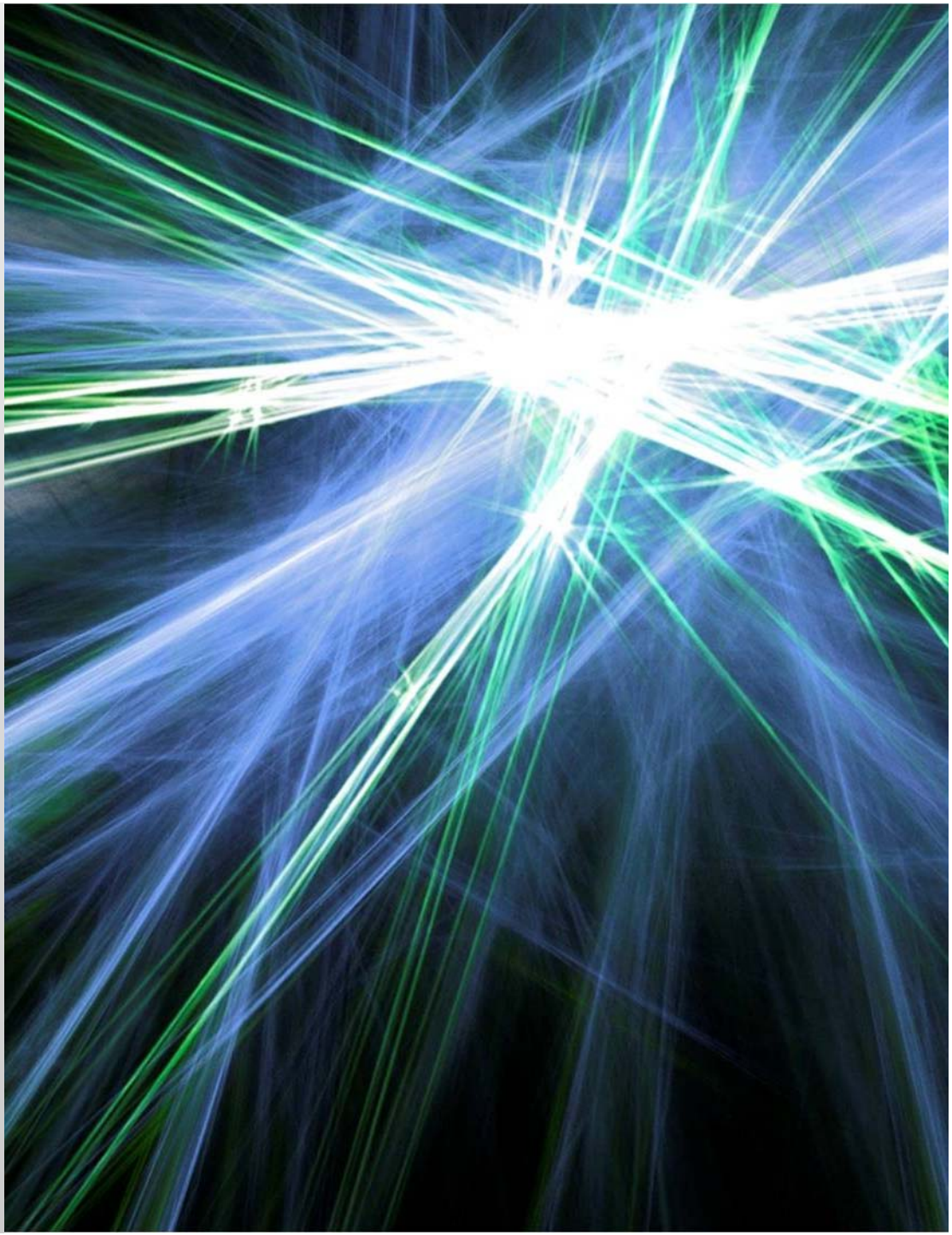
Crosscutting Research Program Review

Susan Maley

Crosscutting Research
Technology Manager

May 19, 2014



U.S. DEPARTMENT OF ENERGY | National Energy Technology Laboratory

Welcome

Registration, Safety, Agenda, Program Materials, Participants & Presentations

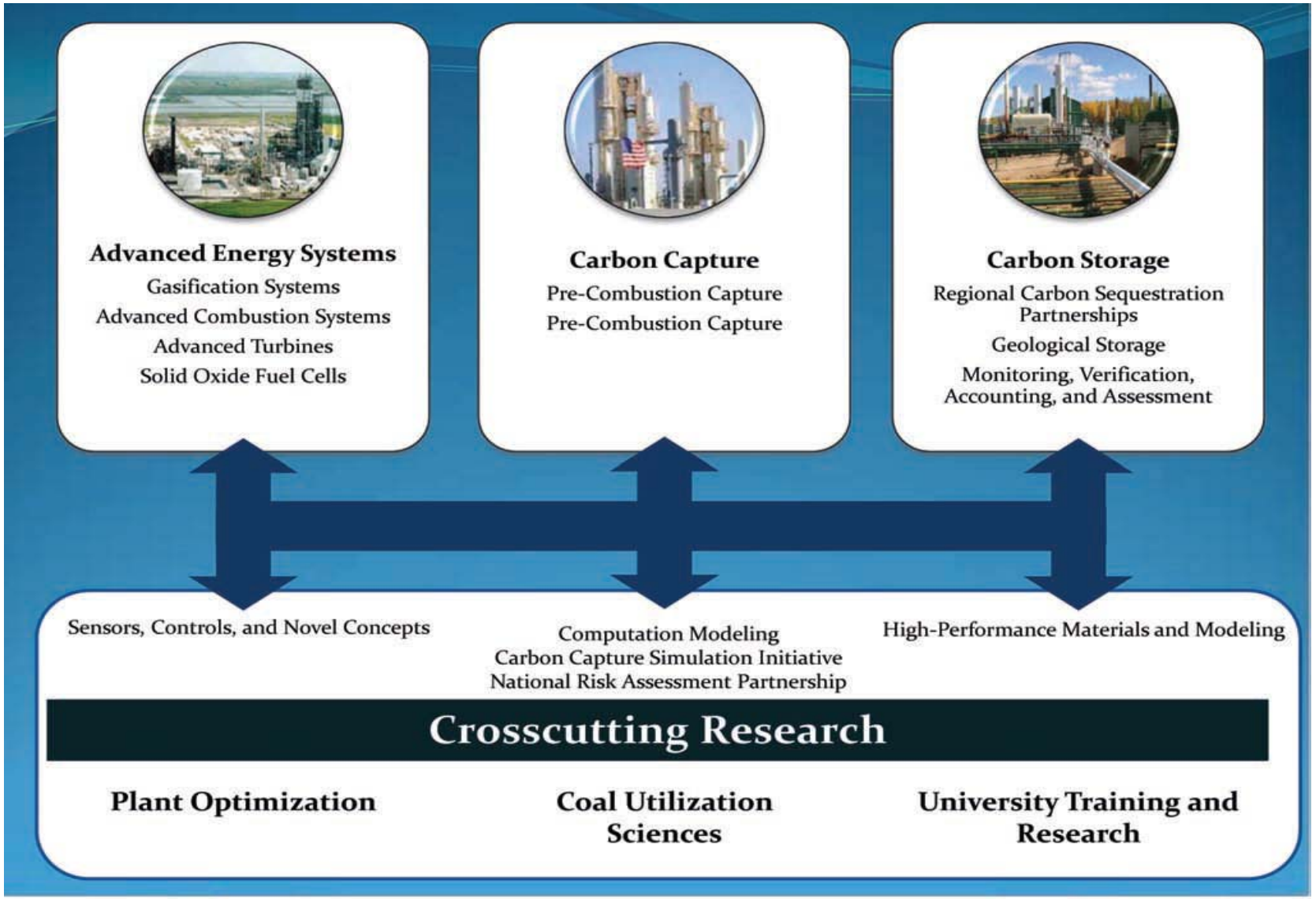
Thank You

Crosscutting Program Overview


THANK
YOU

Crosscutting Research

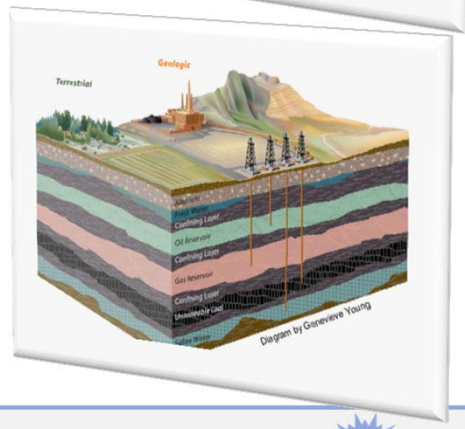
Interconnection with Other Programs



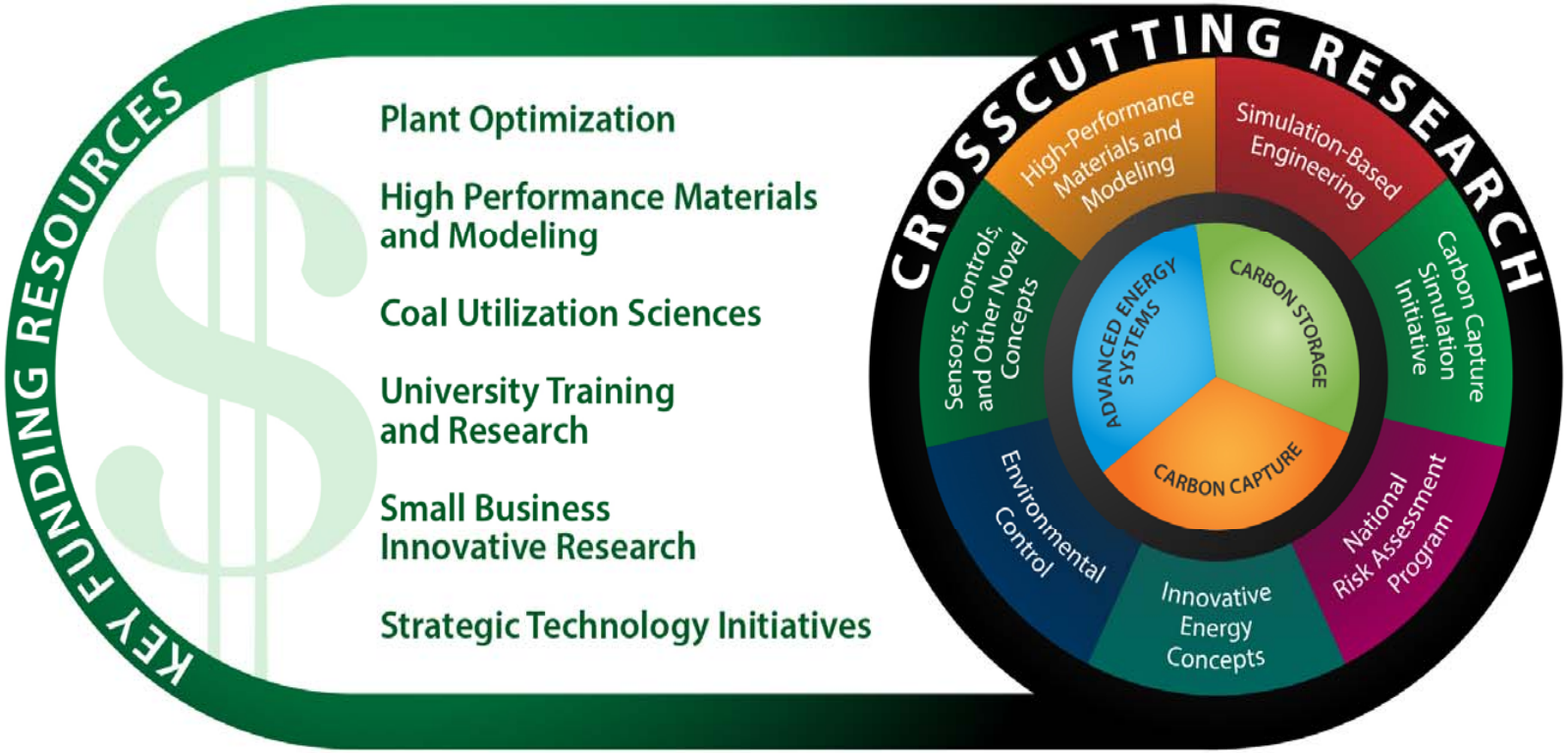
Crosscutting Research Program

Bridging the gap between fundamental research and applied development to support advancement and utilization of domestic energy resources.

- ***Sensors & Controls***
- ***High Performance Materials***
- ***Simulation Based Engineering***
  - *National Risk Assessment Partnership*
  - *Carbon Capture Simulation Initiative*
- ***Innovative Energy Concepts***
- ***University Training Research***
  - *University Coal Research*
  - *Historically Black Colleges and University /OMI*

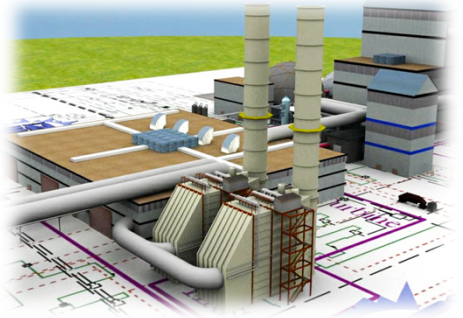


Crosscutting Research Program Overview



Bridge the gap between fundamental & applied technology

- Improve existing plants through efficiency and availability
- Provide materials, design, and operational tools and techniques for advanced power generation; and
- Introduce and foster growth of new technology with step change improvements in efficiency, environmental, or cost.



