

QUESTIONS AND ANSWERS

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I. Concept Paper Phase Questions:

Q1. I have a question for Category D. When we propose the testing and validation cases, shall we consider both residential and commercial cases? In other words, the testing and validation should be conducted in:

- 1. Residential Buildings: a) older homes built in the 1904;b) house stock from 1970-80s;c) a modern very open-plan home.**
- 2. Commercial Buildings: a) an open office with conference rooms; b) a closed individual office with conference rooms; c) an auditorium mixed offices in academic building.**

In total, we should test 6 cases? Or shall we just focus on either residential or commercial buildings?

ANSWER: Proposed Category D testing and validation cases may either address both residential and commercial cases, or residential cases or commercial cases only.

Q2. I would like to submit an application for funding with a collaborator from [omitted]. My question is whether I can be PI or co-PI on the project. At this moment I don't have US citizenship or US permanent residency.

ANSWER: Principal Investigators and other researchers are not necessarily required to be U.S. citizens or permanent residents. Hiring/work assignment decisions for ARPA-E research should consider that ARPA-E awards normally involve technology or software - including any manufacturing know-how - that is "restricted or proprietary" as cited in export control regulations (at 15 C.F.R Section 734.8(a)). This includes when a university awardee partners with/licenses to a for-profit team entity, or if the university awardee seeks ARPA-E approval of "protected data" resulting from the research. Also, awardees' inventions resulting from ARPA-E research must be reported and protected, and are subject to U.S. manufacturing requirements. Refer to Attachment 1, Clauses 3 and 11, and Attachment 2 of your ARPA-E Cooperative Agreement for awardee immigration and export control obligations.

QUESTIONS AND ANSWERS

Q3. I have a few questions:

1) **Category B: FOA page 16 Table 3 “ Ensure a varied number of skin colors, body types, and physical ability levels (i.e. use of wheelchairs and the like) are adequately represented in both simulation and laboratory-scale testing scenarios .”**

For the testing, sensor should be tested for the detection of number of people regardless of skin colors, body type, etc. But for the building energy simulation, as long as number of people is given, the saving potential for occupancy based control can be evaluated. My question: how can the simulation be used to ensure adoption diversity?

2) **Category B and D: What is the definition of the baseline (e.g., HVAC control strategy) for achieve >30% energy savings in the simulation case for commercial buildings? Should the proposer come up the baseline?**

3) **Category D: For the demonstrated savings in lab testing and field testing, what is the required baseline for commercial buildings? Should the current HVAC system in the buildings be used? Or it has to be a system without any occupancy based control. In reality, some buildings may have some limited occupancy based controls, say temperature setback based on occupant presence only.**

ANSWER:

1. Diversity must be accounted for in simulations and any planned experimentation such that the system is proven insusceptible to false negative readings during real-world deployment.
2. Yes it is encouraged the proposer come up with their own baseline case. However it is not required, that Concept Papers provide detailed simulations that justify the feasibility of the proposed technical approach to achieve the energy savings and failure rate metrics. This more detailed analysis will be required in Full Application submissions, please see Section IV of the FOA. A very simple methodology is also shown in Section I.G of the FOA.
3. Yes, it is acceptable to use a steady state building baseline of the applicant's choosing that does already utilize operational setbacks. The accuracy and level to which an applicant's baseline simulation reflects reality will be assessed during submission review. Note that at the Full Application stage, multiple buildings and scenarios will be required.

QUESTIONS AND ANSWERS

Q4.

Reading the (FOA), it seems that we have to submit only one concept paper even if we are targeting more than categories from A,B, and C.

However, I have a complete different approach (and potentially different research team) dealing with each one of these categories. In that case, am I allowed to have more than one concept paper?

ANSWER: See DE-FOA-0001737, Section III.C.4 (Limitation on Number of Submissions).

