FCRPS Program Strategy
Federal Columbia River Power System

Presenters:

- **Bonneville Power Administration**
  - Kim Johnson, Fed Hydro Manager
  - Gordon Ashby, Resource Economic Planner
  - John Hayes, FCRPS Asset Manager

- **Bureau of Reclamation – Columbia-Pacific Northwest Region**
  - Joe Summers, Regional Power Manager
  - Craig Parker, Deputy Regional Power Manager
  - Ben Cano, Strategic O&M Planner

- **USACE – Northwestern Division**
  - Shawn Worthington, Deputy Ops Chief
  - Roger James, O&M and Capital Program Manager
  - Mike Villamar, Strategic O&M Planner
Safety

- Days Away, Restricted, or Transferred
  - Min target and Stretch target are established by the Performance Subcommittee

![DART Incident Rate Chart](image-url)

- FCRPS
- USACE
- Reclamation
- Stretch Target
- Min Target
Fed Hydro Commitment

- Safety First - protect our people and equipment
- Asset Management principles that improve efficiency, affordability and reliability
  - Process improvements for program execution
- Cost effective operation and maintenance
  - Balance cost, performance, and risk
- Risk informed investment decisions
- Deliver value to customers and stakeholders
Direct Funding History: USACE and BOR

  - Section 2406: Direct Funding Legislation
    - Capital investments, operations, and maintenance
    - Power specific and joint costs

- Memoranda of Agreement between Agencies
  - Bureau of Reclamation
    - 1993: Capital
    - 1996: O&M
  - USACE
    - 1994: Capital
    - 1997: O&M
FCRPS Organization

Joint Operating Sub-Committees
(Working Groups)

- Capital Workgroup (CWG)
- Asset Planning Team (APT)
- River Management (RMJOC)
- Cultural Resources (CRSC)
- Reliability Implementation Technical (RITS)
- Hydropower Optimization Team (HOT)
- Technical Implementation Operations (TOIS)
- Performance Committee (PC)
### Asset Management – Strategic Goals

<table>
<thead>
<tr>
<th>Goal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Cost, Reliable Power</strong></td>
<td>We will make sound operations, maintenance, and investment decisions to meet the needs of our power customers, comply with regulations, and support regional generation and transmission requirements at competitive rates.</td>
</tr>
<tr>
<td><strong>Trusted Stewardship</strong></td>
<td>We will balance the multiple uses of our physical assets and natural resources on behalf of the region in support of flood risk mitigation, water delivery, navigation, fish and wildlife mitigation, cultural resources, and recreation.</td>
</tr>
<tr>
<td><strong>Long-term Sustainability</strong></td>
<td>We will balance the cost, performance, and risk of FCRPS assets while investing in our workforce and culture to cultivate the competencies necessary to safely and efficiently deliver upon our missions.</td>
</tr>
</tbody>
</table>
FCRPS Asset Management Structure

Three Agency Executives

Senior Oversight Group

Governance Team (ESC/JOC)

FCRPS Asset Management Program Manager

Asset Strategy and Planning Team

Asset Management Integration Team

Asset Reliability Team

Existing Function

New Function (Current)

New Function (Future)
FCRPS Asset Management – Roadmap

**Currently Underway**

- Asset Planning and Strategy
  - Demand Analysis
  - SAMP Alignment
  - Risk Management Plan
- AM Integration Team
  - AM Literacy, Training, Process Documentation
  - Communication Plan
  - Plant Maintenance Management Plans
- Asset Reliability Team
  - Asset Condition and Monitoring
  - Performance Feedback

**Planned**

- Regional O&M Strategy (Integrate with SAMP)
- Plant Asset Management Plans
- Integration with SAP
- Outage Management

**FY22**
FCRPS Asset Management – Near Term Objectives

- **Objectives**
  - Demand analysis underway at USACE and USBR, these will be used to help inform FCRPS AM strategies/plans.
  - Improve literacy of AM principles among workforce (MAX.GOV site).
  - Begin work to define FCRPS risk appetite and tolerances.
  - Analyze regional O&M strategies and incorporate into SAMP.
  - Develop plant-specific asset/maintenance plans that integrate and implement O&M and Capital strategies.