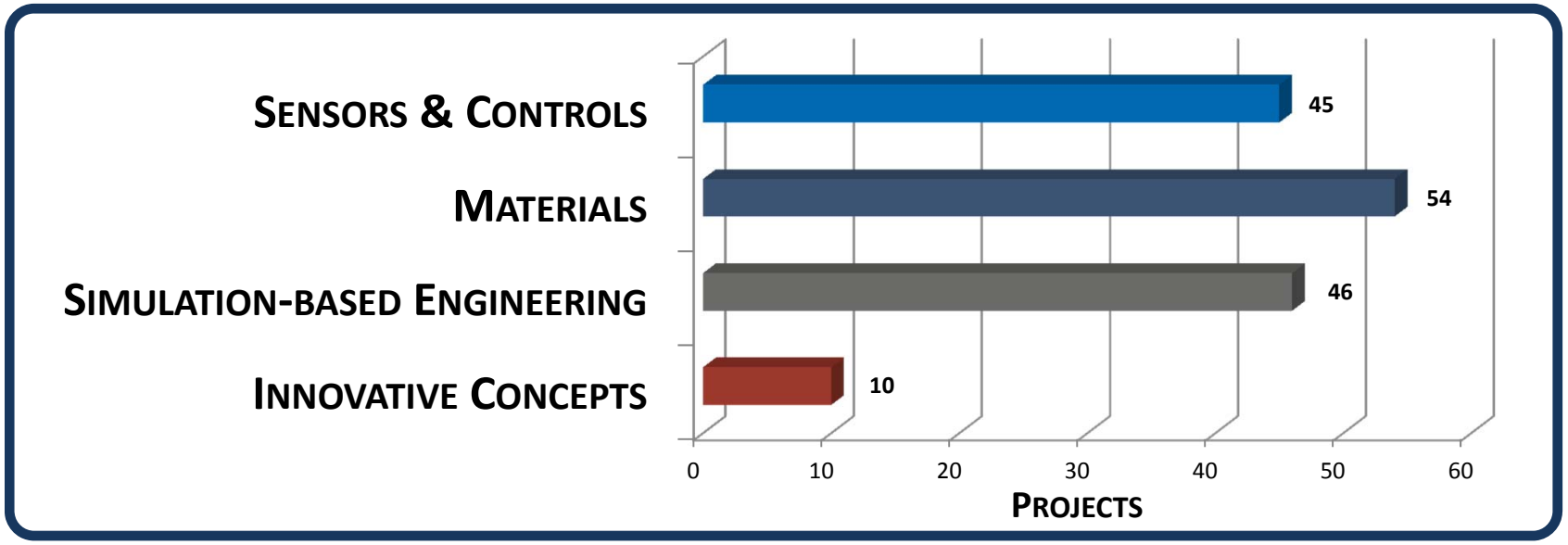
Crosscutting Research

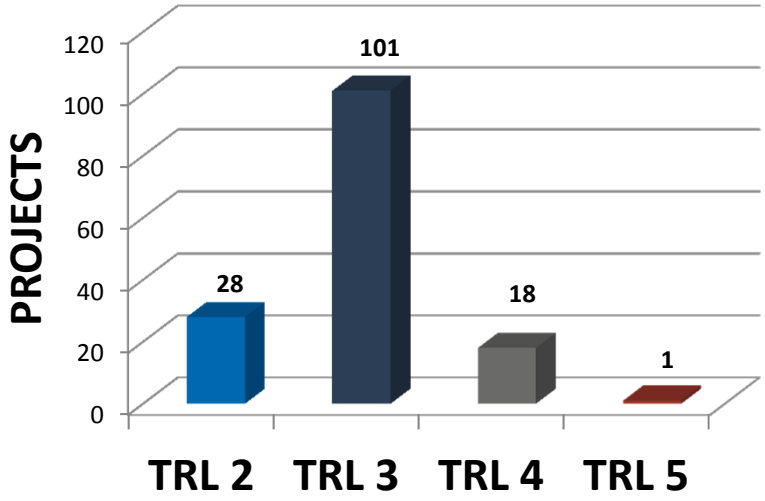
Funding Resources

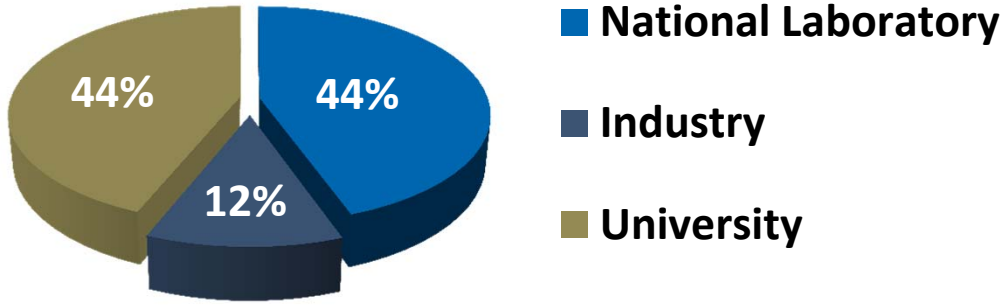
Key Activity / Component	FY13 Actual Budget	FY14 Budget
Plant Optimization Technologies	**13,003**	**17,025**
H2O Management	0	5,000
Materials	797	500
Sensors and Controls	12,206	6,525
A-USC *	0	5,000
Coal Utilization Sciences	23,983	19,000
Computational System Dynamics	2,910	2,700
NRAP	8,320	6,800
Computational Energy Science	4,051	3,700
CCSI	8,702	5,800
Systems Analysis	3,807	0
University Training and Research	**3,807**	**3,600**
University Training & Research	2,855	2,500
Historically Black Colleges & Universities	952	1,100
Crosscutting Research TOTAL	**44,600**	**39,625**

** Note: A-USC received $5M in FY13 from Advanced Combustion Systems*

Crosscutting Research Portfolio Analysis

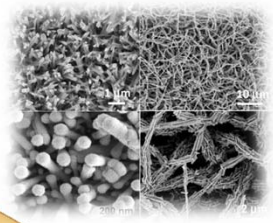






Crosscutting Research in Sensors & Controls

Transformational Development in Process Monitoring and Control

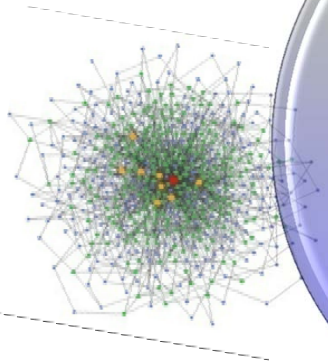


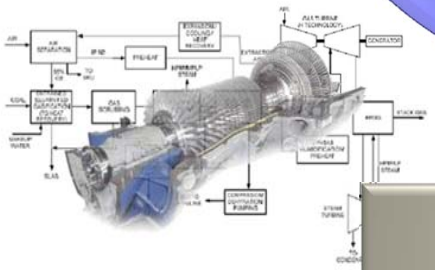
Distributed Intelligence

Computationally driven approaches for novel control architectures and logic, information generation, sensor networking & placement

Advanced Sensing

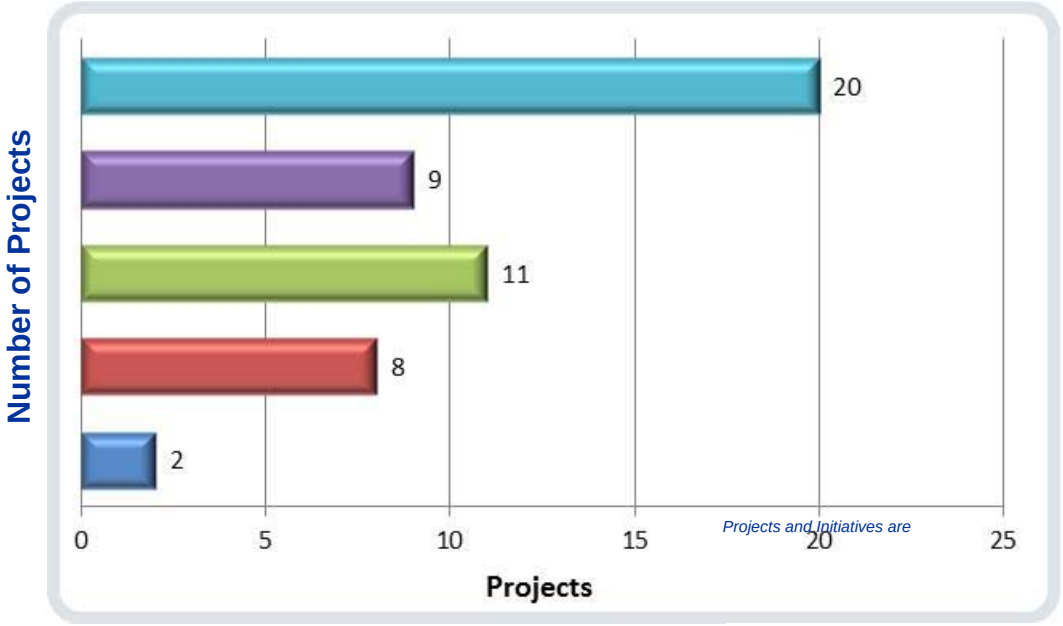
Harsh environment sensing concepts and approaches for low cost dense distribution of sensors





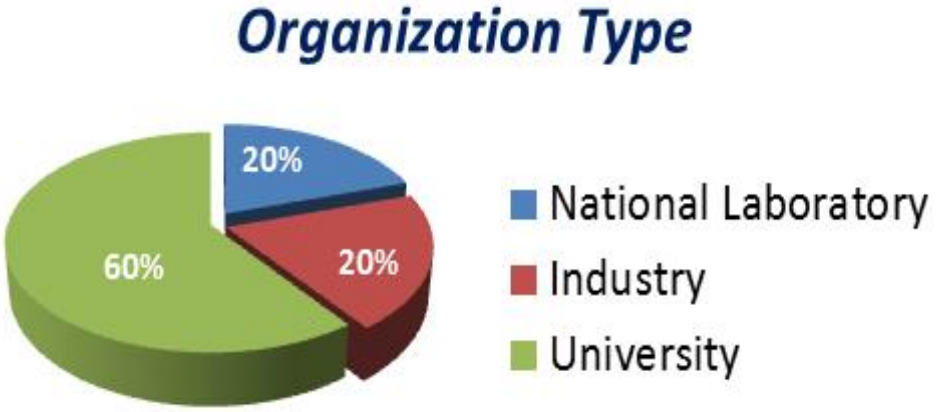
Value derived from an encompassing approach, a purposeful applied development effort, and a clear pathway for transitioning technology.

