MT REDAP Planning Committee: Draft Responses to Steering Committee Guidance from March 5th:

Montana to Washington and Colstrip Transmission Upgrade:

Guidance: *Refresh the cost and timing of previous estimates for the Montana to Washington (M2W) and Colstrip Transmission Upgrade combined incremental ATC efforts. Do not do new studies for this – just update with today's dollars and apply current project knowledge to timing provisions*.

Discussion:

Colstrip Transmission Upgrade

Avista (AVA), NorthWestern Energy (NWE), and the Bonneville Power Administration (BPA) performed joint studies in the 2000's to identify a set of feasible transmission re-enforcements that might enable the Transmission Owners to increase the transfer capability of the system between Montana and the Pacific Northwest. Those studies identified a series of facilities as follows:[1]

- Additions to series compensation of the 500 kV system between Colstrip and the Pacific Northwest between Broadview in Montana and Coulee and Hatwai substations in Washington.
- Several line upgrades on the BPA network
- Line upgrades, transformer upgrades, and continued operation of the "star" network on the AVA system
- Mitigation to the Colstrip generation from changes in Sub-Synchronous Resonance (SSR) due to the series compensation changes on the 500 kV system
- Participation in Remedial Action Scheme(s) (RAS) from resources that would require access to the incremental capacity.

Estimated costs taken from the June 2012 report:

- BPA transmission system: $126.7 million
- Colstrip Transmission System: $87 million
- Avista transmission system: $38 million

Montana to Washington Upgrade Project (M2W)

BPA initiated a project on its network following the 2010 Network Open Season (and further informed in the 2013 Network Open Season) that became known as M2W. The project addressed transmission requirements on the BPA network only. It did not address facilities on the AVA system, nor on any 500

[1] The Planning Committee is still working on including citations and links to as much of the existing study work as possible.

kV facilities east of BPA's Garrison 500 kV substation (nor costs to mitigate the SSR for the Colstrip generation).

BPA initiated a National Environment Policy Act (NEPA) and preliminary engineering effort for the project. In 2014, BPA discontinued the NEPA and preliminary engineering for the project when requests for transmission service to support the project discontinued their participation.

In the 2016 Transmission Service Request Study and Expansion Process (TSEP), there were again a significant number of requestors that would need access to the capacity from the M2W project. BPA is in the process of again proceeding with a NEPA and preliminary engineering effort to determine whether to proceed with development of the M2W project.

The M2W project refers to upgrades on the BPA Network – facilities west of BPA's Garrison Substation plus BPA's share of harmonic filtering at the Colstrip Generating Station:

- The project would involve upgrades at five existing BPA substations (Garrison and Hot Springs Substations in Montana, Dworshak and Hatwai Substations in Idaho, and Bell Substation in Washington)
- Replacement of about 11.4 miles of electrical wire (conductor) along portions of BPA's existing Dworshak-Taft transmission line
- Improvements to about 25 miles of existing access roads
- Construction of a new substation in Montana. The proposed new substation would be constructed along the BPA's existing Garrison-Taft transmission line.
- Direct costs: $119 M (no contingency); energization post 2023 (optimistic). One more update by Apr-27 meeting

It is important to reinforce that the M2W project only addresses the needs on the BPA system. Below is a summary of the status of the various components of the CTS upgrade:

- Significant reinforcements on the Avista system have been completed
    - Westside 230/115 kV autotransformer upgrades and associated equipment.
    - Loop Boulder-Rathdrum 230 kV line into Lancaster Substation.
    - Maintain present "Star Network" configuration on the Avista 115 kV system in the Big Bend area. The Star Network configuration (i.e. open 115 kV lines) should be maintained unless definitive studies show that these lines can be closed.
    - Complete 115 kV reconductoring project (~ 37.4 miles) from Cabinet Gorge to Sandpoint.
    - Avista's new Moscow 230/115 kV transformer in service and associated 115 kV reconductoring to include Turner substation (located in Pullman, WA).
- SSR studies have been completed which identified the mitigation for Colstrip generation assuming all four units would be in service. Additional studies would be needed to address retirement of Units 1 & 2. These costs would be incremental to $119 M identified above.

