapest way to meet demand [13, 23]. Molina [13] reports a range of $16 to 48 per MWh of demand avoided; we assume the cost is $35 per MWh.

With the updated calibration for Texas, we ran the Baseline scenario. Figure 1 shows the result for the CO_2 intensity rate, the key indicator for EPA's CPP. We see that even under the Baseline scenario, Texas reduces its CO_2 intensity rate. EPA calculations for 2012 show that Texas produces 1,284 pounds of CO_2 per MWh; our calibrated results are the same. According to the EIA, Texas ranks first among states in total power generation, total generating capacity, and CO_2 emissions from the power sector. Its intensity rate ranks it 20th [24].

EIA reports that between 2000 and 2010, CO_2 emissions from the Texas power sector dropped by 5 percent while total generation increased by 9 percent. Using EPA's methodology, we calculate that the CO_2 intensity rate declined from 1,558 lbs per MWh to 1,357, a drop of 13 percent [25]. Our results for the 2010 to 2020 baseline

[5] EPA's methodology does not consider growth in power demand. We have set the model up to meet the final and interim intensity rates with rising demand.

[6] The first few years of natural gas prices from the Annual Energy Outlook's tables were very irregular, so we smoothed them to make calibration easier. The beginning prices for natural gas from AEO are slightly different than reported here.

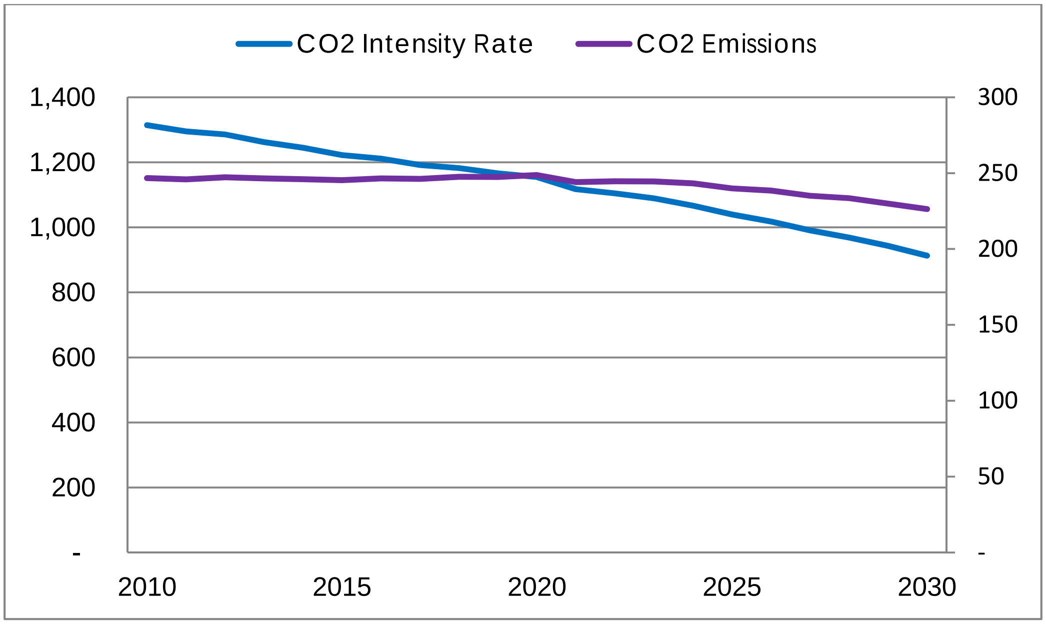
period show a continuation of this trend, with the rate dropping by a further 12 percent.

The baseline shows a final CO_2 intensity rate (for 2029) of 943 lbs per MWh, a decline of 26 percent from the 2012 value. The decline is due to the gradual retirement of coal generating capacity, which is not replaced because natural gas and wind prove to be better economic alternatives. We assume that new coal plants cannot be built because of EPA rules prohibiting the construction of new sources that emit more than 1,000 pounds per MWh, which is not possible without CCS.[7] However, even when this constraint is removed, the model does not choose new coal because it is a more costly option. Across the United States, coal generation has dropped by 25 percent between 2008 and 2012, as natural gas prices plunged because of the shale gas fracking boom. Gas and renewable generation grew [26].

Also shown in figure 1 are the CO_2 emissions (million tons per year) for the Baseline scenario. The graph shows that CO_2 intensity rates can fall even though emissions do not. For the first half of the simulation, CO_2 emissions do not decline at all, but they drop by 7 percent in the second half. This apparent anomaly is due to demand growth, which dilutes CO_2 intensity.

[7] We refer here to new rules proposed under section 111(b) of the Clean Air Act. It is unlikely that the CPP, which is under section 111(d) would come into force without rules covering new sources.

Figure 1. The Texas power sector is already reducing its CO_2 intensity rate, though its CO_2 emissions are flat or falling slowly (Units = lbs/MWh, million tons /yr)



The Clean Power Plan

With the Baseline scenario established, we set up the model to run the CPP scenario under the parameters established by EPA for Texas [10]. In EPA's technical documentation for the CPP, they project that, after 2020, coal prices will drop by 16 to 18 percent and that gas prices will go up by about 9 percent but later fall back to the price in the Baseline. We adjusted our fuel costs for the CPP scenario using these projections [9].

Under the CPP, the final CO_2 intensity rate for Texas is 791 pounds per MWh by 2029, and its interim rate is 853 pounds per MWh. The CPP also calls for demand-side energy efficiency gains of 1 percent (not compounded) per year starting in 2020 in order to achieve a 10-percent cut in the 2029 power demand level relative to the Baseline.

Although EPA has laid out their methodology to calculate the final and interim rates for each state, they are clear that states have the authority to determine how to develop their own regulatory approach to meet these target rates. We attempt to determine the economically optimal pathway, setting up the model to find the cheapest way to meet electricity demand while satisfying constraints to meet the target rates. We assume that a system would be put in place to allocate the target CO_2 emissions and that those credits would be traded between generating units. Different regulatory approaches would produce different cost outcomes.

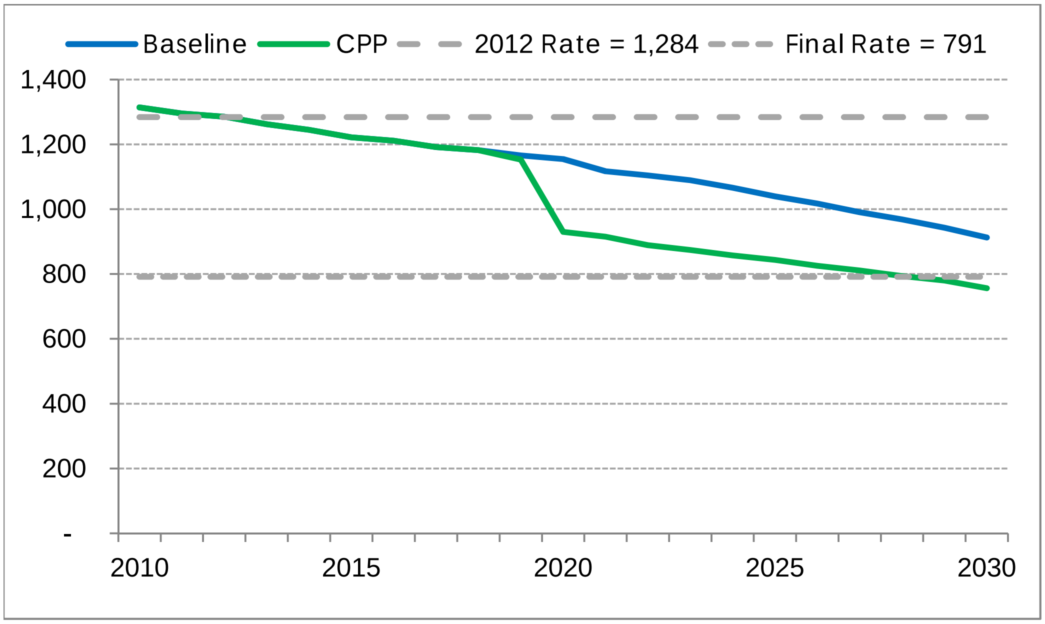
Comparing the Baseline and the CPP scenarios—CO_2 emission rates

In figure 2, we show how CO_2 emission rates compare under the Baseline and the CPP scenarios. Two things stand out: First, under the Baseline scenario, Texas approaches the required CPP final rate without the CPP; the final rate under the Baseline scenario is about 20 percent above the final target rate proposed by EPA under the CPP (913 versus 791). Under the Baseline scenario, Texas would see a 26 percent decline in its CO_2 intensity rate compared with the 2012 value of 1,284; under the CPP, the rate would need to decline 38 percent.

