Progression of Net-Zero Emission Propulsion Technologies for the Off-Road Sector

DATE: 5/7/2024
SUBJECT: Request for Information (RFI)

Description

In September 2022, the U.S. Departments of Energy, Transportation, Housing and Urban Development, and the Environmental Protection Agency executed an historic memorandum of understanding (MOU) for the signatory agencies to accelerate our nation's affordable and equitable clean transportation future.[1] As a result of the comprehensive decarbonization strategy called for in the MOU, those agencies issued the *U.S. National Blueprint for Transportation Decarbonization,* which set the goal to achieve net-zero carbon emissions in the transportation sector – including off-road equipment – by 2050[2.] The Transition to net-zero emission technologies requires coordination among all aspects of the supply chain, including feedstock supply, alternative fuel production, equipment manufacturers, safety implementation, customer demand, and government regulation. To develop a national strategy to decarbonize the sector, three critical questions must be addressed:

1. What is the current state of the off-road vehicle fleet?
2. Which powertrain technologies are most promising for decarbonization of off-road vehicles?
3. What is the timeline for the off-road sector to transition to net-zero emission GHG technologies?

The MOU defines off-road vehicles as: vehicles that are primarily designed to operate away from existing roadways. This category contains a disparate and diverse set of vehicles and use cases, including construction and mining equipment, industrial equipment, agriculture equipment, lawn and garden equipment, and recreational vehicles.[1]

The purpose of this Request for Information (RFI) is to understand the off-road sector alternative propulsion technology preferences, which technologies seem most promising, and what are the key barriers to achieving the transition to net-zero emissions by 2050. The propulsion technologies under consideration for this RFI are: biodiesel, renewable diesel, renewable natural gas, battery electric, direct electrification (catenary), electric hybridization, hydrogen fueled internal combustion engines and hydrogen fuel cells. Currently, no one alternative propulsion technology is a clear choice for sector decarbonization. This RFI is an attempt to aggregate knowledge from stakeholders to help guide actions regarding future propulsion technologies, research and infrastructure investments, and coordination among key

[1] https://www.energy.gov/sites/default/files/2022-09/mou-doe-dot-epa-hud-final_09-15-2022.pdf

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stakeholders to ensure that the off-road sector is meeting or exceeding U.S. decarbonization milestones.

Background

The United States Government, including the U.S. Department of Energy (DOE), has established ambitious goals to address global climate change and is committed to work with industry to formulate and implement robust and actionable decarbonization plans. DOE is tasked with understanding the decarbonizing propulsion technologies landscape and overcoming barriers to innovation and adoption of decarbonizing propulsion technologies. The Biden-Harris Administration has committed the United States to economy-wide decarbonization by 2050, including both ambitious domestic action and sustained international leadership. Recognizing that 10% of domestic transportation greenhouse gas (GHG) emissions come from the off-road sector, the U.S. must do more to bend the emissions trajectory from the sector. The MOU addressing transportation decarbonization among DOE, the Department of Transportation, the Department of Housing and Urban Development, and the Environmental Protection Agency intends to bring together public and private partners to accelerate action in decarbonization. Due to the long lifespan of off-road equipment, in order to enable sector decarbonization by 2050, the domestic fleet will require commercially available, net-zero carbon life cycle (cradle-to-grave) fuels and equipment beginning in the near-term. Thus, an ambitious alliance is required among the private sector, research institutes, and regulatory entities to develop, demonstrate, and deploy net-zero emission equipment options and infrastructure together by 2030. One of the first actions outlined in the *U.S. National Blueprint for Transportation Decarbonization* is to identify and set ambitious decarbonization milestones for the off-road sector.

Purpose

The purpose of this RFI is to aggregate knowledge from stakeholders to help guide actions regarding future propulsion technologies, infrastructure requirements, and coordination among key stakeholders to ensure that the sector is meeting or exceeding U.S. decarbonization milestones. DOE's Office of Energy Efficiency and Renewable Energy (EERE) is specifically interested in information on the off-road sector stakeholders' current alternative fuels trajectory, the driving forces behind it, and the key barriers to achieving this transition.

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. Final details, including the anticipated award size, quantity, and timing of EERE funded awards, will be subject to Congressional appropriations and direction.
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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 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.

