The Advanced Research Projects Agency-Energy (ARPA-E)

Dr. Eric Rohlfing, Acting Deputy Director for Technology

FICR Meeting 2013
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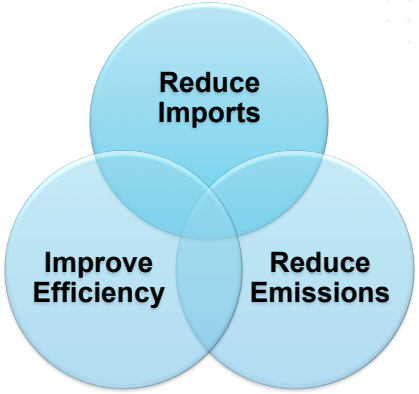
The ARPA-E Mission

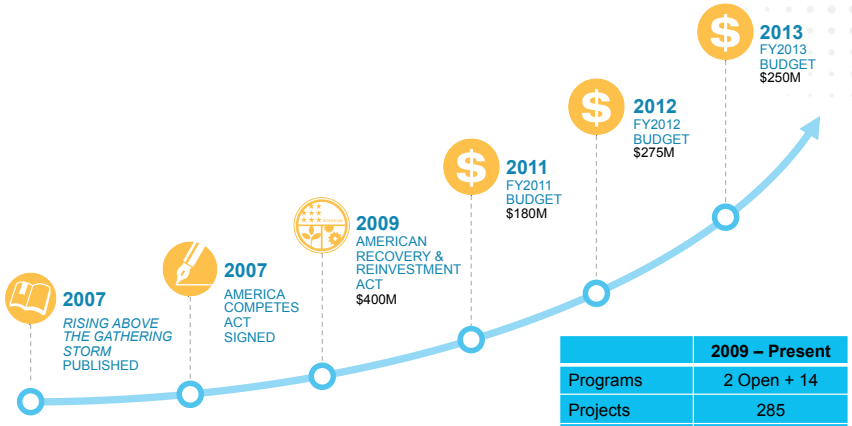
Catalyze and support the development of transformational, high-impact energy technologies

Ensure America's

- National Security
- Economic Security
- Energy Security
- Technological Lead

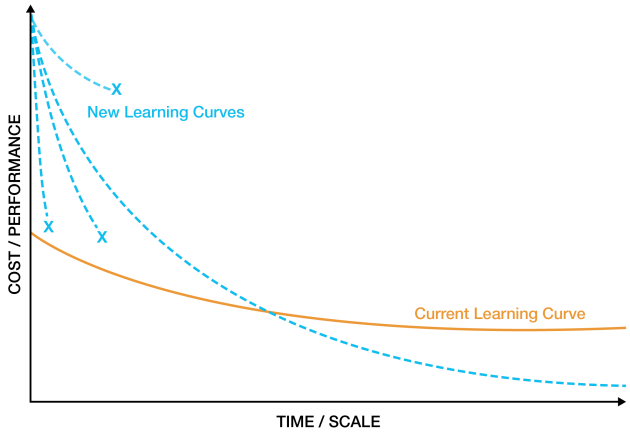


History of ARPA-E



	2009 – Present
Programs	2 Open + 14
Projects	285
Dollars (MM)	$770

Creating New Learning Curves



What Makes an ARPA-E Project?

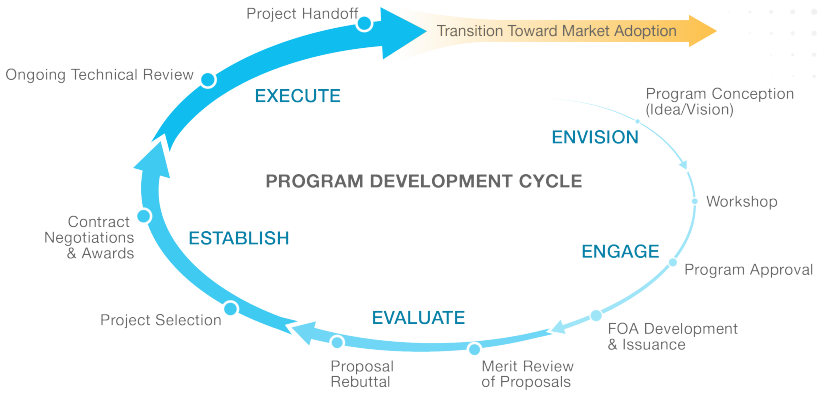
IMPACT
- High impact on ARPA-E mission areas
- Credible path to market
- Large commercial application