Second, we see a sharp divergence in CO_2 emissions rate under the Baseline scenario and under the CPP between 2019 and 2020, which is the year the plan comes into force. This is because behavior in the first few years of the second decade of the simulation is largely determined by the need to hit the interim rate, not the final rate. We set up a constraint in the model that required it to produce annual intensity rates that would be less than or equal to the rates needed to hit the required interim rate. This constraint is binding in the first years of the policy's implementation but not in the second half as load demand is cut due to the demand-side energy efficiency target.

Under the Baseline scenario, by 2029 total CO_2 emissions drop by 7 percent from the 2012 value of 246 million tons per year to 230 tons per year (not shown); under the CPP the cut is 23 percent, dropping to 190. The total reduction in CO_2 emissions under the CPP between 2020 and 2029 is 454 million tons relative to the Baseline scenario.

Figure 2. Both the Baseline and the CPP scenarios produce drops in CO_2 intensity (Units = lbs/MWh)



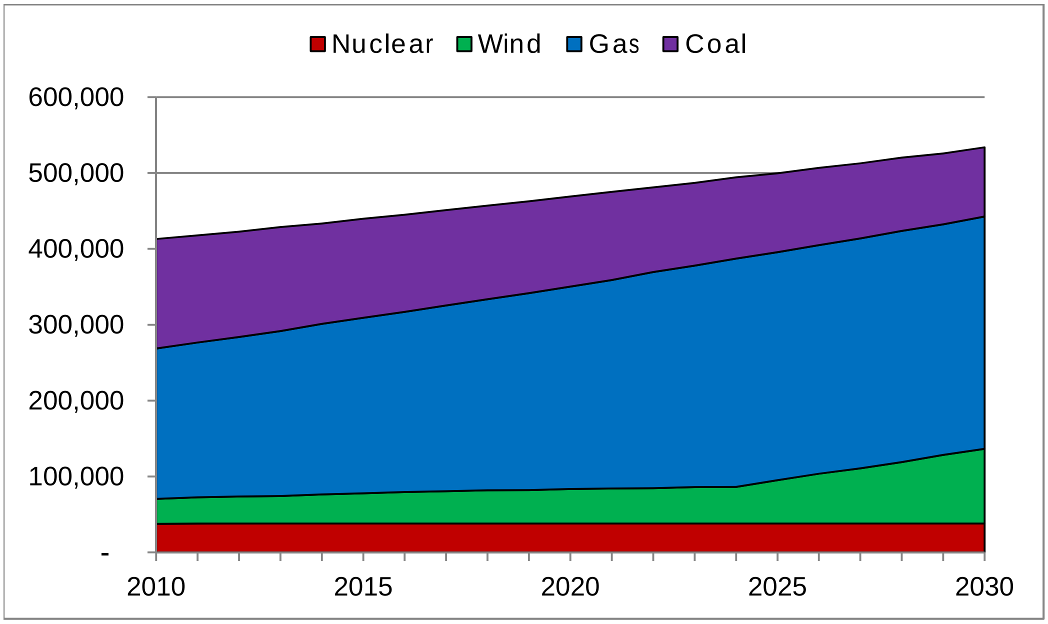
The fuel mix shares that produce the Baseline and the CPP intensity rates are shown in figures 3 and 4. In both scenarios, the starting shares of total power generation are 48 percent gas, 35 percent coal, 9 percent nuclear, and 8 percent wind. For this analysis, we assume that the four nuclear generators in Texas continue to operate through 2030, producing a constant amount of electricity in both scenarios.

Under the Baseline scenario, load growth from 2012 to 2029 is 25 percent, with annual compounded growth set at 1.3 percent as determined by ERCOT [19]. Under the CPP, the growth is the same until 2020, when it flattens because of demand-side energy efficiency. From 2020 to 2029, load growth is just 2 percent. The proposed rules for the CPP allow credit for state programs that cut energy demand by including any savings in total generation, increasing the denominator and lowering the CO_2 intensity. It is important to note that EPA provides great flexibility to determine how to meet the specified rates.

