Real-World Models

DOE and its national labs currently engage in a number of consortia with industry aimed at different targets for different technologies. To illustrate how different consortia organize to achieve these targets, Table 1 outlines the essential components and characteristics of several successful DOE consortia.

Table 1. Summary of Consortia

Advanced Engine Combustion Consortium (AEC)	
Lead Organization	**Membership**
Combustion Research Facility (CRF) at Sandia National Laboratories (SNL)	• Auto industry: Caterpillar, Chrysler, Cummins, Detroit Diesel, Ford, ElectroMotive, GM, John Deere, Mack Trucks, PACCAR, Volvo • Energy companies: BP, Chevron, ExxonMobil, GE Global Research, Shell Global Solutions • National labs: Argonne National Laboratory (ANL), Lawrence Livermore National Laboratory (LLNL), National Renewable Energy Laboratory (NREL), Los Alamos National Laboratory (LANL), National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory (ORNL), SNL • Universities (participants, but not voting MOU signatories): Clemson University, Massachusetts Institute of Technology (MIT), Michigan State University, Michigan Technological University, New Hampshire University, Pennsylvania State University, Stanford University, University of California, Berkeley, University of Connecticut, University of Michigan (U-M), University of Vermont, University of Wisconsin, Wayne State University, Yale University
Essential Components and Characteristics	
Purpose	Support US engine manufacturers by increasing scientific understanding of internal combustion engine processes affecting efficiency and emissions
Nature of technical work	Low TRL
Life cycle	Enduring - Initiated in 2003
Governance model	MOU, signed by membership, who each receive 1 vote Biannual technical review and business meetings
Funding sources	DOE and targeted CRADAs between industry and lab/university partners
IP strategy	Precompetitive R&D – IP owned by industry partners
Metrics	Adoption of combustion models and tools by industry
Impacts on US economy	Over $70B of energy and health care savings over last decade

Carbon Capture Simulation Initiative (CCSI)	
Lead Organization	**Membership**
National Energy Technology Laboratory (NETL)	• National laboratories: Lawrence Berkeley National Laboratory (LBNL), LLNL, LANL, National Energy Technology Laboratory (NETL), Pacific Northwest National Laboratory (PNNL) • Universities: Carnegie Mellon University, West Virginia University, Princeton University, Boston University, University of Texas at Austin • 20 companies via a no-fee advisory board
Essential Components and Characteristics	
Purpose	To help overcome the barriers to widespread, cost-effective deployment of carbon capture technology by developing, demonstrating, and deploying computational tools and models ***to be used by industry*** to reduce the time required to move new energy technologies from discovery to commercialization
Nature of technical work	Low TRL
Life cycle	Five-year project initiated Feb. 1, 2011
Governance model	Technical Director leads overall effort with support from Technical Leadership Team and Executive Committee (high level representatives from each lab and two senior university professors). Board of Directors (Chief Research Officers at each lab) reviews the initiative annually. Industry Advisory Board provides regular input to ensure program is on track to impact industry. Roles are detailed in CCSI Project Plan.
Funding sources	DOE Office of Fossil Energy. Approximately $50 million over 5 years.
IP strategy	Intellectual Property Management Plan signed by labs and universities provides co-ownership of all IP developed under initiative. Any royalties divided equally among parties. Central management of IP provides a single point of contact for licensing. CCSI Toolset initially provided under a Test and Evaluation license.
Metrics	• Industry uptake and licensing of CCSI Toolset • Reduced time/cost to scale up technology (long term metric) • Measurable progress and regular release of CCSI Toolset to industry licensees • Proactive response to recommendations from bi-annual reviews by Industry Advisory Board, Board of Directors, and FE-HQ • Significant scientific contributions as evidenced by high-quality, peer-reviewed publications and invited presentations
Impacts on US economy	New methods and computational tools to accelerate the development and scale up of new carbon capture and related technologies, which could save approximately $500 million during the scale-up per technology taken to commercial scale. Direct assistance to ensure the success of carbon capture scale up projects via Cooperative Research and Development Agreements (CRADA).

Consortium for the Advanced Simulation of Light Water Reactors (CASL)	
Lead Organization	**Membership**
Oak Ridge National Laboratory	• Industry stakeholders: Westinghouse, Electric Power Research Institute, Tennessee Valley Authority • Universities: North Carolina State MIT, U-M • National labs: ORNL, Idaho National Laboratory (INL), LANL, SNL, PNNL • Numerous associate members
Essential Components and Characteristics	
Purpose	Develop and deploy advanced modeling and simulation tools that interoperate so as to create Virtual Environment for Reactor Applications (VERA), "virtual" version of an operating light water nuclear reactor
Nature of technical work	Medium TRL
Life cycle	Two 5-year phases
Governance model	• Consortium agreement signed by all members. • Governed by a director with advice/guidance provided by a Board of Directors consisting of high level representatives from each partner and 3 outside directors • Technically reviewed by Science and Industry councils.
Funding sources	$25M per year provided by DOE Office of Nuclear Energy (NE) with 50% matching by industry
IP strategy	Initial master IP agreement signed by all partners. Implementation of a team-level IP management plan.
Metrics	• Measurable progress and delivery of milestones (541 to date) and the commensurate ability of VERA to demonstrably address nuclear reactor phenomena • Proactive response to findings and recommendations provided by annual DOE NE reviews of CASL • Substantial scientific productivity, measured in part by high-quality, peer-reviewed publications, technical and milestone reports, invited presentations (over 1300 and counting) • Early and aggressive deployment of its M&S technology (VERA) to the nuclear energy and broader science and technology communities.
Impacts on US economy	Development of modeling and simulation tools that will be used by the nuclear energy industry and utilities to address reactor performance and safety issues and thus enabling the increased generation of energy secure electricity

