



U.S. DEPARTMENT OF  
**ENERGY**

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# **Basic Energy Sciences Research and Facilities Promoting Innovation**

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Office of Basic Energy Sciences

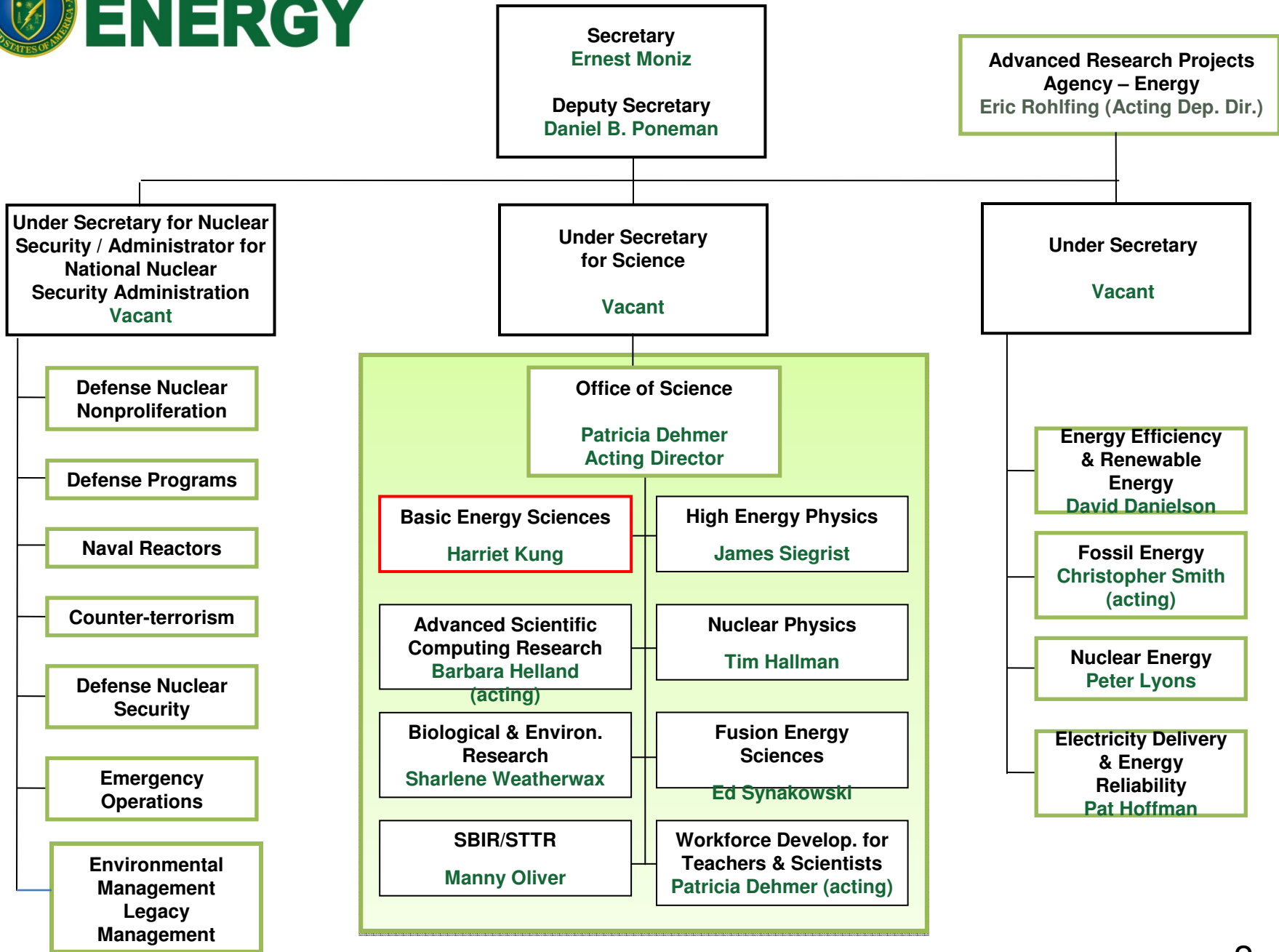
CCR Annual Meeting

May 20, 2013

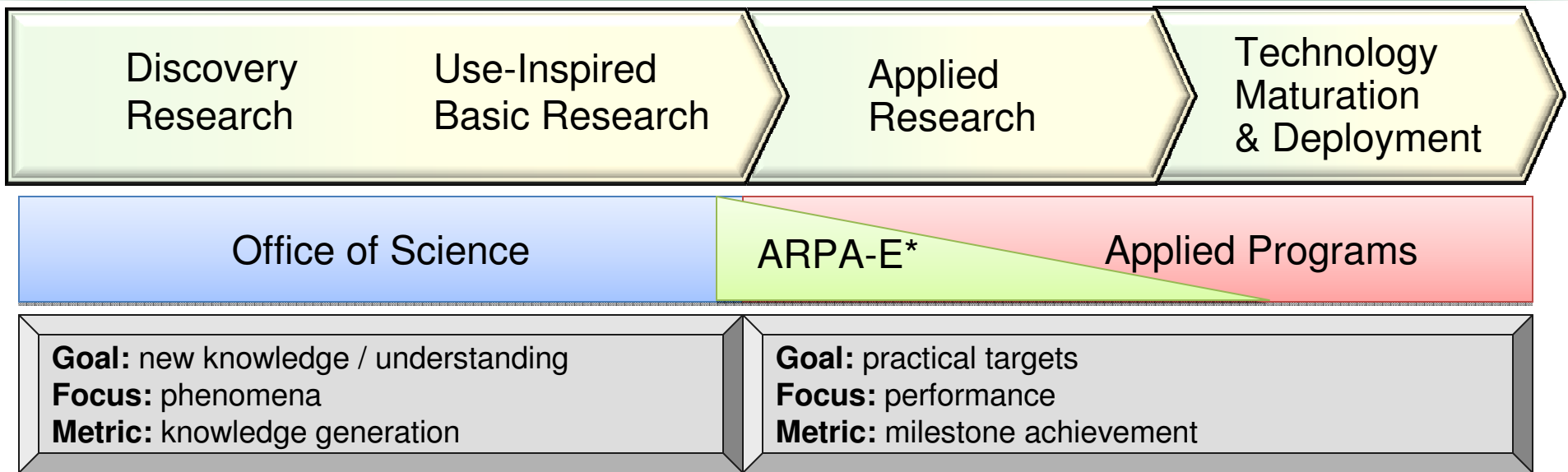
Arlington, VA



# U.S. DEPARTMENT OF ENERGY



# Continuum of Research, Development, and Deployment



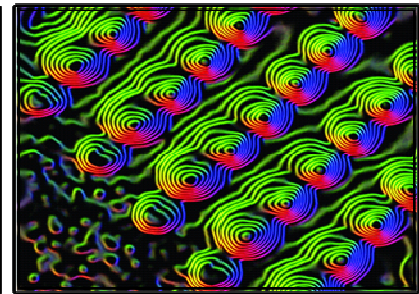
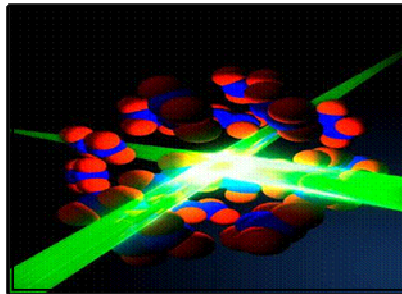
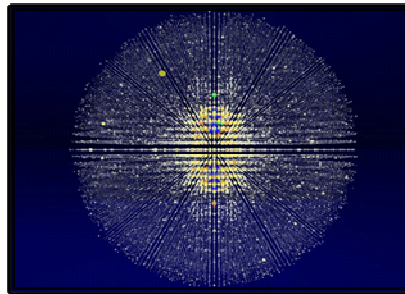
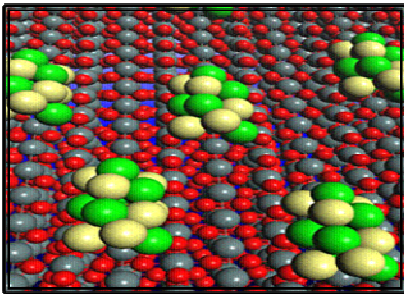
- Basic research to address fundamental limitations of current theories and descriptions of matter in the energy range important to everyday life – typically energies up to those required to break chemical bonds.
- Basic research for fundamental new understanding on materials or systems that may revolutionize or transform today’s energy technologies
- Basic research for fundamental new understanding, usually with the goal of addressing scientific showstoppers on real-world applications in the energy technologies
- Proof of new, higher-risk concepts
- Prototyping of new technology concepts
- Explore feasibility of scale-up of demonstrated technology concepts in a “quick-hit” fashion.
- Research with the goal of meeting *technical milestones*, with emphasis on the development, performance, cost reduction, and durability of materials and components or on efficient processes
- Scale-up research
- Small-scale and at-scale demonstration
- Cost reduction
- Manufacturing R&D
- Deployment support, leading to market adoption
- High cost-sharing with industry partners



