

THE COAL TRUTH

MidAmerican can save customers millions by retiring uneconomic coal plants

August 2020



MidAmerican’s George Neal North and South coal plants have lost \$27.5 million for its customers over the last five years. Low energy prices in 2020 have only worsened the performance of these plants, which are the most expensive in MidAmerican’s coal fleet in Iowa. By committing to retire both plants by 2023, MidAmerican could save customers \$92 million.

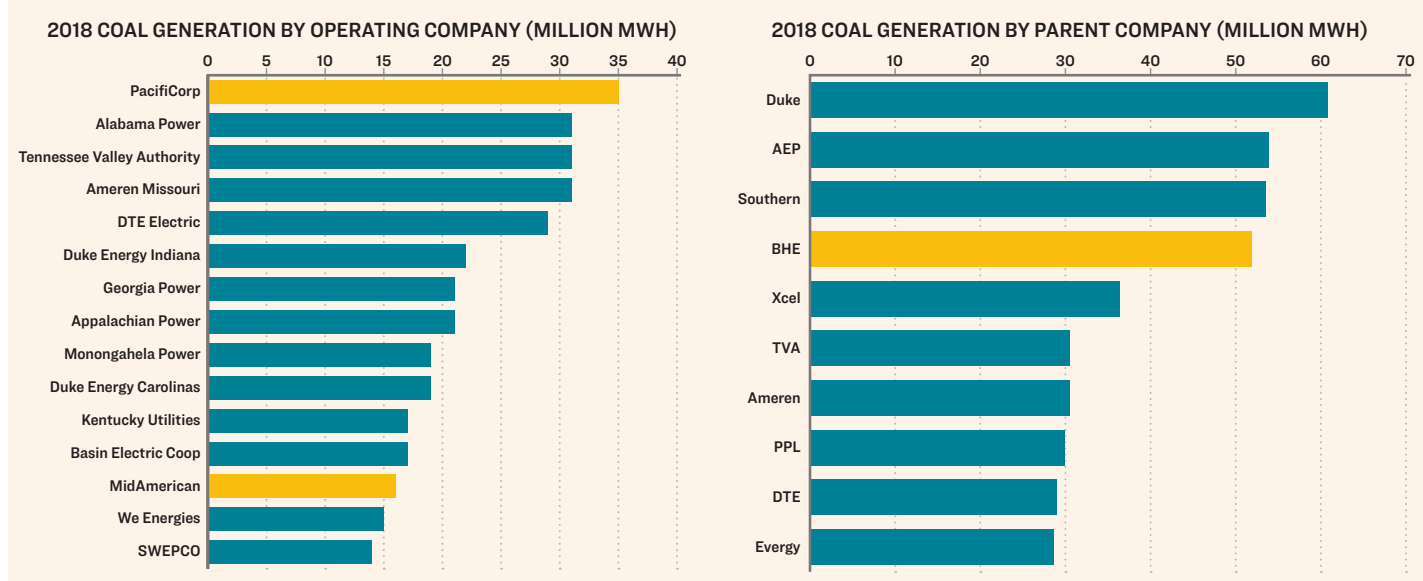
The economic risks presented by continuing to burn coal call into question the operation of these plants. MidAmerican has excess capacity to meet the electricity demand of its customers, and could retire these plants in the near-term without needing to invest in new generation. In particular, according to recently reported data¹, George Neal South has been running at 6% capacity for the last seven months. MidAmerican is overdue for a retirement plan for these plants.

The Coal Truth

MidAmerican and its parent company Berkshire Hathaway Energy (BHE) are not the clean energy leaders they claim to be. **MidAmerican remains one of the 20 largest utility companies in the nation with no climate commitment or emissions reductions target.**²

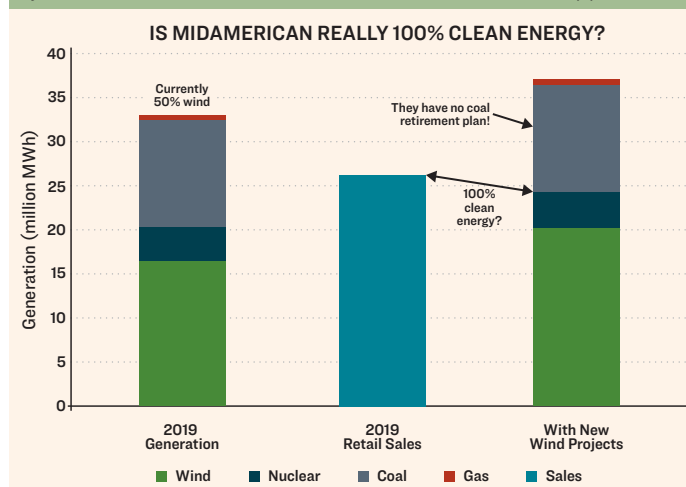
BHE as a whole emitted the fifth most carbon dioxide of any power company in 2018.³ Carbon dioxide emissions correlate closely to coal generation, and the reality is BHE and its subsidiaries still rely heavily on coal power. MidAmerican ranks 14th in the volume of coal generation by a U.S. operating company, owning and operating five coal plants in Iowa; while BHE’s western utility subsidiary PacifiCorp ranks first. When combined, these companies leave BHE ranked 4th in the volume of coal generated power by a U.S. parent company (Figure 1). Unlike MidAmerican, PacifiCorp announced in 2019 an updated retirement schedule for its coal fleet following its latest integrated resource planning process, proposing to phase out 2800 MW of coal by 2030. Yet these efforts are not tied to any emissions targets and BHE remains without a decarbonization plan.⁴

