DE-FOA-0002240 - REEACH

Questions can be sent to ARPA-E-CO@hq.doe.gov

FIRST DEADLINE FOR QUESTIONS TO ARPA-E-CO@HQ.DOE.GOV:
5 PM ET, TUESDAY, JANUARY 21
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5 PM ET, TUESDAY, MAY 12, 2020

QUESTIONS AND ANSWERS

PLEASE REFER TO THE GENERAL FAQS SECTION OF ARPA-E'S WEBSITE (http://arpa-e.energy.gov/?q=faq/general-questions) FOR ANSWERS TO MANY GENERAL QUESTIONS ABOUT ARPA-E AND ARPA-E'S FUNDING OPPORTUNITY ANNOUNCEMENTS. ADDITIONAL QUESTIONS SPECIFIC TO THIS FOA ONLY ARE INCLUDED BELOW. PLEASE REVIEW ALL EXISTING GENERAL FAQS AND FOA-SPECIFIC QUESTIONS BEFORE SUBMITTING NEW QUESTIONS TO ARPA-E.

I. Concept Paper Phase Questions:

Q1. We plan to propose [a technology to synthesize carbon-neutral liquid fuel]. Would this concept meet the intent of APRA-E is looking for in the REEACH FOA?

ANSWER: Refer to General FAQ 6.19.

The REEACH program aims to develop and demonstrate a fuel-to-power conversion subsystem that should fit into the ESPG system model proposed by an applicant. Other ESPG components are commercial and not the subject of development.

Q2. Would a fuel-to-power conversion system that is better suited to the sub-MW scale, such as for Urban Air Mobility applications, be suitable to propose to this FOA? Our system will likely not scale well to the MW power levels described in the FOA, which are required for the narrow-body aircraft applications described. In other words, are solutions that are solely applicable to UAM type missions outside of the scope of the REEACH FOA?

ANSWER: Refer to General FAQ 6.19.

Q3.1 Are RFI-0000042 (HIGH EFFICIENCY, HIGH POWER DENSITY ENERGY STORAGE AND CONVERSION SYSTEMS) and REEACH PROGRAM [DE-FOA-0002240] devoted to the same idea?

ANSWER: RFI-0000042 is the Announcement of Teaming Partner List for DE-FOA-0002240.

Q3.2 The REEACH Program announced the following:

Fully-electric aviation could potentially eliminate emissions, but thus far the application of electrified propulsion technologies has been restricted to relatively smaller and shorter-range aircraft due to the limited specific energy of current batteries (e.g. 250 Wh/kg) and batteries that are currently under development (e.g. 500 Wh/kg). For comparison, these levels are an order of magnitude lower than that of jet fuel, which has a specific energy of >12,000 Wh/kg. In a recent study, NASA concluded that minimum requirement for full electric regional aircraft energy storage system is 2000 Wh/kg. **[refer to Section I.B.2]**

The success of this program is contingent upon the development of ultra-high efficiency and specific power (e.g. kW/kg) CNLF-to-electric-power conversion devices,

such as fuel cells and advanced combustion engines. Furthermore, higher specific power energy storage devices (e.g. batteries, supercapacitors, or other such commercially available electric energy storage devices) may be leveraged to further boost their power output for take-off and climb, if necessary.

But, on page 29 [Section III.C.3] it does say:

> ***Submissions of not interest: Development of novel energy storage devices and/ or the use of energy storage devices that are not currently commercially available (i.e. Technology Readiness Level ≥ 7).***

To our understanding there is no currently commercially available, or even developed in the Labs neither ultra-high efficiency and specific power (kW/kg) CNLF-to-electric-power conversion devices, such as fuel cells, nor energy storage system of 2000 Wh/kg. We wonder, if our Team has demonstrated that our concept of [Description of technology], could we apply for funding within the REEACH, or continue working to move the limits of our [Description of technology] and then apply ?

ANSWER: Refer to General FAQ 6.19.

Q4. I would like to know if ARPA-E is interested in solutions which might only be suitable for the sub-MW scale, such as Urban Air Mobility applications. In other words, would a technology that does not scale well, in terms of specific power, to the narrow-body aircraft power levels discussed in the FOA, be appropriate to propose to the REEACH program? We would propose to thoroughly determine this cross-over point as part of our Phase I efforts.

ANSWER: Refer to General FAQ 6.19.

