Executive Summary

Introduction

The Water Power Technologies Office (WPTO), part of the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE), held a virtual peer review on July 18–29, 2022. The purpose of peer review is to evaluate DOE-funded projects for their contributions to the mission and goals of the office, progress made against stated objectives, and the office's overall management and performance. The peer review process enables external stakeholders to provide feedback on the most impactful use of taxpayer funding and develop recommendations for the most efficient and effective ways to accelerate industry development in water power technologies. This report includes the results of WPTO's 2022 Peer Review.

Review Process

A total of 31 external subject-matter experts from industry, academia, nonprofit organizations, and government agencies evaluated more than 100 projects active in WPTO's research and development (R&D) portfolio in fiscal years (FY) 2019–2021. During the peer review, principal investigators (PIs) presented on their projects, and WPTO staff presented on their program and activity area strategies and progress on stated goals and objectives. See Table ES-1 for a list of the programs, activity areas, and number of projects reviewed in each.

Table ES-1. Number of Projects Reviewed by Program and Activity Area

Program	Activity Area	Number of Projects
Hydropower*	Innovations for Low-Impact Hydropower Growth	16
	Grid Reliability, Resilience, and Integration (HydroWIRES)	25
	Fleet Modernization, Maintenance, and Cybersecurity	6
	Environmental and Hydrologic Systems Science	8
Marine Energy	Foundational R&D	13
	Technology-Specific System Design and Validation	22
	Reducing Barriers to Testing	9
	Data Access, Analytics, and Workforce Development	4

*Projects from the Hydropower Data Access, Analytics, and Workforce Development Activity Area were folded into other relevant activity areas.

The peer review was separated by program, starting with the Marine Energy Program and ending with the Hydropower Program. The first four days of each program's review week were dedicated to public presentations from PIs and feedback from the reviewers, and the last day was dedicated to a closed-door review session where reviewers had the opportunity to discuss their initial thoughts with WPTO staff. Each program was separated into four review sessions that roughly corresponded to individual activity areas. Each review session was structured with an activity area overview that linked the projects to the activity area's challenges and the strategy for measuring progress and managing deliverables toward outcomes. The agenda in Appendix A provides a detailed breakdown of the projects presented within each activity area.

Strategic Direction Underpinning WPTO's 2022 Peer Review

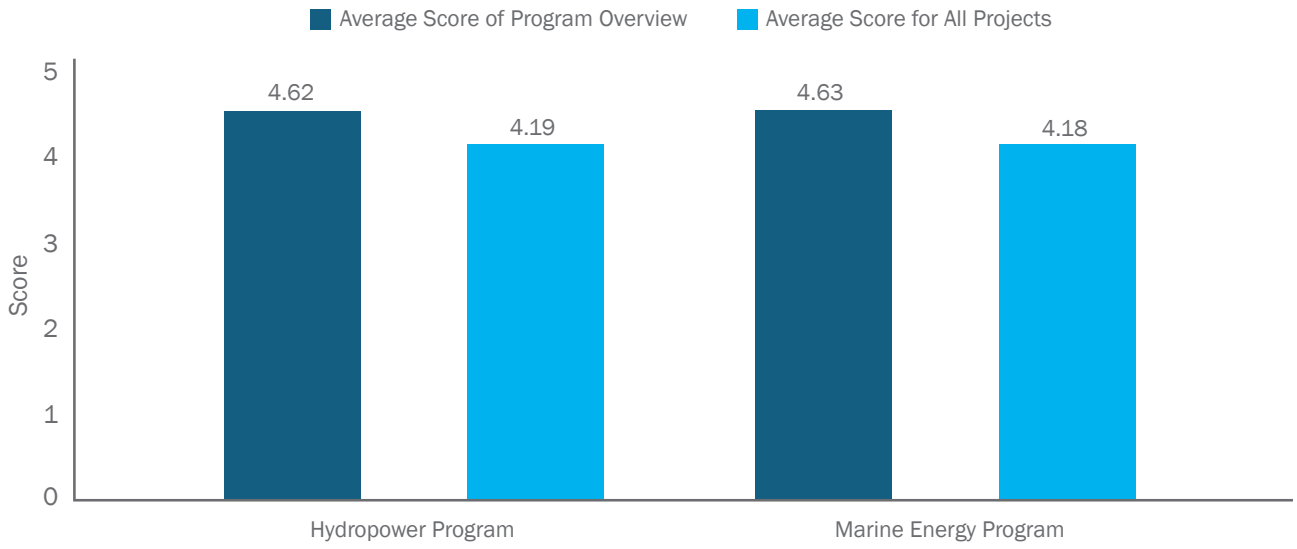
WPTO staff and management considered the 2022 Peer Review a significant milestone and opportunity given that this was the first comprehensive evaluation of WPTO since publishing its Multi-Year Program Plan (MYPP). The MYPP is a comprehensive report that details the office's future research, development, demonstration, and commercial activities across both hydropower and marine energy and describes how these efforts can help meet the nation's energy and sustainability goals. The report outlines key performance goals for each of WPTO's activity areas through 2025 and includes long-term, follow-on objectives through 2030. This report serves as a strategic vision and operational guide to help WPTO manage and coordinate its activities and communicate its mission, goals, and plans.

