

The Shaky Economics of the J.K. Spruce Power Plant

Weighing the Costs of a Coal Plant Against Renewable Energy Options

Prepared for Sierra Club

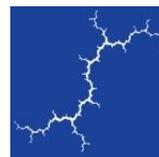
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EXECUTIVE SUMMARY

The J.K. Spruce power plant consists of two coal-fired units operated by CPS Energy in Bexar County, Texas. CPS is currently proposing to install costly selective catalytic reduction (SCR) technology at Spruce Unit 1, with an eye toward limiting the unit's emissions of nitrogen oxides. This report examines whether it is prudent for CPS to invest significantly in the Spruce units, or whether CPS should instead seriously consider retiring one or both of the units. Synapse Energy Economics (Synapse) was retained to assess the recent and projected financial performance of the Spruce units relative to potential replacement alternatives, relying on publicly available information.

Our primary findings include:

- **Both Spruce units have lost money relative to the market over the past five years.** From 2012 to 2016, Synapse estimates that Spruce 1 cost \$8 million more than market-based energy and Spruce 2 cost \$36 million more than market alternatives.
- **Both Spruce units have become increasingly uneconomic over the past two years.** After earning positive net revenues in 2014, each Spruce unit lost more than \$20 million in both 2015 and 2016, for a total of more than \$135 million in plant-wide losses in two years.
- **Both Spruce units are likely to continue to lose money relative to the market for at least the next three years.** From 2017 to 2019, we estimate that Spruce 1 will lose more than \$50 million, and Spruce 2 will likely lose more than \$60 million—together more than \$110 million—relative to market-based alternatives.
- **Only under a series of favorable assumptions, and with no new major capital expenses, could both Spruce units become profitable in the 2020s.** To become profitable, the following conditions would all have to be met: (a) gas prices recover rapidly, (b) coal prices remain relatively flat, (c) Spruce faces no new environmental costs, and (d) the Spruce units are dispatched optimally. Under those conditions, Spruce could produce average annual net revenues of \$20 million for Unit 1 and \$43 million for Unit 2 from 2020 to 2037.
- **However, if gas prices increase only moderately, Spruce will remain uneconomic indefinitely.** Under a scenario in which natural gas prices recover only gradually, both Spruce units would cost more than market-based energy throughout the period from 2017 through 2037. In this scenario, Spruce 1 and 2 incur total losses of \$163 million and \$121 million, respectively (net present value).
- **Installing an SCR at Spruce 1 is a high-risk economic proposition.** Even under favorable assumptions, the costs of an SCR effectively negate the impact of increasing gas prices, reducing the average annual net revenues of Spruce 1 to less than \$2 million from 2017 through 2037. Under our alternative, less favorable natural gas price assumption, Spruce 1 would incur average annual losses of more than \$20 million with an SCR.



- **CPS has access to cost-effective clean energy replacement options.** Recent utility-scale power purchase agreements (PPAs) have demonstrated that solar and wind power can be obtained in Texas in large quantities and at low prices.
- **Replacing Spruce 1 with generation from renewables can be expected to save ratepayers money.** Under current PPA prices and market dynamics, investing in solar and wind would generate levelized net benefits two to three times greater than the benefits offered by Spruce 1—even in the absence of an SCR investment that would make the unit even less economic.
- **Replacing Spruce 1 with renewables would reduce emissions more comprehensively and cost-effectively than installing an SCR.** Even if renewable replacement could only happen several years after a potential SCR installation date, replacing Spruce 1 with solar and wind would lead to greater emission reductions over time, and it would do so at lower costs.

On the basis of these findings, Synapse offers the following recommendations:

- CPS should refrain from embarking on major capital investments at either Spruce unit until it has fully assessed their forward-going economic viability.
- CPS should conduct a rigorous alternatives analysis assessing the costs and benefits of retiring one or both of the Spruce units, using state-of-the-art electric system modeling.
- CPS should explore its options for entering into an increasing number of large-scale renewable PPA agreements as a mechanism for increasing its clean generation profile and possibly replacing the capacity of the Spruce units.
- If future analyses continue to indicate that the Spruce units are likely to remain uneconomic, CPS should proceed with developing retirement plans.



1. INTRODUCTION

This report provides an assessment of the recent and projected financial performance of the J.K. Spruce power plant. The Spruce plant is owned and operated by CPS Energy, a municipal utility company that provides electric and natural gas services to the Greater San Antonio area.¹ CPS is the largest municipal electric utility in Texas, and the second-largest in the United States.² The CPS electric generation fleet currently includes four coal-fired units, all of which are located beside Calaveras Lake, just outside of San Antonio in Bexar County, Texas.³ These units include J.T. Deely Units 1 and 2, and J.K. Spruce Units 1 and 2. CPS plans to retire the Deely units by the end of 2018.⁴ CPS is currently planning on retaining the Spruce units.

Spruce Unit 1 entered operation in 1992 and has a nameplate capacity of 566 megawatts (MW). Spruce Unit 2 became operational in 2010 and has a capacity of 878 MW.⁵ Both Spruce units were constructed with flue gas desulfurization (FGD) systems to limit emissions of sulfur dioxide (SO₂) and baghouses to control emissions of particulate matter.⁶ Spruce 2 was constructed with a selective catalytic reduction (SCR) system to limit emissions of oxides of nitrogen (NO_x). Spruce 1 uses a low-NO_x burner (LNB) to achieve some NO_x reductions, but nevertheless has an emissions rate about three times higher than Spruce 2.⁷ As part of an effort to further reduce emissions, CPS's most recent capital plan includes a proposal to invest in a new SCR system for Spruce 1.⁸ While the CPS budget does not provide a firm cost value, we estimate that a new SCR for Spruce 1 would have an overnight cost of approximately \$160 million. It would also result in substantially increased operational costs.

This report assesses the economics of the Spruce units and evaluates both whether it is prudent to initiate substantial new capital investments in these units, and whether it is prudent to continue to operate the units in any event. We begin by examining the recent performance of the Spruce plant relative to the Electric Reliability Council of Texas (ERCOT) market, within which Spruce operates. We then evaluate the likely future performance of the Spruce units relative to the market, both with and

¹ CPS Energy. February 15, 2017. CPS Energy Corporate Fact Sheet. Available at <https://cpsenergy.com/content/dam/corporate/en/Documents/Trustees/CPS%20Corporate%20Fact%20Sheet2%2015%2017.pdf>.

² U.S. Energy Information Administration (EIA). Form EIA-861 data for 2015. Available at <https://www.eia.gov/electricity/data/eia861/index.html>. Size of utility measured in total megawatt-hours of electricity sold.

³ CPS Energy. Coal. Available at: <https://cpsenergy.com/en/about-us/programs-services/energy-generation/coal.html>.

⁴ U.S. EIA. Form EIA-860 data for 2015. Available at <https://www.eia.gov/electricity/data/eia860/>.

⁵ *Id.*

⁶ U.S. Environmental Protection Agency (EPA). Air Markets Program Data. Available at: <https://ampd.epa.gov/ampd/>

⁷ *Id.*

⁸ CPS Energy. 2017. CPS Budget Plan FY 2018, p. 15. Available at <https://www.cpsenergy.com/content/dam/corporate/en/Documents/Finance/FY%202018%20Budget%20Plan%20-%20FINAL.pdf>.



without the installation of an SCR at Spruce 1. We next compare the likely future economic and environmental performance of the Spruce units to renewable resource options available to CPS. Finally, we conclude with recommendations for CPS moving forward. Our key findings include the following:

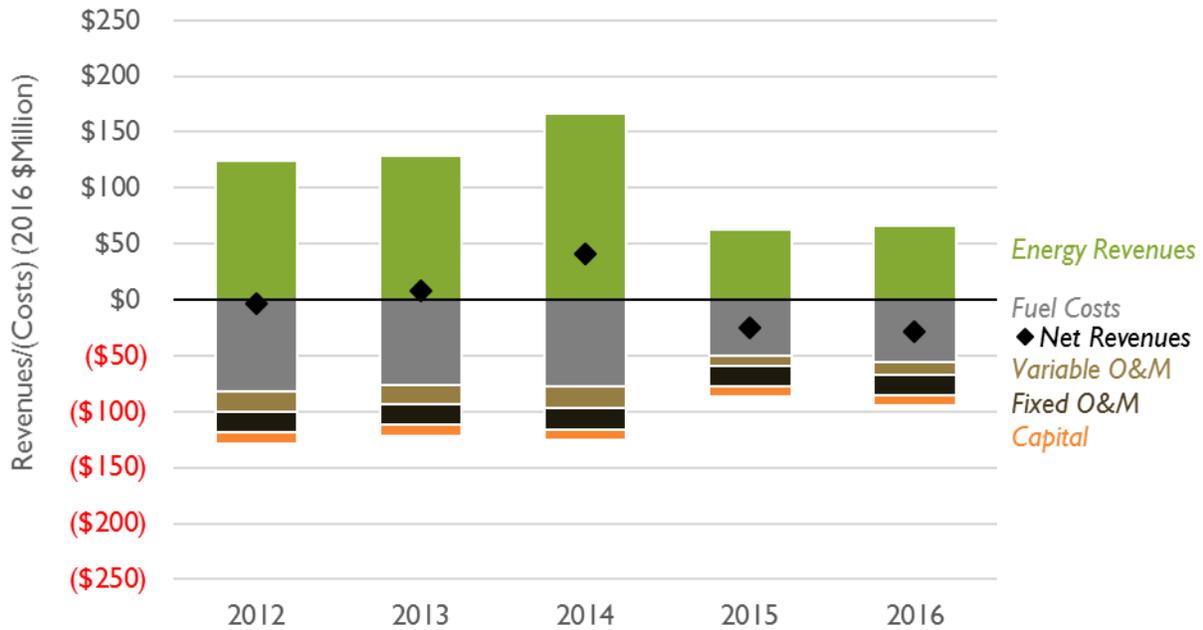
- Operating both Spruce units has cost more than obtaining market-based energy over the past five years;
- Both Spruce units are likely to continue to cost more than market-based energy for at least the next three years;
- The future economic viability of the Spruce units remains dubious, even in the absence of any major incremental investments in pollution controls;
- CPS would be unlikely to recover the costs of a new SCR at Spruce 1; and
- CPS has access to alternative resource options that would be more economically and environmentally beneficial than retrofitting and continuing to operate Spruce 1.