Q5. We are looking to apply for DE-FOA-0002240: RANGE EXTENDERS FOR ELECTRIC AVIATION WITH LOW CARBON AND HIGH EFFICIENCY (REEACH). However, I have some questions around [the] FOA.

Q5.1 Does this FOA also include novel power electronics architecture to combine different energy storage together.

ANSWER: While power electronics are a necessary component for the energy storage and power generation sub-system, they are not the focus of development within this FOA. As noted in Section 1.C ("Program objectives"): "The objective of the **REEACH** program is to develop novel, high specific power, high specific energy, cost-effective technologies for the conversion of chemical energy stored in CNLFs into electric power for use in electrified aircraft powertrains."

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Q5.2 Is this FOA only limited to fuel cell or can we propose some thing related to turbine + electrical generator along with power electronics for hybrid energy storage.

ANSWER: The first paragraph of Section I.D ("Potential Technical Approaches") notes: "The applicant is allowed to select any CNLF, fuel-to-electric power conversion device(s), and ESPG configuration so long as it conforms to the "fuel in – electric power out" program concept and meets performance and cost targets defined in section 1.E."

Q5.3 In FOA it was mentioned that this FOA is around borderline of chemical and electrical. [C]an you [clarify] if this FOA have requires an innovation in energy storage like supercapacitor, engines, battery chemistry, etc.

ANSWER: Refer to Section III.C.3 of the FOA ("Submissions Specifically Not of Interest").

Q6. Is a fuel-to-electric system with a power density less than 2.5 kW/kg while still meeting the overall ESPG system power target considered responsive to this FOA?

ANSWER: As set forth in FOA Section I.F (p.17):

> ***The fuel conversion efficiency target depends on selection of CNLF and ESPG system configuration and should be calculated by the applicant to meet the specific energy target. It is highly desirable that specific power of the fuel-to-electric power conversion device developmental prototype be at least 2.5 kW/kg to be able to meet the overall ESPG system specific power target.*** (emphasis in the original)

II. Full Application Phase Questions:

Q7. Can you please provide instructions on how to split the costs into the file by Years for each phase? The file has columns for Year 1, Year 2, Year 3, Year 4, Year 5

REEACH

42 months starting November 2020
Phase 1 – 36 months – Nov 20 to Oct 23
Phase 2 – 12 months – Nov 23 to Oct 24

ANSWER: Applicants may use the columns titled *Year 1* and *Year* 2 to estimate Phase 1 costs. The columns titled *Year 3*, *Year 4* and *Year 5* can be used to estimate Phase 2 costs.

UPDATE: As noted in FOA Section I.E.3, REEACH Phase 1 is 24 months in duration. REEACH Phase 2 is 24 months in duration.

Q8.1 Please advise if there is a limit to how much we can increase our budget beyond the original white paper estimate.

ANSWER: The maximum Federal share of any agreement resulting from this FOA is $10 million.

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Q8.2 Also, please confirm that if a for-profit chooses to receive patent rights through the class waiver their cost share requirement is 20% If they do not want to receive patent rights through the class waiver, is there cost share only 10%?

ANSWER: This is incorrect. Unless eligible for one of the Reduced Cost Share exemptions set forth at FOA Section III.B.3, recipients are required to contribute cost share per the Base Cost Share requirements at FOA Sections III.B.1-2. As noted in FOA Section III.B.5, contributions may vary by team member as long the requirement in its entirety is met. Among the Reduced Cost Share exemptions, only Project Teams:

> *… where domestic educational institutions, domestic nonprofits, small businesses, and/or FFRDCs perform greater than or equal to 80% of the total work under the funding agreement (as measured by the Total Project Cost) are required to provide at least 10% of the Total Project Cost as cost share.*

Except that entities, such as a large business*:*

> *… receiving patent rights under a class waiver, or other patent waiver, that is part of a Project Team receiving this reduction must continue to meet the statutory minimum cost share requirement (20%) for its portion of the Total Project Cost.* (refer to FOA Section III.B.3)

Q9.1 The FOA suggests a peak delivered power of 26 MW (takeoff) to be modeled. Yet the spreadsheet provided shows a target of 24 MW. What target power should be used?

ANSWER: The target was adjusted in the modified FOA spreadsheet, so the value of 24 MW should be used.

Q9.2 The suggested cruise power is 35% of peak takeoff power, which is 26 MW x 0.35 = 9.1 MW. However, the spreadsheets suggests a target cruise power of 7.14 MW. This is 29.75% of peak power (24 MW). Where does this ratio comes from compared to the 35% cruise power suggested in the FOA? Should we use 30% of peak takeoff power for cruise power instead of 35%?