Q5. We are working on putting together a concept paper with an occupancy sensor company partner. We plan to address Category B and the project will include some product development, integration to a building controls system, testing in the lab, and testing in the field. Can a project proposal for Category B include field testing?

ANSWER: ARPA-E encourages validation testing for all occupancy sensing systems.; If the level of testing doesn't merit a full Part D Concept Paper, the testing is welcome as an addition to parts A, B, or C.

Q6. Will indirect methods (inference based) for accurately determining human presence inside a building be suitable? Or should the human presence be directly sensed?

ANSWER: See General FAQ 2.7, found at <https://arpa-e.energy.gov/?q=faq/general-questions>.

Q7. Is DOE looking for proposals that develop new hardware technologies as sensors in this funding opportunity?

ANSWER: See General FAQ 2.7, found at <https://arpa-e.energy.gov/?q=faq/general-questions>.

QUESTIONS AND ANSWERS

Q8. Can one select to address through concept papers one or more items from the A A,B,C or D items to respond to? or gards;we have to respond to all four items simultaneously?

ANSWER: Refer to the Required Documents Checklist on p.1 of the FOA: Applicants may submit Concept Papers addressing Category A, B, C or any combination thereof. Applicants may also submit Concept Papers solely to Category D. Concept Papers submitted to Category D must be devoted solely for Category D. ARPA-E is not limiting the number of Applications that may be submitted by Applicants, provided that each Application is scientifically distinct. Thus, Applicants may submit a Concept Paper for Category A and/or B and/or C, plus a separate Concept Paper for Category D. However, a Concept Paper submitted to Category D may not identify any other technical Category, or else it will be found to be noncompliant.

Q9. We were wondering if you are available for a quick chat to discuss our research concept?

ANSWER: See General FAQs 2.3 and 2.6, found at <https://arpa-e.energy.gov/?q=faq/general-questions>.

Q10. Will institutions be required to use the DOE IRB protocol for Human Subjects for testing under this FOA?

ANSWER: Research supported by DOE requires compliance with all pertinent Federal regulations, see <https://science.energy.gov/ber/human-subjects/> for details. Consult with your institutional representatives regarding specific application to the proposed work.

QUESTIONS AND ANSWERS

Q11. Please clarify if Category D is desired to include Category C sensors for both lab and field testing - it is stated as such on pg 4: "D. Real-World testing and validation of A, B, and C in both laboratory controlled quasi-real world environments and actual field deployment tests throughout the program timeframe." However, it is left out of the description on page 7: "Testing and validation research must deliver a clear means for assessing the energy saving impact of both the residential and commercial (Categories A and B) technologies in a wide variety of floorplans." It is also left out, potentially, of the description on page 9: "Teams submitting in Category D only will develop simulation tools and real-world field testing protocols for human presence or people counting technologies in general."

ANSWER: Yes, as stated in Section I.D of the FOA on p.12 (Category D: Testing and Validation for Both Residential and Commercial Validation): Laboratory controlled, quasi-real world environments, and actual field deployment tests for technologies from Categories A, B, C, and others in the market throughout the program timeframe."

Q12. For proposers under Cat D, should it be assumed that all proposals submitted under Cat A or B sensors will need to be tested? Or is a subset acceptable? Can Cat D proposals include testing of occupancy sensor technologies that did not apply under Cat A or B but otherwise provide the functionalities described for A and B?

ANSWER: See ARPA-E's response to Q11 above.

Q13. The Template includes a Proposed Work section with the "final deliverable and overall technical approach used to reach project objectives". Is a formal work plan (Gantt chart) required in this section?

ANSWER: No.

Q14. Are there limitations on the project duration (minimum or maximum)?

ANSWER: As stated in Section II.A of the FOA on p.28: The period of performance for funding agreements may not exceed 36 months.

QUESTIONS AND ANSWERS

Q15. If we propose to develop a sensor in Category C, can sensor testing at a subcontractor facility be included as a Task or would that work require a separate submission under Category D?

