CHANGING WHAT'S POSSIBLE

An Overview of the Advanced Research Projects Agency – Energy

Dr. Eric Rohlfing
Acting Deputy Director for Technology

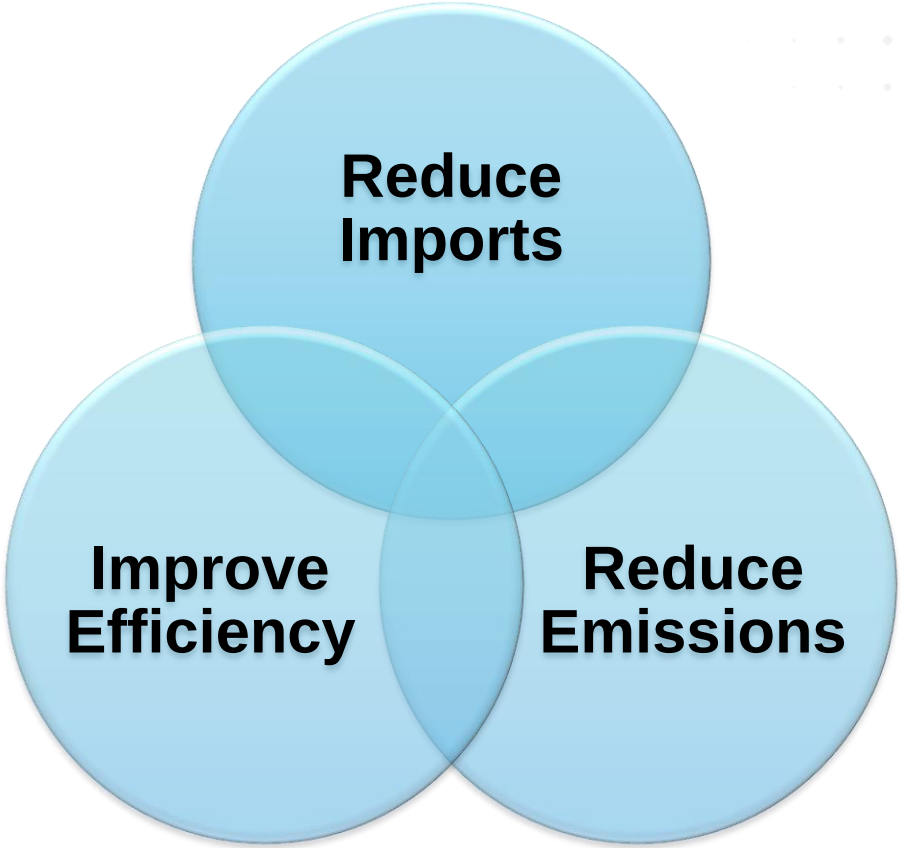
2013 TransTech Energy Business Development Conference
November 6, 2013

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



Agency History

- In 2007, the creation of ARPA-E was authorized by the American COMPETES Act based on a recommendations from the National Academies in *Rising Above the Gathering Storm*.
- In 2009, the first funding for the new agency was provided via American Recovery and Reinvestment Act (ARRA). Annual appropriations have followed in 2011-2013.
- As of March 2013, ARPA-E had funded 285 projects, across 33 states, with $770 million in funding.
- Funding distribution
  - 38% small businesses
  - 35% universities
  - 19% large businesses
  - 6% national labs
  - 3% non-profits

Innovation

People creating value through the implementation of new ideas

- Herman D'hooge,
Intel Innovation Network

Innovation

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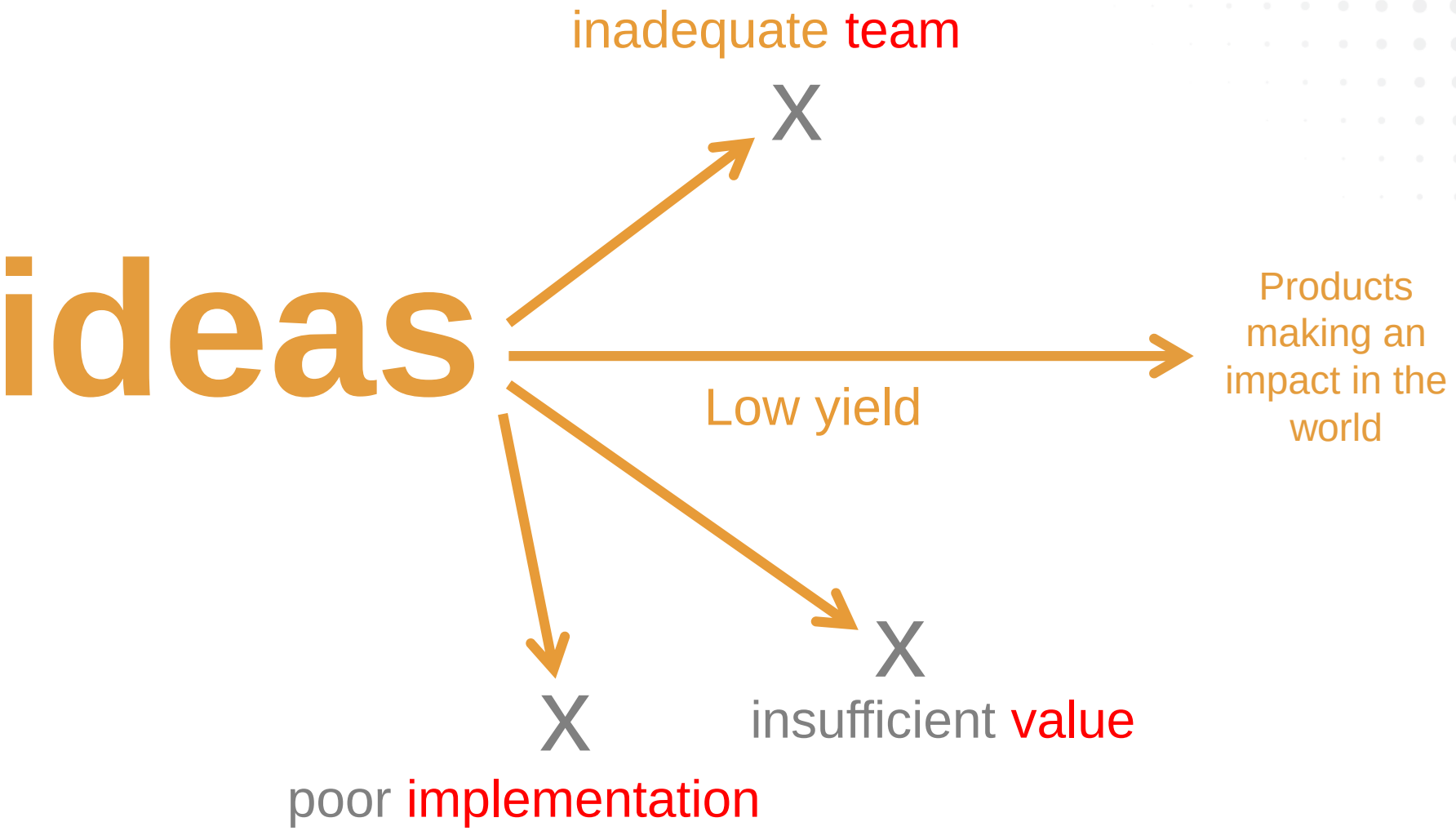
Improving the Yield