The MYPP was an integral part of the peer review, providing reviewers insight and guidance on the office's strategy to which WPTO-funded projects must align. For more information about the office's structure, strategy, and R&D portfolio implementation, please refer to the MYPP or the corresponding office, program, or activity area overview slide decks presented during the review.

Summary of Findings

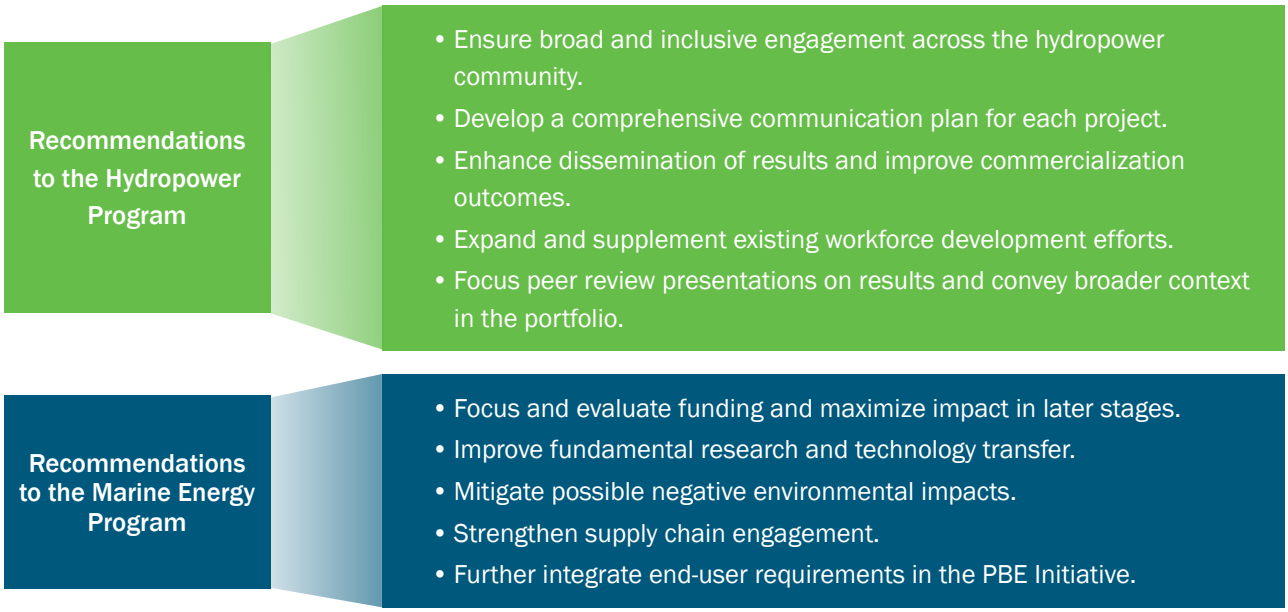
Reviewers rated each program's strategy and implementation higher than the average score for all individual projects. This indicated that current program objectives, which were updated after some of the earliest projects were initiated, align well with evolving industry needs. Figure ES-1 summarizes reviewers' quantitative assessments of how WPTO's programs are performing overall, including the weighted average score of each program and the average score of all projects reviewed per program.

Figure ES-1. Average Score Per Program.