Confidential Business Information

Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email two well-marked copies: one copy of the document marked "confidential" including all the information believed to be confidential, and one copy of the document marked "non-confidential" with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

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 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 Questions

Please provide your responses to the following questions, in as much detail as possible. The RFI also includes a Fleet Summary Worksheet (attached and optional), which is not required for response submissions but may be a more convenient way to answer the General Questions.

General Questions:

1. How many pieces of your company's equipment do you estimate are currently active in the field? Please specify by machine type and/or power level, if possible.
2. What is your company's estimated annual fleet turn-over rate for different types of active machines?
3. What are the typical daily or annual hours of operation for machines in your company's portfolio?

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4. What is the annual energy consumption (by gasoline, diesel, hydrogen, Liquified Petroleum Gas/Natural Gas, or electricity separately) of your machines in the field?
5. How many million metric tonnes (MMT) GHG tailpipe emissions annually do your active machines produce?
6. Based on your knowledge of the proposed decarbonization technologies for your sector, how do you view them for consumer adoption in a) 2035 and b) 2050?
    - Technologies Identified: Battery electrification, Hybrid-electric, Hydrogen fuel cells, Hydrogen Internal Combustion Engines (ICEs), Net-zero carbon fueled ICEs (biofuels and e-fuels), Catenary or tethered equipment
7. What role does fuel efficiency play in your company's decarbonization strategy? If any, what are your company's near-term (before 2030) plans to improve fuel efficiency? Please share any efficiency forecast in your decarbonization plans.

Decarbonization Questions:

8. What product decarbonization plans does your company envision to be feasible by 2035? By 2050? If plans exist, what are the barriers to their implementation?
9. Where does your company see limitations of decarbonizing technologies (e.g., power demand, uptime, energy storage volume/weight, etc.?) Please provide an estimate of current technology readiness level for these in your operation:
    - Battery electrification
    - Hybrid-electric
    - Hydrogen fuel cells
    - Hydrogen ICEs
    - Net-zero carbon fueled ICEs (biofuels and e-fuels)
    - Catenary or tethered equipment
10. Within what time frame will your equipment be compatible with neat Biodiesel, Renewable Diesel, or Ethanol and what barriers exist currently?
11. Other than drop-in biofuels, what other liquid or gaseous fuels do you anticipate in the new sales fleet? By when? What proportions of new sales will run on these alternative liquid or gaseous fuels?
12. How important is refueling/recharging time to your operation? If downtime is increased due to refueling/recharging, how much would be considered acceptable? Is there opportunity in your scheduling to accommodate longer downtimes?
13. How should resale value be considered in the path towards decarbonization?

Definitions

- Uptime: total time equipment was available to perform work
- Downtime: time spent waiting for equipment to become available (examples include: charging and refueling, repairs, and maintenance)

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- Battery electric vehicle: A vehicle exclusively powered by electric motors which are supplied energy from a battery. The battery may be permanent or exchangeable and all operating voltage options are considered.
- Hybrid-electric vehicle: A vehicle which has both a battery electric system and conventional internal combustion engine. Both series and parallel configurations are considered.
- Hydrogen fuel cell vehicle: A vehicle powered by hydrogen fuel cells, batteries, and electric motors.
- Hydrogen ICE vehicle: A vehicle with an internal combustion engine fueled by hydrogen
- Net-zero carbon fuels: Fuels for an ICE developed from feedstocks other than direct petroleum refinement that are net-zero GHG. These include *green* fuels produced from captured CO_2 and electricity (e.g., renewable diesel/gasoline), agricultural/forestry feedstocks (biodiesel/ethanol), and green hydrogen, such as:
- Catenary or tethered: Equipment powered primarily by electricity from either direct mains or catenary/inductive connection. It may include smaller batteries for short-term operation off-grid.

Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to **CleanMachines@ee.doe.gov** no later than 5:00p.m. (ET) on June 7, 2024. 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. Preferred responses should be provided as a Microsoft Word (.docx) (10 page limit) and/or Microsoft Excel (.xslx) attachments to the email. If necessary, a plain text file (.txt) may be submitted. 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 nor 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;
- Primary business purpose (e.g. farming, mining, construction, etc.);
- Primary region(s) of operation (if applicable);
    - Urban, Rural, or Remote
    - Location(s) across the US
- Type of business: OEM/Supplier, Private Fleet, Commercial Fleet, Government Fleet, Rental Fleet, or Other (please specify).

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