ANSWER: The target was adjusted in the modified FOA spreadsheet taking into account anticipated future aerodynamics improvements (15%) due to distributed propulsion on the top of 35% of peak takeoff power. So, the value of 7.14 MW should be used.

Q9.3 The spreadsheet multiplies output power by factors 0.9 and 0.93 in cells D48 and D49 of the spreadsheet respectively, where do these factors come from? (assuming propulsion and electrical to shaft power (ASCEND) efficiencies respectively?)

ANSWER: It is correct, electrical and propulsion efficiencies are taken into account.

Q9.4 Pg. 14 Should specific energy be presented in Wh/kg or kWh/kg?

ANSWER: Specific energy could be presented in either unit, but it is desirable to use cell units as in the spreadsheet.

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Q9.5 On descent, a typical jet engine is typically near idle rather than 30%. Should we use engine efficiency at 30% (which is much higher) or at idle (6-7%) ? (which will penalize our proposal, but is more realistic).

ANSWER: Either approach can be used as long as it is explained and justified in the text.

Q10. We are preparing a proposal in response to DE-FOA-0002240 – REEACH. To calculate specific Power and energy, the fuel tank mass is required (see below).

1.2 Takeoff (peak) power defined by the mission profile above must be used for this calculation. The system description for 1.1 applies here.

$$ESPG\ Specific\ Power\ \left(\frac{kW}{kg}\right) = \frac{Peak\ Electric\ Power\ Output\ of\ ESPG\ system\ (kW)}{Total\ Mass\ of\ ESPG\ System\ (kg)}$$

where the total mass of the ESPG system includes the mass of the fuel conversion, energy storage, balance of plant, and fuel tank components, as well as the mass of fuel.

This information is not available on the Web. One of the reason might be that two out of three fuel tanks are integrated within wings and, except for a protective liner, do not add weight to the aircraft. Can the weight of these two tanks be neglected in our calculations as well?

ANSWER: The weight of fuel tanks may be neglected as a first approximation in the case of fuels liquid at ambient conditions. For fuels that are liquid at elevated pressure or low temperature (e.g. bio-LNG), a reasonable engineering assumption for the weight of pressurized or cooled tank should be made and supported in the full application.

Q11. Can the budget and project title of the full application slightly differ from what were listed in the concept paper in order to better address reviewer's comments?

ANSWER: Yes.

Q12. The fringe benefit page has percentages listed in the cells for which we are to enter a total dollar figure for that year's fringe benefits. The workbook is password protected and does not allow us to change the format of the cells from percentage to numbers. It also does not bring the total to the SF424 summary page. The page marked fringe benefits actually appears to be a duplicate of the indirect cost page. Please advise how we are to get our figures entered correctly into the current fringe benefit page or if you will be posting a new workbook that permits us to do so.

ANSWER: The Budget Justification workbook template is a password protected document. The password protected fields on each page of the workbook function as desgned.

QUESTIONS AND ANSWERS

Q13. If our consortium includes an FFRDC, and we are required to provide at least 10% of the total project cost as cost share, please advise if we are to include the FFRDC in the calculation for that 10%. If the funds are going directly to them, and we are required to include that in the calculation, will we be responsible for reporting that portion of the cost share?

ANSWER: Refer to FOA Section III.B.7.

Q14. I am coordinating the submission of our Full Application to the subject FOA. In your notification letter (attached) it specifies: "The deadline for submission of Full Applications is 9:30 AM Eastern Time on May 18, 2020." However, in Mod 1 of the solicitation it states: "Submission Deadline for Full Applications: 9:30 AM ET, Friday, May 22." Please confirm we are allowed to submit by the solicitation date and not by the award letter date to be compliant.

ANSWER: The DE-FOA-0002240 REEACH Funding Opportunity Announcement Mod 1 Full Application submssion deadline of 9:30 AM ET Friday, May 22, 2020 is correct.

Q15. We have been working through the mandatory workbook associated with the REEACH FOA and have the following two questions about intent:

Q15.1 According to cell E6 of the Worksheet the proposed ESPG does not meet requirements unless it provides 6.05 hours of "flight time". The form of the associated calculation suggest that "flight time" means the cruise phase because it is calculated based on the cruise fuel consumption. The FOA calls for only 5 hours of cruise in table 2, but calls for a minimum of 6 hours "flight time" in section D8. Is the 6 hour target for the total cycle (with or without emergency cycle) or only for the cruise phase?

