ARPA-E

Advanced Research Projects Agency - Energy
U.S. Department of Energy

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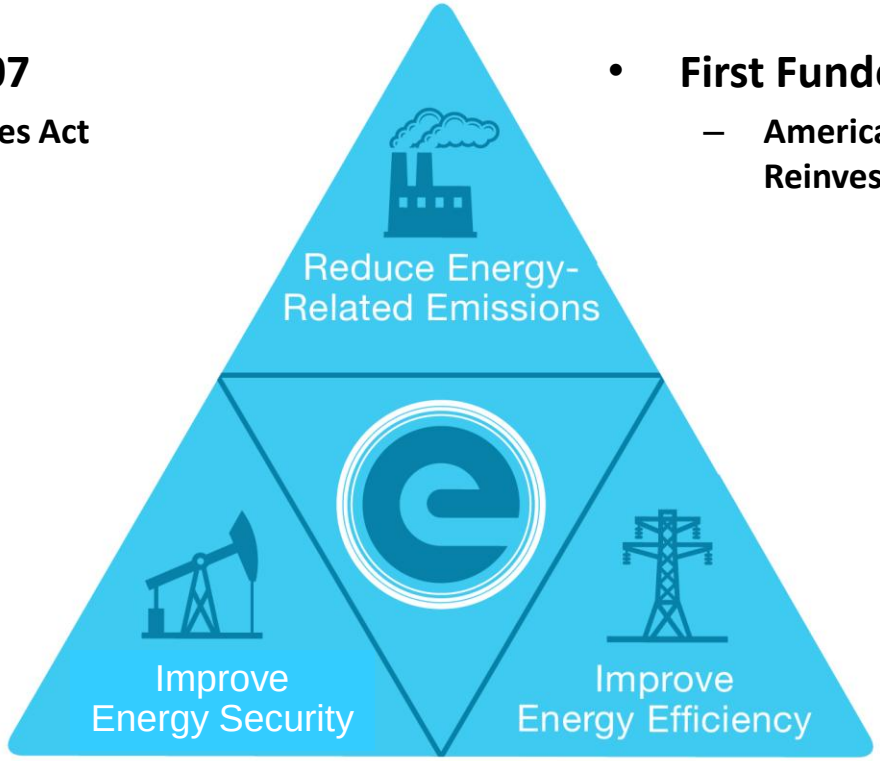
Experts Group on R&D Priority Setting and Evaluation
International Energy Agency
Paris, France

ARPA-E Mission

Catalyze the development of transformational, high-impact energy technologies

- **Authorized in 2007**
  - America Competes Act
- **First Funded in 2009**
  - American Recovery and Reinvestment Act (ARRA) – Stimulus



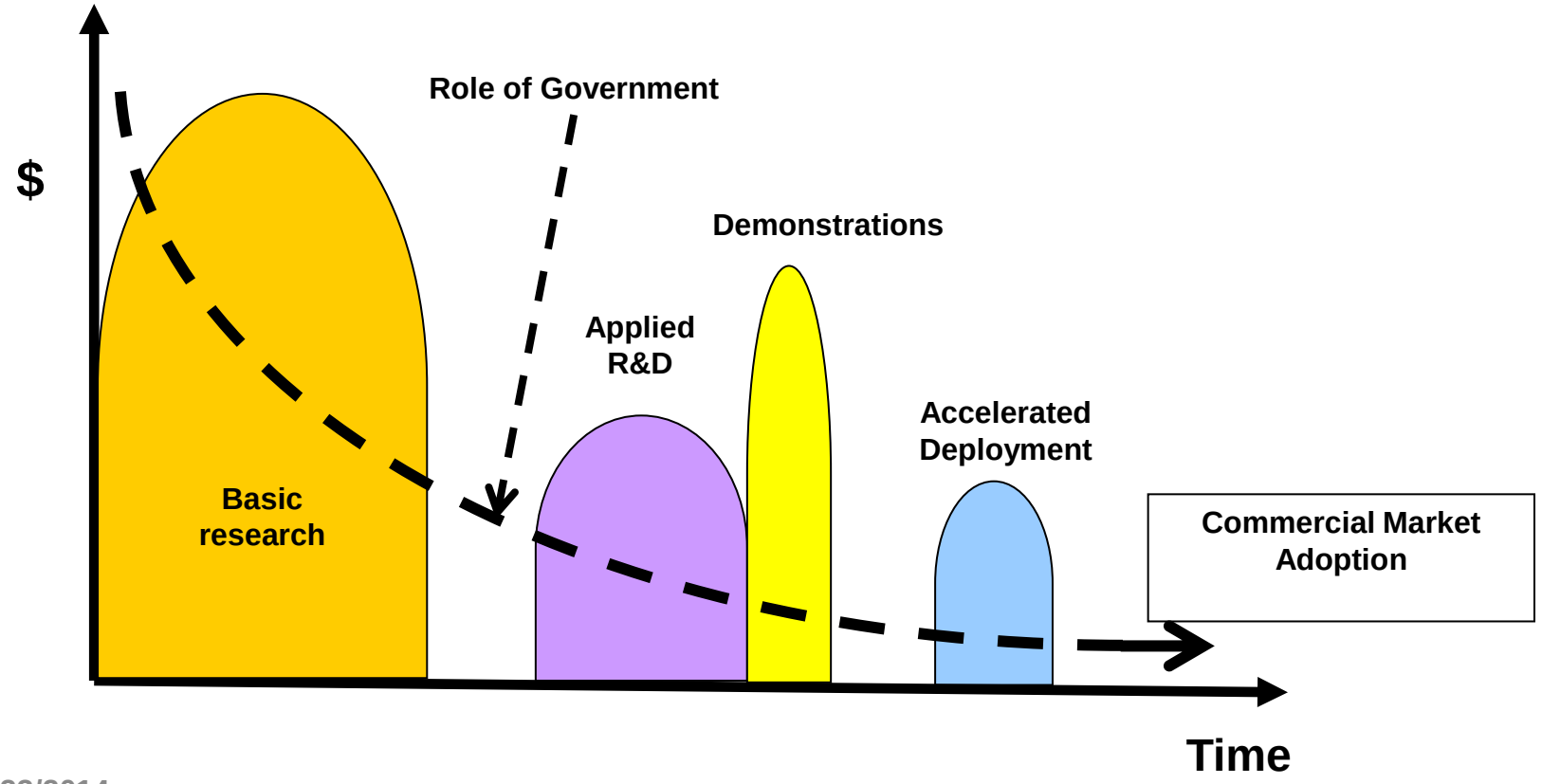
Ensure the U.S. advances -- and benefits from -- development and deployment of advanced technologies