2. LACKLUSTER RECENT FINANCIAL PERFORMANCE

Our analysis indicates that both Spruce units have generally lost money over the past five years, and that they have become increasingly unprofitable during the past two years. Figure 1 shows Spruce 1's revenue and cost streams, along with its net revenues, for each full year from 2012 through 2016. Spruce 1 went from break-even in 2012 to profitable in 2014, but then proceeded to lose more than \$20 million in both 2015 and 2016.⁹ Over the five-year period, Spruce 1 lost a total of \$8 million.

⁹ It is possible that CPS did not actually experience the losses calculated here, possibly due to the presence of hedging mechanisms such as a bilateral contract that locks in the price paid for Spruce's generation. Nonetheless, the performance of Spruce relative to the market as shown here provides the clearest indication of the economic viability of the Spruce plant over the longer term.

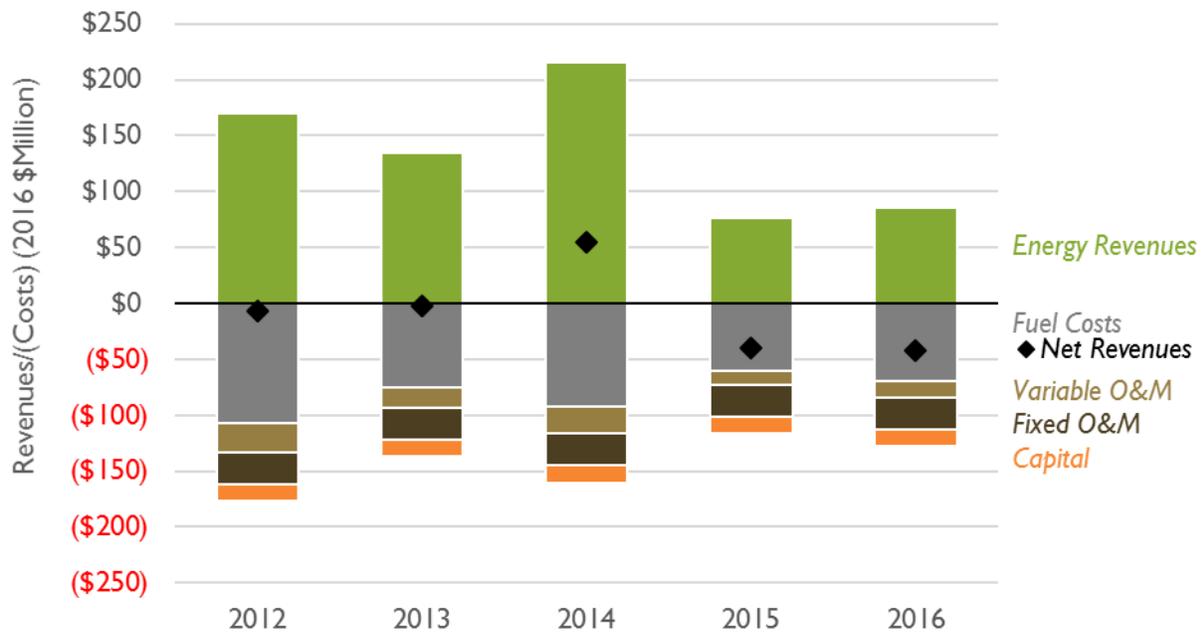
Figure 1. Spruce Unit 1 historical revenues and costs



Source: Synapse calculations.

In recent years, Spruce 2 has fared similarly to Spruce 1, as shown in Figure 2. Spruce 2 likely lost about \$36 million between 2012 and 2016, and more than \$80 million over the past two years alone.

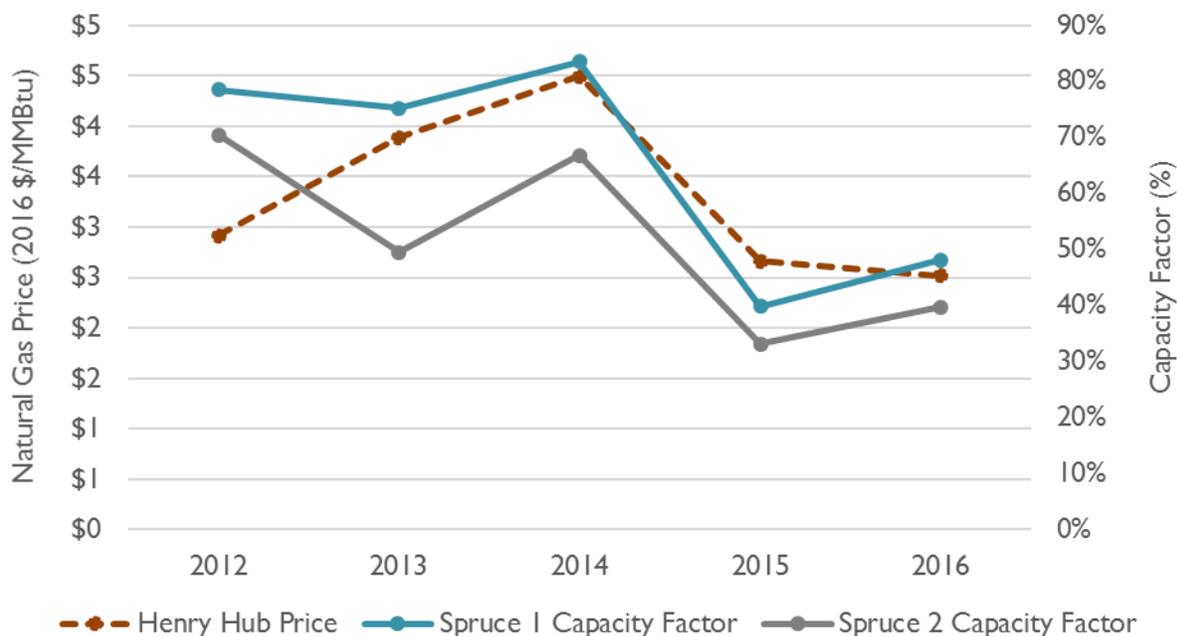
Figure 2. Spruce Unit 2 historical revenues and costs



Source: Synapse calculations.

The recent changes in the profitability of the Spruce units have largely been a result of gas price trends. Figure 3 shows the historical relationship between Henry Hub natural gas prices and the capacity factors of the Spruce units. As the price of natural gas declined sharply from 2014 to 2015, Spruce capacity factors dropped to less than 50 percent. At the same time, lower gas prices have led to lower energy prices in the hours in which Spruce has continued to run, thereby reducing revenues during the hours in which Spruce operates economically.

Figure 3. Historical relationship between delivered natural gas price and Spruce capacity factors



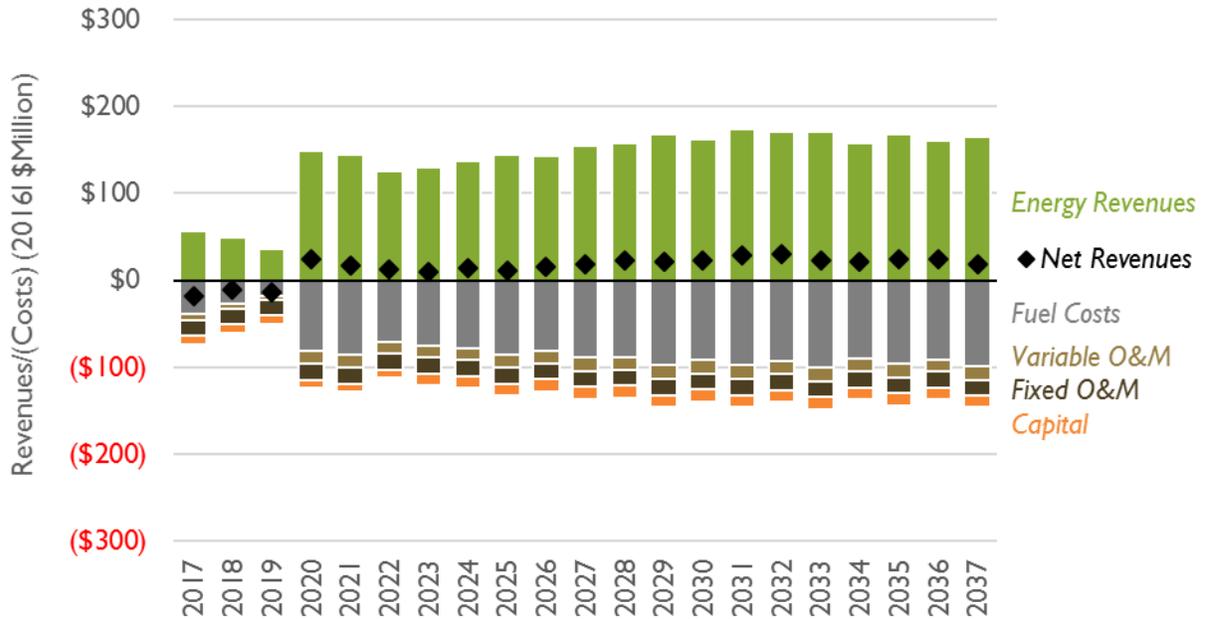
Sources: Form EIA-923, Synapse calculations.