Sensors & Controls: Portfolio Analysis

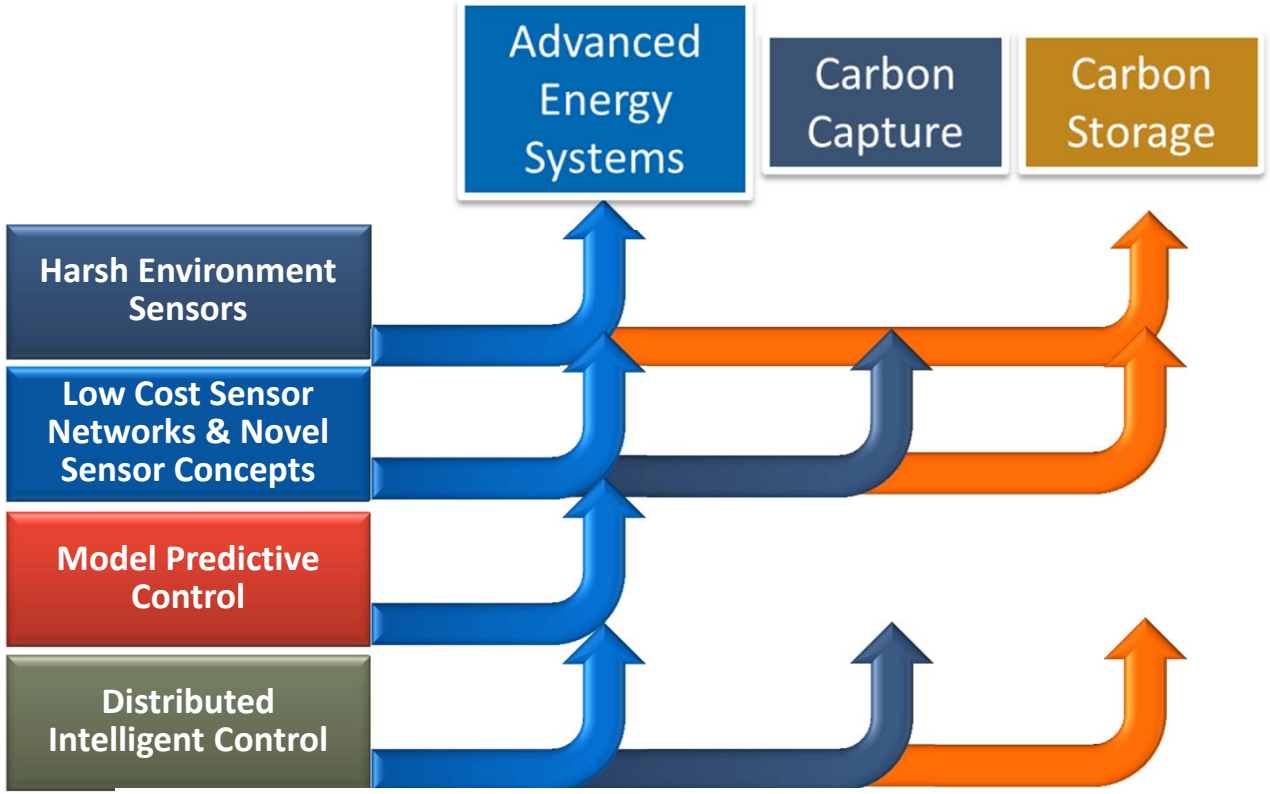


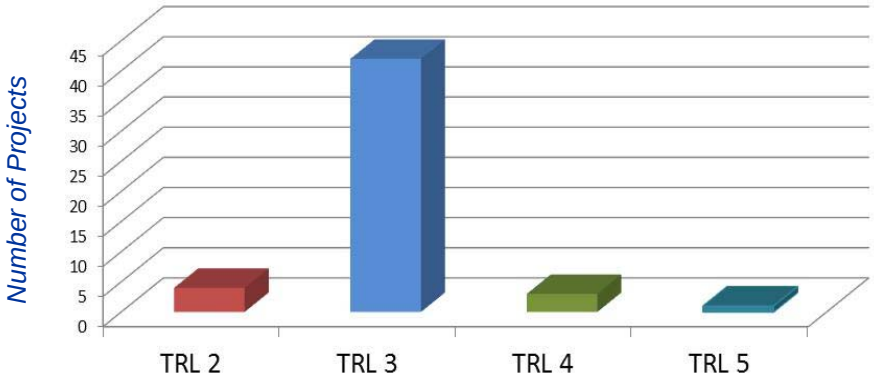
Projects and Initiatives are:

- **Delineated by areas within Roadmap**
- **Mapped to application space for transitioning, use, and benefit**



Sensors & Controls: Application and Maturity Mapping

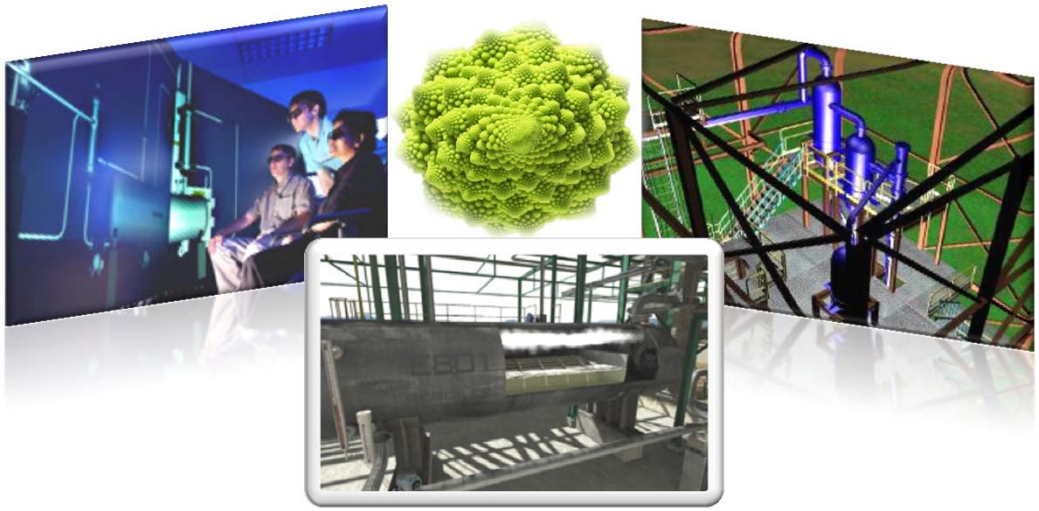


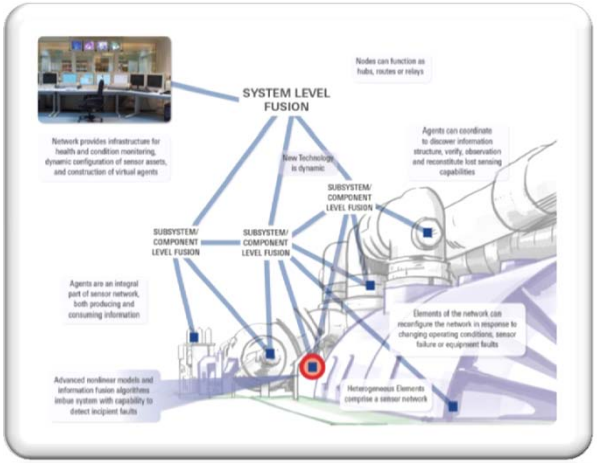


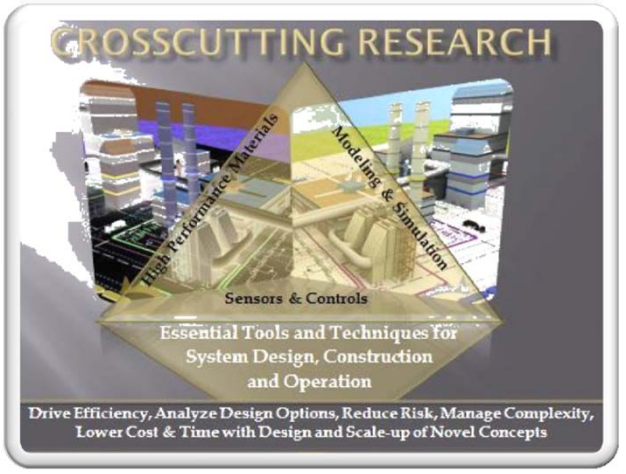
Technology Readiness Levels 2-4

Represent Proof of Concept R&D through Bench and Laboratory Scale Demonstration of Technology

What's Next in Sensors and Controls?





