

# **A Clean Energy Alternative for Minnesota Power: Supplemental Report**

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**July 2022**

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## 1 Clean Energy Organizations' EnCompass Modeling Initial Comments

In our report attached to the Clean Energy Organizations' ("CEOs'") comments filed on April 29, 2022, Energy Futures Group and the Applied Economics Clinic presented results of EnCompass modeling based on their independent technical review of Minnesota Power's IRP and EnCompass modeling, along with the presentation of results from the Clean Energy Organizations ("CEO") modeling runs. The CEO modeling runs evaluated two portfolios with different capacity expansion plans:

- 1) A re-optimized "*Revised Minnesota Power ("MP") Preferred Plan*" that includes Minnesota Power's recently announced Nemadji Trail Energy Center Combined Cycle ("NTEC CC") 20 percent share (rather than 50 percent share) of the proposed plant, and
- 2) an all renewable, storage, and demand side management ("DSM") expansion plan without the NTEC CC that we call the "*CEO Preferred Plan*."

For the initial comments, we evaluated these portfolios under a central set of assumptions that involved making minor corrections and changes to Minnesota Power's modeling assumptions, along with updating the cost of new renewable and storage resources. We also evaluated the two portfolios under five of Minnesota Power's sensitivities<sup>1</sup>, which included "low load", "high load", "low gas", "high gas", and "higher gas". Our findings indicated that a portfolio of renewable, storage, and energy efficiency resources with no new fossil generation has costs comparable to a portfolio that includes Minnesota Power's twenty percent share of the NTEC CC.

This supplemental report includes the modeling results from an additional sensitivity that explores a high-cost sensitivity in which costs are increased for all aspects of the power system, including new supply side resource capital costs, electricity prices, natural gas prices, and Powder River Basin ("PRB") coal prices. This new sensitivity is intended to assess cost risks under the current high-price conditions, assuming that these persist through the planning period. The following section discusses the high-cost sensitivity inputs and the modeling results for the Revised MP Preferred Plan and the CEO Preferred Plan.

## 2 Clean Energy Organizations' Supplemental EnCompass Modeling Sensitivity

The focus of the EnCompass modeling for the supplemental comments was to test the two portfolios from our initial report under a high-cost sensitivity in which costs increase across the board for all

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<sup>1</sup> We followed the same approach that Minnesota Power used for its sensitivities and did not reoptimize the capacity expansion plans. We took the Revised MP Preferred Plan and the CEO Preferred Plan and re-dispatched those resources under each sensitivity.

supply-side resources in the CEO's preferred plan<sup>2</sup>, along with coal, natural gas, and electricity prices. The modeling assumptions and results are presented in the following sections.

## 2.1 High-cost Sensitivity

Our new high-cost sensitivity addresses recent price trends in the energy sector, including the higher capital costs of new resource builds, costs of fuel, and, by extension, cost of electricity. The high-cost sensitivity assumes that the inflationary pressures that have occurred recently will continue to persist through 2035, which is unlikely to occur. Thus, our high-cost sensitivity is not an update or replacement of CEO's base case scenario, but rather is an illustrative stress test of the CEO and MP portfolios to determine whether the CEO preferred plan continues to perform well under persistent high-price conditions.

As with our base case, we developed the levelized costs of new wind, solar, and battery storage for use in the Encompass model. We applied the same methodology to the new sensitivity but used "high" capital cost forecasts instead of base or mid forecasts. Our modeling uses the 2021 National Renewable Energy Laboratory ("NREL") Annual Technology Baseline ("ATB") high forecasts to develop the capital cost assumptions for these resources. These assumptions follow the Company's methodology for its high-cost sensitivity but utilize more recent forecasts than those used by MP. The high forecasts include a substantial premium on the costs of solar PV and battery costs in particular, which have been more sensitive to supply-chain issues in recent months. There is limited public data available on what a reasonable premium would be today. Thus, it is possible that the high forecast overstates the current impact, in which case our modeling would be conservative (i.e. disfavorable to these resources). We also applied the same corrections to these high costs as discussed in our initial comments, such as updating the Investment Tax Credit ("ITC") applied to solar and solar-battery hybrids.<sup>3</sup>

The capital cost estimates for the high-cost sensitivity are shown below in Figures 1 through 3 along with MP's and CEO's base forecasts. On average, the solar PV capital cost estimates for the high-cost sensitivity are 18 percent higher than MP's base forecast, while wind and 4-hour battery storage capital cost estimates were 12 percent higher. These capital cost estimates are substantially higher than the CEO base case forecasts for solar and 4-hour battery storage, 29 and 22 percent, respectively. Our CEO high-cost wind assumption is only 6 percent higher than the CEO base case assumption, which was already higher than MP's base case assumption.

