Request for Information: Challenges and Opportunities for Non-Powered Dam and Pumped Storage Hydropower Development in the U.S.

RFI#: DE-FOA-0001545

DATE: February 24, 2016
SUBJECT: Request for Information (RFI)
RESPONSE DUE: March 18, 2016

Description

The Wind and Water Power Technologies Office (WWPTO), within the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy (EERE), invites input from the public regarding challenges and opportunities associated with hydropower development in two resource classes: existing non-powered dams, and pumped storage hydropower. Information sought under this RFI is intended to assist the WWPTO in developing future activities and priorities. WWPTO seeks input from any stakeholders in the U.S. hydropower community.

Background

Through its HydroNEXT initiative, the WWPTO's Hydropower Program (the Program) invests in the development of innovative technologies that lower cost, improve performance, and promote environmental stewardship of hydropower development across three resource classes to increase the contribution of clean, renewable hydropower to the nation's energy mix: existing non-powered dams (NPDs), pumped storage hydropower (PSH), and undeveloped streams. In 2015, the Hydropower Program made federal funding available to seven projects under a Funding Opportunity Announcement (FOA) to research and develop innovative technologies for low impact hydropower development in undeveloped streams. This year, the Program's efforts will shift to NPDs and PSH.

A recent study[1] by Oak Ridge National Laboratory has identified 80,000 existing U.S. dams that lack electricity-generating equipment and instead are used for other purposes, such as regulating water supply and controlling inland navigation. Furthermore, the study found that there is up to 12 gigawatts (GW) of new hydropower development potential available at existing NPDs throughout the United States. While a number of these sites contain characteristics that are favorable for development using existing technology, the majority of the

[1] http://nhaap.ornl.gov/sites/default/files/NHAAP_NPD_FY11_Final_Report.pdf

existing NPDs have challenges such as low head, low/varying inflows, and environmental effects that will require significant cost reduction strategies to enable development.

Nearly all PSH development in the last 30 years has occurred in Europe and Asia. While there is strong interest in the U.S. in constructing new plants, their development may be hindered by a variety of issues related to capital cost, markets, and regulatory processes. Most plants were constructed in the 1960s-1980s, but there is a renewed interest in PSH plants today due to their ability to help firm variable power provided by some renewable energy technologies. PSH is by no means the only option for large scale energy storage, but it is by far the most prevalent and has proven to be reliable and effective. New technology advancements hold the promise for greater efficiencies and greatly improved abilities to assist in the stabilization of transmission systems.

Purpose

The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on issues related to non-powered dams and pumped storage hydropower. EERE is particularly interested in information on challenges related to development, market variability, and how technology affects deployment. This is solely a request for information and not a Funding Opportunity Announcement (FOA).

As a follow on to this RFI, DOE's Hydropower Program intends to hold a public workshop where questions below will be circulated and discussed with attendees. Details regarding this workshop will be provided in a subsequent public notice.

Disclaimer and Important Notes

This RFI is not a Funding Opportunity Announcement (FOA); therefore, EERE is not accepting applications at this time. EERE may issue a FOA in the future based on or related to the content and responses to this RFI; however, EERE may also elect not to issue a FOA. There is no guarantee that a FOA will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if EERE chooses to issue a FOA regarding the subject matter.

Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development; this RFI does not constitute a formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. EERE will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. EERE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are

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advised that EERE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind EERE to any further actions related to this topic.

Proprietary Information

Because information received in response to this RFI may be used to structure future programs and FOAs and/or otherwise be made available to the public, **respondents are strongly advised NOT to include any information in their responses that might be considered business sensitive, proprietary, or otherwise confidential.** If, however, a respondent chooses to submit business sensitive, proprietary, or otherwise confidential information, it must be clearly and conspicuously marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Federal Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

If your response contains confidential, proprietary, or privileged information, you must include a cover sheet marked as follows identifying the specific pages containing confidential, proprietary, or privileged information:

> **Notice of Restriction on Disclosure and Use of Data:**
> Pages [List Applicable Pages] of this response may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for the purposes described in this RFI, DE-FOA-0001545. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.

