US Army Corps of Engineers

National Hydropower Program

Strategic Plan FY2020 through FY2024

Prepared by Sapere Consulting, Inc. - July 2019

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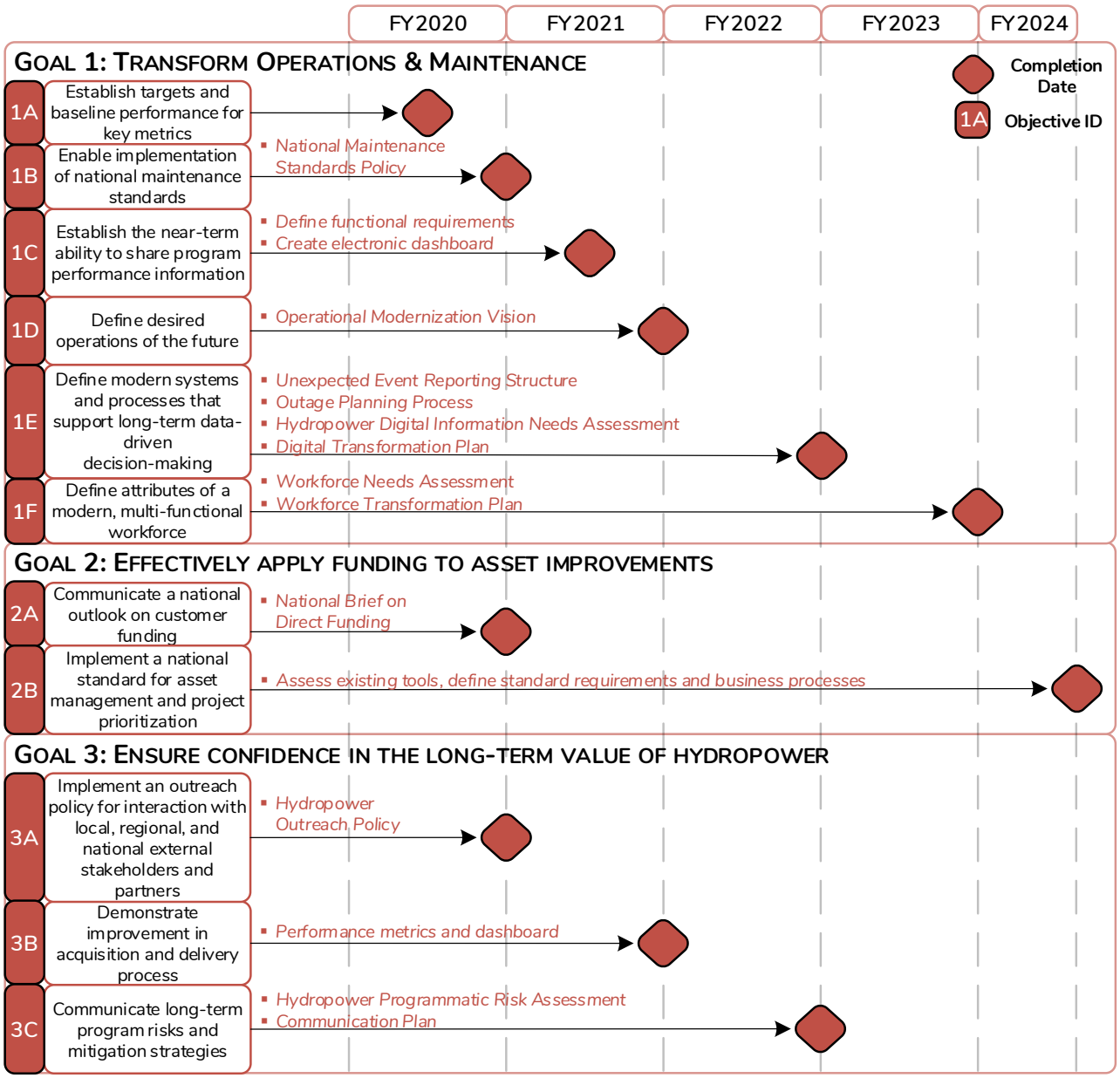
Executive Summary

This USACE National Hydropower Program Strategic Plan is the guiding document for headquarters staff to implement its vision to *establish a USACE Hydropower Headquarters Program that enables and encourages data-driven performance analyses and facilitates timely and effective communication to drive a culture of continuous improvement and accountability.*

While the goals of this plan are oriented toward headquarters staff, the decisions and policies made at the HQ level will affect the entire program at the Division, District, and project levels. The actions associated with this vision are outlined in the following set of broad goals and specific objectives:



Introduction

This strategic plan provides the structure necessary for the United States Army Corps of Engineers (USACE) Hydropower Program headquarters organization to effectively guide and support the National Hydropower Program between fiscal years 2020 and 2024. Through setting policy, supporting nationwide systems that enable data-driven decision making, fostering a culture of continuous improvement, and facilitating communication with internal and external stakeholders; we will effectively execute our ***mission*** to:

> ***Ensure USACE hydropower assets are available to provide reliable renewable energy and flexible capacity to our nation's electric grid.***

As the largest generator of hydropower in the US, with 75 power-producing dams housing 356 individual generating units, our hydropower assets generated about 77 billion kWh of renewable energy in 2017: enough to meet the average load of 7.4 million households and contribute to electric grid reliability services. The energy resources provided by the USACE hydropower fleet is marketed and delivered to customers by the federal Power Marketing Administrations (PMAs). For the foreseeable future, the Hydropower Program must execute our mission in a business environment challenged by low energy prices, constraints on water resources that fuel the system, increased integration of variable renewable energy resources into regional energy markets, and competition for funding.

Accordingly, our ***vision*** for the future is to **establish a USACE Hydropower Headquarters Program that enables and encourages data-driven performance analyses and facilitates timely and effective communication to drive a culture of continuous improvement and accountability in achieving the following Hydropower Program goals:**

> **Goal 1: Transform operations and maintenance of our hydropower assets** to ensure future reliability, flexibility, and competitiveness of our energy resources.
>
> **Goal 2: Effectively apply funding to asset improvements** that are driven by data, informed by external water resource and power marketing requirements, and prioritized based on maximizing return on asset investment**.**
>
> **Goal 3: Ensure confidence in the long-term value of our hydropower assets** by cultivating partnerships and engaging in outreach.

Scope of the National Hydropower Program

The Hydropower Program, situated under the Directorate of Civil Works, is responsible for the operations and maintenance (O&M) of 356 individual generating units at 75 USACE multi-purpose projects operated by 16 districts across five divisions (see Table 1). These projects reside in nine different hydrological regions and 33 hydrological basins across 18 states. The energy resources provided by the Hydropower Program are marketed by four regional PMA's to "preference customers" comprising primarily public-owned and cooperative-owned utilities. Figure 1 provides a map of the locations of the USACE divisions, districts, and hydropower projects as well as the regional PMAs. Figure 2 shows the relative generating capability by division.

Table 1: Summary of generating capacity of the USACE hydropower fleet

PMA	DIVISION	DISTRICT
Southeastern Power Administration (SEPA)	Great Lakes & Ohio River	Nashville
	South Atlantic	Mobile
		Savannah
		Wilmington
Southwestern Power Administration (SWPA)	Mississippi Valley	St. Louis
		Vicksburg
	Southwestern	Fort Worth
		Little Rock
		Tulsa
	Northwestern	Kansas City
Bonneville Power Administration (BPA)	Northwestern	Portland
		Seattle
		Walla Walla
Western Area Power Administration (WAPA)	Northwestern	Omaha
N/A	Great Lakes & Ohio River	Detroit
	South Atlantic	Charleston

