EPA 111-D Consideration
Retirement of CS units 1&2

April, 2015
Regional Electric Transmission Planning

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Executive Summary

The Environmental Protection Agency (EPA) is using its authority under section 111 of the Clean Air Act to issue standards, regulations or guidelines, as appropriate that address carbon pollution from new and existing power plants, including modifications of those plants. Northern Tier Transmission Group (NTTG) received a Public Policy Consideration (PPC) request to investigate retiring 2 coal plants at Colstrip with alternative generation in the form of renewable wind. NWE also analyzed the impact of replacing coal at Colstrip with either combined cycle gas, wind or a combination of both types of generation. The goals of the analyses were to discover if the different types of generation created any impacts to the transmission system and to determine if the maximum export on Path 8 (western transmission corridor from Montana to the interface with the Bonneville Power Administration and Avista) of 2200 MW could be maintained.

Engineering Study

Northern Tier Transmission Group

The Northern Tier Transmission Group (NTTG) received a Public Policy Consideration (PPC) request in the first quarter of the biennial planning cycle. The PPC request, submitted by Renewable Northwest Project (RNP), stated:
"RNP would like to understand the transmission impacts associated with retiring 1) Colstrip units 1&2 and replacing the respective amounts of capacity with proportional amounts of wind capacity in Montana."

The Technical Work Group (TWG) developed a study plan in response to the PPC request. The Study Plan was approved by the NTTG Stakeholders and the NTTG Planning Committee and is available on the NTTG website. The study details include:

1. Use of the 2024 TEPPC cases that had been run through the production cost model process; these cases were also used by the TWG to develop the Regional Transmission Plan.
2. Assumption that the wind would be modeled at the Broadview 500 kV bus as two 305 MW wind farms at full output where the entirety of one farm could be tripped off as quickly as a coal plant at Colstrip.
3. Assumption of no new transmission or facilities.
4. Assumption that the change occurs in 2020.

TWG ran steady-state analysis only for this PPC. The TEPPC cases are not dynamics-ready and there is no requirement that TWG run dynamics for a PPC study. There was a lot of discussion around the idea of running dynamics for this PPC request, however, it was generally concluded that it would take too much time to convert a TEPPC Production Cost Model case into a dynamics-ready case.

Limitations

Colstrip is a uniquely placed generation facility in the Western Interconnection. The four units that make up Colstrip are at the end of a long 500 kV corridor that ultimately ties into the Pacific Northwest. Because of the location and size of the Colstrip plan, there is a device called the Acceleration Trend Relay (ATR) that protects the Colstrip generators and the transmission system during an outage on the 500 kV corridor.

The major limitation to the PPC study is that the ATR is inherently a dynamic device. In order to get a rough idea of how the system would respond following a major 500 kV event, estimated ATR tripping was used based on past studies and events. The ATR is very sophisticated and the PPC study only provides a very rough idea as to how the system could truly respond.

Results

The TWG looked at two scenario cases: a standard heavy summer case and a case with increased Path 8 exports. With the assumptions listed above, the TWG found that the transmission system generally responded similarly to wind at Broadview as it did to coal at Colstrip. The results of this limited, steady-state study neither imply nor suggest that a one-for-one substitution of wind for coal is feasible without further study or possibly system improvements.

Discussion

At this time, the software used to model the response to the ATR is proprietary to NorthWestern Energy (NWE). NWE is working with a power system software vendor to develop a model that all parties can use. Until the model is validated and other vendors have had a chance to collaborate, NWE is still the only utility that is capable of dynamically modeling the response of the ATR. Because of this unique situation, NWE has determined it would perform a high-level dynamics study to better understand the implications of replacing coal with either wind or some other resource.

NWE Study - 2015 Transient Stability Analysis

NWE used a dynamics-ready 2015 case to analyze the impact on the ATR of replacing coal at Colstrip with either combined cycle gas, wind or a combination of both types of generation. The goals of the analysis were to discover if the different types of generation created any impacts to the transmission system and to determine if the maximum export on Path 8 of 2200 MW could be maintained. NWE also evaluated whether there would be any impact to the import capability into Montana.