ANSWER: See ARPA-E's response to Q10 above.

Q16. Question for category A: Would any communication between the proposed technology in the residence and a central system disqualify it from this program (software updates, recalibration, and basically anything other than PII and the occupancy binary signal)?

ANSWER: No, as set forth at Section I.D of the FOA on p.10: Due to the market desire for a solution and the difficulty of obtaining this solution, some researchers have implemented a "data fusion" scheme, and combining information from multiple types of sensors is a growing effort. The greater availability of very low cost and low power distributed sensing networks, based on hardware incorporating communication and significant computation abilities, coupled with novel work in the algorithm space, could have great promise for this sensor fusion area. ARPA-E encourages work in this field and believes there is promise in the data fusion space, as long as any proposed work meets the metrics in this FOA.

Q17. The announcement, page 10, states that ARPA-E encourages data fusion based approaches. However, on page 43 it states "Each Concept Paper must be limited to a single concept or technology". Is it safe to assume that data fusion that integrates several technologies is viewed as a single integrative technology?

ANSWER: Yes.

Q18. Should the focus be on static (e.g., scent, heart rate) and not on dynamic (e.g., gait, vibration, sound) properties/traits?

ANSWER: See General FAQ 2.7, found at <https://arpa-e.energy.gov/?q=faq/general-questions>.

QUESTIONS AND ANSWERS

Q19. What are the required environmental parameters ranges (e.g., noise, vibrations, light levels) for testing?

ANSWER: Environmental thresholds are dependent upon the selected application scenario and not strictly defined within the FOA as these conditions vary across the U.S. building sector.

Q20. Should we consider active deception when designing and testing the system?

ANSWER: See General FAQ 2.7, found at <https://arpa-e.energy.gov/?q=faq/general-questions>, and ARPA-E's response to questions concerning applicability of DOE IRB protocols.

Q21. Is a Category A project required to have field tests? It seems like from Table 1 only lab-based hardware testing with simulated scenarios is required. Is this a correct interpretation of Table 1 about Category A projects?

ANSWER: As set forth in Section I.D of the FOA on pp. 8-9: Submissions addressing Categories A, B, and/or C must be included in one Concept Paper, and Submissions addressing Category D must be included in a separate Concept Paper. For example, this could include a residential solution that includes full, real-world field testing and validation development (Categories A and D – two distinct Concept Papers); a complete commercial solution with both people counting and CO2 sensors and development of a real-world field testing and validation protocol (Categories B, C, and D – two Concept Papers); a sensor system for people counting and CO2 detection (Categories B and C – one Concept Paper), or other combinations. Applicants submitting to Categories A, B, and C but not submitting to Category D must still perform controlled laboratory-based hardware testing (see Section I.E of the FOA), but they will not be required to submit their technologies for testing and validation by Category D teams. Teams submitting in Category D only will develop simulation tools and real-world field testing protocols for human presence or people counting technologies in general. Collaboration between Categories A, B, C and Category D teams are strongly encouraged but not required.

Q22. If a Category A project is not required to have field tests, what are the expectations for simulation software and lab setup to validate the findings?

ANSWER: As set forth in Section I.E of the FOA on p.14: For illustration regarding these failure metrics we provide an example of simple analyses with simplifying assumptions to establish a baseline for the level of detail required to be included in submissions in Section I.G of the FOA. We emphasize that more complex and accurate simulations with more "real-life" data using multiple deployment scenarios will be required as the program progresses. In general, submissions should incorporate milestones at the 6 month mark providing extensive baseline simulations of required performance and at the 2 year mark provide simulations that incorporate actual detector system measurements showing clear progress towards the final metrics of the program.

QUESTIONS AND ANSWERS

Q23. If a Category A project is required to have field tests, will this program facilitate collaborations between teams of Category A and Category D projects?

