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# Response

## SEAB Recommendations Related to the Evaluation of New Funding Constructs for Energy R&D in the Department of Energy

### Introduction

Over the past seven years, the Department of Energy (DOE) has introduced several new energy research and development (R&D) management and funding mechanisms, designed to complement each other, with the goal of maximizing the Nation's ability to achieve energy breakthroughs as quickly as possible.

- *Energy Frontier Research Centers (EFRCs)* focus on fundamental science and support multi-year, multi-investigator scientific collaborations focused on one or more science and energy research grand challenges. Typical awards are \$2-5 million/year, for an initial five-year project period. Forty-six EFRCs were initiated in 2009.
- *Energy Innovation Hubs (Hubs)* and *Bioenergy Research Centers (BRCs)* work at the frontier between basic and applied science. They bring together a large set of investigators spanning science, engineering, and policy disciplines focused on a single critical national need, and work to bridge the gap between basic scientific breakthroughs and industrial commercialization. Three BRCs were initiated in 2007 and renewed for a second five-year period in 2012. The first Hubs were established in 2010 and focused on: Computer Modeling and Simulation for the Development of Advanced Nuclear Reactors; Production of Fuels Directly from Sunlight; and Improving Energy-efficient Building Systems Design. In 2012, two more were established focusing on Critical Materials and on Batteries and Energy Storage. Typical awards are \$22-25 million/year for up to five years.
- *Advanced Research Projects Agency-Energy (ARPA-E)* funds applied research and development of new technologies with emphasis on high risk, potentially transformational (rather than incremental) research. ARPA-E has made awards to about 285 projects totaling approximately \$770M across the entire technology landscape.

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## SEAB Funding Constructs (Hubs+) Review

In September 2013, Energy Secretary Ernest Moniz charged the SEAB to establish a Task Force to evaluate the new funding constructs for energy research and development in the Department of Energy. The Task Force was asked to look at whether there are gaps in the DOE approach to energy, science, and technology innovation, and their impact on industry development and deployment; whether the DOE is effectively drawing on the resources of the labs, academia, and industry, including entrepreneurial startups; and whether the suite of new management and funding mechanisms is proving effective, and if they are complementary.

In March 2014, the SEAB approved the final report of the Task Force. The SEAB report finds that the funding modalities implemented by the DOE address the full range from basic science to speculative innovation to system-level integration, and appropriately balance the magnitude of funding to the risk of successful delivery. However, the Board's recommendations highlight the need for better management and clearer definition of the role of each modality, particularly if the DOE is to provide the leadership management and funding constructs to enable improved focus on transformative R&D in the scientific community and the industrial sector.

## DOE Assessment and Response to Recommendations

The SEAB's 2014 report called on DOE to carefully set a balance between the funding of these new constructs and the 'normal' programs. The report also included recommendations across all the new constructs related to crafting the Funding Opportunity Announcement (FOA), project management and the need for strong leadership, retroactive evaluation, and sharing best management practices across DOE offices. Recommendations from the report and actions being undertaken by DOE are highlighted below.

SEAB Recommendations	DOE Assessment and Actions
<b>1. General Recommendations</b>	
<ul style="list-style-type: none"><li>DOE needs to carefully set a balance between the funding of these new constructs and the 'normal' programs.</li></ul>	<ul style="list-style-type: none"><li>DOE concurs.</li></ul>
<ul style="list-style-type: none"><li>A clearer definition of the role of each modality across the Department and more disciplined management would be beneficial to the Department to ensure that each mode of investment has the greatest opportunity to deliver</li></ul>	<ul style="list-style-type: none"><li>The SEAB review prompted a further refinement of the definitions of each modality and the roles of each within both the sponsoring program and the DOE as a whole. This was presented to SEAB in its first meeting. The Department will continue to address definitions and roles as the programs evolve.</li></ul>

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on its intended objective.

- At the time of this review, the DOE believes that the Energy Frontier Research Centers (ERFCs) and Bioenergy Research Centers (BRCs) have clear definitions, well-defined roles in the Basic Energy Sciences (BES) and Biological and Environmental Research (BER) portfolios and within the broader DOE energy portfolio, and disciplined management, both at Headquarters and at the EFRCs and BRCs themselves.