In the Baseline, coal-fired generation drops by one-third between 2012 and 2029, declining to 18 percent of total generation by 2029. The share of gas-fired power increases by 8 points, up to 58 percent. Wind power's share of generation increases to 18 percent while its contribution increases from 36,000 GWh to about 90,000 GWh. Total generating capacity goes up by 30 percent, from 99,000 MW in 2012 to

128,000 MW in 2029.[8] The increase in wind after 2024 is due to wind becoming less expensive than natural gas at that point.[9]

Figure 3. Baseline power generation fuel mix, where coal is gradually replaced by gas and wind power (Units = GWh/yr)



In contrast, under the CPP, there is a rapid shift from coal to natural gas between 2019 and 2020 (figure 4). The sharp change in generation shares that occurs in 2020 is due to changes in capacity factors for coal and gas, with coal moving from a 64-percent capacity factor to a 25-percent factor and NGCC increasing from 48 to 61 percent.

These adjustments affect about 14 percent of total generation in 2020, with coal dropping by that share and NGCC gaining it. This switch from coal to NGCC is the only way that the model is able to achieve the CO_2 cuts needed to meet the interim target. In EPA's calculations to determine the final target rate, they posit an increase

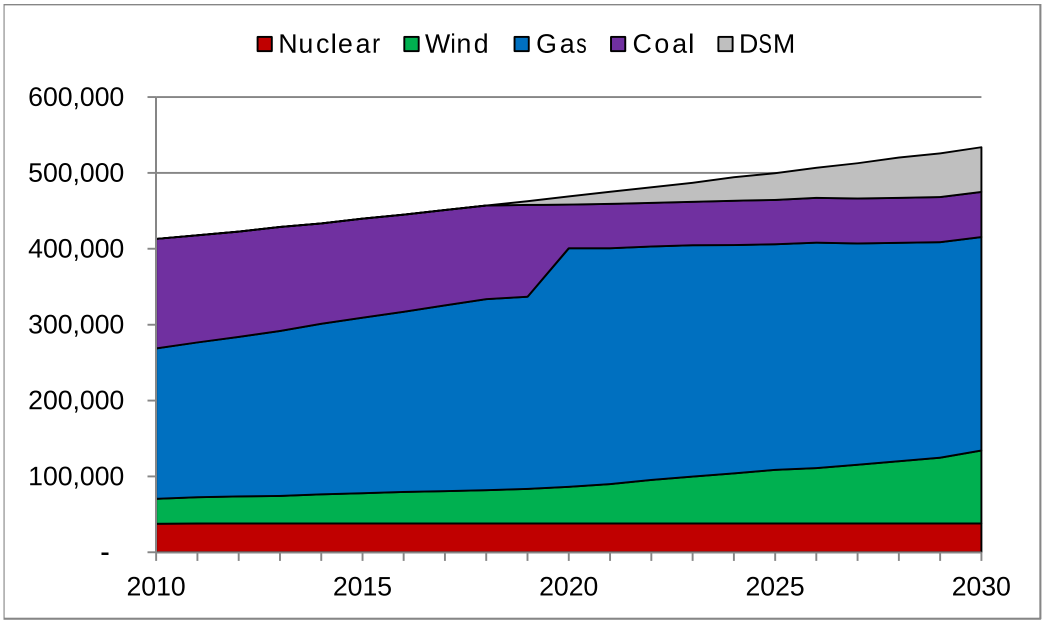
[8] Total generating capacity in Texas was about 108,000 MW in 2010, but not all of it will be covered under the CPP.

[9] Because of our price assumptions for solar PV, we see very little of it coming into the model's solutions. Because the emissions and water characteristics of wind and PV are so similar, there would be no substantial difference in results for those indicators if there were more PV generation. In ERCOT's most recent projections, they report that up to 10,000 MW of new unspecified solar capacity could be in place by 2029 [27].

in the NGCC capacity factor to 70 percent, though we find that 61 percent would be sufficient to meet the interim emissions rate target.

Wind generation grows in both scenarios, eventually achieving about the same amount in 2029. Under the CPP, however, wind power increases fairly quickly after 2020. The increase in wind in figure 4 after 2024 is due to wind becoming less expensive than natural gas at that point.[10]

Figure 4. Under the CPP, coal power is quickly replaced by gas in 2020 and energy efficiency lowers demand (Units = GWh/yr)



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Comparing the Baseline scenario with the CPP—water consumption and withdrawal

As noted in the introduction, under the CPP, Texas may be able to decrease water consumption by its power sector. In this section, we describe how water is accounted for by the model, and we discuss the results of our analysis.

Water accounting

Our model accounts for water that is withdrawn and consumed to generate electricity by simulating representative thermoelectric power plants. We include two types of coal plants—conventional (subcritical) and advanced (supercritical)—and two types of natural gas plants—conventional steam combustion and natural gas combined cycle (NGCC). We represent one type of nuclear plant.