ANSWER: Yes, ARPA-E encourages this activity. As set forth in Section I.D of the FOA on pp. 8-9: Submissions addressing Categories A, B, and/or C must be included in one Concept Paper, and Submissions addressing Category D must be included in a separate Concept Paper. For example, this could include a residential solution that includes full, real-world field testing and validation development (Categories A and D – two distinct Concept Papers); a complete commercial solution with both people counting and CO2 sensors and development of a real-world field testing and validation protocol (Categories B, C, and D – two Concept Papers); a sensor system for people counting and CO2 detection (Categories B and C – one Concept Paper), or other combinations. Applicants submitting to Categories A, B, and C but not submitting to Category D must still perform controlled laboratory-based hardware testing (see Section I.E of the FOA), but they will not be required to submit their technologies for testing and validation by Category D teams. **Teams submitting in Category D only will develop simulation tools and real-world field testing protocols for human presence or people counting technologies in general. Collaboration between Categories A, B, C and Category D teams are strongly encouraged but not required. (emphasis added)**

Q24. The FOA does not clearly state the counting of pets. Are they counted as human or not as humans, or as pets? This statement in the FOA should be clarified, "These metrics must be met including households occupied by both humans and pets."

ANSWER: The text found in Section I.E of the FOA on p.14 is accurate and clear as written.

Q25. Will indirect methods (inference based) for accurately determining human presence inside a building be suitable? Or should the human presence be directly sensed?

ANSWER: See General FAQ 2.7, found at <https://arpa-e.energy.gov/?q=faq/general-questions>.

QUESTIONS AND ANSWERS

II. Full Application Phase Questions:

Q26. For the category D, are we required to do testing and validation in BOTH commercial AND residential buildings? The answer to FAQ question 1 says that “Proposed Category D testing and validation cases may either address both residential and commercial cases, or residential cases or commercial cases only.”

ANSWER: See ARPA-E’s response to Q1 above.

Q27. For the category D, do we need to provide initial preliminary simulations that justify the feasibility of the proposed method to achieve energy savings? Such simulation is required for category A, B.C, but was not mentioned in Category D in FOA.

ANSWER: As stated in section I.E. (TECHNICAL PERFORMANCE TARGETS) of the FOA: “ARPA-E intends that” the Category D portion “of the program will develop tools and field testing protocol that can be utilized by this sensor-driven HVAC energy reduction field in general.” Successful proposals in all cases should clearly explain why a given analysis technique was chosen and provide a quantifiable explanation of why they expect the chosen technique and/or protocol will achieve the goals of the program, and how it will be utilized. How the applicant decides to substantiate such claims within the proposal is up to the applicant.

Q28. For category D, the FOA says “ARPA-E strongly encourages but does not require teams in this area to collaborate in various ways with any stand-alone sensor hardware teams.” During the full proposal application stage, will APPA-E release potential stand-alone sensor hardware teams, so the category D applicants can talk with these teams?

ANSWER: No, ARPA-E will not release a list of potential stand-alone sensor hardware teams.

Q29. Are model predictive control approaches in scope?

ANSWER: As described in the SUBMISSIONS SPECIFICALLY NOT OF INTEREST section of the FOA "New HVAC system controls, pure control algorithms development, and/or improvements to HVAC equipment." Work should focus on the sensors themselves, not the control systems they might enable.

QUESTIONS AND ANSWERS

Q30.1 In the FOA it is indicated that any equipment we need to buy for the project must be made or manufactured in the United States. If it is impossible to find ALL needed system components in the US what is required in the application response?

ANSWER: Clause 10.b of Attachment 1 (Special Terms and Conditions) of ARPA-E's Model Cooperative Agreement states: "Any supplies acquired under this Award must be made or manufactured in the United States, to the maximum extent practicable." (emphasis added). It is the Recipient's responsibility to document any circumstances justifying the purchase of supplies not manufactured in the United States and comply with any prior approval requirements. Generally, pricing considerations alone are not considered sufficient justification for purchases of foreign manufactured goods. Justifications for purchases of goods not manufactured in the United States are subject to audit review. Attachment 1 of the Model Cooperative Agreement is available at <https://arpa-e.energy.gov/?q=arpa-e-site-page/award-guidance>.

