Retiring the Boswell Coal Plant

The Economic Case for Clean Energy in the Northland

Like many parts of the country, Minnesota has been undergoing a transformation of its electricity sector as coal generation is increasingly unable to compete against alternatives. Most Minnesota coal plants are now scheduled for retirement and many are operating seasonally to reduce costs. Meanwhile, the share of renewable energy generation continues to rise as wind and solar outcompete coal and gas on cost, and as clean energy jobs and industry grow in our state. Minnesota Power's Clay Boswell plant is not insulated from these trends. Our analysis finds that retiring the Boswell coal plant and replacing it with a clean energy portfolio of wind, solar, storage, energy efficiency and demand response by 2029 at the latest would provide huge savings to customers.

Coal generation in Minnesota has fallen 57% over the past decade, and both Xcel Energy & Otter Tail Power are switching some coal plants to economic or seasonal dispatch, which helps to reduce uneconomic operations at the increasingly frequent times when coal cannot compete in the market.[1] At the same time, Minnesota's share of energy generated from renewable sources continues to rise: in February through June of this year, the monthly generation from wind farms was greater than that of coal plants in Minnesota.[2]

In northern Minnesota, however, the largest investor-owned electric utility in the region, Minnesota Power, has refused to switch their Clay Boswell plant to seasonal or

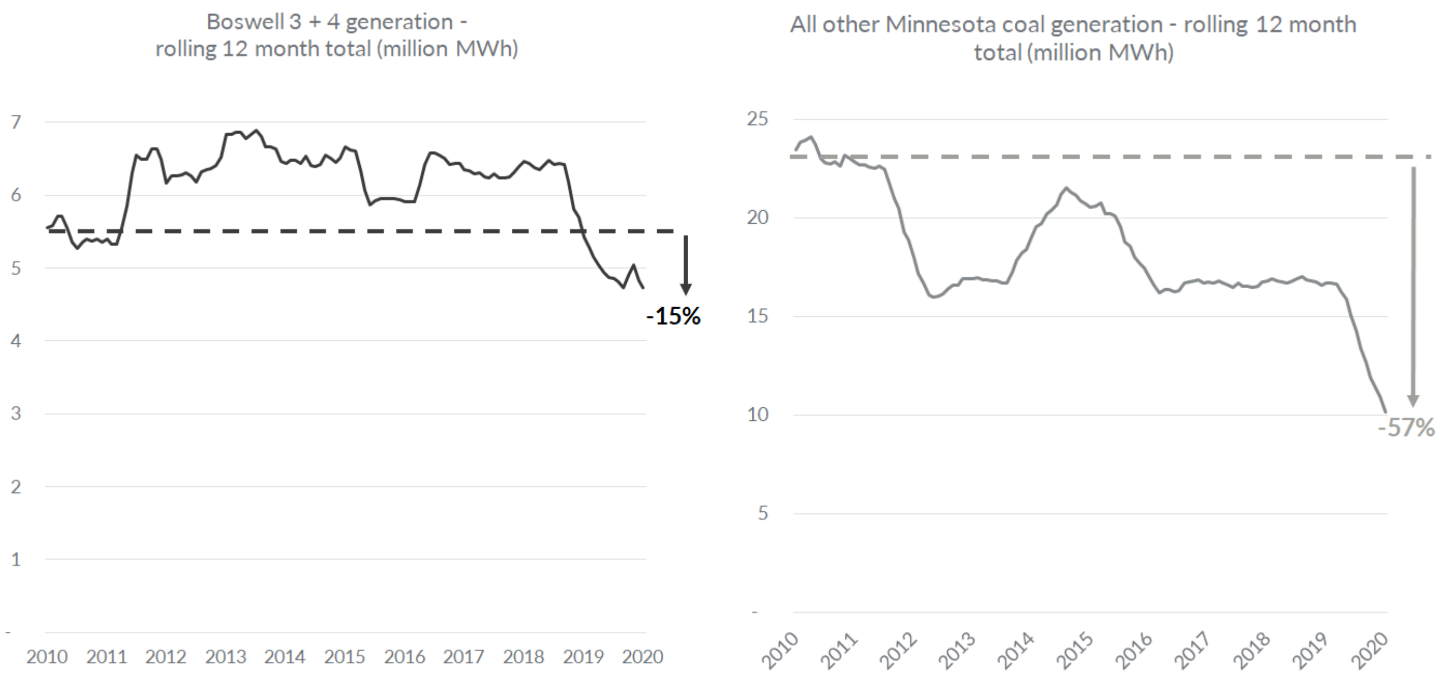

Figure 1: Generation from Clay Boswell vs. the remaining Minnesota coal plants

economic dispatch. Over the past decade, generation from the Boswell plant has only fallen by about 15%.

