Summary Minutes of the

U.S. Department of Energy (DOE)
Secretary of Energy Advisory Board
Public Meeting

Committee Members:	John Deutch, Arun Majumdar, Martha Schlicher, Ram Shenoy, Dan Reicher, EllenTauscher, Harold Varmus, Paula Hammond
Date and Time:	January 26, 2016, 9:30 AM – 12:30 PM PT
Location:	Joint BioEnergy Institute 5885 Hollis Street, 4th Floor Emeryville, CA 94608
Purpose:	Meeting of the Secretary of Energy Advisory Board (SEAB)
SEAB Staff:	Karen Gibson, Designated Federal Officer; Corey Williams-Allen, Deputy Designated Federal Officer
DOE Staff:	Lynn Orr, Under Secretary for Science and Energy
Presenters:	Paul Alivisatos, Director, Lawrence Berkeley National Laboratory; Jennifer Doudna, University of California, Berkeley; Ilan Gur, Director, Cyclotron Road

Opening of the Public Meeting

SEAB Chair John Deutch, called the meeting to order.

Lynn Orr, Under Secretary for Science and Energy, DOE, gave an overview of science and technology accomplishments and priorities for the Department. He noted that the Department's core mission objectives remain: nuclear security, science and energy, and environmental management, but in 2016 there will be an emphasis on clean energy and low costs. Environmental management/cleanup of the legacy of the cold war continues to be a challenge, although the Department has made significant progress.

In terms of 2015 accomplishments, Orr highlighted the Iran agreement, a science based approach to international negotiations, which drew on the expertise and capabilities of the national laboratories. In Paris, 196 countries agreed to address climate change. An important component to this is Mission Innovation, a commitment by 20 countries to double clean energy R&D over 5 years. DOE issued the first Quadrennial Energy Review (QER), looking at energy infrastructure and problems to be solved. Information in the QER led to additional funding to modernize the Strategic Petroleum Reserve (SPR). The Quadrennial Technology Review (QTR) gives a snapshot on where we stand with energy technologies and where we are going forward.

Accomplishments in science and energy included opening the most advanced storage-ring based light source facility – the National Synchrotron Light Source II at Brookhaven; to date completing approximately 140 ARPA-E projects, leading to 30 new companies and 9 new commercial products; establishing a new National Network for Manufacturing Innovation (NNMI) institute; issuing a

Revolution Now update, documenting significant cost reduction and market penetration of wind, solar utility, batteries and changing the landscape; launching the Grid Modernization Initiative; and obtaining Presidential approval to pursue a separate disposal path for defense high level waste. The Department is working now on consent based siting for storage of spent nuclear waste. The Department issued 13 new efficiency standards. These have a big impact on GHG emissions.

Top of the list for 2016 is to continue to work hard on the strategic relationship between the Department and the national labs. The Secretary has put a lot of effort into this. The Department will continue to reduce the worst of the 'annoyances' on the lab contracting system. The Department continues to support scientific user facilities and work on new facilities. DOE is working on joint multi-year Science-NNSA effort on exascale computing; and will also work to evaluate future plans for ITER. The Department will continue to work on renewables and crosscutting initiatives on grid, subsurface engineering, supercritical CO_2, energy- water nexus, and cyber security. The Department will work on implementation of Mission Innovation and technology deployment through the Technology Commercialization Fund. DOE will also issue another 14 energy efficiency standards; develop the second phase of the QER; complete the strategic review of SPR modernization and report to Congress; and host the Clean Energy Ministerial in June 2016.

There are equivalent goals going ahead in nuclear security and environmental management.

Discussion:

In response to a question about what is not going well, Orr noted that the Department is working on management of contracts for labs – this is a long process because contracts are not renewed at the same time. The 'Evolutionary' and 'Revolutionary' working groups process is still in play. The plan is still to work on streamlining and making things more transparent and less transactional.

One area that is going well that the Department wants to continue is in bringing teams together through the Big Ideas Summits and tech teams, to develop ideas and propose research agendas. It is harder to get funding for crosscuts because of the way money is appropriated. The Grid Modernization Initiative proved this could be done. Another crosscut that needs funding is the water/energy nexus.