Critical Materials Institute (CMI)	
Lead Organization	**Membership**
The Ames Laboratory	• 4 national labs • 7 universities • 6 corporate members • 5 voting affiliated organizations • 4 non-voting affiliated organizations
Essential Components and Characteristics	
Purpose	Assure the materials supply chains of critical materials for clean energy technologies
Nature of technical work	TRL 1–TRL 6
Life cycle	5-year term ending on June 30, 2018; renewable for an additional 5 years
Governance model	Advisory Board, Industry Council and Commercialization Council advise the Director
Funding sources	DOE and cost share from corporate partners
IP strategy	IP Management Plan signed by all members
Metrics	Invention disclosures, patents, and licenses
Impacts on US economy	Secure supply chains for clean energy OEMs. Will generate at least one technology adopted by industry in each of three areas: • Source diversification • Materials substitution • Materials re-use and recycling

Joint BioEnergy Institute (JBEI)	
Lead Organization	**Membership**
Lawrence Berkeley National Laboratory	• National laboratories: LBNL, SNL, LLNL, PNNL • University of California at Berkeley and Davis • Carnegie Institution for Science
Essential Components and Characteristics	
Purpose	To advance the development of cellulosic biofuels to replace petroleum-based gasoline, diesel, and jet fuels
Nature of technical work	TRL 1–TRL 3
Life cycle	Funding in 5-year increments, beginning in 2007 and renewed in 2012

Governance model	Executive body is a committee composed of the vice presidents of the 4 JBEI research divisions, the JBEI CEO, CSTO, and COO. A representative Board of Directors provides high-level oversight of management and operations.
Funding sources	$25 M/year DOE funding; funding from nearly two dozen CRADAs and SPPs with industry
IP strategy	An inter-institutional agreement among all member institutions establishes that each member owns its own IP and that LBNL manages and has rights to license all JBEI IP on behalf of the members
Metrics	• Delivery of scientific milestones • Publications and presentations • Patent applications/patents • Technologies licensed • Industry visits/general visits/tours • Education, training, and community outreach • Honors/awards
Impacts on US economy	Reducing US dependence on foreign oil through scientific breakthroughs that will enable advanced biofuels to be cost-competitive with petroleum-based fuels; invigorating economies in some rural areas of the US through cellulosic feedstock production on non-food producing lands; decreasing GHG emissions in the transportation sector; creating jobs through startups and licensing to industry; and developing future generations of scientists who will innovate and create jobs for the US.
Joint Center for Energy Storage Research (JCESR)	
Lead Organization	**Membership**
Argonne National Laboratory (ANL)	• Partners: ANL. LBNL, PNNL, SNL, SLAC National Laboratory, University of Illinois at Chicago, Northwestern University, University of Chicago, University of Illinois at Urbana-Champaign, U-M, Johnson Controls, Dow Chemical, Applied Materials, Clean Energy Trust • Funded collaborators: MIT, Harvard University, Notre Dame University, Northern Illinois University, United Technology Research Centers (UTRC)
Essential Components and Characteristics	
Purpose	Discovery, development, and demonstration at laboratory scale of next-generation, beyond lithium-ion electricity storage technology
Nature of technical work	Discovery science, battery design, research prototyping and manufacturing collaboration
Life cycle	5-year initial term with the possibility of renewal for a second 5-year term
Governance model	Director, management team, research leaders and research team; oversight by Governance Committee, advised by External Advisory Committee

Funding sources	DOE, State of Illinois, State of Michigan
IP strategy	Maximize value through pooling, no a priori exclusive licensing for partners or external entities, single licensing agent acting in consultation with all partners
Metrics	Published papers, patents, prototypes, milestones completed, webinars, in-person interactions, collaborations, reg4ional events
Impacts on US economy	Lithium-ion batteries are a \$10B–\$15B market today, next-generation, beyond lithium-ion electricity storage estimated to become equally large over the next decade
SEMATECH-Lawrence Berkeley National Laboratory Partnership	
Lead Organization	**Membership**
SEMATECH	• SEMATECH core industry members: Intel, Samsung, TSMC, Global Foundries, and IBM • LBNL
Essential Components and Characteristics	
Purpose	Conduct precompetitive research in advanced semiconductor manufacturing
Nature of technical work	TRL 1–TRL 6
Life cycle	Enduring: SEMATECH is more than 25 years and Berkeley partnership has been in effect 15 years
Governance model	Within SEMATECH, each core company gets one seat on the board. SEMATECH partners with Berkeley Lab through work-for-others agreements.
Funding sources	Industry
IP strategy	SEMATECH has the right to request an exclusive license in the field of use of EUVL lithography, with the right to sublicense, to all LBNL inventions.
Metrics	Progress relative to International Technology Roadmap for Semiconductors (ITRS)
Impacts on US economy	The total direct US semiconductor employment is estimated to be just under 250,000 workers which supports more than 1 million jobs in other sectors of the U.S. economy through indirect employment in suppliers to the industry, re-spending of the industry workers and government employment from taxes.