- No further project development of series compensation east of Garrison substation has taken place
- Neither cost allocation nor capacity allocation has taken place for capacity east of Garrison (between and Transmission Owners, including CTS owners)
- No capacity allocation has occurred for capacity within the Pacific Northwest (AVA and BPA)

In the context of Colstrip Units 1 and 2 retiring, the urgency of the M2W and CTS capacity upgrades may be declining. When additional capacity is required west of Garrison, M2W provides a low-cost low-impact option compared to additional linear facilities. When additional capacity west of Colstrip is required, the CTS upgrades provide a similar low-cost low-impact option.

Sub Synchronous Resonance:

The SSR impacts referred to in the CTS and M2W project discussion above warrant additional comment, here. Changes to the 500 kV transmission facilities, either by modification of series compensation on those lines or through addition of new interconnecting stations that change the transmission line configurations could impact the design of the SSR filters that are in place. The required SSR configuration is, and will continue to be, a normal consideration of maintaining the reliability of the transmission system.

Filters can be added to modern wind machines to block them from producing at undesirable frequencies associated with SSR.

Additional Transmission Study Work:

Guidance: *As there is limited time available before the end of June as well as to avoid concern about OATT provisions regarding how, when, and who pays for system impact and interconnection studies, the Steering Committee advises utilizing either existing studies or providing directional, high level assessments to answer assigned questions. The Steering Committee will be judicious in asking for additional planning information. High level non-discriminatory planning scenarios are recommended. Make maximum use of the existing studies such as NWE's Colstrip Shutdown Reports and the Northern Tier Transmission Group (NTTG) Studies. Consider the content of the Stigers report based on existing studies.*

Discussion:

The Planning Committee has reviewed four transmission studies and one whitepaper analyzing various Colstrip Unit 1-4 retirement scenarios.[2] In General, these four studies have not surfaced any insurmountable barriers to the concept of replacing any combination of the Colstrip Units with equal amounts of wind generation. All of the studies rely on several assumptions and the results must be confirmed when new generation is specified. The Committee also identifies additional study work that

[2] 2014-2015, Public Policy Consideration Study for NTTG:
2016-2017, Public Policy Consideration Study for NTTG
NWE sponsored study, retirement of CS units 1 and 2
NWE sponsored study, retirement of all coal in NWE's BA
RNW sponsored whitepaper by Chuck Stigers:

will be necessary under certain future scenarios. At the time of writing, NorthWestern Energy (NWE) is also conducting a study to confirm the carrying capability of the CTS after Colstrip Units 1 and 2 retire. NWE is performing this study per the request of Puget Sound Energy. The scope of the study includes three main sections: a confirmation of the 2200 MW path rating for west-bound Path 8 flows with all four Colstrip units in service, an analysis to determine if 2200 MW west-bound on Path 8 is achievable without Colstrip units 1 and 2 and with the use of replacement generation and adjustment of phase shifting transformers, and an analysis focusing primarily on the 500 kV system assuming no Colstrip units 1 and 2 and without replacing any lost generation or allowing phase shifters to move. The study work is expected to be complete in June, 2018.

Key Findings:

1. Remedial Action Schemes (RAS) will be necessary for any new generation acquiring firm transmission service across the CTS. All of the studies reviewed by this Committee assumed a sufficient RAS. This new RAS will have to coordinate with the ATR RAS at Colstrip as long as any of the Colstrip units are in operation. The new RAS will be developed as a part of the transmission/interconnection study request for a specific generator and is not anticipated to be a major cost or technical barrier. For a more thorough consideration of the potential RAS design options, see the whitepaper by Chuck Stigers.

    a. BPA relies heavily on RAS to maintain the transfer capability across its network. Since BPA's RAS depends upon high speed communication between line sensing facilities, generator projects, and BPA's RAS controllers, BPA has extensive experience with installing communication facilities for a number of Large Generator Interconnection Agreement (LGIA) projects and for transmission line projects in recent years.

    The cost of installing RAS will almost certainly be less than the addition of more linear transmission facilties since the RAS is, by design, intended to avoid or save the cost of those facilities. Costs for installing RAS on BPA's system do vary significantly depending on location of the interconnection facilities to existing communication facilities. Costs can range from the tens of thousands of dollars for projects located near existing communication facilities up to hundreds of thousands or potentially a few million dollars for more remote locations.