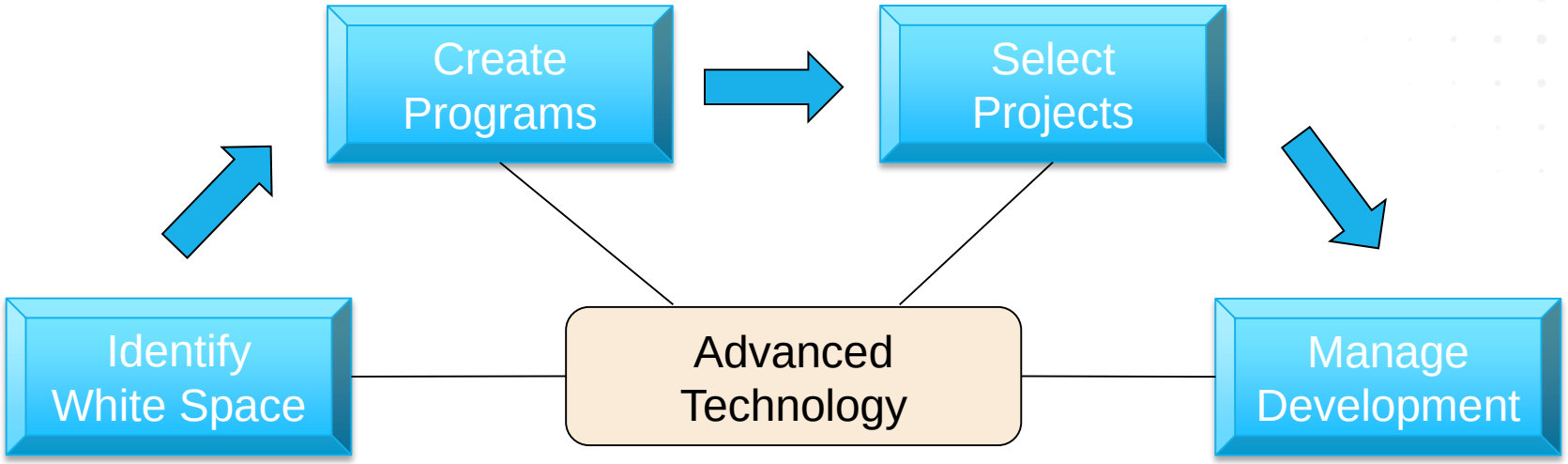
Changing the Model

ideas

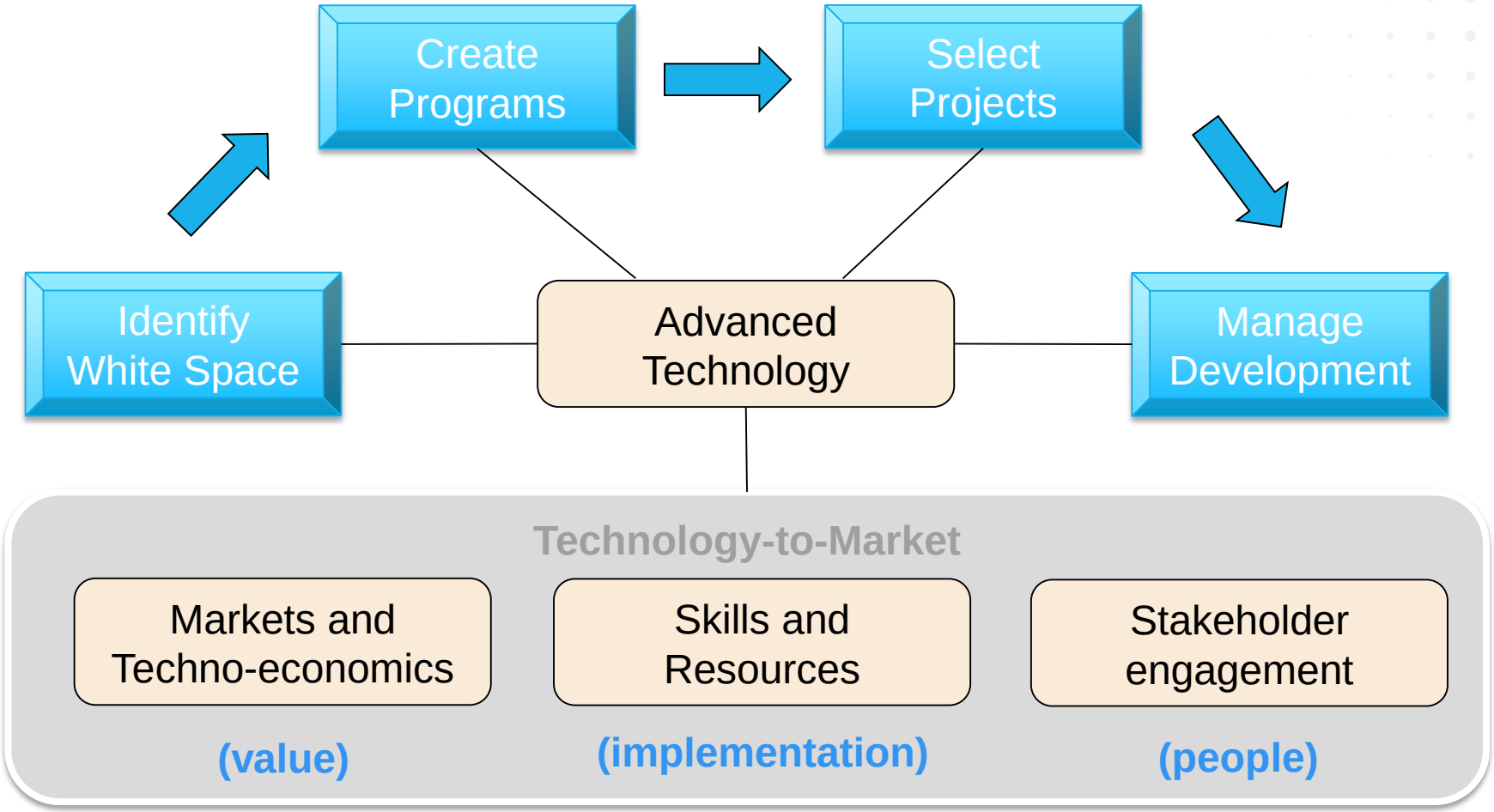
Products making an impact in the world

+ value
+ team
+ implementation

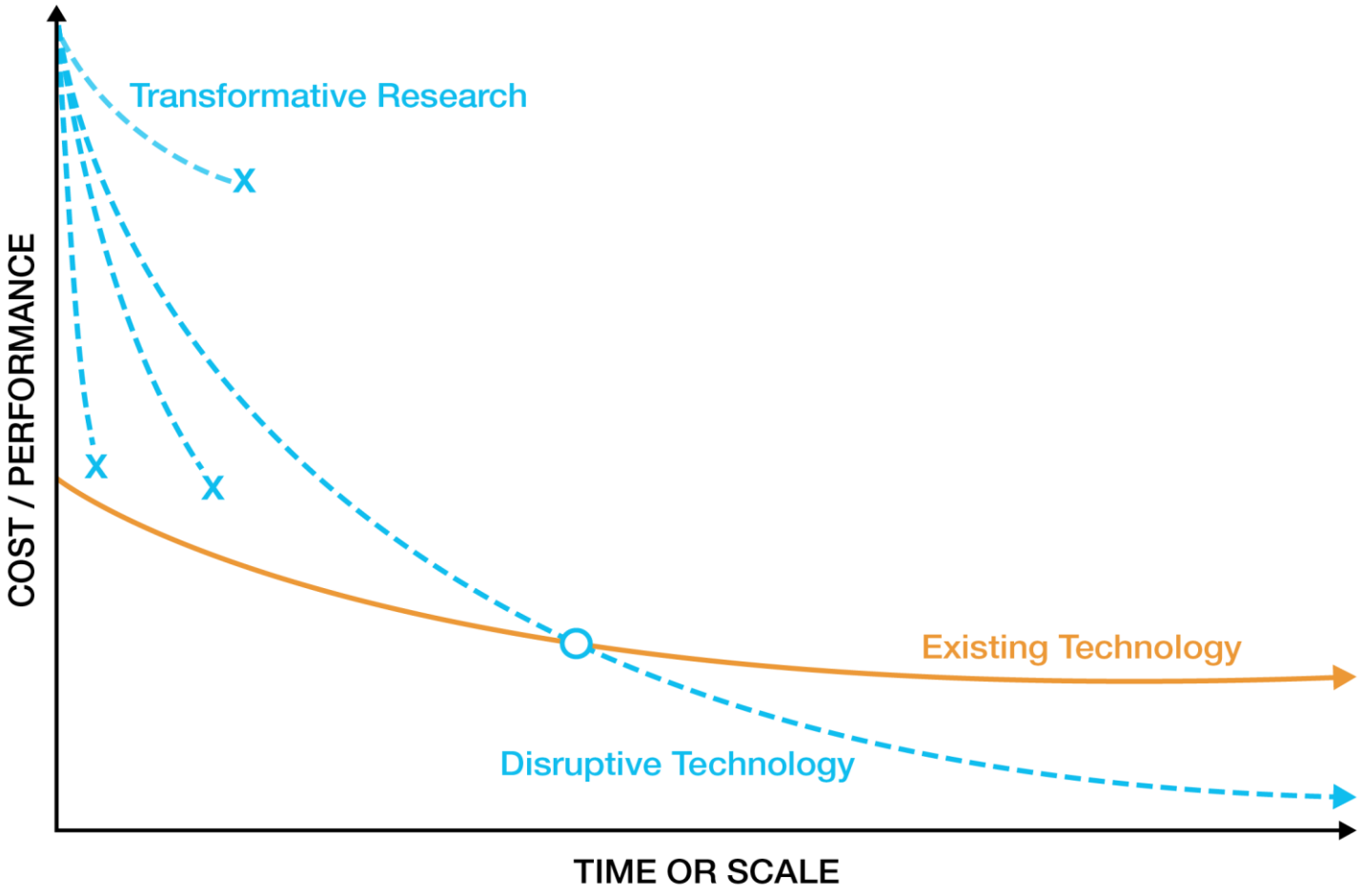
The ARPA-E Approach



The ARPA-E Approach



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

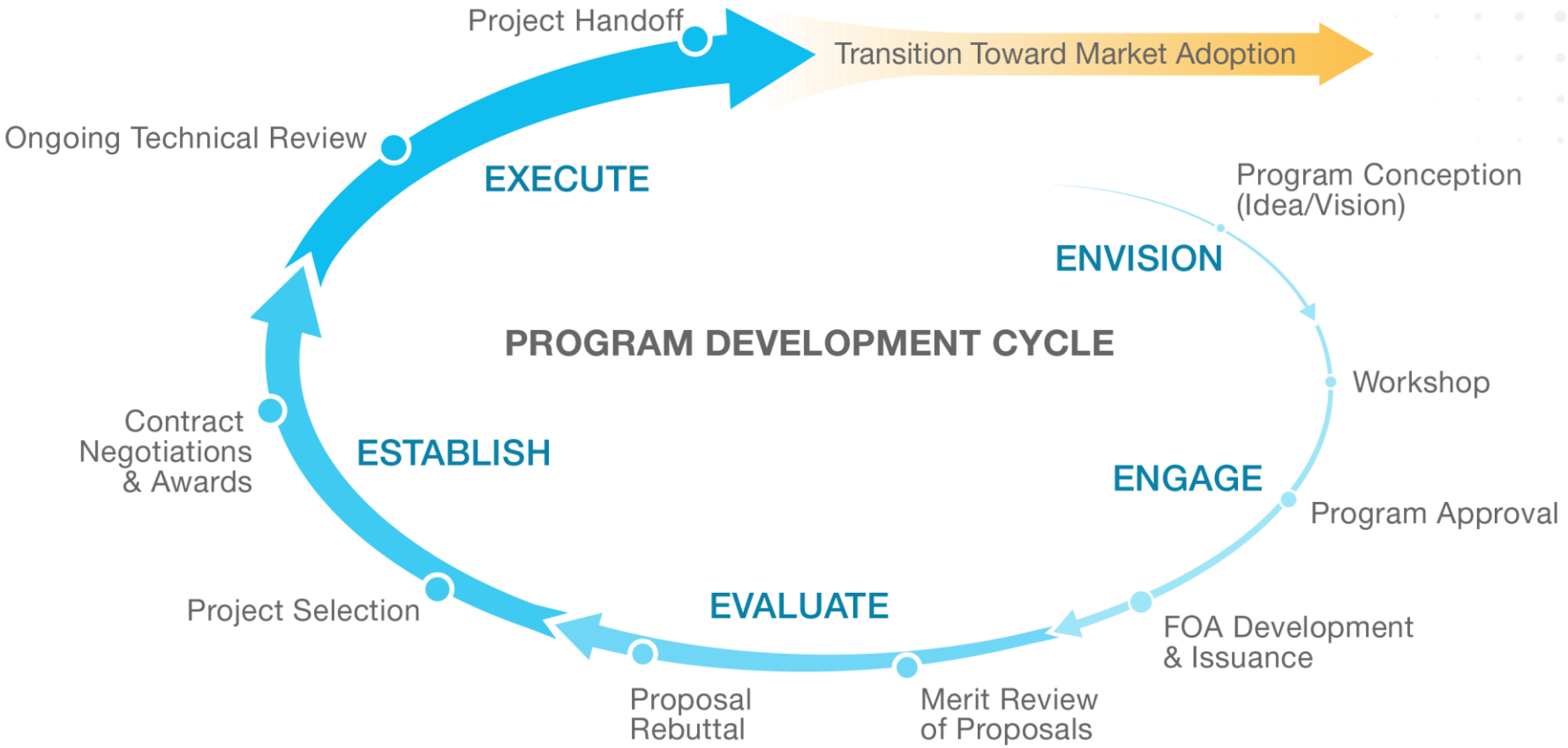
BRIDGE

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

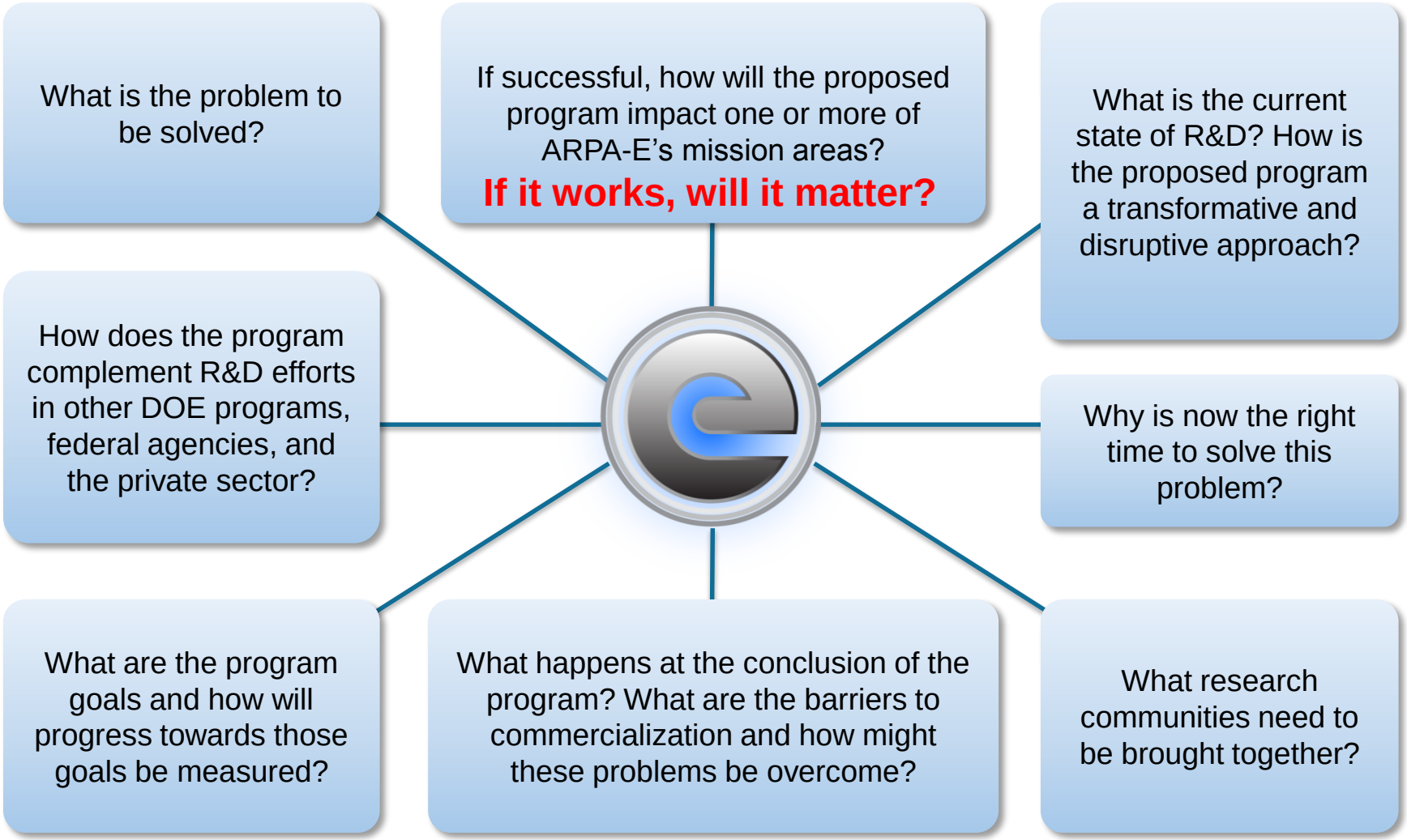
TEAM

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