3. DIM PROSPECTS FOR FUTURE PERFORMANCE

3.1. At Best, Spruce Will Be Marginally Economic Going Forward

Using natural gas price assumptions from EIA’s Annual Energy Outlook (AEO) 2017 Reference Case, and assuming no major environmental costs (including SCR technology), the Spruce plant is slightly profitable relative to the market over the long term. Figure 4 shows that under these assumptions, Spruce 1 is likely to shift between being slightly unfavorable to slightly favorable relative to the market starting in the 2020s. From 2017 to 2037, we project that Spruce 1 will provide net present value (NPV) net revenues of about \$237 million.

Figure 4. Spruce Unit 1 projected revenues and costs under AEO gas price assumptions, 2017-2037

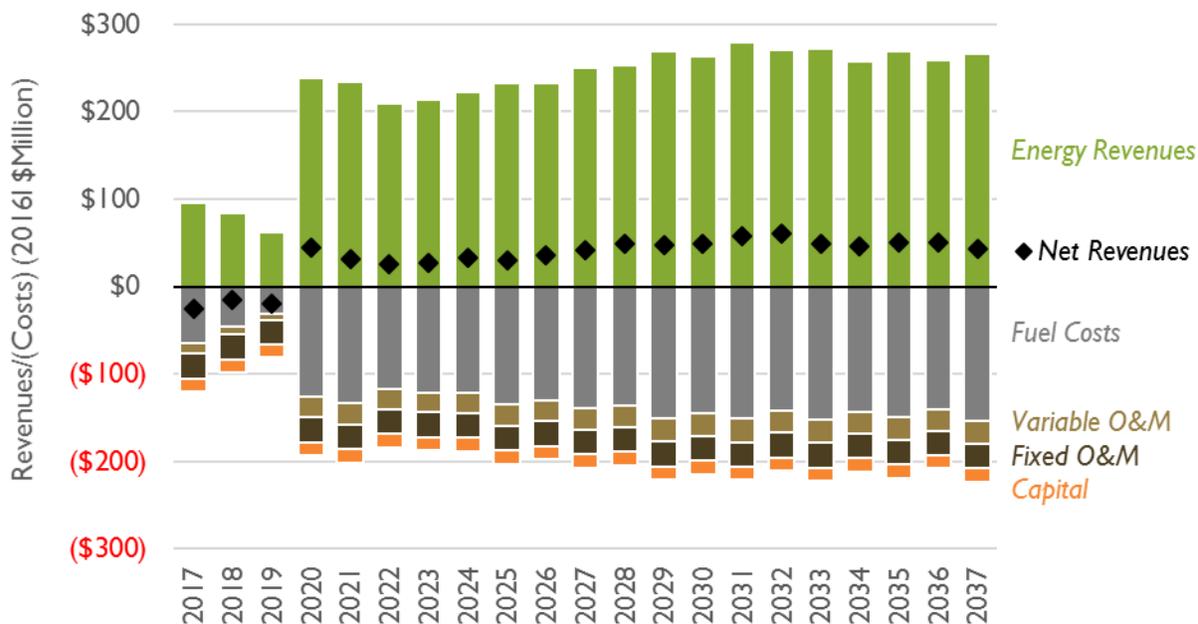


Source: Synapse calculations.

Spruce 2 is likely to be in a slightly better position than Spruce 1 over the long term, largely due to its lower heat rate. However, Spruce 2 will still likely lose more than \$60 million over the next three years, and remain near the border of economic viability over the next two decades, as indicated by Figure 5. Over the full 2017–2037 period, Spruce 2 is projected to generate NPV net revenues of \$543 million.



Figure 5. Spruce Unit 2 projected revenues and costs under AEO gas price assumptions, 2017-2037



Source: Synapse calculations.

These results are based on a set of assumptions that are generally quite favorable to the Spruce units—perhaps an improbably favorable series of assumptions. Some of the more important assumptions include:

- **Rapid recovery of natural gas prices.** AEO 2017 assumes a Henry Hub price increase of 80 percent between 2016 and 2020. This increase in turn drives up energy prices, leading to greatly increased energy revenues starting in 2020.
- **Slow growth of coal prices.** In contrast with the rapid growth of natural gas prices, coal prices increase at less than 1 percent per year under the AEO projection we used. The result is a growing spread between coal and gas prices. Without the re-establishment of this spread, neither Spruce unit would become economically viable.
- **Optimal dispatch.** We assume that the Spruce units operate at full capacity in all hours in which it is profitable to do so, and that they do not run at all during unprofitable hours. In practice, coal plants are not capable of ramping up quickly enough to operate at full capacity in select hours and turn off the very next hour. Instead, coal units end up facing the choice between operating at a loss in some hours or failing to fully take advantage of times of higher energy prices. In addition, all coal plants are out of commission for certain stretches of the year, due to both planned maintenance and

unplanned failures. EIA data shows that Spruce 2 was offline for at least two consecutive full months in each of the past two years.¹⁰

- **No new environmental costs.** Under this scenario, we do not assume any incremental costs associated with complying with proposed or potential future environmental regulations. Over the next 20 years, there is a strong chance that the Spruce units will face new costs associated with regulations addressing coal combustion residuals, effluent limitations, carbon dioxide (CO₂), and criteria air pollutants. Any such regulations would put Spruce at a disadvantage relative to competing natural gas and renewable generation in the ERCOT market.
- **Minimal price suppression by renewables.** We assume that natural gas prices will continue to determine energy market clearing prices. However, as renewables with minimal operational costs continue their rapid growth within the ERCOT system, they may set the market price in an increasing number of hours. This could weaken the link between higher gas prices and higher energy prices and, importantly, increase the number of hours for which the Spruce units cannot operate profitably.

3.2. Spruce's Future Viability Depends Largely on What Happens in the 2020s

Under our base assumptions, both Spruce units continue to lose money over the next three years. Only under the AEO assumption that gas prices will rise rapidly between now and 2020—increasing by more than 50 percent from today to reach prices not seen since before 2010—do the Spruce units return to profitability. Such a price spike is not consistent with current market expectations. In fact, recent settlement prices in the NYMEX futures market indicate that market participants expect natural gas prices to decline between now and 2020.¹¹

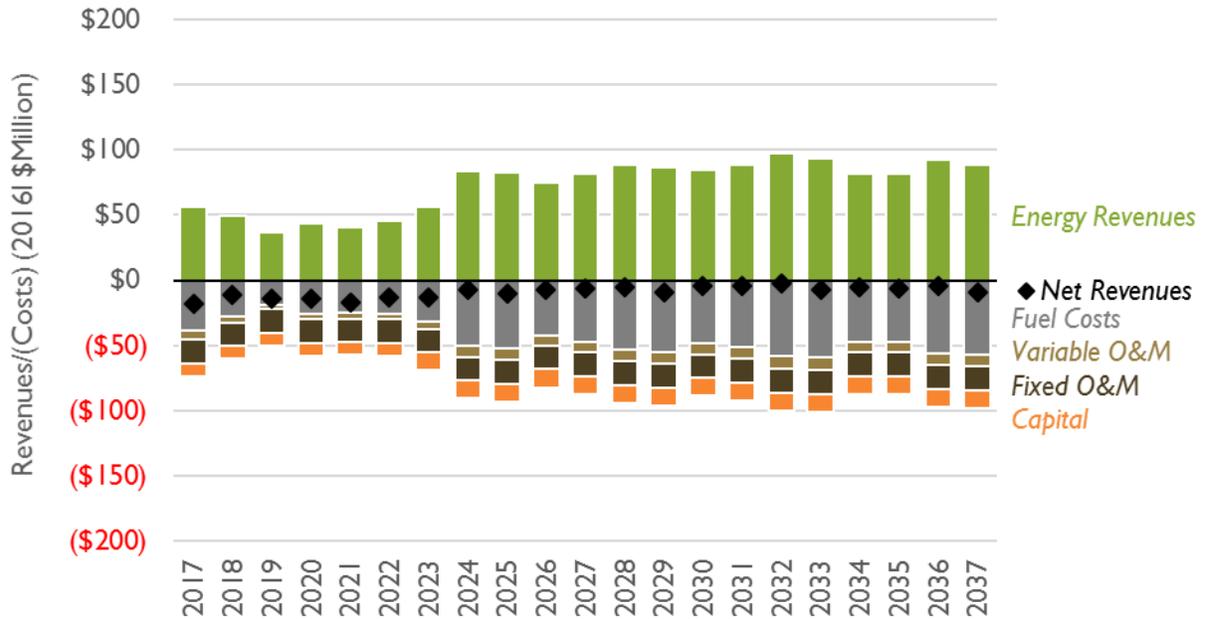
3.3. If Gas Prices Do Not Recover, Spruce Will Remain Uneconomic Indefinitely

Since the economic performance of Spruce is strongly tied to natural gas prices, we examined a scenario in which future gas prices follow an alternative forecast recently published by PacifiCorp, a large Western utility company. According to this projection, which is much more consistent with the NYMEX futures market than the AEO forecast, gas prices will not increase substantially until 2023, and they will ultimately plateau below \$4/MMBtu. Under this altered assumption, Spruce 1 does not earn positive net revenues in a single year between now and 2037, and Spruce 2 does not earn more than \$7 million in any year (see Figure 6 and Figure 7). While the annual losses of each unit decline over time, and are never greater than \$30 million per year after 2021, they remain persistent under this scenario. Overall, they add up to NPV losses of \$163 million for Spruce 1 and \$121 million for Spruce 2.

¹⁰ Form EIA-923.

