Overview on Energy Storage Projects at ARPA-E

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ARPA-E Program Director

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Mark Johnson, Dane Boysen, John Lemmon (SBIR)

EV Everywhere Energy Storage Workshop
Chicago, IL
July 26th, 2012

ARPA-E's creation and launching

Innovation based on science and engineering will be primary driver of our future prosperity & security

2012
FY2012 Budget
($275 Appropriated)

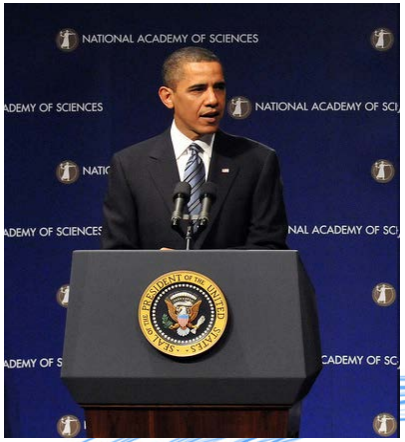
2011
FY2011 Budget
($180M Appropriated)

2009
American Recovery and Reinvestment Act
($400M Appropriated)

2007
America COMPETES Act

2006
Rising Above the Gathering Storm
(National Academies)

President Obama launches ARPA-E at National Academies on April 27, 2009



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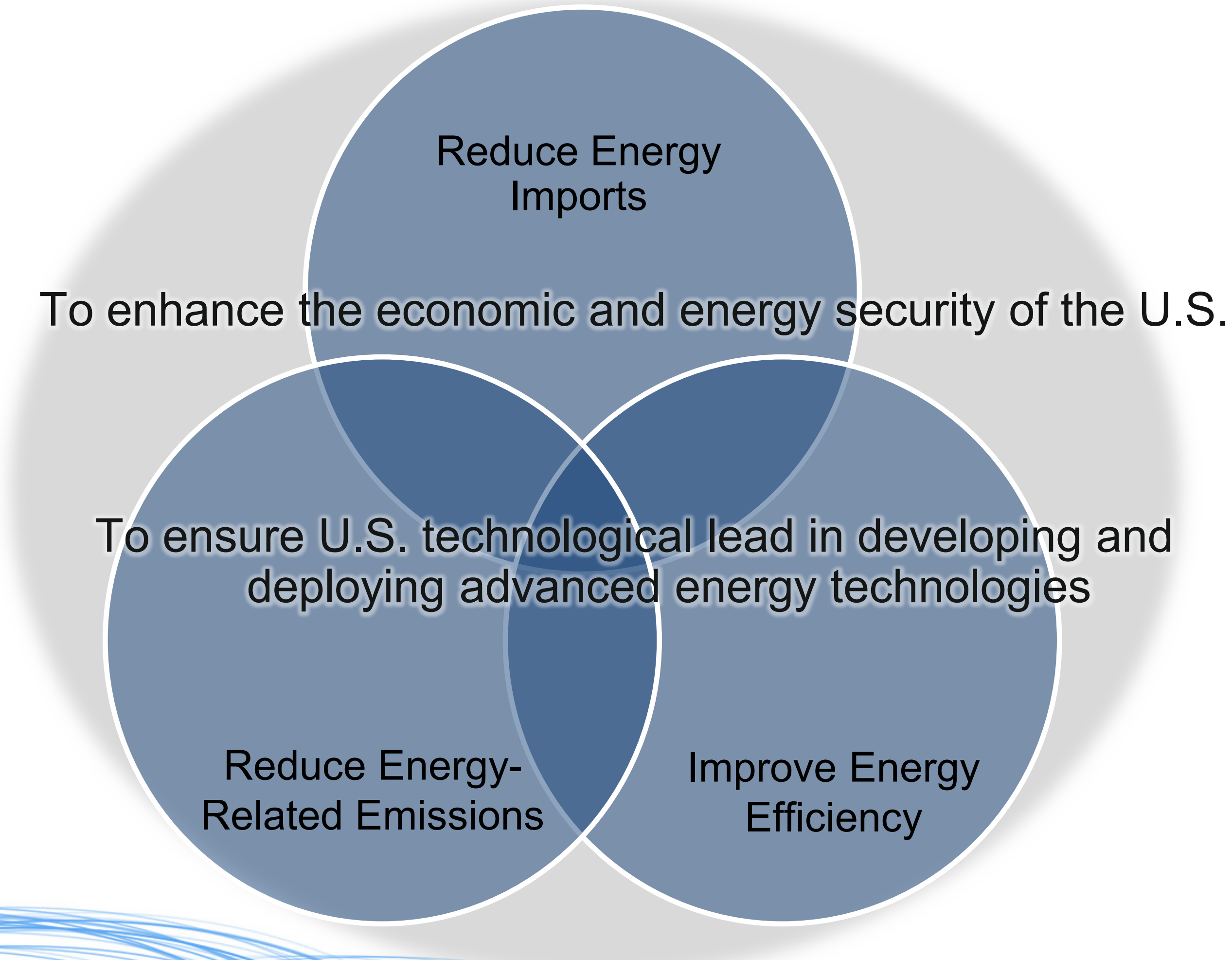
ARPA-E's mission is to overcome the high-risk technological barriers facing energy technologies



