MEMORANDUM

TO:  Council Members

FROM:  John Ollis, Manager of Planning and Analysis

SUBJECT:  Summary of Coal Retirement Scenario Findings

BACKGROUND:

Presenter:  Gillian Charles, John Ollis and Ben Kujala

Summary:  The work on this scenario thus far has focused on early retirement of coal plants inside and outside the region.  An early retirement date of 2027 for all in-region and 2030 for out-of-region coal plants was set to test the combined effect on regional resource strategies.  In comparison to the baseline, this results in nearly 15 gigawatts nameplate of additional coal generation retiring before the end of the plan.

Some needs assessment and resource strategy analysis information from this presentation is pending as staff analyzes ongoing simulation results.

Relevance:  One of the least expensive methods for reducing greenhouse gas emissions in the Seventh Plan, was the retirement of coal generation.  The goal of this scenario is to inform resource strategy development in comparison to other emissions reduction techniques or policies.

Workplan:  A.6.1 Complete scenario analysis for the plan

More Info:  Simulation results related to this scenario will be discussed at the upcoming March 31st System Analysis Advisory Committee (SAAC), and
were discussed previously at the March 24th Power Committee and the March 17th SAAC.

March 24 Power Committee Webinar

March 19 Update to SAAC

March 17 SAAC Results

March 17 Scenario Background
Early Retirement of Coal Scenario

Council Meeting – April 7, 2021

Gillian Charles, John Ollis, Ben Kujala
For discussion today...

- **Setting up the scenario** – what are we exploring and what are the assumptions?
- **Draft results**
Scenario assumptions
Proposed Coal Retirement Scenario: 2021 Power Plan

• Purpose: to analyze effect on resource strategies of 100% coal retirements in the region/WECC
  • What does this do to emissions, system cost?
  • What are the replacement resources?
  • How to maintain adequacy and reliability?

• High level parameters –
  Retire all coal by
  • 2027 for Region
  • 2030 for WECC
Planned retirements based on agreements, announcements, IRPs; subject to change

- Hardin Generating Station was sold to an out-of-region cryptocurrency company; therefore no longer “counts” towards the region
- Idaho Power ended its participation in North Valmy 1 in Dec 2019; unit will likely retire in 2021 (NV Energy)
- Uncertainty remains over timing of Jim Bridger 1,2 potential accelerated retirements
- Uncertainty remains over Idaho Power’s participation in North Valmy 2; may divest ownership in 2022, with unit retiring in 2025
- Colstrip 3,4 owners have discussed potential retirement dates, but nothing official announced

Data source: Council’s project database
## Region Assumptions:
Retire all coal units by 2027

<table>
<thead>
<tr>
<th>Coal Plant Unit</th>
<th>Nameplate Capacity (MW)</th>
<th>Announced/Existing Retirement Date (EOY)</th>
<th>Baseline Conditions*</th>
<th>Scenario: Early Retirement (EOY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colstrip Unit 1</td>
<td>358</td>
<td>2019</td>
<td>Retired</td>
<td>Retired</td>
</tr>
<tr>
<td>Colstrip Unit 2</td>
<td>358</td>
<td>2019</td>
<td>Retired</td>
<td>Retired</td>
</tr>
<tr>
<td>Boardman</td>
<td>601</td>
<td>2020</td>
<td>Retired</td>
<td>Retired</td>
</tr>
<tr>
<td>Centralia 1</td>
<td>730</td>
<td>2020</td>
<td>Retired</td>
<td>Retired</td>
</tr>
<tr>
<td>North Valmy 1</td>
<td>277</td>
<td>2019**/2021</td>
<td>Retired</td>
<td>Retired</td>
</tr>
<tr>
<td>Centralia 2</td>
<td>730</td>
<td>2025</td>
<td>2025</td>
<td>2025</td>
</tr>
<tr>
<td>North Valmy 2</td>
<td>289</td>
<td>2025</td>
<td>2025</td>
<td>2025</td>
</tr>
<tr>
<td>Jim Bridger 1</td>
<td>608</td>
<td>2023</td>
<td>2023</td>
<td>2022</td>
</tr>
<tr>
<td>Jim Bridger 2</td>
<td>617</td>
<td>2028***</td>
<td>2028</td>
<td>2026</td>
</tr>
<tr>
<td>Colstrip 3</td>
<td>778</td>
<td>--</td>
<td>2037</td>
<td>2025 (WA Legislation)</td>
</tr>
<tr>
<td>Colstrip 4</td>
<td>778</td>
<td>--</td>
<td>2037</td>
<td>2025 (WA Legislation)</td>
</tr>
<tr>
<td>Jim Bridger 3</td>
<td>608</td>
<td>--</td>
<td>2037</td>
<td>2026</td>
</tr>
<tr>
<td>Jim Bridger 4</td>
<td>608</td>
<td>--</td>
<td>2037</td>
<td>2026</td>
</tr>
</tbody>
</table>