**Asset Strategy and Planning Team**
- Demand Analysis
- Risk Management Plan
- SAMP Alignment / Incorporate O&M
- Update Strategic Objectives
- APT / System Asset Plan
- Plant Asset Plans

**AM Integration Team**
- Integration with SAP
- Project Maintenance Plan Dev
- Outage Management
- AM Literacy, Training
- Communications

**Asset Reliability Team**
- Asset Condition & Monitoring
- Performance Feedback
- hydroAMP
- Performance Indicators
- HT&E Program
• Marriage of Capital and O&M strategies to create a holistic life cycle asset management program.

• Share best practices between the agencies and document processes to ensure sustainability.

• Encourage open communication at all levels, top down and bottom up; improved maintenance practices must provide true value to our teams working at the plants and our customers.
Initiatives: Pilot efforts to Evaluate Value

- O&M Excellence Initiatives
  - Hydropower Research Institute
  - Maintenance Historian
  - Rotating Machines Big Data

- AIEI and O&M Excellence
  - Machine Condition Monitoring
  - Predictive/start/stop Analysis
  - Hydropower Value Analysis
USACE Asset Management – O&M Integration

- O&M Optimization Initiative (OMOI)
- O&M Budget Planning
  - Labor analysis: Identify areas where efficiencies can be gained
  - Multi-crafting: Improve efficiencies in operations
- Outage Planning
  - O&M: Implement seasonal availability targets and track compliance with outage schedule
- Investment Planning
  - Value measure improvements: Asset life cycle framework initiative
- Maintenance Plans
  - PMMP: Pilots planned for FY23
Cost Effectiveness

- FCRPS related costs represent about 2/3rds of Power Services total costs.
- USACE and Reclamation costs (O&M and Capital-related costs) represent 44% of the fully-loaded Federal Hydro System costs.

- Total Power Services costs
- Break down of all costs allocated to the FCRPS.

*3-year average
Cost Effectiveness

- Cost of Generation represents the Capital and O&M costs associated with producing power at the facilities.

- Corps and Reclamation are first quartile performers among 13 North American utilities.

- BPA costs (asset management, generation planning, etc.) are allocated to Corps and Reclamation facilities and included in benchmark costs.
Cost Effectiveness

- Fully Loaded Cost represent all Power Services costs attributable to the FCRPS (including Fish and Wildlife).
- Increases in Capital investment are offset by mitigated lost generation risk.
- O&M program is assumed to increase at ~2% per year
Reclamation - O&M Budget

- Reclamation Detailed Budget and Proposed Spending Levels

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Base Program</th>
<th>NREX</th>
<th>Cultural Resources</th>
<th>WECC/ NERC</th>
<th>TOTAL BOR APB EXPENSE</th>
<th>Leavenworth Appropriated Expense</th>
<th>Total Budget</th>
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<tbody>
<tr>
<td>2020</td>
<td>$118,839</td>
<td>$27,445</td>
<td>$4,325</td>
<td>$1,290</td>
<td>$151,899</td>
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<td>$121,309</td>
<td>$28,008</td>
<td>$3,363</td>
<td>$1,699</td>
<td>$154,379</td>
<td>$500</td>
<td>$154,879</td>
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<tr>
<td>2022</td>
<td>$125,358</td>
<td>$20,747</td>
<td>$3,932</td>
<td>$1,732</td>
<td>$151,769</td>
<td>$500</td>
<td>$152,269</td>
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<td>$127,899</td>
<td>$18,956</td>
<td>$3,850</td>
<td>$1,758</td>
<td>$152,463</td>
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<tr>
<td>2024</td>
<td>$128,559</td>
<td>$19,481</td>
<td>$4,034</td>
<td>$1,790</td>
<td>$153,864</td>
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<td>$154,364</td>
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<td>$19,737</td>
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<td>$1,822</td>
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<td>$157,218</td>
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<td>$1,891</td>
<td>$155,446</td>
<td>$500</td>
<td>$155,946</td>
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Note: Does Not Include Potential NREX Costs for Grand Coulee G19-21 Modernization and Arc Flash Mitigation Projects
Reclamation - O&M Budget