Q30.2 If travel is required outside of the US to accomplish project objectives should it be included in the proposed budget?

ANSWER: Yes, all planned travel (domestic and international) should be estimated and included in the application budget. The merits of and ARPA-E financial support for foreign travel, if any, will be the subject to ARPA-E approval during award negotiations should the application be selected.

Q30.3 I understand that no "Technology-to-Market Plan" needs to be submitted at the time of full application. Can we use those 4 pages for other parts of the Technical Volume in our full application?

ANSWER: The instructions set forth at FOA Section IV.D (*Content and Form of Applications*) are correct and should be employed as written.

Q31. What is the definition of a 'Project Team' for determining the cost share requirement per section 1.III.B of the FOA? We note per the Glossary that 'A Project Team consists of the Prime Recipient, Subrecipients, and others performing inventive supportive work that is part of an ARPA-E project.' If project participant X is not providing inventive work, but is rather supplying existing information or equipment, please confirm that it follows that they are not considered part of the Project Team.

ANSWER: The definitions of a Project Team and Cost Sharing can be found in FOA Section IX (*Glossary*).

QUESTIONS AND ANSWERS

Q32. If we're submitting in Category D, do we need to cover all of the Category A, B and C type sensors, or can we target a subset of these?

ANSWER: As stated in Section I.E (Technical Categories of Interest) of the FOA "ARPA-E intends that this part of the program will develop tools and field testing protocol that can be utilized by this sensor-driven HVAC energy reduction field in general. ARPA-E strongly encourages but does not require teams in this area to collaborate in various ways with any stand-alone sensor hardware teams." Category D teams may focus on a subset of the A or B sensor type areas (i.e. either residential or commercial or both).

Q33. Should Category D proposals include laboratory testing, field testing, and simulation development or just simulation tools and field testing protocols?

ANSWER: As stated in Section I.C.2 (Background) of the FOA "ARPA-E knows of no existing tools that can fully assess and validate energy saving claims of presence sensor and people counting technologies." There is also a desire to develop a method for determining ground truth for use to compare novel sensor systems developed for both residential and commercial spaces. The testing and validation research associated with Category D must deliver a clear means for assessing the energy saving impact of both the residential and commercial (Categories A and B) technologies in a wide variety of floorplans. To this end, simulation tools and field testing protocols must be developed, followed by completion of real-world field trials for multiple building types to assess sensor performance and energy savings impact.

Q34. If Category D proposals are expected to provide "Laboratory controlled, quasi-real world environments, and actual field deployment tests for technologies from Categories A, B, C, and others in the market throughout the program timeframe," how many sensors should be budgeted for testing? The proposed budget will be highly dependent on the number of sensors to be tested.

ANSWER: The Applicant should propose the number of sensors required to successfully accomplish the goals of their project. At minimum Category D submission must have some means for establishing ground truth and at least one advanced sensor system of the team's choosing must be evaluated against the tools and protocols developed. ARPA-E does not require, but strongly encourages teams in this Category to collaborate in various ways with any stand-alone sensor hardware teams from Categories A, B, and/or C. The Category D Applicant's ability to assess more than the minimum requirement of one advanced sensor system will factor into the competitiveness of the submission.

QUESTIONS AND ANSWERS

Q35. For Category D, is it expected that the laboratory and field tests will validate the sensor performance and the HVAC savings or just the sensor performance? The energy savings achieved is dependent on the control algorithms implemented, which is not part of the FOA

ANSWER: Testing under Category D will be expected to validate both the sensor performance and the actual energy saved during real world deployment and use. Overall energy savings is highly dependent on control methodology, building design, and maintenance. However, if nothing else changes at the field test site except for the addition of sensors and sensor input into the control system, sensor performance and energy savings should be calculable.