TRANSFORM
- Challenges what is possible
- Disrupts existing learning curves
- Leaps beyond today's technologies

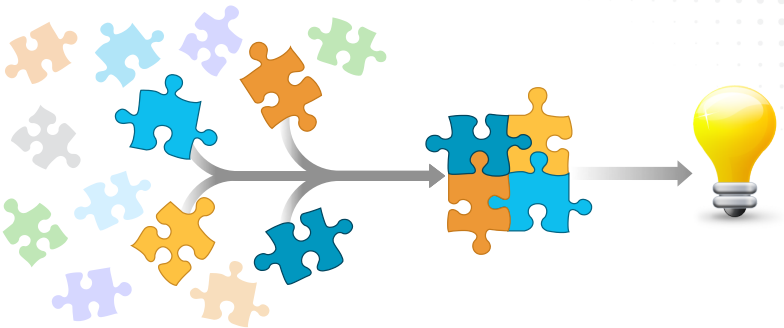
BRIDGE
- Translates science into breakthrough technology
- Not researched or funded elsewhere
- Catalyzes new interest and investment

TEAM
- Comprised of best-in-class people
- Cross-disciplinary skill sets
- Translation oriented

Technology Acceleration Model



How does ARPA-E Enable Transformations?



Science & Technology Knowledgebase | **Unique Project Team** | **Disruptive New Technologies**

ARPA-E teams come from a multiple segments of the S&T base to attack problems in entirely new ways

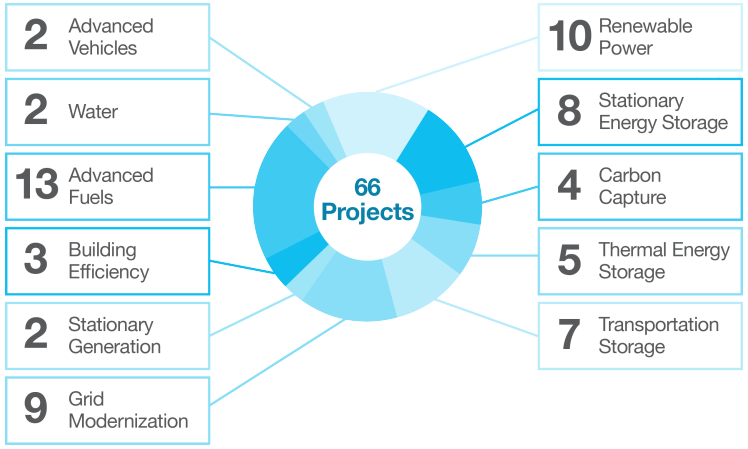
Measuring ARPA-E's Success

MOVING TECHNOLOGY TOWARD MARKET
- Partnerships with Other Government Agencies
- New Company Formation
- Established Company Partnerships
- New Communities

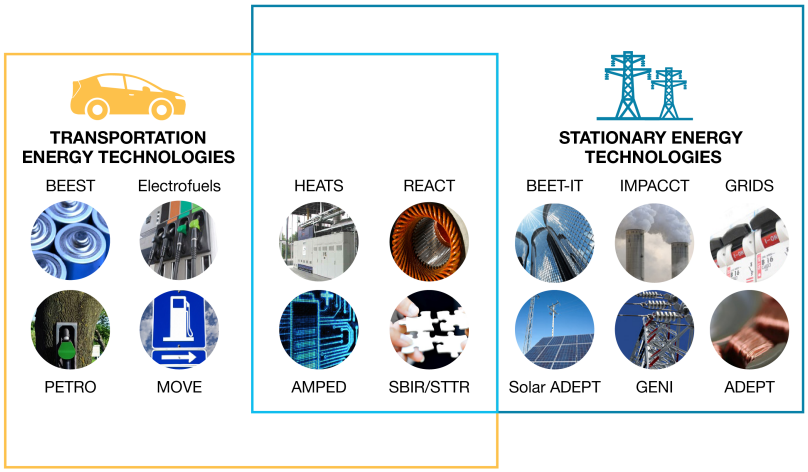
BREAKTHROUGH ACHIEVEMENTS
- Technology breakthroughs
- Patents
- Publications

OPERATIONAL EXCELLENCE
- Expedited program development and project selection
- Aggressive performance metrics

OPEN 2012: 66 Projects, 24 States, 11 Areas



Focused Programs



BEEST

ELECTRIC VEHICLE BATTERIES

Mission

Develop a variety of electric vehicle battery technologies that can compete in both cost and performance with traditional gasoline-powered cars.