- Expenditures

**Expense Program Expenditures 2013-2021**

<table>
<thead>
<tr>
<th>Year</th>
<th>Routine Expense</th>
<th>NREX</th>
<th>IPR Budget</th>
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<tbody>
<tr>
<td>2013</td>
<td>$85,992</td>
<td>$35,137</td>
<td>$131,193</td>
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<tr>
<td>2014</td>
<td>$101,801</td>
<td>$33,676</td>
<td>$145,176</td>
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<tr>
<td>2015</td>
<td>$101,582</td>
<td>$28,709</td>
<td>$151,033</td>
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<tr>
<td>2016</td>
<td>$101,617</td>
<td>$28,591</td>
<td>$155,272</td>
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<td>2017</td>
<td>$114,481</td>
<td>$35,177</td>
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<td>2018</td>
<td>$114,817</td>
<td>$37,288</td>
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<tr>
<td>2019</td>
<td>$121,971</td>
<td>$40,780</td>
<td>$161,123</td>
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<tr>
<td>2020</td>
<td>$122,862</td>
<td>$27,204</td>
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<tr>
<td>2021</td>
<td>$125,464</td>
<td>$24,165</td>
<td>$154,379</td>
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</table>

Note: 2013 WPP Overhaul Project Begins
## Reclamation – Cost Drivers

### Labor
- **$24.8M Increase in Labor Costs**
- **30.7% Cumulative Increase**
- Overtime Costs Consistent
- Staffing Levels Relatively Constant in this Period

### Wage Increase Summary

<table>
<thead>
<tr>
<th>FY</th>
<th>Average Craft Wage Increase at Grand Coulee</th>
<th>Average Craft Wage Increase in Snake River Area Office</th>
<th>GS Wage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>3.54%</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>2016</td>
<td>1.95%</td>
<td>2.65%</td>
<td>1.17%</td>
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<tr>
<td>2017</td>
<td>1.30%</td>
<td>2.38%</td>
<td>1.63%</td>
</tr>
<tr>
<td>2018</td>
<td>4.62%</td>
<td>2.88%</td>
<td>1.67%</td>
</tr>
<tr>
<td>2019</td>
<td>3.95%</td>
<td>3%</td>
<td>1.66%</td>
</tr>
<tr>
<td>2020</td>
<td>3.47%</td>
<td>3%</td>
<td>2.85%</td>
</tr>
<tr>
<td>2021</td>
<td>4.34%</td>
<td>2.98%</td>
<td>1%</td>
</tr>
<tr>
<td>2022 (est)</td>
<td>3% - 3.5%</td>
<td>3% - 3.5%</td>
<td>2.42%</td>
</tr>
</tbody>
</table>

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**Reclamation O&M Labor**

- **Reg Labor**
- **OT Labor**
- **Cumulative Labor Increase**

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**FEDERAL COLUMBIA RIVER POWER SYSTEM | BP24**

**SLIDE 19**
Reclamation – Cost Drivers

• Backlog of NREX Activity
  – Budget Constraints
    • Baseline Budget Defines Minimum Funding to Maintain Capabilities
    • FY18/19 Budget was Reduced $5.6M from the Baseline Budget IPR Request
    • FY20/21 Budget was Reduced $18M from FY18/19 IPR Approved Budget
    • FY22/23 Flat Budget

– Deferred and Delayed Projects (Partial List)