And yet, costs at Boswell continue to rise. In 2016, its average production cost jumped from $16/MWh to $23/MWh as a result of higher fuel prices, but the plant did not operate less as a result. Throughout 2016-19, there were times when the market price was not high enough to cover production costs at the plant, meaning Boswell frequently operated at a loss. Our analysis showed that the Boswell units operated uneconomically for close to or over half of all operational hours in 2017 and 2019 and nearly a third of operational hours in 2018.

In other words, the plant is losing money for much of the year, even when only considering its “production cost”: the cost of its fuel and variable operations and maintenance costs. It’s losing much more money when considering all of the fixed operations and maintenance costs as well as incremental capital expenditures it must frequently invest to keep the plant operating. Additionally, in 2018, the Minnesota Public Utilities Commission established a range of regulatory costs of carbon dioxide, as $5-25 per short ton of CO_2 effective 2025 and thereafter. These costs are used for planning purposes to account for the likely range of costs of future CO_2 regulation on electricity generation. When adding up these various costs, the levelized cost of operating the Boswell coal plant could be anywhere from $43 to $59/MWh when modeled over a 20-year period.

Replacing the Boswell coal plant with clean energy solutions would provide Minnesotans with electricity that is less expensive, equally reliable, and with a smaller environmental footprint. Using Rocky Mountain Institute’s “Clean Energy Portfolio” (CEP) algorithm, we designed a suite of clean energy solutions that would

	2014	2015	2016	2017	2018	2019
Average production cost	$ 16.57	$ 16.25	$ 22.93	$ 23.09	$ 23.75	$ 22.66
Capacity factor - Boswell 3	73%	79%	72%	72%	72%	49%
Capacity factor - Boswell 4	80%	67%	83%	77%	81%	63%
% of hours where market price > cost	90%	78%	25%	40%	52%	45%