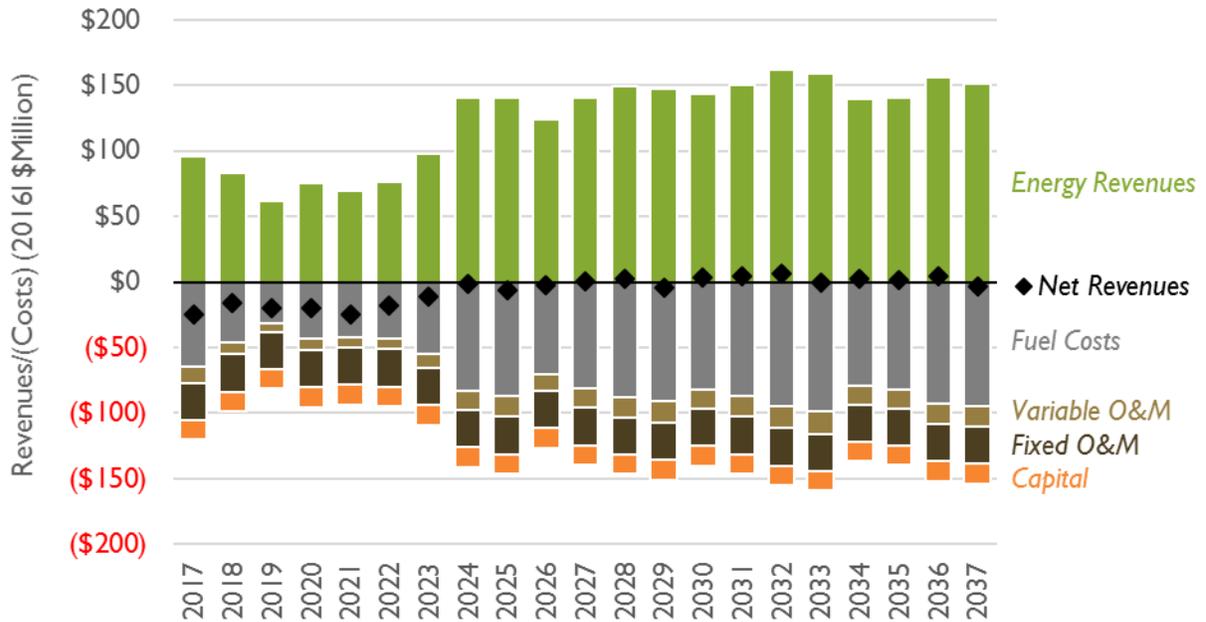
¹¹ NYMEX. Henry Hub Natural Gas Futures Settlements. Accessed July 24, 2017. Available at http://www.cmegroup.com/trading/energy/natural-gas/natural-gas_quotes_settlements_futures.html.

Figure 6. Spruce Unit 1 projected revenues and costs under PacifiCorp gas price assumptions, 2017–2037



Source: Synapse calculations.

Figure 7. Spruce Unit 2 projected revenues and costs under PacifiCorp gas price assumptions, 2017–2037

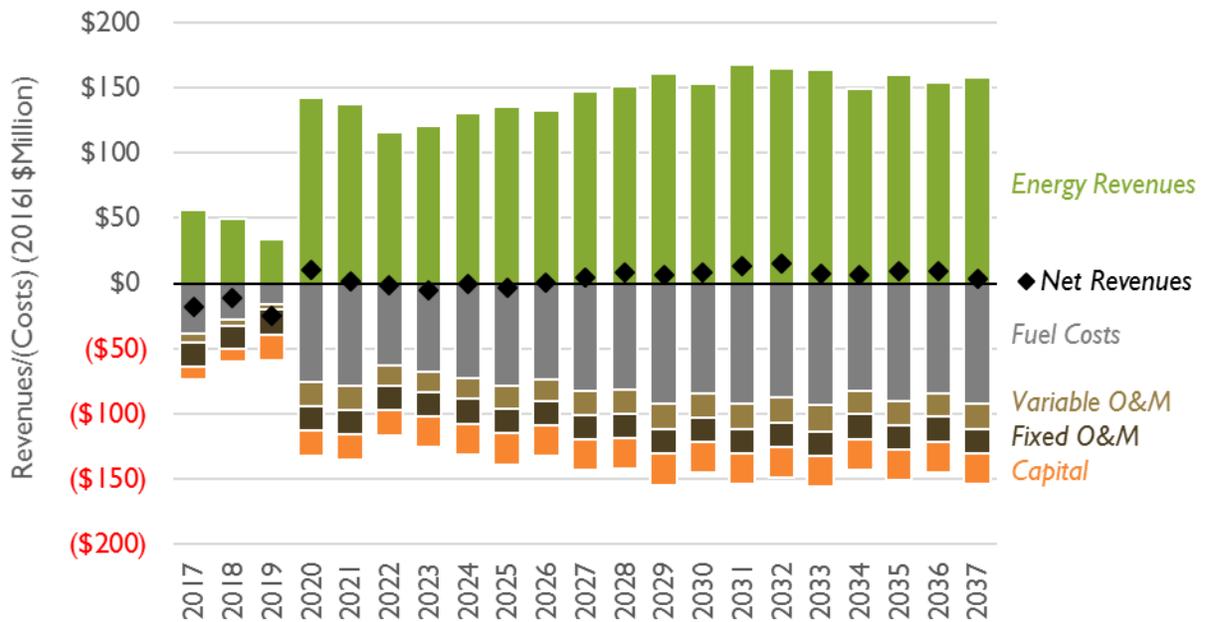


Source: Synapse calculations.

3.4. Spruce 1 May Never Recover the Costs of an SCR

Even under favorable AEO 2017 gas price assumptions, the incremental costs associated with a new SCR system are sufficient to turn Spruce 1 into an economic wash. Figure 8 shows the projected annual revenues and costs faced by Spruce 1, assuming that CPS installs an SCR in 2019. The SCR carrying costs largely offset the impact of increased gas prices in the 2020s. Under this scenario, Spruce 1 earns NPV net revenues of only \$18 million over the next two decades, well within the margin of error for this analysis.

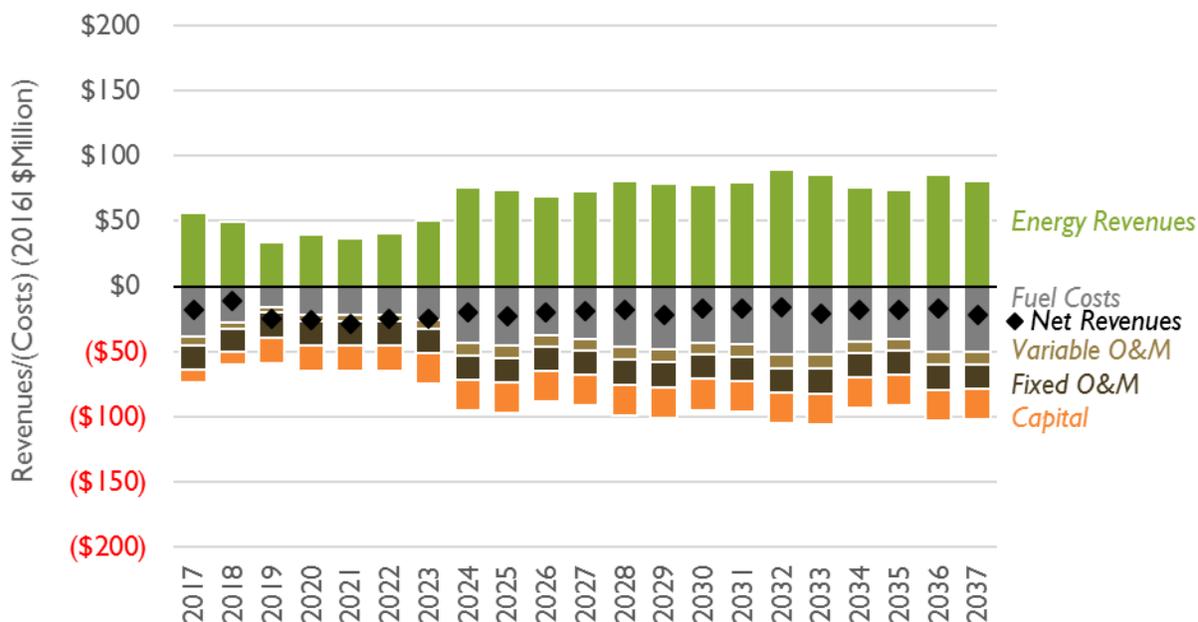
Figure 8. Spruce Unit 1 projected revenues and costs with SCR, AEO gas prices, 2017–2037



Source: Synapse calculations.

If natural gas prices were to not recover to the extent projected by AEO, Spruce 1 would never recover the costs of an SCR. Instead, Spruce 1 would incur NPV net losses of approximately \$350 million between 2017 and 2037 (see Figure 9).

Figure 9. Spruce Unit 1 projected revenues and costs with SCR, PacifiCorp gas prices, 2017–2037



Source: Synapse calculations.

If CPS is unable to recover the costs of an SCR through market revenues, CPS ratepayers and/or San Antonio taxpayers would end up footing the bill. We used projections of CPS sales and average customer consumption based on EIA data to estimate the likely rate and bill impacts of installing an SCR and continuing to operate Spruce 1, rather than retiring Spruce 1 and replacing it with market energy purchases (in the event that ratepayers bear the burden of the losses).¹² Under natural gas prices projected by PacifiCorp, we calculate that retrofitting and maintaining Spruce 1 would ultimately increase average rates by approximately \$0.82/MWh, resulting in average annual residential bill increases of about \$11 per customer.¹³ These bill impacts would be strongest in the years immediately following the installation of the SCR. From 2021 to 2025, we estimate average rate impacts of \$1.02/MWh, and average annual residential bill impacts of \$14 per customer. If CPS were to not increase rates to cover Spruce 1’s losses, San Antonio taxpayers would end up paying for the losses

¹² U.S. EIA. Form EIA-861 data for 2015.

