Presentation to Public Utilities Board - Manitoba Hydro 2025 Integrated Resource Plan (IRP) and Major New Facilities (MNF)

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Summary of Presentation

- We will share new modelling work that has three majors findings:
  - Wind generation with diverse siting and modern turbines has a **far higher winter firm reliability** than assumed by Manitoba Hydro.
  - A combination of wind generation (and even solar generation) with 750 MW of battery energy storage (BESS) can **meet worst -case winter peaks in all modelled scenarios** with the same or even greater reliability than gas generation.
  - Plans that prioritize wind/solar generation and BESS are **substantially cheaper than a new gas plant** , even before tax credits and higher gas turbine costs.

Methodology

- Analysis conducted by Alexander Hogeveen Rutter, an energy modelling specialist who previously worked on Manitoba Hydro's Needs For and Alternatives To (NFAT).
- Wind and solar output was modelled in Renewables Ninja using the internationally recognized MERRA-2 dataset.
- All modelled scenarios were calibrated to meet Manitoba Hydro's standard Loss of Load Probability (LOLP) of 0.1 days/year or 1 day/10 years (99.97% reliability). It also matches existing ELCC methodology.
- As Manitoba Hydro does not publish hourly load data, a modelled load from July 2021 to June 2026 was based on the seasonal profiles provided in the IRP, along with 10 high-load events that were taken directly from the IRP.

1. What Should the ELCC for Wind Be?

- Manitoba Hydro's low capacity accreditation for wind generation (20% for first 700 MW, 4% for subsequent 1,800 MW) is based on the erroneous assumption that all wind farms would be built with **the same geographical and technological profiles** as St. Leon and St. Joseph.
- Manitoba Hydro acknowledges this in CC/MH I -15a-c p. 4: "By restricting the analysis to the *existing* wind generation data, the analysis excludes any potential technological and geographic diversity benefits that might be attained with *future* wind development."

1. What Should the ELCC for Wind Be?

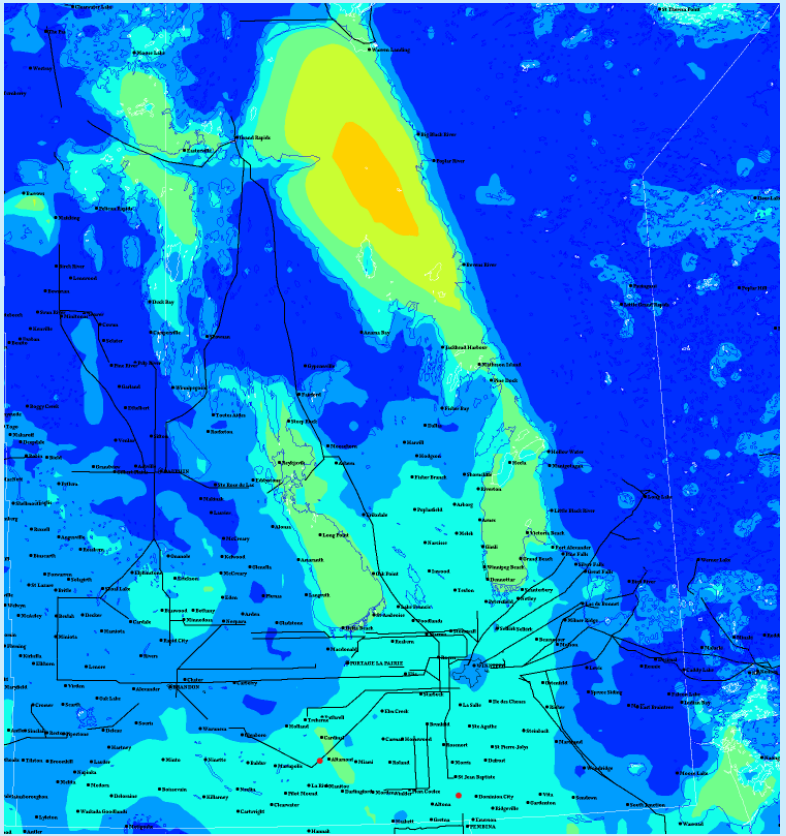
- When wind generation is modelled with diverse siting and modern turbines, wind achieves a **33% winter firm capacity up to 600 MW** and **27% up to 1,080 MW**.
- Greater diversity in wind farm siting reduces the probability of a high load coinciding with low wind at all wind farms at once.

Scenario	MW of new Wind	MW of New Load	ELCC	Incremental ELCC	Peak Deficit Time
St. L and St. Jonly	600	140	23%	-	2026-01-22 18:00:00
St. L and St. Jonly	1080	160	15%	4%	2026-01-22 18:00:00
Diversified Wind	600	200	33%	-	2026-01-22 18:00:00
Diversified Wind	1080	295	27%	20%	2026-01-22 18:00:00
Diversified Wind	1560	320	21%	5%	2026-01-22 18:00:00

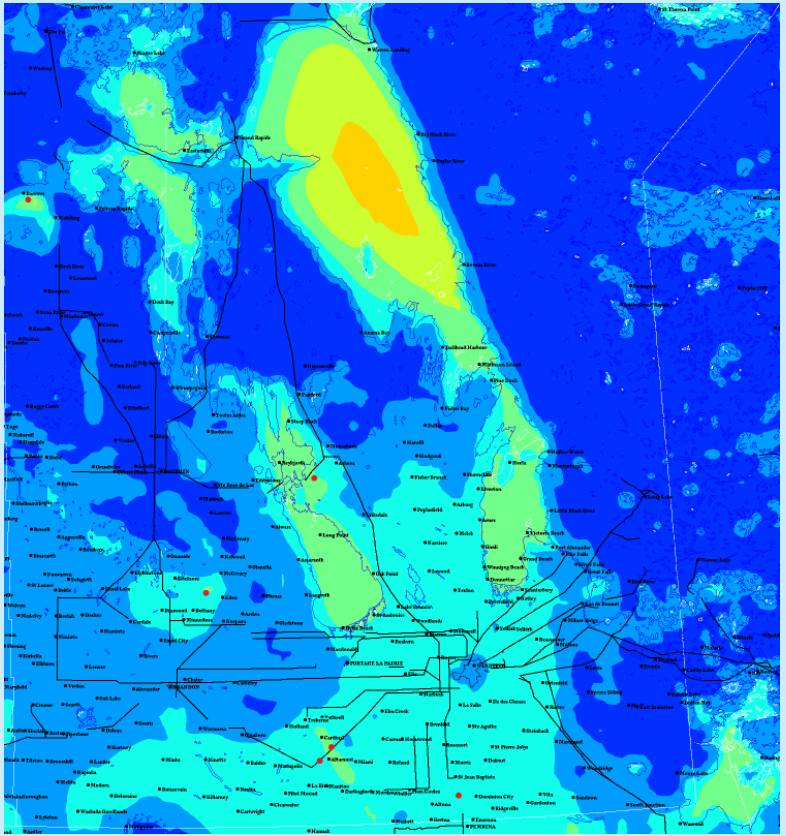
1. What Should the ELCC for Wind Be?

- The modelling used sites with relatively high wind (but did not attempt to optimize them fully), close to existing power lines, and relatively distributed without being implausible.
- These sites are labelled “Altamont” (South-Central), “Minnedosa” (West), “Barrows” (Northwest) and “Ashern” (Interlake), based on proximity to nearby towns.
- It does not advocate for these four sites per se, but uses them as an example to show how ELCC of wind improves with diverse sites.

Current Wind Farm Siting



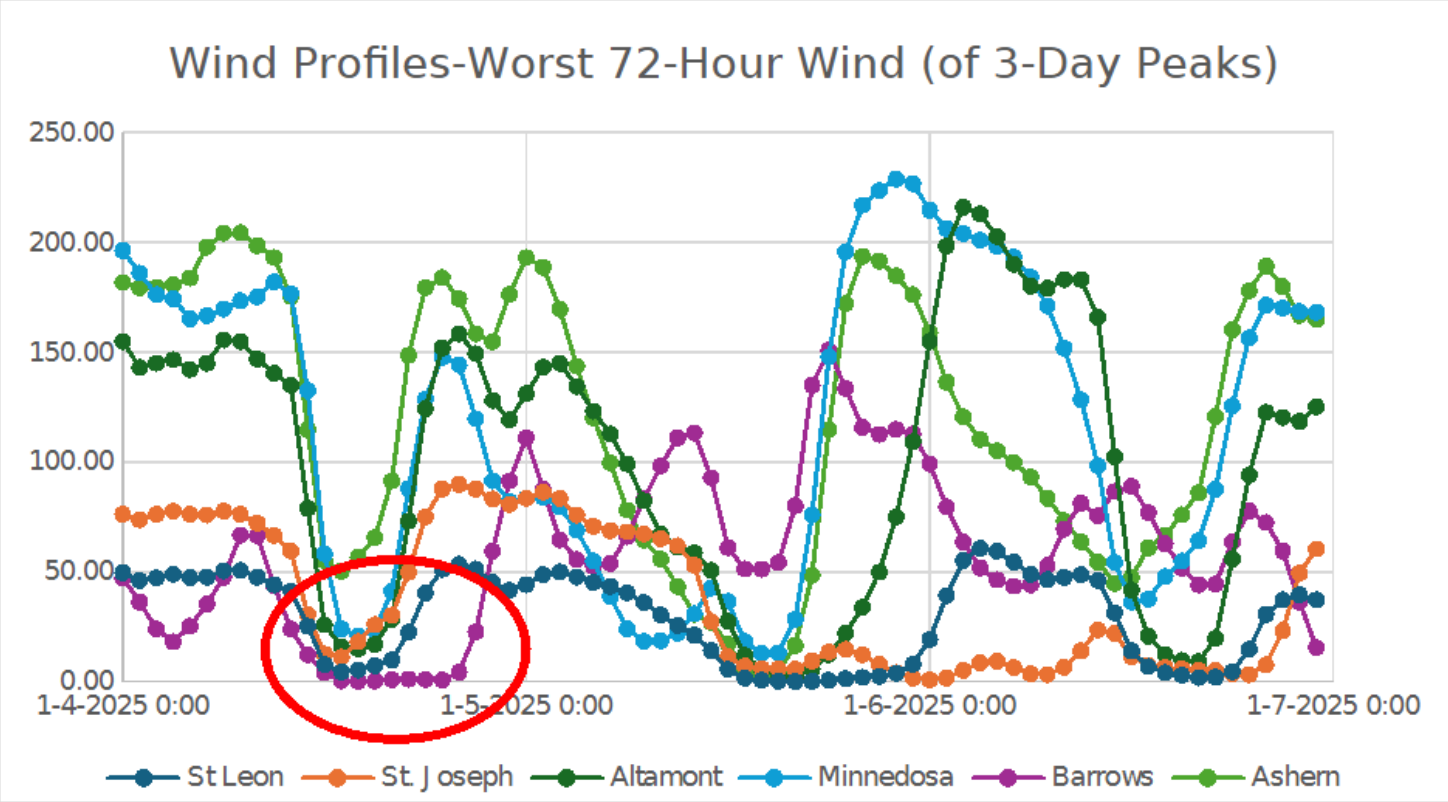
Modelled Wind Farm Siting



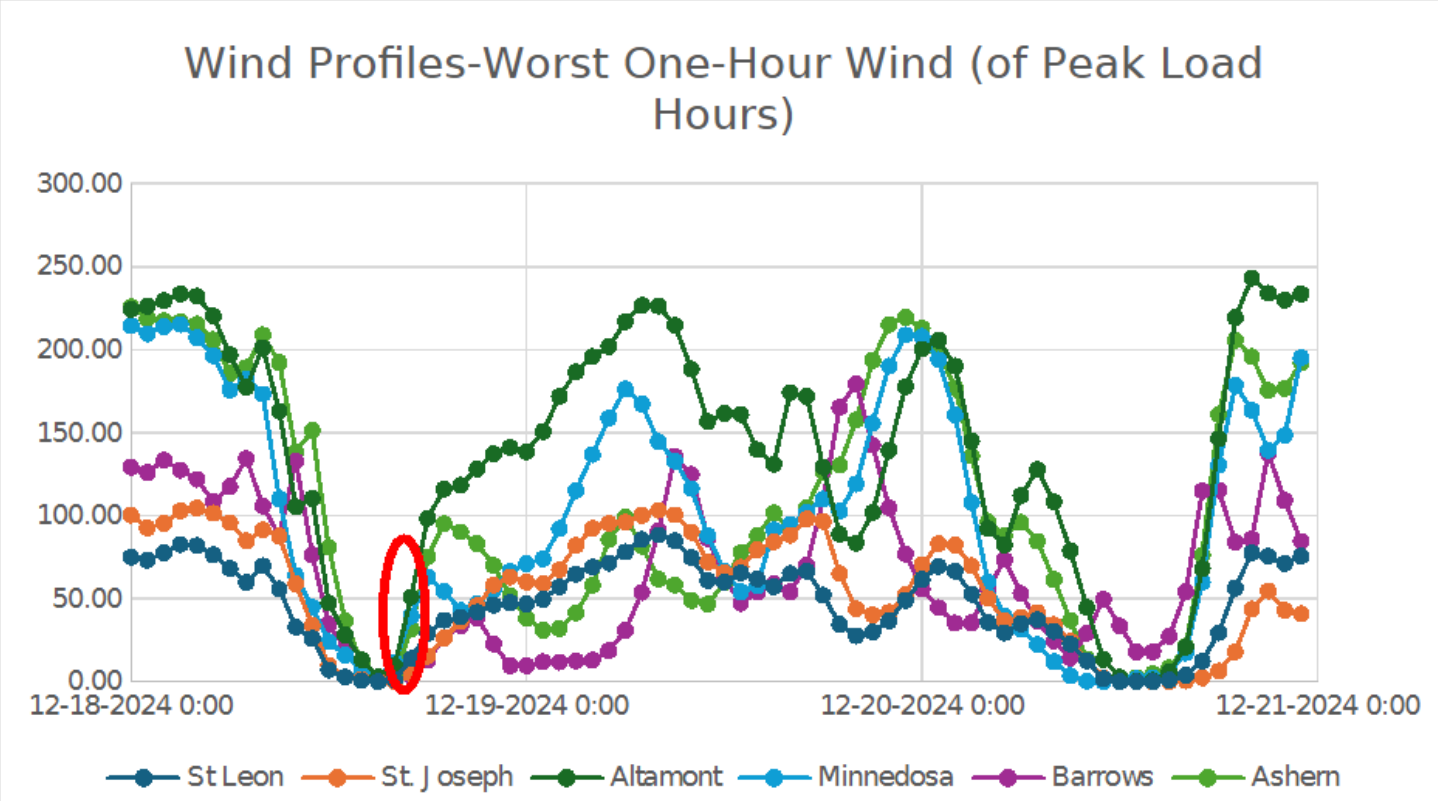
1. What Should the ELCC for Wind Be?

- The following charts show diverse wind generation during the lowest wind period of the 10 high -load periods (Jan. 4–6, 2025) and the worst one-hour wind (Dec. 18, 2024, at 7 p.m.).

Wind Profile of St. Leon and St. Joseph Against Modelled Sites for Worst Wind Drought During High Load



Wind Profile of St. Leon and St. Joseph Against Modelled Sites for Worst Wind During a Peak Hour



1. What Should the ELCC for Wind Be?

- Building wind at diversified sites (rather than concentrated as Manitoba Hydro assumes) **significantly improves the reliability of wind.**
- Secondary factor is assuming modern turbines, with higher hub heights (150 m) and installed capacity (4.5 MW), rather than 80 m/1.65 - 2.3 MW.

2. How Much BESS Would Be Required to Back-up Wind?

- This analysis answers how much BESS would be required to “firm up” the wind. In other words, if wind provides the energy (GWh), how much BESS would be required to meet the capacity (MW)?
- It examines the size and duration of BESS required to replicate the reliability of the proposed 750 MW gas plant, without vetting whether the 750 MW gas plant is necessary to meet Manitoba Hydro’s own load forecast and planning reserve margin.
- It restricted BESS to charge only from surplus wind (with a 15% efficiency penalty, i.e., 85% round-trip efficiency). In reality, some synergy between wind, hydro, and BESS should be expected (such as increasing pondage ahead of high-load events).

2. How Much BESS Would Be Required to Back-up Wind?

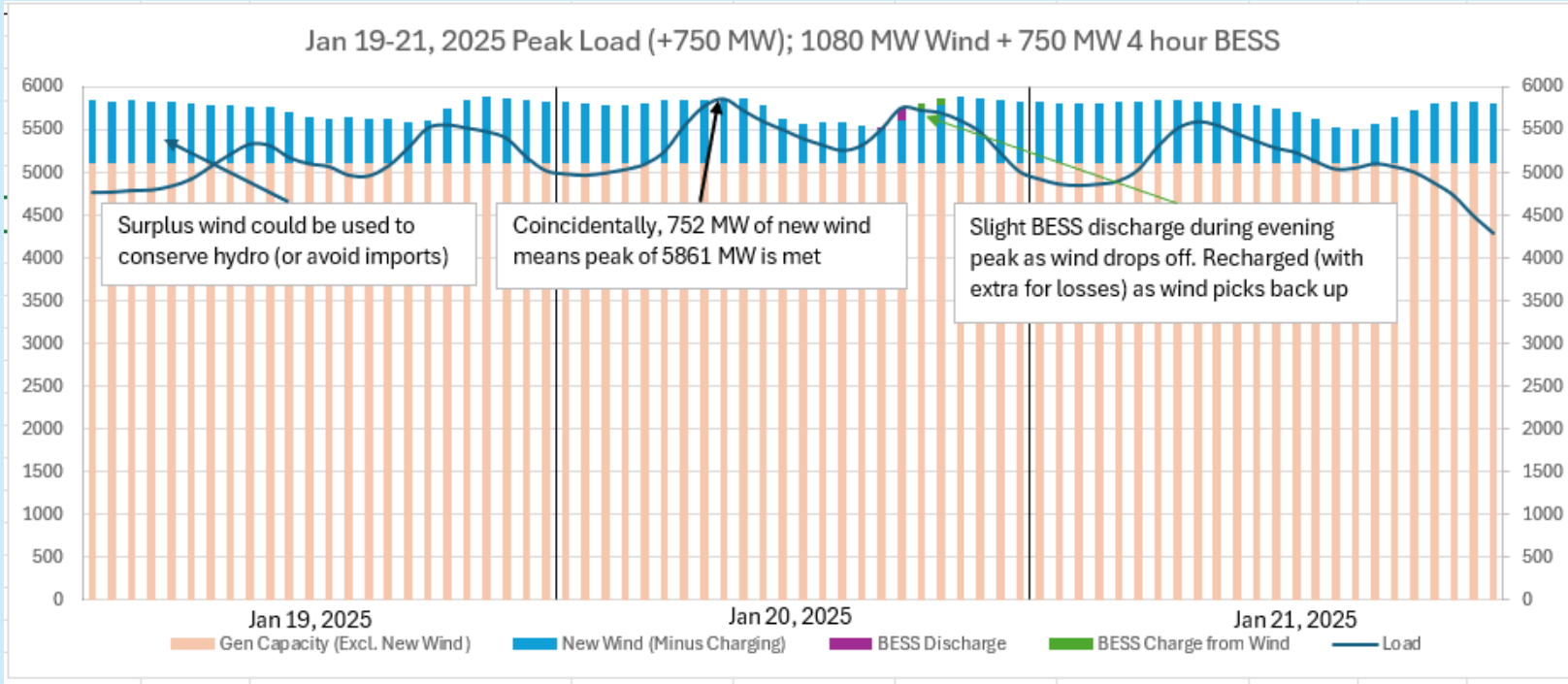
- Wind generation tends to be strongest during cold snaps, meaning it can often directly contribute to meeting peak demand.
- BESS greatly increases winter firm capacity, and can be charged by wind (or even solar) before and after peaks.
- **Winter firm reliability of 99.99%** can be achieved using any of the three modelled resource mixes:
  - **1,080 MW wind** plan.
  - Existing **600 MW wind** plan.
  - **600 MW wind/600 MW solar** plan.

2.1- Scenario 1: 1,080 MW wind + BESS

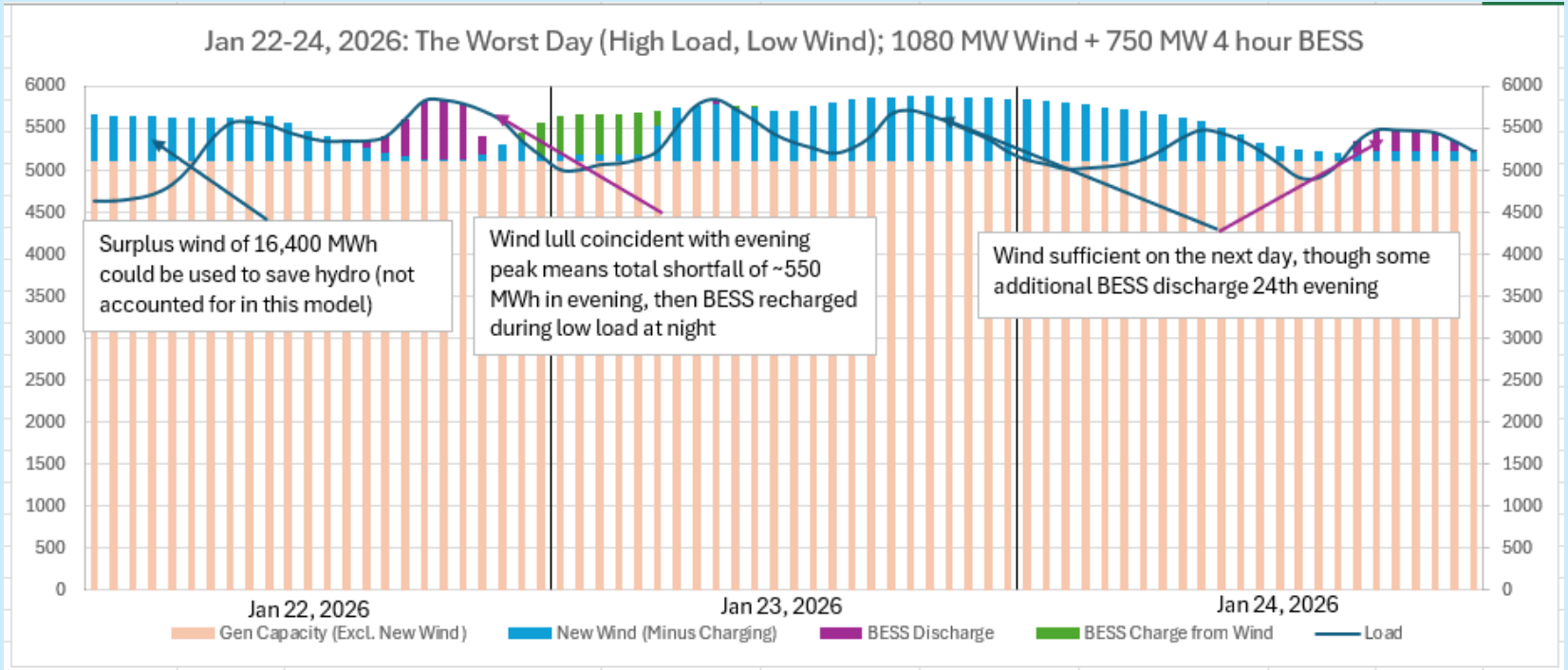
- Our ELCC calculations suggest 750 MW, 4-hour BESS (3,000 MWh) charged by 1,080 MW wind is sufficient to arrive at an **ELCC of 100%.**
- Even a 2-hour BESS would provide an **ELCC of 91%**, comparable to what Manitoba Hydro reports as the SCGT's ELCC.
- Manitoba Hydro reports annual build limit of 600 MW of wind, making 1,080 MW by 2030/31 feasible assuming 2-3 years per wind farm.