Figure 1: Side-by-side rankings of 2018 coal generation by operating and parent company. Sources included in Appendix.



MidAmerican continues to state publicly that its customers will soon be receiving 100% of their energy from renewable resources, **but this claim turns out to be nothing more than a marketing ploy.** MidAmerican is claiming it will meet its 100% clean energy goal when its annual wind energy generation matches its total retail sales over the year — even as it continues to operate all of its Iowa coal plants (Figure 2).

Figure 2: Comparison of MidAmerican electric power generation by source with 2019 retail sales. Sources included in Appendix.



As Figure 2 shows, once MidAmerican’s latest wind project is complete, its total retail sales (in megawatt-hours) on an annual basis will be equivalent to the total megawatt-hours generated by its wind projects. At the same time, though, **a third of MidAmerican’s energy will continue to be coal-generated.** At any given time, MidAmerican sells all of its wind energy and coal energy into the regional market, and buys back all of its customers’ needs from that market. In reality, MidAmerican’s customers receive a mix of these resources, depending on price and availability.

This stated goal by MidAmerican is not a commitment to 100% clean energy 24 hours a day for every day of the year. Though MidAmerican has led in its wind capacity investments, it has not yet committed to retiring its coal fleet and transitioning its resources to make true 100% clean energy a reality, year round and at all times of the day.⁵ **A true commitment to clean energy requires retirement of fossil generation and diversification of MidAmerican’s clean energy portfolio to include solar, battery storage, efficiency, demand management, and distributed resources.**

Our analysis indicates that MidAmerican’s George Neal North (550 MW built in 1975) and George Neal South (640 MW built in 1979) coal plants are the least economic plants in MidAmerican’s fleet. This paper focuses on MidAmerican’s shares in the two Neal plants.

Both plants operate south of Sioux City, Iowa just east of the Missouri River and combined have the capacity to generate 1,190 MW of coal power. MidAmerican would save its ratepayers millions of dollars by retiring these coal plants. **It could retire at least one or both of these plants without need for any new resources.** With a modest investment in additional clean energy beyond its current and planned renewable resources, MidAmerican could satisfy its generation and reserve requirements and retire both plants, thereby maintaining reliable service for customers. In doing so, MidAmerican would save customers money, contribute to an expanding renewable energy job economy in Iowa, and help lower the state’s greenhouse gas emissions.

MidAmerican’s Coal Bet Is Risky For Customers

Many states require utilities to undertake public, transparent resource planning processes in which they must demonstrate that their energy generation continues to provide the least-cost, lowest risk source of energy for customers (including, in some states, climate risk). In Iowa, however, utilities currently lack such accountability. Iowa remains a state with no requirement for investor owned utilities to undergo long-term resource planning. In other dockets in front of the Iowa Utilities Board, MidAmerican has shown its lack of commitment to restrain carbon emissions. In a proceeding at the Iowa Utilities Board in 2018, MidAmerican CEO Adam Wright rejected the notion that the utility should have to show that its entire resource mix was in customers’ interest, or that the Commission should have any oversight over the utility’s resource planning process.⁶ Stakeholders — including environmental advocates and the Office of the Consumer Advocate — argued that transparent planning processes are in the public interest.

MidAmerican’s claim that it has no planning obligation ignores Iowa law, which states utilities should “manage carbon emission intensity in order to facilitate the transition to a carbon constrained environment.”

Expert analysis has found that several of MidAmerican’s coal plants are likely losing money, costing customers more money than the plants are earning.⁷ Detailed analysis of MidAmerican’s generation portfolio demonstrated that MidAmerican’s customers would save money if the utility’s coal plants were retired.⁸ MidAmerican has ignored the call for a plan to phase out coal burning and to deliver savings to its customers. MidAmerican went so far as to advocate the Iowa Utilities Board should have no opportunity to look into coal plant economics until a de-

MIDAMERICAN'S COAL FLEET COMPOUNDS IOWA'S CLIMATE RISKS

Iowans' concerns about climate change are growing as they increasingly experience the impacts of extreme weather. In a 2019 poll by Yale University's Program on Climate Change Communication, more than two-thirds of registered Iowa voters (69%) say they are worried about climate change, and say it affects Iowa agriculture (74%), extreme weather in the state (71%), its economy (59%) and Iowans' health (58%). And as a result of historic floods devastating parts of the Midwest in 2019, roughly a quarter of Iowans (27%) say they or someone in their family has experienced property damage or other economic hardship due to flooding or severe storm damage.¹³ Iowa can take steps to mitigate the worst impacts of climate change by focusing on limiting its greenhouse gas emissions such as carbon dioxide, methane, and nitrogen oxide.

