

Forecast Uncertainty Analysis

Reserve Certainty
Senior Task Force
August 27, 2025

IMM



Monitoring Analytics

Load Uncertainty Analysis Overview

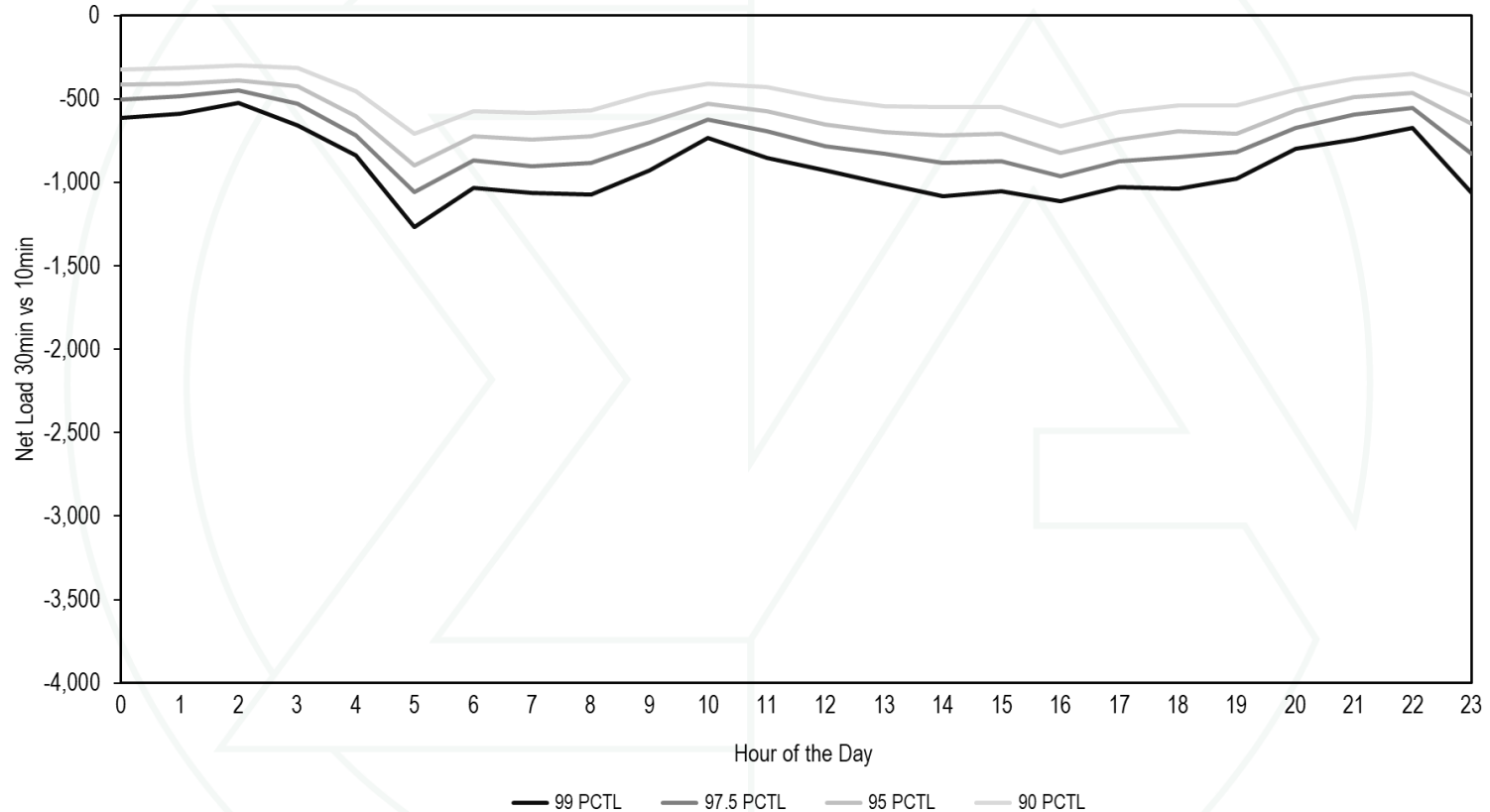
- This analysis quantifies the uncertainty of net load forecasts.
- We compare different forecast horizons
 - 2 hour vs. 30 min (secondary reserve timeframe)
 - 30 min vs. 10 min (primary reserve timeframe)
- This analysis uses net load forecast data from all available intervals from June 2024 to May 2025
 - Net load = Load – Solar – Wind
- Negative values indicate an under forecast, meaning net load increased closer to real time.

Net Load Uncertainty by Hour of the Day

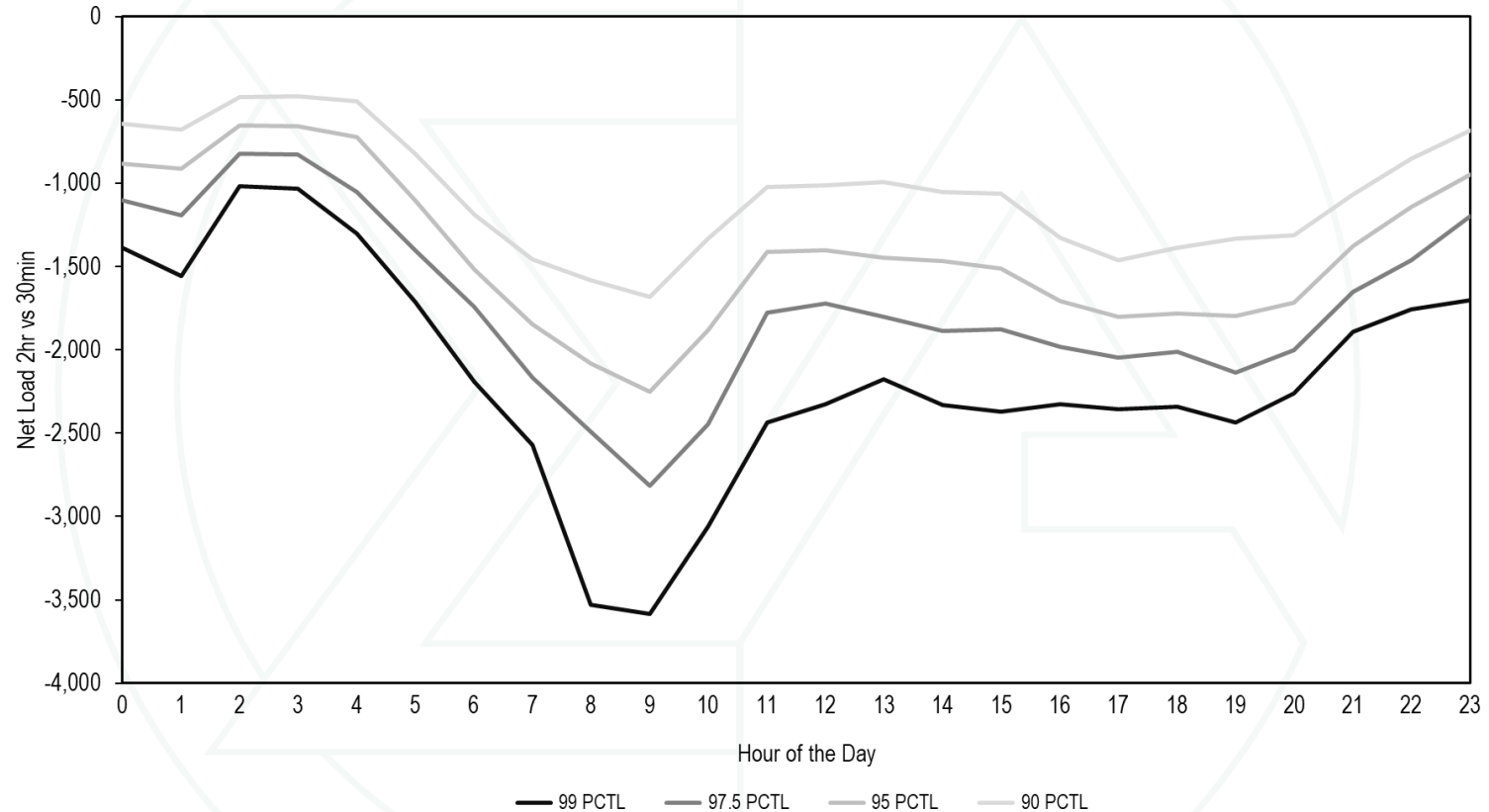
- **The level of uncertainty changes throughout the day.**
- **At 30 min look ahead, the largest under forecasted hours are at 5 AM and 11 PM.**
- **At the 2 hour look ahead, the largest under forecasted hours are at 8 AM and 9 AM.**



Net Load 30 min Less 10 min by HOD



Net Load 2 hour Less 30 min by HOD



Net Load Uncertainty by Hour of the Day

| HOD | Net Load Uncertainty | | | | | | | |
|-----|----------------------|-----------|---------|---------|------------------|-----------|---------|---------|
| | 30 min less 10 min | | | | 2 hr less 30 min | | | |
| | 99 PCTL | 97.5 PCTL | 95 PCTL | 90 PCTL | 99 PCTL | 97.5 PCTL | 95 PCTL | 90 PCTL |
| 0 | (615) | (503) | (412) | (325) | (1,389) | (1,104) | (881) | (646) |
| 1 | (590) | (486) | (410) | (314) | (1,556) | (1,193) | (914) | (680) |
| 2 | (524) | (449) | (391) | (301) | (1,020) | (823) | (656) | (484) |
| 3 | (657) | (528) | (422) | (315) | (1,034) | (826) | (656) | (479) |
| 4 | (838) | (719) | (604) | (455) | (1,305) | (1,051) | (722) | (511) |
| 5 | (1,269) | (1,057) | (897) | (707) | (1,714) | (1,404) | (1,105) | (825) |
| 6 | (1,032) | (866) | (725) | (574) | (2,190) | (1,741) | (1,518) | (1,186) |
| 7 | (1,063) | (903) | (745) | (586) | (2,572) | (2,168) | (1,847) | (1,457) |
| 8 | (1,075) | (882) | (725) | (570) | (3,529) | (2,491) | (2,084) | (1,584) |
| 9 | (926) | (765) | (636) | (470) | (3,583) | (2,815) | (2,253) | (1,681) |
| 10 | (732) | (625) | (527) | (408) | (3,060) | (2,446) | (1,884) | (1,333) |
| 11 | (854) | (695) | (576) | (427) | (2,436) | (1,779) | (1,411) | (1,025) |
| 12 | (928) | (786) | (651) | (498) | (2,326) | (1,723) | (1,402) | (1,013) |
| 13 | (1,009) | (830) | (697) | (541) | (2,178) | (1,803) | (1,450) | (995) |
| 14 | (1,085) | (885) | (718) | (549) | (2,330) | (1,887) | (1,469) | (1,051) |
| 15 | (1,054) | (874) | (709) | (551) | (2,371) | (1,876) | (1,512) | (1,062) |
| 16 | (1,113) | (961) | (826) | (661) | (2,324) | (1,980) | (1,706) | (1,329) |
| 17 | (1,027) | (871) | (741) | (579) | (2,355) | (2,047) | (1,800) | (1,465) |
| 18 | (1,036) | (848) | (696) | (540) | (2,340) | (2,012) | (1,784) | (1,389) |
| 19 | (976) | (816) | (706) | (538) | (2,438) | (2,134) | (1,796) | (1,333) |
| 20 | (799) | (672) | (567) | (445) | (2,261) | (2,003) | (1,718) | (1,310) |
| 21 | (741) | (596) | (489) | (380) | (1,893) | (1,653) | (1,375) | (1,070) |
| 22 | (675) | (555) | (465) | (348) | (1,758) | (1,464) | (1,143) | (855) |
| 23 | (1,063) | (831) | (651) | (478) | (1,702) | (1,196) | (947) | (682) |

