

Integrated Program Review 2

Federal Hydro Capital Program

Webinar - 12/14/2016

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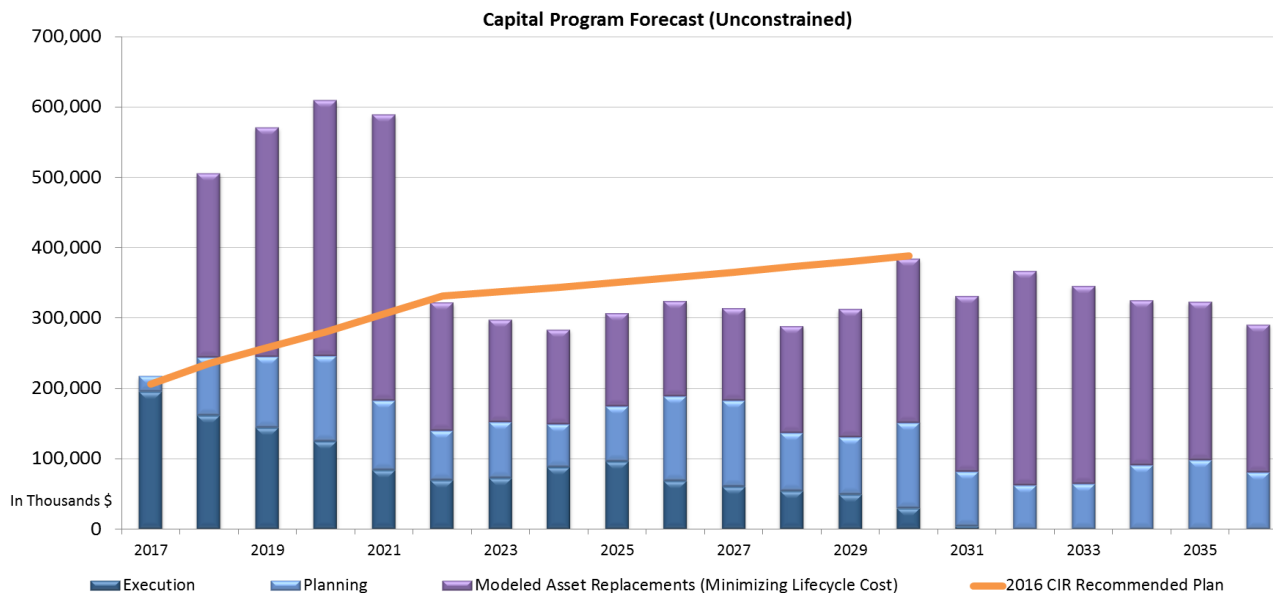
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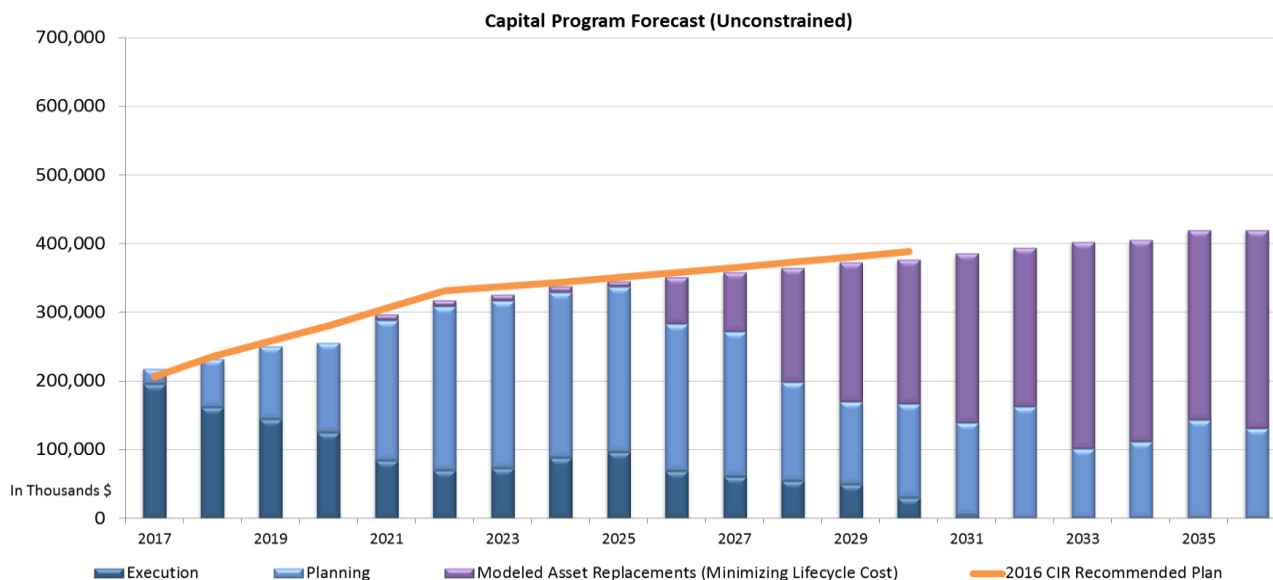
Lifecycle cost minimization

- The Federal Columbia River Power System uses a lifecycle cost minimization model to calculate the optimal replacement date for equipment in the 31 hydroelectric facilities in the Pacific Northwest.
- Running the model without a budget constraint produces an annual capital investment forecast based on replacing equipment at their respective optimal replacement dates (shown in the chart below).
- Modeling results indicate a higher near-term investment need in order to minimize lifecycle costs for the system, suggesting that there is a backlog of equipment at or past the point of lifecycle cost minimization.