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## 2. On Crafting the Funding Opportunity Announcement (FOA)

- **Open Competition:** The best players must be able and encouraged to compete either to manage or perform in each construct. Universities, national labs, and industry should be equally allowed to take the leadership role where relevant in each competition and FOA.
- DOE agrees with this recommendation and notes that the BRC FOA issued in August 2006 was the first Office of Science (SC) FOA to enable universities, National Labs, and industry to compete with one another in the same solicitation. This ability was authorized by the Energy Policy Act of 2005. Since the time of the BRC FOA, SC has continued to use this approach. The original EFRC FOA in 2009 and the recompetition FOA in 2014 both were open to all entities.
- DOE believes that the structure of the FOA was key to forming successful EFRC partnerships between the academic community and the national labs to enable high quality collaborative science with relevance to energy science and/or industry.
- The FOAs for the Critical Materials Hub and the former Hub on Energy Efficient Buildings were both open to universities, national labs, and industry. The Office of Energy Efficiency and Renewable Energy (EERE) will continue to use open competition for any future Hub FOAs.
- **FOA Composition:** The use of both top down grand challenges and bottoms up community input on the scientific and technology innovations needed is a best practice and should be followed for every construct FOA to carefully define the rationale, goals, and metrics for success of the construct, its investment scale, and timeframe.
- DOE agrees with this recommendation. In particular, the FOA for the EFRCs was informed by a community workshop in grand challenge science and by nearly one dozen Basic Research Needs (in specific energy technologies) workshops and reports. Similarly, the BRCs were informed by the Breaking the Barriers workshop and report.
- EERE Program Offices routinely use workshops and/or formal Requests for Information to obtain community input in identifying technology barriers and approaches to overcoming them. EERE uses this information to design R&D initiatives, define program goals, and shape FOAs.

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- **Optimized Funding Profile and Stage Gate Reviews:** The larger constructs such as Hubs should include defined ramp-up and ramp-down phases at the beginning and sunset of each project with appropriate stage gate milestones to determine continuation of the project. It is wasteful to require the spending of a fixed sum of money per year with a fast turn-on. The process for review and sunset should be clearly defined in the FOA.
  - Future FOAs for entities like Hubs will consider all of these recommendations, in particular: the ramp-up and ramp-down of funds during initial and final project stages; the requirement for proposed year-by-year funding estimates that match the proposed work; and intermediate project reviews that will inform future funding.
  - Stage gate and go/no-go milestones are a common practice in EERE-funded projects, and they have now been incorporated in the Penn State Consortium for Building Energy Innovation, formerly the Energy Efficient Buildings (EEB) Hub.

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### 3. SEAB Recommendation on Strong Project Management

- **Effective Project Leader/Manager:** The larger and more applications focused a construct is, it is imperative to have an effective senior on-site leader, respected by the scientific community, to support the research and lead a serious project management culture for the project, including a formal work breakdown structure and change management process. An effective leader who leads both the science and the project management culture should be required from the outset, at proposal stage.
  - DOE agrees with this recommendation and would also like to emphasize the importance of expert DOE project management for the efforts. And because Hubs and Institutes are intended to be specialized, focused, and limited duration activities, suggests that term-limited hiring of DOE Program Managers for those programs supporting Hubs and Institutes might be a beneficial option. This is the Congressionally mandated practice in the ARPA-E modality.
  - **Establishing Milestones:** For the larger constructs, such as Hubs and BRCs, performance milestones should be established and subject to an annual review with a re-baselining procedure in close consultation between DOE and construct senior management where appropriate. How to effectively set more realistic targets for work breakdown of the more exploratory science projects within a construct should be shared as best practice within the Hubs Leadership Council and generally across all constructs.
  - DOE agrees with the comment for large project constructs such as Hubs, but notes that traditional work breakdown structures would not appear to be useful for fundamental research in constructs such as EFRCs.
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#### 4. SEAB Recommendation on Retroactive Evaluation of the Return on Investment