Table 1: Price, production cost, and capacity factor for Clay Boswell, 2014-2019

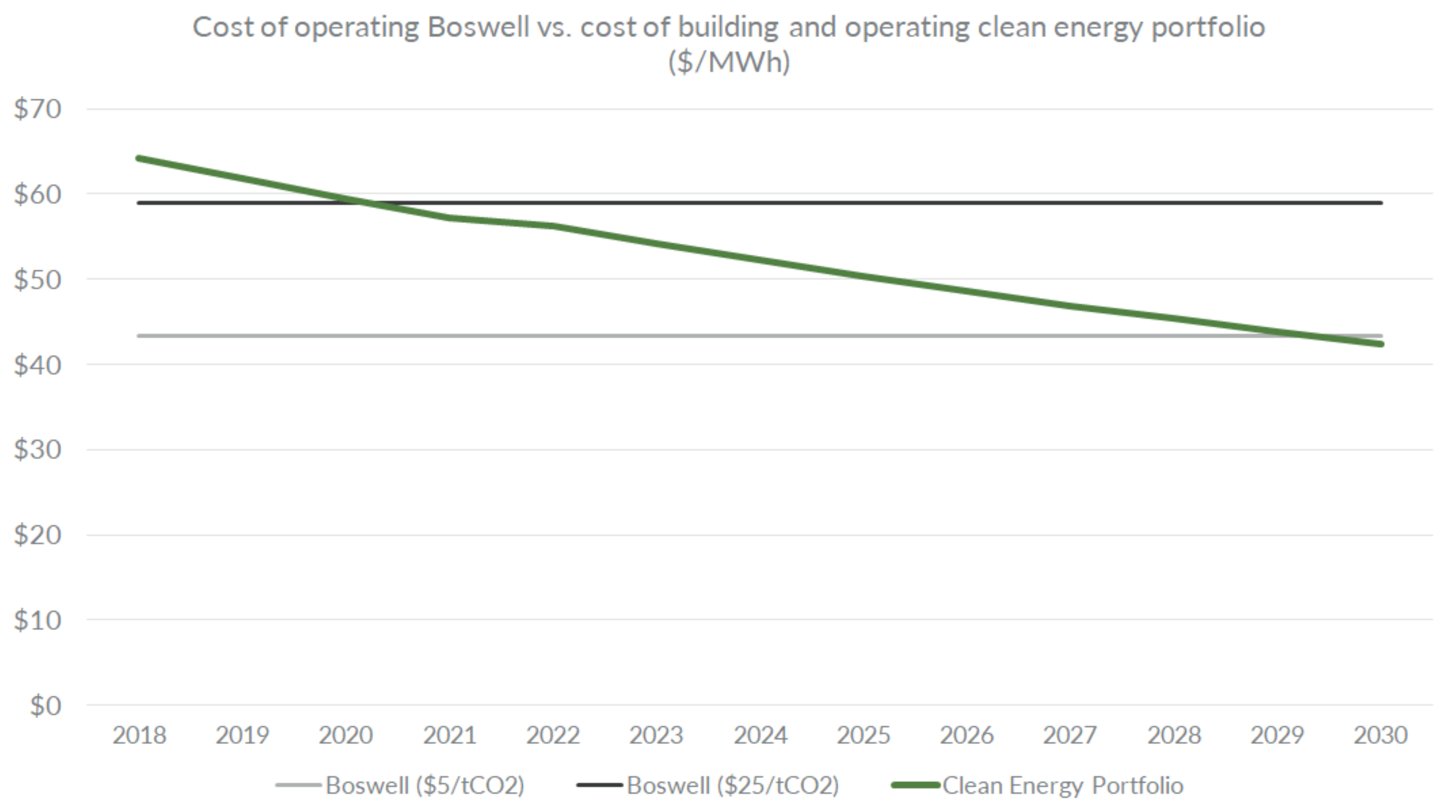

Figure 2: Cost effectiveness of clean energy portfolio replacement vs. coal plant

replace Boswell's energy and capacity. The algorithm uses a study from the National Renewable Energy Laboratory (NREL) to determine state-level economic potential for wind and solar as well as regional wind and solar hourly profiles to determine hourly renewable production. Then, we compared the cost of that CEP with the range of cost estimates for the Boswell plant. This analysis showed that a clean energy portfolio would be cheaper than Boswell by 2029 at the latest, even assuming the lowest range of the Minnesota PUC's regulatory cost of carbon. Should the regulatory cost of carbon be higher, the savings gained from clean energy solutions would be even greater.

Replacing the Boswell coal plant with clean energy could support economic development and help create family-sustaining jobs in the region. When possible, investments—in particular in solar and energy efficiency—could be prioritized in Cohasset and in Itasca County to help with the transition away from coal, and in communities of color and low-income communities that have been disproportionately harmed by the pollution and economic costs of our energy system.

In our methodology, the CEP is constructed to match the energy, peak capacity, and ramping characteristics of Boswell units 3 and 4. Portfolios are optimized to satisfy these needs at the lowest cost possible. In the model, once a CEP is built to match the coal plant's performance, we compare the cost of building and operating that CEP with the going forward costs of operating the coal plant. When the CEP cost becomes cheaper, the coal plant is "stranded" by the CEP. In economic terms, this is when the total cost of a new solution becomes cheaper than the marginal cost of an existing solution. At this point, the sunk costs of the coal plant are the same in both the CEP case and the coal plant case but, going forward, the only way to save customers money is to build and operate the CEP.

The result of the CEP model was 436 MW of solar, 1,348 MW of wind, 400 MW of battery storage, 393 MW of energy efficiency, and 319 MW of demand response. Currently, the cost of building this CEP is higher than the cost of operating the coal plant (largely because battery storage is still relatively expensive), but we have

Boswell 3 & 4	Clean Energy Portfolio by technology (MW)				
	Solar PV	Wind	Battery Storage	Energy Efficiency	Demand Response
949	436	1,348	400	393	319

Table 2: Clean energy portfolio breakdown by technology

determined that the CEP cost would be lower by the year 2029 (and possibly as soon as the mid 2020's) based on industry projections for storage and renewables' costs. More details on our methodology and data sources can be found in the appendix.

These findings suggest Minnesota Power should be actively considering earlier retirement of the Clay Boswell plant and complete replacement with clean energy. Scheduling a retirement date with as much advance notice as possible is critical to ensure that the City of Cohasset, Itasca County and surrounding impacted communities are able to plan for the transition away from fossil fuels. This transition should include a focus by the utility on creating local, family-supporting, clean energy jobs.