Recommended capital program

- The FCRPS program has proposed a ramp up to a \$300 million annual investment level (in 2016 dollars) by 2022 in order to invest in reliability improvements in high-risk equipment at critical plants.
 - Although the modeled need to minimize system lifecycle cost is considerably higher in the near-term, some of the replacements can be deferred with a negligible increase in risk.
 - The modeling results from the previous slide do not consider unit outage constraints, resource constraints or the physical capability to execute work within a powerhouse.
 - An executable plan informed by the modeling results is shown in the chart below. Investments are optimized within constraints using a portfolio optimization tool that seeks to maximize the value of the investment portfolio.



Investment by equipment category FY17-FY36

| Percentage of Capital Investment Forecast FY17-F36 | | | | | | |
|--|-----------------|--------------------|---------------|--------|----------------|-------------|
| Unit Reliability | Station Service | Operations Support | Water Control | Cranes | Infrastructure | Opportunity |
| 65% | 5% | 6% | 10% | 5% | 8% | 1% |

Unit Reliability: Replacement of powertrain equipment and other equipment that directly impact unit reliability.

Station Service: Replacement of electrical equipment that provides power to powerhouse. Station service equipment failure can result in multiple unit outages.

Operations Support: Replacement of equipment that support day-to-day operations such as SCADA systems, communications equipment, fire protection and detection systems, security systems and control room equipment.

Water Control: Replacement of equipment required to dewater units in support of capital investment as well as spillway gate structural improvements in the Willamette Valley based on recommendations following Tainter Gate failure at Folsom Dam.

Cranes: Replacement of cranes that are required to disassemble units and install or remove water control equipment.

Infrastructure: Replacement of roofs, elevators and HVACs as well as the construction or modification of oil water separators in accordance with the Columbia Riverkeeper settlement.

Opportunity: Adding additional generating units to existing FCRPS facilities.

Unit efficiency improvements and uprates

- The potential for efficiency, capacity or outage management improvements are investigated while units are undergoing modernization. These improvements often come at little to no incremental cost. When there is sufficient benefit to outweigh cost these benefits are pursued.
- Grand Coulee G19-G21 Modernization
 - Generators are in poor condition (hydroAMP score of 1.2 out of 10).
 - Turbines are in marginal condition (hydroAMP Score of 5.2 out of 10).
 - Although the turbines may have several years of remaining useful life (40 years old with a 50 year design life), it may be more cost effective to replace the turbine now and avoid another lengthy outage (and the associated generation impacts) for planned replacement in the near future.
 - New turbine runners can be designed with higher efficiency and for a higher capacity.
 - Primary driver is reliability and avoided outage time (both forced and scheduled).