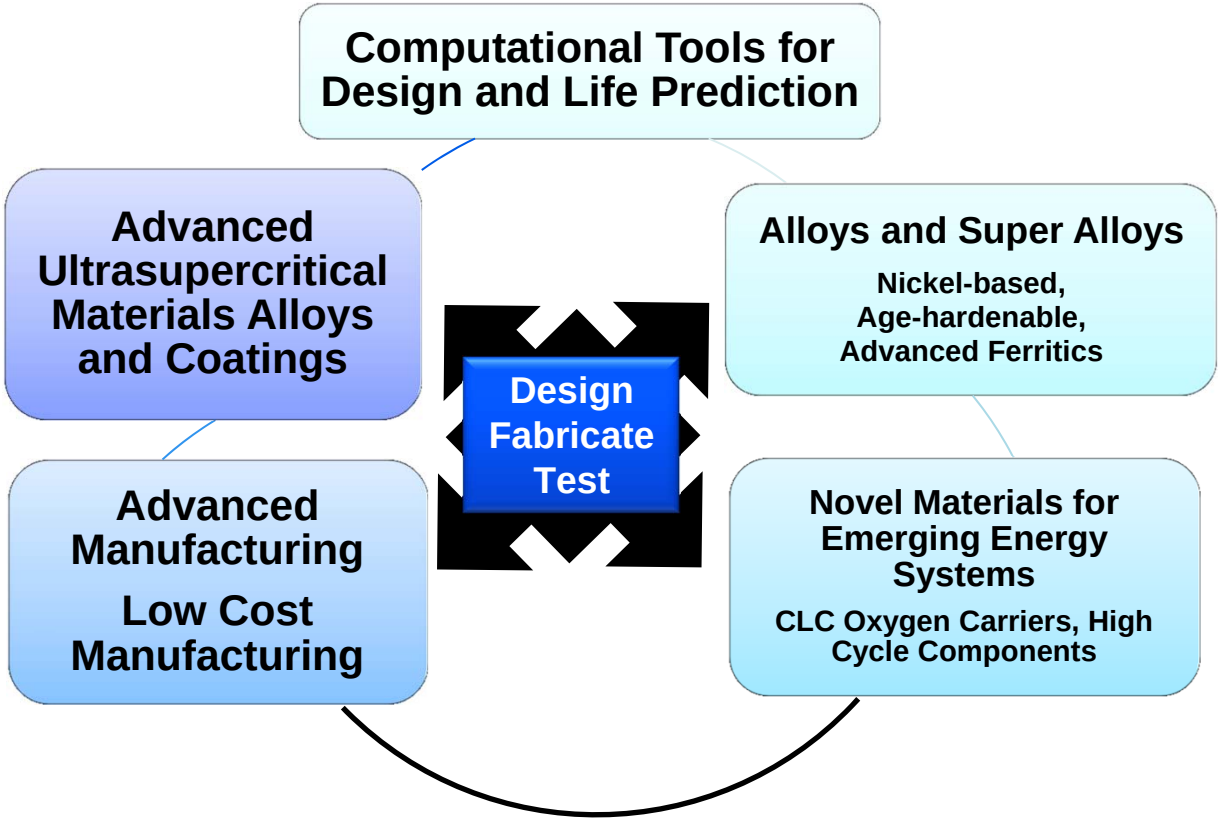


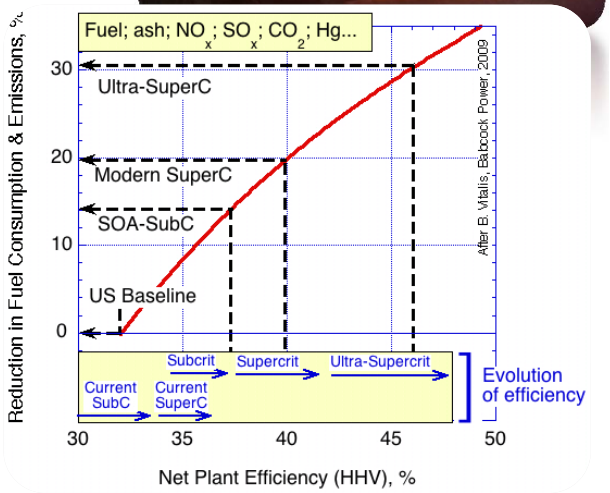
- Vision includes a systems level approach to sensing with placed sensors, networked sensors and actuation, smart components through embedded sensing and distributed intelligent control which can reconfigure, optimize, and manage fast dynamics and competing objectives
- Transformational R&D with an encompassing approach to complexity management and engineering of complex systems

High Performance Materials

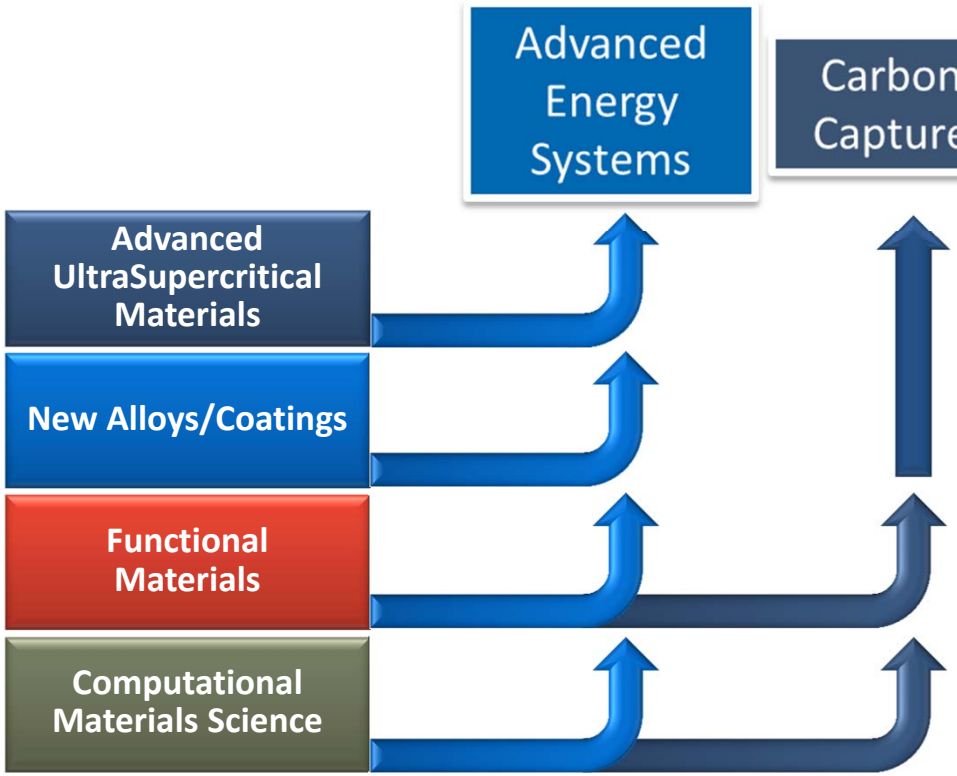
New materials are essential for advanced power generation systems with carbon capture and storage capability to achieve performance, efficiency, and cost goals.

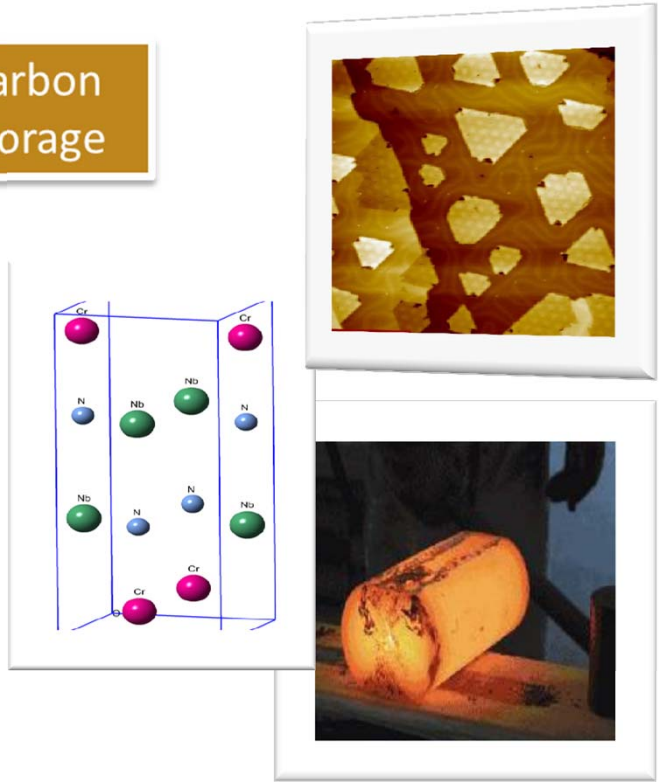
Materials of interest are those that enable components and equipments to perform in the harsh environments of an advanced power system.