(A) promoting revolutionary advances in fundamental sciences

(B) translating scientific discoveries into technological innovations

(C) accelerating transformational technological advances in areas that industry by itself is not likely to undertake

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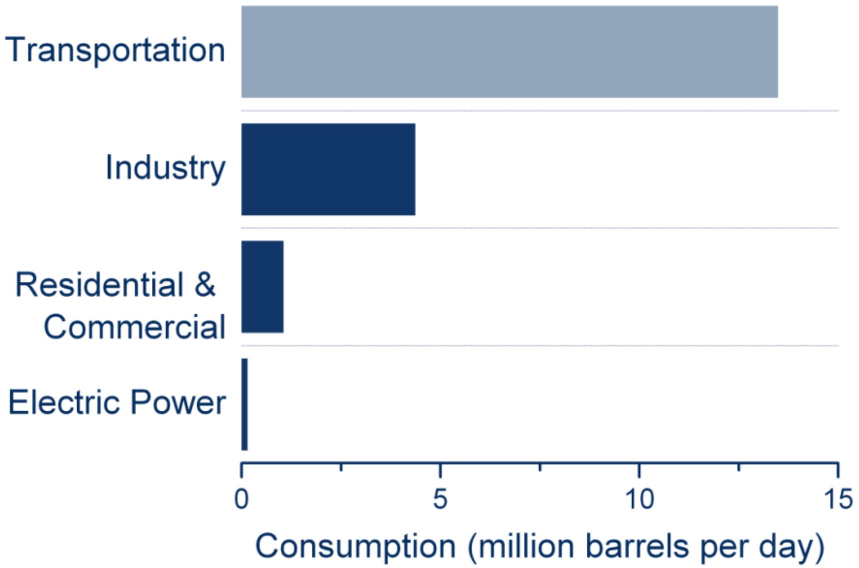
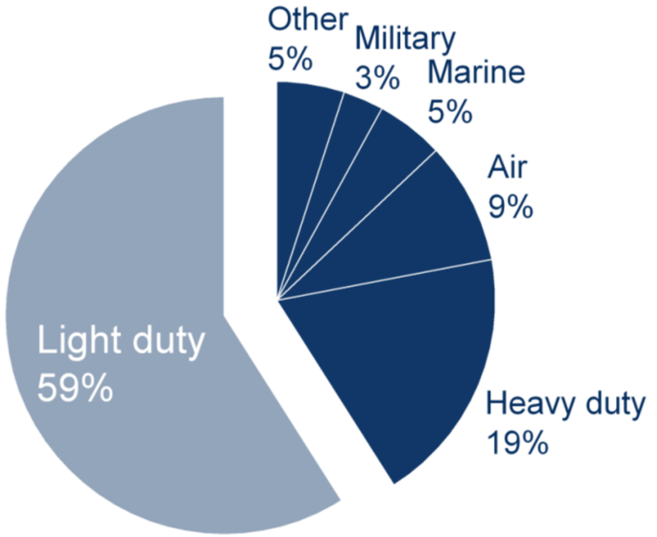
Why should you care?