- **Retroactive Evaluation:** A retroactive evaluation system needs to be established to measure transformational impact of all of the constructs, but especially the Hubs, BRCs, and ARPA-E.
- SC has used retroactive evaluation to assess the Hubs and the EFRCs. The SEAB report endorsed the EFRCs approach noting that “The BES management processes for the EFRCs are very well implemented and effective. A number of well thought out mechanisms are in place and have been actively used to identify issues and resolve them.”
- In the renewal decision for the BRCs, both the review of the renewal proposal and retrospective review, as indicated by the three previous annual peer reviews, were considered.
- EERE has worked with evaluation experts to develop a rigorous, standard methodology for retrospective impacts assessments. Third-party evaluations have been conducted on a number of EERE initiatives, and additional evaluations are currently being planned.
- While DOE agrees in principle with the recommendation to establish a methodology for retroactive evaluation, ARPA-E has observed that intrusiveness into a business’s data (sales, profits, revenue) is a sensitive issue. Methods of tracking over a 10 year time frame could have a chilling effect on applications if the methodology is perceived as burdensome or data is not sufficiently protected.

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#### 5. SEAB Recommendation on Sharing of Best Management Practices across the DOE Offices

- **Extend Hubs Leadership Council:** The Hubs Leadership Council should be expanded to include the BRCs. The Council should continue to compile and continuously share “light-touch, but with teeth when needed” program management lessons learned across all offices. In particular, sharing of best practices and experiences across the BRCs and Hubs would be especially useful.
- DOE supports the inclusion of the senior federal leadership of the BRCs on the Hubs Leadership Council (HLC), and agrees that the Council can do more to facilitate better sharing of management best practices among the Hubs.

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## 6. SEAB Recommendation Specific to Bioenergy Research Centers

- **Process for Renewal/Sunset:** BER has not made a formal public commitment regarding the possibility of an extension beyond the second five-year commitment, which expires at the end of 2017. DOE or the National Research Council should undertake an updated evaluation of the state of the field and the role of the BRCs in contributing to further development of the field. It would also be legitimate to ask whether having three BRCs is still appropriate, whether the mandate and goals of the BRCs is still compelling relative to other opportunities, and whether the BRCs are sized right and appropriately organized relative to forward-looking goals. The program manager of the BRCs is planning a forward-looking workshop in summer 2014, which might address some of these questions.
  - DOE agrees with this comment. As noted, BER has made no public announcement for the BRCs in the post-2017 period. BER continues to engage external stakeholders in the scientific community regarding research needs in bioenergy. The summer 2014 workshop is one component of that engagement.
  - Questions posed by the SEAB report will be considered in determining the future role of the BRCs and/or their follow on constructs.
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- **Industry Voice in Assessment:** The field of advanced biofuels has progressed significantly since the BRCs were first envisioned. There are a few commercial-scale lignocellulosic biorefineries in operation and several more are apparently slated to startup in 2014. Thus, industry should have a voice in assessing future needs for the BRCs. Whatever the case, the future of the BRCs should be decided before mid-2015 in order to ensure an orderly transition to the next phase for the BRCs.
  - DOE agrees with this comment. All BRCs have extensive contact with industry through partnerships and advisory boards. BER included industry participation in the June 2014 workshop. An assessment of the state of the science and where/how/whether BRC science and technology fits into a biofuels economy will be critical in determining the future of the program.
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- **Evaluation of the BRCs:** Although the BRCs are considered by DOE to be part of a single program, they were
  - DOE agrees with the comment. The BRCs are subject to annual peer review, with some overlap of the review teams. Reviewers are selected for their subject matter
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reviewed separately until year three. It is desirable to periodically have a single committee review all three centers to facilitate a comparison of effectiveness of the three centers.

expertise in order to provide evaluation of specific scientific thrusts of each BRC. The three BRCs were reviewed together in year three as noted by SEAB.

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- **Importance of Team Research:** The key opportunity of the BRCs is the potential to have multidisciplinary teams of researchers working coherently to solve a larger problem than typically feasible for an individual research group. The degree to which such team efforts have been implemented should be added as a criterion for evaluation of success. Certainly a lesson learned in starting the BRCs was the lack of academic experience in managing large multi-institution efforts as high performance teams. Management training should be considered as a part of any further similar funding concepts.
  - DOE agrees with the comment. Team synergy and effective management were criteria for the BRCs from the very beginning of the program. As the Task Force report notes, “Team Integration” has been an explicit criterion in evaluating BRC performance in annual peer reviews. In general, in the experience of the BRCs, it has proved more practical to ensure that already experienced and seasoned managers are part of the leadership and management of each BRC than to attempt to instill management skills belatedly through management training. The university-led BRC has received high marks from reviewers for its management performance, benefiting from strong academic institutional commitment and support.