Trustworthy Cyber Infrastructure for the Power Grid (TCIPG)	
Lead Organization	**Membership**
University of Illinois at Urbana-Champaign	• Arizona State University • Dartmouth College • Washington State University
Essential Components and Characteristics	
Purpose	R&D to advance cyber security and resiliency of energy delivery systems
Nature of technical work	Research activities spanning cyber security and resiliency for generation, transmission, distribution, and customer premise. Pilot deployment of developed technologies in utility environments.
Life cycle	Funded through 08/30/2015
Governance model	PI from Illinois, leadership team with site leads from all member institutions, external advisory board (EAB). Weekly leadership meetings (telecom). Quarterly reviews with funding agencies and EAB.
Funding sources	DOE, Department of Homeland Security, university cost-share
IP strategy	Multiple: Startup, licenses, pilot technology deployment, and open-source
Metrics	Technology adoption by the sector. Graduates in the field.
Impacts on US economy	Two startups. Adoption of solution by a leading utility equipment vendor. Pilot deployment of security for advanced metering infrastructure (AMI) at a major utility. Outreach to K–12 students and the general public on smart grid awareness. Workforce development in the form of training modules.

US Advanced Battery Consortium (USABC)	
Lead Organization	**Membership**
EERE Vehicle Technologies Program	• Fiat-Chrysler Automobiles • Ford Motor Company • General Motors Company
Essential Components and Characteristics	
Purpose	Conduct pre-competitive automotive battery R&D
Nature of technical work	Fund competitively awarded R&D contracts for advanced automotive batteries for hybrid, plug-in hybrid, and full electric vehicles. To a lesser extent, USABC also funds competitively awarded R&D contracts for battery components, such as separators or electrolytes.
Life cycle	Partnership conducted through a 5-year CRADA. However, the DOE has been working closely with the USABC through a series of cooperative agreements that

	span over 20 years.
Governance model	The CRADA calls for substantial involvement"= by DOE regarding program direction, funding, proposal review and selection, and project review. The USABC Management Committee (MC) comprises one management employee from each of the auto companies, FCA, Ford, and GM, and one member from DOE; one of the OEM individuals serves as Chair. The MC makes both personnel and funding level decisions for the USABC: they allocate staff to various USABC functions and decide if a given proposal will ultimately be funded. A technical advisory committee (made up of 20–30 technical experts in the battery development field, drawn from each of the automotive OEMs, DOE, and the national laboratories) provides technical guidance and recommendations to the MC.
Funding sources	Department of Energy EERE Vehicle Technologies Office provides 50% of contract costs, battery developers cost share their contracts at a minimum of 50%. Automotive OEMs provide in-kind contributions through their MC and TAC members.
IP strategy	IP developed under USABC contracts is held by the technology developer, who cost shares the development effort at 50%. DOE retains marching rights to that IP. Developers are given wide latitude to develop and commercialize their technology as none of the USABC members directly compete with battery or ultracapacitor developers; rather, the member organizations are users and purchasers of that technology.
Metrics	Quantitative battery performance requirements are developed and used for all electric drive vehicle applications. USABC uses a "gap chart" for each energy storage technology (EV, PHEV, HEV batteries) that specifies performance metrics, mass, volume, and cost. Developers are evaluated based on the ability of their hardware deliverables to meet those performance and cost goals. USABC also uses standard test procedures and a standard cost model to ensure use of consistent methods to quantify a developer's progress towards those goals each quarter.
Impacts on US economy	The DOE has been working closely with the USABC through a series of cooperative agreements that span over 20 years. These agreements have resulted in many successes, including the development of the battery currently powering the GM Volt; NiMH batteries used in nearly all HEVs; and Maxwell ultracapacitors currently in use in millions of vehicles. An analysis by RTI International, "Benefit-Cost Evaluation of U.S. DOE Investment in Energy Storage Technologies for Hybrid and Electric Cars and Trucks" determined that the DOE's \$971 million R&D investment (including \$315M funds to USABC) in advanced battery technology for electric drive of vehicles (EDVs) from 1991–2012 directly led to the commercialization of the 2.4 million EDVs sold between 1999–2012 that incorporate nickel metal hydride and lithium ion batteries, which are projected to reduce U.S. fuel consumption by \$16.7 billion through 2020.