Importantly, a portion of the CEP is supplied by demand-side technologies that are cheaper than building large new power plants and thus save customers more money. For demand response, the technology mix selected in the model largely relied on residential heating and cooling as well as industrial customer demand response. For energy efficiency, the technology mix included residential lighting, space cooling, and space heating as well as commercial lighting.

Minnesota Power can and should pursue higher levels of energy efficiency and demand response for its customers if it wants to find the most cost-effective energy and capacity replacements for its aging coal plants. Implementing energy efficiency programs is often less expensive than building new power plants and would enable more customers to reduce their energy costs. By prioritizing low-income customers and multifamily homes for residential programs, Minnesota Power could also address racial disparities in access to such programs. Home energy efficiency programs are often more easily obtainable for homeowners, and Minnesotans of color are significantly less likely to own homes than white Minnesotans.[3] Increasing energy efficiency for industrial customers, who make up nearly 75% of Minnesota Power's sales, would lower overall generation needs and lower costs for all customers.

According to its filings with EIA (Energy Information Administration), Minnesota Power has not reported any energy efficiency savings for its industrial customers, despite the fact that industry accounts for 75% of the utilities sales. This is because Minnesota Power's industrial customers have requested and received exemptions from the state's Conservation Improvement Program and therefore are not counted in its energy efficiency savings measurements. The utility only achieved a level of energy savings equal to 0.7% of its sales in 2018 across all customers.

Building a new gas plant would leave Minnesota Power ratepayers on the hook for hundreds of millions of dollars in stranded costs. Despite these economic shortcomings, Minnesota Power, along with Dairyland Power, has proposed a very large gas plant, the Nemadji Trail Energy Center, to be built in Superior, Wisconsin, and serve customers in both Minnesota and Wisconsin. We have already written about how a CEP would be cheaper than this gas plant by $231 million and would itself be stranded by clean energy by 2032 (within 10 years of operation) if built.[4]

Clean energy solutions are already cost-effective today, and the costs of clean energy will continue to drop moving forward. It is inevitable that both existing coal plants and new gas plants will be stranded by clean energy, including the Boswell coal-fired power plant and any gas-fired power plant that might replace it. In addition to the ample environmental, climate and health reasons to transition to clean energy, the economics are clear: The wisest decision for Minnesota is to move to clean energy as soon as possible.

Appendix: Sources and Methodology

Sources

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

- State-level monthly coal generation: EIA's Electric Power Monthly, released August 2020 https://www.eia.gov/electricity/monthly/
- 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/
- Variable and fixed operations and maintenance: FERC Form 1 filed by Minnesota Power, 2015-2018 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/**

Future coal costs

In order to estimate the levelized cost of operating Boswell for the period 2020-40, 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 the unit 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 stays fixed for the 20-year period at its 2019 operating level of 58%
- Fuel costs: 2018 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 West North Central region. We assumed a heat rate of 10,150 British thermal units (btu)/kilowatt hour (kWh), the plant's reported heat rate in 2018.
- Variable O&M (operation and maintenance) expenses: 2018 variable O&M costs were used as a starting point and inflated by two percent per year, in line with standard inflation. For variable O&M, the following categories of FERC reporting were included: Steam Expense, Electric Expense, Miscellaneous Power Expenses.
- Fixed O&M expenses: 2018 fixed O&M costs were used as a starting point and inflated by two percent per year, in line with standard inflation. For fixed O&M, the following categories of FERC reporting were included: Operating Supervision and Engineering, Maintenance Supervision Expense, Maintenance of Structures, Maintenance of Boiler Plant, Maintenance of Electric Plant, Maintenance of Other Plant.
- Carbon costs: Starting in 2025 at $5 or $25 per short ton of CO_2 and increasing by 2% per year as approved by the MN PUC.
- 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 (listed 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 desulphurization (FGD). For coal plants across the US, the range for ongoing capital expenditure (CapEx) is $19 to $30/kW-year. For JH Campbell unit 3, the average ongoing CapEx is on the higher end of the range at $27/kW-year (2017 dollars), as the unit has FGD and is 40 years old. From here, we inflate this figure by two percent per year to account for normal inflation.

$$CAPEX = 16.53 + (0.126 * age) + (5.68 * FGD)$$
$$where\ FGD = 1\ if\ a\ plant\ has\ an\ FGD, 0\ if\ a\ plant\ does\ not\ have\ FGD$$

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 eight percent) and dividing it by annual generation.