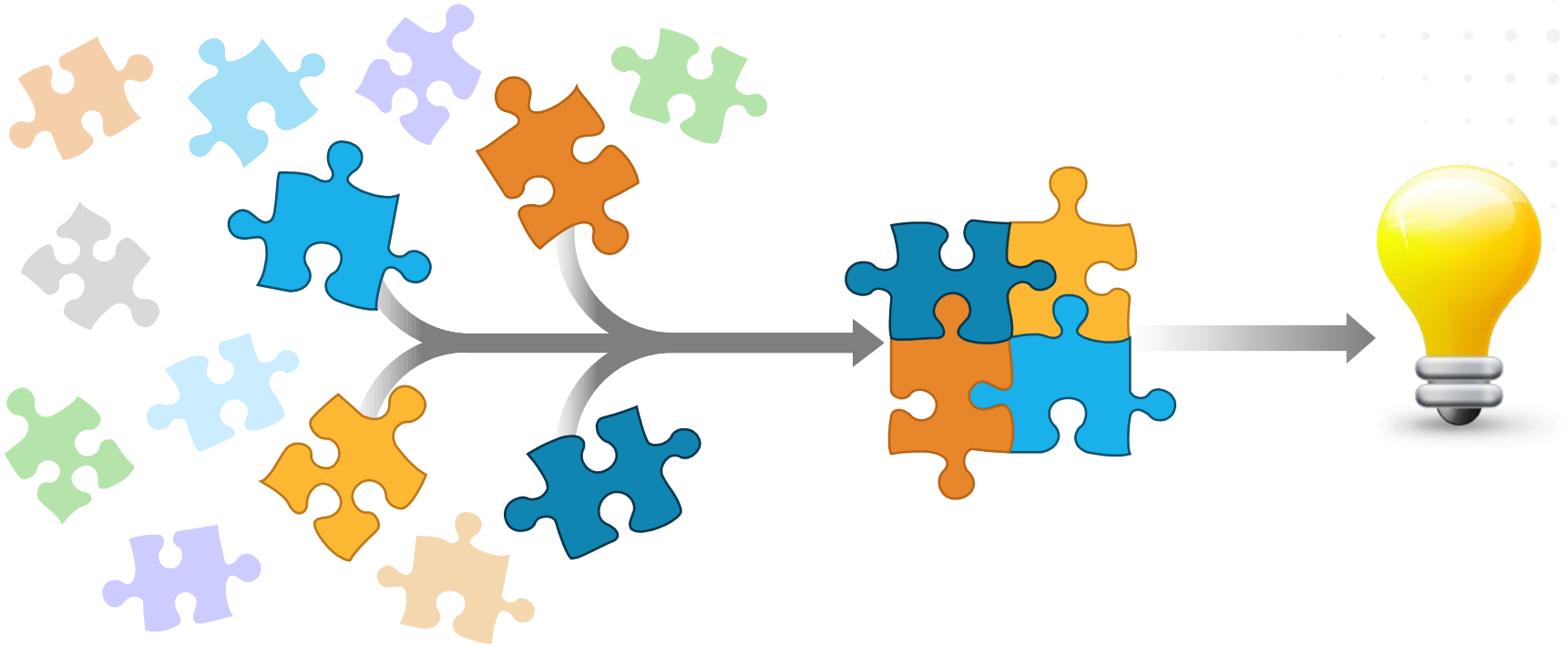
Program Development



ARPA-E Program Framing Questions



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

Focused Programs

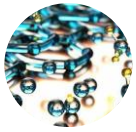

BEEST

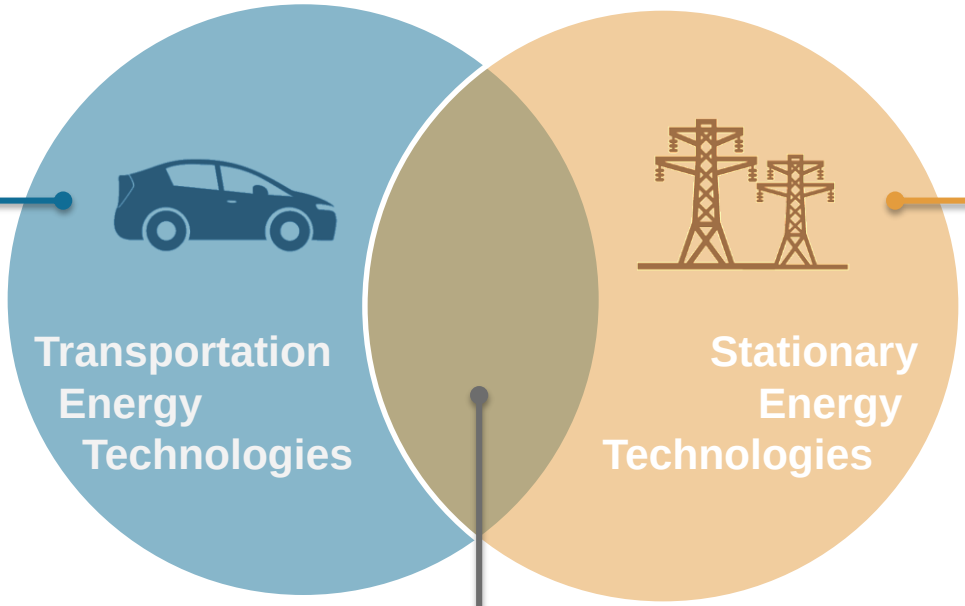

PETRO


Electrofuels


MOVE


RANGE


REMOTE



HEATS


AMPED


REACT


SBIR/STTR


METALS


SWITCHES

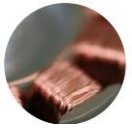

Solar ADEPT


BEETIT


GRIDS


IMPACCT


ADEPT


GENI


FOCUS

FY13 Focused Solicitations

RANGE

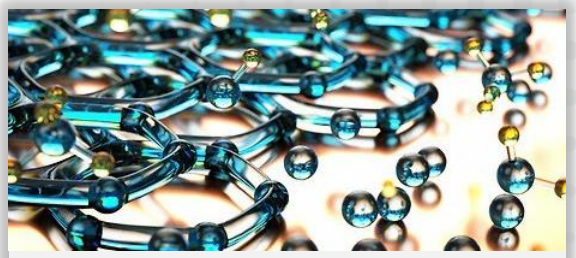