Duration (Hours)	MW (Load)	ELCC
2	680	91%
3	745	99%
4	>750	100%

2.1- Jan. 19, 2025 peak (+750 MW)



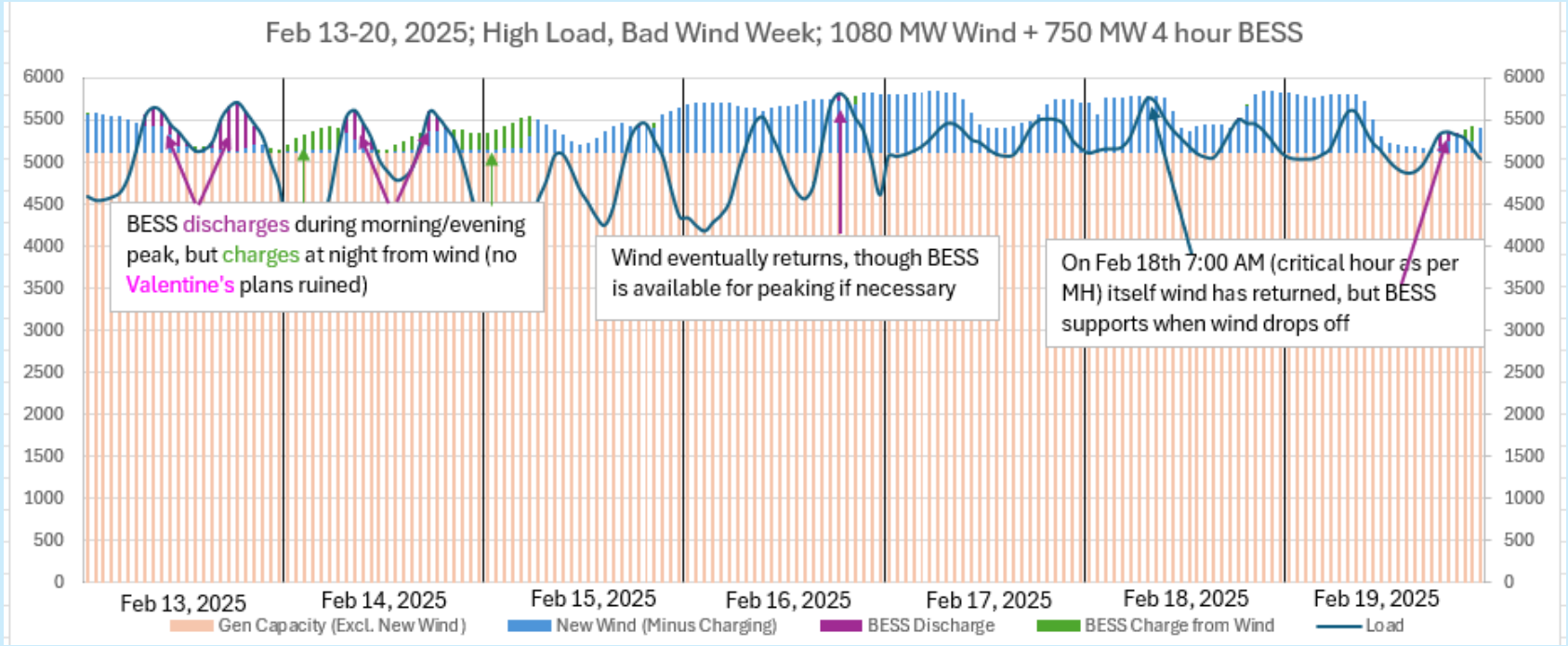
2.1- Model's "worst" day on Jan. 22, 2026 (+750 MW)



2.1- Scenario 1: 1,080 MW wind + BESS

- This missing 550 MWh results from modelling to meet reliability standard of 99.97%.
- Duration of deficit is two hours, and could be met by extending BESS from 4 to 5 hours (extra 750 MWh), using saved hydro from previous night, calling on curtailable load customers, and/or with spot market purchases.