2010 U.S. Petroleum Consumption by Sector



2010 U.S. Transportation Consumption by Mode



Transportation drives U.S. dependence on imported oil

Electric vehicles could reduce or eliminate need for imported oil

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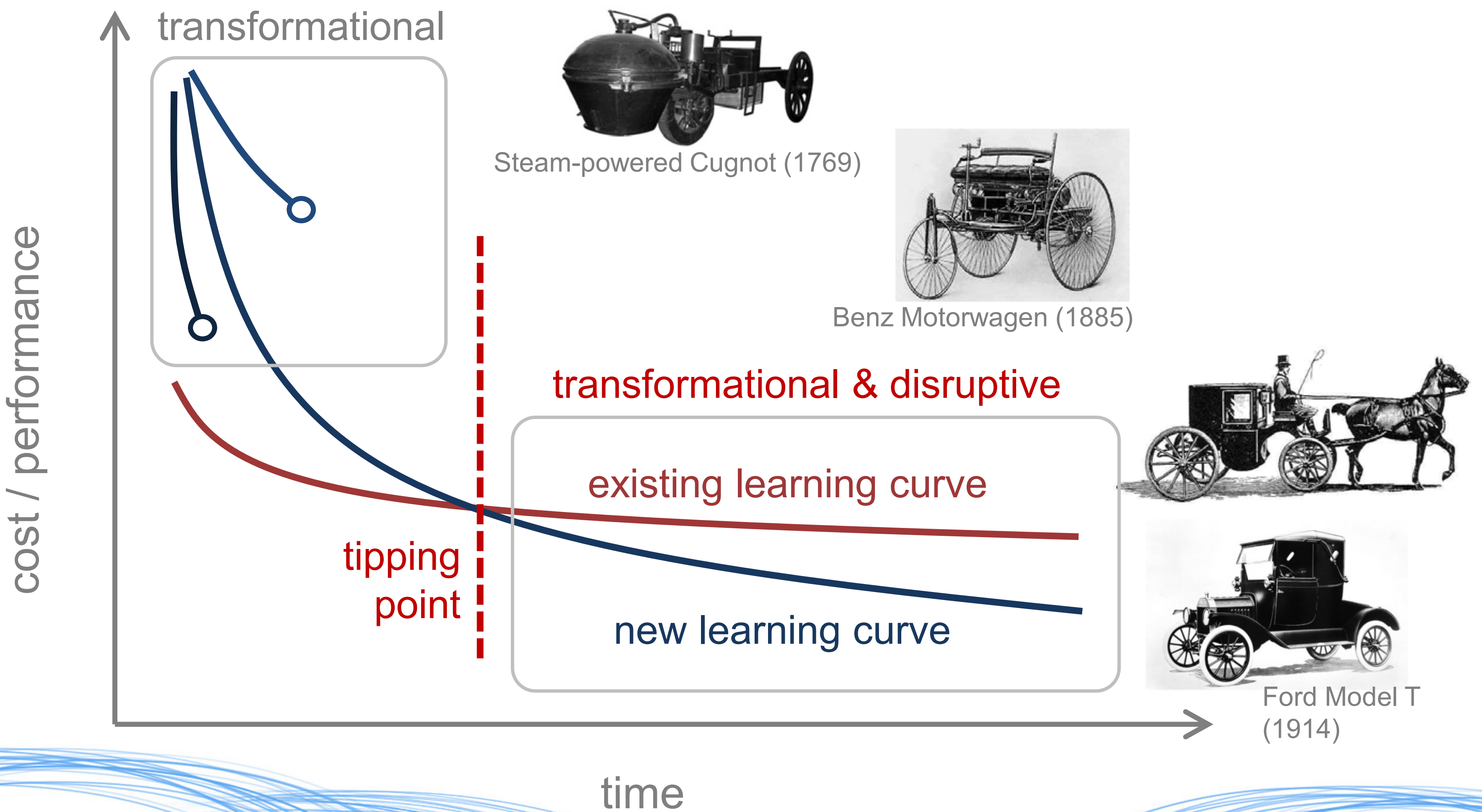
The ARPA-E Approach

Transformational & disruptive technologies that lead to new learning curves



DOE Coordinated Battery R&D Efforts

Basic Energy Sciences

U.S. DEPARTMENT OF ENERGY | Office of Science

Advanced Research Projects Agency-Energy

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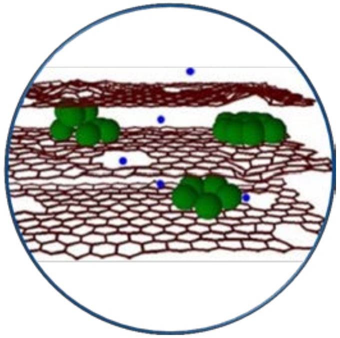
EERE-Vehicle Technologies Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Materials Research

- structure and interfaces
- measurement
- mechanisms
- analyses
- user facilities

Cell Research & Development

- new chemistries
- electrodes
- electrolytes
- microstructure

Battery System Development

- design and construction
- life testing
- cost reduction
- safety and durability

0	1	2	3	4	5	6

Technology Readiness Level (TRL)