We also represent three categories of thermal cooling in the model: once-through, recirculating, and dry. Once-through cooling withdraws more water but consumes less than recirculating cooling; dry cooling does not require water. Wind and PV don't require any cooling, though water is used to wash PV panels. All possible combinations are not represented because they are not all used in the state. For example, nuclear power generation in Texas does not use once-through or dry cooling.

We calibrated the model for the 2010 starting value for total water consumption by using the water demand estimate for 2010 for the power sector from the 2012 Texas state water plan [5, 28]. The estimate for steam electric power is 416,000 ac-ft per year. Our water withdrawal calibration number came from the U.S. Geological Survey [30]. For Texas, fresh water withdrawals for thermoelectric power were 10.9 million ac-ft in 2005, which is 41 percent of total freshwater withdrawals.

Results

Tables 2 and 3 provide median water consumption and withdrawal values in gallons per MWh, respectively, for the power generation options available in the model as calibrated for Texas.[11,12] The boxes shaded in blue indicate the most widely used

[11] Demand-side energy efficiency is not shown, but avoiding new capacity development will reduce water use.

power generation options. In 2010, conventional coal with recirculating cooling made up 31 percent of total generation. NGCC made up 35 percent, conventional nuclear made up 9 percent, and wind made up 8 percent. Together, these four made up 83 percent of generation in 2010.

Table 2. Water consumption values by power generation and cooling option (Units = gals/MWh)

	Once-through	Recirculating	Dry	No cooling
Conventional coal	250	471		
Conventional gas	240	340		
Nuclear		672		
Advanced coal		493		
NGCC		198	2	
Wind				0
Photovoltaic				28

Source: Adapted from Macknick et al. [14]

Table 3. Water withdrawal values by power generation and cooling option (Units = gals/MWh)

	Once-through	Recirculating	Dry	No cooling
Conventional coal	36,350	531		
Conventional gas	35,000	425		
Nuclear		1,101		
Advanced coal		609		
NGCC		253	2	
Wind				0
Photovoltaic				28

Source: Adapted from Macknick et al. [14]

In earlier sections, we saw that coal declines and natural gas and wind increase under both the Baseline scenario and the CPP. Under the CPP, energy efficiency requirements slow demand, and, as a result, the need for new capacity is reduced. In tables 2 and 3, we see that use of NGCC with recirculating cooling instead of conventional coal with the same form of cooling cuts the amount of water that is consumed and withdrawn. Wind power doesn't require consumption or withdrawal of water, and energy efficiency avoids the need for water altogether. We would expect

[12] This part of the calibration was done using a database developed by the Union of Concerned Scientists [29].

then that total water consumption and withdrawal would drop for both the Baseline and the CPP. This is, in fact, what we see in figures 5 and 6.

Figure 5. Less water is consumed under the CPP than under the Baseline scenario (Units = ac-ft/yr)

