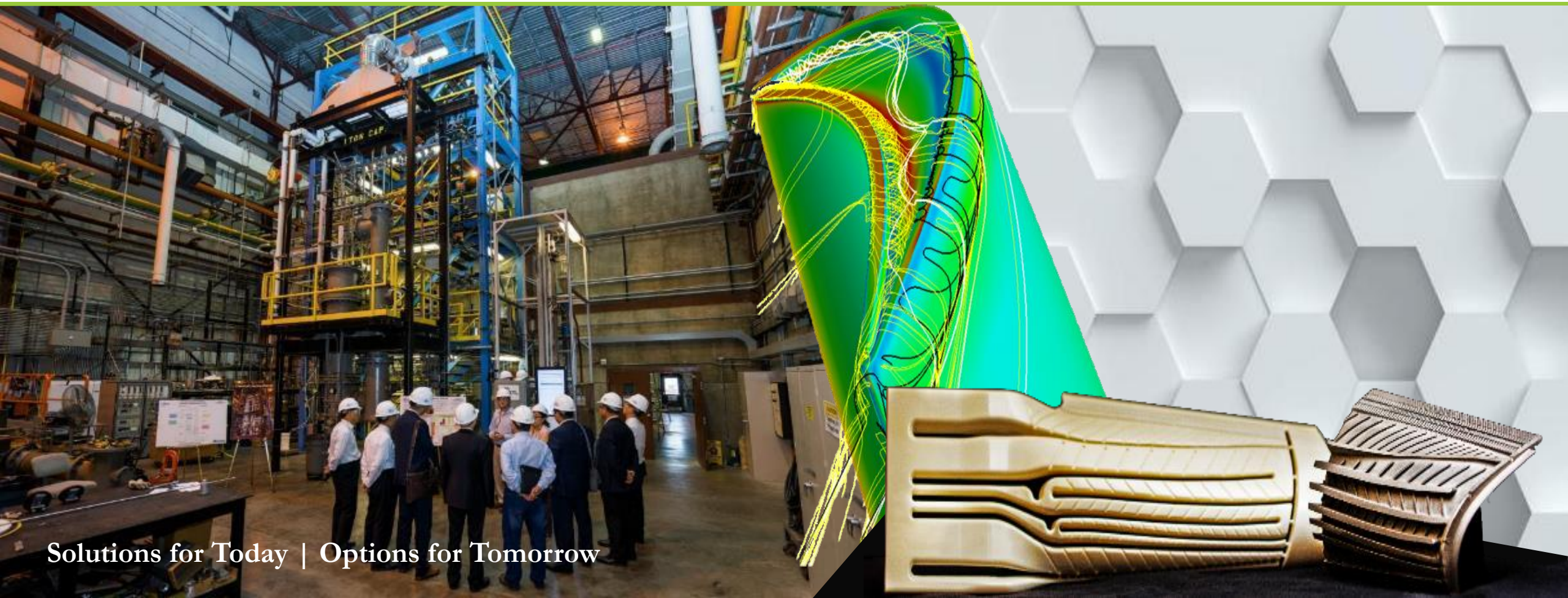
Defining the Future
The Imperative of Coal Research

