Grid Scale Energy Storage Workshop: ARPA-E and Workshop Introduction

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Seattle Renaissance Hotel

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Workshop Overview

Purpose

Obtain guidance from leading experts in the field on how ARPA-E can create a high impact funding program in grid scale energy storage

Format

9 focused breakout sessions with reports to the group

- Energy Management – “Hours/Diurnal”
- Power Applications – “Seconds/Minutes”

10 minute “report out” by chair of each session

Key Questions for Program Design

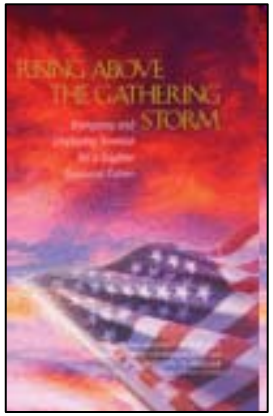
- Highest mission impact applications
- Required performance/cost
- Key technical challenges and new technology opportunities
- “Over the horizon” new technology concepts
- Development stage focus
- Synergy between ARPA-E and Office of Electricity
- Required funding levels
- Level of development required for hand-off

ARPA-E Orientation

Funding Program Schedule

Meeting Goals

ARPA-E Background and Beginnings



Rising Above the Gathering Storm, 2006 (National Academies)

- Establish an Advanced Research Projects Agency for Energy (ARPA-E)
- "Creative, out-of-the-box, transformational" energy research
- High risk, high payoff energy research
- Spinoff Benefit – Help educate next generation of researchers
- Secretary Chu (then Director of Berkeley National lab) on committee

America COMPETES Act, 2007

- Authorizes the establishment of ARPA-E

American Recovery and Reinvestment Act of 2009 (Recovery Act)

- $400M provided for ARPA-E
- President Obama launches ARPA-E in a speech at NAS on April 27, 2008
- First Funding Opportunity: $150M open call for "transformational energy technologies" (Awards to be announced in October '09)
    - Average: $3-$5M, 2-3 year projects
- $200M+ for targeted Funding Programs in the near future

Background on ARPA-E

Mission

- To enhance the economic and energy security of the US through:
  - Reduction of **foreign energy imports**
  - Reductions of **energy-related emissions**, including greenhouse gases
  - Improvement in the **energy efficiency** of all economic sectors

- To ensure **US technological lead** in developing and deploying advanced energy technologies"