Overall, reviewers agreed that each program has a defined strategy, as outlined in the MYPP, that considers challenges facing industry and other stakeholders and leverages appropriate funding mechanisms to achieve intended outcomes. Reviewers were impressed with the depth and breadth of each of the programs and noted that the variety of funding mechanisms used across the office was a significant strength. Across both programs, reviewers noted the importance of meaningful, early, and frequent stakeholder engagement and impactful dissemination of results. Reviewers also recommended opportunities for WPTO to ensure stronger connections to industry by developing or advancing commercialization strategies, diversifying communication approaches, and improving information sharing. These recommendations are summarized in Figure ES-2.

Figure ES-2. Summary of Reviewer Recommendations to WPTO's Programs.



Key Actions and Next Steps

WPTO takes the peer review process seriously and developed a preliminary set of actions it will take to incorporate feedback and strengthen its body of work over the coming years. Below are high-level, office-wide actions and areas of improvement that WPTO will work toward before its next peer review. Further, each program and activity area section in this report contains additional actions based on reviewer recommendations and feedback.

Ensure Relevance and Connections to Industry and Academia

A key theme that emerged from reviewers during both the hydropower and marine energy reviews was the need to ensure continuous industry feedback, input, relevance, and adoption of work WPTO supports. In recent years, the office has begun to strengthen industry connections and will continue these efforts, while recognizing the private sector's adoption of WPTO-developed solutions will ultimately ensure success. The office is also considering actions that will strengthen connections to industry, including academia, during strategy and solicitation development, project development and implementation, and post-project evaluation and support for commercialization.

In the development of its MYPP, WPTO issued requests for information, met with stakeholders, and considered ongoing stakeholder interactions. As the office updates its MYPP and develops other strategies to inform investments, the office will build on and enhance this engagement. Additionally, WPTO strives to be as collaborative and open as possible in shaping solicitations, prizes, and lab work to be as impactful to industry as possible. WPTO looks forward to hearing more feedback from its partners on how to enhance industry relevance in its projects.

WPTO recently took steps to ensure project outcomes are vetted and analysis has industry relevance. This has included forming technical advisory committees on research, which has led to collaboration during publication of that research and involving industry and academia in design reviews. However, the office recognizes the need to publish information on projects even before their conclusion and engage a broader set of stakeholders in both hydropower and marine energy, including environmental and community-based organizations.

Support Technology Transfer and Strengthen Commercialization

Reviewers noted that for the office to be successful, industry adoption of solutions is critical, and commercialization of WPTO-funded solutions is crucial to ensuring that adoption. Commercialization has become an increasing focus and will be at the center of both the hydropower and marine energy programs, both within projects and through activities being pursued across WPTO. This includes focusing on projects' and programs' follow-on investment potential, strengthening connections to investors in the private sector, requiring serious commercialization strategies from performers, and supporting the broader innovation ecosystem engine through incubators and accelerators.

To support commercialization and adoption of solutions, WPTO will provide the support technologies need to translate from laboratories into their relevant markets. WPTO is currently developing materials for awardees on commercialization processes and options for intellectual property. The office also works closely with national laboratory commercialization offices to understand the options for technology transfer of WPTO-funded tools and technologies. WPTO will publish more public information about intellectual property that could potentially be commercialized and organizations supported by the office that can assist with commercialization, as well as case studies on how the office's support has helped advance technologies in both industries to provide further transparency.

Ensure Impact of Investments and Fit for Financing Mechanisms and Impact

While reviewers noted that WPTO has employed a variety of financing mechanism (e.g., prize, technical assistance, cooperative agreement), the office needs to ensure those mechanisms are the right fit to maximize investment and ensure projects can ultimately achieve success. In recognition that either projects did not align with overall program strategy or a funding mechanism did not fit the purpose of the original technical intent, WPTO is launching a new internal effort to develop a rigorous solicitation selection and evaluation process. The office will implement a process early in solicitation development to determine the correct mechanism for the desired purpose; determine the target audiences and applicants and design a solicitation and complementary outreach plan to engage them; leverage each solicitation to reach new audiences and expand the diversity of research partners; and determine the appropriate budget and sequencing of funding opportunities.

Efforts to ensure solicitations maximize investment need to be coupled with an effort focused on revisiting the metrics that communicate the success or lack thereof in a project. Given the interrelated nature of water power technologies with water quality, environmental performance, community impacts, and greenhouse gas avoidance, the success of WPTO's portfolio is not as easily captured by traditional technology metrics such as levelized cost of energy or other types of cost reduction. New metrics for modeling efficacy and uptake, for example, could be developed, especially as the current portfolio of projects continues to progress. WPTO will work across DOE and with partners to hone and define these metrics. This will include building metrics collection in at the solicitation development stage to better communicate to performers the expectations for the metrics they will need to report on as part of their awards.