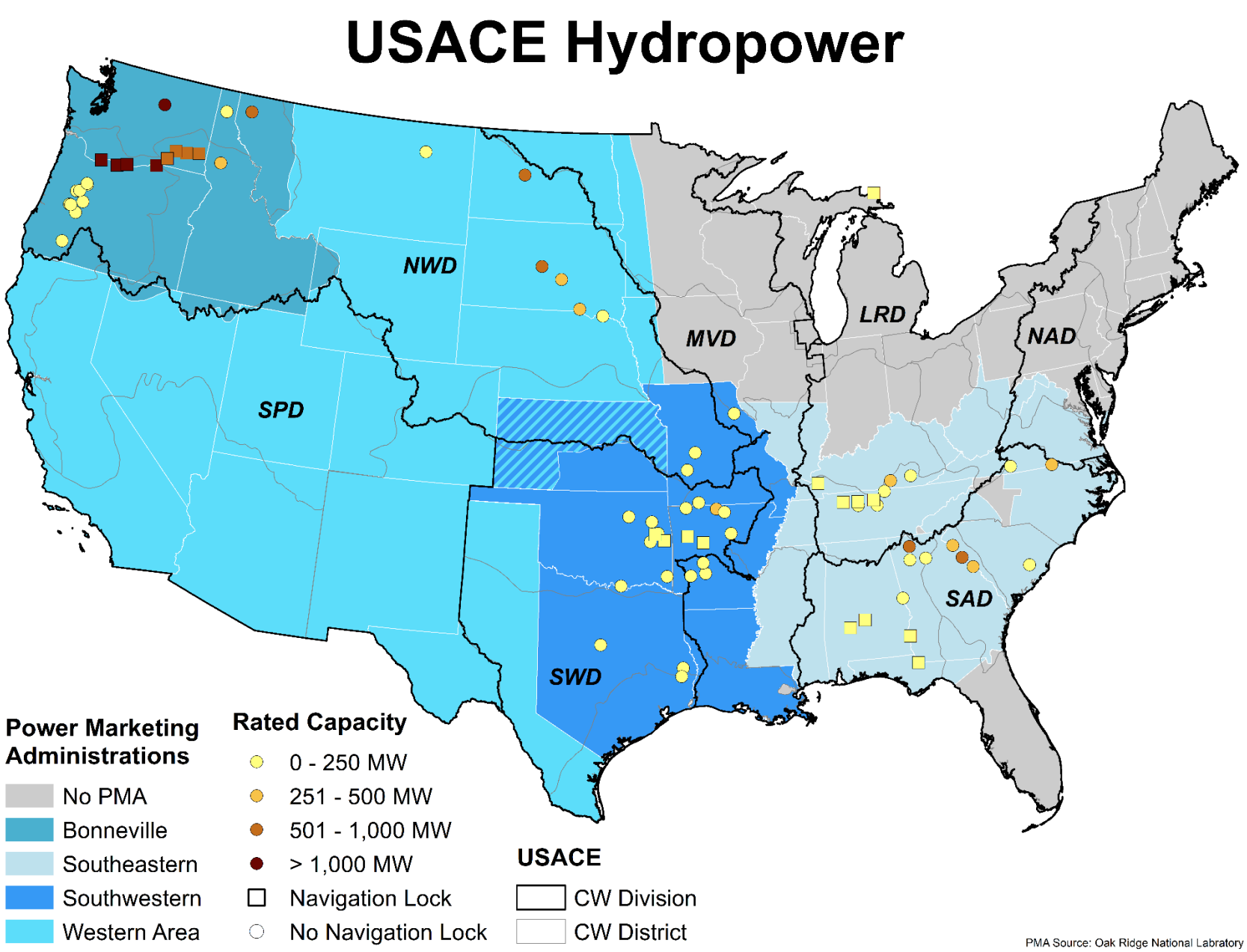


Figure 1: Map of USACE divisions, districts, hydropower projects and PMAs

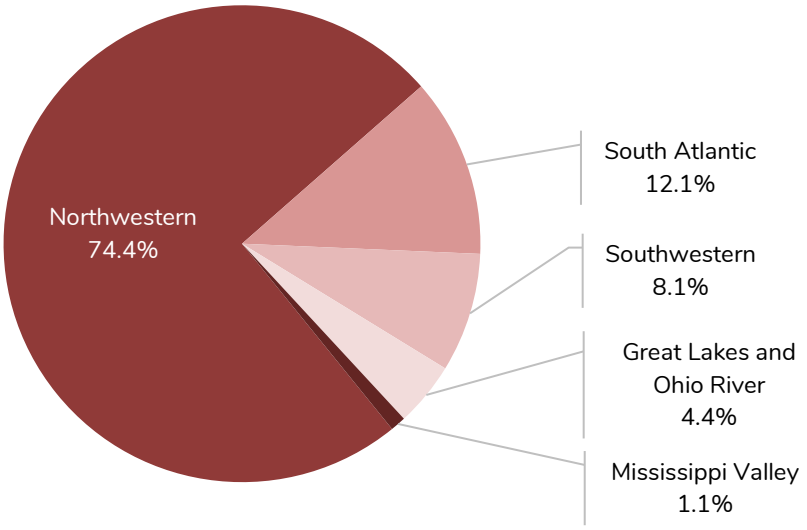


Figure 2: Percent of Hydropower Program capacity by division

The Hydropower Program has approximately 1,730 staff encompassing operations, maintenance, engineering, supervisory and managerial roles (see Figure 3 for a breakout by division). In addition to the Hydropower Program staff that carry out the Hydropower Program mission, the divisions and districts rely on USACE functions outside of the Hydropower Program to support their work.

Figure 4 identifies the supporting USACE functions and describes the general role they play.

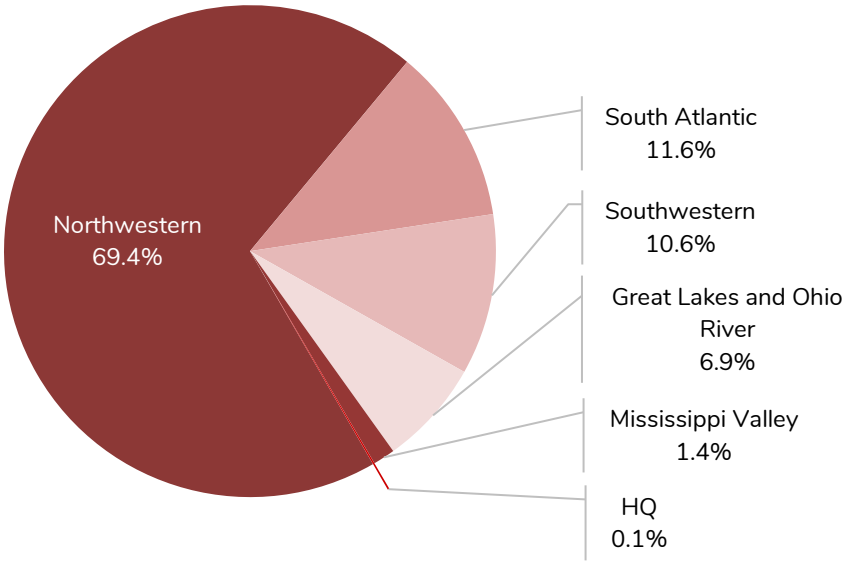


Figure 3: Percent of Hydropower Program staff at each division and headquarters

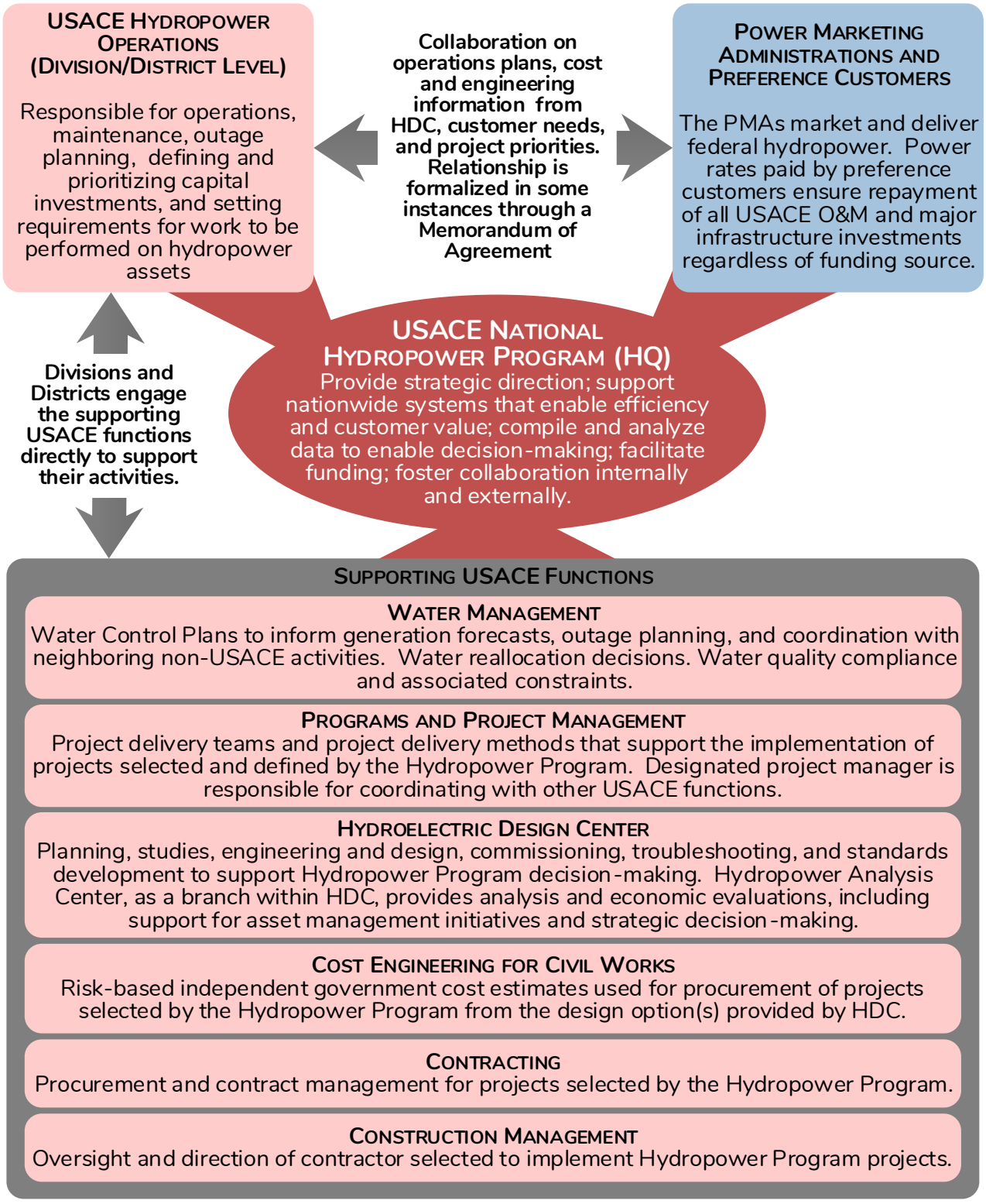


Figure 4: Hydropower Program relationships

Benefits of the USACE Hydropower Fleet

According to the International Renewable Energy Agency's Renewable Capacity Statistics 2018 report, about 44% of all renewable capacity in the U.S. is supplied by hydropower. USACE hydropower plants account for 25% of the Nation's total hydropower and 3% of the Nation's total electrical generation.

The Flood Control Act of 1944 stated that the electric power generated by USACE was to be sold "in such manner as to encourage the most widespread use thereof at the lowest possible rates to consumers consistent with sound business principles." [1] Historically, the hydropower generated by USACE was available at costs favorable to the public. However, the "increases in U.S. natural gas resources and declines in natural gas cost from 2009 through 2015" have challenged the current cost competitiveness of the Nation's federal hydropower fleet. [2]

The Congressional Research Service identifies hydropower's benefits to be zero to minimal greenhouse gas emissions during operation, high operational efficiency, reliability and flexibility.[3] The Department of Energy's (DOE's) Hydropower Vision suggests that "a range of cost-effective, low-carbon generation options — including hydropower — are needed to reduce the power-sector emissions that contribute to climate change."[4] Hydropower is particularly complementary to increased integration of variable energy resources (wind and solar) due to its load management and energy storage capabilities. While existing hydropower resources are typically not credited as "renewable" in renewable energy legislation, it is recognized as a carbon free resource.

According to PJM's Evolving Resource and Reliability Report (2017),[5] hydropower is the only resource type exhibiting both essential reliability services (frequency, voltage, and ramping capabilities) and flexibility services (see Figure 5).

[1] 58 Stat. 887, 890; 16 U.S.C.A. 825s
[2] United States Department of Energy. *Hydropower Vision*. July 2016. Document can be accessed at https://www.energy.gov/sites/prod/files/2018/02/f49/Hydropower-Vision-021518.pdf.
[3] Congressional Research Services. *Hydropower: Federal and Nonfederal Investment* (file: R42579). 7 July 2015. Document can be accessed at: https://fas.org/sgp/crs/misc/R42579.pdf.
[4] United States Department of Energy. *Hydropower Vision*. July 2016. Document can be accessed at https://www.energy.gov/sites/prod/files/2018/02/f49/Hydropower-Vision-021518.pdf.
[5] Figure adapted from PJM Evolving Resource Mix and System Reliability, March 2017.

● = Exhibits Attribute
◐ = Partially Exhibits Attribute
○ = Does Not Exhibit Attribute

Resource Type	Essential Reliability Services (Frequency, Voltage, Ramp Capability)					Fuel Assurance		Flexibility			Other		
			Ramp										
	Frequency Response (Inertia & Primary)	Voltage Control	Regulation	Contingency Reserve	Load Following	Not Fuel Limited (>72 hours at Eco. Max Output)	On-site Fuel Inventory	Cycle	Short Min. Run Time (<2 hrs)/ Multiple Starts Per Day	Startup/ Notification Time < 30 Minutes	Black Start Capable	No Environmental Reactions (That Would Limit Run Hours)	Equivalent Availability Factor
Hydro	●	●	●	●	●	○	◐	●	●	●	●	◐	●
Natural Gas – Combustion Turbine	●	●	◐	●	◐	●	○	●	●	●	●	◐	◐
Oil - Steam	●	●	●	●	●	●	●	●	○	○	○	○	◐
Coal - Steam	●	●	●	●	●	●	●	◐	○	○	○	◐	◐
Natural Gas - Steam	●	●	●	●	●	●	○	●	○	○	●	◐	◐
Oil/Diesel – Combustion Turbine	●	●	○	●	○	○	●	●	●	●	●	○	◐
Nuclear	◐	●	○	○	◐	●	●	○	○	○	○	◐	●
Battery/Storage	◐	◐	●	●	◐	○	○	●	●	●	◐	●	●
Demand Response	○	○	◐	◐	◐	◐	◐	●	●	◐	○	●	●
Solar	◐	◐	○	○	◐	○	◐	●	●	●	○	●	●
Wind	◐	◐	○	○	◐	○	○	●	●	●	○	◐	●

Figure 5: PJM reviews energy resources for reliability and flexibility characteristics[6]

Projections from varying sources nationwide suggest increased generation will not be the primary value of hydropower assets in future markets; instead, as non-hydropower renewable resources generate a greater share of the national portfolio, flexibility, storage, and ramping attributes of hydropower will become more valuable. While Figure 5 notes some limitations regarding hydropower "Fuel Assurance", in some cases fuel storage in reservoirs is a significant attribute. Additionally, as more states move towards reduced or zero emissions standards, hydropower's

[6] PJM Interconnection. PJM's Evolving Resource Mix and System Reliability. March 30, 2017. Document can be accessed at https://www.pjm.com/~/media/library/reports-notices/special-reports/20170330-pjms-evolving-resource-mix-and-system-reliability.ashx

clean energy attributes will become a necessary component of customer's resource portfolios. The following sources support these expectations for the future of hydropower:

- The US Energy Information Administration's (EIA's) Annual Energy Outlook projects relatively flat energy demand in their models of markets through 2050.[7] In projections of national future energy demand, expectations for generation from hydropower assets remains relatively consistent with current generation; the EIA projects that hydropower generation will add only 0.2 GW by 2050, as compared to 42.5 GW growth of wind and 23.6 GW of Solar PV.
- BPA's Strategic Plan for 2018-2023 "assumes a future of relatively low wholesale energy prices and declining costs of alternative sources of supply." Meanwhile, they are preparing to see "additional upside if power prices recover and the demand for clean capacity increases."[8]
- WAPA Strategic Roadmap 2024 states: "The energy landscape today is being changed by a number of drivers, including increasing intermittent and behind-the-meter generation, stagnating demand and the need to invest in aging infrastructure."[9]
- PJM's Evolving Resource Mix and System Reliability report states "As the potential future resource mix moves in the direction of less coal and nuclear generation, generator reliability attributes of frequency response, reactive capability, and fuel assurance decrease, but flexibility and ramping attributes increase." The report also cites hydropower amongst most flexible resources and amongst those potentially capable of black-start. [10]
- An August 2016 study conducted by the U.S. Department of Energy's National Renewable Energy Laboratory concluded that a portfolio mix consisting of greater than 30 percent renewable energy resources such as wind and solar "will cause other generators to ramp and start more quickly."[11]
- The Northwest Power and Conservation Council's Seventh Power Plan stated "since 2000, about 5,900 megawatts of natural gas-fired generation have been added in the region. During that same period, over 8,700 megawatts of wind power has also been built in the region. The large increase in wind generation has meant that utilities must hold more resources in reserve to help balance demand and resources minute to minute; therefore, the need for system flexibility has become a growing concern." [12]

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[7] US Energy Information Administration. *Annual Energy Outlook 2018 with Projections to 2050*. 6 February 2018. Document can be accessed at https://www.eia.gov/outlooks/aeo/.

[8] Bonneville Power Administration. Strategic Plan 2018-2023. January 2018. Document can be accessed at: https://www.bpa.gov/StrategicPlan/Pages/Strategic-Plan.aspx.

[9] Western Area Power Administration. Strategic Roadmap 2024 - Powering the Energy Frontier. May 2014. Document accessed at: https://www.wapa.gov/newsroom/Publications/Documents/StrategicRoadmap.pdf

[10] PJM. PJM's Evolving Resource Mix and System Reliability. 30 March 2017. Document can be accessed at: https://www.pjm.com/~/media/library/reports-notices/special-reports/20170330-pjms-evolving-resource-mix-and-system-reliability.ashx

[11] National Renewable Energy Laboratory. Eastern Renewable Generation Integration Study. August 2016. Document can be accessed at https://www.nrel.gov/docs/fy16osti/64472-ES.pdf

[12] Northwest Power and Conservation Council. *Seventh Northwest Conservation and Electric Power Plan.* (Pages 2 - 19). Document can be accessed at: https://www.nwcouncil.org/reports/seventh-power-plan.

Regulations and Policies

The Hydropower Program is currently governed by a variety of regulations and policies; an overview of current requirements can be found in Appendix A – Summary of Current Regulations and Policies.

The *Hydropower Operations and Maintenance Policy Bulk Power System Reliability Compliance Program* (Engineering Regulation (ER) 1130-2-551) requires that each USACE District Command element has policies, practices, and standard operating procedures in place to ensure compliance with reliability standards associated with North American Electric Reliability Corporation (NERC) regulations (see Appendix A for further details).

The Hydropower Program will ensure that *The Hydropower Operations and Maintenance Policy Bulk Power System Reliability Compliance Program* (ER 1130-2-551) remains consistent with the evolution of the external requirements applicable to NERC-regulated operations. Similarly, the Hydropower Program will modernize internal policies, regulations, and guidelines as necessary to reflect current and anticipated future business practices. For example, *The Hydroelectric Power Operations and Maintenance Policies* (ER 1130-2-510), which guides the O&M of USACE hydroelectric power generation facilities and related structures, is currently undergoing revisions that will begin rolling out in 2019. Significant changes include incorporation of National Maintenance Standards, Hydroelectric Power Operations, and Hydroelectric Power Generation Reporting.

We expect continued regulatory and stakeholder pressure to address known and potential impacts to fish, habitat, and water quality. While the Hydropower Program is not in the direct line of responsibility for engaging externally on regulatory change in these areas, the impact on fuel availability and water routing will have a material impact on how the Hydropower Program operates. Future risks will need to be identified and managed at the PMA, division, and district level as regulatory change will occur at the federal, state, and local levels. Similarly, competing interests for water resource usage and changing precipitation and run-off patterns will continue to require water policy decisions to meet the many purposes the projects were commissioned to support. These water policy decisions are outside of, but critical to the Hydropower Program.

Specific to the value of the hydropower assets, more aggressive renewable portfolio standards and evolving greenhouse gas legislation at the federal and state levels will bolster the preference for hydropower as a carbon neutral resource with the flexibility to enable integration of variable energy resources.

Information Systems and Analytical Tools

Technology and data analysis capabilities are evolving rapidly. Most advancements endeavor to eliminate inefficiency, facilitate proactive decision making, and increase situational awareness to reduce uncertainty. Continued technology development is expected in the areas of sub-hourly dispatch of generating resources, modernization of transmission and distribution infrastructure, modeling of the impact of changing weather patterns on water resources, sensor technologies, predictive data analytics, and automation.

These technological advancements will enable system operators to extract more value out of the energy system and make that value available in shorter time increments. These advancements will improve the feasibility of integrating more variable and distributed energy resources and facilitate changing the way USACE hydropower assets are operated to meet PMA and customer needs. Similarly, advancements in sensor technologies and data analytics will enable generation resource operators to institute condition-based, predictive maintenance practices to minimize unplanned outages. Table 2 highlights a few recent technology innovations in the hydropower field as examples of improvements available to our programs, or ones that may inform stakeholder expectations for our future capabilities.

Currently, the Hydropower Program possesses a variety of systems and tools for needs such as time management, maintenance planning, and asset management. A detailed description of available systems is provided in Appendix B – Current Systems and Tools Overview. Utilization of these systems varies by district, as does the perceived value of each system; in some cases, PMAs have worked to supply improved systems used by USACE within their jurisdiction but not currently available to the entire Hydropower Program (e.g. Copperleaf C55).

As headquarters considers ways to provide additional value to divisions and districts, improvement of the available tools, consistency in use of those tools, and provision of business processes related to those tools is of utmost interest. Headquarters will work with divisions to incorporate advancements in technology and meet evolving stakeholder expectations regarding data availability while considering how current tools can be leveraged or adapted as appropriate.

Table 2: Example hydropower-related innovations

Climate Change Flow Predictions (2017)[13]	University of Washington Columbia River Climate Change Group works with regional utilities, including Seattle City Light and Chelan County Public Utility District to predict temperature, precipitation, snowpack, and streamflow in the Northwest under a changing climate, through the year 2100.
Flow Control Automation (2014)[14]	Tacoma Power improved generation and fish passage at its Cushman Complex using programmable automation controllers. A single operator can set desired flow for the plant, and the system will maintain this flow through interruptions in generation and changes in flow into the reservoir.
Hydro Research Institute (2018)	Collaboration of hydropower owners to aggregate hydropower operational data to facilitate research and development of new technology for facilities and equipment. The HRI is leveraging emerging technology to turn massive data sets into predictive analytics, with the aim of reducing cost of forced outages and developing improved sensor technology.
Acoustic Monitoring (2018)[15]	Enel Green Power and 3D Signals are working together in Italy and the US to monitor hydroelectric plants acoustically, detecting minor changes in sound that could indicate a larger problem and promoting preventative maintenance.
Forecast Modeling and Dispatch Optimization (2017)	With increased computing power, hydro owners are able to provide sub-hourly forecast modeling and optimized dispatch models. This allows owners to derive greater value from fuel in river systems with multiple hydro assets by coupling optimization with tighter feedback loops on generation requests and actual conditions.

[13] University of Washington Hydro: Columbia River Climate Change. *Hydraulic Response to Columbia River Basin Climate Change.* Accessed 25 January 2019. Document can be accessed at: http://hydro.washington.edu/CRCC/.
[14] Rockwell Automation: The JOURNAL Magazine. *Power Station integrates Hydro Generation, Fish Passage.* Accessed 25 January 2019. Document can be accessed at: https://www.rockwellautomation.com/global/news/the-journal/detail.page?pagetitle=Power-Station-Integrates-Hydro-Generation%2C-Fish-Passage&content_type=magazine&docid=f5fa911fcf0228156b490d2f747420a5.
[15] Enel Green Power. *Anticipating the Problem.* 25 October 2017. Document can be accessed at: https://www.enelgreenpower.com/stories/a/2017/10/we-listen-to-the-voices-of-our-plants.

Funding and Investment Prioritization

Originally, the source of funding for the Hydropower Program was the congressional appropriations process. Over time, there has been a diversification of funding mechanisms to include funding by PMAs and preference customers.[16]

O&M funding is still primarily received through the appropriations process, with the exception of portions of the Northwestern Division whose O&M is funded directly by BPA, per the energy Policy Act of 1992 and its associated agreements. O&M costs include O&M, compliance (e.g., bulk power system reliability), and Hydropower Program-wide information systems (e.g., FEM).

Capital projects are funded by appropriations, directly from PMAs, or from preference customers. Non-appropriations funding (referred to in this plan as "direct and customer funding") has become the more common practice for capital and non-routine O&M work. Figure 6 provides an overview of funding for the Hydropower Program over the last five years.

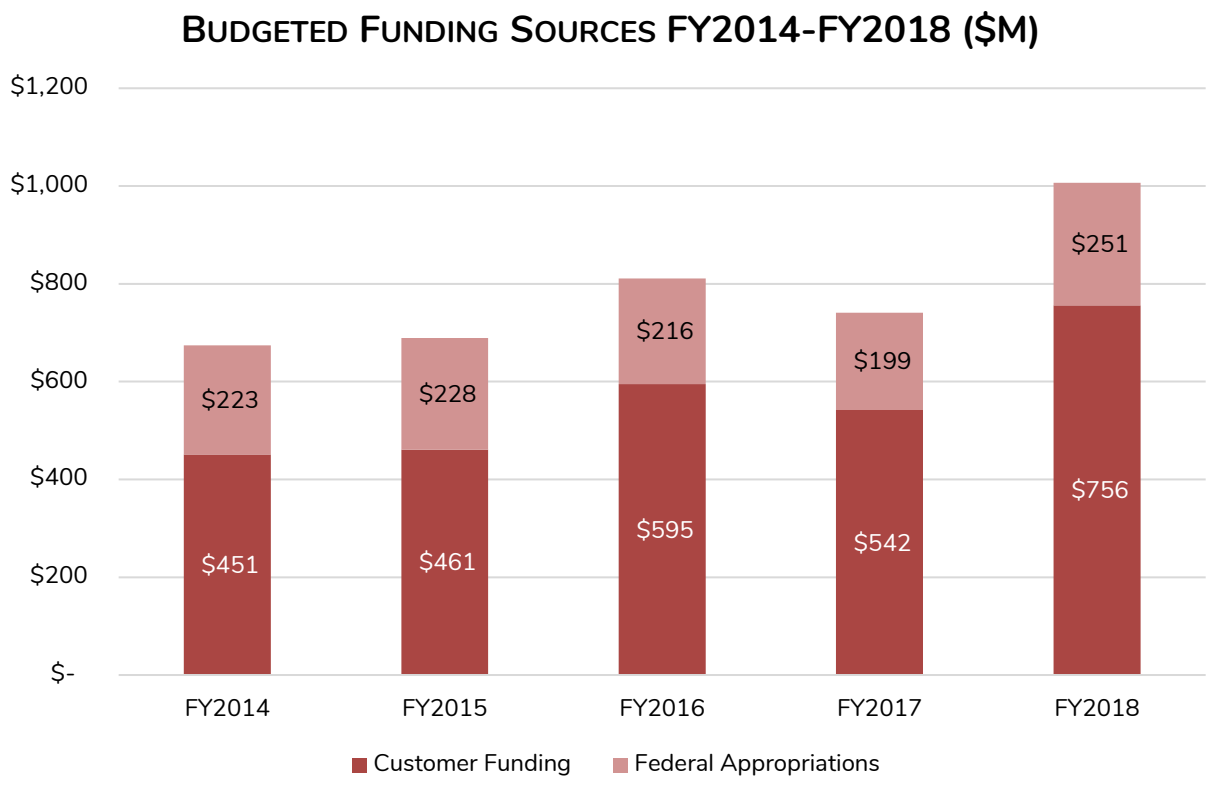

Figure 6: USACE Hydropower Program funding sources, FY2014-FY2018[17]