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## 7. SEAB Recommendation Specific to Energy Frontier Research Centers

- **Extend beyond BES:** Currently EFRCs only exist in the Office of Science, Basic Energy Sciences. DOE may want to consider expanding this successful funding modality for use-inspired research relevant to energy or environment to other parts of the Office of Science.
- DOE will consider expanding the EFRC modality, while maintaining the complementary missions of the different DOE offices.
- **Proposal Review:** EFRCs are best judged by peer review, where the review process includes diversity of thought. There needs to be turnover among the EFRCs, and they should have only competitive renewals as is being planned. In addition, given the five-year funding cycle, we support the current
- DOE agrees with this recommendation and plans to initiate EFRC solicitations every other year to provide greater opportunities for new submissions and to lessen the potential review congestion when all EFRCs are reviewed at the same time.

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EFRC management practice to have an intermediate review with 'teeth'. Finally, we note that the current situation with all EFRC proposals (new and renewals) being reviewed at the same time, presents a significant challenge for the review process. The advantage of being able to have a comparative review across the entire program is offset by the challenge of reviewing so many proposals involving a large fraction of the community at the same time. DOE should consider a plan to avoid this congestion in the future.

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#### 8. SEAB Recommendation Specific to ARPA-E

- **Validation of Success:** ARPA-E appears to be doing well: it has had strong leadership, it has used workshops to gather community input, it funds a good mix of topics, it provides close monitoring of projects, and it has implemented a quicker than usual funding process. However, at this stage, it is challenging to validate the success of the program. For example, since ARPA-E intentionally funds high-risk projects, one expects a relatively low fraction of success, as measured by throughput to industry and/or follow-on non-government funding. In addition, the program has not undergone an external review. ARPA-E is required by law to have a review done by the National Research Council by 2015, and DOE should be planning now for this review. The Director of ARPA-E is the appropriate Office to contract with the National Academies to sponsor the review.
- DOE agrees that it is too soon to determine whether ARPA-E-sponsored innovations will have transformational market impact. Although challenging, ARPA-E believes measuring preliminary technical indicators for its projects and, most importantly, preliminary indicators for commercial adoption such as company formation, hand-offs, and external funding, as noted on pages 7-8 of this report, to be the best option at this time.
- ARPA-E has engaged the National Academies as required by 42 USC 16538(l).



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- **Caliber of Program Managers:** The Task Force notes that the caliber of the program managers, who should have demonstrated leadership and expertise in energy-related science and technology, is essential to the success of the ARPA-E endeavor. The caliber of the program managers over the entire length of the program should be one of the criteria for measuring success in an external review.
  - DOE agrees hiring is essential to the program.

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#### 9. SEAB Recommendation Specific to Hubs

