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

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

Breakthroughs Enabling Thermonuclear-fusion Energy

The Advanced Research Projects Agency – Energy (ARPA–E) intends to issue a new Funding Opportunity Announcement (FOA) in November 2019 to solicit applications for financial assistance to develop lower-cost fusion-energy concepts.[1] Based on numerous studies examining the cost challenges facing advanced nuclear energy,[2] which shares some attributes with fusion such as unit size and capital cost, ARPA-E believes that a commercial fusion power plant should target an overnight capital cost (OCC) of <US$2B and <$5/W. Furthermore, if fusion energy can be commercialized in about 20 years, then, as a firm low-carbon energy source, it can contribute to meeting global, growing low-carbon energy demand and cost-effective deep decarbonization[3] in the latter half of the century.

As described in more detail below, the purpose of this announcement is to facilitate the formation of new project teams to respond to the planned 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.

Building on the ALPHA program[4] and synergies with the growing private fusion industry,[5] the key objective of this program will be to increase the number and performance levels of lower-cost fusion concepts. Presently, ARPA–E anticipates that this program may have three research categories:

A. Concept Development: projects will develop lower-cost fusion concepts as measured against specific milestones (to be detailed in the FOA), from theoretical/numerical assessment of net-energy-gain potential to experimental demonstration of fusion-triple-product[6] increases toward the notional energy-breakeven requirement of ~3×10^{21} keV·s/m^3. Concepts that have already demonstrated triple products >10^{19} keV·s/m^3 are not eligible for this category but may be eligible for Component Technology Development (Category B) below. ARPA-E may support multiple concepts in this category at a range of entry and exit milestones. Concepts from the full range of thermonuclear parameter space[7] (i.e., from lower-density magnetically confined to higher-

[1] https://arpa-e.energy.gov/?q=workshop/enabling-timely-and-commercially-viable-fusion-energy; this workshop discussed both "lower-cost fusion concept development" and "fusion enabling technologies." This Teaming Partner List and planned FOA are only for the former.

[2] e.g., *The Future of Nuclear Energy in a Carbon-Constrained World, An Interdisciplinary MIT Study*, MIT Energy Initiative (2018).

[3] N. A. Sepulveda et al., "The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation," Joule **2**, 2403 (2018).

[4] Accelerating Low-cost Plasma Heating and Assembly; C. L. Nehl et al., "Retrospective of the ARPA-E ALPHA Fusion Program," J. Fusion Energy, published online Oct. 8, 2019.

[5] See, e.g., member companies of the Fusion Industry Association.

[6] The "Lawson" fusion triple product is a metric for comparing the rate of fusion energy production to the rate of energy lost from the fusion fuel. Above a threshold value of the triple product, fusion energy exceeds the energy lost. This is typically required in a practical fusion power plant.

[7] I. R. Lindemuth and R. E. Siemon, "The fundamental parameter space of controlled thermonuclear fusion," Amer. J. Phys. **77**, 407 (2009).

density inertially confined systems) will be eligible. Proposers will be required to fill in a spreadsheet (to be included with the FOA) to estimate the cost of a short-pulse or single-shot, net-gain experiment based on their concept. Proposals will be evaluated, in part, based on whether the estimated cost for the net-gain experiment is less than ~$100M.

B. Component Technology Development: projects will develop a component technology with the potential to reduce the capital cost of costlier, more mature fusion concepts, such as the tokamak, stellarator, or inertial confinement fusion (ICF). Proposers will be asked to make a quantitative argument (e.g., relative to relevant past reactor studies) that a grid-ready demonstration power plant enabled by the new component technology could satisfy the metrics of OCC <$2B and $5/W.

C. Capability Teams: projects will improve/adapt and apply an existing capability to support multiple Concept Development projects (Category A). Priority needs include (but are not limited to) (i) theory, modeling, and validation for a range of lower-cost fusion concepts, including pulsed, intermediate-density fusion concepts (e.g., magneto-inertial fusion and Z pinches) and magnetic-confinement concepts with reduced magnetic-field strength/complexity and/or linear geometry; (ii) creative application of machine learning to accelerate the development of lower-cost fusion concepts; and (iii) expert engineering design, fabrication, or other support to accelerate progress for multiple projects and lower the overall costs for the program.

In order to realize the goals of this ARPA-E program, expertise in the following areas may be useful: (i) fusion plasma physics; (ii) multi-physics modeling and simulations of fusion plasmas; (iii) design, construction, and/or operation of plasma/fusion experiments; (iv) machine learning; (v) pulsed-power systems; (vi) high-temperature superconducting magnets; (vii) high-field permanent magnets; (viii) plasma-heating systems; (ix) high-efficiency, high-bandwidth, high-average-power lasers for ICF; (x) enabling the use of advanced fusion fuels; and (xi) advanced manufacturing. 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 October 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 November 2019, for instructions on submitting an application and for the

terms and conditions of funding.