[16] It should be noted that regardless of the funding stream, preference customers ultimately recover all costs for the USACE for hydropower as well as all costs for the PMAs through their federal hydropower rates.

[17] Federal Appropriations includes joint funding with other business lines

Memoranda of Agreement (MOAs) and associated sub-agreements between USACE divisions or districts and PMAs or preference customers have been executed at varying levels of locality and with varying expectations for planning, project reviews, prioritization, funding allocation, and reporting on project execution. A complete list of MOAs currently governing PMA or preference customer funded projects is provided in Appendix C – Summary of Memoranda of Agreement with PMAs & Customers.

Figure 7 shows the effective dates of each MOA. This patchwork of agreements and the evolving sources of direct, customer, and appropriated funding drives differences in when and how divisions and districts plan and prioritize their work. This can complicate USACE's ability to coordinate funding requests, potentially resulting in redundant work to request funds from multiple sources to assure important projects receive sufficient funding.

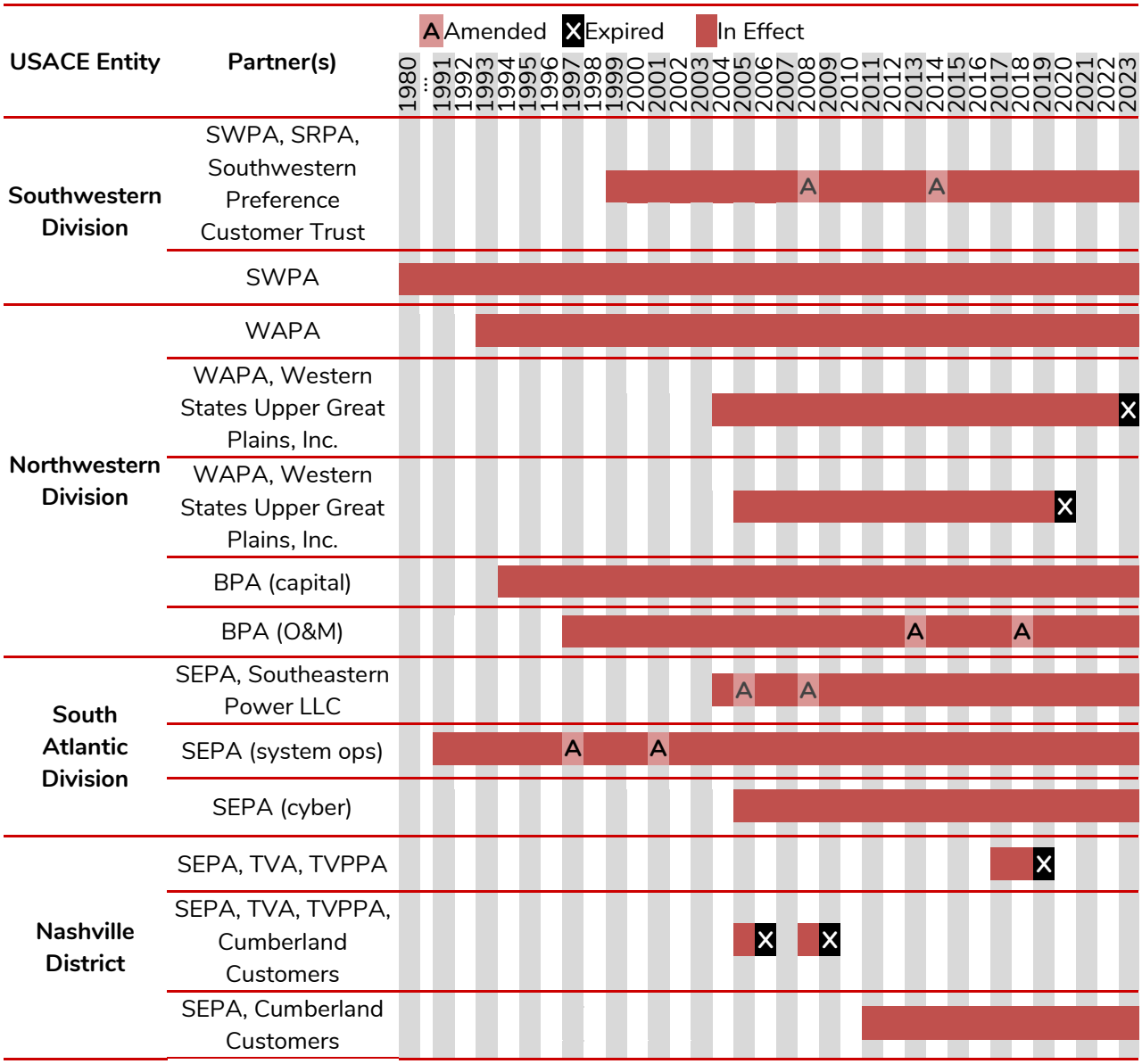

Figure 7: Memoranda of Agreement (MOAs) between Hydropower and other entities

The magnitude, timing, and prioritization of capital funding needs is informed by operational condition assessment tools (e.g., hydroAMP conditions assessment tool, Hydropower Modernization Initiative asset investment implementation plan, budget engineer circulars, balance of plant spreadsheets, Copperleaf's C55 asset investment planning and management tool). While divisions and districts use similar tools, the timing and extent of coordination and collaboration between divisions, districts, PMAs and preference customers varies based on processes defined in MOAs or practices that have organically evolved over time.

Over the next five years, the Hydropower Program will continue to be funded by a mix of congressional appropriations and direct and customer funding. Appropriations are expected to remain consistent with the last five years with annual funding of approximately $250 million per year, primarily for hydropower-specific O&M activities (excluding portions of the Northwestern Division which is funded by BPA). To enable headquarters to accomplish the goals and objectives outlined in this strategic plan, appropriated funds would need to include $2.5 million per year (or 1% of total appropriations) for the next five years. We expect that direct and customer funding will be necessary to meet the capital investment needs of the Hydropower Program for the foreseeable future.

For capital investments in the hydropower fleet, current asset management models provide insight into the magnitude and timing of investments needed to most effectively manage life-cycle costs. Figure 8 illustrates the total planned capital funding obligations for the next five fiscal years. These totals combine the planned obligations for projects from the HMI FY2020 Implementation Strategy and the FY2019 Hydropower System Asset Plan from BPA and the FCRPS.

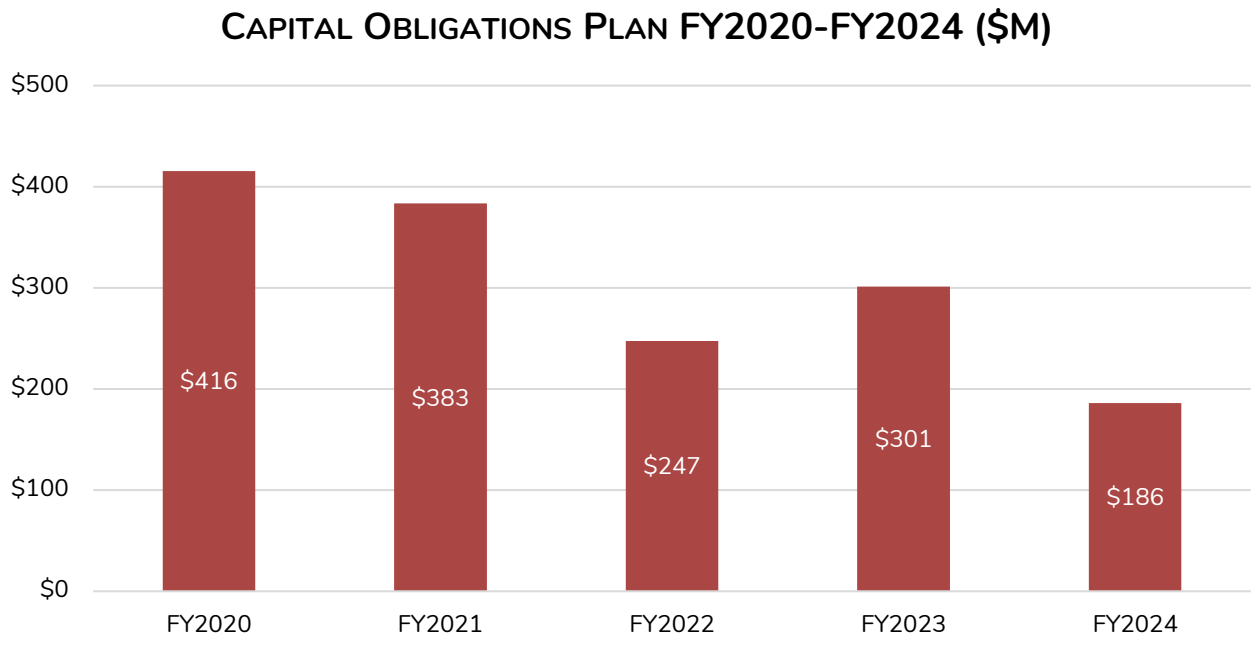

Figure 8: Five Year Planned Capital Funding Obligations, FY2020-FY2024

Hydropower Program Goals and Objectives

This strategic plan draws on the context presented in the preceding sections to identify goals, objectives, and actions to be executed by the Hydropower Program's headquarters organization in support of the Program's mission and vision.

Goal 1: Transform operations and maintenance of our hydropower assets to ensure future reliability, flexibility, and competitiveness of our energy resources.

Our first goal focuses on transforming O&M to meet the nation's energy needs. Meeting the need for reliability will depend on USACE's ability to overcome recent trends of increased forced outages - such outages rose from 4% in 2008 to 7% in 2018. Further, we expect flexibility in the operations of our generation assets (e.g., ramping) to become more valuable and technologically feasible over time. While responding to these trends will rest on the districts and divisions, headquarters can support their improvement and transformation efforts with processes, systems, and communication that will bring issues to light and enable change.

Goal 2: Effectively apply funding to asset improvements that are driven by data, informed by external water resource and power marketing requirements, and prioritized based on maximizing return on asset investment.

With Goal 2, we will address the disparate approaches to funding and asset management seen across divisions and PMAs. Current condition assessment expectations are inconsistently applied, subjective, and based on historical failure models. Headquarters will support improved systems and processes, grounded in quantitative risk-based assessments and consistent prioritization expectations, and will articulate a national perspective on recent trends in funding sources and expectations.

Goal 3: Ensure confidence in the long-term value of our hydropower assets by cultivating partnerships and engaging in outreach.

Goal 3 addresses our relationships with the PMAs, customers, Congress, and the public; as energy markets, funding, and best practices evolve, expectations for engagement with these groups must also grow. In the next five years, headquarters will provide direction and oversight for the evolution of these relationships, from improving communications around project delivery to identifying opportunities to educate stakeholders and partners on impacts of policies and regulations.

In support of each goal, objectives provide measurable outcomes that headquarters will pursue on a specified timeline (see Table 3 for these objectives and Figure 9 for a timeline of execution). These outcomes are further broken down into actions: specific methods, processes, or steps required to support the objectives in the following section.

Note that completion of these objectives and actions (on their associated timelines) is heavily dependent upon resources from USACE management and appropriations. We have identified these objectives specific to the headquarters organization's role within the Hydropower Program, yet the headquarters organization is currently staffed with only two individuals. As noted in previous sections, the Hydropower Program now relies on funding from a variety of sources and identifying sufficient funding for additional human resources with the necessary skills will be essential to our strategic success.

Additionally, the headquarters organization does not directly supervise the staff of the Hydropower Program; so, while our organization will provide leadership and vision to the Program, execution on this plan will largely depend on support from management outside of the headquarters organization. We will set expectations and work to empower divisions and districts to adopt change as necessary, then report annually on progress of actions that support the following objectives.

Table 3: Strategic goals and objectives for the Hydropower Program through FY2024

Goal 1: Transform operations and maintenance of our hydropower assets to ensure future reliability, flexibility, and competitiveness of our energy resources.	**Objective 1A:** Establish targets and baseline performance for key metrics by the end of Q2FY20.
	Objective 1B: Enable implementation of national maintenance standards by the end of FY20.
	Objective 1C: Establish the near-term ability to share program-wide performance information by the end of Q2FY21.
	Objective 1D: Define desired operations of the future by the end of FY21.
	Objective 1E: Define modern systems and processes that support long-term data-driven decision-making by the end of FY22.
	Objective 1F: Define attributes of a modern, multi-functional workforce by the end of FY23.
Goal 2: Effectively apply funding to asset improvements that are driven by data, informed by external water resource and power marketing requirements, and prioritized based on maximizing return on asset investment.	**Objective 2A:** Communicate a national outlook on customer funding by the end of FY20.
	Objective 2B: Implement a national standard for asset management and project prioritization by the end of FY24.
Goal 3: Ensure confidence in the long-term value of our hydropower assets by cultivating partnerships and engaging in outreach.	**Objective 3A:** Implement an outreach policy for interaction with local/regional/national external stakeholders and partners by the end of FY20.
	Objective 3B: Demonstrate improvement in acquisition and delivery process by end of FY21.
	Objective 3C: Communicate long-term program risks and mitigation strategies by the end of FY22.