<table>
<thead>
<tr>
<th>Facility</th>
<th>Deferred Project</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCD</td>
<td>Safety - Switchyard Grounding</td>
<td>Deferred</td>
</tr>
<tr>
<td>BCD</td>
<td>Cooling Water Supply Tubing</td>
<td>Delayed FY18 to FY24</td>
</tr>
<tr>
<td>BCD</td>
<td>Machine Condition Monitoring</td>
<td>Deferred</td>
</tr>
<tr>
<td>MSFO</td>
<td>Safety - Noise Survey and Mitigation</td>
<td>Survey Complete. Mitigation Deferred.</td>
</tr>
<tr>
<td>CDR</td>
<td>Trash Rack Conveyor System Replacement</td>
<td>Deferred</td>
</tr>
<tr>
<td>GCPO</td>
<td>Safety - Power Circuit Breaker Refurbishment</td>
<td>Delayed. Work Commenced 2021</td>
</tr>
<tr>
<td>GCPO</td>
<td>WPP Foundation Drain Cleaning</td>
<td>Delayed 1 year.</td>
</tr>
<tr>
<td>GCPO</td>
<td>Patriotic Pride</td>
<td>Deferred</td>
</tr>
</tbody>
</table>
Reclamation – Cost Drivers

- Equipment Condition/Aging Infrastructure
  - Weighted Availability
    - Industry Average = 83.57%
  - Generation Capacity % in Poor Condition
    - Based on HydroAMP Condition
    - Reclamation Average = 19.8%
  - Weighted Forced Outage Factor
    - Industry Average = 3.54%
Reclamation – Cost Drivers

- **Equipment Condition**

- **Major Drive Train Assets**

- **Forecast Condition Based on Predictive Lifecycle analysis and Assumes Routine O&M and Current Planned NREX**

- **NREX and Capital Investments Needed to Address Bow Wave**
• Equipment Condition
  – Poor Condition Components (Red)
    • Rotor: GCL G16, G24
    • Stator: GCL G8, HGH G3, G4
    • Transformer: GCL G22
    • Turbine Runner: AND G2, HGH G1,G2,G3,G4, MIN G7
    • Exciter: GCL G16, HGH G1,G2,G3,G4,
  
  – Marginal Condition Components (Yellow)
    • Stator: CDR G1-G2, GCL G1-G3, G6, G19-G21, MIN G7, ROZ G1
    • Exciter: GCL G1-G18 (G16 Poor), PG7-PG12, S1-S3, PAL G1-G4
    • Transformers: GCL 3, 7, 12, 14, 16, 21, BCD 1-2
Reclamation – Major NREX Projects

Grand Coulee
• G1-18 Penstocks Rehabilitation (1)
• Safety - Power Circuit Breaker Refurbishment (2)
• PGP Discharge Tube Recoating (3)
• PGP Reverse Flow Coaster Gates (4)

Hungry Horse
• Fixed Wheel Gate Refurbishment (1)

Black Canyon
• Safety - Switchyard Grounding

Chandler
• Generator Test Model Validation

1. Contract Awarded 8/2020
2. Staff commenced work 9/2021
3. Contract Awarded 8/2020


New Start

New Start
Reclamation – Delivering Value

- Reclamation Efficiency/Availability Improvements
  - Grand Coulee Left and Right Powerhouse Crew Realignment
    - Major Maintenance Crew
      - Six Year Major Maintenance
      - 15% Increase in Annual Capacity Available
  - Running Crew
    - Routine Maintenance
  - Support Crew
    - Forced Outages, Backlog
    - Crew composition defined by need not by craft

FY18 Grand Coulee Right Power House (9 units online)
• Grand Coulee Transformer Dissolved Gas Analysis
  – Transformers in Marginal and Poor Condition
    • Asset Management and O&M Emphasis
  – DGA Important to Monitor Condition
  – Annual Testing too Infrequent
    • Manual Testing/Analysis ~20 Hours
    • 10 Days for Results
  – Calisto-9 Selected for Installation on 110 Transformers
    • Online
    • Networked/Component of Asset Monitoring Network
    • Remote Annunciation
• Projects Completed in FY21
  – Grand Coulee WPP Overhaul
    • 2011 Contract Award
    • April 13, 2016: G24 RTS
    • February 1, 2019: G23 RTS
    • September 30, 2021: G22 RTS
  – Grand Coulee GDACS
    • February 2009: Decision to Proceed
    • April 2021: Grand Coulee Complete
  – Inman 8&9 Overhaul
    • May 2015 Contract Award
    • June 2021 RTS
## USACE O&M Budget

- **USACE Detailed Budget and Proposed Spending Levels**

<table>
<thead>
<tr>
<th>FY</th>
<th>Base Program</th>
<th>NREX</th>
<th>Cultural Resources</th>
<th>Fish Wildlife</th>
<th>Total USACE APB Expense Budget</th>
<th>Appropriated</th>
<th>Total Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>$169,002</td>
<td>$28,100</td>
<td>$4,996</td>
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<td>2021</td>
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<td>$28,100</td>
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<td>$48,180</td>
<td>$252,557</td>
<td>$500</td>
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<td>$18,995</td>
<td>$4,625</td>
<td>$48,349</td>
<td>$252,557</td>
<td>$500</td>
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<td>$19,500</td>
<td>$4,671</td>
<td>$48,889</td>
<td>$252,557</td>
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<td>$20,987</td>
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<td>$187,687</td>
<td>$26,038</td>
<td>$4,844</td>
<td>$50,823</td>
<td>$269,392</td>
<td>$500</td>
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</tr>
<tr>
<td>2026</td>
<td>$187,687</td>
<td>$26,038</td>
<td>$4,844</td>
<td>$50,823</td>
<td>$269,392</td>
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<td>$50,823</td>
<td>$269,392</td>
<td>$500</td>
<td>$269,392</td>
</tr>
</tbody>
</table>

**O&M Budgets**

- **Base Program**
- **NREX**
- **Cultural Resources**
- **Fish Wildlife**
USACE O&M Budget

Expense Program Expenditures
2013-2021

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
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<tbody>
<tr>
<td>USACE - Routine Expense</td>
<td>$189,680,233</td>
<td>$208,271,687</td>
<td>$214,235,000</td>
<td>$220,986,635</td>
<td>$225,956,798</td>
<td>$221,471,906</td>
<td>$227,957,000</td>
<td>$219,554,000</td>
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<td>USACE - NREX</td>
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<td>$13,463,000</td>
<td>$15,823,000</td>
<td>$16,521,000</td>
<td>$16,202,000</td>
<td>$24,116,000</td>
<td>$20,763,000</td>
<td>$19,524,000</td>
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<td>USACE IPR Budget</td>
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USACE - Cost Drivers

- Inflationary Pressures
- Supply Chain delays
- Wage increases
• Flat Budget Changes
  – Hiring Board to evaluate backfills vs. leave vacant
  – NWP reduced 51 FTE & ~16k OT hrs
  – NWW reduced 24.5 FTE & ~19k OT hrs
  – NWS reduced 10 FTE & ~11k OT hrs
  – ~$7M reduction in supplies, materials, contracts
USACE – Major NREX Projects

McNary
- GSU T1-T7 Oil Leak Repair
- Preparing construction contract

Chief Joseph
- Spillway Monolith Joint Repairs
- Preparing construction contract

Chief Joseph
- Turbine Oil and Pipe Replacement
  - Contract awarded, work in progress

John Day
- Powerhouse Monolith Joint & Drainage Repair
  - Contract Awarded, construction in progress

Little Goose Dam
- DSAC Spillway 1 Failed Waterstop
  - Contract awarded, work in progress
USACE – Notable NREX Projects at Funding Risk