**EOY = End of Year**

* Baseline conditions – announced retirement date or expected end-of-useful life estimate

** Idaho Power ended it’s participation in North Valmy 1 in 2019

*** PAC and IPC still working out details of the accelerated retirement of Bridger 2, date could be considered tentative.

Accelerated coal unit retirement
Coal Unit Retirements: Baseline Conditions vs. Early Retirement
WECC Assumptions:
Retire all coal units by 2030

All coal units assumed retired by 2030; retirement is varied from 2025-2029
## Status of Colstrip 3, 4

<table>
<thead>
<tr>
<th></th>
<th>Colstrip 3</th>
<th>Colstrip 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nameplate</td>
<td>778 MW</td>
<td>778 MW</td>
</tr>
<tr>
<td>Capacity (MW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Rosebud, MT</td>
<td>Rosebud, MT</td>
</tr>
<tr>
<td>Owners</td>
<td>Talen (30%)</td>
<td>NorthWestern Energy (30%)</td>
</tr>
<tr>
<td></td>
<td>Puget Sound Energy (25%)</td>
<td>Puget Sound Energy (25%)</td>
</tr>
<tr>
<td></td>
<td>Portland General Electric (20%)</td>
<td>Portland General Electric (20%)</td>
</tr>
<tr>
<td></td>
<td>Avista (15%)</td>
<td>Avista (15%)</td>
</tr>
<tr>
<td></td>
<td>PacifiCorp (10%)</td>
<td>PacifiCorp (10%)</td>
</tr>
</tbody>
</table>

### Considerations:
- Washington’s Clean Energy Transformation Act (CETA): **No coal by end of year 2025**  
  Subject to deadline: PSE, Avista, PAC
- Oregon’s Clean Electricity & Coal Transition Plan: **No coal by 2030**  
  Subject to deadline: PGE, PAC  
  (PGE has special extension until 2035)
# Future of Colstrip 3, 4

<table>
<thead>
<tr>
<th>Company</th>
<th>Exit Plan</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puget Sound Energy</td>
<td>Exit Colstrip 3, 4 by EOY 2025</td>
<td></td>
</tr>
<tr>
<td>Portland General Electric</td>
<td>Exit Colstrip 3, 4 by 2035</td>
<td></td>
</tr>
<tr>
<td>Avista</td>
<td>Exit Colstrip 3, 4 by EOY 2025 (for WA customers); Draft 2021 IRP - Most economic to exit units 3, 4 earlier than 2025 (for WA and ID customers)</td>
<td></td>
</tr>
<tr>
<td>PacifiCorp</td>
<td>Assumed early exit of 2027 in 2019 IRP - most economic option in preferred portfolio; end of useful life assumed in 2037; further analysis underway for draft 2021 IRP</td>
<td></td>
</tr>
<tr>
<td>NorthWestern Energy</td>
<td>Continue operations; end of useful life 2042</td>
<td></td>
</tr>
<tr>
<td>Talen Energy</td>
<td>Continue operations</td>
<td></td>
</tr>
</tbody>
</table>

**Potential Future Options:**
- Sell/transfer ownership shares and continue running one or both units
- Retire units 3, 4
- Consider Carbon Capture and Sequestration at Colstrip
- Consider brownfield development of small modular nuclear (SMR) or enhanced geothermal systems (EGS)
**Status of Bridger 3, 4**

<table>
<thead>
<tr>
<th></th>
<th>Jim Bridger 3</th>
<th>Jim Bridger 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nameplate Capacity (MW)</strong></td>
<td>608 MW</td>
<td>608 MW</td>
</tr>
<tr>
<td><strong>Location:</strong></td>
<td>Sweetwater County, WY</td>
<td>Sweetwater County, WY</td>
</tr>
<tr>
<td><strong>Owners:</strong></td>
<td>PacifiCorp (66.7%) Idaho Power (33.3%)</td>
<td>PacifiCorp (66.7%) Idaho Power (33.3%)</td>
</tr>
</tbody>
</table>