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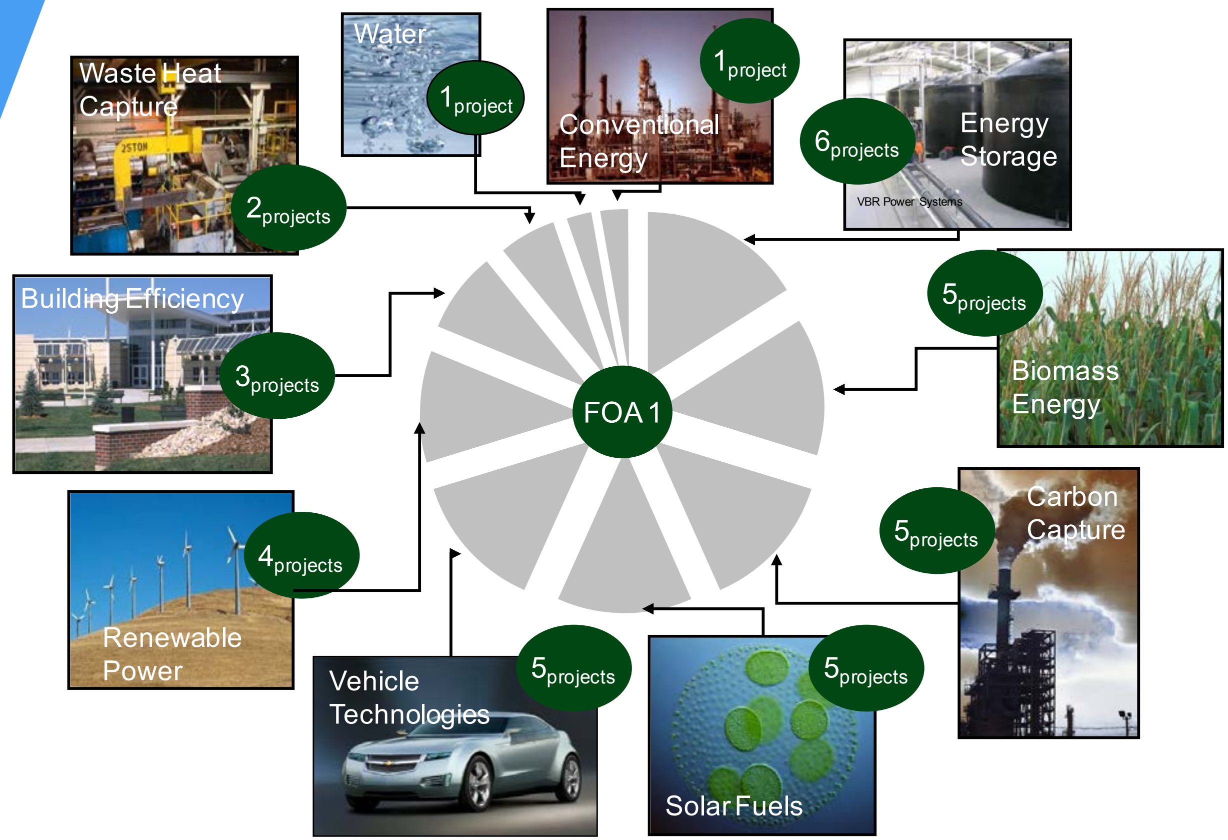
ARPA-E's first open FOA resulted 37 projects across a wide variety technology areas