Iowa's continued reliance on coal-fired power plants remains the state's largest contributor to carbon dioxide emissions. Ten coal-fired power plants continue to operate in the state with no plans for retirement, despite major investments in wind power over the last decade. MidAmerican operates five massive coal plants in Iowa, with no retirement plans for any of them (Table 1), making it the single largest carbon polluter in our state. For example, the Walter Scott plant emitted 8,785,670 tons of CO₂ in 2019 — equivalent to over 1.7 million cars.¹⁴ MidAmerican should undertake a comprehensive, transparent planning process to phase out all coal power and replace with clean energy, but its most uneconomic plants, George Neal North and South, should be slated for retirement as soon as possible.

These coal plants pollute communities and hold Iowa back from true clean energy leadership. Despite nearly a decade of growth in wind energy, Iowa had not seen a measurable decline in greenhouse gas emissions. According to state emissions reports, Iowa's 2018 reported emissions were on par with its emissions from 2010. Iowa's most recent greenhouse gas emissions inventory actually stated that emissions in Iowa increased in the reporting timeframe, and stated that the cause of this increase could be attributed to Iowa's coal plants.¹⁵

Table 1: Iowa coal plants operated by MidAmerican Energy in 2020. Sources included in Appendix.

Plant Name	Location	Capacity (MW)	Year Operational	2019 CO ₂ Emissions (tons)
George Neal North	Sioux City	550	1975	1,880,389
George Neal South	Sioux City	640	1979	1,599,447
Louisa	Louisa county	812	1983	3,623,292
Ottumwa	Ottumwa	726	1981	4,463,912
Walter Scott	Council Bluffs	1649	1978/2007*	8,785,670

*The Walter Scott plant is composed of two units, one installed in 1978 (726 MW) and the other installed in 2007 (923 MW).

cade from now, or later, when the Company files its next rate case even if it means customers may pay more for electricity in the meantime.

The economics of coal plants have only further eroded during the current COVID-19 pandemic. Nationally, declining power demand has accelerated the decision of many utilities to close coal plants or to run them less.⁹ In April 2020, for the first time ever, renewables generated more electricity than coal nationally, every day for a month, due to the combination of low gas prices, favorable weather, more capacity and declining demand.¹⁰ As the cost of renewables and storage continue to decline, coal continues to lose cost competitiveness as an energy resource. In the midst of such market disruption, the time is ripe to consider the need for coal retirements in Iowa. MidAmerican should undertake a comprehensive, transparent planning process to phase out all coal power and replace with clean energy, but its most uneconomic plants, George Neal North and South, should be slated for retirement as soon as possible.

MidAmerican currently owns more generation than is needed to reliably meet customers' energy needs (Figure 5). MidAmerican's own data shows the company projects to have an overabundance of energy supply to meet the demand of its customers over the next five years, peaking in 2022. Making this excess capacity available on the market offers only a small source of additional revenue, especially during times of lower demand, that does not justify the units' continued operation. The current economic situation changes the trajectory of projected demand, and calls into question the justification of continuing to run and maintain expensive coal plants that will exacerbate the risks of climate change.

The Case to Retire George Neal North and South

Iowans deserve an ambitious course of action to replace all coal-fired power plants within the state's borders with clean energy by 2030 to limit the worst impacts of climate change and reduce the economic burden on customers. To this end, the Sierra Club has investigated MidAmerican's remaining coal fleet in Iowa from three standpoints: 1) its economic performance over the past five years, 2) its economic outlook through 2030, and 3) whether the coal plants can be cost-effectively replaced with clean energy. From this investigation, we find:

- The George Neal North and South coal plants are no longer economic and lost more than \$27 million over five years relative to the cost of market-based energy.

- Operating both plants through 2023 would incur losses to MidAmerican’s ratepayers of up to \$92 million.
- MidAmerican currently has enough excess capacity to not need George Neal North and South; therefore continuing to operate them will waste more money for their customers.
- George Neal North would inflict \$107 million in excess costs on customers if run through 2028. George Neal South would lose customers \$77 million if run through 2030.

Results

George Neal North and South have lost \$27.5 million for MidAmerican customers over the last five years.

As recently as March 2019, MidAmerican’s coal fleet was running at 70% of its full capacity, referred to as the “capacity factor”. As of March 2020, however,

Figure 3: MidAmerican coal fleet capacity factor, 2009–current (rolling 12-month average). Sources included in Appendix.

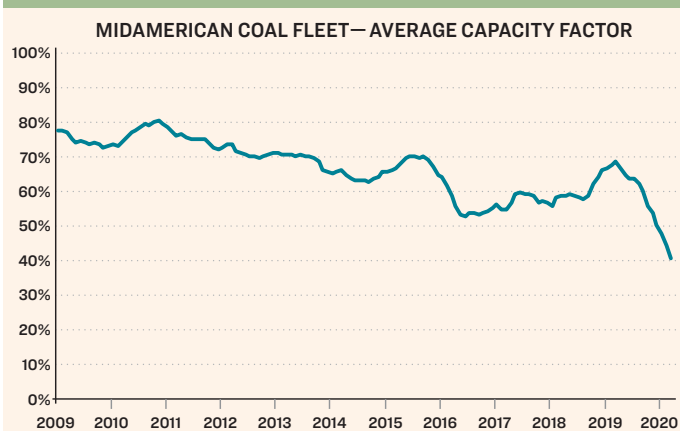
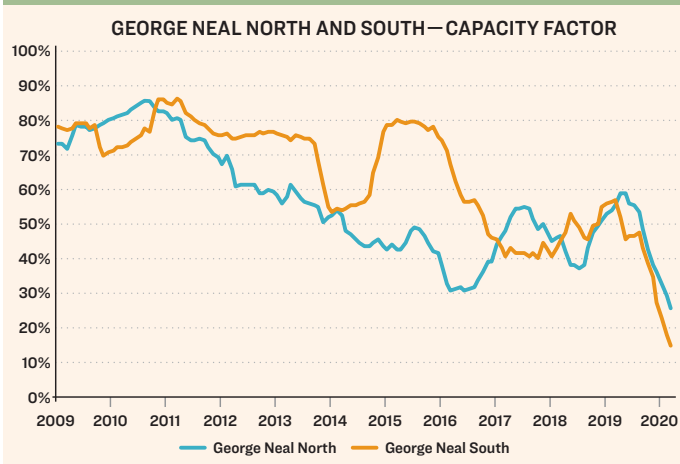


Figure 4: George Neal North and South capacity factor, 2009–current (rolling 12-month average). Sources included in Appendix.



the fleet’s capacity factor had fallen to 40% (Figure 3). George Neal North and South are the most costly coal plants that MidAmerican owns, and as such, their capacity factors have been falling even faster than the fleet average (Figure 4). Energy market prices have fallen precipitously, meaning that these coal plants make far less economic sense to operate than they did even last year. For example, George Neal South operated at a high capacity factor in the summer of 2019 but has not operated above 6% capacity factor for the past seven months reported (Sept 2019 to March 2020).

Since the plants are operating less and less, they are earning less energy market revenue with which to cover their ongoing costs of operation. Coal plants are extremely expensive to maintain, and so only make economic sense if they can make money in the energy markets the majority of the time.

The tables below present a summary of George Neal North and South’s costs and revenues from 2015–2019 (Tables 2 & 3). The full methodology of these calculations is detailed in the appendix. In each year, the plants had a positive short-term energy margin. Short-term energy margin looks only at the immediate costs of producing electricity — such as the cost of fuel burned to generate the energy — compared to revenue earned in the market, without considering the significant costs required to make the plant available (such as costs of replacing and maintaining plant components). The long-run margin accounts for these other costs. With the exception of 2018, the long-run margin for these plants was negative. (2018 was a year with abnormally high market prices; prices in 2020 are below those experienced in any other year in 2015-2019). **In total, the plants lost \$47 million over the five year period.** MidAmerican owns 72% of George Neal North and 41% of George Neal South, so the losses for their customers total **\$27.5 million.**

Table 2: George Neal North operation and economic summary, 2015-2019 summary. Sources included in Appendix.

	2015	2016	2017	2018	2019	Total
Capacity factor	41%	39%	48%	50%	36%	43% (average)
Energy revenue	\$42m	\$45m	\$57m	\$65m	\$42m	\$251m
Energy costs	\$39m	\$39m	\$47m	\$49m	\$35m	\$208m
Energy margin	\$3m	\$6m	\$10m	\$17m	\$7m	\$43m
Long run margin	\$-7m	\$-4m	\$-4m	\$-8m	\$-4m	\$-27m
MidAmerican share	\$-5.3m	\$-2.7m	\$-3m	\$-5.5m	\$-2.8m	\$-19.2m

Table 3: George Neal South operation and economic summary, 2015-2019 summary. Sources included in Appendix.

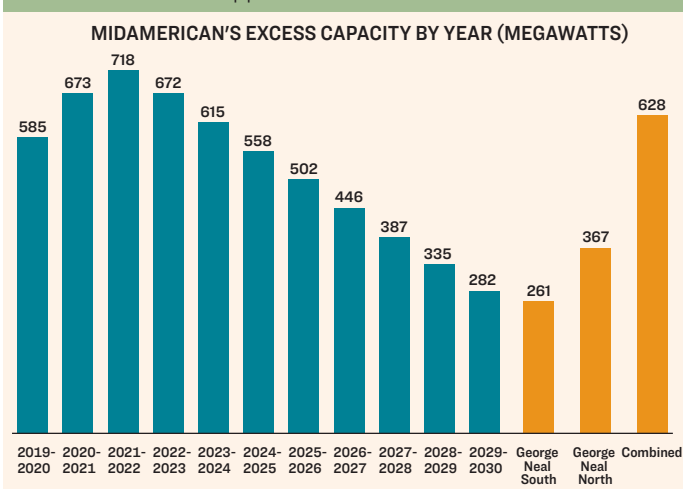
	2015	2016	2017	2018	2019	Total
Capacity factor	75%	46%	43%	55%	27%	49% (average)
Energy revenue	\$86m	\$64m	\$64m	\$90m	\$40m	\$344m
Energy costs	\$81m	\$56m	\$54m	\$64m	\$31m	\$284m
Energy margin	\$5m	\$8m	\$10m	\$27m	\$9m	\$59m
Long run margin	\$-8m	\$-6m	\$-3m	\$11m	\$-14m	\$-20m
MidAmerican share	\$-3.4m	\$-2.3m	\$-1.4m	\$4.7m	\$-5.9m	\$-8.3m

MidAmerican does not need George Neal North and South; continuing to operate them will waste more money for their customers.

Not only are the plants no longer economically competitive, but MidAmerican does not need them for reliability. When MidAmerican filed testimony in 2018 for its expanded wind energy plans, it included information about its capacity balance: its supply of electricity (via plants it owns or purchases from) minus its demand for electricity (known as the planning reserve margin requirement). MidAmerican’s testimony showed that it had supply in excess of demand for the next decade, peaking at 718 megawatts in 2021, which is greater than the amount of capacity the company owns in George Neal North and South.

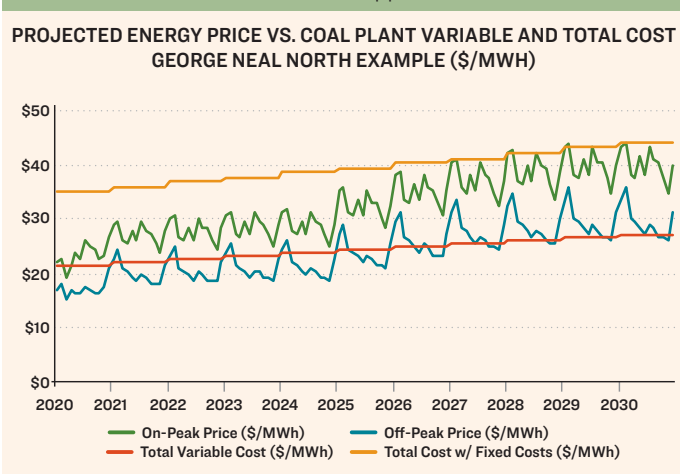
Over time, the amount of excess capacity drops due to MidAmerican’s projected increases in demand. Even in 2030, however, the amount of excess capacity is still in excess of the capacity the company owns in George Neal South (Figure 5). In 2028, the excess capacity is still greater than the capacity MidAmerican owns in George Neal North.

Figure 5: MidAmerican’s excess capacity by year compared to capacity owned at George Neal North and South coal plants. Sources included in Appendix.



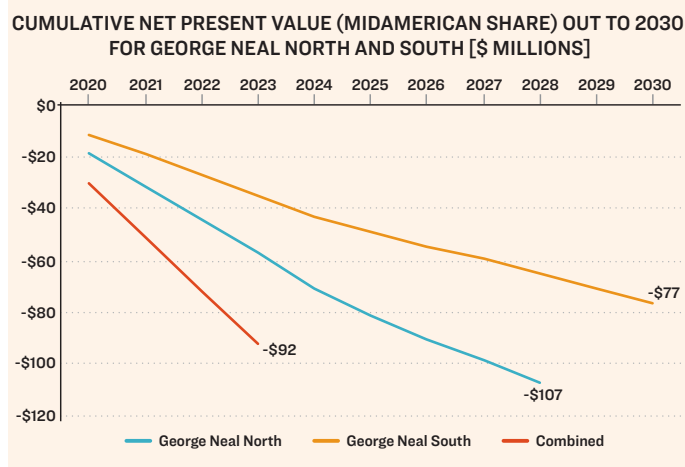
In order to estimate how much additional money these plants will waste, we built out a model for projecting plant costs and plant energy revenue, the full details of which can be found in the appendix. We projected on-peak and off-peak monthly average prices and assumed the plants would run at a capacity factor of 50% in 2020 falling by 3% per year.¹¹ (This is generous, given that Neal South has not operated above 6% capacity factor in the last 7 months.) In addition to the fuel costs and operations and maintenance costs used for the historic analysis in the prior section, we also assumed an average annual capital expenditure of \$27/kW-year. In the chart below, we show those price projections compared against both the total variable cost (the cost to produce energy each hour), and the total plant cost including annual fixed costs and capital expenditures.