**Considerations:**
- Washington’s Clean Energy Transformation Act (CETA): No coal by end of year 2025
  
  Subject to deadline: PAC
- Oregon’s Clean Electricity & Coal Transition Plan: No coal by 2030
  
  Subject to deadline: PAC

Photo from Andrew Graham/WyoFile
Future of Bridger 3, 4

**PacifiCorp**: Exit by **2030** for OR customers; Assumed retirement in **2037**, as part of 2019 IRP preferred portfolio; further analysis underway for draft 2021 IRP

**Idaho Power**: Exit by **2028** and **2030** (unit order TBD), as identified in the 2019 IRP update.

While several early retirement dates are being considered, Idaho Power and PacifiCorp have not come to any official decision or agreement about these units.

**Potential Future Options:**
- Run units until end of useful life, as determined by owners
- Accelerate retirement for one or both units
- Other?
Sensitivity Study: Run Colstrip 3, 4 to 2042(?)

- Run a sensitivity that allows Colstrip 3 and 4 to run through 2042 (date TBD)
  - Colstrip 3 and 4 have six owners between the two units
  - Each owner has a preferred strategy for the future operation of the unit(s)
  - In NorthWestern Energy’s 2020 Supplement to the 2019 Electricity Supply Resource Procurement Plan, Colstrip 4 runs through 2042

- Purpose: Test the reliability and adequacy of the system with these coal units available

- Logistics around this sensitivity are still under development; it may be a sensitivity to a different scenario
Draft Results

WECC Buildout, Mid-C Prices, Emissions, Adequacy Need
Summary

• Bigger WECC buildout from early coal retirement than in baseline.
• Emissions and market emissions rate drop considerably in early coal retirement scenario in comparison to baseline.
• Market prices are slightly lower in later years than in the baseline.
• Needs shift from early 2020’s in the baseline, to 2027 and 2031 after the early coal retirements.
Summary of Revised Results

Overall WECC build is 45 GW higher than baseline

1. CO₂ Emissions drop by 39% from baseline by 2045
2. Annual/seasonal planning reserve margins are less effective at efficiently enforcing adequacy on a power system with the following characteristics:
   • High penetration of renewables
   • Massive thermal retirements by 2030
3. Clean requirements are more expensive to meet than in the baseline (more renewable curtailment, less overall system flexibility).
Emissions Drop By 38% in 2030 and by 39% in 2045
Early Coal Retirement
- 474 GW Nameplate
Baseline - 429 GW Nameplate
More Builds in a Coal Retirement Scenario

Observations:
1. Less solar early, more late, more solar plus battery.
2. Builds of offshore wind and storage deferred to later in study
3. Proxy clean resource builds in first year available.
Almost 8 GW more resource built in California, Desert SW and Mexico
37 GW More Resource Built in the Pacific NW, Mountain West and Canada

Early Coal Retirement

Baseline

Buildout

Resource Buildout

- Hydro Clean
- Pumped Storage
- Storage
- Solar Plus Battery
- Wind
- NG
- SUN
With Larger Build in NW Comes a Higher Proportion of Costs, Costs Similar to Baseline Overall

**Early Coal Retirement**
Cumulative Fixed Versus Production Costs over Time (in thousands of dollars)

**Baseline**
Cumulative Fixed Versus Production Costs over Time (in thousands of dollars)
Recall: Baseline Clean Policies Met Until 2037
Clean Policies Mostly Met Until Late 2030s, Significantly More Curtailment than Baseline
Buildout Observations

• Current buildout is less adequate and less successful at fulfilling policies than the baseline run
  • Many resources were available to meet PRMs and clean requirements.
  • Model likely could be tuned better to improve run, but for price purposes seems good enough.
  • This build reflected SAAC suggestions on improving build presented in 3/17/2021 meeting

• This will likely show more price volatility and definitely a lower market emissions rate.

• Buildout will likely show a less surplus market in needs assessment, since more build in Pacific NW.
Pricing and Emissions Summary for the Early Coal Retirement Scenario

- Prices at the Mid-Columbia go lower than baseline on an annual basis.
  - More renewable builds in the NW than in the baseline
- Slightly less seasonal price variability than baseline.
  - Less renewable builds in general than the baseline
- Avoided CO2e Emissions Rate decreases faster than the baseline and ends up about 50% of the baseline market emissions rate
Early Coal Retirement Monthly Mid C Prices in 2016 $ per MWh

Prices lower than baseline faster, but level off after coal plan retirements...
MidC Prices 2016 $ per MWh Monthly

For reference...

Baseline
Midday price dip less prominent than in baseline
Avoided CO2e Emissions Rate decreases slightly faster than the baseline and is half the magnitude by the end of the study.
Needs Assessment Results

• Needs in 2023 in baseline are lessened in winter and increase in summer by changing market supply early.
  • Earlier and more gas builds in AURORA by neighboring regions

• Less regional resource available in 2027 and 2031 to meet regional needs.
  • More renewables built in Pacific NW to backfill coal in AURORA buildout. These are not part of external market in needs assessment and are removed from GENESYS analysis.
Maximum Needs Change from Winter to Summer, Slight Increase in Needs After Retirements

Baseline

Early Coal Retirement

Needs: Peak and Energy

- Energy Needed For Adequacy (aMW)
- Peak Capacity Needed for Adequacy (MW)

Graphs showing energy needs and peak capacity needed for adequacy over the years.
Conclusions

• Bigger, more diverse WECC buildout backfills for early retirements.

• Less emissions and lower market prices than in baseline

• Increase in regional needs coincides with the early coal retirements
Baseline Conditions Update
Change in Coordination between RPM and GENESYS

Previous approach overstated the resource needs in the Early Coal Retirement Scenario leading to overbuilding resources.

Adapted the approach to make sure when RPM has peak loads equivalent to the highest loads GENESYS tests, the resource need matches what GENESYS finds.

Based on these finding we decided updating the Baseline Conditions was appropriate.

We are exploring further refinement of these results with respect to reserves which may further alter the results shared today – but the update is needed for comparing to the Early Coal Retirement Scenario.
Update Eliminated Both Natural Gas Generation and Demand Response

Results from the update to Baseline Conditions reduced the resources needed for adequacy and led to some significant changes, including:

• No natural gas generation is built
• No demand response is selected
• Less renewables and energy efficiency are built
Large Build of Renewables

4.9 GW Nameplate Renewables by 2027
Renewable Curtailment

Onshore Wind - Montana

On average producing less than 40% of potential energy for 20 hours of the day by the end of the study.
GHG Emissions

2019 Emissions were ~56.6 MMT

GHG emissions in the region fall throughout the plan.

Net Annual CO2 Emissions (Millions of Metric Tons)

Simulation FY

Statistics
- Min
- Median
- Mean
- Max
- Std. Dev.
- Variance
- Skewness
- Kurtosis
Impact of Electricity Price Forecast

Off-peak Electricity Prices

Off-peak prices are frequently negative by the end of the study.
Maximum Amount of Conservation Purchased by FY

- Seventh Plan Targeted 1400 aMW by end of FY 2021
- About 500 aMW purchased by end of 2027
Percent of Conservation Supply Purchased

Near-term adequacy needs & market conditions drive early EE purchases
Immediate Adequacy Need

Minimal adequacy needs throughout the entire study
Resource Adequacy Contribution
Summer – Capacity

Summer capacity falls throughout the study
Resource Adequacy Contribution
Summer – Energy

Critical Water Reduction Based on Climate Change Record
Early Coal Retirement Resource Strategy Comparison
High-level Take-aways

• Change in timing of renewable builds
• Increase in natural gas generation build
• Substantial near-term reduction in greenhouse-gas emissions
• Around 6% increase in residential bills over 20-years
Average EE Acquired

Slight reduction in EE

- Red line: Baseline
- Orange dashed line: Early Coal Retirement

Years: 2022 to 2041

Units: EE (Electricity Energy)
Average Renewable Build

Renewables build shift to earlier in the study
Thermal generation is built to replace regions retiring coal fleet.
Substantial emissions reductions based on both change in regional & market resource mix
Average Exports (aMW)

Baseline - Revised ARMs
Early Coal Retirement

Less exports after regional coal fleet retirements
About 6% average Increase in bills
Questions