2.1- Worst cold snap in Feb. 2025 (+750 MW)

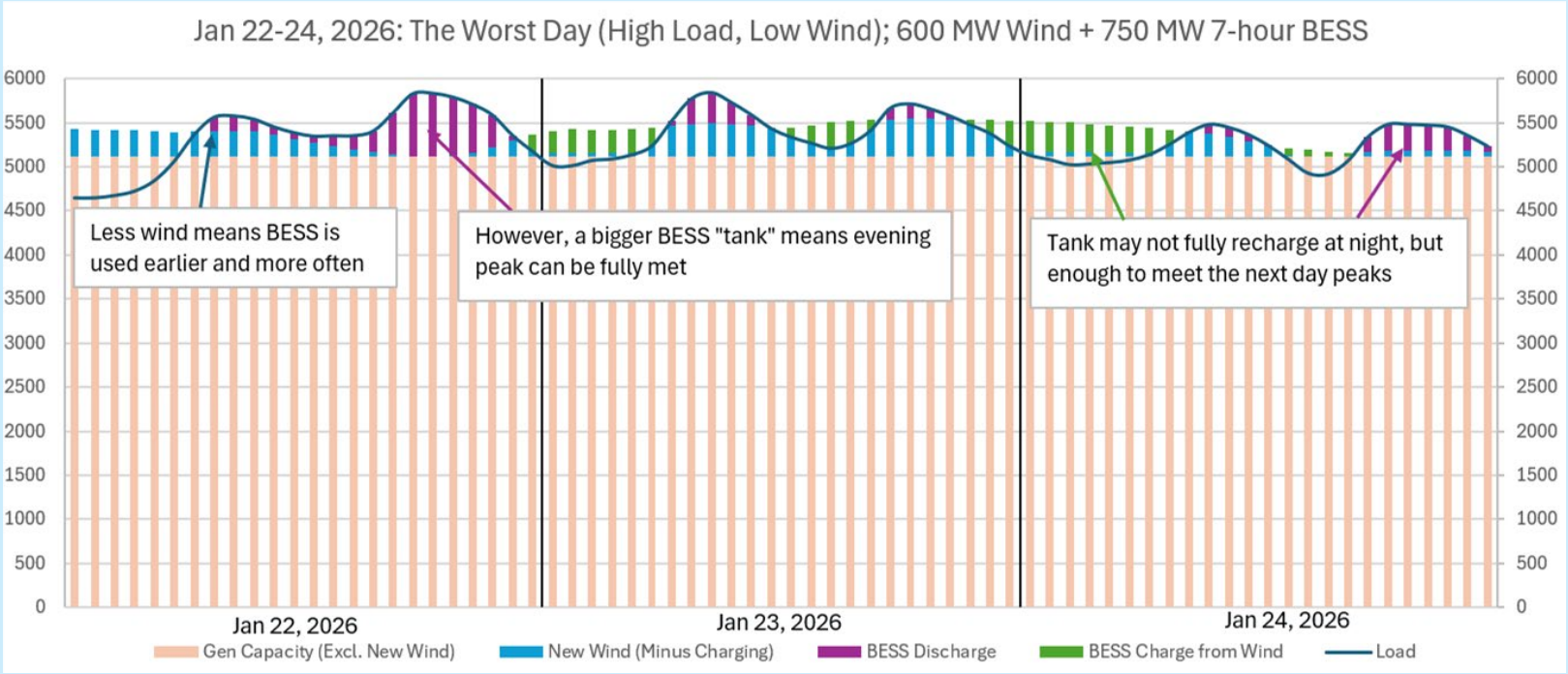


2.2 - Scenario 2: 600 MW wind + BESS

- If wind is capped at 600 MW, load can still be met with BESS, but **7-hour duration** is required for the same level of reliability as before.
- Less wind means the BESS is used more, but because it has large capacity, it can fully last through the ~8 hour evening peak.

Duration (Hours)	MW (Load)	ELCC
4	675	90%
5	705	94%
6	735	98%
7	>750	100%

2.1- Model's "worst" day on Jan. 22, 2026 (+750 MW)

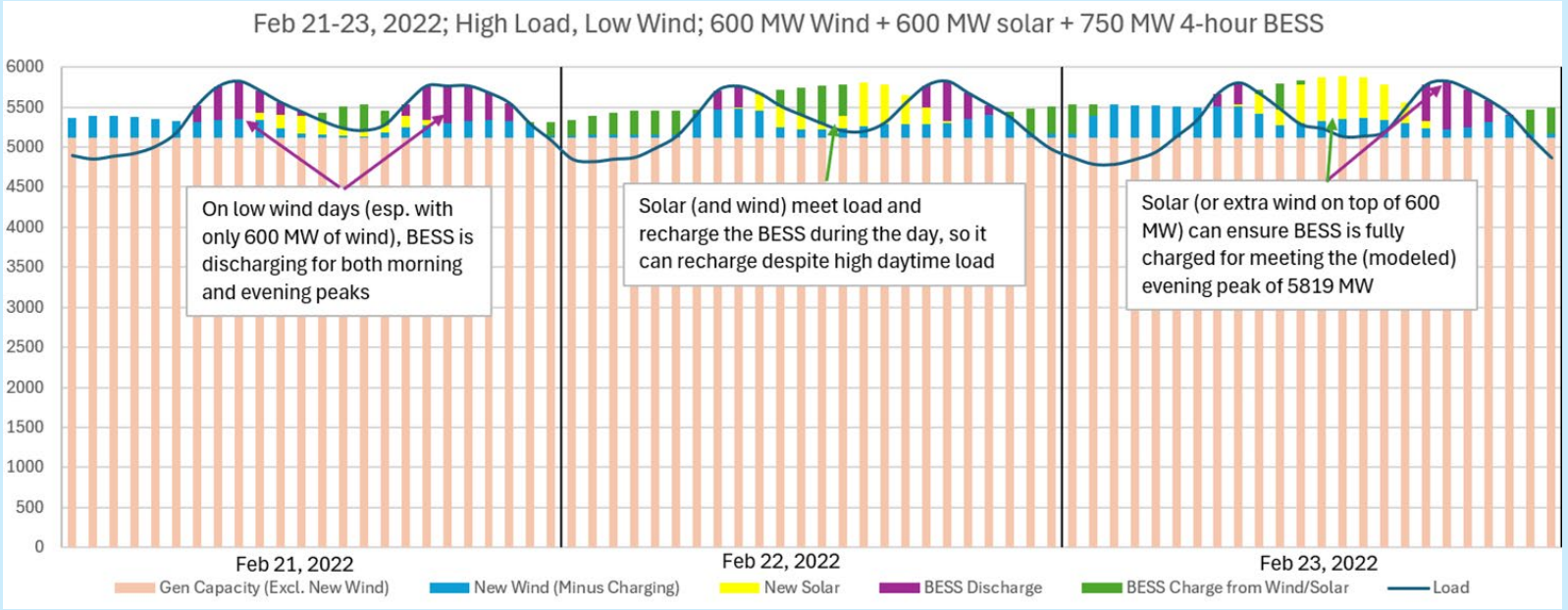


2.3 - Scenario 3: 600 MW wind + 600 MW of solar + BESS

- Solar has winter capacity of 0 on its own.
- The “worst” days for wind + BESS tend to be when there is a morning peak that depletes the battery and then not enough wind during the day to recharge the battery for the evening peak.
- **Even a modest amount of solar during the day** ensures the BESS is fully recharged to serve the evening peak.

Duration (Hours)	MW (Load)	ELCC
2	670	89%
3	735	98%
4	750	100%

2.3 - High-load, low-wind stretch on Feb. 21-23, 2022 (+750 MW)



2.3 - Scenario 3: 600 MW wind + 600 MW of solar + BESS

- Even if wind is capped at 600 MW, a 4 -hour BESS is sufficient for reliability if Manitoba Hydro also contracts/builds 600 MW of solar to “top up” the BESS during low-wind days.

3. Cost Comparisons of MH Plan vs. Our Proposed Plans

- Section 1 and 2 have shown that Manitoba Hydro's load growth can be reliability met with a combination of wind and BESS (and possibly solar).
- We believe that if Manitoba Hydro includes a plan with up to 750 MW BESS and updates the wind ELCC for a diversified rather than concentrated profile, their own models will show the economic benefit of wind and BESS over the proposed natural gas plant.
- On upfront capacity cost, energy cost, and blended cost, plans which prioritize wind + BESS are **substantially cheaper than new SCGTs.**

3. Cost Comparisons of MH Plan vs. Our Proposed Plans

Scenario	Capacity	ELCC (MW)	Energy	GWh	Capacity Capex ($M)	Energy Cost ($/MWh)	Blended Cost ($/MWh)
0	750 MW SCGT	682.5	750 MW SCGT	329	$1,217	$108	$391
1	750 MW/3000 MWh BESS	750	1080 MW Wind	4154	$1,015	$56	$85
2	750 MW/5250 MWh BESS	750	600 MW Wind	2308	$1,548	$56	$136
3	750 MW/3000 MWh BESS	750	600 MW Wind, 600 MW Solar	3131	$1,015	$64	$103

3. Cost Comparisons of MH Plan vs. Our Proposed Plans

- Assumes BESS cost is fully loaded onto firming wind/solar, does not account for any value stacking (reducing ancillary service costs, better optimizing existing hydro assets, reducing transmission/distribution costs).
- Gas turbine costs taken from IRP: if they cost significantly more, as expected, the cost differential with wind and BESS **would be even higher** .
- If solar is relatively cheaper due to global price declines, Scenario 3 may be more cost effective.
- Did not thoroughly vet Manitoba Hydro's load growth projections nor model interaction between wind and hydroelectric generation.

Key Conclusions

- Manitoba Hydro's energy demand growth can be met by **modestly increasing Manitoba Hydro's wind (and/or solar) targets.**
- Building wind **at diversified sites** (rather than concentrated as Manitoba Hydro assumes) improves the reliability of wind.
- Manitoba Hydro's capacity shortfall can be met with a **moderate (by Canadian and international standards) amount of BESS.**
- Building **~1,080 MW of wind and 750 MW/3,000 MWh** of BESS would provide a higher level reliability than a 750 MW natural gas plant at a lower cost.
- The exact figures could be further optimized with better access to Manitoba Hydro's load profile and forecast.