- **Hub Model Not Always Appropriate:** For example, some R&D challenges may not be large enough to require a Hub, or, in other cases, it may not be possible to aggregate resources into a large, centralized Hub. A Hub would not be the right construct for funding fundamental science with a very long time horizon or for funding pure deployment.
    - DOE agrees with the finding. Our initial experience with Hubs and the SEAB review comments will inform our future investments with this type of construct.
  - **Consensus Building on Topics:** Selecting topics for any of the modalities requires due diligence, and should include community input and consensus building in defining priority challenges for energy. This is particularly important for the Hubs, which represent a large effort. For new Hubs, DOE should engage with the scientific and industry community to define priority challenges as well as to decide if a Hub is the best approach for a particular challenge.
    - DOE agrees with the recommendation. Our initial experience with Hubs and the SEAB review comments will inform our future investments with this type of construct.
  - **Multiple Hubs on a Single Topic:** In some cases, funding multiple, complementary Hubs aimed at a single broad problem may be appropriate.
    - Certainly, multiple investments aimed at a single broad problem was the model used to establish the three BRCs. Going forward, we will consider whether multiple Hubs or perhaps multiple mini-Hubs, with later down selection, make sense.
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- **System Feasibility and Market Relevance vs Prototypes:** While product prototypes are a desirable goal of the Hub process, a deliverable prototype should not be required of every Hub. In some cases, demonstrating system feasibility and market relevance, with deliverables consistent with market feasibility, is more important than delivering a prototype.
  - DOE agrees with the comment that the Hub goals must be appropriately tailored to the scientific/technical challenge.
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- **Funding Level:** DOE should consider a range of funding levels for Hubs, for example between \$15 and \$30 million per year.
  - DOE agrees with the comment.
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- **Hubs Leadership Council:** Oversight and involvement by DOE is essential. To this end, the DOE Hubs leadership council plays an important role in helping avoid basic management failures and in communicating best practices. Key characteristics for success of a Hub are a focus on a high-level energy goal, a coherent research plan that incorporates community input, clear objectives with measurable milestones/outcomes and tracking of progress to the plan, a strong leader, and excellent program management.
  - The combination of the Hubs Leadership Council, the Hubs Working Group, and strong programmatic line management—each with different roles and responsibilities—has worked well.
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- **Mid-Term Reviews with Teeth:** Within the contract for five years plus a possible five-year extension, DOE should conduct a mid-term review in the first five years that includes termination or funding level modification within the first award period as possible outcomes, and another mid-term review in the second five years that addresses reevaluation of the need for the Hub and plans for the transition of the Hub
  - DOE agrees with the comment and notes that the Hub reviews are more frequent than suggested by SEAB and include an early-operations management review for each Hub, a practice that has benefitted the young Hubs.
  - Additionally, such reviews for CASL are also substantially more frequent than the report indicated. DOE agrees with the range of outcomes proposed by SEAB.
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enterprise after DOE funding is completed. The recent modification of the EEB Hub funding during the first award period is an example of how such midterm evaluations can be used.

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- **Extended Funding beyond 10 Years:** DOE should not extend funding beyond 10 years without a reevaluation of the need for the Hub that includes input of the external community, industry, and the DOE Hubs Leadership Council.
  - DOE agrees with the comment.

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- **Hubs Acting as Hubs:** Hubs should make effective use of the output of EFRCs and ARPA-E projects as well as regular DOE programs that are funded in their particular area of focus by including the PIs in their regular meetings and communications.
  - DOE agrees with the comment.

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## 10. SEAB Recommendation

- **“Hubification” of the National Laboratories:** We encourage DOE to consider how the efficiencies and productivity of the funding modalities discussed in this report, particularly at the scale of the Hubs, could be an appropriate way to organize work at the National Laboratories to ensure focus on problems of national interest.
  - Siting large projects, with clear goals and active management, within and among labs, is undergoing further examination. Several specific topics are under discussion.
  - During the past decade, SC has experimented with a variety of constructs, some of which were under review by this SEAB Task Force. Others include the BES Nanoscale Science Research Centers (5 centers at \$20-25M/each/year) and the ASCR SciDAC Institutes (4 at a total of \$16M/year).
  - Over the past three years, EERE has piloted a Manufacturing Demonstration Facility (MDF) model (\$8M-\$10M/year) to unify national lab efforts around a single high-impact technical problem of additive manufacturing and to coordinate that effort with industry and other governmental (primarily DoD) investments in this technology. While early, this pilot appears positive as measured by ever increasing

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industrial participation, partnerships with other government entities and increasing impact across DoE (National Security efforts) on issues relating to the technical expansion of additive manufacturing.

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▪ **Hubs+ Report Figure 1 - New Management and Funding Modalities at DOE:** Notional depiction of the span of the new management and funding constructs across the disciplines in the offices within the Office of Science and the Applied Energy Programs (horizontal axis) as well as the spectrum of basic research to industry deployment (vertical axis).

- The figure provides a very good way to look at each of the various constructs.
  - However, ARPA-E respectfully disagrees with this characterization. ARPA-E is depicted as later stage Prototyping and Scale Up. However, the report on page 3 correctly states, “EFRCs and ARPA-E projects are appropriately scoped and funded for the more basic, innovative and uncertain exploratory work they respectively represent.” ARPA-E should fall between use-inspired research and applied research.
  - Additionally, EERE is uncertain how to interpret its position in Figure 1. EERE conducts applied research, and develops and demonstrates prototype technologies systems, and supports some scale-up and deployment activities.
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