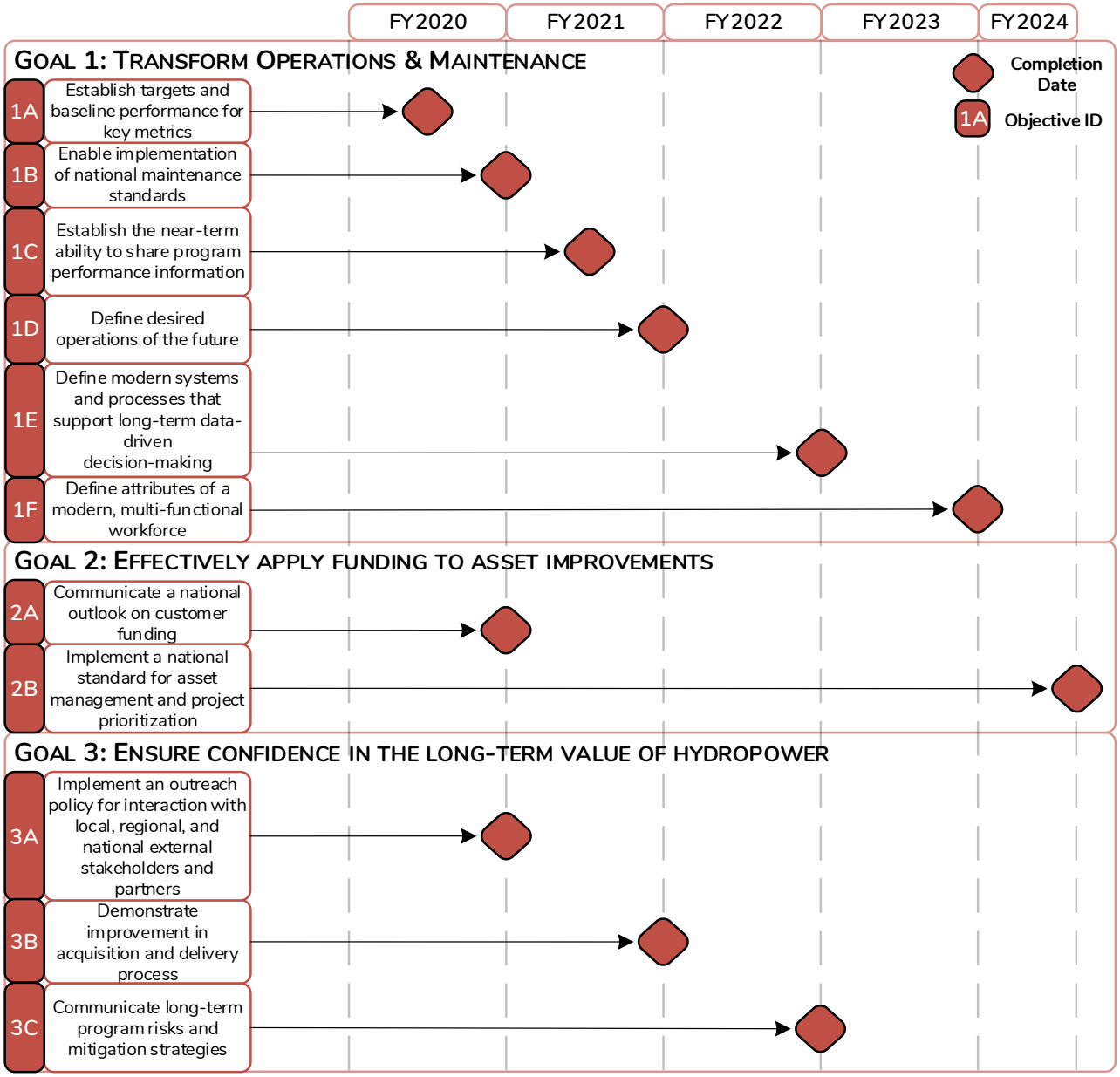

Figure 9: Timeline for objective completion

Hydropower Program Action Plan

GOAL 1: TRANSFORM OPERATIONS AND MAINTENANCE OF OUR HYDROPOWER ASSETS TO ENSURE FUTURE RELIABILITY, FLEXIBILITY, AND COMPETITIVENESS OF OUR ENERGY RESOURCES.	
Objective 1A: Establish targets and baseline performance for key metrics by the end of Q2FY20.	– Define metrics and performance baselines necessary to measure O&M performance. – Identify benchmarks and targets for improvements in chosen metrics. – Define graded approach to applying performance metrics based on significance of asset to overall resource capability. – Define methods and requirements for collecting identified data and institute associated business processes.
Objective 1B: Enable implementation of national maintenance standards by the end of FY20.	– Identify necessary business practice updates. – Establish a **National Maintenance Standards Policy** and implementation guidance that includes expectations for tracking and reporting on implementation.
Objective 1C: Establish the near-term ability to share program-wide performance information by the end of Q2FY21.	– Define functional requirements for a headquarters-managed information system that also meets the needs of the divisions and districts. – Review current division- and district-level performance management tools to define best practices and ascertain potential to scale to program-wide. – Implement a program-wide electronic performance dashboard.
Objective 1D: Define desired operations of the future by the end of FY21.	– Collaborate with PMAs and preference customers regarding long-term perspective on energy needs and associated products and marketing. – Collaborate with other USACE Civil Works business lines to establish long-term perspective on water resource demands (i.e., fuel). – Evaluate opportunities for remote operations, as per the Federal Hydropower Council's O&M cost reduction and efficiencies working group recommendation. – Create an **Operational Modernization Vision** that identifies system, process, and tool transformation necessary to support future operations.

Objective 1E: Define modern systems and processes that support long-term data-driven decision-making by the end of FY22.	– Complete a **Hydropower Digital Information Needs Assessment**: ▪ Review division/district/PMA forecast, dispatch, water resource management, and water quality tools including information from Civil Works Business Intelligence Initiative. ▪ Perform a gap analysis regarding information available to staff to support future operations and enable timely decision making. – Develop a **Digital Transformation Plan** to address outcomes of needs assessment. – Define and implement **Unexpected Event Reporting Structure** to ensure timely tracking and analysis of unexpected events; and generate information on cause and effect that can be used for continuous improvement. – Create a data-driven, proactive, performance-based **Outage Planning Process** that can adapt to: ▪ Base schedule for maintenance based on national maintenance standards; ▪ Peak demand; ▪ Least-cost outage windows based on market value; ▪ Changes in water forecasts; ▪ Transmission outage plans; and ▪ Condition assessments and predictive analytics using operations data, including industry data and diagnostic tools from the Hydropower Research Institute.
Objective 1F: Define attributes of a modern, multi-functional workforce by the end of FY23.	– Complete a **Workforce Needs Assessment**: ▪ Define a baseline for current state of workforce alignment with necessary functions. ▪ Define functions of a modern, multi-functional work force necessary to support operations of the future and identify gaps. ▪ Analyze management-level functions necessary to ensure effective leadership and organizational efficiency under future operations. – Create a **Workforce Transformation Plan**: ▪ Define actions to respond to outcome of needs assessment. ▪ Identify training, hiring, or communication needs for non-hydropower program staff executing work for hydropower projects (e.g. acquisition, contracting, project management). Consider outcomes of the Federal Hydropower Council's acquisition and delivery process working group. ▪ Develop succession-planning policies that identify capable and skilled replacements in a timely manner and encourage knowledge retention. ▪ Create a business case supporting necessary changes.
GOAL 2: EFFECTIVELY APPLY FUNDING TO ASSET IMPROVEMENTS THAT ARE DRIVEN BY DATA, INFORMED BY EXTERNAL WATER RESOURCE AND POWER MARKETING REQUIREMENTS, AND PRIORITIZED BASED ON MAXIMIZING RETURN ON ASSET INVESTMENT.	
Objective 2A: Communicate a national outlook on	– Perform an assessment of current MOAs to establish an understanding of the breadth of existing commitments and future funding expectations. – Develop a model Memorandum of Agreement for use and reference for future agreements to ensure consistency and efficiency.

customer funding by the end of FY20.	– Establish **National Information Brief on Customer Funding** that acknowledges the role customer funding plays in the ability for the Hydropower Program to execute its mission.
Objective 2B: Implement a national standard for asset management and project prioritization by the end of FY24.	– Perform an assessment of the scope (e.g., components represented) and utilization of available asset management tools (HMI, Copperleaf, etc.). – Define requirements for an improved, standardized approach to asset management to be met by available asset management tools. – Define associated business processes for utilizing the national standard including synchronization of decision-making timelines between appropriations and customer funding agreements.
GOAL 3: ENSURE CONFIDENCE IN THE LONG-TERM VALUE OF OUR HYDROPOWER ASSETS BY CULTIVATING PARTNERSHIPS AND ENGAGING IN OUTREACH.	
Objective 3A: Implement an outreach policy for interaction with local/regional/national external stakeholders and partners by the end of FY20.	– Assess the current state of communications between local/regional/national USACE and external stakeholders. ▪ Define purpose of interaction. ▪ Identify participating entities. ▪ Determine engagement driver (e.g., MOA, ad hoc). – Establish **Hydropower Outreach Policy** that sets expectations for how regional organizations inform/relate to national forums (e.g. Federal Hydropower Council).
Objective 3B: Demonstrate improvement in acquisition and delivery process by end of FY21.	– Identify performance metrics for acquisition and delivery and collect current data. For example, budget, schedule, requirements solicitation, stakeholder engagement, reporting, project governance. – Create a reporting mechanism (e.g., dashboard) compiling and communicating acquisition and delivery metrics for both customer and appropriation-funded projects. – Assign accountability to identified metrics to encourage continuous improvement. – Determine how the use of non-hydropower USACE resources impacts acquisition and delivery, identify and implement improvements. – Implement standardized contracts and designs where appropriate for hydropower items.
Objective 3C: Communicate long-term program risks and mitigation strategies by the end of FY22.	– Work with PMAs and divisions/districts to complete a **Hydropower Programmatic Risk Assessment** of primary program influences such as fuel, energy markets, funding, regulatory change, labor, cost of materials and equipment, etc. – Identify mitigation strategies that put the Hydropower Program in the best position to protect the long-term value of the assets. – Provide divisions and districts with a Communication Plan addressing identified risks that they can use for local communications.

Appendix A – Summary of Current Regulations and Policies

There are several Engineer Regulations (ER) that pertain directly to the Hydropower Program or indirectly through supporting USACE functions.

- Direct:
  - ER 1130-2-551; 30 September 2009; Hydropower Operations and Maintenance Policy Bulk Power System Reliability Compliance Program.
  - ER 1130-2-510; 12 December 1996; Hydroelectric Power Operations and Maintenance Policies
  - EM 1110-2-4205; 30 June 1995; Hydroelectric Power Plants Mechanical Design
  - EM 1110-2-3006; 30 June 1994; Hydroelectric Power Plants Electrical Design

- Indirect:
  - ER 1110-2-1400; 30 May 2016; Reservoir/Water Control Management
  - ER 10-1-53; 30 April 2015; Roles and Responsibilities Hydroelectric Design Center
  - ER 1110-2-8156; 30 September 2018; Preparation of Water Control Manuals
  - ER 1105-2-100; 22 April 2000; Planning Guidance Notebook
  - ER 25-1-110; 31 July 2013; Enterprise Data Management Policy Corporate Information

The *Hydropower Operations and Maintenance Policy Bulk Power System Reliability Compliance Program* (ER 1130-2-551) requires that each USACE District Command element has policies, practices, and standard operating procedures in place to ensure compliance with reliability standards associated with the following NERC-registered operations:

- Generator Owners (GO) - 15 district registrations (note some districts are registered in two separate Regional Compliance entities)
- Generator Operators (GOP) - 14 district registrations
- Transmission Owners (TO) - 10 district registrations
- Transmission Operators (TOP) - 2 district registrations

The Engineer Pamphlet associated with bulk power system reliability (EP 1130-2-551) describes roles and responsibilities for headquarters, division, and district personnel, including the Army Corps of Engineers Compliance Monitoring and Enforcement (ACE-CME) Oversight Committee that is chaired by the Hydropower Program manager from headquarters and supported by the National Hydropower Operations and Maintenance Practices Advisory Committee (NHOMPAC).