2. Under steady state conditions, studies performed to date did not identify thermal limit violations for any of the scenarios and did not identify new transmission lines are required (as long at the 500 kV system is intact).

3. The studies that conducted dynamic stability analysis also found that the system performed reliably under stress, with no voltage excursions. In some cases frequency concerns lessen when coal is replaced with wind. Wind generation plants do not inherently add a significant amount of inertia to a transmission system; they add some,

but certainly not as much as a coal-fired plant. However, there is an opportunity for wind generation plants to add more inertia than they would otherwise if they are equipped with wind inertia controls (for example, WindINERTIA) which allows the wind generation plant to act as if it has inertia enabling it to contribute to frequency control. Certainly, wind generation plants located in the Billings area will likely have an easier time contributing to frequency control than plants located in the Colstrip area as they would not have to interact with radial 500 kV system between Colstrip and Broadview (Billings).

4. As Colstrip units retire, adequate voltage support in the Billings, MT area may be a concern; the location of replacement generation may help address this concern.

    a. Billings-specific locations for new generation would likely be more beneficial to supporting voltage than locations in the Colstrip area. Voltage is controlled by reactive power which doesn't "flow" as readily as real power. NWE requires a 0.9 leading/lagging power factor for any new generation projects interconnecting to its transmission system. This power factor allows for more voltage support than the historical requirement of 0.95 leading/lagging. This extra range of voltage support for new generators will be beneficial to the transmission system.

    b. Voltage control devices do not always have to be in the form of new generation. For example, due to the loss of the Corette plant, NWE installed 80 MVAR of new capacitor banks to account for the loss of voltage support previously supplied by the Corette plant.

        Additional voltage control measures might include various storage projects, including pump storage, the addition of switched capacitors (to relieve low voltage), or switched reactors (to relieve high voltages).
        More elaborate measures could involve the use of electronically controlled devices such as Static Var Compensators (which provide continuous operation over a range of voltage conditions) or possibly the use of synchronous condensers. Synchronous condensers would behave similarly to turbine – generators, but, do not have the ability to also provide real energy (or MWs).

5. The 500 KV system is an essential component of reliable load service within Montana as well as for supporting exports to the Pacific Northwest. In the face of retiring Colstrip Units, changes to the transmission system and/or operations are inevitable. Adding new generation in the vicinity may provide additional benefit to the transmission system to help mitigate the loss of the Colstrip generating resources.

    a. Without the 500 kV CTS system, a 230 kV line would have to be built to reinforce the South of Great Falls cut plane.

b. If all coal in Montana is retired and no replacement generation is put in place, one of the parallel 500 kV lines comprising the CTS may have to be de-energized.

Additional Study Work Required To Interconnect New Generation:

Transmission planning studies will have to confirm the results of the generic studies reviewed by this committee once specific generators are identified.

Interconnection Studies: Interconnection Studies for each individual generator will address the following questions:

1. Local voltage control issues: Depending on the location of new generation local voltage control issues may need to be addressed, especially in the Billings, MT area. Most wind machines today can produce VAr output even when they are stopped; using such machines will help mitigate voltage concerns. If necessary, Voltage Source Converters could be place near Billings, MT and are not cost-prohibitive.
2. Sub Synchronous Resonance (SSR): Frequency scans should be conducted for each generator interconnection to test for SSR concerns. Recent interconnection study work for the Gordon Butte Pump Storage project did not identify any SSR concerns under the current transmission configuration.[3]
3. RAS Design: As discussed in detail above, RAS designs will have to be specified and implemented as part of each new generators interconnection process.

Blackstart: "Blackstart" studies are required to confirm that a system can recover from a complete system blackout/outage. Such studies are required every five years, or within 90 days of a major system change. The last blackstart study conducted by NorthWestern was in 2017 and did not include the now planned closure of Colstrip Units 1 and 2. NWE's current plan is to follow the regular cycle and initiate the next blackstart study in 2021 (for finalization in 2022), which aligns nicely with a 2022 retirement of Colstrip Units 1 and 2.

Historically, the NWE blackstart plan has been to use hydro facilities to start the system, and then to "grow" the island of in-service components to the point where one of the Colstrip Units could be started without causing extreme voltage or frequency excursions on the transmission system. NWE is well-prepared to meet the requirements of NERC EOP-005 under a variety of resource and topology scenarios by utilizing the hydro resources, Dave Gates generating station, Colstrip 3 and 4, and imports from neighboring systems.