¹³ These calculations assume that rate impacts are evenly spread out across all customer classes.

through some combination of tax increases and reduced government services. These losses would amount to an annual average of \$21 million between 2019 and 2037.

4. SPRUCE REPLACEMENT OPTIONS

If CPS were to retire one or both Spruce units, it would not be bound to replace those units with its own generating capacity. One of the benefits of participating in a market such as ERCOT is the option of replacing uneconomic internal resources with external market purchases, and thereby reducing ratepayer bills. Nonetheless, CPS may wish to replace retiring resources with its own capacity for a variety of reasons, ranging from concerns about market volatility to the desire to promote and invest in certain types of generating resources. Fortunately, CPS operates in a region in which economically and environmentally appealing alternatives to uneconomic coal units are plentiful.

4.1. CPS Has Access to Cost-Effective Clean Energy Alternatives

CPS has the benefit of being in a state where renewable resources are very cost-effective. The U.S. Department of Energy's (DOE) latest wind technologies report estimates that the average price of wind power purchase agreements (PPAs) in the Interior region, of which Texas is a part, has dropped 60 percent in eight years to reach \$20/MWh.¹⁴ This is lower than average ERCOT energy prices. As a state, Texas has responded to the low cost and high availability of wind resources by rapidly building new wind farms. More than 3,600 MW of wind capacity was installed in Texas in 2015.¹⁵

Solar power is also cheap and abundant near CPS's service territory. DOE recently reported that in 2015, two large Texas solar PPAs were signed for less than \$35/MWh.¹⁶ The recent experience of Austin Energy indicates that these low prices are available at large scale to central Texas municipal utilities such as CPS. In 2015, Austin Energy received more than 1,200 MW of solar PPA bids priced below \$40/MWh.¹⁷

CPS has itself made significant strides toward developing cost-effective renewable resources in Texas. By 2014, CPS had already contracted for over 1,000 MW of wind capacity.¹⁸ Over the past two years, CPS

¹⁴ U.S. Department of Energy (DOE). August 2016. 2015 Wind Technologies Report, pp. 62-63. Available at: https://emp.lbl.gov/sites/default/files/2015-windtechreport.final_.pdf

¹⁵ *Id.* p. 7.

¹⁶ U.S. DOE. August 2016. Utility-Scale Solar 2015. Available at: https://emp.lbl.gov/sites/all/files/lbnl-1006037_report.pdf.

¹⁷ Lacey, S. 2015. "Cheapest Solar Ever: Austin Energy Gets 1.2 Gigawatts of Solar Bids for Less Than 4 Cents." *Greentech Media*. June 30. Available at: <https://www.greentechmedia.com/articles/read/cheapest-solar-ever-austin-energy-gets-1.2-gigawatts-of-solar-bids-for-less>.

¹⁸ CPS Energy. Fiscal Year Ending 2016 & 2017 Budget Report, p. 6.



has worked with OCI Solar to bring online more than 300 MW of new solar capacity.¹⁹ However, CPS's progress toward increasing the share of its renewable generation remains less ambitious than that of some of its peers. According to San Antonio's sustainability plan, 12 percent of CPS's generation capacity came from renewables in 2014, and CPS has set a renewable target of 40 percent of total capacity by 2040.²⁰ In contrast, Austin Energy used renewable energy to meet 23 percent of its load in 2015, more than double its 2011 renewable share, and it is well on its way toward meeting a goal of 55 percent renewable energy by 2025.²¹

4.2. Replacing Spruce 1 with Renewables Would Likely Save Money

Synapse used publicly available data to estimate the economic impact of retiring Spruce 1 and replacing it with PPAs for renewable resources. For the purposes of this analysis, we assumed PPA costs consistent with the above-referenced recent DOE reports (that is, \$20/MWh for wind and \$35/MWh for solar). We then applied historical utility-scale Texas solar and wind hourly generation profiles used by ERCOT for planning purposes to project the hourly revenues earned by each renewable resource.²² While CPS would not directly earn these revenues, it would experience them as costs avoided due to a reduced need to procure energy to serve its load.

Our analysis indicates that, if current relationships between natural gas prices and energy prices continue to hold, local solar and wind are both substantially more cost-effective resources than either Spruce unit. Figure 10 compares the projected levelized benefits and costs, relative to the market, of Spruce 1 (with and without an SCR), Spruce 2, and utility-scale solar and wind contracts. While Spruce 1 and Spruce 2 provide marginal net benefits relative to the market under base assumptions, the solar and wind PPAs are economically superior to either Spruce unit. We estimate that investing in a solar PPA today would provide net benefits of more than \$12/MWh, and a wind PPA would provide net benefits of \$15/MWh. These values are two to three times greater than the net benefits offered by either Spruce unit, even under favorable gas price assumptions and no new SCR investment.

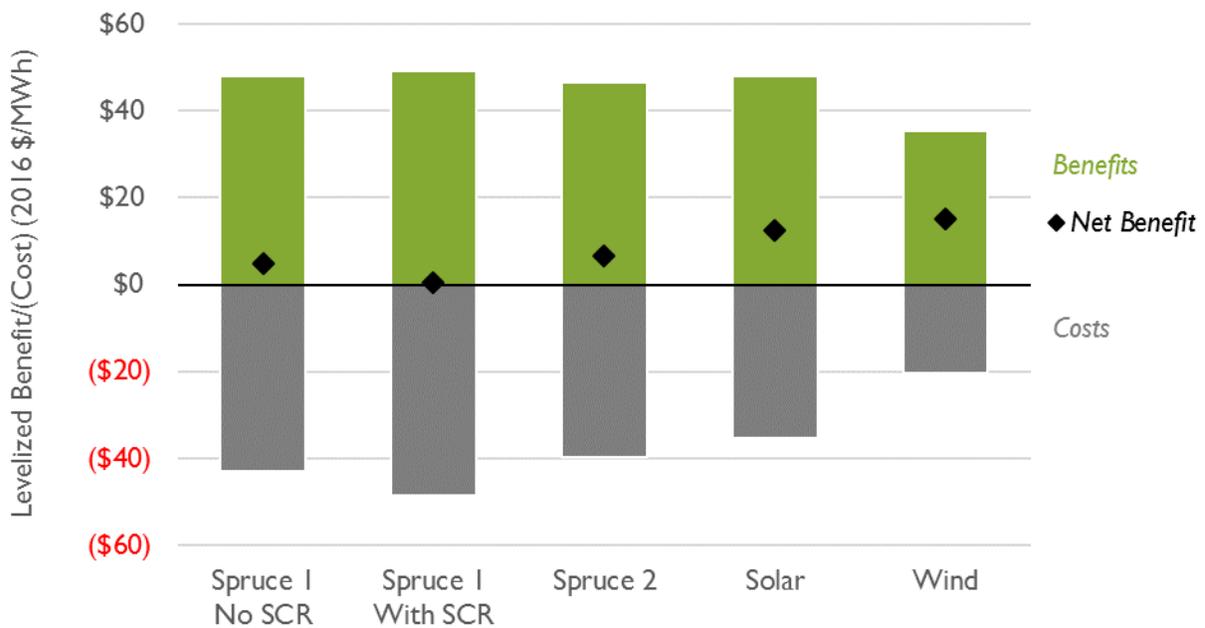
¹⁹ CPS Energy. Basic Financial Statements for the Fiscal Years Ended January 31, 2017 and 2016, p. 88.

²⁰ San Antonio Sustainability Plan. 2016. Available at:
<http://www.sasustainabilityplan.com/files/managed/Document/160/SA%20Tomorrow%20Sustainability%20Plan%20Adopted%2008%2011%202016%20S.pdf>

²¹ Austin Energy. Annual Performance Report: Year Ended September 2015. Available at:
<http://austinenenergy.com/wps/wcm/connect/6157fa61-3612-4443-8985-34f1d98b9eb3/2015AnnualPerformanceReport.pdf?MOD=AJPERES>.

²² ERCOT. "Resource Adequacy: Wind and Solar Profiles for Use in ERCOT Planning Studies." Available at:
<http://www.ercot.com/gridinfo/resource/>. For solar, we used the profile of the Roserock plant because it was built recently, it is relatively large (160 MW), and its output is contracted through a PPA to a nearby municipal utility (Austin Energy). For wind, we used the default "Site 1" profile provided.

Figure 10. Levelized benefits and costs of alternative resources, AEO gas price assumptions, 2017–2037



Source: Synapse calculations.

This assessment may well overstate the benefit offered by renewables relative to the market, for some of the same reasons that the base assumptions are favorable to the Spruce units. Most significantly, as renewable development continues, prices during the hours when renewable resources are most productive will likely decline, decreasing the value of incremental renewables. Nonetheless, there are reasons to believe that renewables will continue to be cost-effective in ERCOT. One key source of optimism for future renewable PPAs is that solar and wind costs are likely to continue to decline. The most recent annual levelized cost of energy (LCOE) report published by Lazard demonstrates that renewable costs have dropped precipitously over the past seven years—by 66 percent for wind and 77 percent for solar.²³ While these declines have recently begun to slow, renewables nevertheless continue to get cheaper with each passing year.

In Texas, solar offers the additional advantage of having its generation coincide with peak system load times. ERCOT’s planning documents assume a solar capacity credit of 77 percent, indicating that during peak hours ERCOT expects solar resources to be generating at levels more than two times higher than their average capacity factors.²⁴ This generation profile protects Texas solar resources against significant price decreases, makes solar PPAs a useful hedge against high market spikes and fuel prices, and provides a substantial capacity benefit.

²³ Lazard. December 2016. “Lazard’s Levelized Cost of Energy Analysis – Version 10.0.”

²⁴ ERCOT. December 2016. Report on the Capacity, Demand and Reserves (CDR) in the ERCOT Region, 2017-2026, p. 20.

4.3. Replacing Spruce 1 with Renewables Would Reduce Emissions

In addition to providing economic benefits, replacing Spruce 1 with renewable resources would result in considerable reductions of harmful emissions in the Greater San Antonio area. Table 1 lists the 2016 average emission rates of SO₂, NO_x, and CO₂ for each Spruce unit. Assuming that these units continue to emit at current levels until the installation of SCR at Spruce 1, replacing Spruce 1 with renewables would substantially reduce emissions.

Table 1. Emission rates of Spruce Unit 1 and Spruce Unit 2, 2016

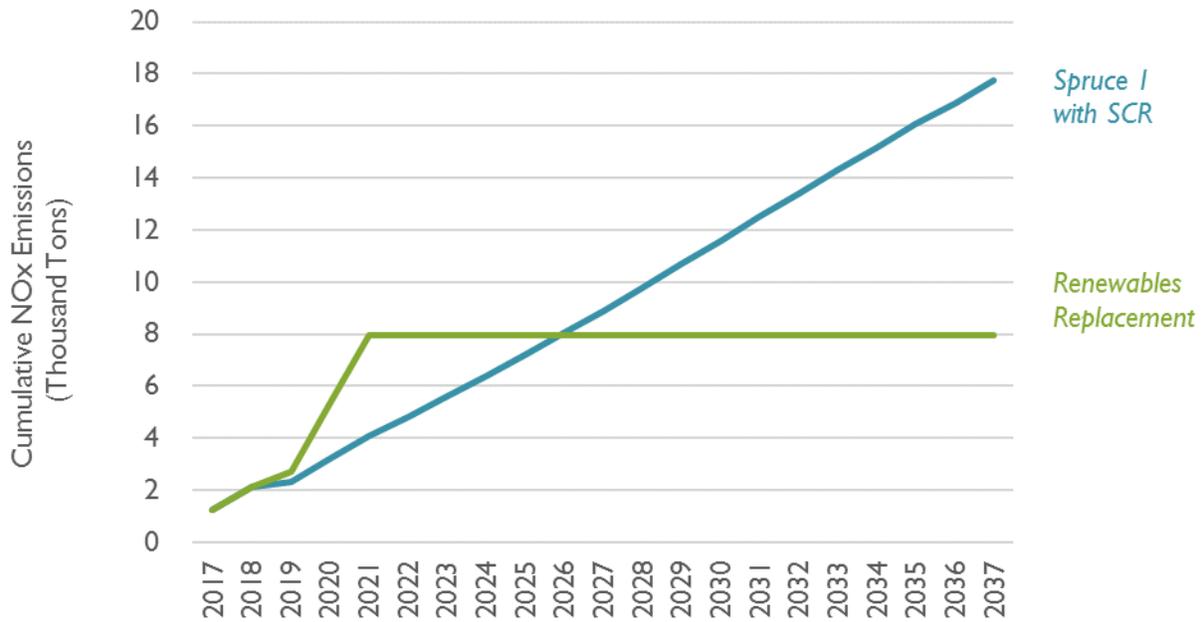
	SO₂ (lbs/MWh)	NO_x (lbs/MWh)	CO₂ (tons/MWh)
Spruce 1	0.37	1.62 (0.52 after SCR ²⁵)	1.11
Spruce 2	0.09	0.49	1.01

Source: EPA Air Markets Program Database.

Even if we were to assume a three-year delay between the earliest possible SCR installation date and the earliest feasible retirement date for Spruce 1, replacing Spruce 1 with renewables would take only seven years to produce sufficient NO_x emissions reductions to make up for the three years of increased emissions relative to an SCR retrofit scenario. Thereafter, renewable replacement would generate ever-increasing cumulative emissions reductions, reaching aggregate avoided NO_x emissions of more than 9,800 tons by 2037 (see Figure 11).

²⁵ Estimated based on heat rate of Spruce 1 and emissions rate of Spruce 2.

Figure 11. Cumulative Spruce Unit 1 NO_x emissions under 2019 SCR retrofit vs. 2022 renewable replacement



Source: EPA Air Markets Program Database.

In addition to reducing NO_x emissions, replacing Spruce 1 with renewable resources would have considerable impacts on emissions of SO₂ and CO₂. We estimate that renewable replacement of Spruce 1 would result in average annual emission reductions of 3.5 million tons of CO₂ and 594 tons of SO₂.

5. CONCLUSIONS

Synapse concludes that the Spruce units are currently not economic resources, and even under a best-case scenario would be only barely economic relative to the ERCOT market. We have further determined that CPS likely has access to clean energy resources that would serve as much more cost-effective and impactful methods of reducing emissions than investing in an SCR at Spruce 1. Given these conclusions, we offer the following recommendations:

- CPS should refrain from embarking on major capital investments at either Spruce unit until it has fully assessed their forward-going economic viability. For a vertically integrated utility, such assessments are typically conducted by testing the costs of continued operation against the next least cost portfolio of supply and demand-side options.

- CPS should conduct a rigorous alternatives analysis assessing the costs and benefits of retiring one or both of the Spruce units, using state-of-the-art electric system modeling and following best practices for integrated resource planning.
- CPS should explore its options for entering into large-scale renewable PPA agreements as a mechanism for increasing its clean generation profile and possibly replacing the capacity of the Spruce units.
- If future analyses indicate that the Spruce units are likely to remain uneconomic, CPS should proceed with developing retirement plans. Such plans would lessen the avoidable burden on ratepayers who are effectively subsidizing an uneconomic plant, and they would minimize any harmful impacts on employees and communities who may be affected by retirement.



APPENDIX A: METHODOLOGY AND ASSUMPTIONS

1. Historical Analysis Methods and Assumptions

We used publicly available data to evaluate the Spruce units as merchant-equivalent generation, testing whether the units earn enough energy market revenues to offset fuel, operation and maintenance (O&M), and ongoing capital costs. While CPS is not in fact a merchant generator, it would best serve its ratepayers by treating its generating units as entirely divorced from its load-serving operations. If CPS can obtain energy from the ERCOT market more cheaply than it can provide energy through the continued operation of a given unit, then that unit should be shuttered. If CPS acts otherwise, it spurns the benefits of the ERCOT market and incurs unnecessary expenses that are ultimately paid by the residents and businesses of San Antonio.

As part of our retrospective analysis of the performance of the Spruce units, we estimated each unit's hourly energy revenues using generation data reported by CPS to EPA's Air Markets Program Database²⁶ and day-ahead energy market settlement prices for the CPS load zone.²⁷ We calculated monthly fuel costs using EIA data on unit-specific fuel consumption and plant-specific delivered fuel prices.²⁸

CPS does not publish unit-specific variable O&M, fixed O&M, or ongoing capital cost data. We therefore estimated those costs using generic assumptions from EIA's Annual Energy Outlook (AEO).²⁹ We compared EIA's ongoing capital cost assumptions against cost projections from CPS's 2018 capital budget to verify that our assumptions were reasonable. According to the cost ranges provided in the latest CPS budget, CPS is planning on capital expenditures between \$11 million and \$35 million at Spruce 2, and between \$3 million and \$33 million at Spruce 1 in 2018 (excluding the anticipated cost of the

²⁶ U.S. EPA. Air Markets Program Data. <https://ampd.epa.gov/ampd/>. Since EPA reports gross generation, (that is, total generation produced by the generator, as opposed to net generation provided to the grid, which excludes internal plant electric consumption), we used net generation as reported by U.S. EIA to calculate monthly net-to-gross factors for each unit. We then multiplied each unit's hourly gross generation by the relevant net-to-gross factor to determine hourly net generation for which CPS gets compensated through the ERCOT market. See Form EIA-923. Available at <https://www.eia.gov/electricity/data/eia923/>.

²⁷ ERCOT. Historical DAM Load Zone and Hub Prices. Available at <http://mis.ercot.com/misapp/GetReports.do?reportTypeId=13060&reportTitle=Historical%20DAM%20Load%20Zone%20and%20Hub%20Prices&showHTMLView=&mimicKey>.

²⁸ U.S. EIA. Form EIA-923. Since delivered coal prices were not available for Spruce, we used delivered coal prices for the Deely plant. As described above, the Deely and Spruce plants are co-located. In addition, EIA data indicates that the Deely and Spruce plants both burn sub-bituminous coal that is imported from Wyoming. This evidence all suggests that the Deely and Spruce plants share a coal source and a delivered coal price.

²⁹ U.S. EIA. January 2017. Assumptions to the Annual Energy Outlook 2016, p. 114 (ongoing capital costs of coal plants). Available at <https://www.eia.gov/outlooks/aeo/assumptions/pdf/0554%282016%29.pdf>; U.S. EIA. September 2015. Assumptions to the Annual Energy Outlook 2015, p. 105 (O&M costs of scrubbed coal plants). Available at <https://www.eia.gov/outlooks/aeo/assumptions/pdf/0554%282015%29.pdf>. AEO 2105 was the last version of AEO that provided O&M cost assumptions for coal plants that do not include carbon capture and sequestration technology.

SCR).³⁰ Our 2018 ongoing capital expenditure estimates of \$10 million at Spruce 1 and \$18 million at Spruce 2 fall roughly in the middle of these ranges.