Robust Affordable Next Generation EV-storage

Awards Announced 8/21/13

METALS

Modern Electro/ Thermochemical Advances in Light-metal Systems

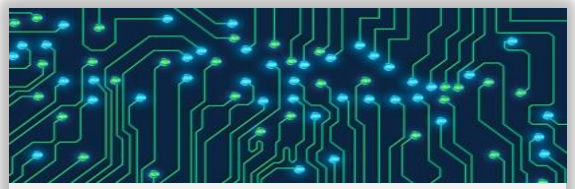
Awards Announced 9/19/13



REMOTE

Reducing Emissions Using Methanotrophic Organisms for Transportation Energy

Awards Announced 9/19/13



SWITCHES

Strategies for Wide-bandgap, Inexpensive Transistors for Controlling High Efficiency Systems

Awards Announced 10/21/13

FOCUS

Full-spectrum Optimized Conversion and Utilization of Sunlight

FOA Release Date: 7/16/2013

Learn more at
www.arpa-e.energy.gov

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	15
Available Funding	$34 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

- *Awards announced on September 19, 2013.*

Why bio-conversion of natural gas to fuels?

Science & Technology

- The direct conversion of methane to a more functional liquid fuel has been an important area of investigation for catalysis for decades.
  - Yet practical catalysts and low-cost implementation remain elusive.
- Biology as route to high-efficiency CH_4 activation & conversion at STP
  - Biological enzymes such as MMO are capable of partial methane oxidation at STP with high specificity but are inefficient.
  - New biological tools, pathway engineering, and recent mechanistic understanding of aerobic & anaerobic methane metabolism open up opportunities for bio-conversion approaches to methane to liquids.
  - **Challenge: design new enzymes to activate CH_4 and new pathways to convert activated molecule to liquid fuel at high carbon and energy efficiencies.**