Given the various options for implementing a viable blackstart plan, the Planning Committee does not anticipate this requirement to be overly burdensome without Colstrip Units 1 and 2. It

[3] http://www.oatioasis.com/nwmt/nwmtdocs/Project310-SystemImpactStudy.pdf

also may be premature to perform such an analysis today as the analysis itself depends solely on the topology of the transmission system at the time of the study; conjecture could lead to an inaccurate blackstart plan. NWE will start thinking about how the blackstart plan would look in a post-Colstrip world, however, until the actual topology of the system is known, NWE will not be initiating a post-Colstrip blackstart analysis.

With respect to the Montana Renewable Resource Development Action Plan's focus on renewable energy, NWE does not plan to use wind generation resources as part of its blackstart plan as there is no guarantee that the wind will be blowing in the event of a blackout.

Recommendation: The Planning Committee recommends that NWE wait until 2021 for the next regularly scheduled blackstart study consistent with reliability requirements. This recommendation is based on our understanding that a blackstart study must be completed with 90 days of a major system change.

Transmission Planning for A Shutdown of Colstrip Units 3 and 4

Guidance: *Although Colstrip 3 and 4 commercial retirement is not a focus of this Project, post-June 2018 work should examine the potential impact of that retirement on the Total Transmission Capacity (TTC) for transmission planning purposes, as the Accelerated Trend Relays (ATR) will all be gone at that point. Prepare a study scoping document to assess the transmission system with retirement of Colstrip 3 and 4, and return to the Steering Committee when complete for consideration of this scope.*

Discussion:

Additional analysis confirming the ability of the CTS to maintain its current path rating if all four Colstrip Units are retired will be required at some point. This analysis would be similar to the work NWE is currently conducting for Units 1 and 2 and would take approximately six months to develop the assumptions and an additional six months to conduct the study work. The retirement of the ATR and any impacts on RAS for new generation would also need to be considered.

Existing studies have looked at: 1) no coal in Montana (with no replacement energy and different mixes go wind and gas replacement) and 2) the retirement of CS Units 1, 2, and 3 (with equal amounts of wind and other replacement energy added). This work tells us that without any coal and no new resources added, some relatively minor system changes may be needed (denergized parallel 500 KV lines or reactive additions) but it is feasible that the system can support a MW for MW replacement resources.

The study scope for examining the impacts of Units 1-4 retiring would need to consider the following:

1. Queued generation: there are multiple projects on either the 500 kV CTS or on the 230 kV buses that connect to the CTS, assume that all projects will achieve interconnection
2. Assume firm transmission service for any projects interconnecting to the CTS, either 500 kV or 230 kV; in some instances, this may mean having to identify upgrades on the 500 kV system to accommodate all the requests. Suggestion to draw upon upgrades identified in the M2W project.
3. Assume that the 500 kV system is no longer directly tied to generation output from the current Colstrip Units and will remain as an in-tact system
4. Assume sufficient RAS are in place for each of the generation projects that have achieved interconnection and firm transmission service; and that each RAS doesn't negatively impact another RAS on the system
5. Assume appropriate load growth for the projected year of study
6. Assumption of all other coal on the system needs to be considered: Will this analysis be a "no-coal" analysis?
7. Assume that any regionally significant projects currently in proposal will be considered- perhaps only consider those projects that are at least in Phase 2 of the WECC path rating process
8. Assume that any new wind generation plants will have some form of inertial controls
9. As there will no longer be any Colstrip coal-fired units; assume no ATR

Additional decisions about the study parameters will also have to be made. For example, should the study analyze the retirement of all coal in Montana or just the Colstrip Units; and, should the study consider new transmission lines necessary to serve all resources in NorthWestern's transmission and interconnection queues, or just enough to utilize the freed up capacity from coal retirements?

One scenario that may be of nearer term concern and that has not been studied to date, is what happens if Units 1 and 2 are replaced with 610 MW of wind and later Units 3 and 4 are also retired but not replaced with any new generation.