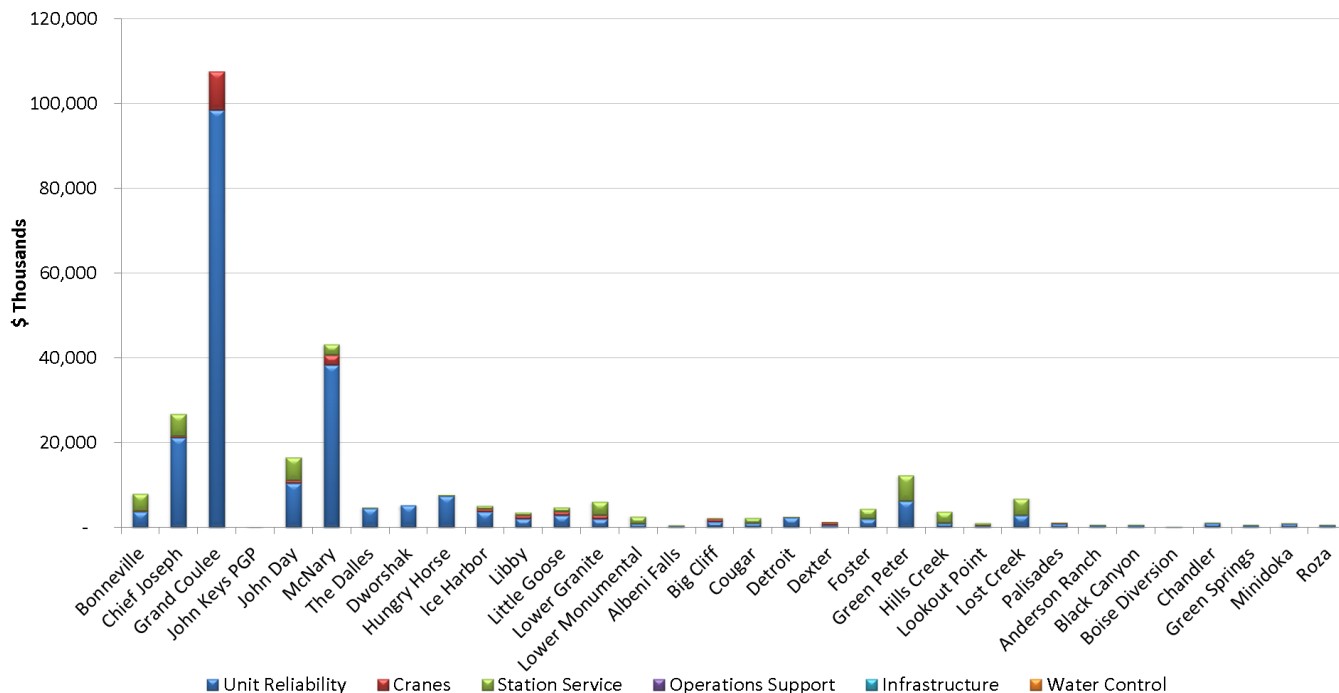
Grand Coulee and McNary

- The FCRPS program is taking a more holistic power plant approach to investment in order to minimize unit outages over the long-term and more efficiently execute work.
- Grand Coulee and McNary are the first two plants that are planned to undergo long-term modernization projects due to their criticality and the high cost when they are unavailable.
- The work identified at these two plants averages \$150 million per year from 2020 to 2029 with individual years costing as much as \$210 million. If held to current investment levels, the remaining plants in the FCRPS would receive very little investment until the completion of the modernization projects at Grand Coulee and McNary.
 - This results in increasing lost generation risk in the 2020s under the 2014 CIR investment levels as conditions degrade and probabilities of failure continue to increase throughout the rest of the system.

Lost generation risk

- Lost generation risk is the risk associated with the failure of a component within a powerhouse.
- Lost generation risk is calculated for powertrain and critical ancillary components based on their condition, probability of failure and outage consequence.
- Outage consequences vary by plant and by equipment type.

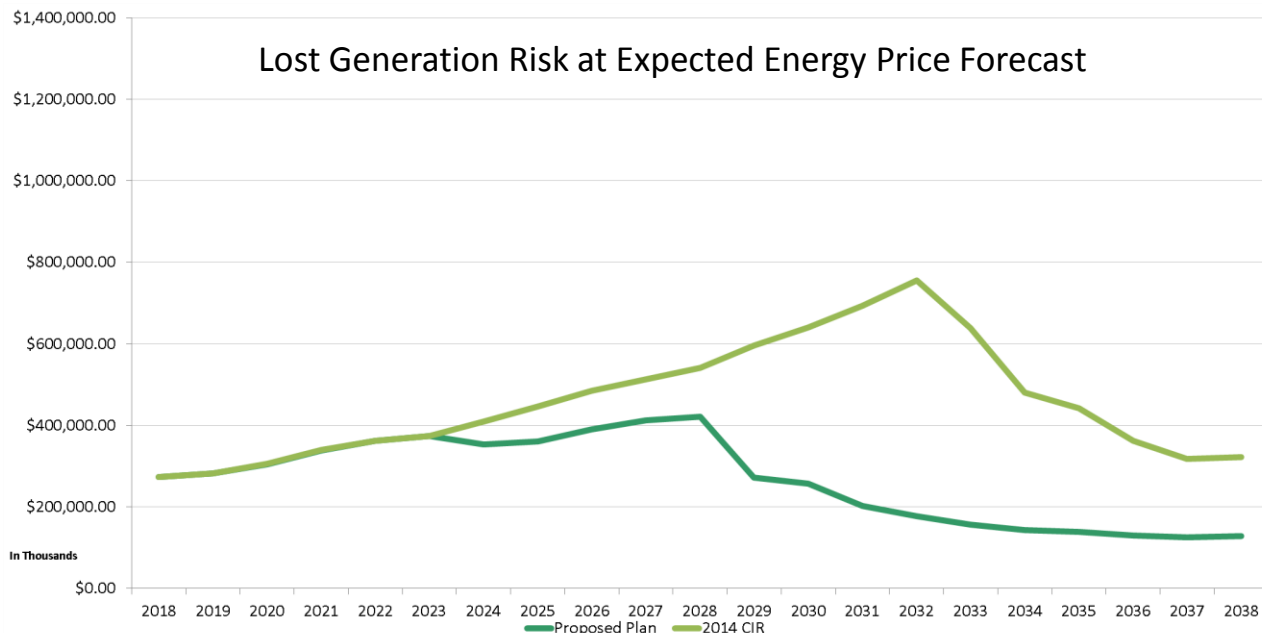
Current lost generation risk



- The chart above illustrates the lost generation risk at each plant resulting from current equipment condition and associated probabilities and consequences of failure.
- Due to their relatively high cost of unavailability and poor equipment condition, Grand Coulee and McNary represent more than 50 percent of the current lost generation risk in the FCRPS.

Lost generation risk forecast

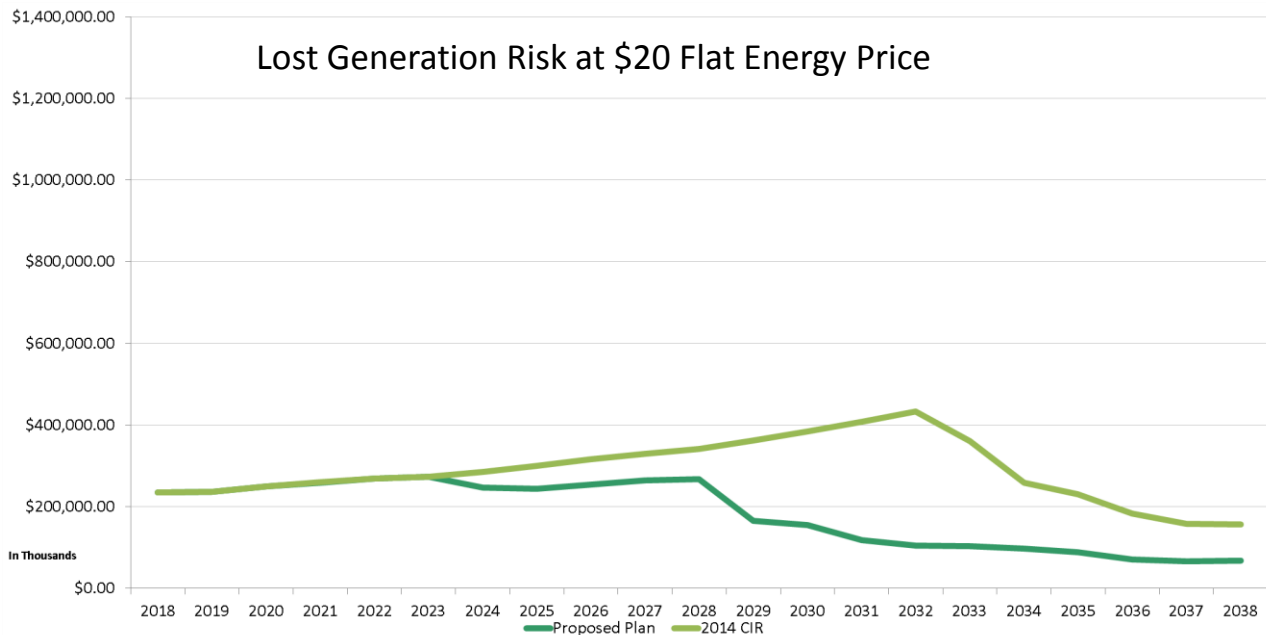
- At 2014 CIR levels, lost generation risk is expected to continue to increase through the 2020s as plants other than Grand Coulee and McNary receive funding for critical safety and environmental investments with little funding available to address unit reliability concerns.
- The proposed plan is expected to keep risk more stable across the system during the two long-term modernization projects, with significantly less risk in the 2030s relative to 2014 CIR levels.



| Lost Generation Risk Reduction of Proposed Plan compared to 2014 CIR (\$000s) | | | | | | | | | | | | | | | |
|---|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|--|
| 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | |
| \$55,056 | \$85,743 | \$94,769 | \$100,739 | \$119,818 | \$322,903 | \$382,563 | \$491,308 | \$577,291 | \$482,110 | \$336,444 | \$303,284 | \$232,610 | \$192,017 | \$193,076 | |

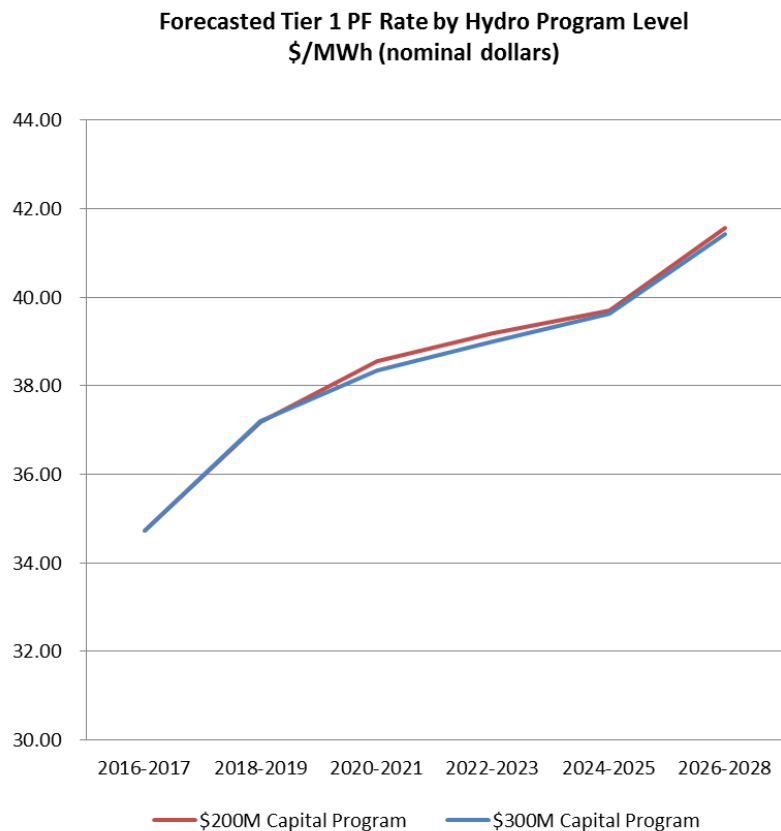
Lost generation risk forecast

- The expected lost generation risk benefits of the proposed investment plan relative to the 2014 CIR levels are reduced, but still significant with conservative energy price assumptions.



| Lost Generation Risk Reduction of Proposed Plan compared to 2014 CIR (\$000s) | | | | | | | | | | | | | | |
|---|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|
| 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 |
| \$39,424 | \$57,485 | \$61,375 | \$63,854 | \$74,669 | \$196,362 | \$229,967 | \$289,161 | \$328,052 | \$257,430 | \$161,069 | \$142,685 | \$111,848 | \$91,931 | \$88,869 |