Increase International Collaboration and Information Exchange

Lastly, reviewers provided feedback across WPTO's portfolio to look outside the United States for opportunities for collaboration, best practices, research advancements, and technologies. The office has been actively engaged with the International Energy Agency in both hydropower and marine energy, and WPTO plans to continue that engagement and look for additional opportunities for international partnerships. WPTO will also continue to approve international subcontract arrangements on its industry and lab projects and engage the international community to serve as independent reviewers for proposal evaluations and public peer reviews.

In the future, WPTO will look at new ways to exchange information with international counterparts, ensure due diligence by encouraging researchers to conduct literature reviews using relevant international publications, and strengthen relationships with countries and organizations seeking to advance water power technologies abroad.

WPTO again thanks its reviewers for their time, effort, and attention. This report has additional details on actions at the program and activity area levels to address both the opportunities and weaknesses elucidated by reviewers. WPTO commits to providing progress on this work during its public updates, through its annual accomplishment reports, and at semiannual public webinars.

List of Acronyms

Argonne	Argonne National Laboratory
C-Power	Columbia Power Technologies, Inc
CAISO	California Independent System Operator
CEC	current energy converter
CEM	capacity expansion model
DEEC-Tec	distributed embedded energy converter technologies
DEI	diversity, equity, and inclusion
DOE	U.S. Department of Energy
EERE	Office of Energy Efficiency and Renewable Energy
EMEC	European Marine Energy Centre
EPRI	Electric Power Research Institute
FAST	Furthering Advancements to Shorten Time Commissioning for PSH
FERC	Federal Energy Regulatory Commission
FOA	funding opportunity announcement
FOSWEC	floating oscillating surge wave energy converter
FY	fiscal year
GHG	greenhouse gas
GIS	geographic information system
HAWSEC	Hawaii Wave Surge Energy Converter
HFI	Hydropower Fleet Intelligence
HydroWIRES	Hydropower and Water Innovation for a Resilient Electricity System
I AM Hydro	Innovations in Advanced Manufacturing for Hydropower
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IHA	International Hydropower Association
INL	Idaho National Laboratory
IO&M	installation, operations, and maintenance
ISO	independent system operators
kW	kilowatt
LCOE	levelized cost of energy
MECC	Marine Energy Collegiate Competition
MHK	marine and hydrokinetic
MHKiT	Marine and Hydrokinetic Toolkit
MISO	Midcontinent Independent System Operator
MW	megawatt
MYPP	Multi-Year Program Plan
NERC	North American Electric Reliability Corporation
NHA	National Hydropower Association
NMRECs	National Marine Renewable Energy Centers
NPD	non-powered dam

NREL	National Renewable Energy Laboratory
NOAA	National Oceanic and Atmospheric Administration
NYISO	New York Independent System Operator
O&M	operations and maintenance
OES	Ocean Energy Systems
ORNL	Oak Ridge National Laboratory
ORPC	Ocean Renewable Power Company
OWC	Oscillating Water Column
PBE	Powering the Blue Economy™
PI	principal investigator
PNNL	Pacific Northwest National Laboratory
PRIMRE	Portal and Repository for Information on Marine Renewable Energy
PSH	pumped storage hydropower
PTO	power take-off
PUMPSS	Predicting Unique Market Pumped Storage Significance
R&D	research and development
RoR	run of river
Sandia	Sandia National Laboratories
SBIR	Small Business Innovation Research
SEAT	Spatial Environmental Assessment Toolkit
SMH	standard modular hydropower
SR-WEC	surface riding wave energy converter
STEM	science, technology, engineering, and mathematics
TEAMER	Testing Expertise and Access for Marine Energy Research program
TPL	technology performance level
TRL	technology readiness level
UMERC	University Marine Energy Research Community
USACE	U.S. Army Corps of Engineers
VGOSWEC	variable-geometry, oscillating surge wave energy converter
VGWEC	variable-geometry wave energy converter
WBS	Work Breakdown Structure
WEC	wave energy converter
WEC-Sim	Wave Energy Converter SIMulator
WECC	Western Electricity Coordinating Council
WETS	Wave Energy Test Site
WPTO	Water Power Technologies Office
ZAO	Zero Ascend Omnispecies

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