There are other potential sources of revenues and costs that we do not capture, but we would expect those cash flows to be negligible in the context of the Spruce units. For example, ERCOT runs an hourly market for ancillary services, through which power plants can earn incremental revenue.³¹ However, most coal plants are unable or unwilling to depend heavily on the ancillary market, and past ERCOT market reports have assumed that coal plants do not earn any net ancillary revenues.³² In addition, the Spruce units likely bear some cost, or at least an opportunity cost, associated with procuring emission permits through SO₂ and NO_x markets. However, the low clearing prices of recent emission permit auctions indicate that any such costs would be too small to have a noticeable impact on Spruce's economic status.³³

2. Forward-Going Modeling Assumptions

Synapse used a custom-built, cash-flow model to evaluate the likely economic performance of the Spruce units relative to the market from 2017 through 2037. This model ignored all previously incurred capital expenses as irrelevant to the determination of whether to retire or continue to operate each unit. While utilities occasionally raise concerns that coal plant retirements may result in “stranded” capital costs that have not yet been recovered through rates, such concerns are grounded in a flawed line of reasoning that economists often call the “sunk cost fallacy.” All previous capital costs, whether “stranded” or not, must be paid off, regardless of current and future decisions about generation resources. There is no resource planning decision that CPS can make that would change its debt payments for prior capital costs. The best CPS can do for its customers is to maximize its forward-going net revenues, without respect to prior costs or revenues.

Synapse's forward-going cash-flow model necessarily relied on several input assumptions, as described below.

Coal Prices and Fuel Costs

JK Spruce was built to burn Powder River Basin (PRB) coal.³⁴ Synapse relied upon EIA's AEO 2017 projection of PRB minemouth coal prices to forecast annual average delivered coal prices at the Spruce

³⁰ CPS Energy. 2017. CPS Budget Plan FY 2018, pp. 15-17.

³¹ ERCOT. Zonal Energy and Ancillary Services Archives. Available at: <http://www.ercot.com/mktinfo/services/>.

³² ERCOT. 2014 State of Market Report, p. 88. Available at http://www.puc.texas.gov/industry/electric/reports/ERCOT_annual_reports/2014annualreport.pdf.

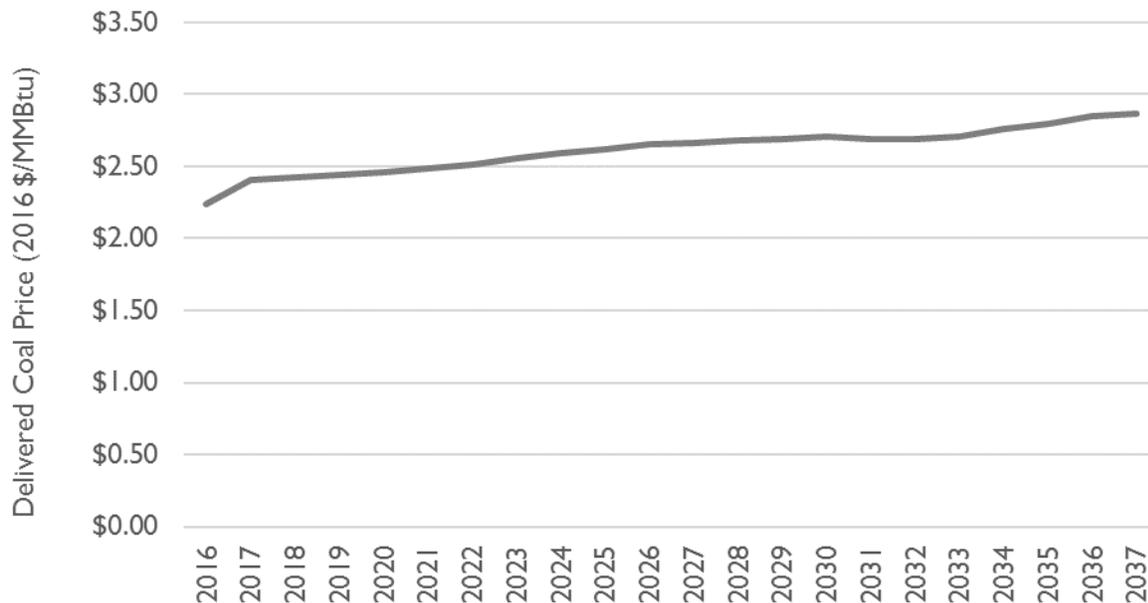
³³ EPA. SO₂ Allowance Auctions. Available at: <https://www.epa.gov/airmarkets/so2-allowance-auctions#tab-2>.

³⁴ Burns McDonnell. JK Spruce Unit 2. Available at: <http://www.burnsmcd.com/projects/jk-spruce-unit-2>.



plant.³⁵ We assumed that Spruce delivered coal prices would increase at the same rate as the minemouth prices.³⁶ Figure 12 shows the resulting delivered coal price projection. Under this projection, coal prices increase at an average annual rate of 0.87 percent from 2017 through 2037.

Figure 12. Spruce delivered coal price forecast (2016 \$/MMBtu)



Sources: Form EIA-923, AEO 2017.

To arrive at dollar per megawatt-hour (\$/MWh) fuel costs, we multiplied the projected coal price by projected heat rates for each Spruce unit. We assumed that Spruce 1 and Spruce 2 would each maintain their 2016 net heat rate levels of 10.4 and 9.8 MMBtu/MWh, respectively.

Natural Gas Prices

Synapse’s analysis relies on multiple forecasts of monthly average Henry Hub natural gas prices. For each month between now and the end of 2019, we use current Henry Hub settlement prices in the NYMEX futures market.³⁷ Since NYMEX Henry Hub trading volumes for months beyond 2019 are currently relatively thin, we rely on other forecasts for months from January 2020 onward. In our base

³⁵ EIA. AEO 2017. Table 71. Coal Minemouth Prices by Region and Type. Available at: https://www.eia.gov/outlooks/aeo/supplement/excel/suptab_71.xlsx.

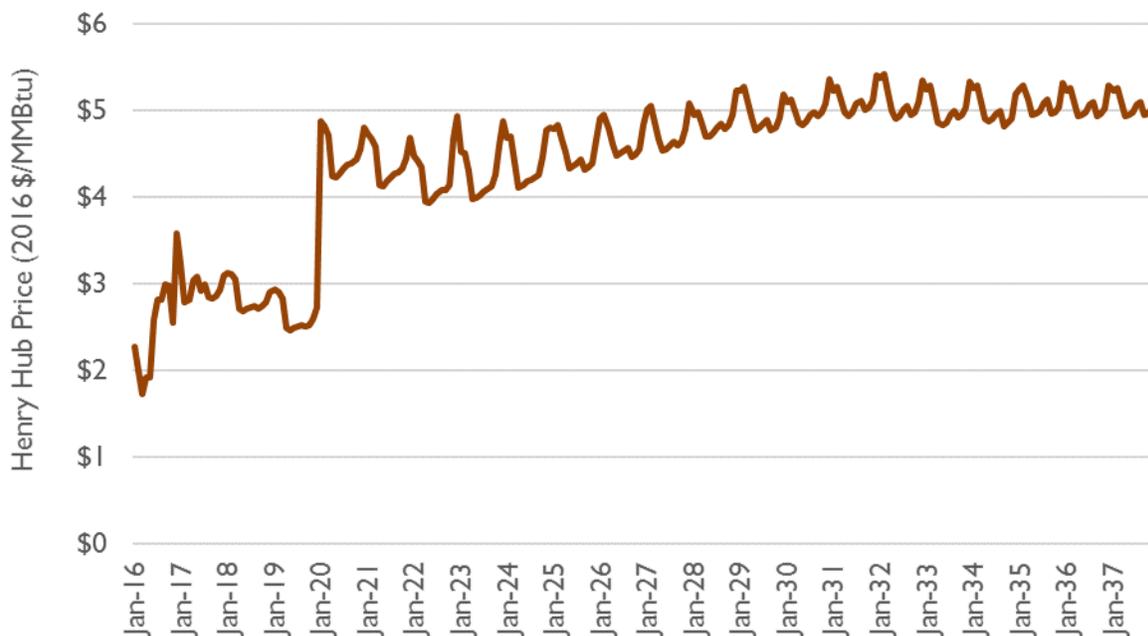
³⁶ Note that this implicitly assumes that coal transportation costs will increase at the same rate as the price of the coal commodity, a reasonable assumption given the modest, steady coal price growth projected by AEO.

³⁷ NYMEX. Henry Hub Natural Gas Futures Settlements. Accessed July 24, 2017. Available at http://www.cmegroup.com/trading/energy/natural-gas/natural-gas_quotes_settlements_futures.html



projection, we use the AEO 2017 annual average Henry Hub forecast, as adjusted to account for monthly fluctuations, to project gas prices from 2020 through 2037.³⁸

Figure 13. Henry Hub natural gas price base forecast



Sources: EIA, NYMEX.

Figure 13 shows our base Henry Hub forecast. The most notable element of this forecast is the jump in projected price at the start of 2020, when we transition from reliance on NYMEX futures to the AEO 2017 reference case long-term projection. The NYMEX market indicates that Henry Hub prices will rise between now and the end of 2017, but will subsequently decline through 2018 and 2019 to reach an annual average of \$2.63/MMBtu in 2019. The sharp discontinuity is caused by EIA’s assumption that Henry Hub prices will recover substantially toward the end of this decade, climbing from \$3.40/MMBtu in 2018 to \$4.51/MMBtu in 2020.