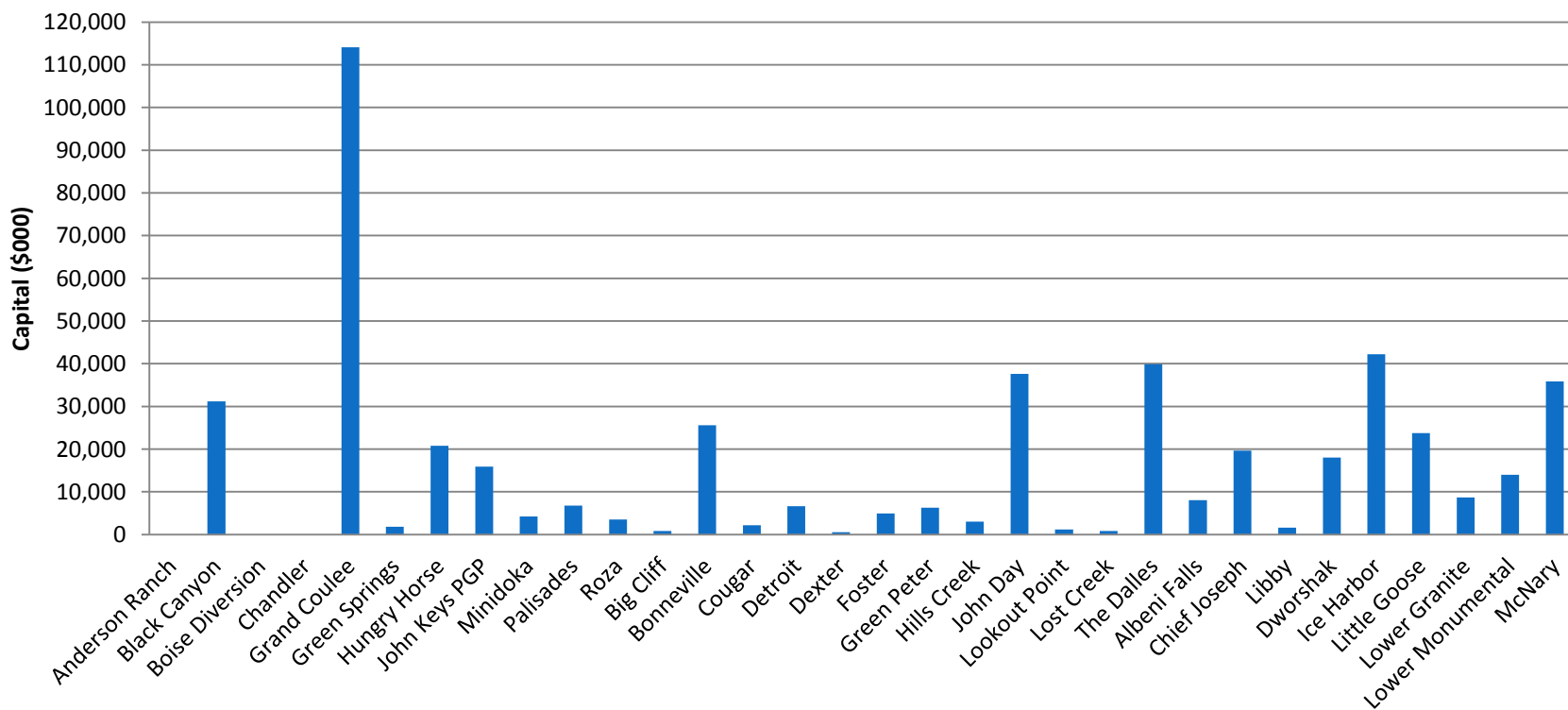
Rate impact



- A long-term rates analysis was performed in late 2015 on the proposed \$300 million capital program as well as a \$200 million capital program.
- The long-term financial and rates analysis incorporates the results from the hydro asset strategy modeling in order to adjust the expected generation of the hydro system at varying annual capital investment levels over time.
- The analysis showed that the higher investment level is expected to have a slightly lower Tier 1 Priority Firm rate in 2028, due to less lost generation than what is expected at the lower investment level.
- This long-term rate impact includes any additional federal repayment that results from the increased capital program.

Proposed capital program FY18-19

Proposed FY18-FY19 Capital Program by Plant



Capital program FY18-19

Army Corps of Engineers

- Ice Harbor:
 - Units 1,2,3 Turbine Runner Replacement
 - Stator Winding Replacement
- The Dalles:
 - Transformers Replacement
 - Fish Unit Breaker Replacement
- Bonneville 1 Main Unit Breakers and Station Service Reconfiguration
- Chief Joseph DC and Preferred AC Upgrade
- McNary:
 - 4160-480V Station Service Replacement
 - Turbine Design and Replacement
 - Generator Rewinds (remaining units)
- John Day:
 - BLH Turbine Hub Upgrades and Fixed Blade Conversions
 - Emergency Gantry Crane Replacement
- Dworshak Unit 3 Rehabilitation
- Lower Monumental Digital Governor Upgrade
- Albeni Falls Station Service Switchgear Replacement

Capital program FY18-19

Bureau of Reclamation

- Grand Coulee:
 - Firehouse
 - GDACS
 - G1-18 Stator Windings and Cores Replacement
 - G1-18 Static Exciters Replacement
 - G1-18 Governors Replacement
- John Keys Pump Generating Plant:
 - P1-P6 Exciters, Relays & Controls
 - PG7-PG12 Governors, Exciters, Relays and Controls
 - P5 and P6 Impellers, Stators and Core Rewinds
- Hungry Horse:
 - Power plant Crane Controls (pending approval)
 - Units 1-4 Static Exciters
- Black Canyon Dam:
 - Third Unit (pending approval)
 - 69kV Switchyard

Asset Investment Excellence Initiative (AIEI)

The AIEI is an on-going, three agency effort to implement system-wide, long-term capital planning to improve capital investment decision making and to improve program execution in the FCRPS.

An improved process for the capital program.



**US Army Corps
of Engineers®**

What has changed / is changing in Fed Hydro's capital program?

| Former process | New process |
|--|--|
| <i>Investment decision making process</i> | |
| <p>Decentralized project submission process:</p> <ul style="list-style-type: none"> ✓ BPA's <i>asset strategy</i> provided guidance and direction on system needs. ✓ Corps and Reclamation provided business cases to justify all investments. ✓ The FCRPS program capital program was the total of projects that were economically justified. | <p>Centralized system-wide prioritization on what FCRPS projects should be invested in to return the highest value to the system process:</p> <ul style="list-style-type: none"> ✓ Investments are prioritized base on a value framework to optimize both what projects are planned and when capital investments are made. ✓ Long-term planning team develops a <i>system asset plan</i>. The SAP uses the asset strategy as a foundation and is a system-wide, project-level executable plan. ✓ Business cases are needed to justify all investments. ✓ Continuous improvement is part the process. |
| <i>Capital Program Execution</i> | |
| <p>The execution of the capital program was somewhat reactionary.</p> <ul style="list-style-type: none"> ✓ Scoping, design, project planning, staffing and contracting completed on shorter timelines. | <p>The FCRPS program's system asset plan provides a multi-year roadmap allowing for a less reactionary execution of the capital program</p> <ul style="list-style-type: none"> ✓ More certainty and time to complete project scoping, design, planning, staffing and contracting actions. |

