

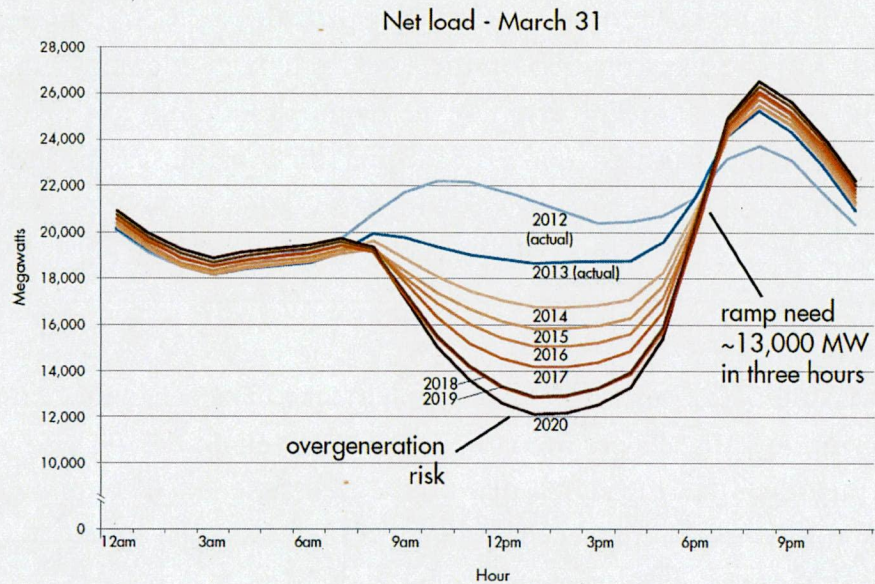
Executive Summary

This supplemental exhibit provides further details on the hand-drawn chart provided by Mr. Haeger during oral testimony. The exhibit provides a description of the impact of the 187 MW Solar Portfolio on the NSP System and demonstrates the impact will not be significant. The exhibit extends the description to the Minnesota 10 percent Solar Energy Standard goal to show that likewise the system and the conditions shown in the California Duck Chart do not apply to NSP.

This late-filed Exhibit NSP-9 (KJH-3) is a supplement to Haeger Direct Testimony. During oral testimony Mr. Haeger prepared a hand drawing in response to a question posed to him regarding the impact of solar on the NSP System. The following provides a description of the impact of adding the 187 MW Solar Portfolio on the NSP System. The impact is not expected to be significant.

The hand drawing prepared by Mr. Haeger was an illustration of “The California Duck Chart,” which is shown below in Figure 1. The chart received its name because the outline of the plotted lines resembles a duck. The Duck Chart shows the *net load* for a single day from the year 2012 until the year 2020 within the California Independent System Operator (CAISO) Energy Market. Each line represents a different year of the same calendar day. Net load is defined as the remaining load after all available renewable generation has served load. The top two lines of Figure 1 show the actual net loads for years 2012 and 2013. The remaining lines below those show projected net loads for years 2014-2020. In 2020, renewable generation is expected to meet 33 percent of system energy requirements. As a comparison of the year 2012 and 2020 shows, the ramp requirements increase significantly as the level of renewable generation energy contribution increases to 33 percent over this period.

Figure 1: The California Duck Chart: Net Load 2012-2020 for the Same



The Duck Chart first appeared in a document prepared by the CAISO¹. This document was prepared by the CAISO to illustrate its concern regarding:

- 1) Ramping flexibility – significant ramp down in the morning and significant ramp up in the evening.
- 2) Over generation mitigation – existing fleet has many long start resources, which require they stay online to react to load changes.
- 3) Frequency response – reliability requires automated response in the event of a disturbance such as the loss of a generator or transmission line. Renewable generation displaces conventional generation that has been used for automated responses to unexpected events.

The question posed to Mr. Haeger is whether a “Duck Curve” situation is something we could expect to see develop on the NSP System. His reply was the NSP System would not experience these issues because the solar additions envisioned in the NSP

¹ “What the Duck Curve Tells us About Managing a Green Grid,” California Independent System Operator, CommPR/HS/10.2013.

https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf

Upper Midwest Resource Plan 2016-2030 are substantially lower than that expected in California. Figure 1 shows the net load reduction for California in 2020, as compared to 2013, is 7,000 MW (19,000 to 12,000) or about a 65 percent net load reduction during midday. The 187 MW Solar Portfolio generation addressed in this ADP reduces NSP System net load at peak by only about 3 percent on a 7,000 MW load day.

Figure 2 below shows the forecasted generation of the portfolio for a single day. The day shown (in July 2020) includes the peak generating hour of the portfolio for that month. The solar generation doesn't reach the full nameplate capacity of the 187 MW Solar Portfolio because the three projects that comprise the portfolio have some geographical diversity. Figure 2 shows that the 187 MW Solar Portfolio generates between the hours of 6am and 9pm, and the peak hour occurs in hour 11.

Figure 2: 187MW Solar Portfolio Generation, July 2020 Day

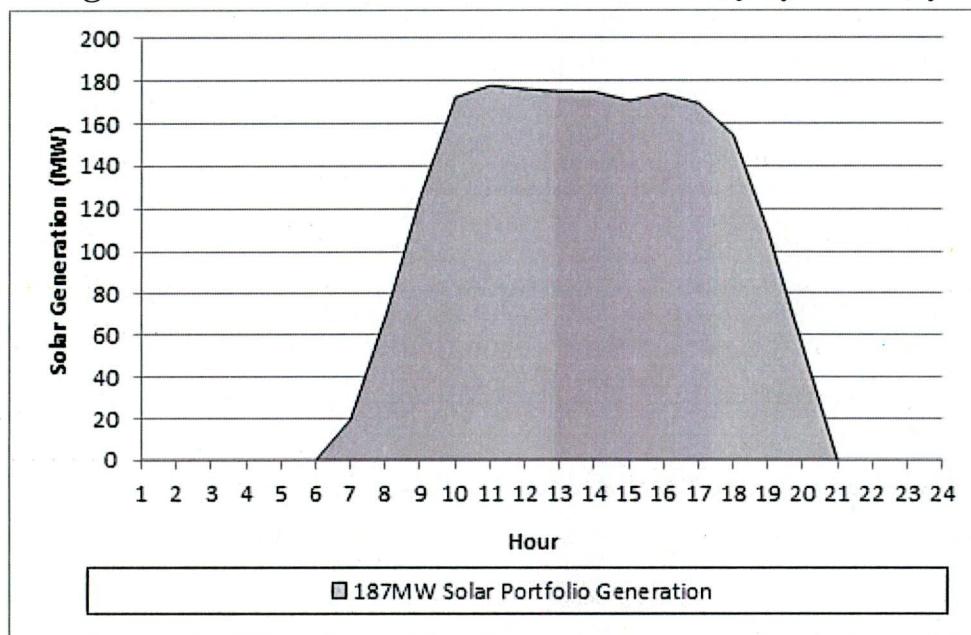


Figure 3 below shows the impact of the 187 MW Solar Portfolio on NSP Net Load. The solar generation of the 187 MW Solar Portfolio is the dark-shaded area and is the difference between the two lines. This is the same solar generation which is shown in Figure 2 (note the axis scaling differences: the range of the vertical scale in Figure 2 is

200 MW, and the range in Figure 3 is 8,000 MW). The peak net load for this day is 6,945 MW which is approximately 37 times greater than 187 MW. As a comparison of the top line and bottom line shows, the addition of the 187 MW Solar Portfolio has negligible impact on the system ramp requirements for the NSP System.

Figure 3: NSP Net Load without and with the 187MW Solar Portfolio, July 2020 Day

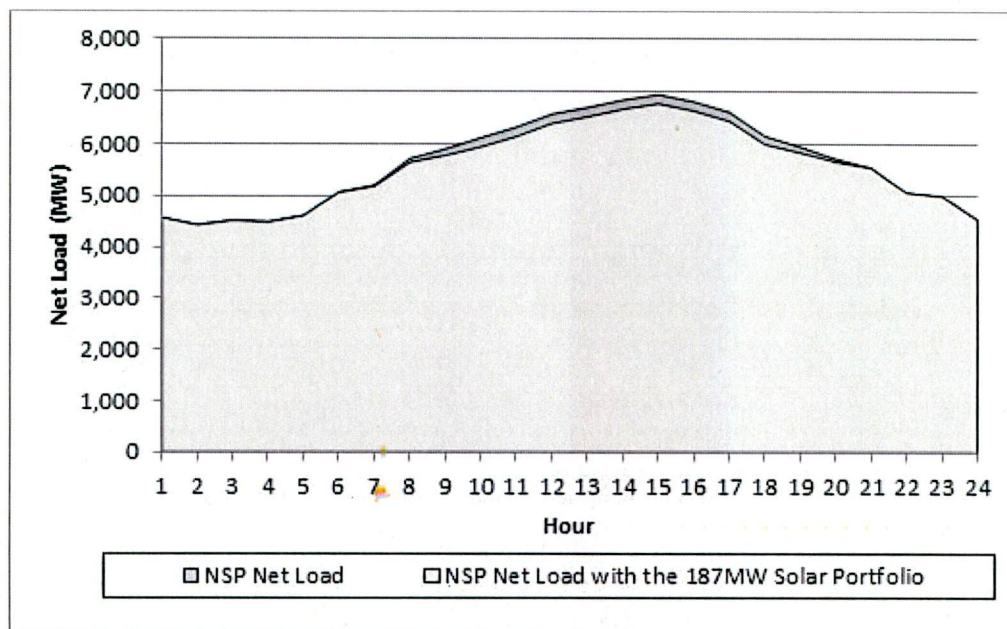


Figure 4 below shows the increase of solar beyond the 187 MW Solar Portfolio to a 10 percent Solar Energy Standard (SES). The Minnesota SES has a goal of reaching solar generation equal to 10 percent of Minnesota electric sales by 2030. The solar generation for the 10 percent Solar Energy Standard is the dark-shaded area and the difference between the two lines. The 10 percent Solar Energy Standard has approximately 9 times greater solar generation than the 187 MW Solar Portfolio. The 10 percent Solar Standard still does not have a significant impact on the NSP System ramp requirements.

Figure 4: NSP Net Load without and with a 10% Solar Standard, July 2020 Day