3,700 Concept Papers

360 Full Applications

37 Selected projects for $151M



BEEST Primary Technical Target

Batteries for Electrical Energy Storage in Transportation

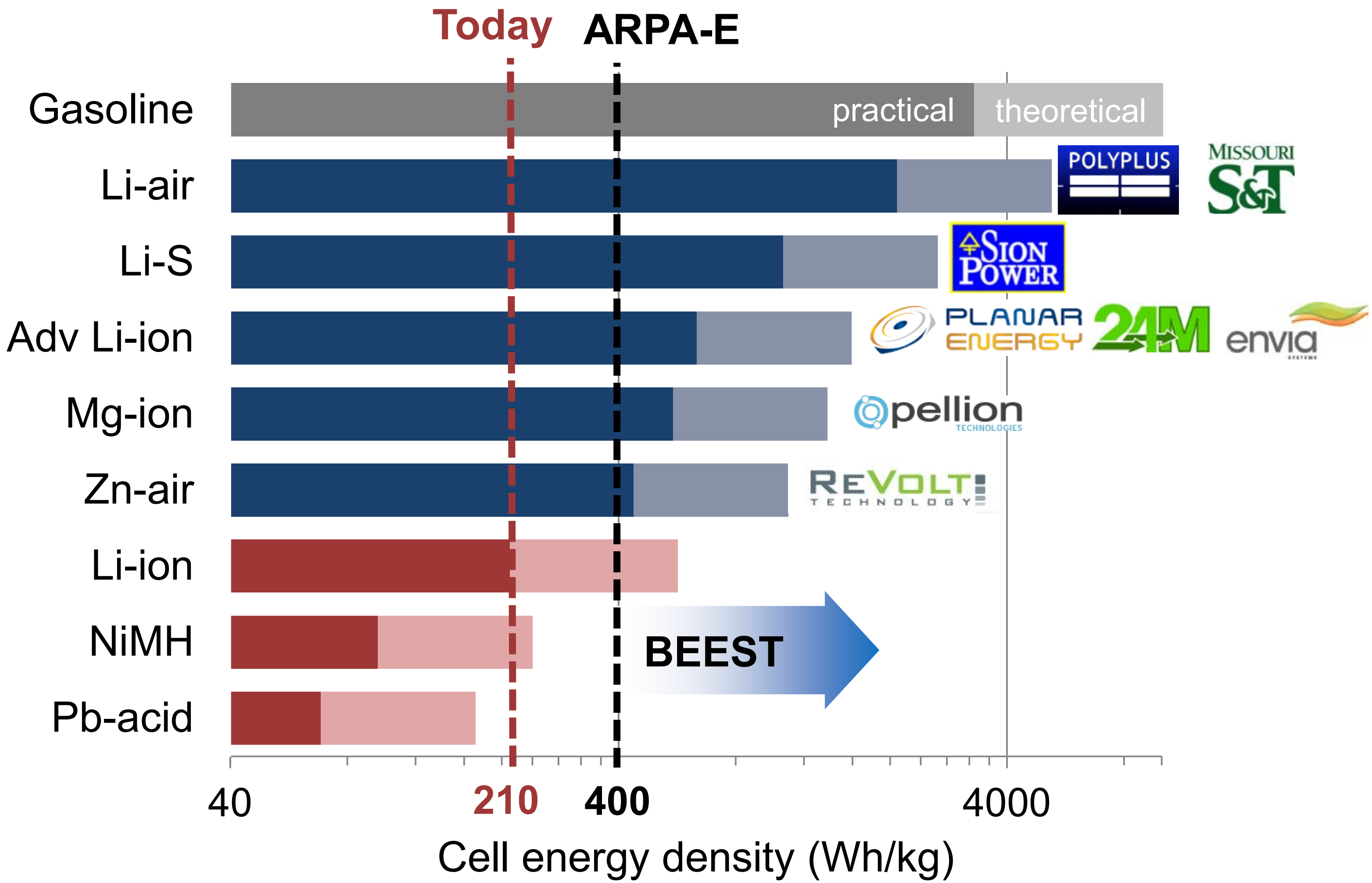
David Danielson
Assistant Secretary, EERE

BEEST Primary Technical Targets

ID No	Metric	System	Cell	Units
1.1	Specific Energy Density (at C/3)	200	400	Wh/kg
1.2	Volumetric Energy Density (at C/3)	300	600	Wh/L
1.3	System Cost	< 250		$/kWh

State-of-the-Art
System: 120 Wh/kg, 250 Wh/L, >600 $/kWh
Cell: 220 Wh/kg, 500 Wh/L

What is new about our approach?



High risk-high reward batteries chemistries with potential for higher energy density and lower cost

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BEEST Program – Dane Boysen PD

Batteries for Electrical Energy Storage for Transportation

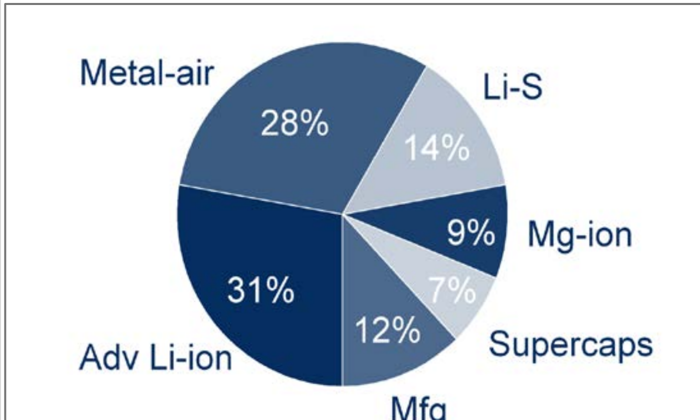
Objectives

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

2-5x performance
+
1/3 price

1. 24M-MIT
2. Applied Materials, Inc
3. Missouri University of Science & Technology
4. Pellion Technologies, Inc.
5. PolyPlus Battery Company
6. Recapping, Inc.
7. ReVolt Technology LLC
8. Sion Power Corporation
9. Stanford University
10. Planar Energy

Term:	2010-2013
Projects:	10
Investment:	$33.6M



AMPED Program – Ilan Gur PD
Advanced Management and Protection of Energy-storage Devices
Program Status: Proposals Under Review

What is the problem we want to solve?