How we value investments

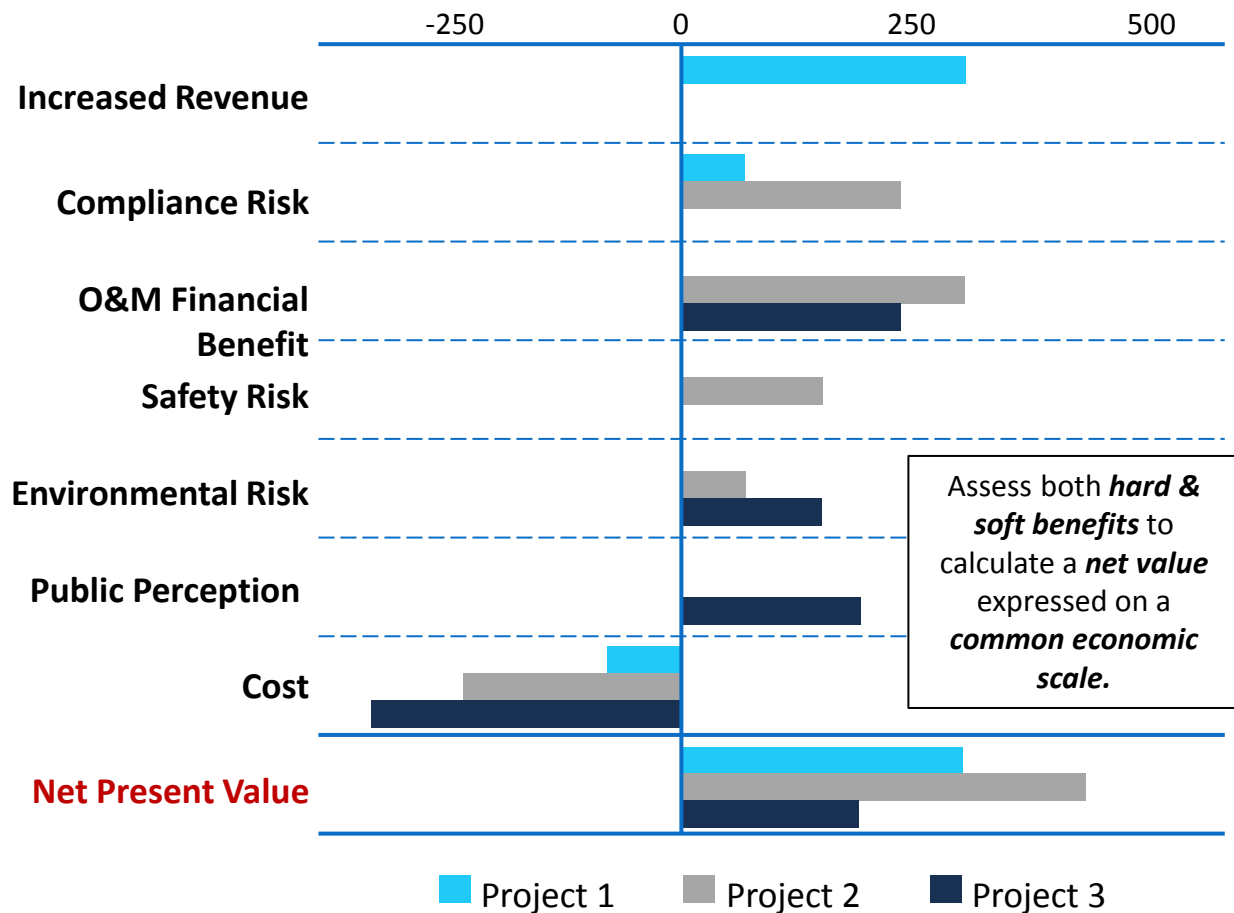
| Value measure category | Value measures | System goal |
|------------------------|-----------------------------------|---|
| Financial | Capital financial benefit (+) | Maximize cost saving and increase efficiency. |
| | O&M financial benefit (+) | |
| | Expenditure cost (-) | |
| | Financial risk (+) | |
| | Lost generation risk (+) | |
| Reliability | Reactive power (MVAr) support (+) | Increase reliability. |
| Stewardship | Compliance risk (+) | Mandatory and/or stewardship. |
| | Environmental risk (+) | |
| | Productive workplace (+) | Employee efficiency. |
| Safety | Safety risk (+) | Safety for employees and community. |
| Community | Public perception risk (+) | Public perception. |

- ✓ All proposed capital projects are scored or valued on a common scale.
- ✓ This allows the planning team to compare potential investments system-wide on a common scale.
- ✓ Common financial methods and/or risk matrices used to ensure consistency in scoring.