• FY22/23 NREX New Starts
  – Bonneville PH Metering Improvements for EIM
  – Libby PH Joint Seals
  – The Dalles Transformers 9-11
  – CHJ Spillway Surface Seal Replacement (Downstream)
  – Lower Granite Stilling Basin Sediment Removal
  – Little Goose Stilling Basin Sediment Removal
  – Lower Monumental Stilling Basin Sediment Removal

• FY24/25 NREX New Starts
  – BON 1 Spillway Gates
  – BON 1 Preferred AC/DC Improvement
  – BON 2 Forebay Dredging - 2nd period

• Program Risk
  – TDA Headgate Rehabilitation
  – Libby Transformer T2 rehab
  – Chief Joseph and The Dalles SF6 Breaker Refurbishment
Remote Control of Hydropower

- Evaluation
  - Multi-disciplinary team established
  - Evaluated central and nodal control centers
  - Remoting equipment gap analysis and ROM estimate
  - Staffing analysis

- Conclusions
  - Multi-purpose missions don’t allow de-staffing of plants
  - Minimal staffing reductions
  - Significant remoting costs
  - Economic challenges to feasibility
FCRPS Strategy Development

Strategic Asset Management Plan (SAMP) – Capital Forecast Process
### Asset Condition

- **Likelihood Condition Index Description**
  - 0 to 0.9: Poor
  - 1 to 1.9: Poor
  - 2 to 2.9: Marginal
  - 3 to 3.9: Marginal
  - 4 to 4.9: Marginal
  - 5 to 5.9: Fair
  - 6 to 6.9: Fair
  - 7 to 7.9: Good
  - 8 to 8.9: Good
  - 9 to 10: Good

- **Condition is assessed for 10,000+ assets/systems of assets**

- **hydroAMP is a hydro industry framework that provides guides to objectively assess equipment condition**

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**Almost Certain**

**Rare**

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FEDERAL COLUMBIA RIVER POWER SYSTEM | BP24
Asset Probability of Failure

Equipment Condition → Probability of Failure

- p(f) using effective age: 4.6%
- p(f) using actual age: 2.6%
Asset Risk and Optimal Intervention Calculation

- Use condition and probability of failure to forecast risks and costs
  - Lost Generation Risk (LGR)
  - Direct Cost Risk (DCR)
  - Lost Efficiency Opportunity
  - Asset replacement cost
The “optimal” Capital investment forecast represents the level of investment needed to replace every asset at its optimal replacement date.

Logistically not possible, but sets a baseline for comparison.

Further modeling prioritizes assets within constraints based on their relative risk.
Capital Budget Alternatives Analysis

Determine budget levels to evaluate

Model asset replacements under each budget level

Evaluate impacts on condition, risk, and value

- **Risk**
- **NPV**
- **SAMP Recommended Strategy**
Converting Strategy to a Plan

20-year Plan - Updated Annually

- Investment Planning and Optimization
- Costs
- Benefits
- Maximize Value
- Field Input
- SAMP Recommended Replacements Dates

FEDERAL COLUMBIA RIVER POWER SYSTEM | BP24
Major powertrain modernizations are extensively studied to select an alternative that balances operational, economic, environmental, safety, and other benefits.
• Large powertrain investments that justify the $300 million target have taken longer to plan and execute than expected

• Due to their size and complexity, “filling in the gaps” is not always possible when a large powertrain investment is delayed

• BPA’s requests for additional analysis to select the best investment extended some project planning processes
Recommended Capital Investment Level

- Minimal changes from 2020 IPR recommendation
- Target reaches $300 million in 2024 and then escalates at just over 2% per year
- Corps/Reclamation authorized to spend up to recommended level
- 10% reduction assumed in rates
Current Equipment Condition

- Turbines and windings account for over 45% of the estimated cost of a unit and are a major driver of our investment program.

- Approximately 50% of Kaplan Turbines and more than 50% of generator windings are in marginal or poor hydroAMP condition ratings.