Another question focused on the Department's implementation of the Augustine/Mies report recommendations. Orr noted that the Department is making process. The combination of these three reports – Augustine/Mies, the Lab Commission (CRENEL), and SEAB – had a lot of overlap and common suggestions. CRENEL and SEAB in particular are in concert with what the Department wants to do.

A final question centered on what portion of activity involves biomedical sciences. This is a small percentage in terms of a DOE program. However, NIH puts approximately $250m/year into user facilities, beam lines, etc. And there have been recent discussions this year with respect to BRAIN and a pilot project with Cancer Institute. In terms of ideas, this is very important. Neither DOE nor NIH can do this on its own, and there are many opportunities to advance the science.

Brief updates on task force operations:

SEAB Vice Chair, Arun Majumdar gave an update on National Lab task force activities. The Task Force has issued an interim report and letter assessments of the Augustine/Mies report, the Lab Commission (CRENEL) report, and the NAS/NRC report. Most recently the Task Force has drafted a letter assessing the final Lab Commission report. It is now up to DOE to implement the recommendations. The Task Force is also forming a subgroup led by Dick Meserve and Rich Mies to review the Department's implementation of the recommendations in the NNSA-related reports. Deutch noted that SEAB is pushing to make the lab system more efficient and effective. Majumdar said that he understood that there is progress being made and the Board members look forward to hearing more.

Task Force Co-chairs, Dan Reicher and Ellen Tauscher presented an update on the Federal Energy Management Task Force. The purpose of the Task Force is to look at how to improve the use of energy across Federal buildings and land. DOE has a Federal Energy Management Program (FEMP). The report will look at the operation of the office and at opportunities for improvement across federal energy management. An initial draft of the report is underway and is anticipated to be issued this spring. This is an area of enormous opportunity. A challenge is to be both an incubator and leader in this effort. The report, which was in part in response to the President Executive Order issued last spring, will be a large report that can be broken down into pieces, and will look at how to implement the Order. The report will serve to inform the next Administration.

Task Force Chair, John Deutch outlined the goals of the Future of Nuclear Energy Task Force. The Task Force is looking at what would be necessary for the US to be able to lead nuclear power in 2030-2050. The Task Force has had 2 meetings. The group has already formed a consensus view of the substantial challenges on nuclear waste, choice of new technologies, the benefits of those new technologies over others, the cost of nuclear power, and how the country might manage such an initiative. The Task Force will report by the end of year.

Task Force Co-chair, Harold Varmus gave an update on the Task Force on Biomedical Sciences. There are important and exciting opportunities in this area. The Task Force is looking for areas where DOE and NIH can work productively together on the fundamentals of biomedicine. Nucleotides and beamlines, in particular, illustrate things that are not usually available to NIH scientists. Areas might center on neuroscience technology that involve computation and relevant for medicine and understanding the brain as a machine, and imaging, sensing, genomics, biotechnology, etc. These areas are consistent with DOE's national science mission. The Task Force is collecting topics from the national labs on things that would be interesting to look at and will organize the first meeting in Brooklyn, NY on March 10-11. The Task Force will report to SEAB in September.

One goal for SEAB as a whole is to determine how to summarize its work in important areas in order to leave its findings for future Administrations.

SEAB work for approval:

Arun Majumdar gave an overview of the letter drafted by the SEAB National Lab Task Force on the CRENEL report. He noted that the recommendations by CRENEL were not very different from those in the SEAB report on the relationship of DOE and the labs, clarity of roles and management, M&O contracts, and incentives. The CRENEL report had a recommendation that SEAB did not address, calling

for NETL to be split into a GOCO and a GOGO. Both CRENEL and SEAB called on DOE to issue a clear statement that technology transfer should be part of the mission. Both reports endorsed the planning process of the Office of Science. The CRENEL report called for a standing body to oversee implementation. SEAB in its letter calls for the standing body to be comprised of the three Under Secretaries and chaired by Under Secretary for Management and Performance. SEAB also recommended that the Laboratory Operations Board (LOB) have a small group of career people that would worry about day to day operations. SEAB also noted in the letter that the CRENEL report could have gone further on whether the labs are too big or too small and whether there is duplication; and suggested that the report should have included a timeline for implementation. The letter was discussed amongst the SEAB members; approved by SEAB; and will be posted on the SEAB website and transmitted formally to the Secretary.