Opportunity

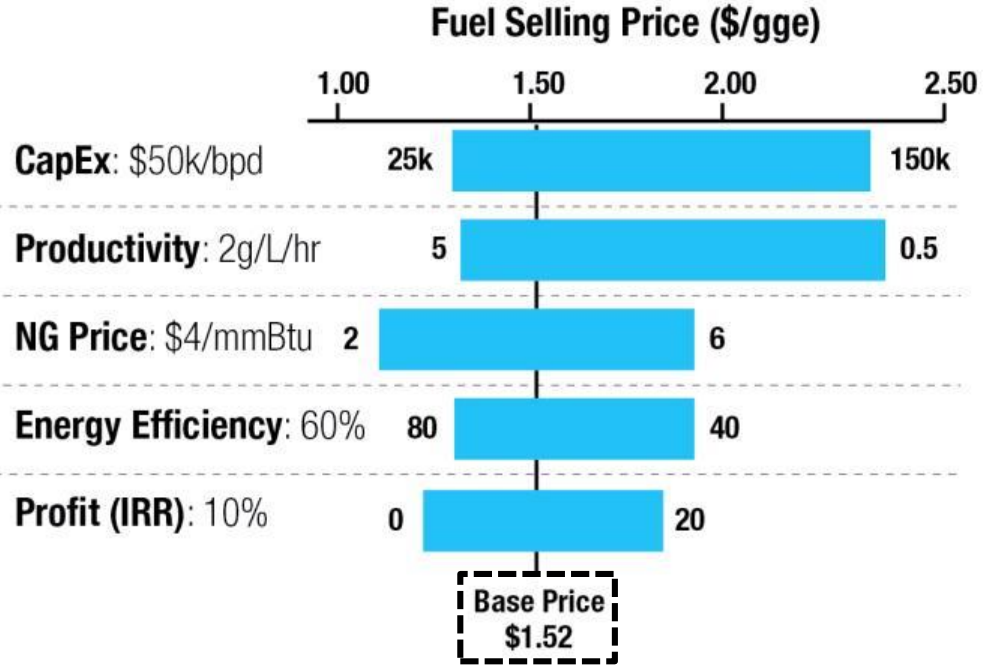
- Cost-effective, one-step conversion of methane to liquid transportation fuels with low CapEx across scales.
- Flexible deployment to access gas in a variety of environments.

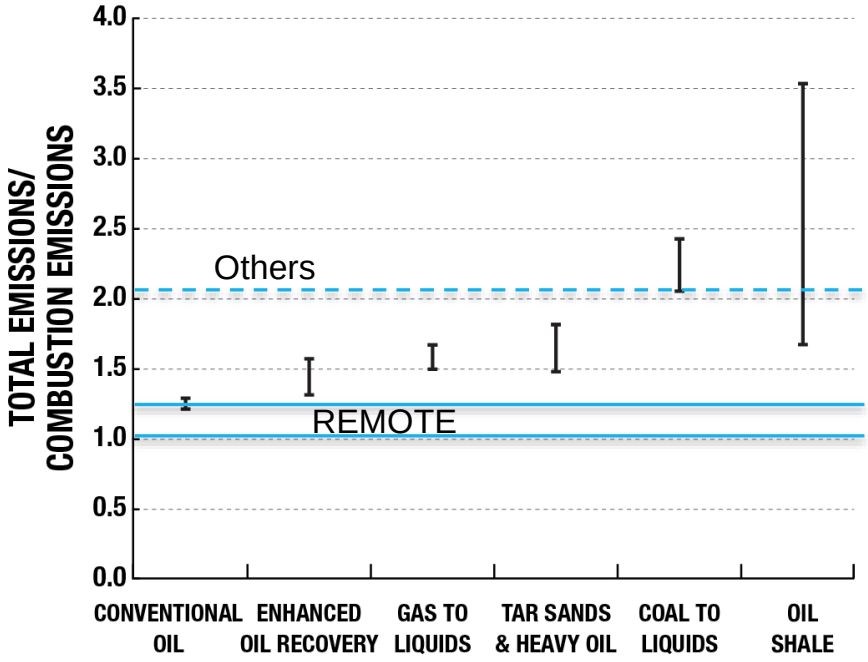
Impact

- Production of transportation fuels at low cost to meet US demand over next 50 years.
- Improve energy security by reducing petroleum imports.
- Lower carbon footprint relative to other non-traditional fuel sources.

REMOTE: Reducing Emissions using Methantrophic Organisms for Transportation Energy

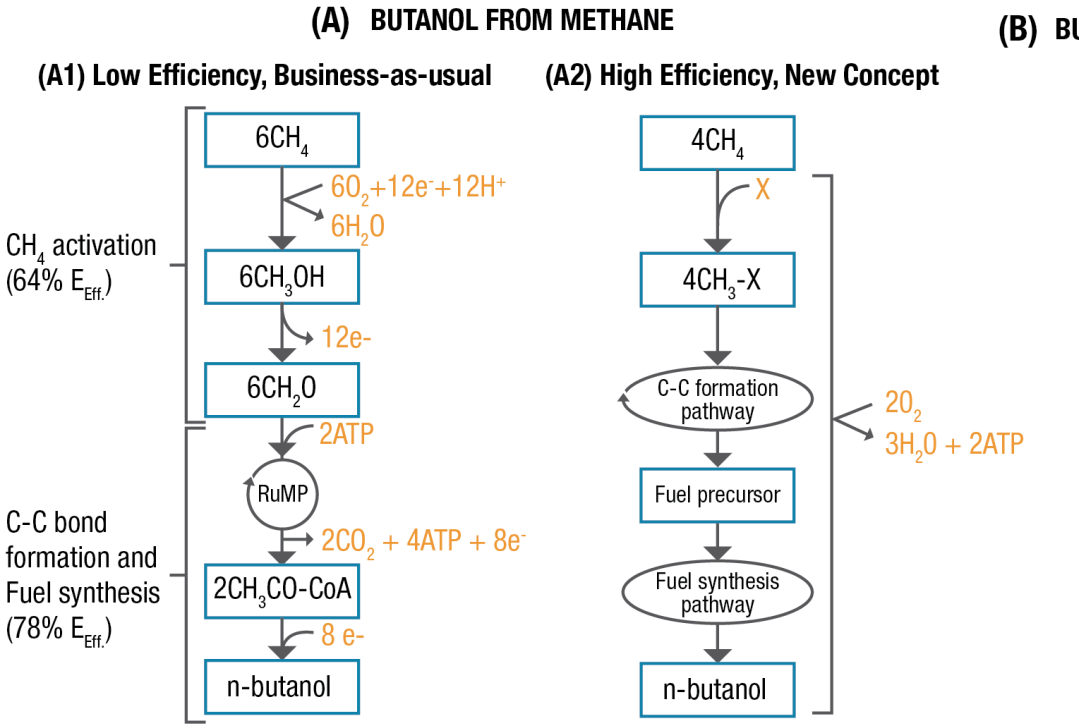
Methane bioconversion to fuel at low cost and with small C footprint