What Does ARPA-E Do

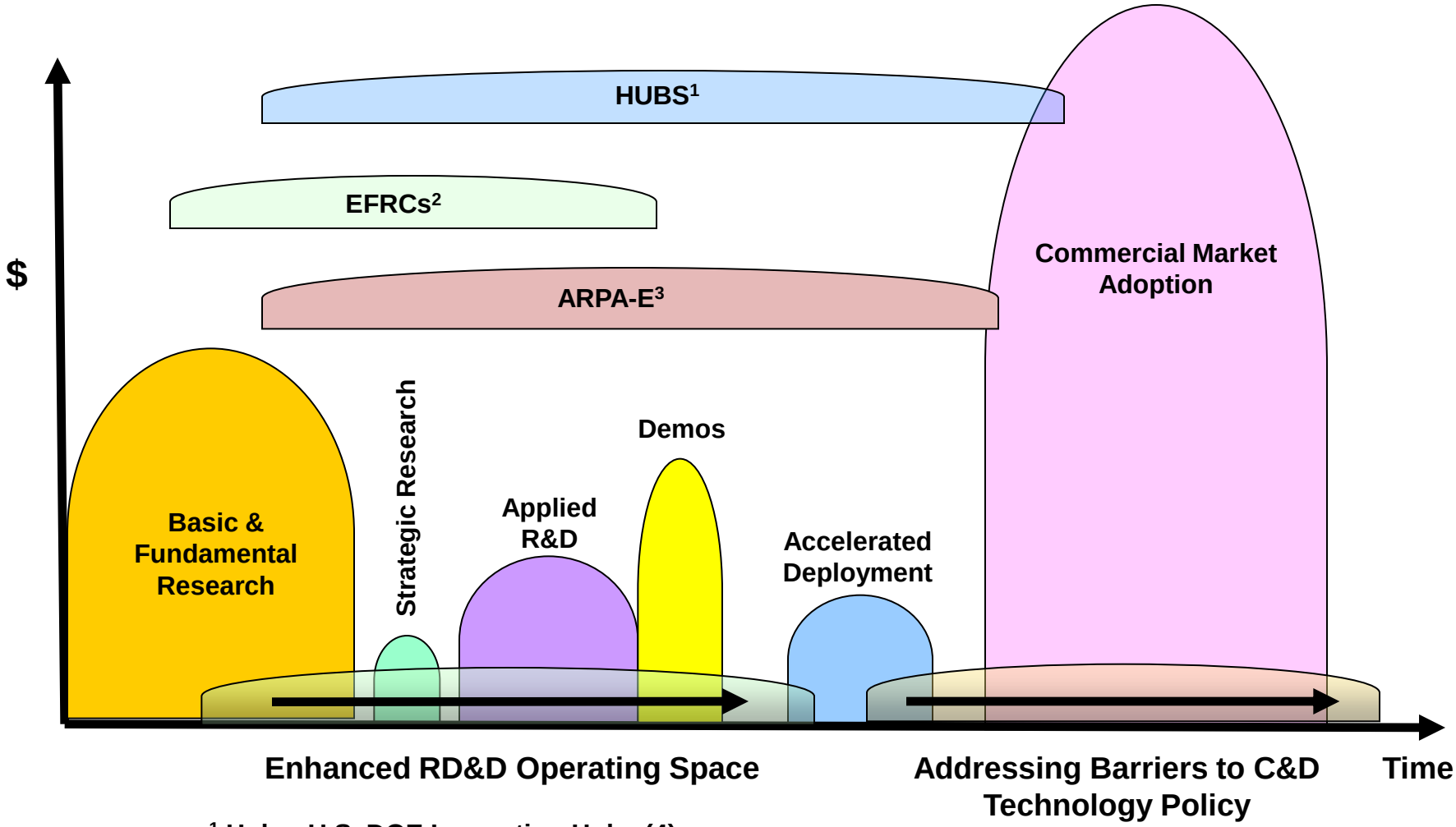
- Identifies transformational energy technologies with high-potential and high-impact
- Catalyzes development with unique team formation and funding
- Focuses on energy technologies that can be meaningfully advanced with a small investment over a defined period of time in areas that are not funded elsewhere due to high technical and financial uncertainty
- Provides awardees with technical assistance and marketing context, strategies and information to help projects succeed
- Provides a unique bridge from basic science to early stage technology
- Hands off promising concepts to others for commercialization or more R&D

Traditional Roles for Government Support of Technology Related RD&D

Are Traditional Models Sufficient to Address Urgent Challenges of Energy & Environment?

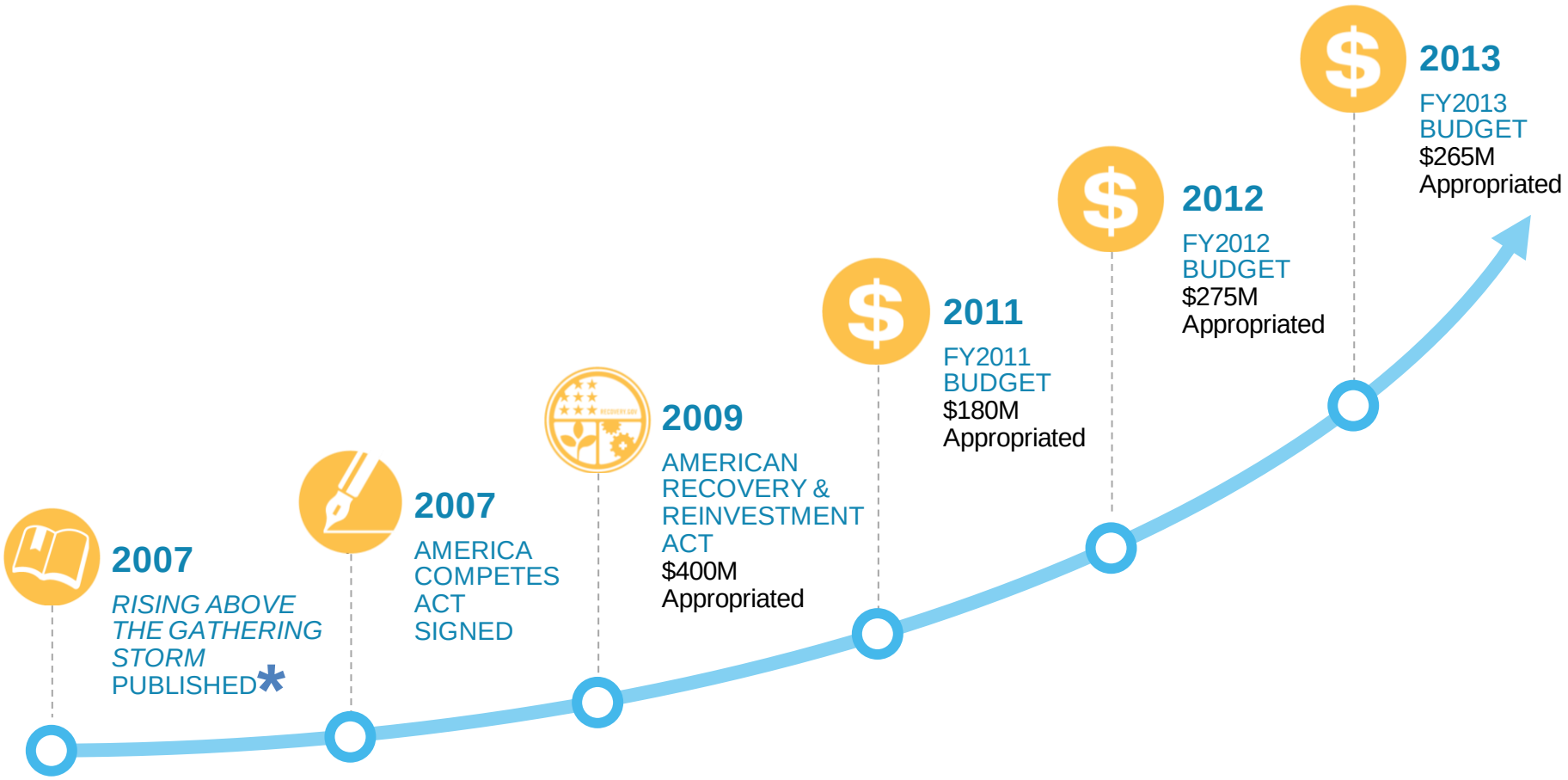


Innovative Models for Energy-Related RD&D Leadership at the U.S. Department of Energy



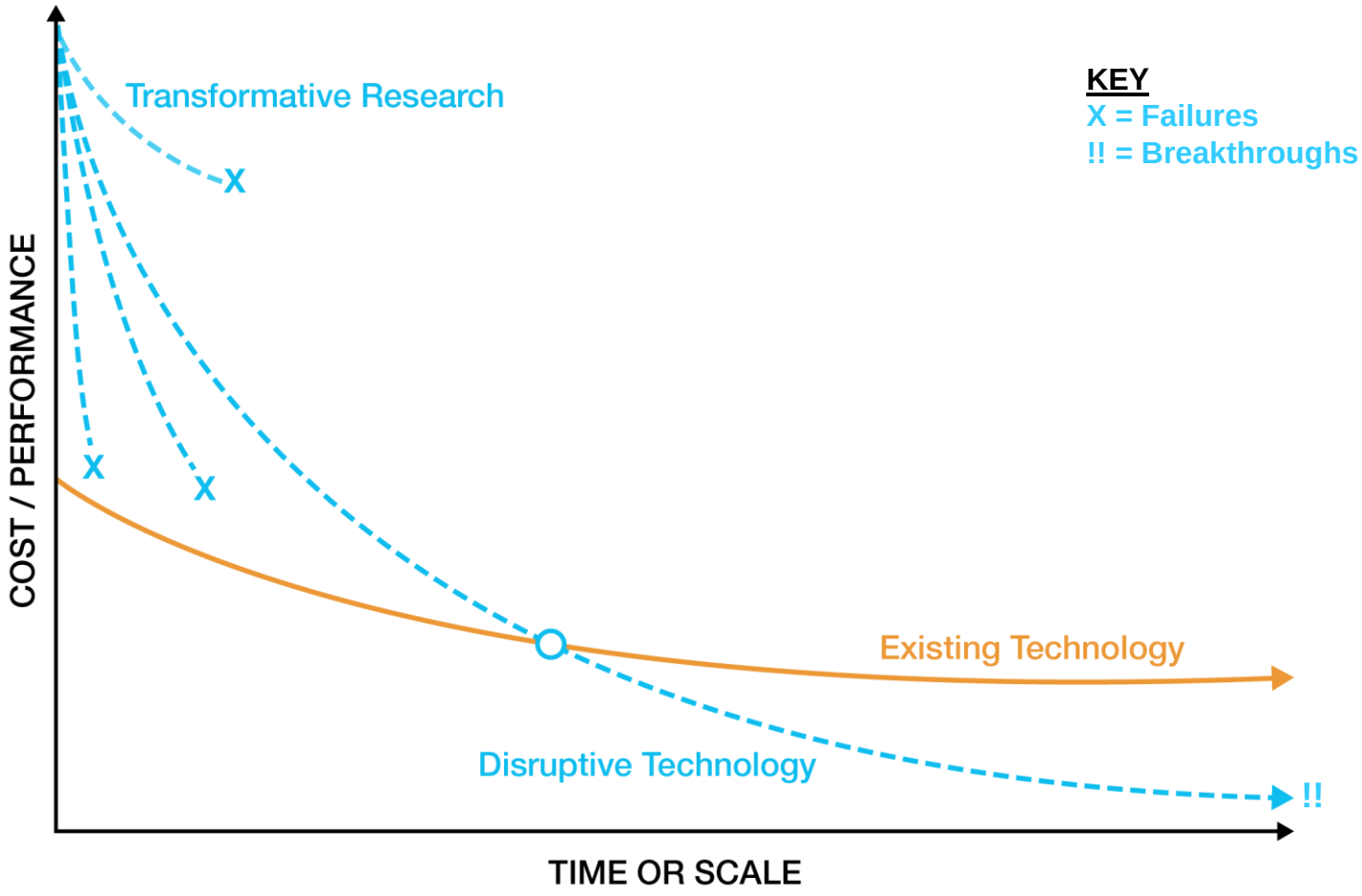
[1] Hubs: U.S. DOE Innovation Hubs (4)
[2] EFRCs: Energy Frontier Research Centers (46)
[3] ARPA-E: Advanced Research Projects Agency - Energy

Evolution of ARPA-E



*National Research Council. Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. Washington, DC: The National Academies Press, 2007.

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

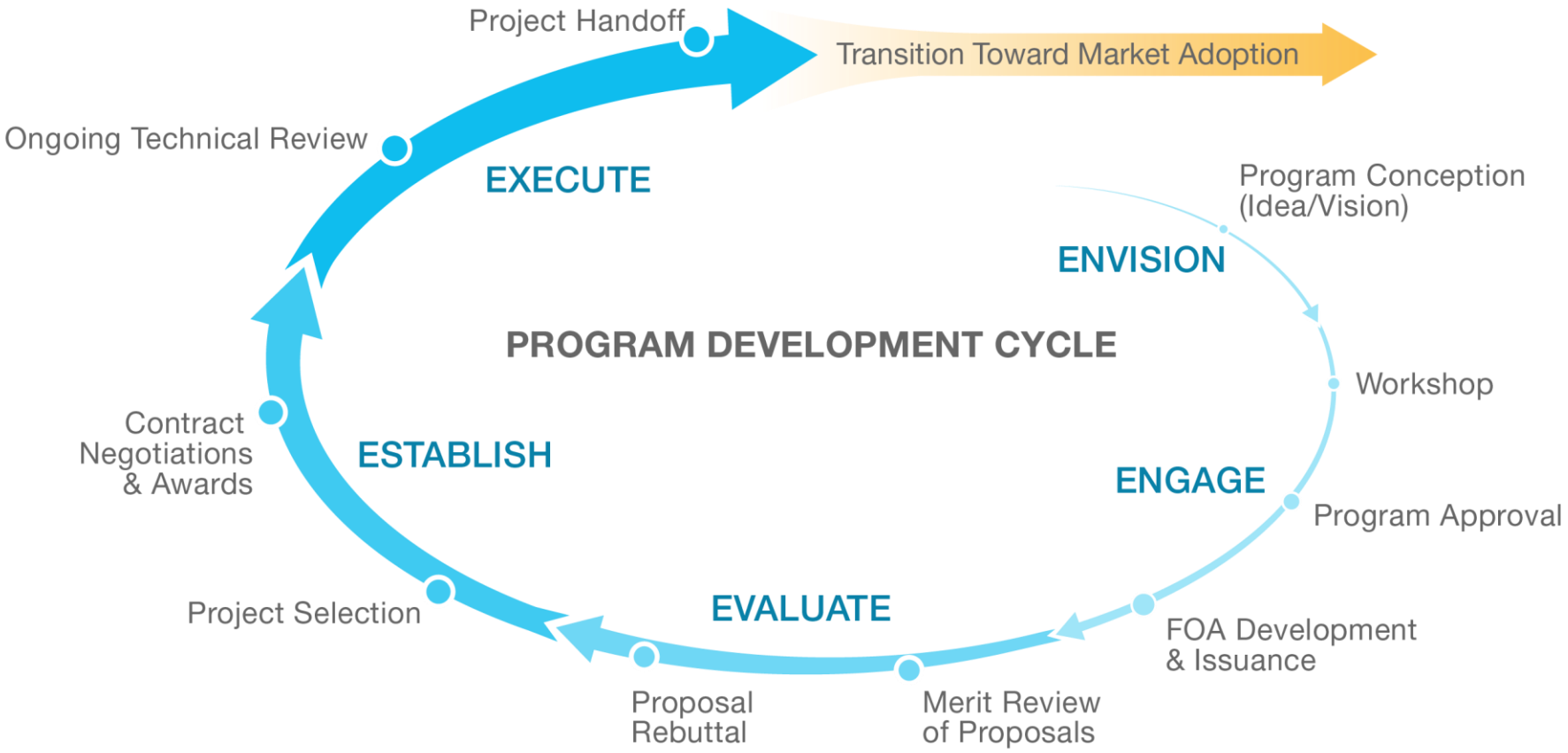
- Comprised of best-in-class people
- Cross-disciplinary skill sets
- Translation oriented

ARPA-E Program Framing Questions*

- What is the problem to be solved? Is the problem stated clearly so it is easily understood?
- If successful, how will the proposed program impact one or more of ARPA-E's mission areas: reducing imported energy, enhancing energy efficiency, and reducing energy related emissions?
- What are the program goals and how will progress towards those goals be measured?
- What is the current state of research and development in this area and how is the proposed program a transformative and disruptive approach relative to the current state?
- Why is now the right time to solve this problem?
- What research communities need to be brought together to create project teams to address the program goals?
- How does the program complement research and development efforts in other Department of Energy programs, other federal agencies, and the private sector?
- What happens at the conclusion of the program? How will the program transition? Who will be the early adopters? What are the barriers to commercialization and how might these problems be overcome?

*** Adapted from the DARPA Heilmeier questions**

Technology Acceleration Model



Current Focused Programs

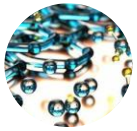

BEEST


PETRO


Electrofuels


MOVE


RANGE


REMOTE

HEATS


AMPED


REACT


SBIR/STTR


METALS


SWITCHES

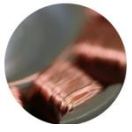

Solar ADEPT


BEETIT


GRIDS


IMPACCT


ADEPT


GENI


FOCUS

Current Focused Programs

Transportation Energy Technologies

1. BEEST: Batteries for Electrical Energy Storage in Transportation
2. PETRO: Plants Engineered to Replace Oil
3. Electrofuels: Microorganisms for Liquid Transportation Fuel
4. MOVE: Methane Opportunities for Vehicular Energy
5. RANGE: Robust Affordable Next Generation Energy Storage Systems
6. REMOTE: Reducing Emissions using Methanotrophic Organisms for Transportation Energy

Stationary Energy Technologies

7. SOLAR ADEPT: Solar Agile Delivery of Electrical Power Technology
8. BEETIT: Building Energy Efficiency Through Innovative Thermodevices
9. GRIDS: Grid-Scale Rampable Intermittent Dispatchable Storage
10. IMPACCT: Innovative Materials and Processes for Advanced Carbon Capture Technologies
11. ADEPT: Agile Delivery of Electrical Power Technology
12. GENI: Green Electricity Network Integration
13. FOCUS: Full-Spectrum Optimized Conversion and Utilization of Sunlight