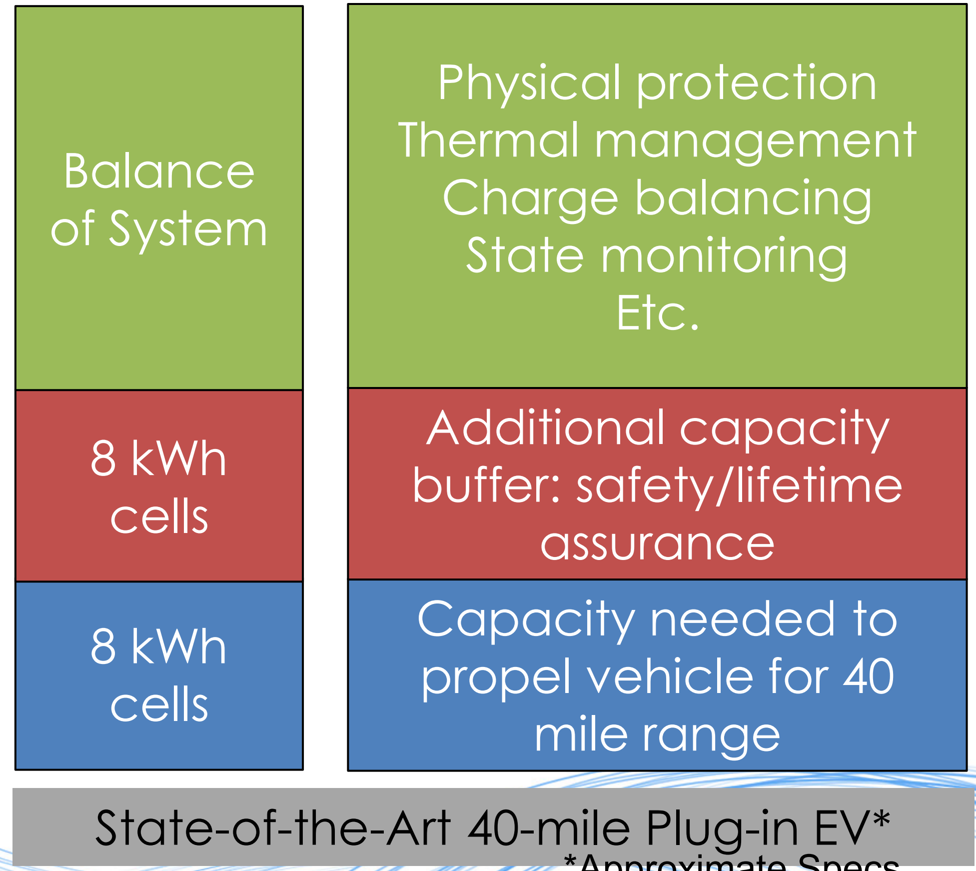
~75% of total system weight, volume, cost spent on safety, reliability, and lifetime assurance