Lynn Orr noted that this spring the Office of Science and Energy will adopt a planning process for the applied energy labs modeled on Office of Science and that the NNSA labs will also participate.

Task Force Chair, Martha Schlicher discussed the report of the Methane Hydrates Task Force. She described the recommendations in the consensus on the report. The Task Force determined that DOE's methane hydrates program should remain a priority and funding should remain at its FY15 level of $15M per year to provide guidance to other countries; split the program budget between fundamental science/research and field experiments; build on prior strong external engagement with industry and academia; and do a better job of using the existing methane hydrate committee. The SEAB members offered input for refinements to the draft, including the suggestion to add more context setting summary up front and to distinguish between trying to address technological barriers and not commercial barriers. The Board approved the report for transmission to the Secretary with these changes.

LBL Overview

The SEAB Chair introduced **LBL Director, Paul Alivisatos** and congratulated him on being awarded the National Medal of Science.

Alivisatos described the increased activity of the National Lab Directors' Council and noted that the network of labs is a very powerful concept for the labs and DOE to think about. Here is a spectrum of institutions with different expertise and different cultures and capabilities from a technology point of view and this diversity is one of the most important features of how DOE accomplishes its work.

He then went on to describe how LBL fits in this network. LBL is the 'open node' on the network with the culture of a public university – through which DOE can be in contact with huge swaths of society. This happens through the facilities that exist at LBL. For a facility/program/national lab to do well, it has to be a place where the stability is strongly tied to the fact that early career folks can come and define their paths; tools are state of the art and open access; ideas can flow; and there are many opportunities for collaborations and publishing with other universities, labs, and industry. At LBL, there are broad fields of activity and they have been able to create new infrastructure with the university, private philanthropy, and DOE. They also have their own Berkeley Lab Foundation.

Two areas that need to be fostered:

1. *People inside the labs as a cultural change*. For people who work in a lab, their consciousness is traditionally affiliated with their institute. They are now realizing that they are part of a system and exploring how to take advantage of other labs and contribute. This consciousness is incomplete and needs to be fostered. Part of the role of the Lab Director is to communicate to the lab personnel. The mission is to promote science as a whole and not just for an individual institution.
2. *Fostering and exploiting the network to maximum degree*. So far this has been uneven – only managing specific programs at specific labs. The planning process has made strides, to the extent that DOE is planning as a network. Redundancy, competition, and reinforcement are good characteristics of a network.

This progress happens by cultural change and permeates consciousness at DOE and the labs and outside.

Alivisatos also noted that the Lab Directors are thinking about diversity and attracting talent. From outside no one knows what a career track at a lab might look like or how to go about finding the jobs. The Lab Directors held a workshop on diversity in September where one of the ideas was to develop a common application across the lab system for postdocs.

Presentations:

Jennifer Doudna, University of California, Berkeley, described the origins of the CRISPR-Cas technology and how it will be impactful in human health and energy. CRISPR-Cas is a revolutionary genome technology that started with curiosity about how bacteria fight flu. CRISPR-Cas genome engineering has spurred fundamental changes in biological and biomedical research, enabling scientists to read and rewrite genetic code.

Cas9 is a bacterial DNA nuclease enzyme that originally evolved in bacteria to provide protection against viral infection. The CRISPR-Cas9 genome editing tool is a programmable bacterial binding/cleaving enzyme that allows researchers to introduce desirable genetic changes in individual organisms or populations. It uses pieces of RNA to guide its activity, enabling researchers to target any specific region of a genome simply by providing a "short guide" RNS that can pair with the region of interest. Once targeted, different versions of Cas9 can be used to activate or inhibit genes, and make targeted cuts within the genome. Depending on the experimental design, researchers can use these latter cuts to either disrupt genes or replace them with newly engineered versions of genetic code.