Crosscutting Technologies

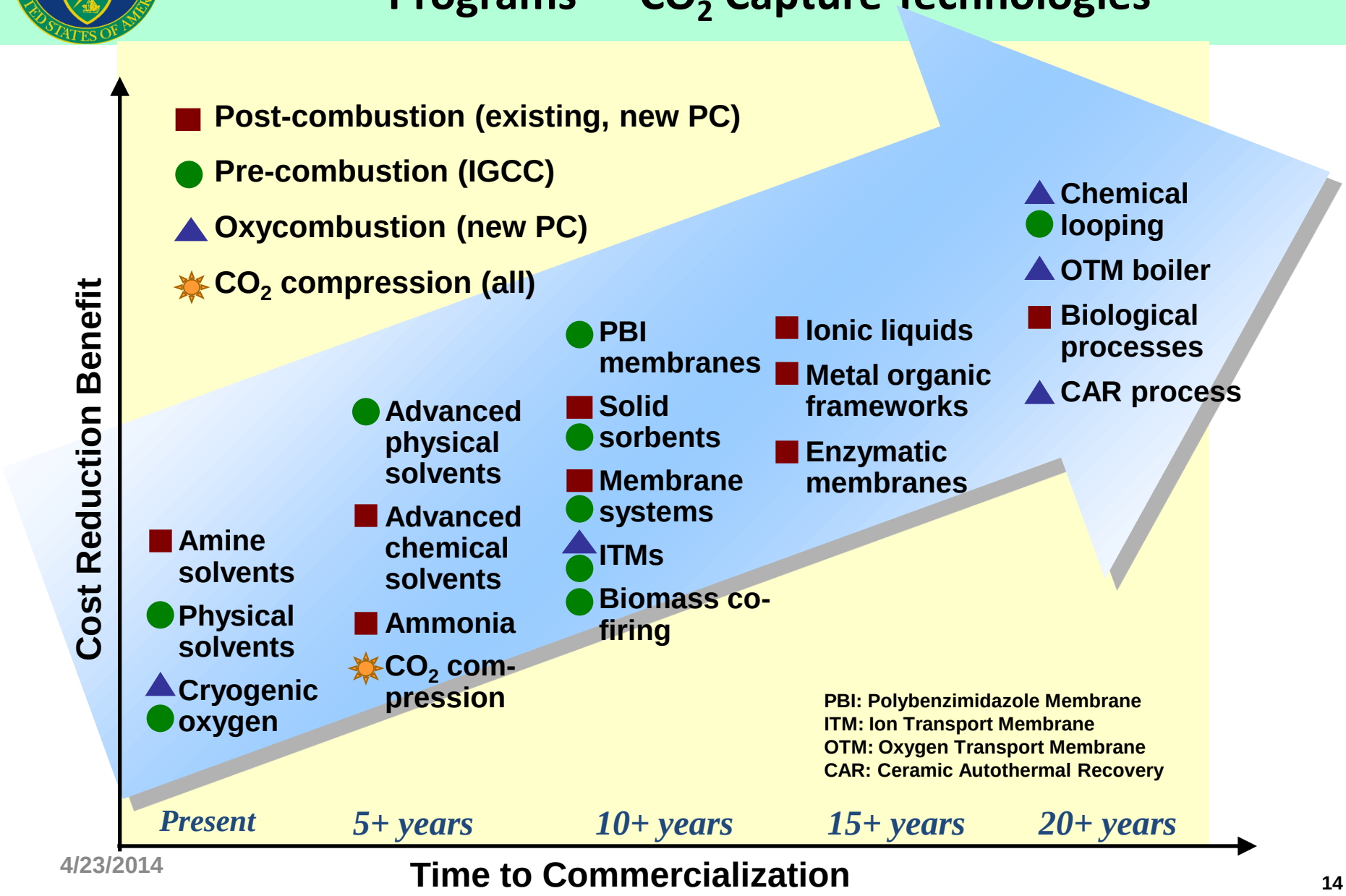
14. HEATS: High Energy Advanced Thermal Storage
15. AMPED: Advanced Management and Protection of Energy Storage Devices
16. REACT: Rare Earth Alternatives in Critical Technologies
17. SBIR/STTR: Small Business Innovation Research/Small Business Technology Transfer
18. METALS: Modern Electro/Thermochemical Advances in Light Metals Systems
19. SWITCHES: Strategies for Wide Bandgap, Inexpensive Transistors for Controlling High-Efficiency Systems