Clean energy portfolio

Given that continuing to run these coal units would be a net cost to customers compared with the energy market, the next step in the analysis was to investigate whether they can be cost-effectively replaced with clean energy and on what timeline. For this analysis, we used the Rocky Mountain Institute's Clean Energy Portfolio algorithm from its 2019 report "The Growing Market for Clean Energy Portfolios" to identify a suite of clean energy technologies (wind, solar, storage, energy efficiency, and demand response) that could replace the services of Minnesota Power's Clay Boswell coal plant.

A clean energy portfolio, or CEP, is a combination of renewable energy, storage, and demand-side management (DSM) projects that meet the needs of the grid and a utility's customers. We use the term DSM to collectively refer to energy efficiency projects (which lead to a reduction in load) and demand response projects (which lead to the shifting or temporary reduction of load). The use of CEPs differs from traditional resource planning, which typically focuses on a specific technology. Instead, a CEP looks at how a range of available clean energy resources could contribute in each hour of the year and finds the combination that meets the unique needs of customers at the lowest feasible cost. In this study, the CEPs are constructed to match the energy, peak capacity, and ramping characteristics of Boswell units 3 and 4. Portfolios are optimized to satisfy these needs at the lowest cost possible.

The CEPs are conservatively designed to meet peak capacity needs in the top 50 hours of capacity need of the year in the Midcontinent Independent System Operator (MISO), the grid region where Minnesota Power and Clay Boswell operate. Some of the 50 peak hours are in the summer, when solar output is high, and some of the hours are in the winter, when solar output is low. As such, the CEP must not rely on solar alone, but rather a complement of wind, solar, storage, and demand-side management technologies. The CEP also must meet the monthly energy requirement of the coal plant's total generation in each month of the year 2017. The CEP algorithm errs on the side of caution, in the sense that other grid resources (like existing gas plants or market purchases) play no role in the replacement, but those resources are typically included in system dispatch or capacity-expansion models that utilities utilize in portfolio analysis. In other words, the CEP algorithm accounts for a complete energy and capacity replacement of the coal plant **without the benefit of any other existing grid resources.** We assume that energy efficiency and demand response could only account for up to 25 percent of the replacement energy and capacity of replacement portfolios, respectively.

We populated the Rocky Mountain Institute model framework with storage and renewable cost assumptions from Lazard's Levelized Cost of Energy, Version 11, and Bloomberg New Energy Finance's New Energy Outlook 2018, both industry standard reports. In addition, the modeling includes the solar investment tax credit, excludes the wind production tax credit, and excludes an investment tax credit for storage (even though many storage projects qualify for that tax credit by pairing with solar). Any excess energy that renewables produced above and beyond the coal plant was valued at $27/MWh, which was the off-peak average price in MISO in 2018. The levelized costs of the CEPs were compared with the average LCOE calculated for the coal units. The result for a full replacement of Boswell units 3 and 4 was 436 MW of solar, 1,348 MW of wind, 400 MW of battery storage, 393 MW of energy efficiency, and 319 MW of demand response. The cost of this CEP would be lower than the cost of continuing to operate the coal plant by 2029 at the latest.

Endnotes

1 Xcel Minnesota: Running coal seasonally will save customers millions, reduce emissions
https://www.utilitydive.com/news/xcel-minnesota-running-coal-seasonally-will-save-customers-millions-reduc/569971/

2 EIA Electricity Browser for coal and wind generation in Minnesota
https://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=808&geo=000004&sec=g&freq=M&start=200101&end=202006&ctype=linechart&ltype=pin&rtype=s&maptype=0&rse=0&pin=

3 Understanding Homeownership Disparities Among Racial and Ethnic Groups - Minnesota Homeownership Center
https://www.hocmn.org/wp-content/uploads/2013/12/REPORT_UnderstandingHomeownershipDisparities_Final.pdf

4 Building New Gas Plants will leave Minnesota ratepayers on the hook for hundreds of millions of dollars in stranded costs
https://www.sierraclub.org/minnesota/blog/2019/11/building-new-gas-plants-will-leave-minnesota-ratepayers-hook-for-hundreds

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