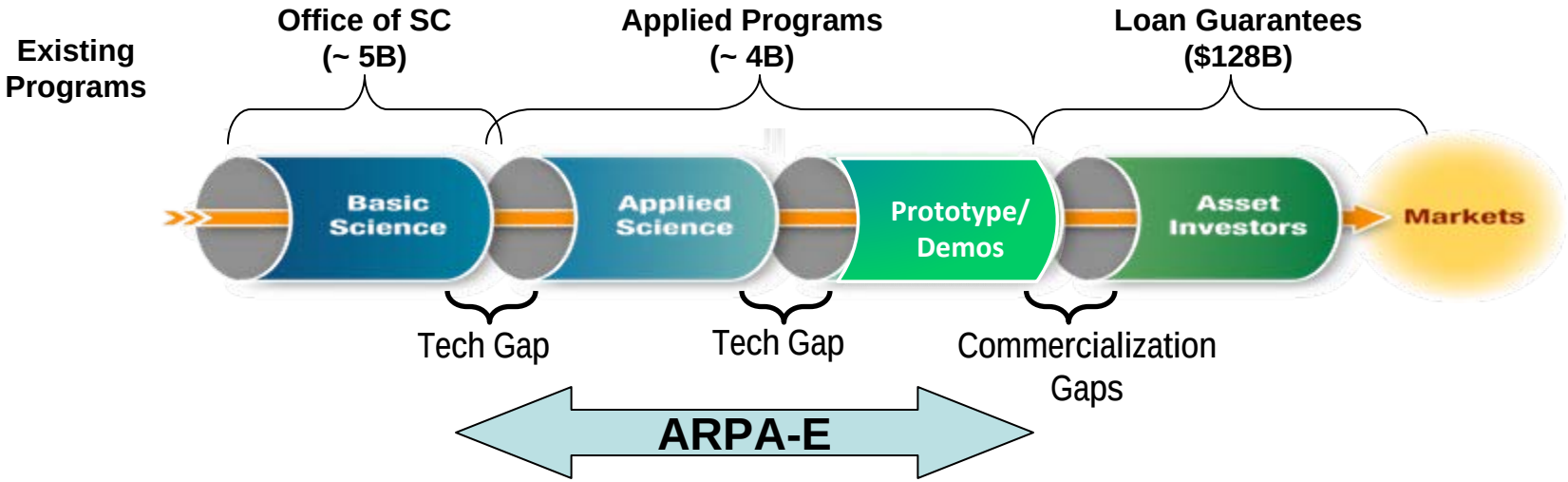
Means

- Identifying and promoting **revolutionary advances** in fundamental sciences
- **Translating scientific discoveries** and cutting edge inventions into technological innovations
- Accelerating **transformational technological advances** in areas *that industry by itself is not likely to undertake*
  - Authority for: testing and evaluation, demonstration, mfg. technology, tech transfer

Key Takeaways

- Creates a new organization within DOE, reporting directly to the Secretary
- Hiring and management unrestricted by civil service laws - very broad authority
- **Lean, flat** organization (70-120 program managers planned); 3 year PM tenure
- Use of existing DOE authorities, including "Other Transactions Authority" (OTA)
- Can engage universities, industry, and FFRDCs when in consortia with others

Filling the Gaps



What ARPA-E Will Do:

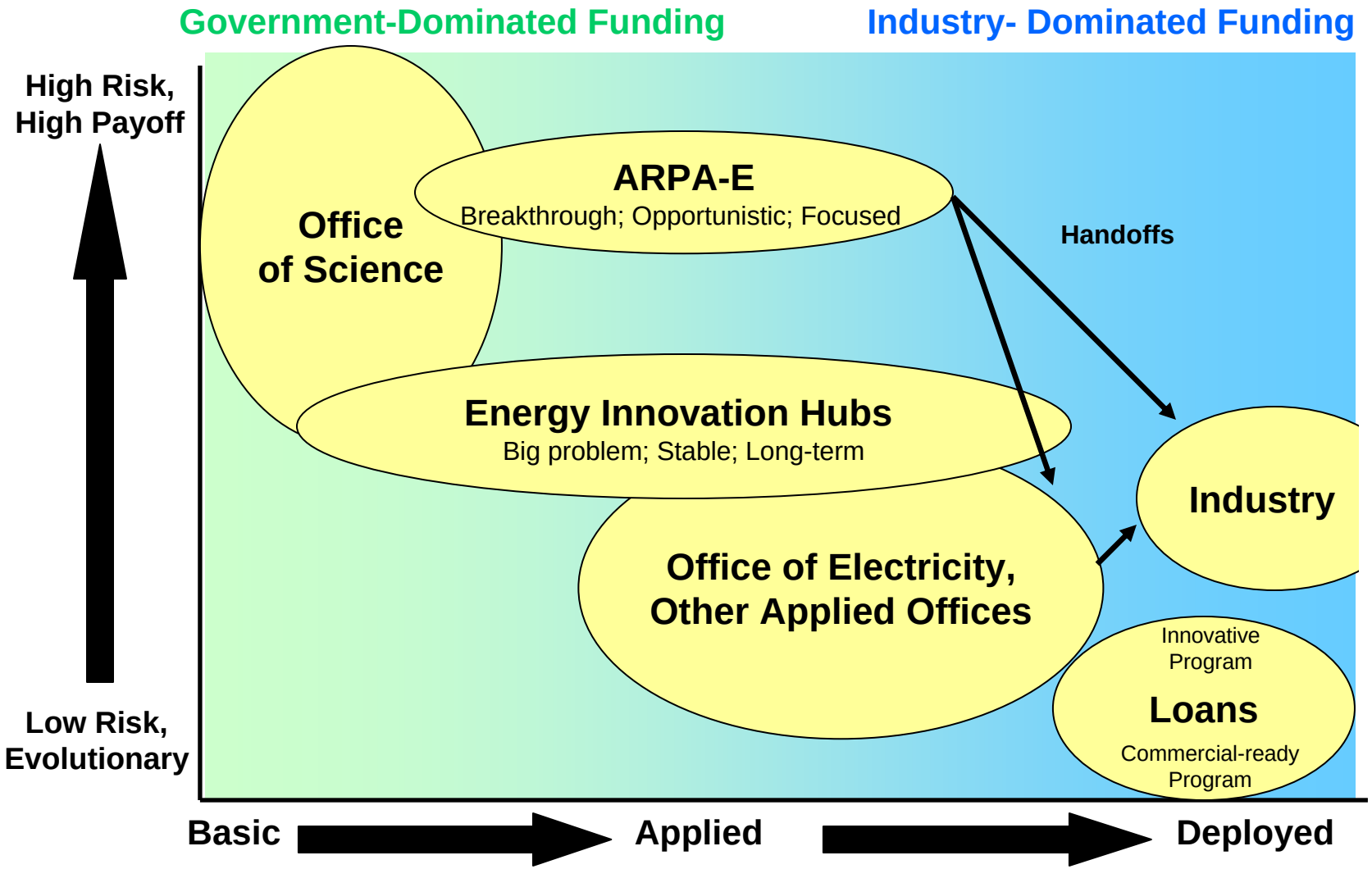
- Disruptive transformational technologies
- High risk, high potential programs
- Projects in need of rapid and flexible experimentation/engineering
- Marry technical opportunities with mission gaps
- Breakthrough science that can transform a field

What ARPA-E Will Not Do:

- Basic research
- Lowest Technology Readiness Level projects
- Projects longer than 5 years
- Evolutionary improvements
- Large scale commercial viability demos
- Projects other DOE program offices are already focused on

ARPA-E can move across the energy innovation pipeline depending on the needs of the technology

ARPA-E Role in the Innovation Pipeline



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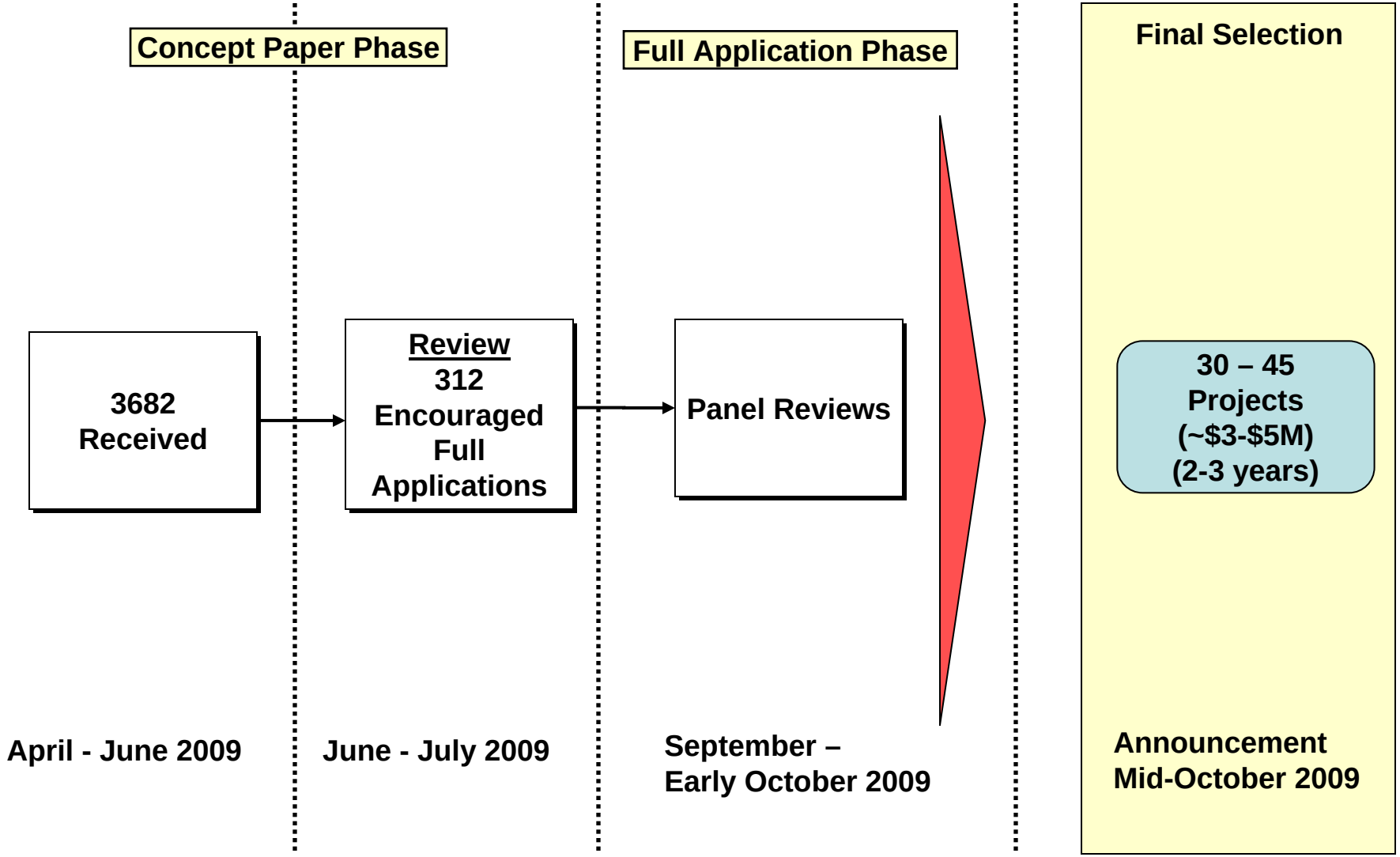
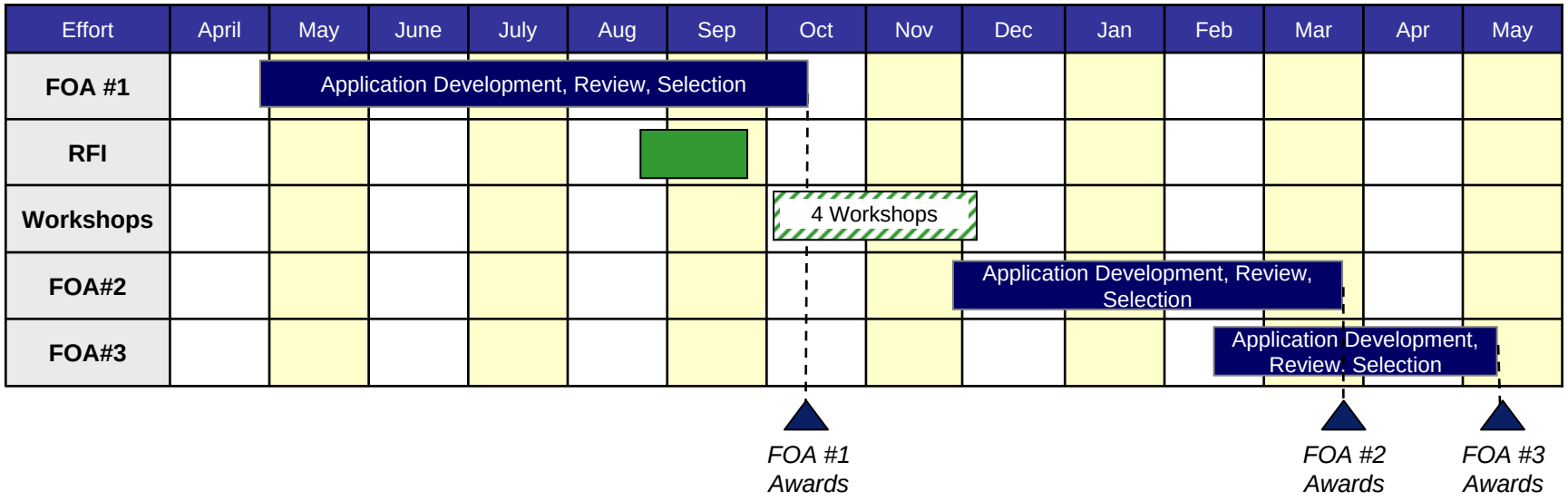
Meeting Focus