# Basic Energy Sciences Mission

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- **Fundamental research** to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels.
- Provide the foundations for new energy technologies to support DOE's **missions in energy, environment, and national security**.
- Plan, construct, and operate **world-leading scientific user facilities** for the Nation. BES user facilities provide **open access** to users from universities, national laboratories, and industry.



# BES Research — Science for Discovery & National Needs

## Three Funding Modalities

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increasing progression of scientific scope and level of effort



### ■ Core Research

Single-investigator, small groups, and targeted larger programs

- Enable seminal advances in the core disciplines of the basic energy sciences—materials sciences and engineering, chemistry, and aspects of geosciences and biosciences. Scientific discoveries at the frontiers of these disciplines establish the knowledge foundation to spur future innovations and inventions.

### ■ Energy Frontier Research Centers

Started in FY 2009

\$2-5 million-per-year research centers; multi-investigator and multi-disciplinary

- Harness the most basic and advanced discovery research in a concerted effort to accelerate the scientific breakthroughs needed to create advanced energy technologies. Bring together critical masses of researchers to conduct fundamental energy research in a new era of grand challenge science and use-inspired energy research.

### ■ Energy Innovation Hubs

Started in FY 2010

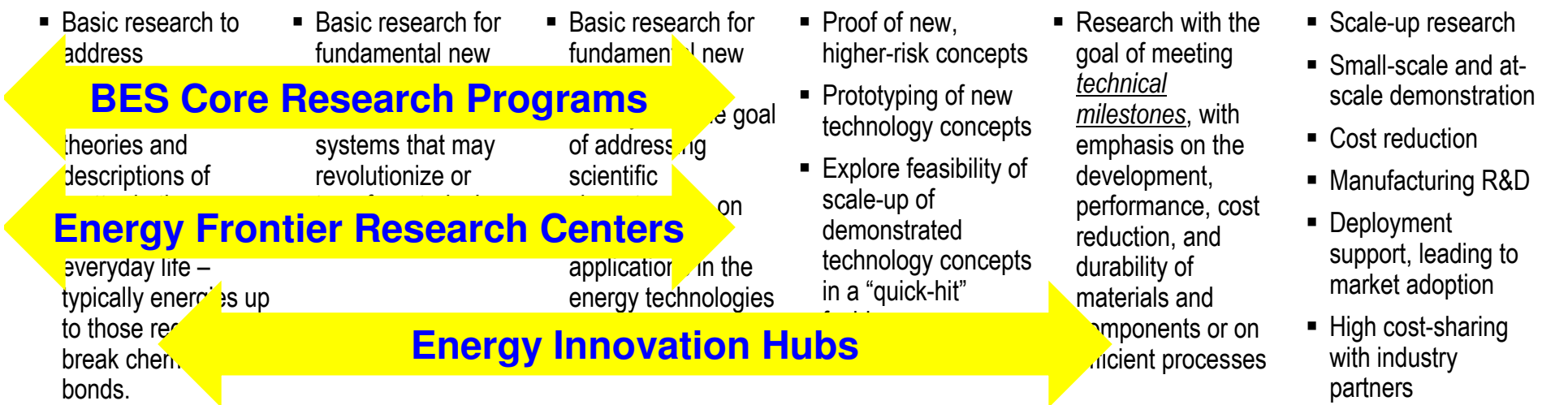
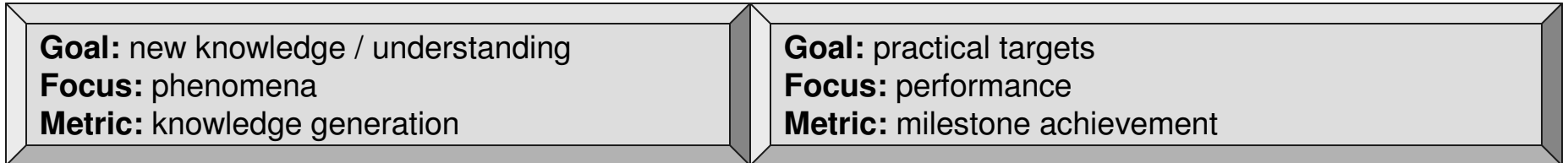
\$25 million-per-year research centers focus on co-locating and integrating multi-components, multi-disciplinary research with technology development to enable transformational energy applications.



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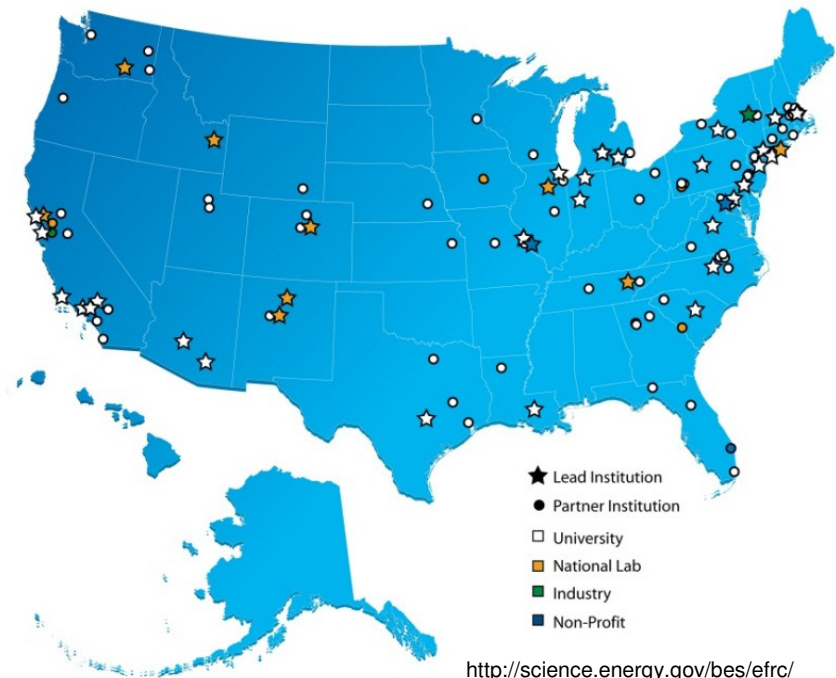
# Energy Frontier Research Centers Update

## Participants:

- **46** EFRCs in **35** States + Washington D.C.
- **~850** senior investigators and **~2,000** students, postdoctoral fellows, and technical staff at **~115** institutions
- **>250** scientific advisory board members from **13** countries and **>40** companies