In addition, (1) the header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: “Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure” and (2) every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

Evaluation and Administration by Federal and Non-Federal Personnel

Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The Government may seek the advice of qualified non-Federal personnel. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response, consent to EERE providing their response to non-Federal parties. Non-Federal parties given

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access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

Request for Information Categories and Questions

DOE's Hydropower Program requests information regarding hydropower technologies related to non-powered dam and pumped-storage development. The information gathered from this RFI will be used to inform strategic planning by DOE.

Topic 1: Non-Powered Dams

Even with existing infrastructure in place, development at non-powered dams (NPDs) can be challenging. As in many areas of hydropower development, capital costs can be the determining factor when considering the commercial feasibility of a project. DOE is interested in innovative solutions to help lower both civil works and turbine/generator equipment costs. While advancements in technology can address capital costs, other challenges such as regulatory framework, environmental effects, project location, interconnection, and ownership structure may require unique solutions. DOE is seeking novel solutions to these challenges in order to continue hydropower's contribution to the growth of renewable power generation in the U.S.

NPD Category 1: How can new technology solutions be used to enable further hydropower development at NPDs?

a) What are the technical challenges and solutions needed for development at NPDs with heads of less than 50 feet?
b) How can the modularization of new turbine/generator technology affect costs related to the following:
    i. Equipment
    ii. Civil infrastructure modifications
    iii. Design
    iv. Permitting
c) Considering modular turbine/generator technologies, what are the technical challenges these units encounter with respect to the following:
    i. Availability/competition in the marketplace
    ii. Adequate number of designs to meet varying heads and flows
    iii. Efficiency and reliability
    iv. Integration with existing civil works
    v. Environmental performance

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d) Excluding powertrain technologies, what other technology advancements would be beneficial to NPD development? Please consider the following:
   i. Standardized civil structures
   ii. Advanced tunneling
   iii. Alternative penstock materials
   iv. Siphon technologies
e) What other technology challenges, not addressed above, may be encountered by NPD developers?

NPD Category 2: What novel approaches and solutions can be used to address the timeline of NPD development?

a) Although every project is unique, how can standardized equipment build familiarity and assist with regulatory review?
b) The nuclear industry, for example, has modularized reactor technologies with participation of regulatory agencies. How can the hydropower industry work with their regulatory agencies to develop "pre-approved" technologies?

NPD Category 3: While environmental effects must be considered during all hydropower development, how can NPD development more readily address existing and new environmental challenges?

a) With recent advancements in additive manufacturing, it has become increasingly easier to embed sensors and other smart technology into equipment. How can this advancement be used to build smarter machines and change the way stakeholders address environmental effects?
b) How could "smart" turbine development and deployment be utilized to change dispatching and operating practices?

NPD Category 4: What other challenges are facing NPD developers?

a) Given that interconnection is a vital consideration to every commercial NPD development, what type of impacts do the following have on the development potential:
   i. Interconnections studies
   ii. Distribution versus transmission interconnection
   iii. Timeline for interconnection in the commercial development vs regulatory approval process
b) How is NPD project financing viewed by traditional lending sources? Are there alternative financing sources being utilized in the NPD development community?

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c) Considering next-generation equipment development, how impactful would a full-scale, grid-connected test facility be to the industry? What types of effects would this facility have on the following:
    i. Iterative process of equipment development
    ii. Perceived financial risks from project financers
    iii. Establishing full-scale environment performance
    iv. Understanding Operations and Maintenance (O&M)challenges

Topic 2: Pumped Storage Hydropower

Pumped storage hydropower (PSH) comprises the overwhelming majority (97%) of utility-scale storage in the U.S. The value proposition of PSH lies in its ability to provide operating flexibility to balance system loads and variable generation from other renewables. However, since 1995, only one PSH plant has been deployed in the U.S. Furthermore, while advanced PSH is being used worldwide, no single project in the U.S. is currently taking advantage of this technology. Advanced PSH refers to ternary and variable speed units, as opposed to conventional PSH units which only have fixed-speed capabilities. Models developed by Argonne Nagional Laboratory under a DOE-funded study[2] described the value that advanced PSH can have in the U.S. power system. While DOE is currently investing in the development of new modular pumped-storage technologies, DOE is also looking to continue to assess and better understand the barriers faced by the PSH industry as they relate to technology advancements for small, modular and large systems, market structures and civil works, and their respective technical, financial, market and regulatory challenges.