REMOTE: Reducing Emissions using Methantrophic Organisms for Transportation Energy

Reconceptualizing methane bioconversion



New Biocatalysts

- C & E efficiency
- Kinetics

New Bioreactors & Processes

- Mass & heat transfer
- Kinetics

$E_{eff.}/C_{eff.}$=51%/67%	$E_{eff.}/C_{eff.}$=76%/100%	$E_{eff.}/C_{eff.}$=97%/67%
ΔG° = -2,130 kJ/mol	ΔG° = -672 kJ/mol	ΔG° = -280 kJ/mol
ΔH° = -2,464 kJ/mol	ΔH° = -885 kJ/mol	ΔH° = 74.9 kJ/mol
$T\Delta S^\circ$= -334 kJ/mol	$T\Delta S^\circ$= -214 kJ/mol	$T\Delta S^\circ$ = 178.3 kJ/mol

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	22
Available Funding	$36 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

- *Awards announced on August 21, 2013.*

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	18
Available Funding	$32 Million

Goals

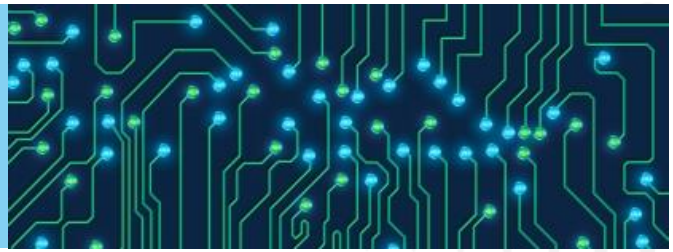
- Advance technologies to develop metals have high strength-to-weight ratios, making them ideal for creating lighter vehicles that save fuel and reduce carbon emissions
- Utilize domestically available ores
- Reduce energy inputs and emissions from processing to make light metals cost competitive with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

Highlights

- *Awards announced on September 19, 2013.*

SWITCHES

Advanced Power Electronics



Mission

Develop advanced wide bandgap (WBG) semiconductor materials, device architectures, and fabrication processes for a range of power electronics applications

Program Director	Dr. Tim Heidel
Year	2013
Projects	14
Investment	$27 million

Goals

- Enable the development of high voltage (1200V+), high current (100A) single die power semiconductor devices that would have the potential to reach functional cost parity with silicon power transistors
- Enable breakthrough relative circuit performance (low losses, high switching frequencies, and high temperature operation)
- Reduce the barriers to widespread deployment of low-loss WBG power semiconductor devices in stationary and transportation energy applications

Highlights

- *Awards announced on October 21, 2013.*

FOCUS

Advanced Technologies for Solar Energy

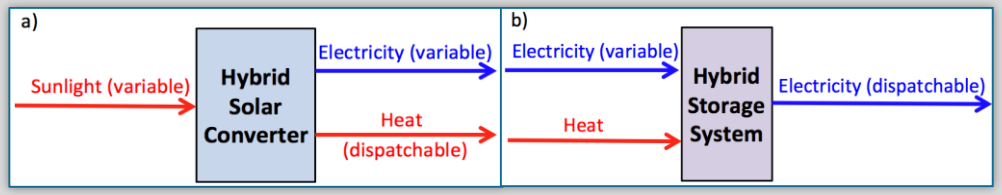
Mission

Develop technologies to advance solar energy beyond current photovoltaic (PV) and concentrated solar power (CSP) technologies to ensure solar power remains a consistent, cost-effective renewable energy option.

Program Director	Dr. Howard Branz
Year	2013
Projects	TBD
Investment	Up to $30 Million

Goals

- Develop two distinct technology options to deliver low-cost, high-efficiency solar energy on demand: (1) new hybrid solar energy converters and (2) new hybrid energy storage systems
- The first approach will develop advanced solar converters to turn sunlight into electricity for immediate use, while also producing heat that can be stored at low cost for later use (using the entire solar spectrum more efficiently than PV or CSP technologies)
- The second approach will develop innovative storage systems that accept heat and electricity from variable solar sources to deliver electricity when needed



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CHANGING WHAT'S POSSIBLE

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

www.arpa-e.energy.gov

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CHANGING WHAT'S POSSIBLE

APPLY FOR FUNDING

ARPA-E Funds 22 Revolutionary Storage Projects

New $36 million "RANGE" program seeks to develop innovative electric vehicle battery chemistries, architectures, and designs.

Learn More »

"We're investing in the best people, the best small companies, and the best ideas to bring entirely new energy technologies to market."

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WHO

WHAT

HOW

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Unparalleled Showcase and Networking

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Compelling Discussions

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Early-bird registration by Dec. 20

www.arpae-summit.com

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