## Progress to date (~3.5 years funding):

- **>3,400** peer-reviewed papers including **>110** publications in *Science* and *Nature*
- **18** PECASE and **11** DOE Early Career Awards
- **>200** patent/patent applications, plus an additional **>60** invention disclosures and at least **30** licenses
- At least **60** companies have benefited from EFRC research
- EFRC students and staff now work in: **>195** university faculty and staff positions; **>290** industrial positions; **>115** national labs, government, and non-profit positions



<http://science.energy.gov/bes/efrc/>



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# Companies that Benefit from EFRC Research





# Fuels from Sunlight Hub Joint Center for Artificial Photosynthesis (JCAP)

## Mission

Develop a solar-fuels generator scalable to manufacture, from earth-abundant elements, that uses only sunlight, water, and carbon dioxide in the robust production of fuels

## JCAP Team

Carl Koval, Director (CalTech); Nate Lewis, Founding Director and Chief Scientist (CalTech); two Assistant Directors; about 150 staff

## Space

- JCAP North at LBNL: 14,000 sq. ft. leased space
- JCAP South at Caltech: 18,500 sq. ft. in renovated Jorgensen Lab Building (by Caltech & initial startup funds from DOE)

## Funding & Oversight

- Up to \$122 million over five years
- External reviews in 2011, 2012; scheduled at both sites for April 2013

## Goals & Lasting Legacies

- Produce fuel from the sun 10x more efficiently than crops
- Library of fundamental knowledge
- Research prototype solar-fuels generator
- Develop the science and the critical expertise for a solar fuels industry

## Milestones

- 2013:** Establish benchmarking capabilities to compare large quantities of catalysts and light absorbers under standard conditions. Progress:
- Benchmarking protocols established for thin films, plan to benchmark over 40 catalytic thin films.
  - As of March 2013, more than 20 films evaluated
- 2014:** Design the first prototypic devices for testing components (catalysts, light harvesters, membranes, interfaces, etc.) as an integrated system

Jorgensen Laboratory Building



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# Batteries and Energy Storage Hub Joint Center for Energy Storage Research (JCESR)

## Mission

Science to enable next generation batteries—beyond lithium ion—and energy storage for the grid and for transportation

## JCESR Team

George Crabtree, Director (ANL); 5 national labs, 5 universities, 4 industry partners, and 2 individual members' institutions

## Space

- ANL Electrochemical Discovery Laboratory will provide lab and office space for use by all JCESR Institutions.
- State of Illinois has provided \$5M for a new JCESR building with state-of-the-art laboratory and meeting space

## Funding & Oversight

- Up to \$120 million over five years
- Management review (PY1), Annual external S&T reviews (PY2-5)

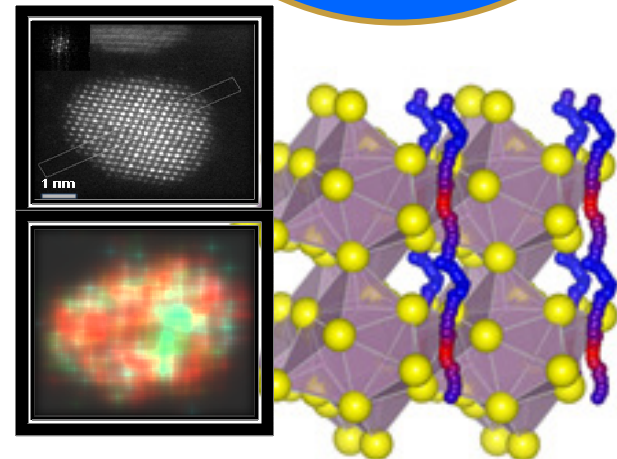
## Goals & Lasting Legacies

- 5x Energy Density, 1/5 Cost, within 5 Years
- Library of fundamental knowledge
- Research prototype batteries for grid and transportation
- New paradigm for battery development

## Initial Milestones

### 2013-2014:

- Bring suite of experimental tools to full operation.
  - Design new architectures of electrode/working ion combinations
  - Begin the development of an electrolyte database to predict the design of new electrolytes



JCESR will use nanoscience tools and theoretical approaches to enable next generation energy storage



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**Thank You!**