Q36. Which criterion (or criteria) does the Technology to Market section of the Technical Volume contribute to?

ANSWER: All applicable merit review criteria is provided in Section V.A.2 (Criteria for Full Applications) of the FOA.

Q37. With respect to Category D proposals, will sensors to be tested provide outputs of number of occupants in a space for commercial buildings and the presence (or absence) of occupants for residential buildings or will the outputs of the sensors require post-processing of the sensor output to determine the number of people in the room (commercial) or presence/absence of occupants (residences)?

ANSWER: For Category D it should be expected that the sensors / sensor system / distributed sensor networks developed will deliver either the number of people in the HVAC zone for the commercial case, or binary presence in the residential case. The technical approach for each project will be evaluated in accordance with the Evaluation Criteria provided in Section V.A.2.

Q38. For category D for rooms that require multiple sensor units for complete coverage, are sensor developers expected to provide processing across the multiple sensors to arrive at a value of occupants in a room (for commercial) or is post-processing for this purpose expected to be done a part of testing?

ANSWER: See the answer to question 37 above.

QUESTIONS AND ANSWERS

Q39. Are project teams in Categories A, B and C expected to provide indicators of uncertainty of the measurements by their sensors that testing by Category D teams would validate, or will all determinations of uncertainty be determined by Category D project teams?

ANSWER: Determinations of uncertainty are expected to be assessed in both development and validation of any SENSOR system; thus an applicant submitting under any Category will be expected to make these determinations.

Q40. Concerning distinctions between commercial spaces based on space type (e.g., classrooms and conference rooms) and submarket segment (e.g., office buildings and academic buildings) for Category D, do both space type and submarket segment need to be covered separately? Or, are these just two different perspectives on meeting the requirements for commercial buildings?

ANSWER: As specified on page 20 of the FOA; “commercial space must use building examples from at least two distinct sub-markets (for example, office and lodging, office and academic, etc.).”

Q41. In Category A: Residential occupancy section on p. 17 of the FOA, Perceivable false negatives are described as “when a sensor does not detect that a space is inhabited such that temperature setbacks are triggered.” Is the triggering of temperature setbacks integral to this definition or is the intention for the false negative to only represent the sensor failing to detect the presence of occupants in the monitored space?

ANSWER: A false negative is signified by the sensor system registering the space as unoccupied when ground truth identifies the space as occupied.

QUESTIONS AND ANSWERS

Q42. Underlying the fail rate criterion, was there a required frequency of occupant presence measurements that applicants should use with respect to the maximum number of “failures”? If the measurement frequency is once per 10 minutes, occupants would likely readily notice the failure to detect their presence, but if the measurement frequency were once per 10 seconds, for example, the occupants would likely not perceive the missed occupant presence detection because the next measurement would likely provide a correct detection and cause the HVAC system to change to the correct occupied state. It would seem that the frequency of occupant presence measurement can have a significant effect on the consequences of false negatives, especially because perception likely depends on the rate of measurement.

ANSWER: It is up to the individual applicant to establish a data rate based on the applicant’s proposed technology and selected and targeted market (and control system and HVAC system).

Q43. Where should we include letters of commitment and/or letters of support from testing facility, testing building and other related supporting stakeholders? Should we just include these letters in the appendix section in the technical volume? Are these letters excluded from overall 30-page limit for Sections 1-5?

ANSWER: Letters of support may be included in the Technical Volume or cited in the Technical Volume, but in both cases will count towards the maximum page limitation for the Technical Volume. If applicants exceed the maximum page limitation for the Technical Volume, ARPA-E will only review the authorized number of pages, starting with the first page and disregard any additional pages exceeding the limit. Please refer to the “Content and Form for Full Applications” section of the FOA for applicable page limitations.