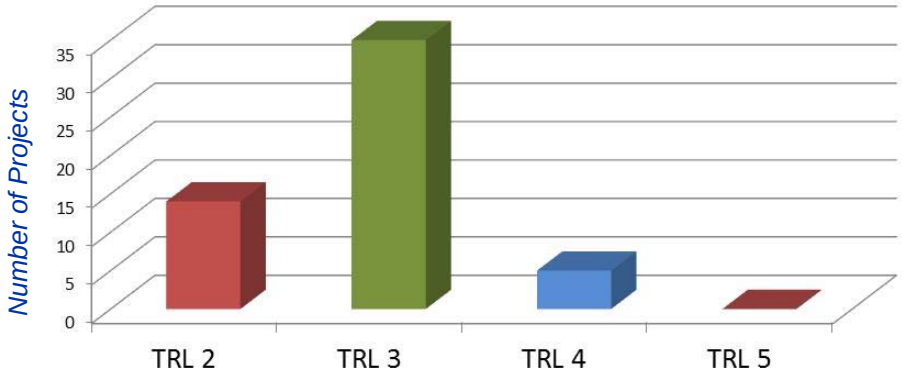




Materials: Application and Maturity Mapping







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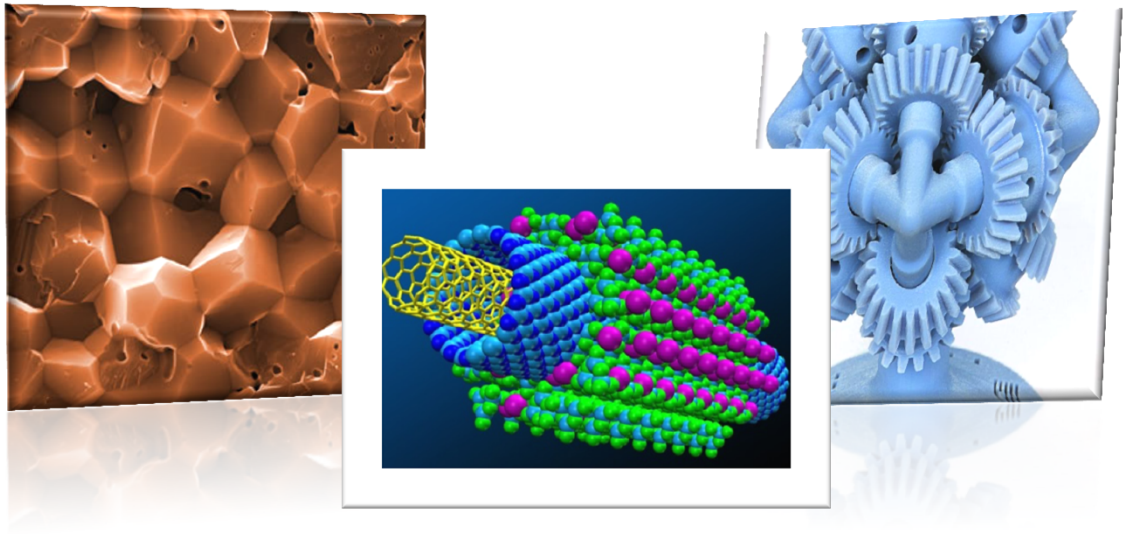
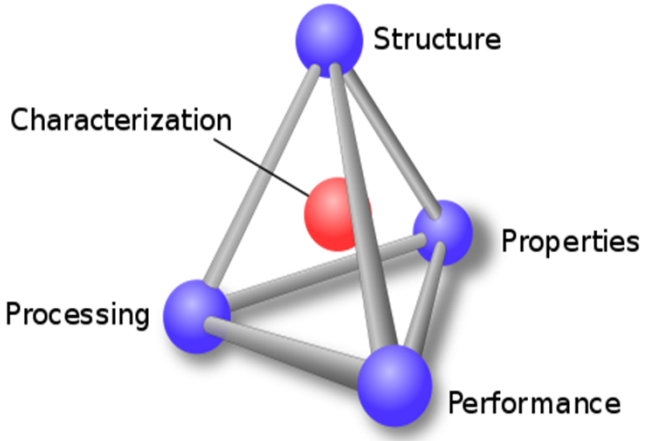
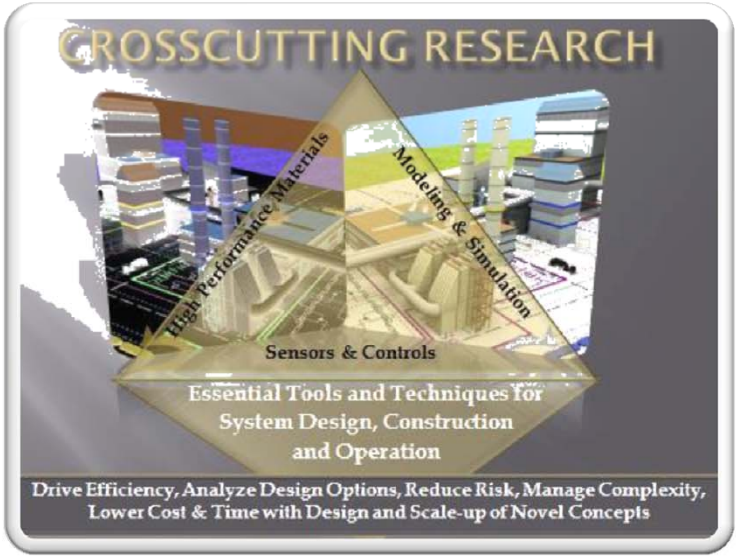
What's Next in Materials?





- Supply chain development of materials with greatest market value potential
- High temperature, high cycle materials for fast ramping
- Structured performance evaluation program of materials
- Optimization of Advanced Manufacturing for functional and structural materials
  - Rapid prototyping to support evaluation and design
- Transformational engineering of ceramics for high temperature functional applications
- Magneto Hydrodynamic & Rare Earth Materials



Simulation Based Engineering

GOAL

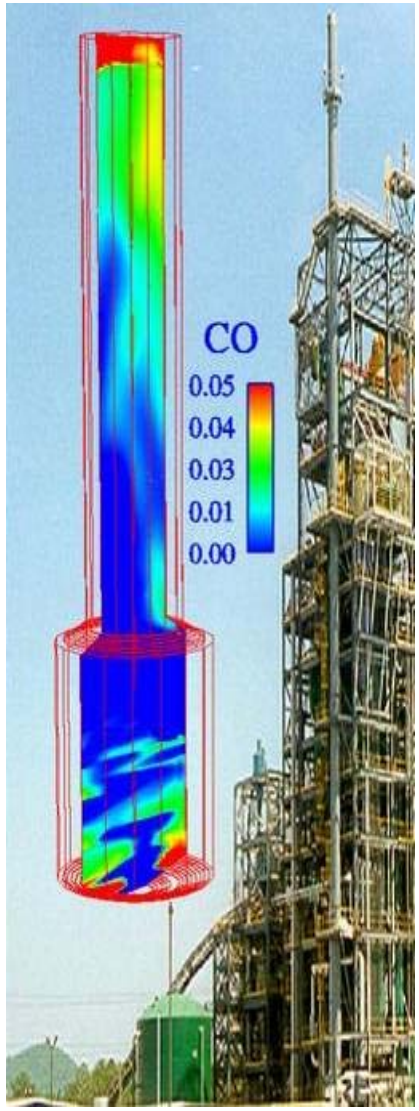
Accelerate development, design, and deployment of energy systems through the use of simulation and visualization tools.

APPROACH

Develop computational tools & techniques for multi-scale modeling & simulation. Validate & verify computational tools through experimental data & use of representative energy systems.

BENEFITS

- ***Enables information and analysis beyond the reach of experiments alone,***
- ***Guides research and investment decisions,***
- ***Lowers cost of technology maturation through accelerated design and scale up and risk reduction,***
- ***Enables pre-build optimization of design and operation that leads to saving time and money along with major risk mitigation, and***
- ***Barrier issues can be addressed in a cost effective manner***