Three Open Funding Solicitations

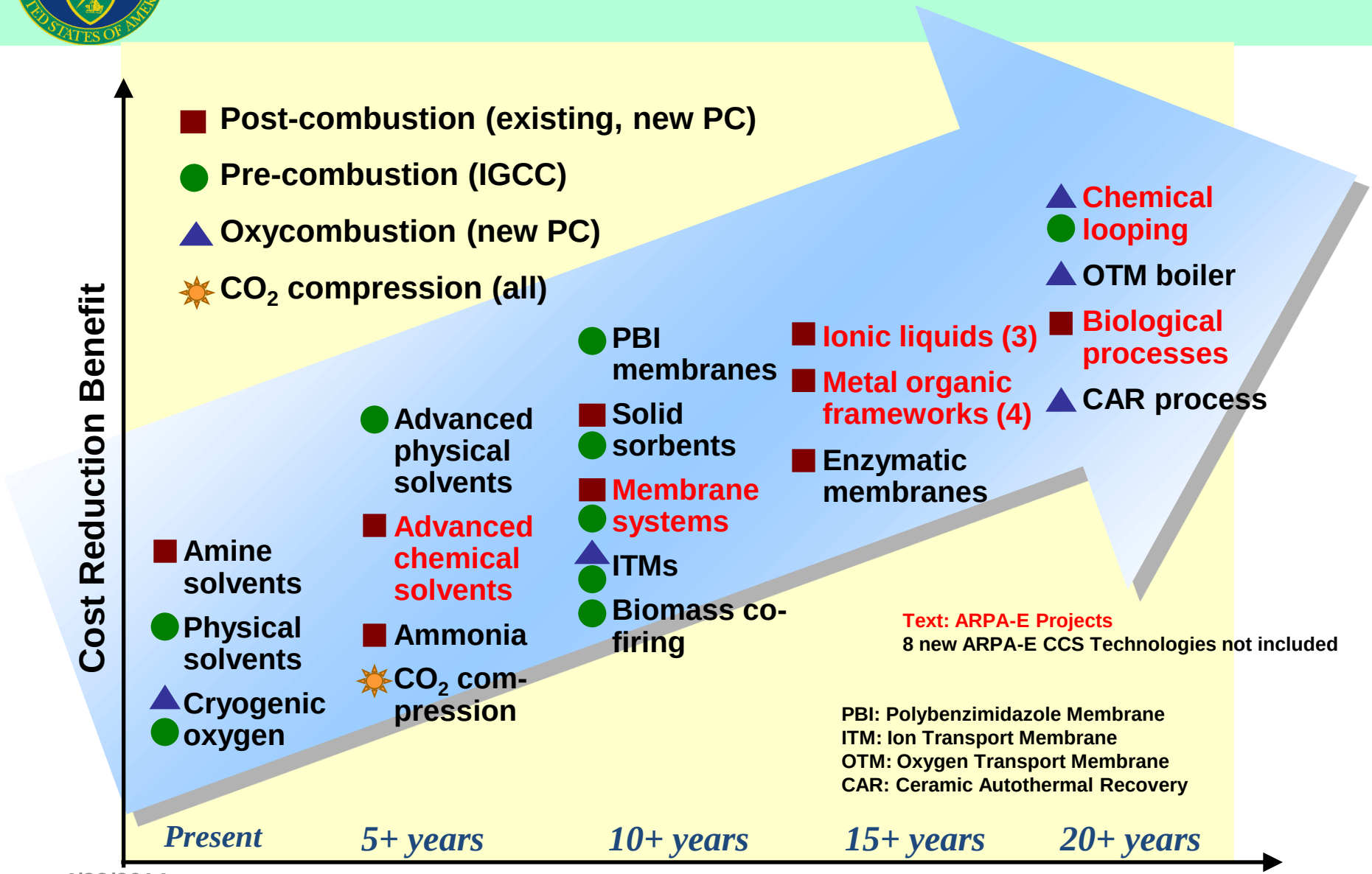
More Details of Process

- Set performance metrics informed by probable (expected) value and cost
- Solicit ideas to meet Program objectives
- Select 10-12 ideas for award
- Average Award ~ $2 to $3M over 3 years
- Open (unstructured) solicitations (free ideas) are also used
- Set clearly defined technical and commercial milestones that awardees are required to meet throughout the life of a project
- Work closely with each awardee to review progress quarterly
- Provide technical assistance as needed
- When a project is not achieving the goals of the program:
  - ARPA-E works with the awardee to rectify the issue or,
  - In cases where the issue cannot be corrected, ARPA-E discontinues funding for the project
    - 19 projects have been cancelled; fail fast
- ARPA-E has in-house legal, procurement, and contracting staff co-located with the Program Directors to provide direct access and timely communication
- The final element of the ARPA-E model is the Technology-to-Market program

Example #1: How ARPA-E Complements Main Line R&D Programs - - CO_2 Capture Technologies



ARPA-E Projects Boosting Novel Concepts



Text: ARPA-E Projects
8 new ARPA-E CCS Technologies not included

PBI: Polybenzimidazole Membrane
ITM: Ion Transport Membrane
OTM: Oxygen Transport Membrane
CAR: Ceramic Autothermal Recovery

Example of a Project Success
Primus Power

- **Zinc bromine, rechargeable liquid flow batteries for grid storage**
  - **Could store substantially more energy at lower cost than conventional batteries.**
- **Awards & Investments**
  - **2014: South Africa's Anglo American Platinum; ($20M); Three others ($15M)**
  - **Modesto Irrigation District (MID) Smart Grid Demo: 25Mw, 75Mw-hr energy storage system (2013). Funded by DOE-ARPA-E, California Energy Commission, MID**
  - **DoD/USMC: Test of electrical energy storage system for a microgrid at the Marine Corps Air Station (MCAS) in Miramar, California**
  - **Primus Power Partners with the Bonneville Power Administration, Puget Sound Energy and DOE on 500 kW Energy Storage Project**

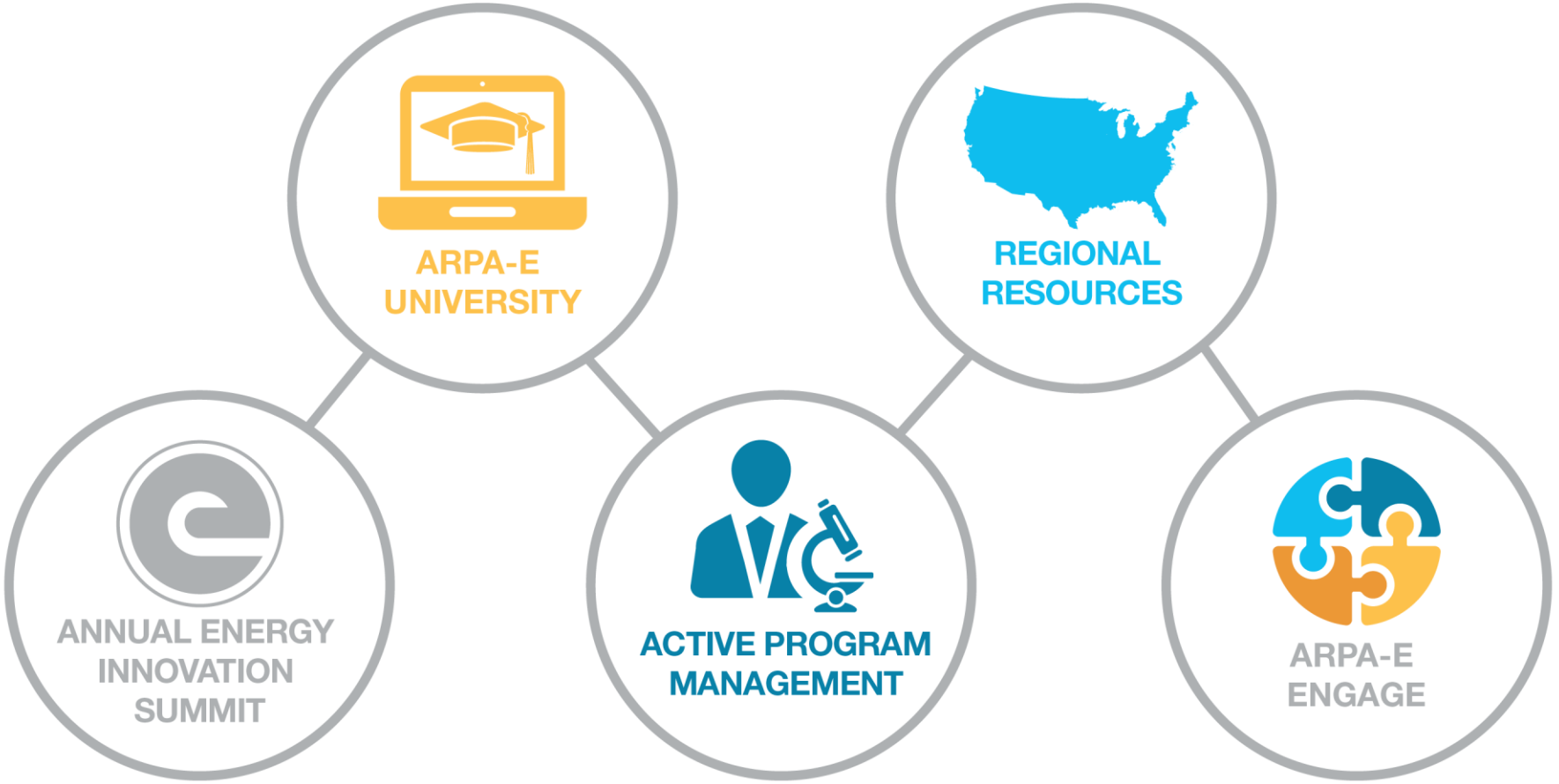
Dr. Cheryl Martin, Acting Director, ARPA-E