PSH Category 1: What role can new technologies, for both conventional and advanced machines, play in the renewed development of PSH in the U.S.?

a) What primary factors are considered when deciding to pursue a project with conventional versus advanced PSH technologies?
b) Given that advanced PSH development in other countries is occurring, what are the technology barriers to implementing this technology in the U.S.?
c) Describe the main technical challenges that PSH units encounter with respect to cavitation, efficiency, longevity, etc.
    i. For conventional PSH technologies
    ii. For advanced PSH technologies
d) What opportunities exist for reducing the cost of advanced PSH technologies? Please consider powertrain and balance of plant equipment as well as civil infrastructure.

[2] http://ceeesa.es.anl.gov/projects/psh/ANL-DIS-14-7_Advanced_PSH_Final_Report.pdf

e) What are the prospects for small-scale or modular PSH? Are they needed and are they feasible?
f) What opportunities exist for improving performance of advanced PSH technologies? Please consider turbine, generator, and ancillary equipment.
g) What are the challenges associated with new storage technologies such as underground closed-loop, compressed air/hydro hybrid, and others?
h) What technologies would benefit from competitive demonstrations?

PSH Category 2: How can technology, operation, or integration changes affect PSH's value in the current market structures throughout the U.S.?

a) What market/value challenges do you see related to PSH deployment?
    i. For conventional PSH
    ii. For advanced PSH
b) How can ancillary benefits of PSH be valued under the existing market revenue structure?
c) With the constant evolution of energy markets, and energy arbitrage not always viable, what new operational opportunities exist to create additional revenue streams for PSH? Please consider conventional, advanced, and new technologies.
d) How can advanced PSH designs (underground closed-loop, compressed air/hydro hybrid, etc.) be better integrated with variable generation to improve market value?

PSH Category 3: Given that capital costs related to civil works can be the major cost driver in PSH development, what new approaches can be used to lower this cost?

a) What infrastructure challenges do you see related to PSH deployment (cost, size, equipment life, etc.)?
    i. For conventional PSH
    ii. For advanced PSH
b) What siting challenges do you see related to PSH deployment (geography, environmental considerations, etc.)?
    i. Conventional vs advanced PSH
    ii. Closed loop vs open loop PSH
c) What plant design/layout changes could be investigated to lower cost? What lessons/techniques could PSH developers and engineers leverage from other industries?

PSH Category 4: What other challenges are facing PSH development in the U.S.?

a) While other countries have seen an increase, only limited PSH development has occurred in the U.S. since 1995. What are the drivers for PSH deployment in Asia and Europe? Are they relevant for the U.S.?

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b) Based on the challenges identified in Categories 1 – 3, what types of studies, modeling, and analyses can be performed at a national level that can further the development of PSH in the U.S.?
c) Based on the challenges identified in Categories 1 – 3, what kinds of technologies could be developed to address these challenges?
d) How have the recent advancements in energy storage (batteries, flywheels, etc.) and flexible generation (fast-start natural gas) impacted PSH development in the U.S.?

Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to PSH_RFI@ee.doe.gov no later than **5:00pm (ET) on March 18, 2016**. Responses must be provided as attachments to an email. It is recommended that attachments with file sizes exceeding 25MB be compressed (i.e., zipped) to ensure message delivery. Responses must be provided as a Microsoft Word (.docx) attachment to the email, and must be no more than 5 pages in length, 12 point font, 1 inch margins. Only electronic responses will be accepted.

Please identify your answers by responding to a specific question or topic if applicable. Respondents may answer as many or as few questions as they wish.

EERE will not respond to individual submissions or publish publicly a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name;
- Company / institution contact;
- Contact's address, phone number, and e-mail address.

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