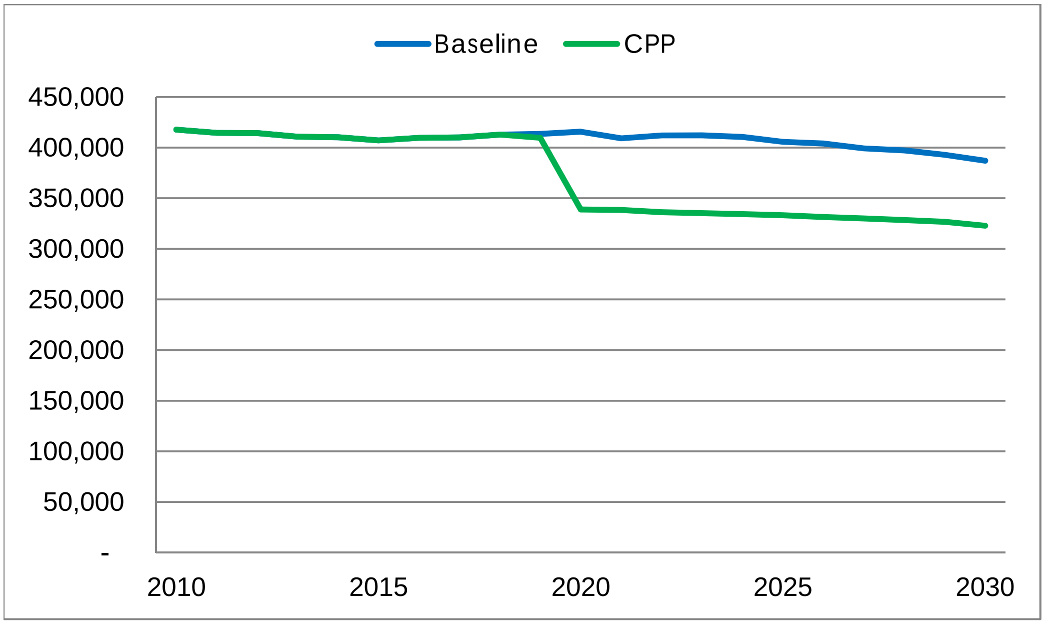
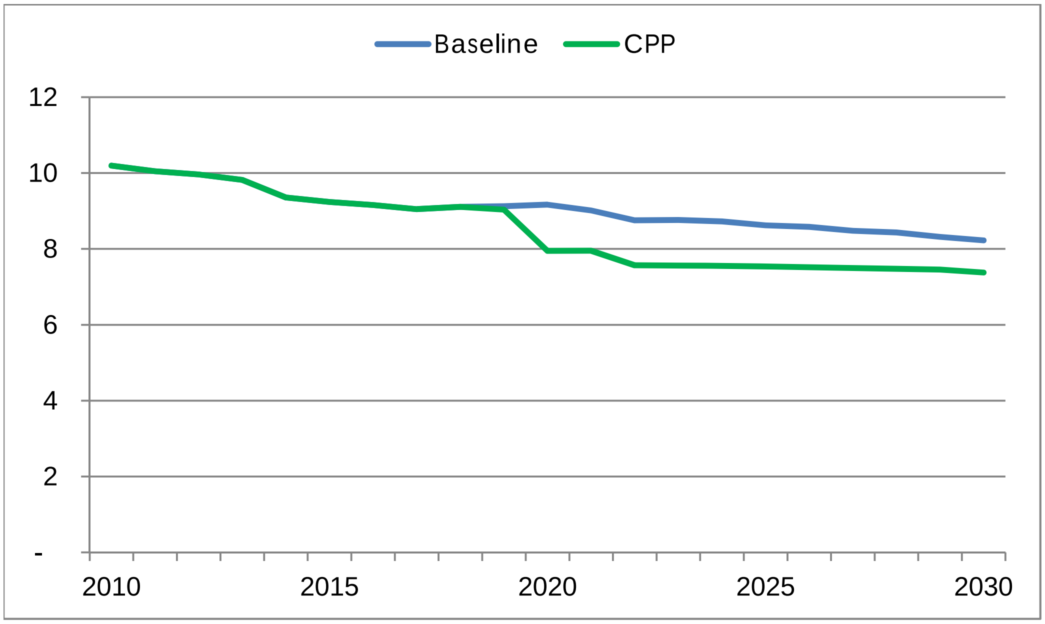


Figure 6. Water withdrawal declines in both scenarios (Units = million ac-ft/yr)



Under the Baseline scenario, we project a 5 percent decline in water consumption between 2012 and 2029. Under the CPP, we expect a 21 percent cut, amounting to 88,000 ac-ft (figure 5). The gain under the CPP represents a savings of 66,000 ac-ft per year in 2029 compared with the Baseline.[13]

The rate of water consumption per unit of generation improves under both the Baseline and the CPP. Table 4 shows the average water consumption rates for all generation in Texas including avoided generation from demand-side energy efficiency.

Table 4. The average rate of water consumption for power generation goes down in both scenarios, but most under the CPP

Average Water Consumption Rate (gals/MWh)		
Baseline 2012	Baseline 2029	CPP 2029
322	305	254
--	-5%	-21%

Water withdrawals (figure 6) also decline under both scenarios. There is less variance between the two because the results are highly dependent on the two options that use once-through cooling: conventional coal and conventional gas. The sharp drops in the figure occur when the once-through cooling plants are retired. The initial number we use for total state water withdrawal is 10 percent smaller than that reported by USGS [6] because the CPP does not apply to all generation in Texas.

Comparing the Baseline scenario with the CPP—conventional air pollutants

As with water consumption and withdrawal, we also expect to see a decline in emissions of conventional air pollutants under both the Baseline scenario and the CPP. We give our results below.