1. C55 is an integrated business decision analytic software tool developed by Copperleaf .

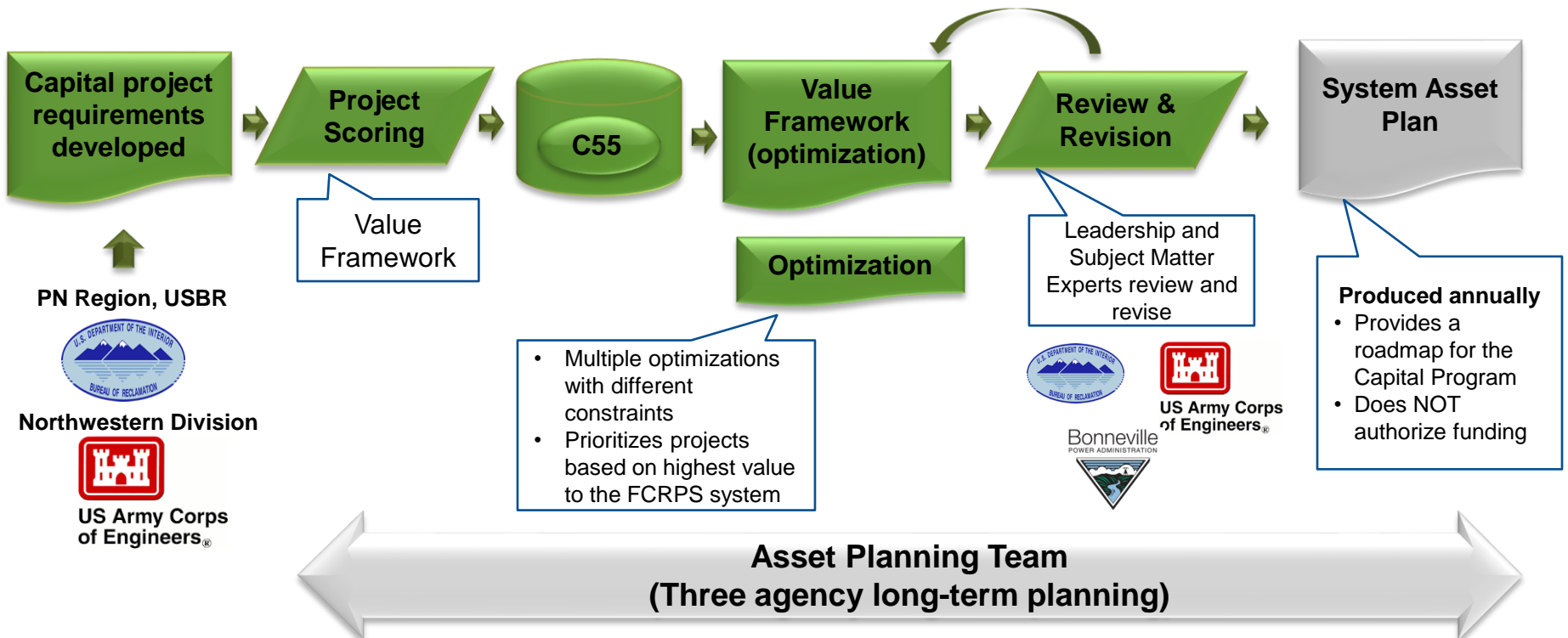
How we value and prioritize investments

Example Capital Investment
Common Economic Scale (unitless)



- ✓ Once a potential investment is scored, C55 can calculate its net present value.
- ✓ Net present values change based on project start date (risk and cost change over time).
- ✓ C55 optimizes all potential investments (priority and timing) to maximize the value of the entire portfolio and then develops a system-wide integrated output .
- ✓ C55 allows for multiple optimizations of the plan based on varying constraints (e.g. budget levels).

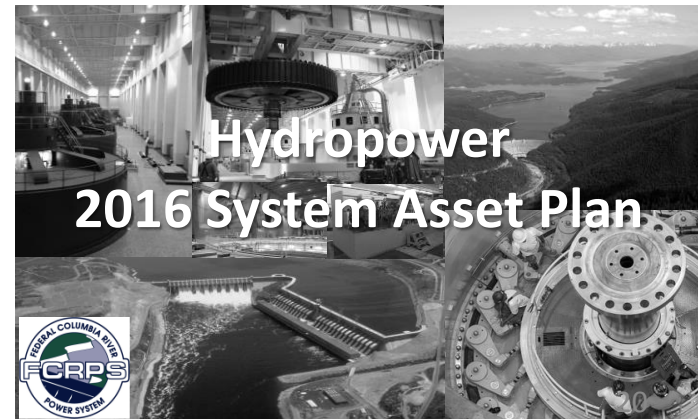
Annual long-term capital planning process under the initiative



FCRPS System Asset Plan *(long-term capital plan)*

System Asset Plan:

- ✓ Provides a 20+ year plan (roadmap) for the FCRPS capital program.
- ✓ Value-based prioritization and timing of capital projects.
- ✓ Aligned with agency strategic goals via the value framework.
- ✓ Updated and revised annually.
- ✓ We are in a transitional period.
 - Because many projects have multi-year durations it will take several years to fully transition.
 - Controlled but continuous improvements/refinements based on lessons learned.
 - First plan produced in 2016.
- ✓ Does not authorize funding of specific projects; rather it provides direction for which projects should move forward.



Execution improvements:

- ✓ Longer term planning allows for a more proactive scoping and planning of work as well as longer times for design and contracting actions.

Financial Disclosure

- This information was made publicly available on Dec. 9, 2016, and contains information not sourced directly from BPA financial statements.