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

Announcement of Teaming Partner List for an upcoming Topic:

Solicitation on Topics Informing New Program Areas: LOwering CO2: Models to Optimize Train Infrastructure, Vehicles, and Energy Storage (LOCOMOTIVES)

The Advanced Research Projects Agency – Energy (ARPA–E) anticipates issuing a new Topic for the FOA "Solicitation on Topics Informing New Program Areas" in August 2020 to solicit applications for financial assistance to develop a publicly available model that enables evaluation of the benefit of various energy storage (ES) technology developments to the rail freight sector.

As described in more detail below, the purpose of this announcement is to facilitate collaborations among performing teams including the testing and resource support teams to respond to the upcoming Topic. The Topic will provide specific Program goals, technical metrics, and selection criteria and the Topic terms. For the purposes of the Teaming Partner List, the following summarizes current planning for the Topic:

US rail freight Class 1 rail system is a large transportation sector, responsible for the movement of a significant amount of freight throughout the country. It is an extremely efficient mode of transportation, accounting for 40% ton-miles of freight movement while consuming 2% of the total US transportation energy budget. Nonetheless, the GHG emissions from freight movement (not accounting for passenger trains, rail yard movement, etc.) are very large, approximately 40 $MTCO_2$ per year [i].

A long series of incremental advancements have made it one of the most efficient modes of transportation, and thus one of the cleanest (GHG/ton-km) today. As a result, there is limited opportunity to further reduce rail GHG emissions associated with rail freight via efficiency and logistics improvements alone. This has been borne out in recent years by the observed flattening of the efficiency curve. Moreover, the locomotive fleet is well into conversion to tier 4 emission standards and further implementation of emissions reductions may actually work against further efficiency improvements. Deep decarbonization analyses show that, as with most of the transportation sector, fuel switching represents the biggest opportunity for significant further reductions in GHG associated with rail freight.

If full de-carbonization of fleet GHG emissions is to be achieved, new propulsion and energy storage (referred to generally as ES systems) technologies, as well as the charging/fueling infrastructure, must be developed. However, this will be more difficult for the rail freight sector than for much of the rest of the transportation sector since the unique operational and financial characteristics of the rail freight sector combine to drive very challenging requirements:

- Very high energy storage requirements > GJ
- High power drive systems: Rail freight requires high propulsion power (> 10 MW provided by multiple locomotives)
- Need for widely distributed infrastructure
- Industry moving to larger trains
- High capital costs → long lifecycle for new technology
- Mostly privately owned → desire for short term ROI

Although the rail industry and government have done research to decarbonize rail freight, no comprehensive plan has emerged given the many challenges discussed above. The new ES systems studied to date are not viewed by all stakeholders to have a reasonable technical or economic viability.

A global rollout plan must be developed to replace or modify the existing fleet of approximately 25,000 locomotives and expand the fraction of cargo moving by rail if rail is to become an integral part of full de-carbonization in the next decades. Fortunately, the rail sector includes a manageable number of routes, well characterized trains and infrastructure systems, predictable schedules, and diesel-electric propulsion. As a result, at least theoretically, this enables optimal planning for potential technology infusion into the sector. Of course, a comprehensive ES rollout modeling tool must be informed by and consistent with the economic and logistical constraints of the rail freight system.

ARPA-E seeks diverse interdisciplinary teams in the development of planning and simulation tools that model deployment of new ES technologies with output values over a few time scales (e.g., 10, 20, 30 years) of GHG emissions, and levelized cost of Mt-km (LCOTKM). Optionally as a stretch goal, the simulation tool would also enable automated optimization of the technology deployment at specific target levels of GHG emissions and/or LCOTKM reductions. The LCOTKM model should be defensible based on historical analysis of investments, new technology deployment and regulatory compliance in the rail freight industry. A realistic physical model should be built for each new ES so that its performance and energy consumption on a route-by-route basis is validated.

ARPA-E envisions that inputs to the model would fall into three main classes: ES properties, rail route constraints and logistics, economic model assumptions. Since the logistics will often include consist (group of locomotives on one train), multiple EV technologies should be explored. The GHG accounting will utilize the standard DOE recommendations contained in https://greet.es.anl.gov/.

The targeted outcome of the program is a set of publicly available planning tools for identification, evaluation, and prioritization of ES-related technology developments whose deployment would significantly reduce GHG in the rail freight sector. This tool must account for the existing constraints of the rail freight system or reasonable extrapolation thereof. This analysis will inform the priorities in ES technologies development and deployment utilizing a common validated tool.

As a general matter, ARPA–E strongly encourages different organizations with outstanding scientists and engineers, and across different scientific disciplines and technology sectors to participate in this Program. 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 August 2020. 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 August 2020, for instructions on submitting an application and for the terms and conditions of funding.

[i] https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions.