

QUESTIONS AND ANSWERS

PLEASE REFER TO THE GENERAL FAQS SECTION OF ARPA-E'S WEBSITE ([HTTP://ARPA-E.ENERGY.GOV/?Q=FAQ/GENERAL-QUESTIONS](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. Full Application Phase Phase Questions:

Q1. I AM REACHING OUT TO YOU REGARDING THE FUNDING OPPORTUNITY OF "PIONEERING RAILROAD, OCEANIC AND PLANE ELECTRIFICATION (PROPEL-1K)", DE-FOA-0003162 OF ARPA-E. IS THE FOCUS OF THIS OPPORTUNITY ONLY ON DEVELOPING ENERGY STORAGE DEVICES WITH HIGHER ENERGY STORAGE CAPABILITIES, OR IT ALSO INCLUDES EFFORTS ON MULTIFUNCTIONAL ENERGY STORAGE DEVICES WHICH WOULD ALLOW FOR HIGHER SYSTEM'S LEVEL ENERGY STORAGE BY STORING ELECTROCHEMICAL ENERGY IN VARIOUS COMPONENTS OF A VEHICLE? THE LATTER INCLUDES CONCEPTS SUCH AS STRUCTURAL BATTERIES, STRUCTURAL ENERGY STORAGE DEVICES, ETC. THIS CONCEPT IS OUTLINED IN ONE OF OUR RECENT PAPERS: *REDACTED*****

ANSWER: The goal of this program is to develop systems that can achieve a net energy density of 1000 Wh/kg and 1000 Wh/L. Applications must propose solutions capable of achieving these metrics. There are no preconceived expectations regarding whether the proposed solution(s) can only be achieved by devices with higher energy storage capabilities. Multifunctional energy storage devices that can achieve the program targets, including structural batteries, may be appropriate solutions.

Q2. IN THE FORM ARP_PROPEL-1K_FULL_APPLICATION_TECHNICAL_VOLUME (1) THERE IS A DESCRIPTION REQUIRING THE FOLLOWING:

1.2 POTENTIAL IMPACT.

*** (1ST BULLET)**

*** (2ND BULLET) 5DESCRIBE HOW THE PROPOSED EFFORT ADDRESSES ONE (OR MORE) OF THE "TECHNICAL AREAS OF INTEREST" FROM SECTION I.D OF THE FOA.**

WHERE DO I FIND " THE "TECHNICAL AREAS OF INTEREST" FROM SECTION I.D OF THE FOA"? IS I.D ROMAN NUMBER 1 THE SUBPARAGRAPH "D" OR SOMETHING ELSE.

WHERE IS SECTION I.D OF THE FOA FOUND, AND SINCE I HAVEN'T BEEN ABLE TO MAKE THE ASSOCIATION COULD YOU COPY AND PASTE WHAT IT SAYS AS WELL AS ARROWS POINTING TO A SCREEN SHOT WHERE I SHOULD START CLICKING ON. TO GET TO I.D . ALONG WITH THE SUBSEQUENT PAGES ALSO REQUIRING ADDITIONAL CLICKING ON SPECIFIC LOCATIONS ON THOSE PAGES BEFORE REACHING MY GOAL ?

ANSWER: The Technical Areas of Interest are discussed in Section I.D. of the standard FOA (DE-FOA-0003162) and Section I.E. of the SBIR/STTR FOA (DE-FOA-0003163).

Q3. I HAVE TWO QUESTIONS REGARDING DE-FOA-0003162 :

1.) THE FOA DOES NOT SEEM TO BE SPECIFIC ABOUT THE C-RATE OR MA/G CURRENT DENSITY AT WHICH TO MEASURE THE 1000 WH/KG ENERGY DENSITY PER MASS OF THE CELL. WHAT IS THE SMALLEST ACCEPTABLE MA/G VALUE AT WHICH THE 1000 WH/KG ENERGY DENSITY IS TO BE DEMONSTRATED AT THE CELL LEVEL?

2.) ARE LI-CFX CELLS ELIGIBLE FOR THIS FOA? I AM ASKING THIS AS THE FOA APPEARS TO EMPHASIZE METAL+O2 REACTIONS.

ANSWER: 1000 Wh/kg and 1000 Wh/L must be experimentally shown at the continuous rate specified in metric #9, i.e., 0.5 kW/kg for Category A and 0.1 kW/kg for Category B. Applicants must translate these metrics as needed into mAh/g using relevant voltages and other factors.

This FOA is open to all electrochemistries that can achieve the metrics and deliverables and is not limited to metal+O2 reactions.

Q4. I AM WRITING WITH REGARD TO THE SUBJECT FOA, AND SPECIFICALLY TO PARAGRAPH 10. APPLICANT RISK ANALYSIS, AND THE ASSOCIATED CLAUSE WHICH STATES:

ARPA-E will not make an award if ARPA-E has determined that:

- The entity submitting the proposal or application:
 - o has an owner or covered individual that is party to a malign foreign talent recruitment program;
 - o has a business entity, parent company, or subsidiary located in the People's Republic of China or another foreign country of concern; or
 - o has an owner or covered individual that has a foreign affiliation with a research institution located in the People's Republic of China or another foreign country of concern; and

- 1) DOES THE CLAUSE PRECLUDE APPLICANTS FROM BEING AWARDED FUNDING FROM ARPA-E FOR PROJECTS LIKE THIS (ASSUMING THAT PROPOSALS ARE ASSESSED AS BEING WORTHY OF AN AWARD)?
- 2) DOES FOA SECTION VI.B.10 PRECLUDE ARPA-E AWARDING FUNDING TO A U.S. BASED PRIME APPLICANTS IF THEIR PROPOSAL INCLUDES A SUBRECIPIENT DETERMINED TO HAVE THE SPECIFIED OWNERSHIP AND/OR ASSOCIATIONS (ASSUMING THAT PROPOSALS ARE ASSESSED AS BEING WORTHY OF AN AWARD)?
- 3) IS IT ARPA-E'S INTENT TO INCLUDE SIMILAR CLAUSES IN FUTURE FOAS?
- 4) DOES THE CLAUSE PRECLUDE US OEMS FROM BEING AWARDED FUNDING FROM ARPA-E? IS THIS THE INTENT OF THE CLAUSE?

ANSWER: 1. Having an affiliate located in a foreign country of concern does not necessarily preclude an applicant from being selected for award negotiations. The Department of Energy takes seriously its responsibility to protect federal investments from undue foreign influence and to accomplish its mission in ways that protect and further energy security and technological advancement of the United States. The Office of Research, Technology, and Economic Security - [Research, Technology & Economic Security | Department of Energy](#) - supports the Department's programs in due diligence reviews and risk mitigation to ensure our national security, economic competitiveness, and technological leadership imperatives are duly incorporated into its financial assistance and loan activities.

2. See answer above.

3. This clause or a similar clause will be included in future FOAs, consistent with DOE's Research, Technology & Economic Security policies and procedures.

4. It does not preclude US OEMs from being awarded funding, and that is not the intention of the clause.

Q5. THE FOLLOWING ARE QUESTIONS REGARDING DE-FOA-0003162:

- 1. IS \$30M THE MAXIMUM ANTICIPATED FOR BOTH POP1 AND POP2? DOES \$30M INCLUDE ARPA-E MANAGEMENT AND SUPPORT CONTRACTS, OR IS THAT FUNDED SEPARATELY? WHAT FUNDS ARE AVAILABLE SPECIFICALLY FOR POP 1?**
- 2. SINCE “THE ENERGY DENSITY CALCULATION AT THIS STAGE DOES NOT NEED TO INCLUDE CELL MODULE, STACK OR SYSTEM PACKAGING [...]”, HOW WOULD A SOLUTION PROVIDER TAKE CREDIT FOR GANTRIFICATION OF A BATTERY SOLUTION WITHOUT ACCEPTING THE PENALTY OF ACCOUNTING FOR PACKAGING?**

ANSWER: 1. The total amount to be awarded is approximately \$30 million, subject to the availability of appropriated funds to be shared between FOAs DE-FOA-0003162 and DE-FOA-0003163. According to Section I.E of DE-FOA-0003162, PROPEL-1K Phase 1 is anticipated to last 18 months and have federal funding of between \$500,000 and \$1,500,000 per award. The combined federal funding for both phases (Phase 1 + Phase 2) should not exceed \$5 million in federal funds.

2. Please refer to Section I.F. of FOA Number DE-FOA-0003162 and Section I.G. of FOA Number DE-FOA-0003163, “Program Structure and Deliverables” for detailed descriptions of Phase 1 and Phase 2 expectations and deliverables.

Q6. WHILE THIS FOA IS OPEN TO ALL TYPES OF ELECTROCHEMICAL ENERGY STORAGE, THE TABLE 1 METRICS ARE BATTERY SPECIFIC AND DON'T ADDRESS THE USE OF FOR EXAMPLE FUEL CELLS WHERE THE MASS OF FUEL FOR THE DURATION OF THE FLIGHT IS REQUIRED. FUEL CELLS HAVE POWER DENSITIES OF KW/KG AND THE MASS OF FUEL (KG) WOULD REQUIRE THE FLIGHT TIME AND PROFILE IN ORDER TO CONVERT POWER (KW) TO ENERGY (KWH) REQUIRED. THE ONLY TIME GIVEN IS 3 MIN FOR PEAK POWER, BUT THIS WOULD ONLY BE TAKEOFF AND DOES NOT INCLUDE THE TIME AND THUS FUEL CONSUMPTION DURING CRUISE.

IN ADDITION, THE MASS OF FUEL WOULD DECREASE DURING FLIGHT, SO DO WE HAVE TO ACHIEVE 1 KWH/KG AT TAKEOFF WITH FULL TANK OF FUEL OR IS IT 1 KWH/KG AVERAGE OVER THE FLIGHT PROFILE?

ANSWER: The weight of fuel storage tanks is a required input as is BOP (Balance of plant) for a system >1 MWh. (See spreadsheet notes: e, i, k, l). The 1 kWh/kg metric must be achieved as an average for the equivalent of the continuous rate. The cruise, voyage, or trip duration = metric 1 divided by metric 9 (per Table 1). The weight of the fuel cell stack included in the system must be sufficient to deliver the power capability per metric 8 (per Table 1). Applicants are instructed to include any assumptions in column F of the spreadsheet.

Q7. IN PHASE 2 WE ANTICIPATE INDUSTRY PARTNERS TO TAKE MORE ACTIVE ROLE AND THEREFORE DO MORE WORK. THAT WILL REQUIRE HIGHER COST SHARE WHICH INDUSTRY PARTNER WILL BE READY TO PROVIDE.

DOES THAT MEAN THAT WE NEED TO HAVE THE SAME COST SHARE PERCENTAGE IN PHASE 1 EVEN THOUGH INDUSTRY PARTNERS WILL BE LESS ENGAGED AND WILL BE DOING ONLY 10% OF PROJECT WORK?

ANSWER: Please refer to Section 1.F of the FOA. The application should focus primarily on Phase 1 and provide a brief overview of the Phase 2 approach, schedule, and anticipated budget. ARPA-E may select certain awardees for negotiation of Phase 2 funding. The Budget Justification Workbook submitted with the application should only reflect proposed Phase 1 funding. Cost share for Phase 1 is specified in the FOA; cost share minimums for Phase 2 will be determined at some point during Phase 1 performance.

Q8. ---REDACTED--- CORPORATION HAS THE FOLLOWING QUESTIONS REGARDING THE SUBJECT FOA:

- 1. PAGE 58 OF DOCUMENT, SECTION 10, APPLICANT RISK ANALYSIS**
 - A. ---REDACTED--- IS A SUBSIDIARY OF THE ---REDACTED COMPANY. --- REDACTED--- HAS AN OFFICE IN BEIJING, CHINA. ---REDACTED--- DOES NOT INTEND TO UTILIZE ---REDACTED--- CHINA IN ANY CAPACITY UNDER THIS EFFORT. DOES THIS STILL PRECLUDE US FROM RECEIVING AN AWARD?**
- 2. PAGE 22 OF DOCUMENT, SECTION 3, OTHER TRANSACTIONS AUTHORITY**
 - I. THE FOA MENTIONS THE POTENTIAL USE FOR ARPA-E TO UTILIZE ITS "OTHER TRANSACTIONS" AUTHORITY AS A POTENTIAL AGREEMENT FOR THIS EFFORT. THE SECTION REFERENCES 42 U.S.C. 7256, WHICH PROVIDES MINIMAL REGULATION REGARDING THE AUTHORITY (IT APPEARS IT IS MOSTLY WRITTEN FOR LEASES, ETC.), OTHER THAN MENTION OF 10 U.S.C 2371 (THE DOD'S AUTHORITY FOR OTAS) AND THE DEFINITION OF "NON-TRADITIONAL DEFENSE CONTRACTORS". ---REDACTED--- IS FAMILIAR WITH AND PERFORMS UNDER SEVERAL OTAS, BUT UNDER 10 U.S.C 2371, WE HAVE NOT SEEN A 50% COST SHARE REQUIREMENT. ---REDACTED--- , AS A LARGE BUSINESS, TYPICALLY PERFORMS WITH UNIVERSITIES AND SMALL BUSINESSES AS NTDCS IN ORDER TO ASSEMBLE TEAMS OF SUBJECT MATTER EXPERTS AND RESEARCHERS FOR SOLICITATION REQUIREMENTS. IT IS OUR INTENT FOR THIS PROGRAM TO DO THE SAME. CAN ARPA PROVIDE REGULATORY GUIDANCE AS TO WHERE THE 50% COST SHARE IS CODIFIED, OR IF IT IS GOVERNED BY 10 U.S.C 2371, WHEREIN THERE ARE EXEMPTIONS FOR COST SHARING?**

ANSWER: 1. DOE performs its due diligence reviews and determines any necessary risk mitigation measures on the basis of information submitted by applicants, not prior to submission.

2. Please refer to the Guide for Other Transactions, dated September 2023 and located here: [PF 2023-39 Announcing the new Guide to Other Transaction Authority and the Guide to Partnership Intermediary Agreements and a new webpage devoted to Other Transaction Authority | Department of Energy for information and background on the cost share requirements of other transactions entered into under 42 U.S.C. 7256\(g\) and 42 U.S.C. 7256\(a\).](#)

Q9. OUR TEAM HAS BEEN WORKING ON CALCULATING THE “THEORETICAL GRAVIMETRIC ENERGY DENSITY (WH/KG)” ON LINE 6 OF THE TAB “GRAVIMETRIC ED CALCULATION” IN THE “PROPEL-1K_ENERGY_DENSITY_WORKBOOK.XLSX”. I WOULD RESPECTFULLY POINT OUT THAT THE USUAL WAY TO CALCULATE THIS NUMBER WOULD BE TO DIVIDE THE THEORETICAL OPEN-CIRCUIT VOLTAGE BY THE SUM OF THE MASSES OF THE POSITIVE AND NEGATIVE ACTIVE MATERIALS IN A CONSISTENT CHARGED OR DISCHARGED STATE.

(TOTAL G/MAH) = (POSITIVE G/MAH) + (NEGATIVE G/MAH)

THEORETICAL GRAVIMETRIC ENERGY DENSITY = (OPEN CIRCUIT VOLTAGE) / (TOTAL G/MAH)

THE SPREADSHEET CURRENTLY USES THE LARGER MASS ONLY. THIS GIVES THE CORRECT ANSWER FOR METAL/AIR BATTERIES IF THE OXIDIZED PRODUCT IS INPUT AS THE CATHODE, BUT WILL NOT RETURN THE CORRECT ANSWER FOR MOST COMMON BATTERY SYSTEMS. I AM CONCERNED THAT THIS COULD CONFUSE SOME RESPONDENTS.

ANSWER: For batteries, in which all materials are retained within the battery during operation, the mAh/g value for the oxidized or discharged anode product should be used in the calculation. This is per Figure 3 for a metal air system while in other cases it will be the material specific to the chemistry of interest (e.g., Li_2S or LiF_x). Alternatively, or additionally, cathode active material can be included in the supporting chemistry per row e with notes in column F, as appropriate.

Q10. TWO QUESTIONS ON THE PROPEL1K FOA:

- 1) I BELIEVE THERE MAY BE AN ISSUE IN THE "PROPEL1K ENERGY DENSITY WORKBOOK," IN THE FIRST LINES WHERE THE THEORETICAL WH/KG IS CALCULATED. IT LOOKS LIKE ONLY ONE OF THE TWO ACTIVE MATERIAL MAH/G VALUES IS USED. HENCE, FOR SOMETHING LIKE LI-ION, THE FORMULA PRESENT DOES NOT WORK. AS STATED, THE CALCULATION ONLY WORKS IF THE ELECTROCHEMICAL COUPLE IS SUCH THAT ALL OF THE INITIAL MASS IS IN ONE OF THE TWO ELECTRODES. THE NOTES SPECIFY THAT ONLY THE MASS OF THE LIMITING ELECTRODE IS USED, BUT THAT DOES NOT GIVE THE CORRECT THEORETICAL WH/KG FOR ALL ELECTROCHEMICAL CONFIGURATIONS. AS AN EXAMPLE, LI/S CELLS ARE TYPICALLY MADE IN THE CHARGED STATE, BUT THE CALCULATIONS APPEAR TO REQUIRE THAT THE CELL START WITH LI2S.
- 2) PAGE 9 STATES THE FOLLOWING TOPIC IS OF INTEREST: "SOLUTIONS THAT COMBINE ELECTROCHEMICAL FUNCTION WITH MECHANICAL STRUCTURE". CAN ANY ADDITIONAL CLARIFICATION BE PROVIDED ON THIS? IS IT REQUIRED THAT THE BATTERY COMPONENTS THEMSELVES PROVIDE MECHANICAL STRUCTURE?

ANSWER: 1. As per Q9

2. The FOA does not require that battery components provide mechanical structure. This is identified as a topic of interest since, if combined with other technologies, it may help the achievement of the 1000 Wh/kg and 1000 Wh/L net system target.

Q11. THE ORGANIZATION I AM WORKING FOR HAS A FEW QUESTIONS ABOUT THE SF424 FORM AND THE BUSINESS ASSURANCES DISCLOSURES FORM.

- ON SF-424 THERE IS A QUESTION PERTAINING TO EXECUTIVE ORDER 12372, IS PROPEL-1K SUBJECT TO EO 12372 AND IF SO, HAS IT BEEN SELECTED FOR REVIEW?
- ON THE BUSINESS ASSURANCES DISCLOSURE FORM SECTION 4 ASKS ABOUT CURRENT, PENDING, AND PAST SUPPORT. THE SUMMARY OF THIS SECTION SEEMS TO INDICATE THIS IS LOOKING FOR INFORMATION ABOUT DUPLICATION OF WORK, CONFLICTS OF INTEREST, AND OTHER ONGOING WORK, HOWEVER LEAVES OPEN THE QUESTION OF OTHER SUPPORT. SHOULD THIS SECTION BE USED TO REPORT 100% OF WORK WITHIN THE LAST FIVE YEARS FOR THE TEAM APPLYING OR ONLY ONGOING/RELEVANT WORK?

ANSWER: 1. Per Section IV.E of the FOA, this Program is not subject to EO 12372.

2. All sources of past support within the last 5 years should be included, whether ongoing or otherwise.

Q12. I AM TRYING TO WORK WITH THE ENERGY DENSITY WORKBOOK; HOWEVER, IT SEEMS THAT IT IS PROTECTED AND REQUIRES A PASSWORD?

ANSWER: Specific fields of the energy density workbook have been intentionally password protected. Applicants should work with the existing formulas accordingly and provide notes in column F for clarification or explanation, as appropriate.

Q13. WE ARE CURRENTLY FOUNDING OUR SUBSIDIARY " ---REDACTED---". APPLICATION FOR ALL RELEVANT NUMBERS (LIKE EIN, AIN ETC) IS IN PROGRESS.

IT IS UNLIKELY THAT WE GET ALL NUMBERS UNTIL THE DEADLINE OF THE APPLICATION OF THE PROPEL PROGRAM (UNTIL OCTOBER 17TH) BUT WE WILL SHOW THAT WE APPLIED FOR SUCH NUMBERS, AND UNTIL THE START OF THE PROJECT WE WILL CERTAINLY HAVE ALL NUMBERS. MY QUESTION: CAN WE APPLY FOR THE PROPEL PROGRAM WITHOUT HAVING SUCH NUMBERS AT THE DATE OF THE APPLICATION BUT SHOWING THAT THE APPLICATION FOR IT IS IN COURSE?

ANSWER: ARPA-E does not require that registration be complete at the time of application but does require that the information be available for review at the time of award. For more information, please see question 2.15 on the "General Questions" page of ARPA-E's website: [General Questions | arpa-e.energy.gov](https://arpa-e.energy.gov).

Q14. THE ANSWER TO MY QUESTION IN FAQ STILL MAKES NO SENSE, SPECIFICALLY "THE CRUISE, VOYAGE, OR TRIP DURATION = METRIC 1 DIVIDED BY METRIC 9 (PER TABLE 1). THE WEIGHT OF THE FUEL CELL STACK INCLUDED IN THE SYSTEM MUST BE SUFFICIENT TO DELIVER THE POWER CAPABILITY PER METRIC 8 (PER TABLE 1)." FROM TABLE 1 DIVIDING METRIC 1 (≥ 1000 WH/KG) BY METRIC 9 (≥ 0.50 KW/KG) GIVES 2000 HRS. I CAN'T IMAGINE BEING ON A PLANE FOR 2000 HRS, 3-4 HRS IS MORE TYPICAL FOR REGIONAL FLIGHT. SIMILARLY METRIC 8 IS THE POWER CAPABILITY ≥ 1.5 KW/KG BUT DOES NOT GIVE THE SIZE OR MASS, ONLY POWER. WE CAN ACHIEVE THAT MASS NORMALIZED POWER WITH OUR FUEL CELL, BUT NEED TO KNOW THE POWER (NOT MASS NORMALIZED POWER) REQUIREMENT TO DETERMINE THE FUEL CELL SIZE/MASS SO THAT THAT MASS CAN BE ADDED TO THE FUEL TANK MASS TO GET ENTIRE SYSTEM (FUEL CELL AND TANK) POWER DENSITY.

ANSWER: Metric 1 = 1000 Wh/Kg; Metric 9 = 0.5 kW/Kg (=500W/Kg) Metric 1 divided by metric 9 = 2 hours.

For a 1 MWh system, for example, the system must have a weight of 1000 Kg or one metric ton. It must be capable of 1.5 MW for 3 minutes for take-off and be able to cruise for 2 hours at a power drain of 0.5 MW. At this stage we are not counting the energy required for the three minutes against the other

metrics. Ultimately, the project will evolve to consider actual mission profiles but at the beginning only demonstration of capability is required.

Q15. TEAM ---REDACTED--- HAS THE FOLLOWING QUESTIONS WRT THE ENERGY DENSITY WORKBOOK:

- 1. HOW IS THE ANODE CAPACITY AND CATHODE CAPACITY (MAH/G) TO BE ESTIMATED FOR A FUEL CELL? UNLIKE BATTERIES, A FUEL CELL DOES NOT STORE ENERGY BY ITSELF. A CURRENT AND VOLTAGE RATING MAY BE ASSUMED FOR A FUEL CELL BUT IN ORDER TO TRANSLATE IT TO AMPERE-HOURS (AH), A TANK CAPACITY MUST BE ASSUMED THAT DEPENDS ON THE KWH RATING OF THE SYSTEM. THE METRIC MAH/G IS NOT DEVICE SPECIFIC AND RATHER TANK-SPECIFIC.**
- 2. THE SAME QUESTION APPLIES TO ESTIMATING GRAVIMETRIC ENERGY DENSITY. THE AMOUNT OF WH PRODUCED BY THE SYSTEM DEPENDS ON THE AMOUNT OF FUEL IT STORES. THIS IS HOWEVER PARTLY ADDRESSED IN NOTES FOR PART E).**
- 3. FOR SUPPORTING CHEMISTRY AND ACTIVES, IF MEA AND ENDPLATES ARE INCLUDED, WHAT THEN ARE THE SO-CALLED "ACTIVES"?**

ANSWER: 1. The emphasis of this program is the consideration of anodes as electrochemical fuels. For fuel cells, hydrogen or ammonia might be considered and their mAh/g and mAh/cm³ can be readily calculated whether in pressurized gas or liquid form. Per the spreadsheets, applicants are invited to consider 1 kWh and >1 MWh energy storage systems to calculate the requested parameters. Commentary in column F is equally important to the numbers inputted.

2. See Answer 15.1
3. For some systems actives could be catholytes, e.g., onboard oxygen. For the majority of fuel cells the oxygen is in the air and leaves the cell as water, Therefore, there is no appreciable weight impact.