Several Planning Committee participants have emphasized that there is urgency and interest to the State of Montana in understanding the implications for the Colstrip Transmission System if all Colstrip Units were to retire. The Planning Committee has laid out a scope of work that could provide incremental value. It is less clear there is enough new information that would substantially change the inputs, and thus the findings, of the previous studies. The Path 8 transmission providers are also concerned about the staff resources necessary to complete this study work at this time.

Consensus Recommendation: The Planning Committee supports the completion of the scope of work outlined here, either by a third-party, or as soon as staff resources are available within the Path 8 transmission providers. Additional feedback from the Steering Committee is appreciated.

WECC Path Rating Questions:

Guidance: *OK to do the WECC Path Rating process on an advantageous schedule – with retirement of Colstrip 1 and 2 and identification of replacement resources examined together.*

Discussion:

The current WECC Path 8 (Montana to the Northwest) Accepted rating is 2,200 MW. There has been concern whether that path rating may be maintained as the coal fired generation at Colstrip retires. Two different outcomes could force the path to be subject to re-rating under WECC's Three Phase Rating Methodology. First, when Colstrip Units 1 and 2 retire, it may have appeared that the owners of the Path (NWE, AVA, and BPA) would be required to pursue a de-rate of the path. Second, as replacement resources become clear for the retired resources at Colstrip, the transmission owners would then be required to pursue an uprate back toward the original rating.

While a de-rate study could be possible with the retirement of Colstrip Units 1 and 2, the owners have had informal discussion with WECC indicating that there is not a plan to immediately pursue a de-rate of Path 8 prior to the retirement of Colstrip Units 1 and 2, but rather, an appropriate path rating (up-rate or de-rate) would be pursued at such time as the owners have clarity of the retirement Colstrip Units 1 and 2 and the replacement resources. Feedback from WECC was generally supportive of waiting for clarity rather than proceeding to a de-rate study only to be followed by an up-rate (or re-rate) study. If a de-rate study is necessary, the transmission owners could seek an expedited review of the path rating.

Such a treatment is consistent with other Accepted paths in WECC.

The Transmission Owners feel that they will be able to select an appropriate time to pursue WECC rating for Path 8 in a timely fashion for the retirement of Colstrip Units 1 and 2. Immediate action is not warranted at this time. When the transmission owners pursue an updated WECC rating for Path 8, they will include any system reinforcements not previously considered (such as the completed improvements Avista discussed in the Colstrip Transmission Upgrade section).

Remedial Action Scheme Changes

Guidance: *The Steering Committee does not advise preparation of a broad specification of Remedial Action Scheme (RAS) as detailed specifications of replacement generation is required to do so.*

Discussion:

The transmission capacity of Path 8 (Montana to the Northwest) and Path 6 (West of Hatwai) are supported by existing Remedial Action Schemes (RAS). For Path 8, the RAS is supported by a protection scheme local to the Colstrip plant known as the Acceleration Trend Relay (ATR). The ATR measures system voltages and angles as well as the shaft speed of the generation at Colstrip. The ATR can trip as many units as needed in response to deviations in the Colstrip generation shaft speed (and acceleration) with respect to the system angles in order to preserve the stability of the transmission system.

The studies done by NTTG and NWE, as well as the paper by Chuck Stigers all acknowledge that RAS will continue to be necessary as coal fired generation at Colstrip retires in order to support the reliable operation of the path. Those studies (and paper) anticipate that the ATR RAS will continue to support reliable operation of the path as Colstrip Units 1 & 2 retire. Replacement generation will, however, need to participate in RAS; the RAS for the replacement resources will need to coordinate with the existing ATR RAS.

As additional unit(s) at Colstrip retire, the ATR itself may need to be replaced or re-designed. NWE, supported by AVA and BPA, will need to work together to make appropriate design decisions for the RAS modifications to continue to support reliable operation of the transmission system.

For the Steering Committee: The Planning Committee does not propose further action at this time.

While the Transmission Owners have not made any design decisions on how to coordinate with the Colstrip ATR or what a RAS implementation might be when all coal fired generation at Colstrip is retired, the Transmission Owners anticipate that they will be able to identify appropriate schemes that will support the reliable operation of the system in a timely fashion.

It is also important to note that Transmission Owners have a common interest to have a viable scheme(s) to maintain transfers across Path 8. The Transmission Owners will work together and with the developers of replacement resources to ensure the timely incorporation of the RAS system needed to provide service to accommodate the needs of the transmission system.