[13] We project a larger drop in coal generation in our Baseline compared to other modeling exercises for Texas [19]. If it turns out that coal does not decline as much as we show, then reductions in water consumption, water withdrawals, NO_x, SO_2, and carbon dioxide due to the CPP would be greater than we estimate. Costs would also be somewhat higher. While the specifics would change, our conclusions would not.

Background

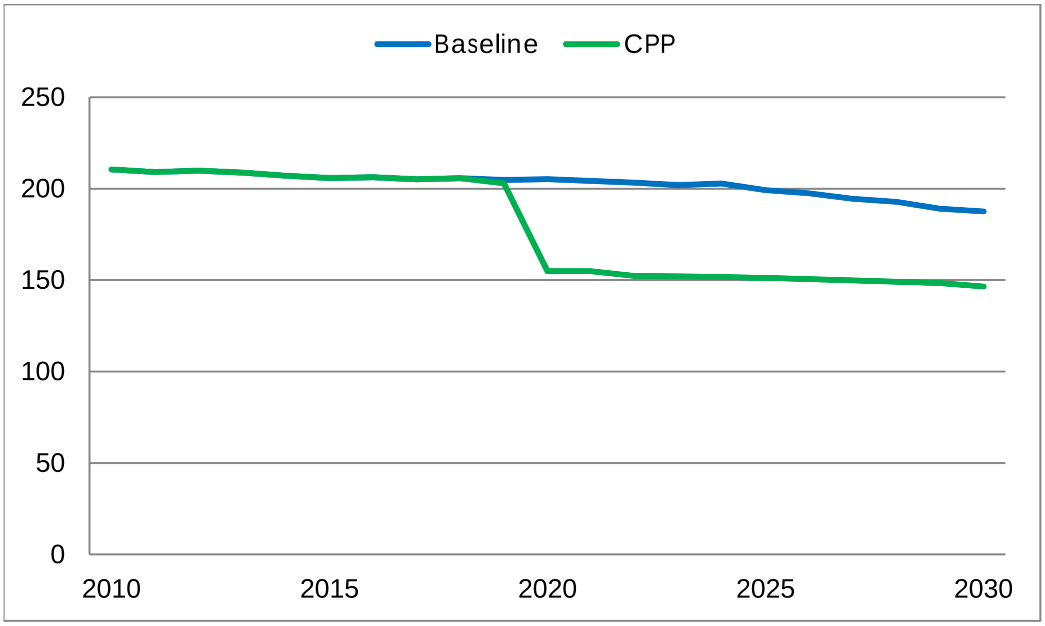
Depending on how power is generated (e.g., coal, gas, wind), there is a large difference in the emissions of conventional air pollutants—i.e., nitrogen oxide (NO_x), sulfur dioxide (SO_2), particulate matter (PM 2.5 micron), and mercury (Hg). With the exception of NO_x, emissions of these pollutants are only associated with coal. That is, SO_2, PM 2.5, and Hg are not associated with generation from natural gas, nuclear power, wind power, or PV. Incentivizing energy efficiency on the demand side means that fewer pollutants are emitted as well. Natural gas generation emits about 10 percent the NO_x that coal generation emits. (See Table 1 above for a summary.)

Texas has the highest NO_x emissions from the power sector in the nation and the second highest for SO_2 [24].

Results

All conventional air pollutant emissions drop in both scenarios. NO_x emissions (shown in Figure 7) decline by 10 percent between 2012 and 2029 under the Baseline scenario and by 29 percent under the CPP. Since natural gas generation produces some NO_x emissions, the decline under both scenarios is lower than it is for the other emissions. For example, SO_2 emissions are cut by 33 percent and 57 percent under the Baseline and the CPP, respectively (not shown).

Figure 7. The CPP produces lower NO_x emissions (Units = 000 tons/yr)