Case Prep

The Corette plant was assumed to be offline. Corette has been offline permanently since early March 2015. Colstrip 1&2 each generate approximately 300 MW of net generation onto the transmission system. NWE considered both steady state and transient stability in this analysis and studied the following scenarios, in all cases Path 8 exports were at 2200 MW:

1. Colstrip 1&2 online, no additions (unmodified comparison case)
2. Colstrip 2 offline, no additions
3. Colstrip 1&2 offline, no additions
4. Colstrip 1&2 offline, 300 MW wind at Colstrip
5. Colstrip 1&2 offline, 300 MW wind in the Broadview (west of Billings) area
6. Colstrip 1&2 offline, 300 MW combined cycle gas modeled in the Alkali Creek area
7. Colstrip 1&2 offline, 300 MW combined cycle gas in the Alkali Creek area and 300 MW wind at Colstrip
8. Colstrip 1&2 offline, 300 MW combined cycle gas in the Alkali Creek area and 300 MW wind in the Broadview area

In cases 2-6, generation in Montana was redistributed to account for the net loss of generation. By doing this, NWE was able to maintain exports of 2200 MW in all the cases.

Results

The transmission system responded similarly to outages for all eight cases, both steady-state and dynamically and was capable of achieving 2200 MW of exports on Path 8. Again, these results neither suggest nor imply that a one-for-one substitution of coal at Colstrip for another type of generation is feasible without further study or possible system upgrades.

Considerations

Frequency

The Colstrip units are geographically located in the northeast of the Western Interconnection at the end of a long 500 kV corridor. The large size of the Colstrip units combined with the length of the 500 kV corridor create frequency concerns not typically seen elsewhere in the Western Interconnection. The Colstrip units will accelerate rapidly for outages on the 500 kV corridor and that rapid acceleration and increase in frequency could impact the Western Interconnection if it were not for the ATR which trips Colstrip generation during an event. Ostensibly, if alternate generation were to replace Colstrip, there would be fewer high frequency concerns for a major contingency on the 500 kV corridor.

On the other hand, for loss of a major generator inside or outside of the NorthWestern Energy system, system frequency decreases and Automatic Generation Control (AGC) kicks in and large units such as Colstrip supply much needed spinning reserves to the interconnect. If alternate generation were to replace Colstrip, it would need to provide the same capability to meet our Balancing Authority Operating Reserves criterion. Typical wind machine packages don't include a speed governor required for this type of action. The fuel (wind) is variable by nature and is not controllable for spinning reserve. Therefore, new generation would need to have other means of responding to this type of event.

Total Transfer Capability, Path Capacity

The capacity of a line does not decrease when a resource is removed much like a garden hose's capacity does not disappear when the water spigot is shut off. That being said, it is possible that the path rating/transmission capability might have to be reduced due to resource limitations. This does not mean the capacity is not there, just that the system is not physically capable of reaching those types of flows with the reduced amount of resources available. In other words, without Colstrip generation to "push" through the garden hose, transmission capability out of Montana will also reduce – nearly at a one-for-one basis to the amount of generation reduction.

Local Area

Any time generation is added or removed from the system, extensive study work is required to assess any impact to loads and transmission near the generation. If the alternate generation resources are at or near Colstrip, there may be no change in the Colstrip area but if not, system improvements may be required.

While high-level impacts to the local area were analyzed, the study did not focus on load growth or future local area projects.

Voltage Support

The Colstrip facility currently provides important voltage support to the transmission system in eastern Montana, and is vital in keeping the Montana 500kV system within its voltage limits. Any replacement alternate generation would need to be capable of providing equal voltage support capability so that there is no negative affect to the system or stress on nearby generation. If a variable alternate generation resource such as solar or wind was chosen, additional dynamic and/or static VAR devices may be necessary to maintain adequate voltage on the 500kV system. In general, the alternate generation resource will need to boost voltage under heavy generation

output and suppress voltage under low generation output. As a side note, capital investments in devices to provide voltage support in the Billings area were planned and installed recently, in large part due to the known closure of the Corette Coal Fired plant in Billings. That facility traditionally provided significant voltage support in the Billings area.