Figure 6: Estimated on and off-peak prices compared with George Neal North coal plant variable and total costs, 2020-2030. Sources included in Appendix.



Knowing MidAmerican is holding excess generation capacity, our estimates show that if both plants continue to operate until 2023, then MidAmerican will be wasting its customers money to the tune of \$92 million, or \$23 million per year (Figure 7). **MidAmerican could retire those plants in 2020, save customers money, and not have to find replacement capacity until 2023.** If MidAmerican misses this milestone, it would still hold excess capacity until 2028 in an amount equivalent to its share of George Neal North. By keeping George Neal North running, MidAmerican would be wasting \$12 million per year, or \$107 million total through 2028. Similarly, MidAmerican would hold excess capacity until 2030 equivalent to its share of George Neal South. Running George Neal South would waste \$7 million per year, or \$77 million through 2030.

Figure 7: Estimated cumulative net present value for George Neal North and South coal plants out to 2030. Sources included in Appendix.



There are two important conditions that strengthen and reinforce the above conclusions. First, MidAmerican is holding excess capacity and thus would not need to replace capacity until the noted dates. Second, the result is net of any energy purchases MidAmerican would need to make from the market, and thus is representative of the full customer savings amount.

Even if MidAmerican pursued a retirement date of 2023 or sooner for both coal plants, the company has a wide array of options it could evaluate for a cleaner and more affordable future for its ratepayers, including:

1. Stronger commitment to energy efficiency and demand response resources across its suite of customers;
2. Buying low-cost capacity through a bilateral contract for any temporary needs (2-3 years) or through the MISO planning resource auction¹²;
3. Procuring any incremental long-term capacity needs through an all-source procurement process that puts renewables and storage on a level playing field with fossil fuels.

Conclusion

The tumultuous year of 2020 has placed utilities and customers in a double bind. With declining demand, utilities may be evaluating whether they can raise rates to replace lost revenues. But with record unemployment, customers may not be in a position to afford higher rates. Our analysis shows MidAmerican could retire its most uneconomic coal plants today and not need to invest in new generation for at least 2-3 years, saving customers money in the process.

Given its excess capacity position, MidAmerican can retire George Neal North and South with no investment in new generation while still maintaining reliable service. **By committing to retire both plants by 2023, MidAmerican could save customers \$92 million**, and would also deliver significant carbon dioxide emissions reductions. The climate crisis requires that MidAmerican plan to phase out its remaining coal plants, and deliver with it many benefits beyond saving customers money. The economic and public health burdens presented by the COVID-19 pandemic only increase the urgency while amplifying the negative impacts of coal-fired power.

Without such a transition, or even by delaying that transition, lowans will pay a high price for climate change in the form of increased flooding, decreased crop yields, and heightened risk of future pandemics. Retiring George Neal North and South and replacing that power with clean energy can be the first step in a larger commitment to decarbonize, putting people back to work on large infrastructure and installation projects for new generation, and rebuilding our economy in the process.

Appendix

Sources

The data sources for this analysis are from public sources, including data reported by MidAmerican Energy Company to the Energy Information Administration (EIA), Environmental Protection Agency (EPA), and Federal Energy Regulatory Commission (FERC).

- Hourly generation: EPA Air Markets Program Database <https://ampd.epa.gov/ampd/>.
- Energy market prices: MISO via S&P Global Market Intelligence
- Coal prices and power plant deliveries: EIA-923, costs through 2019 reported as of February 2020 <https://www.eia.gov/electricity/data/eia923/>
- Coal and gas price forecasts: EIA Annual Energy Outlook 2020 Reference case: <https://www.eia.gov/outlooks/aeo/>.
- Variable and fixed operations and maintenance: FERC Form 1 filed by MidAmerican, 2015-2019 <https://www.ferc.gov/docs-filing/forms/form-1/data.asp>
- Capital expenditures: EIA Annual Energy Outlook <https://www.eia.gov/outlooks/aeo/assumptions/pdf/electricity.pdf> (p. 14)

- Clean Energy Portfolio algorithm: Rocky Mountain Institute, “The Growing Market for Clean Energy Portfolios,” <https://rmi.org/insight/clean-energy-portfolios-pipelines-and-plants/>
- MidAmerican demand and supply balances: Wind XII testimony

Historic performance

To evaluate historic performance from 2015 to 2019, we pulled hourly day-ahead energy market prices for the appropriate nodes (MEC.NEALS_4, MEC.NEALN_3) and aligned them with hourly gross generation pulled from the EPA’s Air Market Programs Data tool to produce energy market revenue. Fuel costs were pulled from fuel deliveries data reported on the EIA-923 and multiplied by the units’ average heat rate for the year to get a fuel cost per MW hour of electricity produced. Variable and fixed operations and maintenance (O&M) data were pulled from FERC Form 1 filed by MidAmerican for the years 2015 to 2019. For variable O&M, the following categories of FERC reporting were included: Steam Expense, Electric Expense, Miscellaneous Power Expenses. For fixed O&M, the following categories were included: Operating Supervision and Engineering, Maintenance Supervision Expense, Maintenance of Structures, Maintenance of Boiler Plant, Maintenance of Electric Plant, Maintenance of Other Plant. Fuel costs and variable O&M were subtracted from energy market revenue to arrive at the energy margin. Fixed O&M was subtracted from the energy margin to arrive at the long-run margin.