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<sup>2</sup> We did not make any changes to the costs that Minnesota Power modeled for the NTEC CC ownership share.

<sup>3</sup> Hotaling et al, *A Clean Energy Alternative for Minnesota Power*, April 2022, p.10-12.

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Figure 1. Solar PV Capital Costs (\$2020/kW)

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Figure 2. Battery Storage (4-hr) Capital Costs (\$2020/kW)

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**Figure 3. Wind Capital Costs (\$2020/kW)**

We calculated the levelized cost of energy (“LCOE”) of solar PV, wind, and battery resources as inputs for the Encompass model. The LCOE includes capital and operations costs over the project life, represented as a cost per MWh (for solar PV and wind) or kW-month (for battery storage).

Table 1 below shows our levelized costs of solar, wind, and battery storage resources under the high-cost sensitivity.

**Table 1. CEO’s Levelized Cost Estimates by Resource Type under High-Cost Sensitivity**

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CEO’s high-cost sensitivity also considered increases in coal, gas, and electricity prices due to recent market changes in the respective markets. Notably, these markets are interrelated—especially gas and electricity prices which tend to move closely with one another. In addition, coal prices in the U.S. spiked starting late in 2021 in part due to increased demand as a response to high natural gas prices.<sup>4</sup>

For natural gas and electricity price forecasts in our high-cost sensitivity, we used MP’s “higher” gas and electricity price forecasts, which were 50 percent above its base forecasts. As shown below in

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**Figure 4**, of MP’s multiple gas forecasts, actual natural gas prices in 2021 and 2022 for Minnesota Citygate hewed closely to MP’s “higher” gas price forecast. More recent gas price data was available for Henry Hub (which tends to be lower than MN Citygate) and that was well above the “higher” price in May and June. But the spike in May and June is unlikely to persist: futures markets of late anticipate that Henry Hub prices will level out in early 2023 and 2024 to around \$4.50-\$5/MMBtu.<sup>5</sup> Because of the tight correlation with natural gas and electricity prices, we used MP’s “+50%” electricity prices along with the 50 percent increase in MP’s “higher” gas price forecast for our high-cost sensitivity.

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**Figure 4. Natural Gas Price Forecasts and Actuals (\$/MMBtu)<sup>6</sup>**

<sup>4</sup> EIA, “Historic coal prices by region”, available at: <https://www.eia.gov/coal/markets/#tabs-prices-1>

<sup>5</sup> CME Group, Henry Hub Natural Gas Futures, Settlements from July 18, 2022, available at: <https://www.cmegroup.com/markets/energy/natural-gas/natural-gas.settlements.html#tradeDate=07%2F15%2F2022>

<sup>6</sup> EIA actual Henry Hub and MN Citygate gas prices, available at: <https://www.eia.gov/naturalgas/data.php#prices>. Note that data was unavailable for MN Citygate gas prices in September and November of 2021; Please see DOC IR01 TS Attach - FINAL FEB1 IRP2020 MODEL for MP’s modeled natural gas prices.



Our new sensitivity also addressed recent increases in coal prices. The Boswell coal plant burns Powder River Basin (“PRB”) coal, which had a sharp price increase along with other coal regions starting in late 2021.<sup>7</sup> More recently, PRB coal prices have tempered but remain slightly higher than they were prior to 2021.<sup>8</sup> To address a slightly higher coal price, we used the recent changes in long-term forecasts of PRB coal prices from the EIA’s most recent Annual Energy Outlook (“AEO”). This forecast increased PRB prices by roughly 11 percent on average (for the period of 2021 through 2035) from the previous year’s forecast—as shown below in Figure 5.