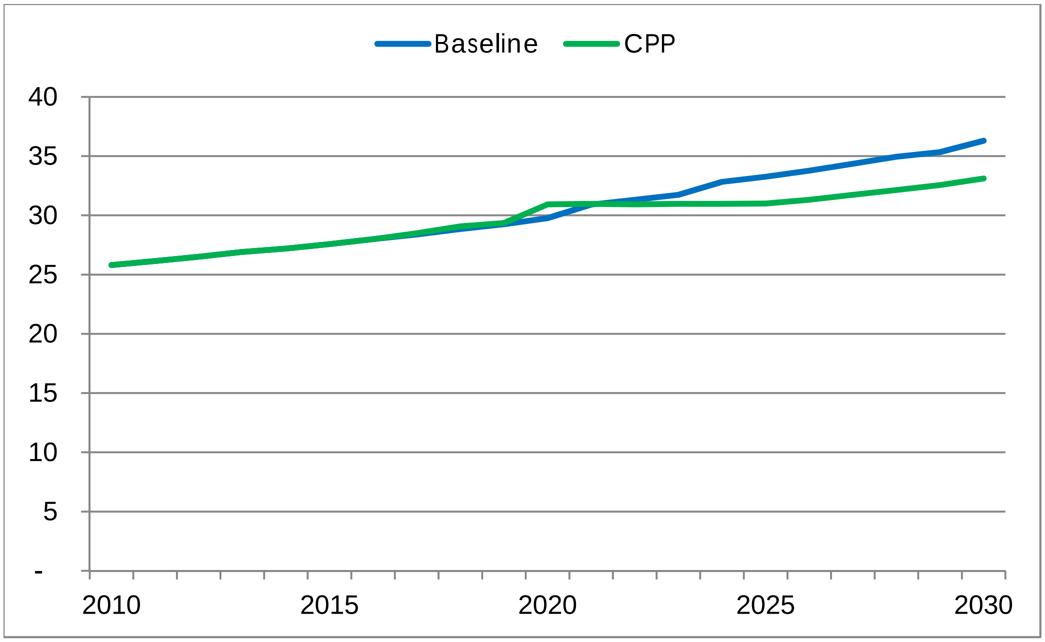


Comparing the Baseline scenario with the CPP—cost

The difference in cost between the two scenarios is not large. As shown in figure 8, under the CPP there is a small total system cost savings over the 2020 to 2029 period—about 2 percent lower than the Baseline scenario. The savings are primarily due to demand-side energy efficiency, which reduces the need for new capacity. Compared with the Baseline in 2029, generating capacity is just 110,000 MW versus 128,000 MW, a reduction of 14 percent.[14]

The savings derive from flat fixed costs (i.e., fixed O&M costs and amortized capital costs), where the costs under the Baseline scenario are higher than the costs under the CPP because of additional capacity requirements.

Figure 8. Total system costs are lower for the CPP because of flat fixed costs (Units = $ billion/yr)



[14] We do not assume improvements in energy efficiency in the baseline. If energy efficiency is economical, one could conclude that power companies or consumers would make these investments on their own and so they should be part of the Baseline. Keeping it out of the Baseline is a more rigorous assumption, as it provides less improvement in the CO_2 intensity rate without the rule and attributes more costs to the CPP scenario. The EPA has included a 10 percent gain in energy efficiency for Texas, so we have characterized it that way as well.

Variable costs (i.e., fuel costs and variable O&M costs) are also lower under the CPP than under the Baseline scenario. While the cost of energy efficiency is greater than the variable costs for coal, gas, or wind, it is applied across fewer units of generation. Furthermore, EPA's expected price of coal drops by about 18 percent, while the price of gas goes up at first and then declines.

The average cost per MWh of electricity goes up under both scenarios between 2012 and 2029, by 5 percent for the Baseline and 10 percent for the CPP. Part of this is due to the fact that there are fewer units of power to spread the costs across.

Conclusions

The results of our analysis lead us to make the following conclusions:

1. EPA's Clean Power Plan (CPP) will produce water conservation benefits. Under the Baseline scenario, we see a 5 percent drop in water consumption in 2029 compared with 2012, while under the CPP there's a 21 percent decline. The additional savings are equivalent to about 66,000 ac-ft of water per year. Wind requires no water, and natural gas uses about half the cooling water that coal does. In addition, demand-side energy efficiency programs will cut load demand and result in water savings. As these three building blocks are core to the CPP, we expect the CPP to trim water requirements not only in Texas but nationwide.

2. Texas is positioned to make significant cuts in its CO_2 intensity rate even without the CPP. Under the Baseline scenario, which includes switching from coal to natural gas and implementing wind power, Texas will lower its overall CO_2 emissions for the power sector and make a 26 percent cut in its CO_2 intensity rate by 2029 even though electricity demand is expected to increase by 25 percent.

3. The CPP will require modest adjustments for Texas. The CPP calls for a 38 percent cut in CO_2 intensity which is only 12 points beyond what we project will happen without it. Almost 70 percent of the proposed cut would occur under the Baseline anyway. The two principal adjustments will be a quick change from coal to gas at the beginning of the implementation period and the addition of demand-side energy efficiency programs.

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