Interview of 4 March 2014

- **Energy & Environment TV News**
  - How do you manage risk?
  - How Critical is Private Funding?
  - What do you learn from failed projects?
  - What are your expectations for solar energy?
  - How does CCS technology get up to speed in an economic way?
  - Is there a timeline to Commercialization?
  - How quickly do you see stationary energy storage coming to the forefront?

http://www.eenews.net/videos/1793

ARPA-E Ecosystem



ARPA-E Resources

- **ARPA-E University**
  - ARPA-E University is an executive education webinar series that provides the energy technology community with expert insight and practical information to help transition innovations into the marketplace. Webinars feature deep dives into specific energy technologies, creating effective teams, selling your idea, licensing, effective negotiating, and navigating IP strategy.
- **Regional Resources**
  - The ARPA-E Technology-to-Market Regional Resource Map was developed to help ARPA-E awardees identify regional and national resources that can help them evaluate the market viability of their technologies. Includes: incubators to manufacturing centers—that were suggested by a diverse set of practitioners.
- **ARPA-E Engage**
  - ARPA-E brings together the best minds in academia, business, and government to advance energy technology innovation. We continually seek out ways to collaborate and share ideas through workshops, summits, and webinars. ARPA-Engage highlights these collaborative efforts and features resources to help energy innovators succeed.
- **Active Program Management**
  - Congress directed ARPA-E to "establish and monitor project milestones, initiate research projects quickly, and just as quickly terminate or restructure projects if such milestones are not achieved."
- **Annual Energy Innovation Summit**

arpa·e energy innovation summit

Unparalleled Showcase and Networking

Insightful Keynotes

Compelling Discussions

www.arpae-summit.com

Feb. 24-26, 2014 | Washington, D.C.

2014 ARPA-E Energy Innovation Summit

- 2,100+ registered attendees
- Technology Showcase displaying 274 breakthrough energy technologies from ARPA-E awardees and other innovative companies
- Over a dozen keynote speakers, including Pulitzer Prize winning author Thomas Friedman and Energy Secretary Ernest Moniz
- Dynamic panel discussions and networking sessions that enabled participants to meet with ARPA-E Program Directors, global industry leaders and energy technologists
- Often referred to as the “Woodstock” of Energy Technology Innovation

Measuring ARPA-E's Success

MOVING TECHNOLOGY TOWARD MARKET

- Partnerships with Other Government Agencies
- Licensing/Acquisition by an Established Firm (Hand-off)
- Licensing/Acquisition Resulting in a Spinoff
- Private-Sector Funding
- Growth of Existing Company (e.g., Organic Growth)

BREAKTHROUGH ACHIEVEMENTS

- Invention Disclosures and Patent Filings
- Patents Issued
- Publications

OPERATIONAL EXCELLENCE

- Expedited program development and project selection
- Aggressive performance metrics
- Regular progress reviews

Measures of Success
(As of February 2014)

- **Measures of Technical Market Progress:**
  - **ARPA-E has Invested Over $900M in 362 Projects**
- **Metrics of Success:**
  - **Follow-On Private Sector Investment**
    - **Private Sector Invested $625M in Follow-On Funding to 22 selected projects**
    - **ARPA-E had invested $95M in these 22 selected Projects**
  - **New Company Formation**
    - **24 Start-up Companies**
  - **Hand-Off to Other Public Partners**
    - **16 Projects Continued with Government Entities**
- **Four Projects have Preliminary Sales**
- **Among 123 Projects Whose Outcomes are Known:**
  - **54 Projects Meet "Success" Metrics Above (44%)**
  - **19 Projects Were Cancelled (15%)**

Note: Unofficial tally of successes inferred from project data posted on ARPA-E website at: www.arpa-e.energy.gov ."