Lifetime of battery systems is still << lifetime of vehicle

Safety still major liability

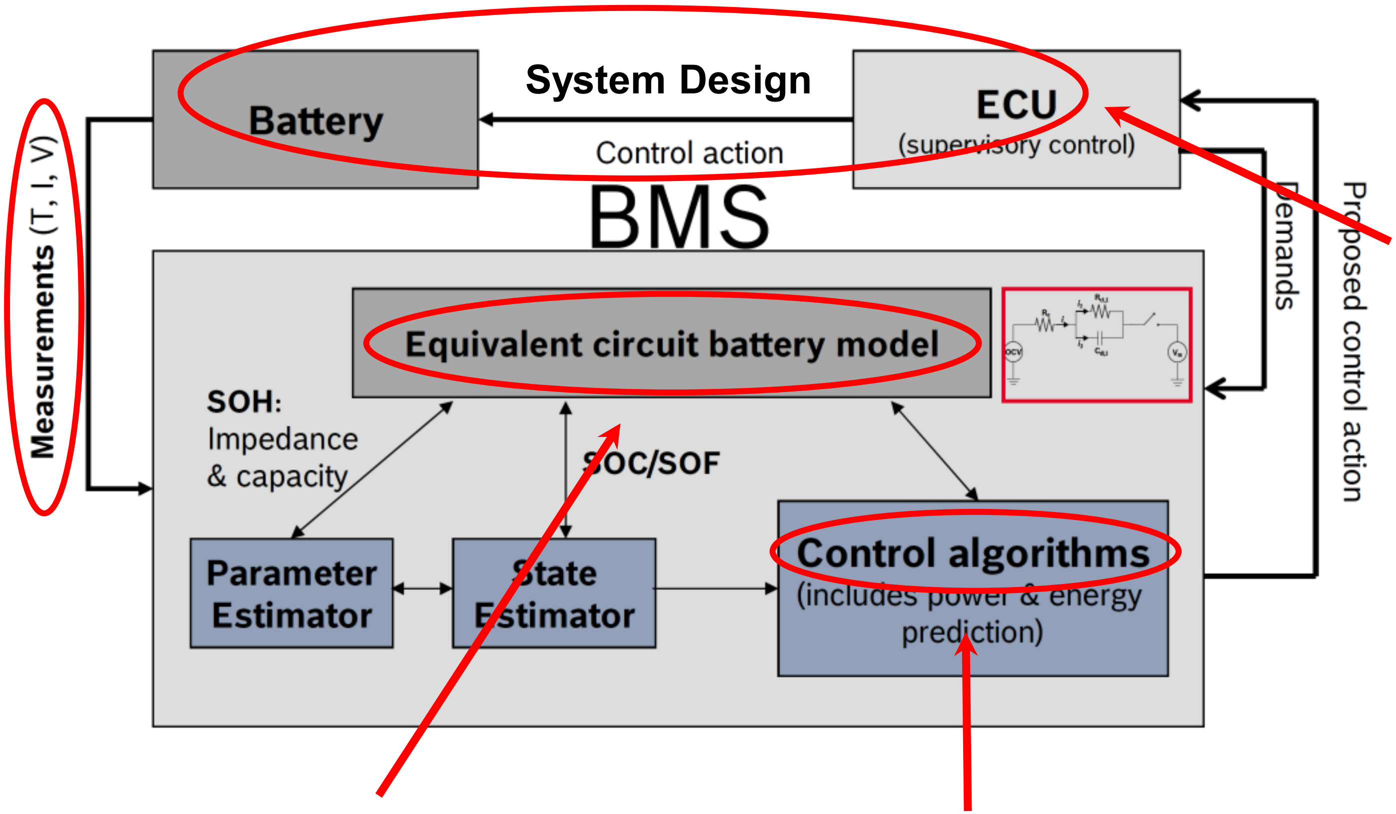
Charge-rate limited due to risk of degradation/failure

Reliability risks prohibit secondary and dual use



Many opportunities for disruptive innovation at the system level.

1. Sensing provides indirect state information with low spatial and temporal resolution



4. System designs are simple: passive balancing, modular monitoring and control

2. Simple equiv. circuit models, heuristically validated, limited accuracy

3. Simple rule-based control imposes “static” and conservative constraints

ARPA-E's AMPED PROGRAM

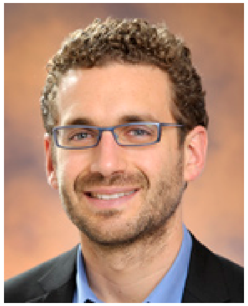
Approx. $30 million for disruptive innovation in battery management

Sensing

Modeling — Controls

Systems

Program Director: Dr. Ilan Gur



(Matl Sci, UC Berkeley)

SBIR – High Energy Density Electrical Energy Storage For Transportation. PD Dane Boysen

Program Status: Proposals Under Review

PRIMARY TECHNICAL TARGETS

ID	Category	Value (Units)
3.1.1	Specific energy density	> 400 Wh/kg
3.1.2	Volumetric energy density	> 600 Wh/L
3.1.3	Electrode materials cost	< 50 $/kWh

SECONDARY TECHNICAL TARGETS

ID	Category	Value (Units)
3.2.1	Specific power density	> 800 W/kg
3.2.2	Volumetric power density	> 1200 W/L
3.2.3	Cycle life	> 100 cycles
3.2.4	Energy efficiency	> 80%
3.2.5	Self-discharge	< 15%/mo

What ARPA-E is looking for:

Non-lithium based battery chemistries

Metal-air battery approaches

Novel battery architectures

New electrolytes

Metal-sulfur battery approaches

Advanced lithium-ion based battery systems

Other novel electrical energy storage approaches

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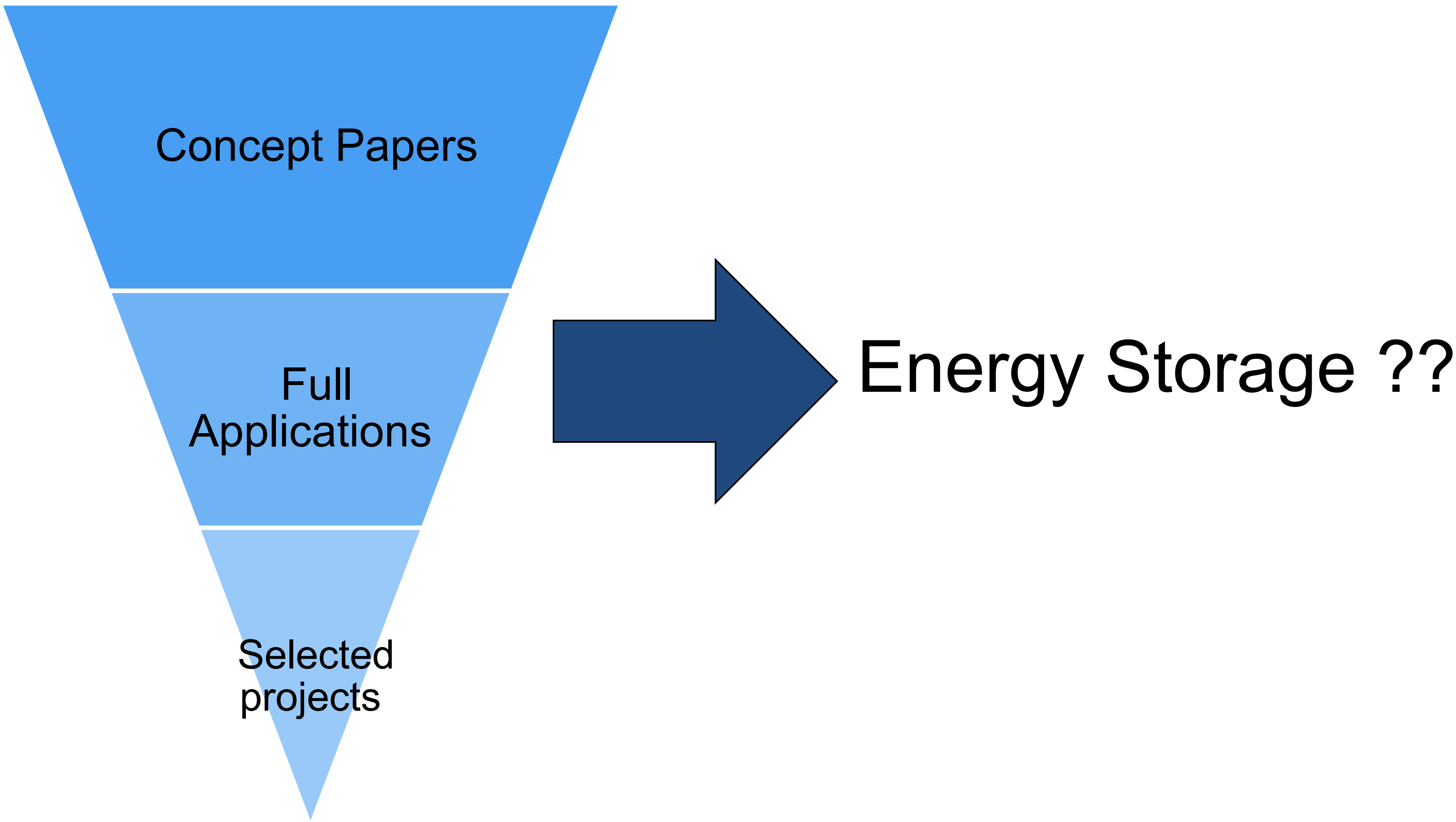
ARPA-E's Open FOA 2 – full applications under review



Thank You

BEEST Secondary Technical Target

BEEST Secondary Technical Targets

ID No	Metric	Target
2.1	Specific Power Density	400 W/kg (system) 800 W/kg (cell) [80% DOD, 30s]
2.2	Volumetric Power Density	600 W/L (system) 1200 W/L (cell) [80% DOD, 30s]
2.3	Cycle Life	1000 cycles at 80% DOD
2.4	Round Trip Efficiency (RTE)	80% at C/3
2.5	Temperature Tolerance	-30°C to 65°C with < 20% degradation in energy/power density; cycle life, RTE vs 25°C
2.6	Self Discharge	< 15%/month
2.7	Safety	Tolerant to abusive charging/damage
2.8	Calendar Life	10 years