Laboratory Directed Laboratory Research (LDRD) supported research to study structures within RNA. This led to work on different types of CRISPR systems. Cas9 protein is an enzyme that can bind to RNA molecules and can create breaks in DNA.

There have been over 2000 publications in which this technology has been used. There are many applications in animals and plants. Opportunities are growing for solving problems in human health and agriculture. There is a huge opportunity to apply this technology in industrial applications and in agriculture. Applications in the energy sector include using CRISPER-Cas9 to engineer fungi for biofuel production and using CRISPER-Cas9 to introduce DNA molecules and encodes a protein for improved

biochemical functions. The ethical use of this technology is an important topic that impacts all applications. There is a paper on this topic and an NAS summit last month.

The challenge is how to take a technology that is effective and disseminate it - to think about how to apply it to new systems. The Joint Genomics Institute (JGI) is a powerful team building on these technologies. Collaborators include UC Berkeley, UCSF, Columbia, LDRD, and the Bill and Melinda Gates Foundation.

Ilan Gur, Director, Cyclotron Road, gave an overview of the Cyclotron Road program. He noted that it would not have been possible without ARPA-E, LBL leadership and DOE -who have partnered with the labs to run the program.

He noted that it is very easy for an innovator to explore ideas in digital age. But what happens to the technologies that aren't so lean? The traditional startup path has disappeared for hard science energy technologies. Fewer big ideas are being translated. Technical founders are being displaced. Investors aren't putting money into materials development, metals, etc. It's not that investors don't see the opportunities for technologies to disrupt, but the turn on investment isn't worth it.

The Cyclotron model recruits best energy technology innovators, leverages experts and facilities at a world-class R&D institute, gives innovators some time at the national lab with the expertise and facilities with the goal of providing up to 2 years to figure out risk and whether an idea makes sense. This model provides a runway to get started, including a living stipend, dedicated lab and office space, alignment to R&D funders, world class facility and expert support, and unparalleled mentorship. The first call for ideas received 150 proposals, from which 6 were selected.

Projects have avoided millions in R&D capital expenditures and raised follow-on funding; the Lab isn't just leveraged. The scientists in the program say what they are doing is of value to the labs. Berkeley Lab scientists say it lets them diversify their knowledge, network, and research portfolio; upgrade equipment and capability; bring funding into the research group; and bring different perspectives. Key stakeholders include DOE, private sector, Berkeley Lab, and innovators.

Lessons learned in the pilot include being able to attract high caliber innovators, win-win collaborations with lab scientists, projects can leverage modest program support to attract more funds, and DOE and the private sector are enthusiastic to engage. Challenges include IP constraints and programmatic constraints for the program. The decision was to set up Cyclotron Road as a public private partnership.

There were brief reports from a few of the first cohort on thermionic power and biofuels.

The SEAB Chair raised the question of why the lab has the competence or mission to make this type of investment. Other SEAB member comments noted that this program is enormously creative and a bridge, but must be the right use of big public investment.

<u>Public Comment Period</u>

Katy Christiansen, Strategic Analyst for the Biosciences Area at Berkeley Lab

"I'd like to use this time to encourage the Advisory Board to consider how DOE can contribute to making biology efficient and facile to engineer. Today, you are at JBEI and even with significant investment and scientific advancements, we still find biology slow and expensive to engineer. At LBL, we are working

with eight other national labs to develop a vision for how DOE's investments in infrastructure and expertise can be leveraged to create an accessible platform and user facility that will democratize the ability to create microbes and plants to solve challenges in energy and environment."

Wrap up

The next quarterly SEAB meeting is scheduled for March 23, 2016 in Washington, DC. The June meeting date and location – one of the national labs - will be determined soon. The September and December quarterly meetings will take place in Washington, DC.

The meeting adjourned at 12:30PM.

Respectfully Submitted:

Karen Gibson
Designated Federal Officer

I hereby certify that these minutes of the January 26, 2016 SEAB meeting are true and correct to the best of my knowledge.

John Deutch
Chair