Simulation Based Engineering

Tools and Techniques for Rapid, Low Cost Technology Development

CCSI
Carbon Capture Simulation Initiative

NRAP
National Risk Assessment Partnership

C3M™
Carbonaceous Chemistry for Computational Modeling

Technical Knowledge

Collaborative Partnerships

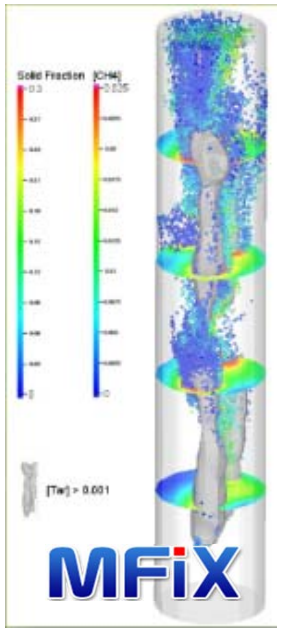
Code & Software Development

Accelerated solutions for complex power systems

Experimental Facilities

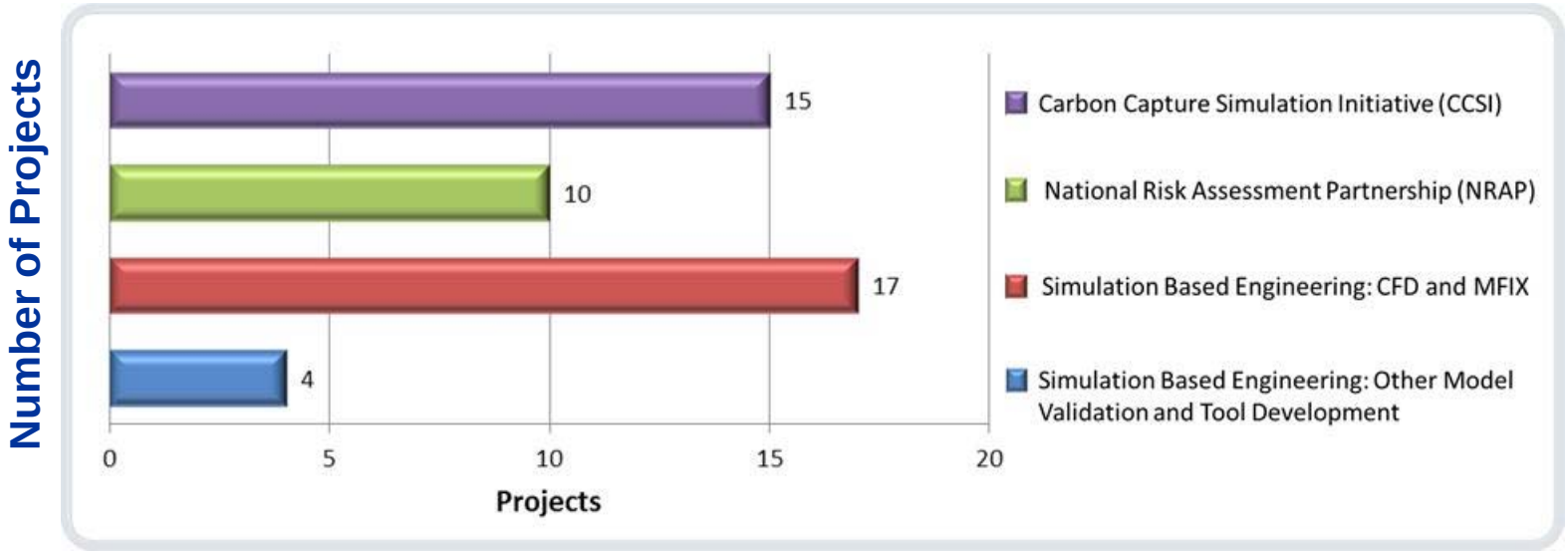
Computational Power

Data Repository



SBEUC
SIMULATION BASED ENGINEERING USER CENTER

Simulation Based Engineering: Portfolio Analysis



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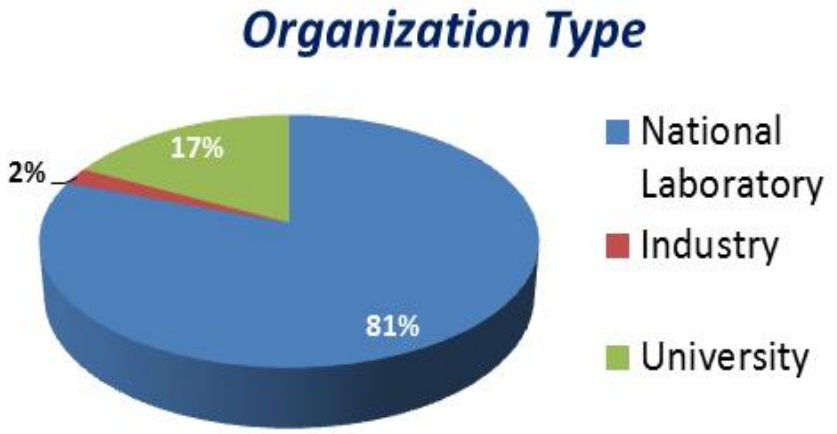


Carbon Capture Simulation Initiative:

Computational Tools to Accelerate Technology Deployment

Identify promising concepts → Reduce the time for design & troubleshooting → Quantify the technical risk, to enable reaching larger scales, earlier → Stabilize the cost during commercial deployment

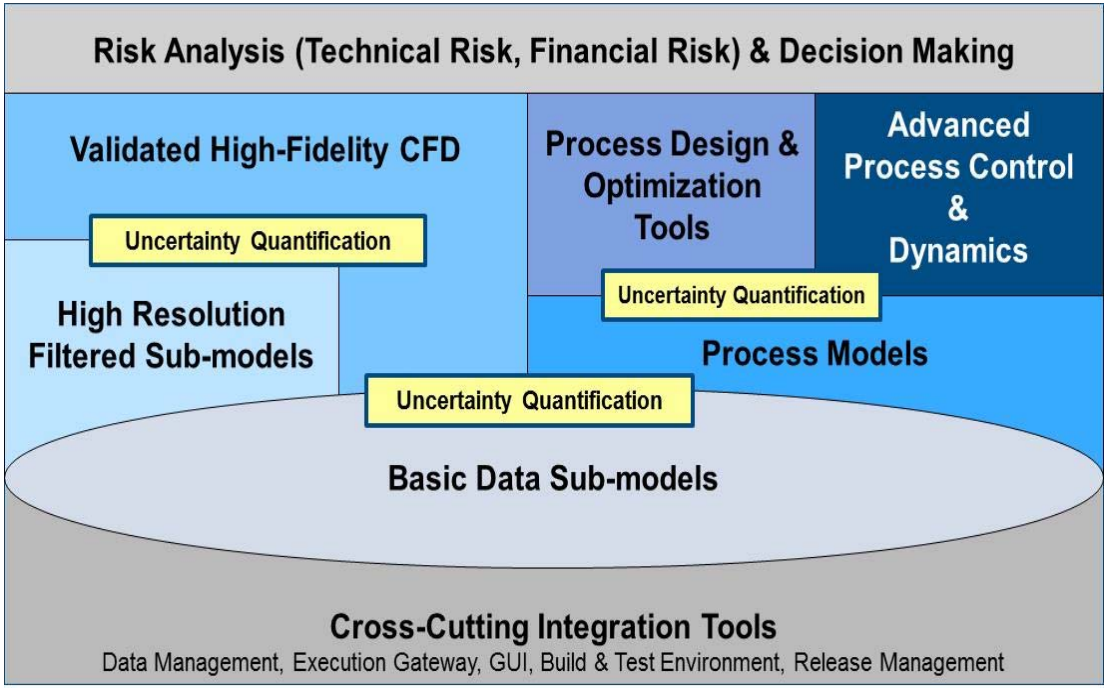
Lawrence Livermore National Laboratory

Los Alamos National Laboratory

NETL

Pacific Northwest National Laboratory

Berkeley Lab



The University of Texas at Austin

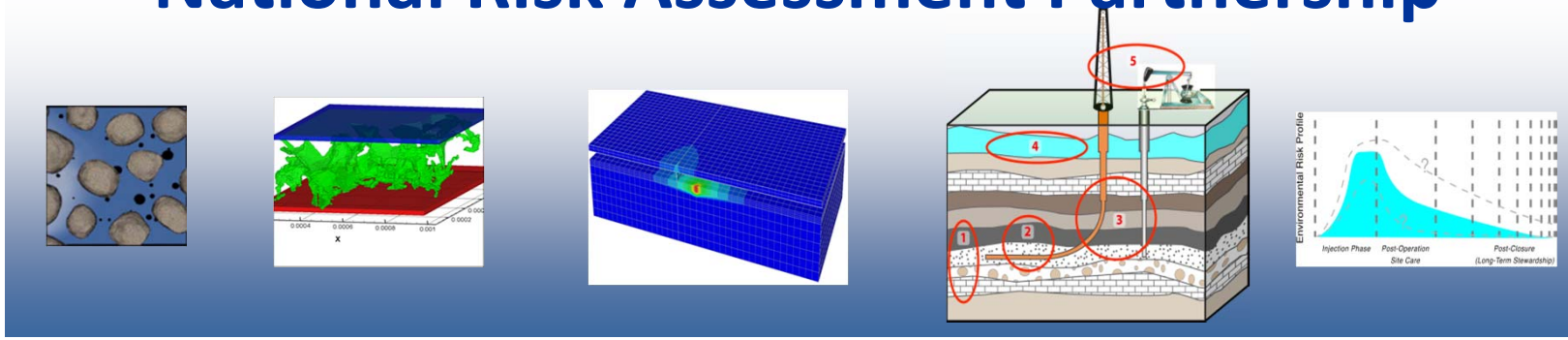
Boston University

West Virginia University

Princeton University

Carnegie Mellon

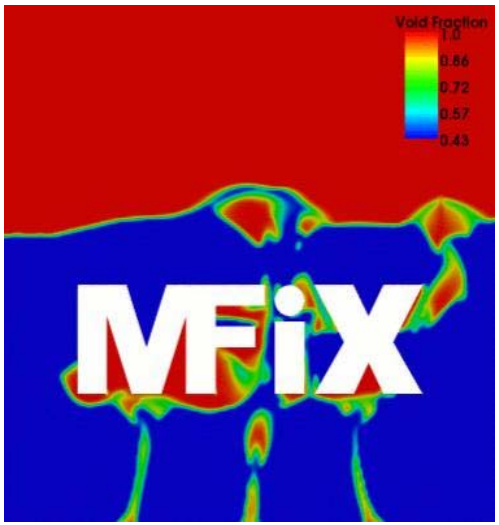
National Risk Assessment Partnership

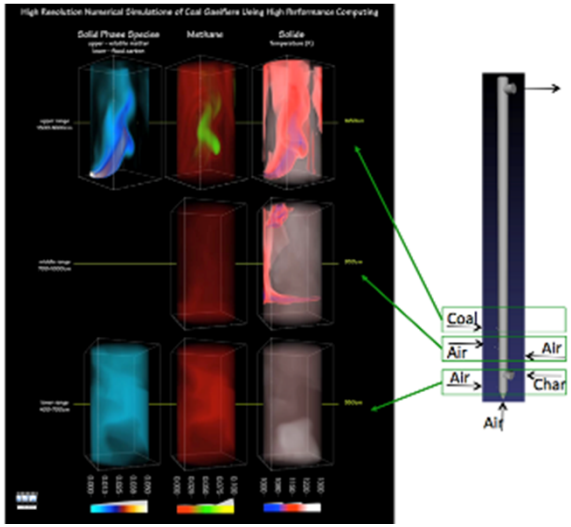


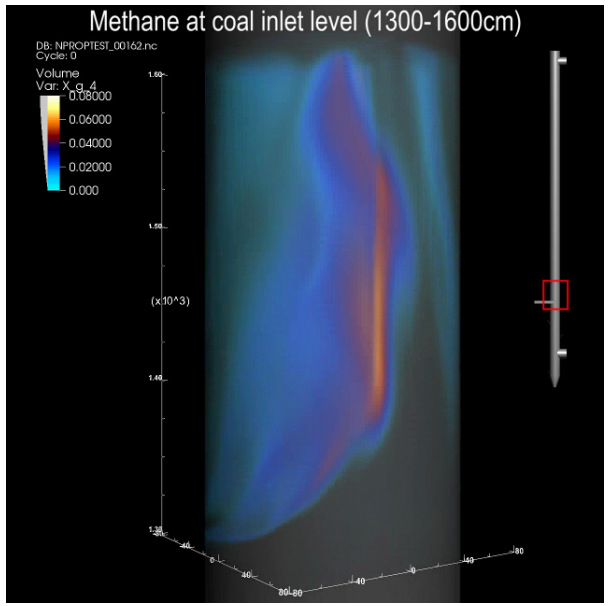
NRAP leverages the Department's competency in science-based prediction for engineered–natural systems to build confidence in the business case for CO_2 storage.