ARPA-E's first solicitation spanned the entire realm of novel energy topics ($150M, open to all energy technology areas)



ARPA-E is operating under an aggressive schedule to build programs with potential for transformational impact



Upcoming Workshops

- Grid Scale Energy Storage – Oct. 4 (Seattle, WA)
- Direct Solar Fuel Technologies - Oct. 21 (Arlington, VA)
- Carbon Capture and Conversion – Oct. 28 (Pittsburgh, PA)
- Energy Storage for Vehicles – Nov. 3 (Washington, DC)

Your comments in this workshop will have *direct* impact on future Grid Storage program development

ARPA-E Orientation

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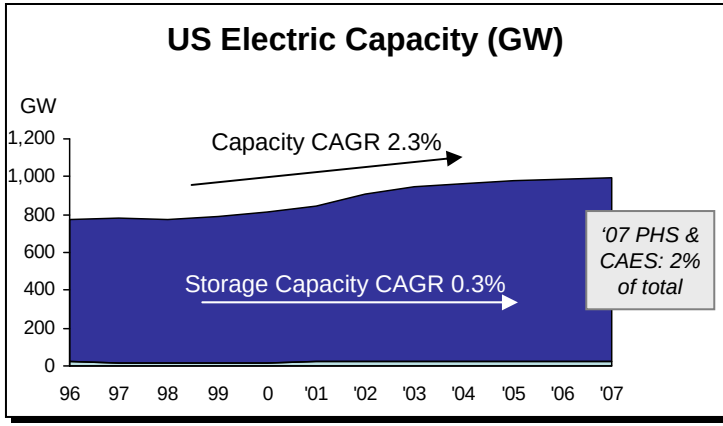
Meeting Focus

Our workshop concerns two broad categories of energy storage and how to advance technology in these areas



Energy Storage Benefits

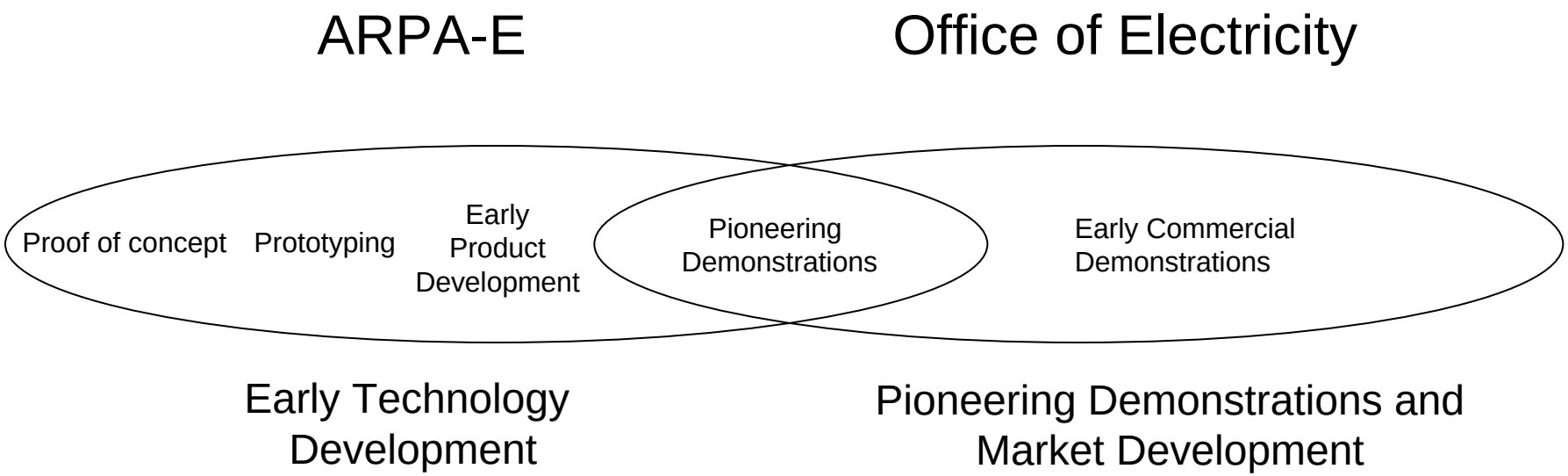
- Enabling **renewable** penetration
- Reduction of **Generation and Delivery Inefficiencies**
- **Distributed Generation**
- **Demand/Peak Load Management**
- **T&D Asset Optimization**
- Ensuring a **Robust/Reliable Grid**
- **Electricity Arbitrage**