ANSWER: The 6 hour target is for the total cycle without an emergency cycle.

Q15.2 The worksheet calculations (D9) allow for a power demand reduction during the cruise phase from 35% of peak down to 29.75% of peak (cruise power taken as 85% of the original 35% of peak reported in table 2), by our interpretation this comes from the improved aerodynamics mentioned in FOA section D8. We propose that this reduction could apply to all flight phases that were originally at 35% peak power or below, and that it could apply on a sliding scale for power levels between 35% and 100% in the original flight profile table (Table 2). Is this a correct understanding and approach?

ANSWER: That is correct. This reduction can be applied to all phases of flight.

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Q16. Because of the current pandemic situation and the ensuing lockdowns, the administrative functions in our university and at our proposed partner (national laboratory and industry) locations have slowed considerably requiring additional time to complete all the required documentation for the proposal. Will ARPA-E grant a two-week extension to June 5, 2020 to submit the proposal?

ANSWER: ARPA-E is not contemplating a revision to the deadline for submission of applications.

Q17. I have two questions related to the REEACH FOA, which are:

Q17.1 Our project team would like to buy a piece of equipment … from a foreign vendor. … There are no domestic companies that make the hardware that we need to purchase. … I was not able to find guidance on foreign vendors or a limit on equipment expenses to foreign vendors. Are there any additional forms or justifications that are required for our team to be able to purchase this hardware from a foreign vendor besides the vendor quote attached to the SF-424A?

ANSWER: Refer to FOA Section IV.G.7. As set forth therein:

> *All equipment purchased under ARPA-E funding agreements must be made or manufactured in the United States, to the maximum extent practicable.* (emphasis added) *This requirement does not apply to used or leased equipment.*

If selected for award negotiations, ARPA-E will assess the prospective awardee's justification for the purchase of non-domestically manufactured equipment.

Q17.2 In the REEACH_Metrics_Workbook, the weight of the fuel tank is constant at 15,000 kg, which doesn't allow for reductions in the fuel tank weight based on either higher energy density CNLFs (e.g., Bio LNG at 14 kWh/kg) or higher efficiencies of the ESPG which would reduce the required fuel tank capacity to travel 6.05 hrs. I propose changing the formula to for the fuel tank weight to "= 1.1*(weight of the fuel)". In this equation, the additional 10% is to account for the weight of the metal tank container itself and is approximated based on other fuel tank weights that were readily available. This equation would take into account the energy density of the fuel and the efficiency of the ESPG system. Does this approach seem reasonable?

ANSWER: The formula D6*D12 may be used for cell D7, which should be changeable (refer to REEACH FAQ Q10).

Q18.1 The worksheet provided by ARPA-e has a fixed fuel tank weight of 15,000 kg in cell D7, which is not considered changeable input. We believe this should be a product of cells D6 * D12. Can we make this modification.

ANSWER: The formula D6*D12 may be used for cell D7 (refer to REEACH FAQ Q10 and Q17.2).

QUESTIONS AND ANSWERS

Q18.2 Cells D42 and D43 relate to the charging and discharging of the ESD. If the ESD is discharged or charged over multiple mission segments, it would be reasonable to make a modification to the formulate here to capture this, is this acceptable?

ANSWER: As stated in FOA section 1.D, the ESD must be fully charged at the end of each mission, prior to landing. If any changes in formulas are made, they should be clearly marked and explained in the technical volume and workbook.

Q19. Questions regarding ARPA-E REEACH (DE-FOA-0002240)

Q19.1 Is Phase 1 2 years, as stated in the solicitation, or 18 months, as stated in one of the published responses to a question?

ANSWER: Phase 1 can be any duration not exceeding 24 months.

Q19.2 Capital cost of the ESPG sub-system: ≤ $1000/kWdelivered ------ does the denominator regard rated "peak" /"take-off" power?

ANSWER: Yes.

Q19.3 Is the high desirability of a 2.5 kW/kg specific power capacity of the ESPG developmental prototype based upon ** its peak power ** capacity?

ANSWER: Yes, it is based upon the peak power capacity.

Q19.4 Please clarify what's explicitly meant by a "detailed design" requirement of the ESPG in Phase 1. Is a resolved process design sufficient for further development appropriate for follow-on in Phase 2, ----- or ---- are mechanical, electrical, etc. "pre-fab" details supposed to be resolved before entering Phase 2?