- **Science-based predictions to quantify storage-security relationships**
- **Assessment of validity & nature of relationships over variety of engineered-geologic conditions**
- **Quantification & reduction of uncertainty**

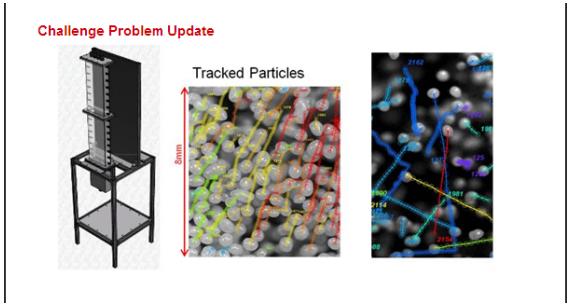
What's Next in Simulation-based Engineering?







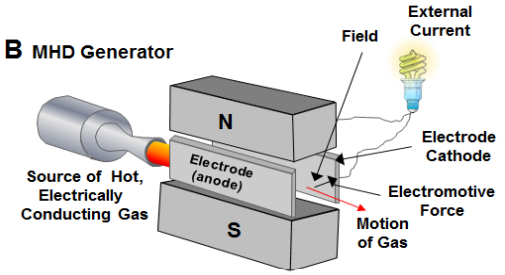
- *Revamping of MFIX Code for efficiency and accuracy*
- *Employ and develop new computational architectures*
- *Deploy next generation High Performance Computing for exercising and expanding computationally intensive codes for chemistry and materials*
- *Merging of scales with higher degrees of integration or interaction between scales*
- *Full embodiment of plant design and operability analysis*



Crosscutting Research: Innovative Concepts

Target Concepts and Research:

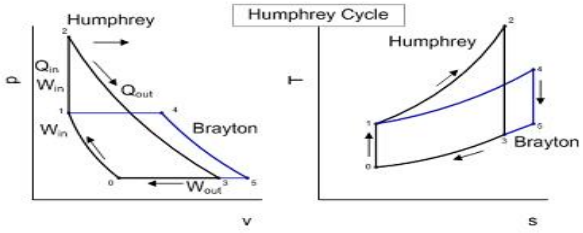
-That removes barriers to applying new technologies
- Has opportunity to transform a system
- Introduces step change improvements in a process
- Reduces cost associated with emerging technologies
- Removes/reduces environmental impacts



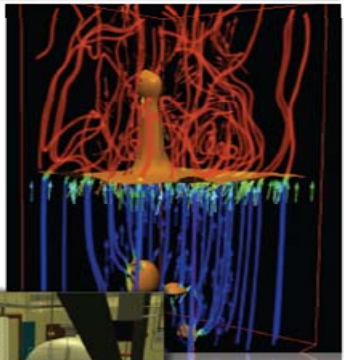
Magnetohydrodynamic (MHD) Power Generation

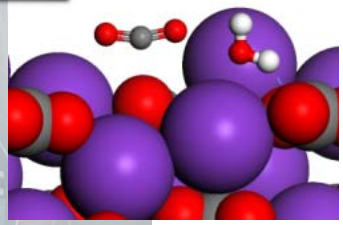
Nano materials

Advanced Manufacturing



Thermal and Power Cycle Improvements





Water Use/ Reuse Novel Cooling & Heat Transfer

Virtual and Immersive Engineering

Conclusion

The Crosscutting Research Program is organized to grow new concepts, remove barriers, and provide enabling tools and techniques for Fossil Energy based Systems.

Quality and Success of the Program is dependent, in part, on the projects that make up the portfolio.

Enjoy your time and Thank You for Participating

Questions

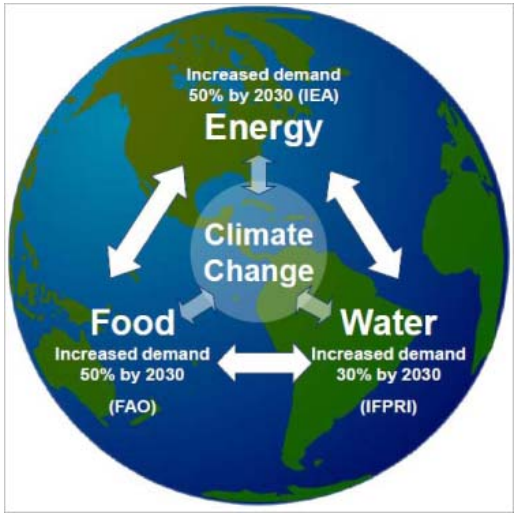
Contact Information

Susan Maley
304-285-1321
Susan.Maley@NETL.DOE.GOV

Office of Fossil Energy
www.fe.doe.gov

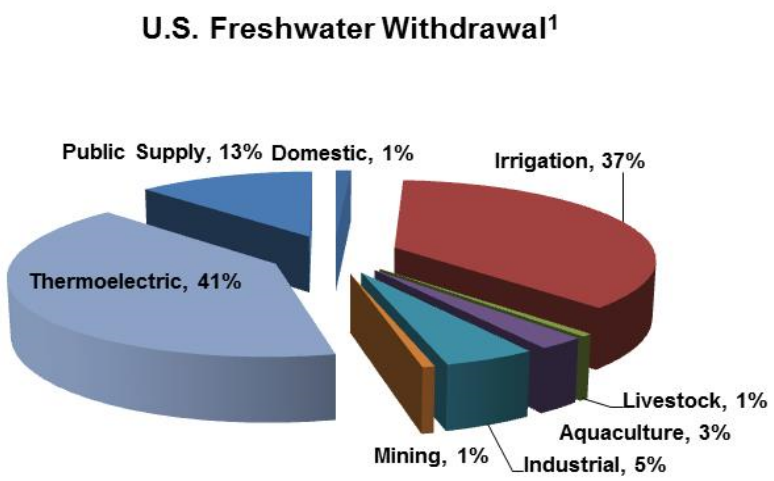
NETL
www.netl.doe.gov

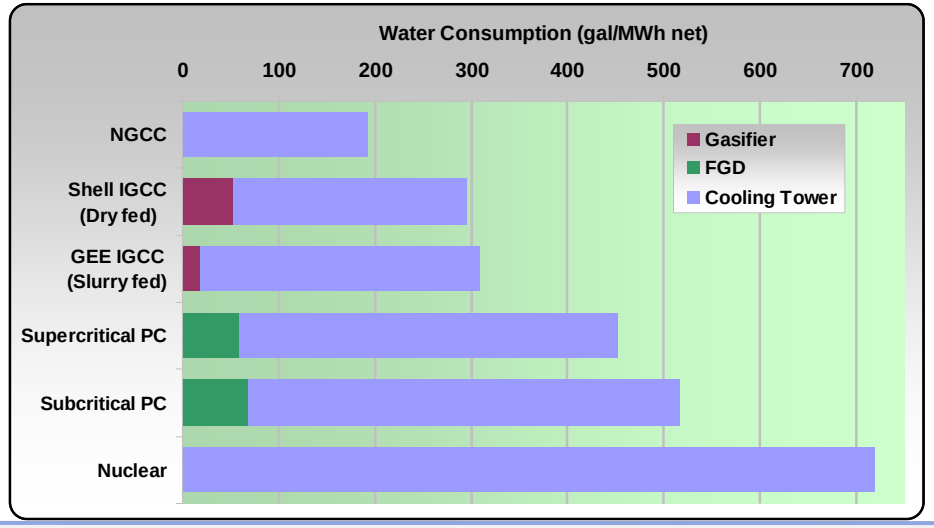
Energy Water Nexus: Water Management



- **Water Withdrawal vs Consumption**
  - Technologies that reduce or are alternatives to large volumes of freshwater withdrawal
- **Alternative Sources of Water**
  - Brackish, Brine and Salt water sources
- **Waste Heat Utilization**
  - Opportunities for large scale utilization of low grade or waste heat
- **Water Recovery and Treatment**

Thermoelectric water requirements: Withdrawal: ~ 143 BGD vs. Consumption: ~ 4 BGD





USGS 2005 data on water withdrawal vs consumption(2005)