Program Director	Dr. Dane Boysen
Year	2010
Projects	6
Total Investment	$35.5 Million

Goals

- Cost-competitive with traditional cars
- 30% of today's cost at 2-5x energy storage
- 300-500% longer battery life + range

Highlights

- PolyPlus
  - $9 million Vehicle Technologies grant
  - Contracted with Hitachi for fabrication line (Navy as first market)
- Sion
  - CERDEC grant from Army for lithium sulfur battery for UAV's/Air Force
  - Funding from Simon Foundation and $20M from BASF

GRIDS

GRID-SCALE RENEWABLE ENERGY STORAGE

Mission

Develop technologies that can store renewable energy for use at any location on the grid at an aggressive investment cost less than $100 per kilowatt hour, creating a stronger and more robust electric grid.

Program Director	Dr. Mark Johnson
Year	2010
Projects	12
Total Investment	$33.2 Million

Goals

- Balance intermittent renewable sources connected to the grid
- Efficiently store and send electricity anywhere in the U.S. at a lowest possible cost
- Strong, efficient, stable and robust electric grid

Highlights

- General Compression:
  - $54.5M follow-on funding from private investors for CAES technology deployment
- ABB/SuperPower/Brookhaven NL
  - $4.2M follow-on funding from US Army Research Laboratory for SMES development and testing in DOD microgrids
- Bosch/Lawrence Berkeley NL
  - Attained highest power density ever in hydrogen-bromine flow battery system

HEATS

THERMAL ENERGY STORAGE

Mission

Develop revolutionary, cost-effective ways to store thermal energy by innovating electricity delivery, creating synthetic fuel from sunlight, and improving the range of electric vehicles (EVs).

Program Director	Dr. James Klausner
Year	2011
Projects	15
Total Investment	$37.6 Million

Goals

- Enable non-intermittent solar power plants and peak-power nuclear power plants
- Create transportable fuels from sunlight
- Modular thermal energy storage for EVs

Highlights

- UT Austin
  - Developing sugar derivatives-graphene foam composites with heat of fusion 2-3 x of state of the art and thermal conductivity > 10 – 20 x of state of the art
- Halotechnics
  - Developing low cost molten glass as heat transfer and thermal storage for CSP
- MIT
  - Developing energy storage device which captures energy from the sun, is transportable like fuels, rechargeable like a battery and emissions-free

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Electrofuels

VERSATILE TRANSPORTATION FUEL SOLUTIONS

Mission

Develop microorganisms to create liquid transportation fuels in a new and different way that could be up to 10 times more energy efficient than current biofuel production methods.

Program Director	Dr. Ramon Gonzalez
Year	2010
Projects	13
Total Investment	$48.3 Million

Goals

- Develop and integrate organisms for autotrophic/ non-photosynthetic biological systems
- Increase liquid fuel energy density beyond ethanol

Highlights

- OPX Biotechnologies (Boulder, CO)
  - Demonstration of fatty acid production from engineered microbes fed H2 and CO2
  - Raised $64M with venture investors
  - Named to 2012 Global Cleantech 100 list
- University of California Los Angeles
  - Demonstration and publication in Science magazine of an integrated system for In situ formate production and microbial conversion to alcohols

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PETRO

HIGHER PRODUCTIVITY CROPS FOR BIOFUELS

Mission

Develop non-food crops that directly produce transportation fuels to be cost-competitive with petroleum and not impactful on U.S. food supply.

Program Director	Dr. Jonathan Burbaum
Year	2011
Projects	10
Total Investment	$37.3 Million

Goals

- To reduce biofuel production costs
- To increase energy yields per acre of land
- To recycle atmospheric CO_2

Highlights

- Develop pine trees that will accumulate 20% of their biomass as high energy terpene molecules
- Develop tobacco that produces oil directly, together with high planting density agriculture
- Introduce multiple metabolic pathways into oilseed crops to significantly improve photosynthesis

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IMPACCT

CARBON CAPTURE TECHNOLOGY

Mission

Develop new materials and processes to lower the cost of removing carbon dioxide (CO_2) from existing coal-fired power plants, thus enabling continued use of coal with reduced emissions.