Future performance

In order to estimate the net present value of George Neal North and South for the period 2020 to 2030, we constructed a model to project future costs and revenues. All of the assumptions and projections are derived from publicly available information. As we note in several places below, many of these estimates are conservative, and the actual performance of George Neal North and South may be less favorable to customers than our estimates. To build our model, we created starting assumptions or built projections for the following values:

- **CAPACITY FACTOR:** The capacity factor starts at the 2017–2018 average for the units, around 49 percent, and then falling by 3 percent per year. The units’ capacity factors fell by 4 percent/year on average between 2009 and 2019.
- **ON- AND OFF-PEAK GENERATION:** On-peak generation was assumed to account for 45 percent of operating

hours, representative of 9 A.M. to 5 P.M. weekdays. The remaining generation was assumed to be off-peak.

- **FUEL COSTS:** An average of 2015–2019 fuel costs as reported on EIA-923 for these plants were used as a starting point. From there, the costs were inflated in line with the EIA AEO 2020 reference coal price forecast for the East North Central region. The following heat rates were used: 10,293 British thermal units btu/kilowatt hour (kWh) for George Neal North and 10,338 btu/kWh for George Neal South.
- **VARIABLE O&M EXPENSES:** An average of 2015–2019 variable O&M costs (see “Historic performance” methodology) was used as a starting point and inflated by 2 percent per year, in line with standard inflation.
- **FIXED O&M EXPENSES:** An average of 2015–2019 fixed O&M costs was used as a starting point and inflated by 2 percent per year, in line with standard inflation.
- **ANNUAL CAPITAL EXPENSES:** Ongoing annual capital additions were calculated according to an equation found in EIA’s Annual Energy Outlook methodology. EIA found a generalized equation (shown below) that describes how much coal plant owners spend on capital expenditures on average per year, as a function of coal plant age and whether or not the coal plant had flue gas desulfurization (FGD). For coal plants across the US, the range for ongoing capital expenditure (CapEx) is \$19 to \$30/kW-year. For George Neal North and South, the average ongoing CapEx is on the higher end of the range at \$27 to \$28/kW-year (2017 dollars), which makes sense as all units have FGD installed and the ages of the units ranges from 41 to 45 years. From here, we inflate this figure by 2 percent per year to account for normal inflation.
- $CAPEX = 16.53 + (0.126 * age) + (5.60 * FGD)$
where $FGD = 1$ if a plant has an FGD,
 0 if a plant does not have FGD
- **ON- AND OFF-PEAK PRICES:** In order to forecast on- and off-peak power prices between 2020 and 2030, we multiplied the EIA’s forecast (from Annual Energy Outlook 2020) for gas delivered to West North Central (an EIA census region that includes Iowa) electric sector customers by the implied heat rate of each unit, since gas is commonly the marginal, price-setting resource in most markets today. The implied heat rate for each plant was calculated by looking at historic on- and off-peak prices (monthly average day ahead on- and off-peak strips) for the relevant market hub and dividing by the average monthly delivered gas

price at the Chicago hub. Then the average of those implied heat rates during the years 2016 to 2019 was taken to represent the heat rate going forward. The resulting on-peak prices ranged from \$19 to \$44/MWh, while the resulting off-peak prices ranged from \$15 to \$36/MWh across the 10-year period.

We calculated the sum of energy revenues minus the costs (fuel, variable and fixed O&M, capital) for each year. The net present value of those annual sums was calculated using a discount rate of 8 percent, which is a typical rate used by utilities across the US in integrated resource planning. The levelized cost of energy (LCOE) was calculated by taking an annualized payment of the net present value of all costs (also using a discount rate of 8 percent) and dividing it by annual generation.

These results ignore the possibility of any future environmental regulations, including prices or caps on carbon emissions, that could make the plants even more uneconomic. In addition, the analysis assumes that the marginal cost of energy in MISO remains linked to the cost of gas, which may be an overly conservative assumption. The rapid increase in renewable energy deployment in the Midwest suggests that marginal energy costs may in fact continue to be depressed relative to the current market, where gas is predominantly the price setter. If either of these events occur (environmental regulations or a decoupling of market revenues and gas prices), the economic outcome for MidAmerican's coal units will be substantially worse than what is shown here, and our results already show that George Neal North and South will be financial losers over the next decade.