- Note that there are very few Oil Circuit Breakers left in the system.
• Majority of Capital investment is targeted at Main Stem Columbia.

• Generally, investments are closely tied to lost generation risk mitigation.

• Other investments target multipurpose missions.

*Lost Generation Risk is the expected value of lost revenue from replacement power purchases or lost sales due to equipment failure. It is the product of equipment probability of failure times outage consequences at average water conditions. Current Lost Generation Risk by plant is a sum of the lost generation risk for each piece of equipment based on current equipment condition.
Financial Risk Reduction Benefits

- Risk impacts were evaluated across five different Capital investment levels
- Results from the recommended strategy are illustrated by the dashed line
Lost Generation Risk – Plant Detail

- 75% of current system lost generation risk (LGR) represented by these 5 dams.

- White bars illustrate duration of major projects.

- Investments expected to reduce annual LGR by $210 million (in real 2022 dollars) by 2041.
High risk assets are typically mitigated through operational measures until they can be replaced.

These counts are not necessarily additive (a single asset can pose both a high safety risk and high environmental risk).

Minor differences between investment scenarios.
The Recommended Strategy is believed to provide the best balance of:
- Risk Reduction (Financial and Non-Financial)
- Efficiency improvements
- Affordability
- Implementability

Higher levels of investment:
- Higher NPV but decreasing incremental benefits
- Less affordable
- Harder to implement

Lower levels of investment:
- Less upfront Capital cost
- Lower NPV from increasing risk costs

The recommended strategy achieves 94% of the net benefits of the “optimal” scenario.
### Grand Coulee Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Current Phase</th>
<th>Planned Schedule</th>
<th>Value to Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Scoping (FY)</td>
<td>Design (FY)</td>
</tr>
<tr>
<td>LPH/RPH Bridge Cranes</td>
<td>Construction</td>
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<td>--</td>
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<tr>
<td>G11-18 &amp; WPP Transformer Replacement</td>
<td>Construction</td>
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<tr>
<td>G19-G21 Modernization</td>
<td>Design</td>
<td>--</td>
<td>22 – 24</td>
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<tr>
<td>LPH/RPH Gantry Cranes</td>
<td>Scoping</td>
<td>22</td>
<td>24</td>
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<tr>
<td>Fire Protection Modernization</td>
<td>Scoping</td>
<td>22 - 23</td>
<td>23 – 24</td>
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<tr>
<td>Arc Flash Mitigation</td>
<td>Scoping</td>
<td>22</td>
<td>TBD</td>
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</table>

*Supply chain issues will likely delay current project milestones

**Results of design will influence planned construction timeframe
## Hungry Horse Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Current Phase</th>
<th>Planned Schedule</th>
<th>Value to Cost Ratio</th>
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</thead>
<tbody>
<tr>
<td>Powerplant Cranes</td>
<td>Construction</td>
<td>Design (FY) -- Construction (FY) 22-24</td>
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<tr>
<td>Transformer Fire Protection</td>
<td>Construction</td>
<td>Design (FY) -- Construction (FY) 23-24</td>
<td>2.77</td>
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<tr>
<td>Static Exciters</td>
<td>Construction</td>
<td>Design (FY) -- Construction (FY) 24-26</td>
<td>2.53</td>
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## Palisades Projects