Program Director	Dr. Karma Sawyer
Year	2010
Projects	15
Total Investment	$39.9 Million

Goals

- Capture 90% of CO_2 from coal-fired power plants at no more than a 35% increase in the cost of electricity
- Focus on technologies that could be retrofitted to existing power plants
- Accelerate implementation of carbon capture technology

Highlights

- Texas A&M University
  - Designed new class of materials, Single Molecule Traps, tailor-made to capture CO2
  - Created spinout named framergyTM to commercialize the technology
- University of Colorado – Boulder
  - Developing new type of membrane based on gels and composite polymer designs
  - Engaged with Total and 3M as industrial partners to commercialize the membranes

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REACT

ALTERNATIVES TO CRITICAL MATERIALS IN MAGNETS

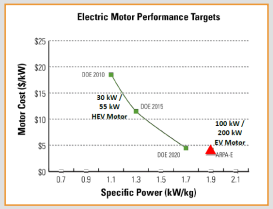
Mission

Identify low-cost, abundant replacement materials for rare earths while encouraging existing technologies to use them more efficiently.

Program Director	Dr. Mark Johnson
Year	2011
Projects	14
Total Investment	$27.7 Million

Goal

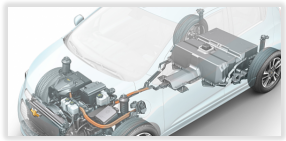
- Eliminate most or all rare earth magnets in electric vehicle motors & wind generators



Highlights

- Several new chemistries, not containing critical materials, show promise on a laboratory scale as a replacement for permanent magnets containing critical materials
- Cost-competitive large-scale off-shore wind generators will be enabled by using high current carrying superconductor wiring

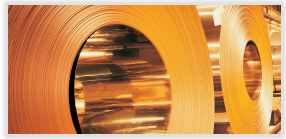
New Funding Opportunities



RANGE

Robust Affordable Next Generation EV-storage

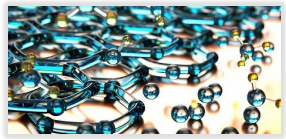
Release Date: 2/19/2013



METALS

Modern Electro/Thermochemical Advances in Light-metal Systems

Release Date: 3/20/2013



REMOTE

Reducing Emissions Using Methanotrophic Organisms for Transportation Energy

Release Date: 3/15/2013

RANGE

NEXT-GENERATION ENERGY STORAGE SYSTEMS FOR ELECTRIC VEHICLES

Mission

Improve EV range and reduce vehicle costs by re-envisioning the total EV battery system, rather than working to increase the energy density of individual battery cells.

Program Director	Dr. Ping Liu
Year	2013
Projects	TBD
Available Funding	$20 Million

Goals

- Develop robust battery chemistries and architectures that would improve vehicle driving range and overall battery robustness
- Focus on multifunctional energy storage designs that use these robust storage systems to simultaneously serve other functions on a vehicle, thus further reducing an energy storage system's effective weight and overall electric vehicle weight

Highlights

- *Coming soon*

METALS

ADVANCED PROCESSING AND RECYCLING OF LIGHTWEIGHT METALS

Mission

Develop innovative technologies for cost-effective processing and recycling of Aluminum, Magnesium and Titanium for lightweight vehicle materials.

Program Director	Dr. James Klausner
Year	2013
Projects	TBD
Available Funding	$20 Million

Goals

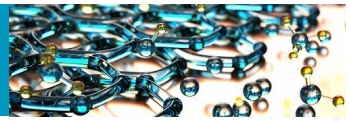
- Advance technologies to develop metals have high strength-to-weight ratios, making them ideal for creating lighter vehicles that save fuel and reduce carbon emissions
- Utilize domestically available ores
- Reduce energy inputs and emissions from processing to make light metals cost competitive with current materials, such as steel
- Develop technologies for rapid and efficient light metal sorting to enable domestic recycling

Highlights

- *Coming soon*

REMOTE

BIOLOGICAL CONVERSION OF GAS TO LIQUIDS



Mission

Develop transformational biological technologies to convert gas to liquids for transportation fuels.

Program Director	Dr. Ramon Gonzalez
Year	2013
Projects	TBD
Available Funding	$20 Million

Goals

- Develop innovative catalysts and lab scale reactors to efficiently and cost-effectively convert natural gas
- Lower the cost of gas to liquids conversion
- Enable the use of low-cost, domestically sourced natural gas for transportation, which could reduce vehicle emissions compared to conventional gasoline engines

Highlights

- *Coming soon*

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