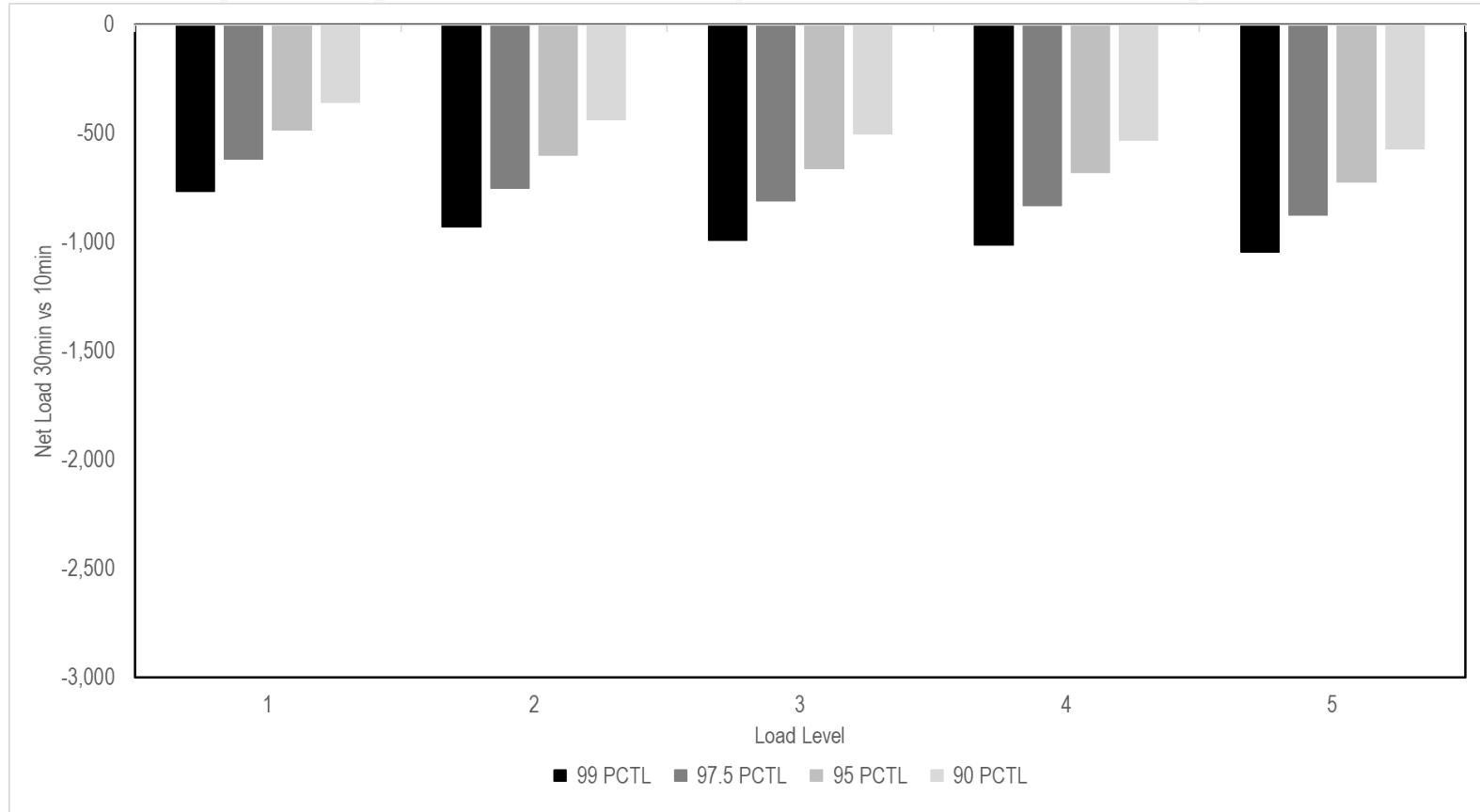
Net Load Uncertainty by Load Level

- **Uncertainty varies with the load level**
- **There is a greater chance of under forecasting net load at higher load levels.**
- **For the 30 min forecast, the largest under forecast net load is about 1,000 MW.**

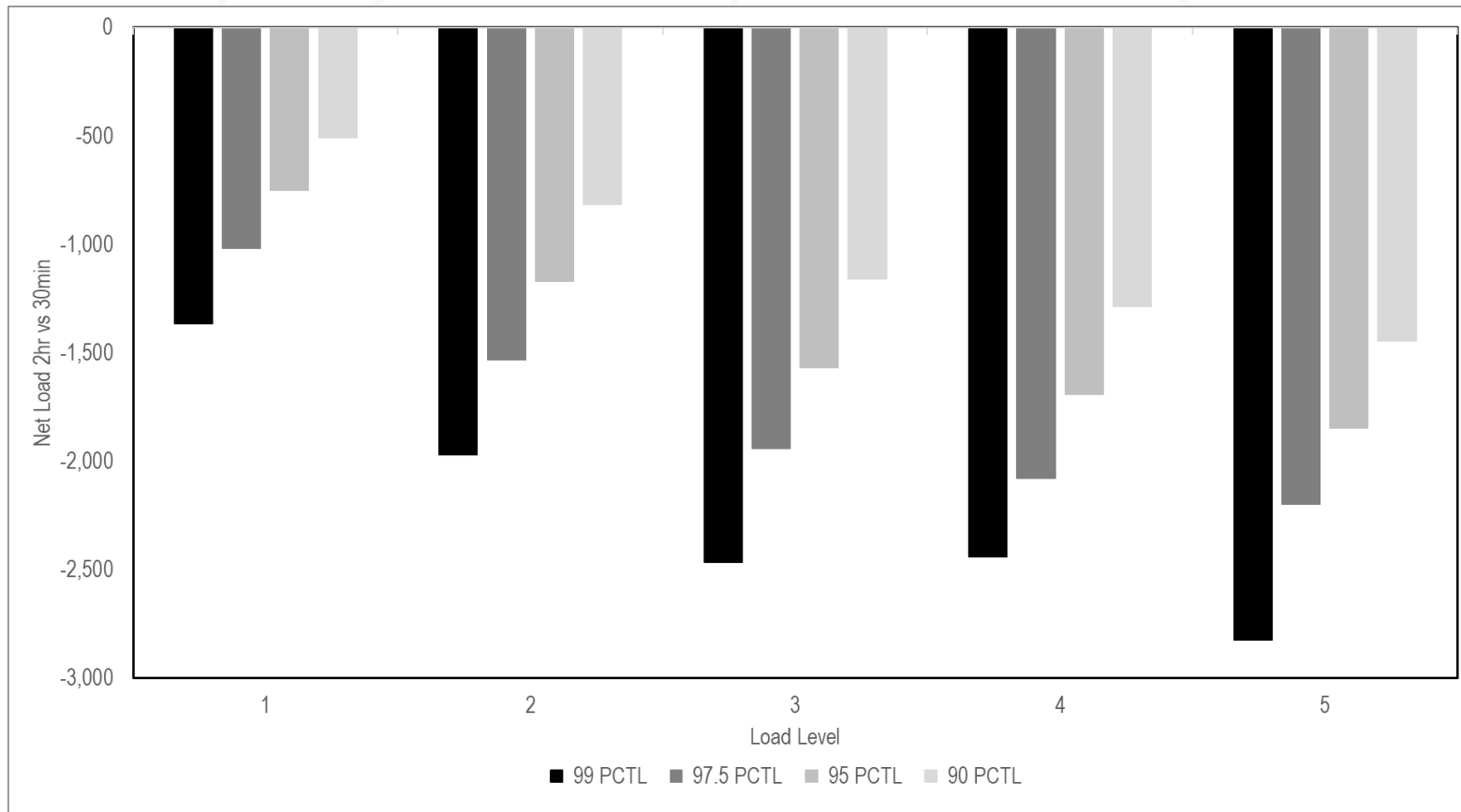
| Load Level | Net Load Range | | 30 min less 10 min | | | | 2 hr less 30 min | | | |
|------------|----------------|---------|--------------------|-----------|---------|---------|------------------|-----------|---------|---------|
| | | | 99 PCTL | 97.5 PCTL | 95 PCTL | 90 PCTL | 99 PCTL | 97.5 PCTL | 95 PCTL | 90 PCTL |
| 1 | 52,866 | 71,900 | (765) | (617) | (483) | (356) | (1,367) | (1,019) | (751) | (505) |
| 2 | 71,900 | 79,927 | (928) | (750) | (598) | (437) | (1,970) | (1,532) | (1,172) | (816) |
| 3 | 79,927 | 88,342 | (990) | (807) | (659) | (499) | (2,466) | (1,939) | (1,568) | (1,158) |
| 4 | 88,342 | 100,735 | (1,013) | (830) | (679) | (528) | (2,441) | (2,078) | (1,690) | (1,287) |
| 5 | 100,735 | 145,221 | (1,043) | (873) | (723) | (570) | (2,824) | (2,196) | (1,848) | (1,445) |

Note: Each load level in this analysis contains the same number of data intervals.

Net Load 30 min Less 10 min



Net Load 2 hour less 30 min

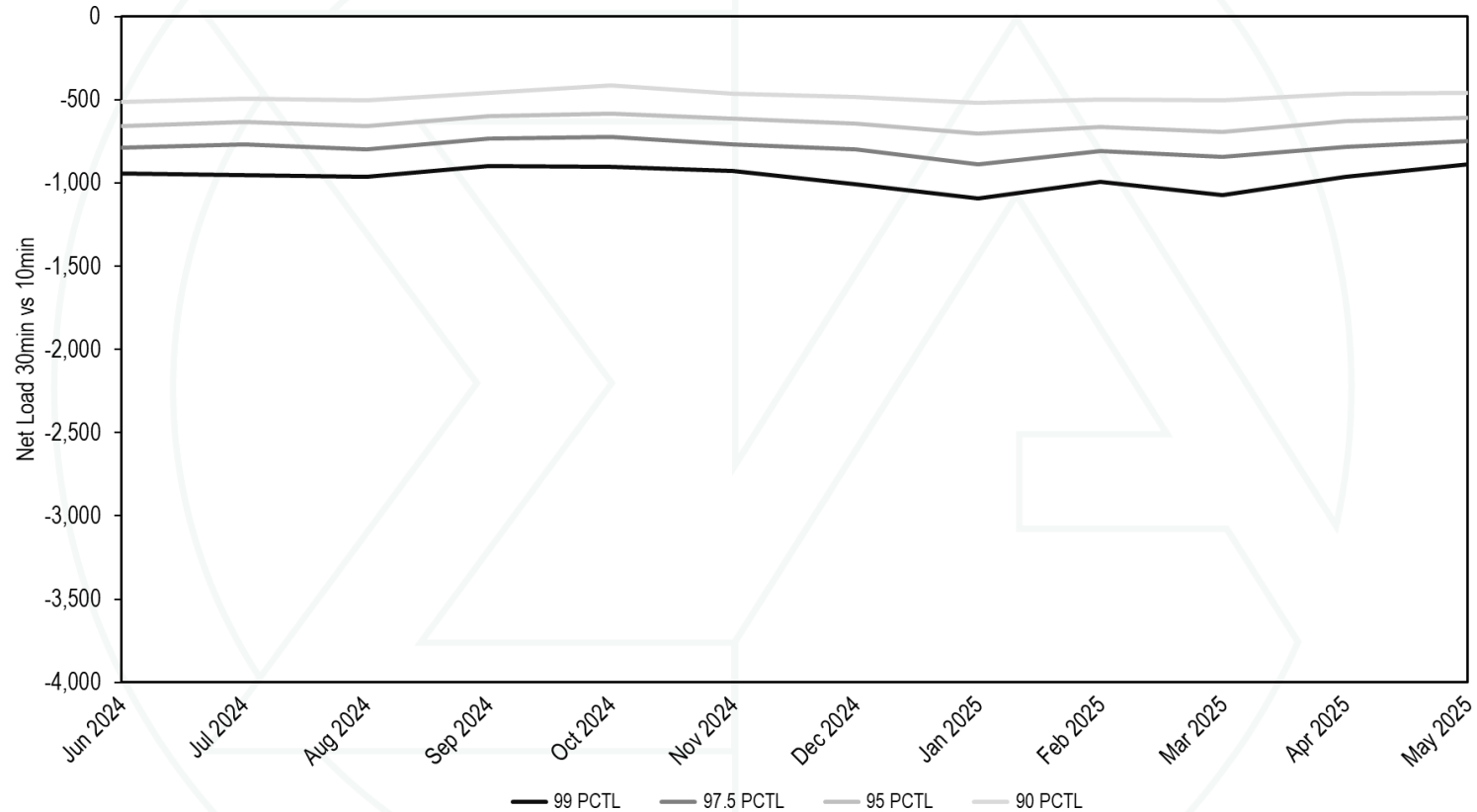


Net Load Uncertainty by Month

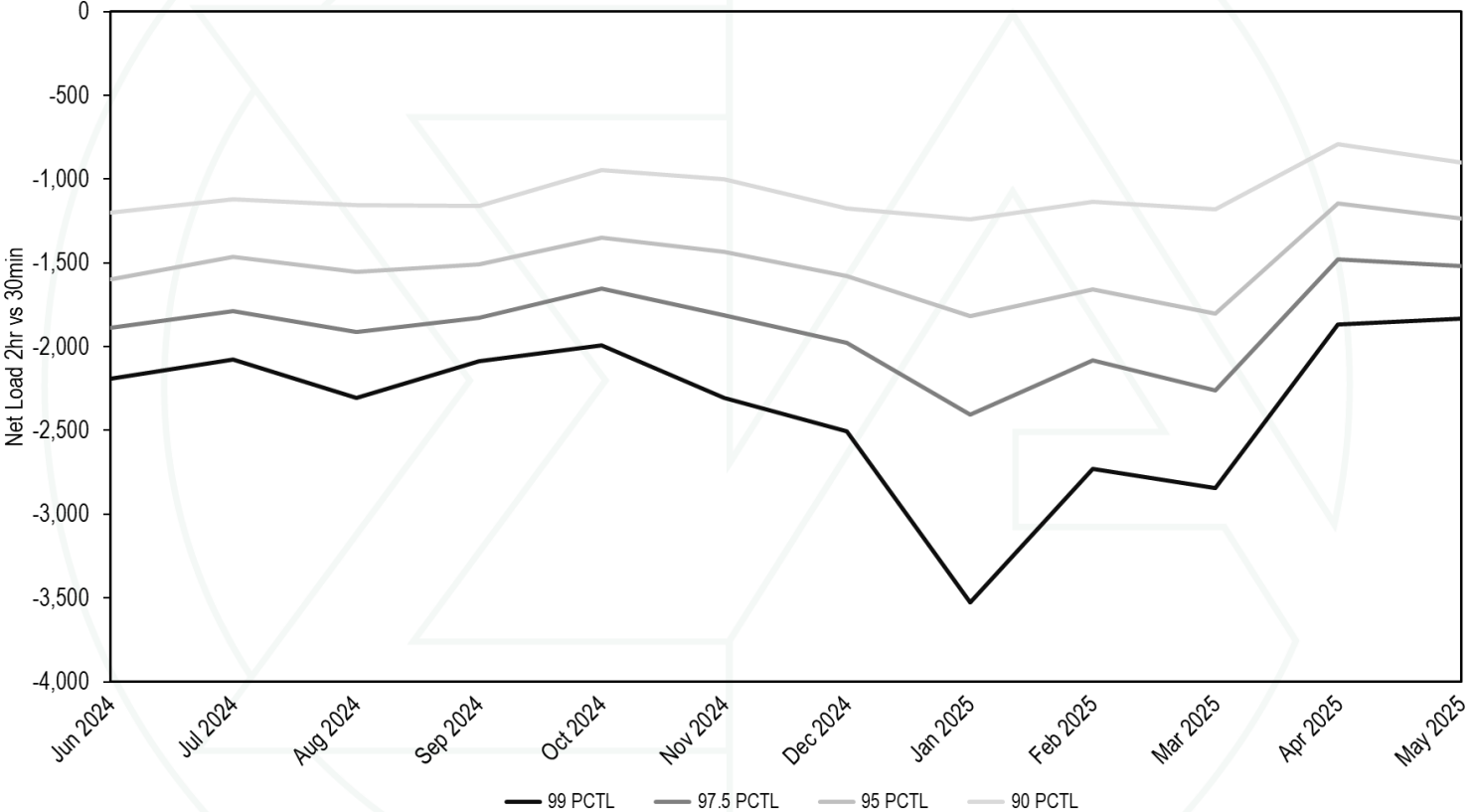
- **For 30 minute forecasts, uncertainty remains consistent throughout the year.**
- **For 2 hour forecasts, uncertainty significantly increases in the winter.**
 - **This could be influenced by the sample period which included polar vortex 2025.**
 - **Additional historical data is needed to confirm this correlation.**
- **Both 30 minute and 2 hour forecasts show decreased uncertainty in April and May.**