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<th>Project Title</th>
<th>Current Phase</th>
<th>Planned Schedule</th>
<th>Value to Cost Ratio</th>
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</thead>
<tbody>
<tr>
<td>Hollow Jet Valve</td>
<td>Construction</td>
<td>Design (FY) -- Construction (FY) 22-23</td>
<td>4.17</td>
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<tr>
<td>Butterfly Valve Replacement</td>
<td>Planning</td>
<td>23 24 25-30</td>
<td>1.89</td>
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### McNary Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Current Phase</th>
<th>Planned Schedule</th>
<th>Value to Cost Ratio</th>
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</thead>
<tbody>
<tr>
<td>MCN Turbine Design and Replacement</td>
<td>Construction</td>
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<tr>
<td>MCN Headgate System Rehabilitation (McMod)</td>
<td>Construction</td>
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<td>0.25</td>
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<td>MCN Iso-phase, HV Bus and Switch Upgrade McMod</td>
<td>Construction</td>
<td>23 – 24</td>
<td>2.75</td>
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<tr>
<td>MCN Levee Drainage Pump Station Upgrades</td>
<td>Construction</td>
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<td>2.18</td>
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<tr>
<td>MCN Exciters Upgrade</td>
<td>Construction</td>
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<td>1.32</td>
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<tr>
<td>MCN Spillway Gate Rehab and Gate Hoist Uprate</td>
<td>Design</td>
<td>21-22</td>
<td>0.33</td>
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</tbody>
</table>

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*Supply chain issues will likely delay current project milestones
**Results of design and cost share funding availability may influence planned construction timeframe
<table>
<thead>
<tr>
<th>Project Title</th>
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<th>Value to Cost Ratio</th>
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<tbody>
<tr>
<td>CHJ Unit 1-16 Generator Rewind</td>
<td>Design</td>
<td>Scoping (FY) -</td>
<td>Design (FY): 22</td>
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<tr>
<td>CHJ Intake Gantry Crane</td>
<td>Construction</td>
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<tr>
<td>CHJ Upgrades for Station Service Units SS01 &amp; SS02</td>
<td>Construction</td>
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</table>

**John Day Projects**

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Current Phase</th>
<th>Planned Schedule</th>
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<tbody>
<tr>
<td>JDA Turbine Runner Replacement and Generator Rewind</td>
<td>Design</td>
<td>Scoping (FY) -</td>
<td>Design (FY): 22-24</td>
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<tr>
<td>JDA Submerged Traveling Screen Crane</td>
<td>Construction</td>
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</tbody>
</table>

*Supply chain issues will likely delay current project milestones

**Results of design may influence planned construction timeframe
FCRPS Long-Term Program Summary

- Capital and Expense programs are heavily driven by generation importance but support multiple missions for the three agencies.

- The long-term programs developed for this IPR result in a 50-year Cost of Generation of $10.14/MWh and a fully loaded cost of $22.13/MWh.

<table>
<thead>
<tr>
<th>Strategic Class</th>
<th>% of FCRPS Average Annual Generation</th>
<th>% of 50-Year Capital Forecast</th>
<th>% of 50-Year Expense Forecast</th>
<th>50-Year Cost of Generation/ ($/MWh)</th>
<th>50-Year Fully Loaded Cost/ ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Stem Columbia</td>
<td>77%</td>
<td>63%</td>
<td>66%</td>
<td>$8.08</td>
<td>$19.46</td>
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<tr>
<td>Lower Snake</td>
<td>12%</td>
<td>12%</td>
<td>13%</td>
<td>$12.50</td>
<td>$27.22</td>
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<tr>
<td>Headwater</td>
<td>6%</td>
<td>9%</td>
<td>8%</td>
<td>$13.15</td>
<td>$24.97</td>
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<tr>
<td>Area Support</td>
<td>4%</td>
<td>12%</td>
<td>9%</td>
<td>$32.77</td>
<td>$47.87</td>
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<tr>
<td>Local Support</td>
<td>1%</td>
<td>4%</td>
<td>4%</td>
<td>$42.24</td>
<td>$55.17</td>
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<tr>
<td>FCRPS</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>$10.14</td>
<td>$22.13</td>
</tr>
</tbody>
</table>

1/ Cost of Generation represents the forecasted levelized capital and expense costs associated with producing power at the facilities for the next 50 years.

2/ Fully Loaded Cost includes the Cost of Generation plus allocations for all remaining Power Services costs attributable to the FCRPS including Fish and Wildlife. The majority of these costs are system-wide costs that would still be incurred and reapportioned across other Strategic Classes if generation ceased at a certain project or projects.
Questions?