



**U.S. Department of Energy
Advanced Research Projects Agency – Energy**

**Announcement of Teaming Partner List for an upcoming
Funding Opportunity Announcement:**

Optimal Operations and Maintenance for Advanced Reactors

The Advanced Research Projects Agency – Energy (ARPA-E) intends to issue a new Funding Opportunity Announcement (FOA) in September 2019 to solicit applications for financial assistance to develop innovative technologies for the optimization of operations and maintenance (O&M) of advanced nuclear reactors.¹ As described in more detail below, the purpose of this announcement is to facilitate the formation of new project teams to respond to the upcoming FOA. The FOA will provide specific program goals, technical metrics, and selection criteria and the FOA terms are controlling. For the purposes of the Teaming Partner List, the following summarizes current planning for the FOA:

Advances in autonomous, efficient, and low-cost operations and maintenance are happening in many industrial sectors, largely powered by artificial intelligence (AI), advanced data analytics, distributed computing, powerful physics simulation tools, and other breakthroughs. To date, little of this advancement has been adopted by the nuclear energy industry. There is a crucial need to design and execute extremely robust and low-cost operations and maintenance procedures (O&M) for advanced reactors (AR).² The aim of this ARPA-E program is to make a transformational change to the current state-of-the-art in operating nuclear reactor plants, and improve AR designs with O&M in mind. ARPA-E is interested in solutions focusing on operating and maintaining the reactor core, the balance of plant (BOP), or the entire reactor plant system (including both the reactor core and BOP).

To accomplish this goal, ARPA-E is looking for interdisciplinary teams to develop digital twins (DTs),³ or a technology with similar capability, for an AR design as the foundation of their O&M strategy. The digital twins (or equivalent) the teams will develop will include diverse technologies that are driving efficiencies in other industries, such as AI, advanced control systems, predictive maintenance, and model-based fault detection. Teams will use the DTs to assess, diagnose, and prescribe O&M activities and needs. Because ARs are still in design phases, with no physical units operating, teams working on core operations will also develop cyber-physical systems (CPS)⁴ that simulate advanced reactor core operating dynamics using a combination of non-nuclear experimental facilities (e.g., flow loops) and software. Teams will use these systems as the “real asset,” a surrogate upon which developers can test their DT platforms for operations and maintenance. CPS may also provide validation data for regimes or conditions with high uncertainty. ARPA-E will also support research for filling specific technical gaps to enable the O&M strategies. This program lays the basis for a future where ARs operate with a staffing plan and fixed O&M costs more akin to that of a combined cycle natural gas plant than that of the legacy light-water reactor fleet.

¹<https://arpa-e.energy.gov/?q=workshop/optimal-operations-advanced-nuclear-reactors>

² Advanced reactor designs include classes of reactors that are being planned but are not currently deployed. This includes designs that use as heat transfer media: gas, lead (or lead-bismuth alloy), molten salt, sodium, heat pipes, supercritical water, supercritical CO₂, and light water; and as nuclear fuel types: ceramic oxides, nitrides, metal, triso clad, silicon carbide clad, metal clad, liquid eutectic.

³ <https://www.networkworld.com/article/3280225/what-is-digital-twin-technology-and-why-it-matters.html>

⁴ <https://ptolemy.berkeley.edu/projects/cps/>



Beyond providing lower fixed O&M costs, development of DTs for ARs has multiple other benefits. In particular, ARPA-E sees DT development contributing to the following areas: generating timely reactor design feedback, enhancing regulatory efficiency, de-risking market adoption challenges, informing new quality assurance standards, and laying the basis for future personnel training.

Currently, ARPA-E anticipates that this program will have two research categories.

1. Optimal operations and maintenance for ARs: teams will build a digital twin(s) for an advanced reactor system and use it to develop and test advanced O&M techniques and strategies.
2. Targeted topics: Technical gaps may exist that prevent the O&M solutions developed in this program from being fully usable, such as a lack suitable data necessary for modeling or simulation, insufficient essential sensors, or inability to execute specific maintenance tasks. Progress toward sophisticated O&M may be accelerated through the development of smaller, more specific, and focused technology-oriented research programs to address these gaps.

In order to realize the goals of the proposed ARPA-E program, expertise in the following areas may be useful: (i) artificial intelligence; (ii) industrial condition monitoring/asset performance management/predictive maintenance; (iii) advanced, autonomous control systems; (iv) multi-fidelity modeling and simulations; (v) robotics and remote maintenance systems; (vi) advanced reactor design; (vii) nuclear plant O&M activities; and (viii) harsh environment sensors and instrumentation.

As a general matter, ARPA-E strongly encourages outstanding scientists and engineers from different organizations, scientific disciplines, and technology sectors to form new project teams. Interdisciplinary and cross-sector collaboration spanning organizational boundaries enables and accelerates the achievement of scientific and technological outcomes that were previously viewed as extremely difficult, if not impossible.

The Teaming Partner List is being compiled to facilitate the formation of new project teams. ARPA-E intends to make the Teaming Partner List available on ARPA-E eXCHANGE (<http://arpa-e-foa.energy.gov>), ARPA-E's online application portal, starting in September 2019. The Teaming Partner List will be updated periodically, until the close of the Full Application period, to reflect the addition of new Teaming Partners who have provided their information.

Any organization that would like to be included on the Teaming Partner list should complete all required fields in the following link: <https://arpa-e-foa.energy.gov/Applicantprofile.aspx>. Required information includes: Organization Name; Contact Name; Contact Address; Contact Email; Contact Phone; Organization Type; Area of Technical Expertise; and Brief Description of Capabilities.

By submitting a response to this Notice, you consent to the publication of the above-referenced information. **By facilitating this Teaming Partner List, ARPA-E does not endorse or otherwise evaluate the qualifications of the entities that self-identify themselves for placement on the Teaming Partner List.** ARPA-E will not pay for the provision of any information, nor will it compensate any respondents for the development of such information. Responses submitted via email or other means will not be considered.

This Notice does not constitute a FOA. No FOA exists at this time. Applicants must refer to the final FOA, expected to be issued in September 2019, for instructions on submitting an application and for the terms and conditions of funding.