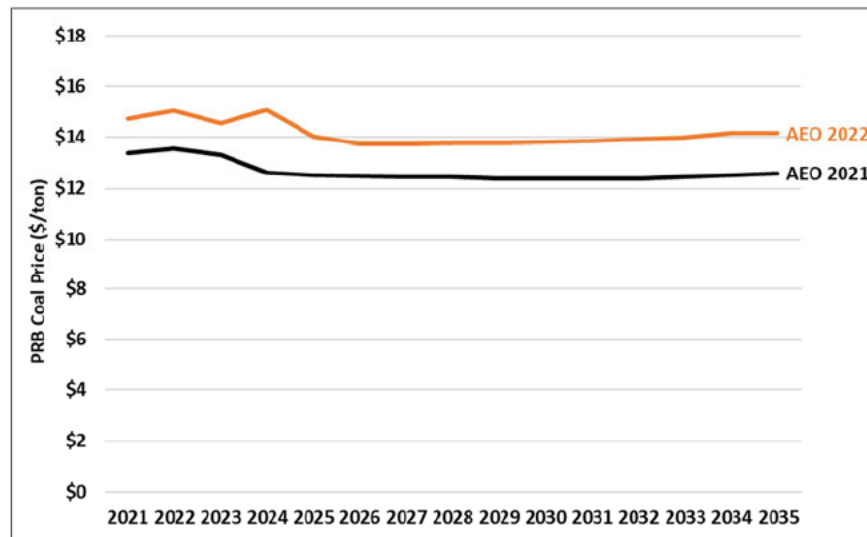


Figure 5. EIA Powder River Basin Coal Price Forecasts (\$/ton)<sup>9</sup>

## 2.2 High-cost Sensitivity Modeling Results

Table 2 below shows the present value of revenue requirements (“PVRR”) and present value of societal cost (“PVSC”) for the Revised MP Preferred Plan and the CEO Preferred Plan for the period 2021 – 2035 as presented in the initial EFG/AEC report. Table 3 shows the results for the Revised MP Preferred Plan and the CEO Preferred Plan under the high-cost sensitivity. These results indicate that a plan that does not rely on the NTEC CC or additional fossil fuel-based generation would remain slightly lower cost even under the high-cost sensitivity.

<sup>7</sup> EIA, “Historic coal prices by region”, available at: <https://www.eia.gov/coal/markets/#tabs-prices-1>

<sup>8</sup> Id.

<sup>9</sup> EIA AEO 2021 and 2022, Coal Supply Minemouth Price West Northern Great Plains (ND, MT, WY), available at: <https://www.eia.gov/outlooks/aeo/data/browser>

**Table 2. PVRR and PVSC Results for Initial (April 2022) CEO Modeling (\$000)**

	<b>Revised MP Preferred Plan</b>	<b>CEO Preferred Plan</b>
PVRR	\$6,402,903	\$6,391,441
Externality	\$1,839,387	\$1,849,611
<b>PVSC</b>	<b>\$8,242,290</b>	<b>\$8,241,052</b>

**Table 3. PVRR and PVSC High-Cost Sensitivity Results for CEO Supplemental Modeling (\$000)**

	<b>Revised MP Preferred Plan High-Cost</b>	<b>CEO Preferred Plan High-Cost</b>
PVRR	\$6,830,797	\$6,809,463
Externality	\$2,390,235	\$2,390,488
<b>PVSC</b>	<b>\$9,221,032</b>	<b>\$9,199,952</b>

### 2.3 Carbon Dioxide (“CO<sub>2</sub>”) Emissions

Table 4 below shows the CO<sub>2</sub> emissions from the Revised MP Preferred Plan and the CEO Preferred Plan under the high-cost sensitivity. The level of CO<sub>2</sub> emissions under both the Revised MP Preferred Plan and the CEO Preferred Plan are both higher under the high-cost sensitivity when compared to the modeling presented in the original report due to the changes made to the commodity prices, including the electricity, natural gas, and coal prices. The increase in the commodity prices result in a change in the dispatch of Minnesota Power’s resource fleet, along with the interaction with the MISO market and the levels of purchases and sales. Both portfolios see a higher dispatch from both Boswell 3 and 4 under the high-cost sensitivity, which is the main contributor to the higher level of CO<sub>2</sub> emissions. The Boswell units dispatching at higher levels occurred in both plans under the high-cost sensitivity and it does not change the overall result: that the CEO Preferred Plan has a lower level of CO<sub>2</sub> emissions when compared to the Revised MP Preferred Plan.

Table 4. CO<sub>2</sub> Comparison for High-Cost Sensitivity (Tons)

Year	Revised MP Preferred Plan High-cost	CEO Preferred Plan High-cost
2021	6,324,964	6,304,785
2022	5,747,952	5,798,840
2023	5,605,189	5,672,443
2024	5,366,052	5,131,561
2025	3,111,879	3,394,934
2026	3,223,834	3,494,537
2027	3,525,882	3,696,866
2028	3,529,499	3,715,250
2029	3,548,895	3,482,583
2030	2,294,977	2,100,378
2031	2,224,317	1,977,038
2032	2,310,918	2,023,929
2033	2,179,491	2,026,575
2034	2,170,721	1,879,787
2035	2,211,052	1,756,212
<b>Total</b>	<b>53,375,620</b>	<b>52,455,718</b>

### 3 Summary

The EnCompass modeling described in this report evaluated the results of looking at a high-cost sensitivity where costs for all supply side resources, coal prices, and natural gas prices are all increased. The results indicate that the CEO Preferred Plan without the NTEC CC or new fossil generation still performs well in comparison to the Revised MP Preferred Plan that includes its share of the NTEC CC.