Storage Applications	Description	Performance Metrics	Technology Examples
Energy Management (*hours/ diurnal*))	The strategy of adjusting and optimizing energy generation including reducing the large fluctuations that occur in electricity demand by storing excess electricity during periods of low demand for use during periods of high demand.	▪ Discharge Time ▪ System Power Rating ▪ Round Trip Efficiency ▪ Capital Cost ▪ Cycle and Calendar Life ▪ Site Availability	▪ Pumped Hydro Storage ▪ CAES ▪ Bulk Electrochemical Storage ▪ Advanced Batteries ▪ Chemical Storage
Power Applications (*seconds/ minutes*))	Faults, dynamic operations, or nonlinear loads often cause various types of power quality disturbances such as voltage sags, voltage swells, impulses, notches, flickers, harmonics, etc.	▪ Response Time ▪ System Power Rating ▪ Round Trip Efficiency ▪ Capital Cost ▪ Cycle and Calendar Life	▪ Bulk Electrochemical Storage ▪ Advanced Batteries ▪ Flywheels ▪ Ultracapacitors ▪ SMES

Where can ARPA-E make the greatest impact?

Source: DOE Electric Power Annual 2007, Energy Storage Association, BAH Analysis

Grid Scale Energy Storage Support @ DOE is synergistically divided between ARPA-E and the Office of Electricity



What are we trying to achieve today

- Deep dives on high potential technologies to enable low cost, high performance storage systems for grid scale energy storage
- Identification of key challenges and emerging opportunities for these technologies
- Identification of high impact areas where ARPA-E programs can have a large ADDITIONAL impact

- Discussion of ARPA-E Grid Scale Energy Storage Targets/Focus
  - What are the appropriate metrics to employ for energy storage R&D programs?
  - Which projects could benefit the most from ARPA-E support?
  - What new horizons exist in storage chemistries to change the grid?
- Focus of ARPA-E vs DOE Office of Electricity roles
- Best way to structure a $30-$45M, 3 year ARPA-E program
  - Fund multiple technology approaches?
  - Focus on one major technology challenge?

Breakout Session #1: Energy Management: Hours/Diurnal

- Compressed Air Energy Storage (CAES)
  Chair: Georgianne Peek, Sandia

- Bulk Electrochemical Storage: Liquid metal/flow batteries/metal air)
  Chair: John Boyes, Sandia

- Advanced Batteries: Advanced Li-ion/NiCd/Pb-Acid/beyond Li-Ion)
  – Chair: Ali Nourai, AEP

- Other Bulk Storage Approaches: Underground Pumped Hydro/Chemical Storage
  – Chair: Klaus Lackner, Columbia University

- Power Conditioning Systems and Balance of Plant
  – Chair: Brad Roberts, ESA

Breakout Session #2: Power Applications: Seconds/Minutes

- Bulk Electrochemical Storage: Liquid metal/flow batteries/metal air)
  Chair: Ali Nourai, AEP

- Advanced Batteries: Advanced Li-ion/NiCd/Pb-Acid/beyond Li-Ion)
  - Chair: John Boyes, Sandia

- Ultracapacitors/SMES
  - Chair: Dan Rastler, EPRI

- Flywheels and Other Power Focused Storage Applications
  - Chair: Haresh Kamath, EPRI