Endnotes

- 1 Hourly generation: EPA Air Markets Program Database <https://ampd.epa.gov/ampd/>
- 2 Van Atten, C., Saha, A., Helligren, L., & Langlois, T. (2019, June). Benchmarking Air Emissions Of the 100 Largest Electric Power Producers in the United States (Rep.). Retrieved July 30, 2020, from <https://www.dropbox.com/s/31wpcctt3w1gmlht/M.J.%20Bradley%20report.pdf>; reported in the *LA Times* June 26, 2019 (<https://www.latimes.com/projects/la-fi-power-companies-ranked-climate-change/>)
- 3 Van Atten, C., Saha, A., Helligren, L., & Langlois, T. (2020, May). Benchmarking Air Emissions Of the 100 Largest Electric Power Producers in the United States (Rep.). Retrieved July 30, 2020, from <https://www.ceres.org/sites/default/files/reports/2020-07/Air%20Emissions%20Benchmark%202020.pdf>
- 4 Pomerantz, D. (2019, June 15). Utility carbon targets reflect slowdown in decarbonization. Retrieved July 30, 2020, from <https://www.energyandpolicy.org/utility-carbon-targets/>
- 5 For a good discussion and case study on this topic: (2018, October). Moving toward 24x7 Carbon-Free Energy at Google Data Centers: Progress and Insights, <https://storage.googleapis.com/gweb-sustainability.appspot.com/pdf/24x7-carbon-freeenergy-Data-centers>
- 6 Hearing Transcript from MidAmerican's Wind XII approval docket, RPU-2018-003, at 22:11-14 (Question: "MidAmerican's 100% renewable energy vision does not include any plans to retire additional fossil generating plants, does it?" MidAmerican CEO Adam Wright: "That's correct." Question: "And MidAmerican has not done any studies or analyses into retirement of any of its coal generating plants; is that correct?" Mr. Wright: "That's correct."); same at 92:17-93:6 (Q (Board Member Lozier): "Do you have any plans to analyze the risk involved in the retirement of coal generation facilities?" Mr. Wright: "...[W]e don't have any plans today to look at when are we going to retire our coal assets. It's something we haven't evaluated. We don't have any statutory requirements to do so, and we don't have any plans to do so.").
- 7 Rowberry, G., & Williams, L. (2018, October 29). Post-Hearing Brief of Sierra Club (Docket No. RPU-2018-0003). Retrieved July 30, 2020, from https://efs.iowa.gov/cs/idcplg?IdcService=GET_FILE&dDocName=1821916&allowInterrupt=1&noSaveAs=1&RevisionSelectionMethod=LatestReleased
- 8 Chernick, Paul. (2018, August 3). Direct Testimony of Paul Chernick on Behalf of Sierra Club (Docket No. RPU-2018-0003). Retrieved July 30, 2020, from https://efs.iowa.gov/cs/idcplg?IdcService=GET_FILE&dDocName=1776607&allowInterrupt=1&noSaveAs=1&RevisionSelectionMethod=LatestReleased
- 9 See, e.g., Coal Suffers as Coronavirus Saps Power Demand, *The Wall Street Journal*, April 23, 2020.
- 10 Feaster, S. (2020, May 4). Renewables surpass coal in U.S. power generation throughout the month of April 2020. Retrieved July 30, 2020, from [https://ieefa.org/ieefa-update-renewables-surpass-coal-in-u-s-power-generation-throughout-the-month-of-april-2020/#:~:text=Utility%2Dscale%20solar%2C%20wind%2C,generated%20power%20every%20single%20day&text=May%204%2C%202020%20\(IEEFA%20U.S.,Information%20Administration%20\(EIA\)%20shows.](https://ieefa.org/ieefa-update-renewables-surpass-coal-in-u-s-power-generation-throughout-the-month-of-april-2020/#:~:text=Utility%2Dscale%20solar%2C%20wind%2C,generated%20power%20every%20single%20day&text=May%204%2C%202020%20(IEEFA%20U.S.,Information%20Administration%20(EIA)%20shows.)
- 11 For reference, the capacity factor for George Neal North and South have fallen by 4% per year on average over the past decade.
- 12 The average clearing price for Zone 3 over the last four years of the MISO PRA was \$5/MW-day, or about \$2/kW-year. In the 2016-2017 auction, the price was higher at \$72/MW-day, or \$26/kW-year, which is still lower than the going forward fixed costs of either George Neal North or South.
- 13 Yale Program on Climate Change Communication. "Poll: Iowans on Board With Climate Action as Impacts Hit Home." (2019, August 12). Retrieved July 30, 2020, from <https://climatecommunication.yale.edu/news-events/poll-iowans-on-board-with-climate-action-as-impacts-hit-home/>
- 14 U.S. EPA: Greenhouse Gas Emissions from a Typical Passenger Vehicle. (2018, March). Retrieved July 30, 2020, from <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>
- 15 Iowa Department of Natural Resources. 2018 Iowa Statewide Greenhouse Gas Emissions Inventory Report. (2019, December). Retrieved July 30, 2020, from http://www.iowadnr.gov/Portals/idnr/uploads/air/ghgemissions/Final%202018%20GHG%20REPORT_12.31.19.pdf

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