The *Hydroelectric Power Operations and Maintenance Policies* (ER 1130-2-510) guides the operation and maintenance (O&M) of USACE hydroelectric power generation facilities and related structures at civil works water resource projects. This includes the training of new maintenance staff, drills for emergency operation, coordination with PMAs, and data needed for annual reports on generation.

The *Hydroelectric Power Plants Mechanical Design* and *Hydroelectric Power Plants Electrical Design* manuals (EM 1110-2-4205 and -3006) provide guidance and assistance to design engineers in the design and selection of mechanical and electrical equipment and systems.

Appendix B – Current Systems and Tools Overview

The Hydropower Program relies on various information systems and analytical tools to support internal and external tracking, reporting, and analysis as described below.

- **Civil Works Business Intelligence (CWBI)** is a USACE data platform that manages operational data in support of the Civil Works mission. CWBI IT staff are responsible for acquiring, integrating, visualizing, and analyzing this data as requested by other Civil Works offices. CWBI has integrated the **Enterprise Geospatial Engineering System (EGES)** and **Operations and Maintenance Business Information Link (OMBIL)** into a single information system. EGES is the framework used for geospatial data and applications throughout Corps offices at all levels, establishing a common network. OMBIL is an information system that provides data in support of performance-based budgeting and Federal data requirements.
- **Civil Works Integrated Funding Database (CW-IFD)** is the tool used to collect project/program data from the various other data sources within the Corps and then provide an intuitive and user friendly platform for users to enter and manage the project and program data needed for budget and allocation strategy development.
- **Corps of Engineers Financial Management System (CEFMS)** is one of three systems used by USACE Civil Works to prepare and compile financial reports. CEFMS is used at the field office level to report transactions, which are compiled into ledgers at the district, division, and headquarters levels.
- **Generating Availability Data System (GADS)** is a database maintained by NERC to support reliability in the Bulk Power System. Generation operators of units with a capacity of 20MW or greater must report event, performance, and design information into GADS regularly. USACE does this as part of its Compliance Monitoring and Enforcement (CME) Program.
- The **Hydropower Modernization Initiative (HMI)** uses an Asset Investment Planning tool to develop long-term management strategy based on economics and risk principles. Operational data is fed into the tool via input from projects, districts, divisions, and headquarters. Field offices input **Hydroelectric Asset Management Partnership (hydroAMP)** data from six individual components of the hydroelectric powertrain: runner, generator, transformer, breaker, excited, and governor. Higher-level offices use this data to assess the condition of hydroelectric equipment. They may also use the **Planning Level Energy and Economics Study Model (PLEESM)**, which considers equipment condition, plant energy production data, and market opportunities into a model for value of added capacity.
- **Copperleaf C55** is a long-term asset and capital project planning analytics software used by Bonneville Power Administration to develop its biennial Hydro Asset Strategy, and to manage ongoing capital projects. C55 uses hydroAMP data to develop plans for each asset based on risk.
- The **Electric Utility Cost Group (EUCG)** is an industry group focused on improving operating, maintenance, and construction performance among utilities. Data from utility

members is uploaded to a central **Hydroelectric Productivity Committee (HPC)** database, and benchmarks assembled for comparison. USACE is a founding member.

- **Facilities and Equipment Maintenance (FEM)** is a version of IBM Maximo customized for USACE that tracks parts, work orders, and time spent on tasks. The program can be used to schedule routine maintenance and supply purchases as well. At each project, a FEM technician is responsible for maintaining FEM records and interfacing with the proper departments to administer budgets.

Appendix C – Summary of Memoranda of Agreement with PMAs & Customers

USACE Entity	Partners	Date Signed	MOA Subject
Southwestern Division	SWPA, Southwestern Power Resources Association; Southwestern Preference Customer Trust	2014 previous (2008, 1999)	Establishes a framework governing the respective responsibilities of the Parties regarding funding operation, maintenance, rehabilitation and modernization activities at hydroelectric facilities of the districts of the USACE in Southwestern's marketing region. # DE-PM75-00SW00431-M002
Southwestern Division	SWPA	1980	Establishes expectations for the coordination between SWD and SWPA in the scheduling and operation of the hydropower projects in a manner that meets the mutual needs and constraints of each party. # DE-PM75-80SW00058
Northwestern Division	WAPA	1993	Provides for financing for specific operation and maintenance costs of the Fort Peck Dam and Powerplant and permits each Party to perform maintenance activities for the other. Establishes expectations for billing and payment; and coordination of planning, design, construction, installation, operation, and maintenance activities. # 89-BAO-386
Northwestern Division	WAPA, Western States Upper Great Plains, Inc.	2004	Parties agree to use Project Agreements to document specific hydropower related work to be performed at the Corps UGPR generation and appurtenant facilities. Hydropower work that may be considered in a Project Agreement include operation, maintenance, replacement, additions, and construction features of the Corps UGPR power plants where such activities will optimize the efficiency of energy production or increase the capacity of the facility, or both. Expires in 2023. #03-UGPR-04

USACE Entity	Partners	Date Signed	MOA Subject
Northwestern Division	WAPA, Western States Upper Great Plains, Inc.	2005	Project agreement enables Western States UGP to contribute funds for activities necessary to maintain the reliability and good operating condition of the power facilities to include operation, maintenance, replacement, additions, and construction of features at Corps Upper Great Plains Region power plants where such activities will optimize the efficiency of energy production or increase the capacity of the facility, or both. Expires in 2020. # 04-UGPR-65.
Northwestern Division	BPA	1994	Establishes a mutual framework governing the respective responsibilities of the parties regarding the development of capital generation additions, improvements, and replacements at U.S. Army Corps of Engineers (USACE) hydroelectric projects or other projects operated and maintained in the Pacific Northwest Region. This MOA is entered into pursuant to Section 2406 of the National Energy Policy Act of 1992. # DE-MS79-94BP4655
Northwestern Division	BPA	1997 (Am. 2013, 2018)	BPA shall pay all costs, including overhead charges, on O&M requirements, addition, replacement, or improvement work pursuant to mutually agreed-upon Five Year Power Budgets, and Annual Power Budgets entered into under this Agreement. Establishes expectations for the collaboration in the planning, design, construction, O&M activities and costs of the Corps' facilities and projects, with the Corps retaining the responsibility to ensure the integrity of the power generation facilities. Associated Implementation Guidance for BPA-Corps Joint Operating Committee was signed in 1998. This MOA is entered into pursuant to Section 2406 of the National Energy Policy Act of 1992. Expires September 30, 2028. # 98PB-10211
South Atlantic Division	SEPA, Southeastern Power LLC	2004 (Am. 2005, 2008	Establishes a framework governing the respective responsibilities of the Parties regarding funding maintenance, rehabilitation or modernization activities at hydroelectric facilities owned by the Department of the Army in those USACE districts of the South Atlantic Division within SEPA's marketing region.

USACE Entity	Partners	Date Signed	MOA Subject
South Atlantic Division	SEPA	1991	Addresses disposal of electric power and energy generated at the Corps projects within the Mobile, Savannah, and Wilmington Districts. Establishes agreement to operate the system of facilities in the overall most cost-effective manner for the entire Southeast region of the country. Establishes expectations for sharing of information (e.g., cost); availability of power; and cooperation & coordination.
South Atlantic Division	SEPA	1997	This amendment to the 1991 agreement establishes roles and responsibilities for a Federal Operations Center and Federal Control Area for the Georgia-Alabama-South Carolina System.
South Atlantic Division	SEPA	2001	This amendment to the 1991 agreement establishes a policy and roles and responsibilities associated with inclusion of the Corps transmission facilities (switchyards) into a Regional Transmission Organization (RTO) by SEPA and the operation of the Corps hydroelectric plants within the RTO.
South Atlantic Division	SEPA	2005	Provides a framework for the Parties to meet the cyber security certification and accreditation requirements of the Department of Defense and the Department of Energy and effectively allow the exchange of critical information and data over the hybrid sensor and control system in a secure enterprise environment.
Nashville District	SEPA, TVA, TVPPA	2017; previous (2016, 2011)	Establishes a framework governing the respective responsibilities of the Parties regarding funding of certain non-routine maintenance, rehabilitation and modernization activities at Cumberland River hydroelectric facilities operated and maintained by the Great Lakes and Ohio River Division of the Corps in SEPA's marketing region. Expires in 2019.
Nashville District	SEPA, Cumberland Customers	2011	Establishes a framework governing the respective responsibilities of the Parties regarding funding of certain non-routine maintenance, rehabilitation and modernization activities at Nashville District's hydropower projects. Expires in 2032.