ANSWER: The "detailed design" requirement of the ESPG in Phase 1 should include a system-level design for the ESPG, pre-fabrication details for all major components, as well as energy and materials flows, including operating temperature, pressures, and other conditions.

Q19.5 Is there an expectation of a certain maximum fraction of cost to occur in Phase 1; e.g., is Phase 1 cost required/expected to be less than Phase 2 cost?

ANSWER: The cost distribution between Phases 1 and 2 should be defined by the applicant, though it is generally assumed that building and demonstration of an integrated prototype is more expensive than component development.

Q19.6 The technical volume template has "AR-351-09.16" in the footer. Please confirm that this should remain in the footer of the submitted technical volume.

ANSWER: AR-351-09.16 is the ARPA-E control number for the Techncial Volume Template. It may remain or be deleted at the discretion of the applicant.

Q19.7 I'm not following the error statement given in E6; it doesn't seem to correlate to C6,D6 comparison.

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ANSWER: This error statement appears when the calculated flight time with the proposed ESPG, as calculated by cell D64, is less than reference C64 (e.g. in the case of low energy density of selected CNLF).

Q19.8 There was an explanation given regarding the changes in peak power and cruise power in the Workbook versus the Mod1 version of the FOA, but how should we also update the other portions of the flight mission?

ANSWER: Refer to REEACH FAQ Q15.2.

Q19.9 Specifically, Table 2 of the FOA lists percentages of peak power at different stages of flight; with specific conveyance that cruise is 35% of peak power. The Workbook shows a cruise power that is 30% of peak power; that was previously the "sub-cruise" percentage. * Given this change in percentage, what are the revised percentages of peak power to be used at each of the ten tabulated portions of flight?**

ANSWER: Refer to REEACH FAQ Q15.2.

Q19.10 Please assist with the precise understanding and calculation steps of the fuel carbon intensity requested in Workbook Cell D15. The stated units are "[kg/kg]," and the closest ref. seen in the FOA references calculation have units of "[gCO2/kWh]."

ANSWER: The kgCO2/kg fuel unit for carbon intensity should be used in the workbook. As stated in the FOA, the number in the D15 cell serves for informational purposes only.

Q19.11 Start-up strategy: The solicitation references the high desirability of a half-hour start-up, but is there allowance for consideration of concepts that will require longer start-up time and strategy (e.g., extended pre-flight start-up)?

ANSWER: As stated in the FOA, this requirement is highly desirable but not mandatory.

Q19.12 Workbook: Does "Delivered fuel energetic capacity, [kWh] (propulsive energy based)" {Cell B16} mean the total work provided by the ESPG for the given mission profile?Workbook: {Cell D21} Do we leave this "blank," since REEACH is only about fuel-to-electricity; or do we assume an electricity-to-propulsion efficiency and multiply that factor by D20? If the latter, please provide guidance and justification for an electricity-to-propulsion efficiency value to assume.

ANSWER: Cells 16 and 21 are automatically calculated by the workbook based on prior inputs and should not be altered. Cell 16 represents the total propulsive energy delivered by the full propulsive system (ESPG, distribution, electric motor and propulsor; it is reflective of the chemical to propulsion conversion) when converting the entire fuel contained in the tank. Cell 21 represents the cruise efficiency of the entire propulsive system (chemical to thrust). It is a function of the ESPG efficiency and of the downstream components (electric motor and propulsor) efficiencies (embedded in the workbook and which should not be modified).

QUESTIONS AND ANSWERS

Q19.13 Workbook: {Cells C7, D7}: * The nominal fuel tank mass values seem quite large**, and given the typical association/integration of fuel tank with aircraft body design, this has been a more challenging metric to quantify. Nonetheless, our team has a much lower expectation of "fuel tank mass" value to be counted as understood by the solicitation and Q&A. Will there be an allowance for an initial value fuel tank mass estimate with limited justification, yet a plan for rigorous confirmation during Phase 1? Please also comment on the justification for the nominal C7,D7 fuel tank masses given in the Workbook.**

ANSWER: Refer to REEACH FAQ Q10 and Q17.2.

Q19.14 Workbook: {Cells D59-61}: ESPG capital costs inclusive of power electronics seem to be calculated, but the REEACH capital costs threshold (i.e., $1000/kW) are understood to not include power electronics costs. Please clarify.

ANSWER: ESPG capital costs calculated in the workbook is inclusive of power electronics, but the $1000/kW threshold does not include power electronics costs.