Net Load 30 min Less 10 min



Net Load 2 hour Less 30 min



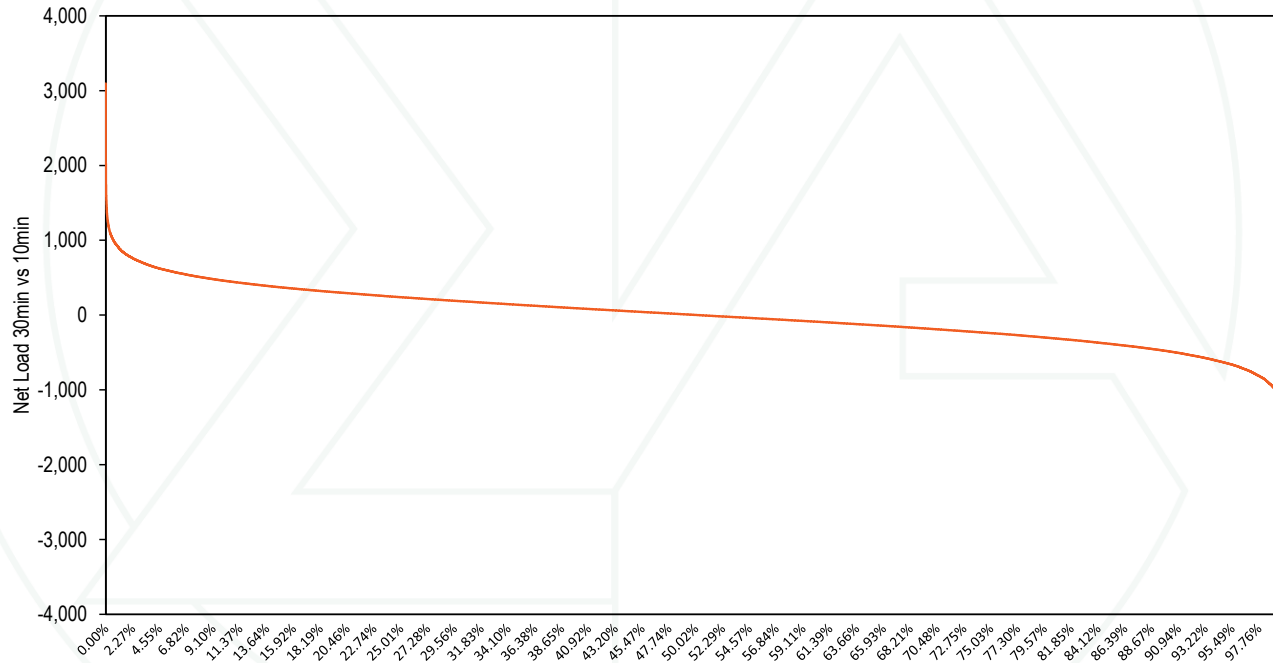
Net Load Uncertainty by Month

| Month | Net Load Uncertainty | | | | | | | |
|----------------|----------------------|-----------|---------|---------|------------------|-----------|---------|---------|
| | 30 min less 10 min | | | | 2 hr less 30 min | | | |
| | 99 PCTL | 97.5 PCTL | 95 PCTL | 90 PCTL | 99 PCTL | 97.5 PCTL | 95 PCTL | 90 PCTL |
| June 2024 | (941) | (788) | (661) | (516) | (2,191) | (1,886) | (1,596) | (1,201) |
| July 2024 | (954) | (769) | (631) | (494) | (2,075) | (1,786) | (1,466) | (1,120) |
| August 2024 | (961) | (797) | (658) | (506) | (2,307) | (1,914) | (1,556) | (1,155) |
| September 2024 | (898) | (731) | (600) | (459) | (2,088) | (1,826) | (1,509) | (1,160) |
| October 2024 | (903) | (721) | (583) | (414) | (1,991) | (1,654) | (1,347) | (946) |
| November 2024 | (929) | (770) | (614) | (465) | (2,308) | (1,812) | (1,434) | (1,000) |
| December 2024 | (1,008) | (799) | (645) | (486) | (2,507) | (1,979) | (1,580) | (1,176) |
| January 2025 | (1,094) | (888) | (705) | (521) | (3,528) | (2,407) | (1,817) | (1,240) |
| February 2025 | (992) | (810) | (661) | (501) | (2,730) | (2,081) | (1,656) | (1,134) |
| March 2025 | (1,071) | (843) | (691) | (505) | (2,845) | (2,263) | (1,803) | (1,178) |
| April 2025 | (962) | (782) | (629) | (463) | (1,865) | (1,480) | (1,144) | (790) |
| May 2025 | (890) | (746) | (611) | (457) | (1,833) | (1,517) | (1,236) | (901) |



Overall Uncertainty

- Only 0.83% (99.17 percentile) of all intervals showed a 30 minute forecast with under forecast of 1,000 MW or more.



Net Load 30 min Less 10 min Larger Than 1,000 MW

| HOD | Interval Percent |
|-----|------------------|
| 0 | 0.11% |
| 1 | 0.00% |
| 2 | 0.00% |
| 3 | 0.05% |
| 4 | 0.25% |
| 5 | 3.07% |
| 6 | 1.16% |
| 7 | 1.27% |
| 8 | 1.39% |
| 9 | 0.73% |
| 10 | 0.14% |
| 11 | 0.32% |
| 12 | 0.55% |
| 13 | 1.05% |
| 14 | 1.55% |
| 15 | 1.25% |
| 16 | 2.14% |
| 17 | 1.23% |
| 18 | 1.12% |
| 19 | 0.93% |
| 20 | 0.09% |
| 21 | 0.23% |
| 22 | 0.05% |
| 23 | 1.36% |

| Net load level | Interval Percent |
|----------------|------------------|
| 1 | 0.24% |
| 2 | 0.68% |
| 3 | 0.93% |
| 4 | 1.05% |
| 5 | 1.26% |

| Month | Interval Percent |
|-------|------------------|
| 1 | 1.66% |
| 2 | 0.97% |
| 3 | 1.31% |
| 4 | 0.83% |
| 5 | 0.36% |
| 6 | 0.64% |
| 7 | 0.77% |
| 8 | 0.71% |
| 9 | 0.60% |
| 10 | 0.54% |
| 11 | 0.60% |
| 12 | 1.02% |

30 minute forecast with under forecast of 1,000 MW or more often occurred at 5:00 AM and 4:00 PM.

These instances were concentrated during the highest load levels.

These instances were concentrated in winter months.

Conclusions and Further Analysis

- **Uncertainty is not constant**
- **Uncertainty varies with load, weather and time of day**
- **Additional analysis is needed to better understand exact relationships and to make levels of uncertainty more predictable**



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