To account for the possibility that the AEO may be projecting an unreasonably rapid increase in gas prices, we conducted a gas price sensitivity wherein we relied on a Henry Hub price forecast recently published by PacifiCorp, a large utility company with operations in six different western states.³⁹ Besides being recent, this forecast is generally consistent with NYMEX futures and is provided on a monthly

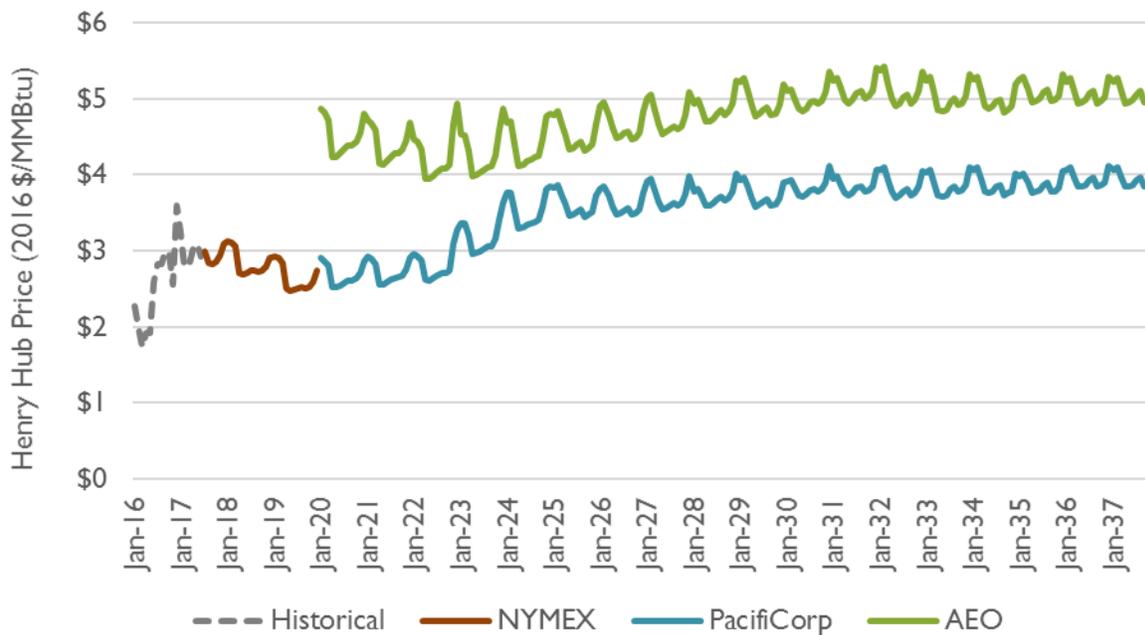
³⁸ EIA. AEO 2017. Table 13. Natural Gas Supply, Disposition, and Prices. Available at https://www.eia.gov/outlooks/aeo/excel/aeotab_13.xlsx.

³⁹ PacifiCorp. 2017. PacifiCorp Facts. Available at: http://www.pacificorp.com/content/dam/pacificorp/doc/About_Us/Company_Overview/PC-FactSheet-Final_Web.pdf

basis. PacifiCorp’s projection contains Henry Hub prices for every month between now and the end of 2037.⁴⁰

Figure 14 compares recent historical monthly Henry Hub prices to projections based on NYMEX futures, PacifiCorp’s forecast, and AEO 2017. Over the longer term, PacifiCorp, like EIA, projects that Henry Hub prices will increase from recent levels. However, PacifiCorp’s forecast envisions that recovery happening more slowly, and leveling off at a lower price point, relative to the AEO projection.

Figure 14. Henry Hub Natural Gas Price Forecast Comparison



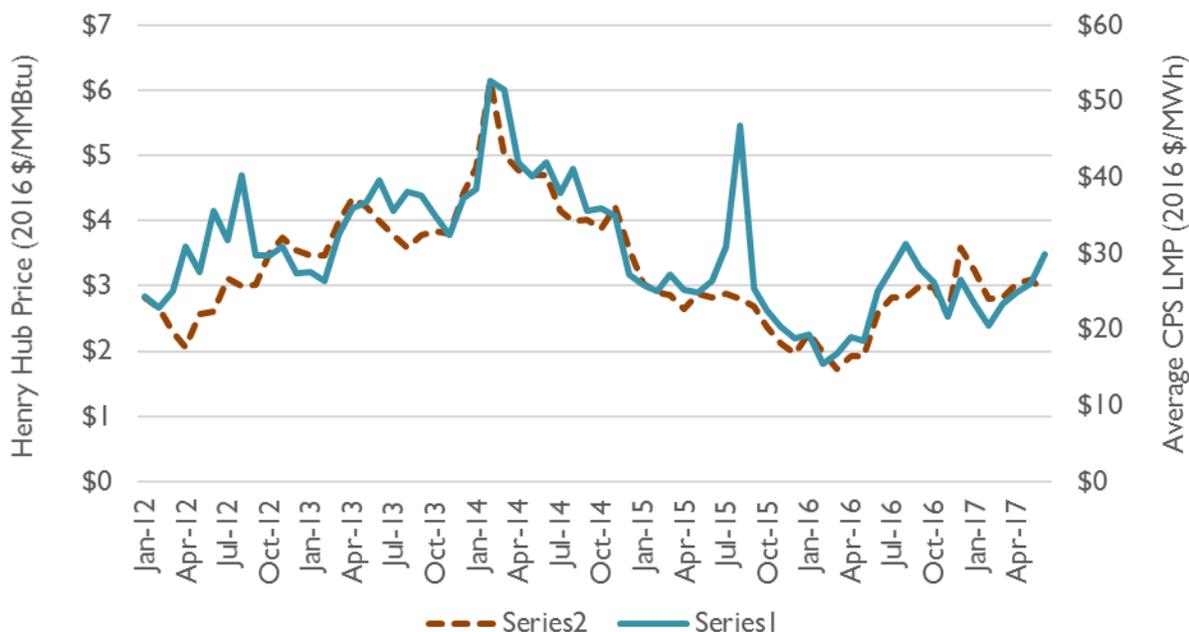
Sources: EIA, NYMEX, PacifiCorp.

Market Energy Prices

Energy market prices at Spruce are strongly correlated with natural gas prices. This is demonstrated by Figure 15, which compares historical monthly Henry Hub prices with monthly average day-ahead energy prices for the CPS load zone. Since October 2012, CPS load zone energy prices have moved in near lockstep with Henry Hub prices in almost all months, with the notable exceptions of August 2015 and August 2016. In those months, energy prices spiked for reasons unrelated to natural gas prices. Accordingly, we used forecasted monthly Henry Hub prices to project future hourly energy prices faced by the Spruce plant.

⁴⁰ PacifiCorp. October 12, 2016. October 2016 Official Forward Price Curve.

Figure 15. Recent historical relationship between Henry Hub price and average CPS energy price



Sources: EIA, ERCOT.

Our forecast of hourly Spruce energy prices proceeded in three steps. First, Synapse employed 12 linear regression models to assess the relationship between Henry Hub prices and average CPS energy prices over the past five years, one for each month.⁴¹ In 11 of these 12 regressions, the simple linear model based on Henry Hub prices explains more than 90 percent of the variation in average CPS energy prices.⁴² Second, Synapse used forecasted Henry Hub prices to project average monthly CPS energy prices for every month between now and 2037. Finally, we used the percentage difference between the projected average energy price for a month and the average energy price for the same month in a prior year to calculate the energy price for each hour, assuming that energy prices for all hours in a given month would change by the same percentage.

Ongoing Capital and O&M Costs

We assumed variable and fixed O&M costs would remain constant in real terms over the lifetime of the Spruce plants, at the levels assumed by EIA for a “scrubbed” coal plant.⁴³ Ongoing capital costs were also assumed to remain flat in most years, excepting for our inclusion of EIA’s assumption that annual

⁴¹ These regressions used data from between October 2012—when natural gas prices and energy prices began to track each other most closely—and June 2017, which is the last month for which we have historical data.

⁴² The lone exception is August, which, as mentioned previously, has consistently high energy prices, irrespective of gas prices. Under Synapse’s forecast, August prices rely on the same derivation as other months, and remain high through the analysis period.

⁴³ Assumptions to the Annual Energy Outlook 2015, p. 105.

capital costs increase by approximately \$7/kW-year when a unit exceeds 30 years of age.⁴⁴ Spruce 1 reaches that point in 2023, while Spruce 2 remains less than 30 years old at the end of the study period.

SCR Costs

In evaluating the impact of an SCR investment on the economic viability of Spruce 1, we relied upon SCR costs as estimated by EPA in regulatory modeling.⁴⁵ Those cost estimates, which include incremental O&M costs as well as capital costs, are reproduced in Table 2.⁴⁶

Table 2. SCR incremental cost estimates

Cost Type	Cost
Overnight Capital (2016 \$/kW)	\$287
Fixed O&M (2016 \$/kW-year)	\$0.74
Variable O&M (2016 \$/MWh)	\$1.42

Source: EPA.

Spruce Generation Patterns

For the purposes of this modeling exercise, we assumed that each Spruce unit will operate at full capacity in every future hour in which the CPS load zone energy price exceeds production costs, and will stand idle in all hours in which its production costs exceed the local energy price. Production costs were defined as the sum of fuel costs and variable O&M costs incurred by a unit, and they were calculated as an annual average.

⁴⁴ U.S. EIA. January 2017. Assumptions to the Annual Energy Outlook 2016, p. 114.

⁴⁵ U.S. EPA. November 2013. Documentation for EPA Base Case v.5.13 Using the Integrated Planning Model, pp. 5-7. Available at https://www.epa.gov/sites/production/files/2015-07/documents/documentation_for_epa_base_case_v.5.13_using_the_integrated_planning_model.pdf.

⁴⁶ The costs shown here are for a 500 MW unit with a heat rate of 10 MMBtu/MWh, since these characteristics most closely match those of Spruce 1. In addition, these costs have been converted into 2016\$.