ATR

The Acceleration Trend Relay (ATR) monitors the acceleration on each of the four Colstrip units. If the ATR senses rapid acceleration on any of the units, it makes a decision as to how many units to trip offline such that the stability of the transmission system is maintained and the Colstrip units and local and regional transmission system are protected. Removing any combination of Colstrip units has little-to-no impact on the ATR by design. For the removal of any of the four units, the acceleration and speed values seen by the ATR will look roughly the same and the ATR will act accordingly for all major contingencies.

In order to avoid negatively impacting the owners of the remaining Colstrip units, a new Remedial Action Scheme (RAS) or modifications to the ATR may be needed. If a new RAS was to be designed, it would likely need to act faster than the ATR in order to not cause excess tripping of the remaining Colstrip generation. Since the ATR usually reacts within 1/10 of a second, the new RAS would need to act faster than that, and trip for contingencies anywhere on the 500 miles of 500 kV transmission lines west of Colstrip, which could be very costly depending on what type of tripping scheme was used.

If a modification of the ATR logic is necessary, the several utilities that own the ATR, collectively known as the Colstrip transmission partners, all have to agree on any changes to the ATR. Other issues include extensive hardware modifications, planning and engineering work. All these things would be needed in order to properly tie the resource into the ATR logic, but would not be possible without very detailed information on exactly what type of resource is chosen. The development or modification of any RAS is far outside the scope of any request that has been made by any group, and it would vary depending on what type of generation was chosen.

To sum all that up; the addition of any other form of generation in place of Colstrip is practically guaranteed to have an effect on the response of the ATR. However, with a good amount of thought and engineering, a RAS, or modification of existing RAS, could most likely be designed such that effect is reduced. This is likely to be a complex, time intensive and costly process. However, it should be noted that a fundamental reason for the ATR is allow the transfer capability to be as high as it is to transmit Colstrip energy. The tripping that occurs at Colstrip would need to be built into replacement generation as well in order to maintain reliability and transfer capability.

Impact to Import Capability

None of the studied changes to the transmission system impacted the import capability on Path 8 (from the west into Montana).

Economic Impact

The analysis above does not consider the economics, viability or other infrastructure requirements associated with a large build out of wind generation or gas generation in eastern Montana as

replacement to Colstrip generation. We do not take a position regarding the economics of wind generation in Montana and ability to find a customer, presumably outside of Montana, for a large wind resource. With regard to gas generation, if Colstrip generation was shut down, presumably transmission capacity would be available on the Colstrip 500 kV system for replacement generation. There is multi-party ownership of this transmission capacity. However, significant consideration would be required of gas transportation and gas supply for large scale gas generation in eastern Montana.

Conclusions

The goals of these studies were to discover if replacing coal with alternative types of generation created any impacts to the transmission system. It should be noted that economics were not considered in this study, but are discussed at a high level below.

TWG found that the transmission system responded comparably for wind at Broadview or coal at Colstrip. The results of this limited, steady-state study neither imply nor suggest that a one-for-one substitution of wind for coal is feasible without further study or possibly system improvements.

NWE analyzed the impact on the system for replacing coal at Colstrip with either combined cycle gas, wind or a combination of both types of generation. For all cases studied, the transmission system responded similarly for both the steady-state and dynamic assessments. The path capacity would not change and frequency concerns would lessen. Also, the addition of an alternate resource in place of coal will have an effect on the response of the ATR and may very well necessitate the design of a new RAS.

Again, these results neither suggest nor imply that a one-for-one substitution of coal at Colstrip for another type of generation is feasible without further study or possible system upgrades.