Grace M. Bochenek, Ph.D., Director

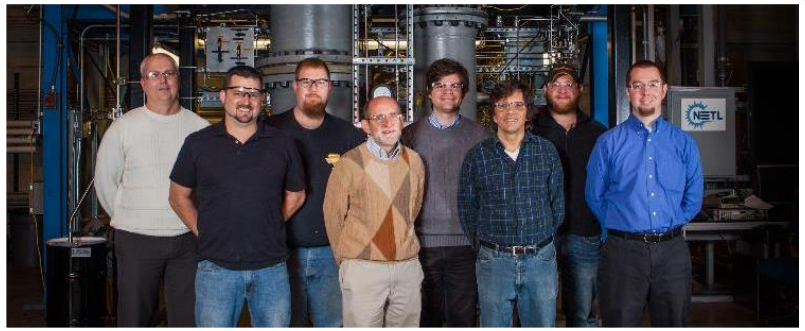
NATIONAL ENERGY TECHNOLOGY LABORATORY



Solutions for Today | Options for Tomorrow

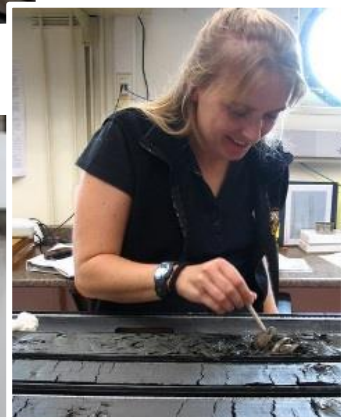
NETL is…

…the only U.S. National Laboratory devoted to Fossil Energy Technology Discovery, Development and Deployment.



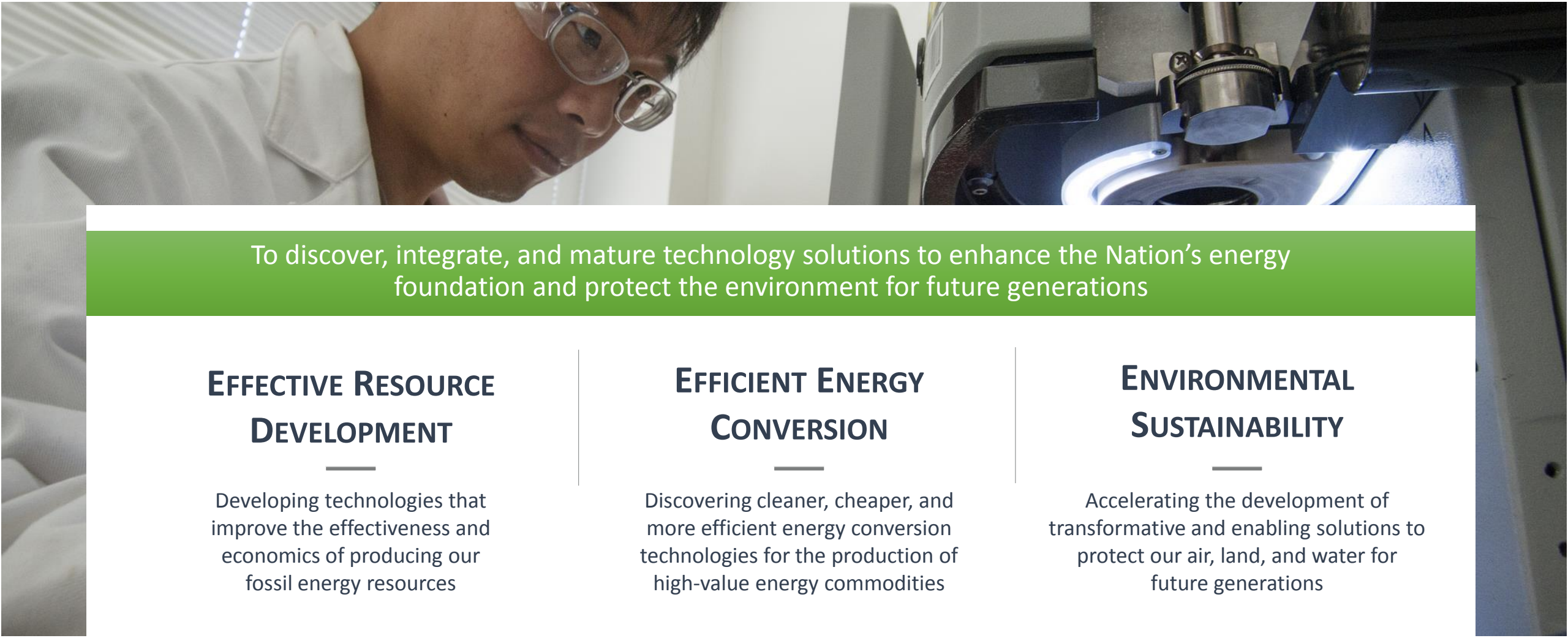
Responsible Steward

Knowledge and Technology Generation Center



Technology Convener

NETL's Mission



To discover, integrate, and mature technology solutions to enhance the Nation's energy foundation and protect the environment for future generations

Effective Resource Development

Developing technologies that improve the effectiveness and economics of producing our fossil energy resources

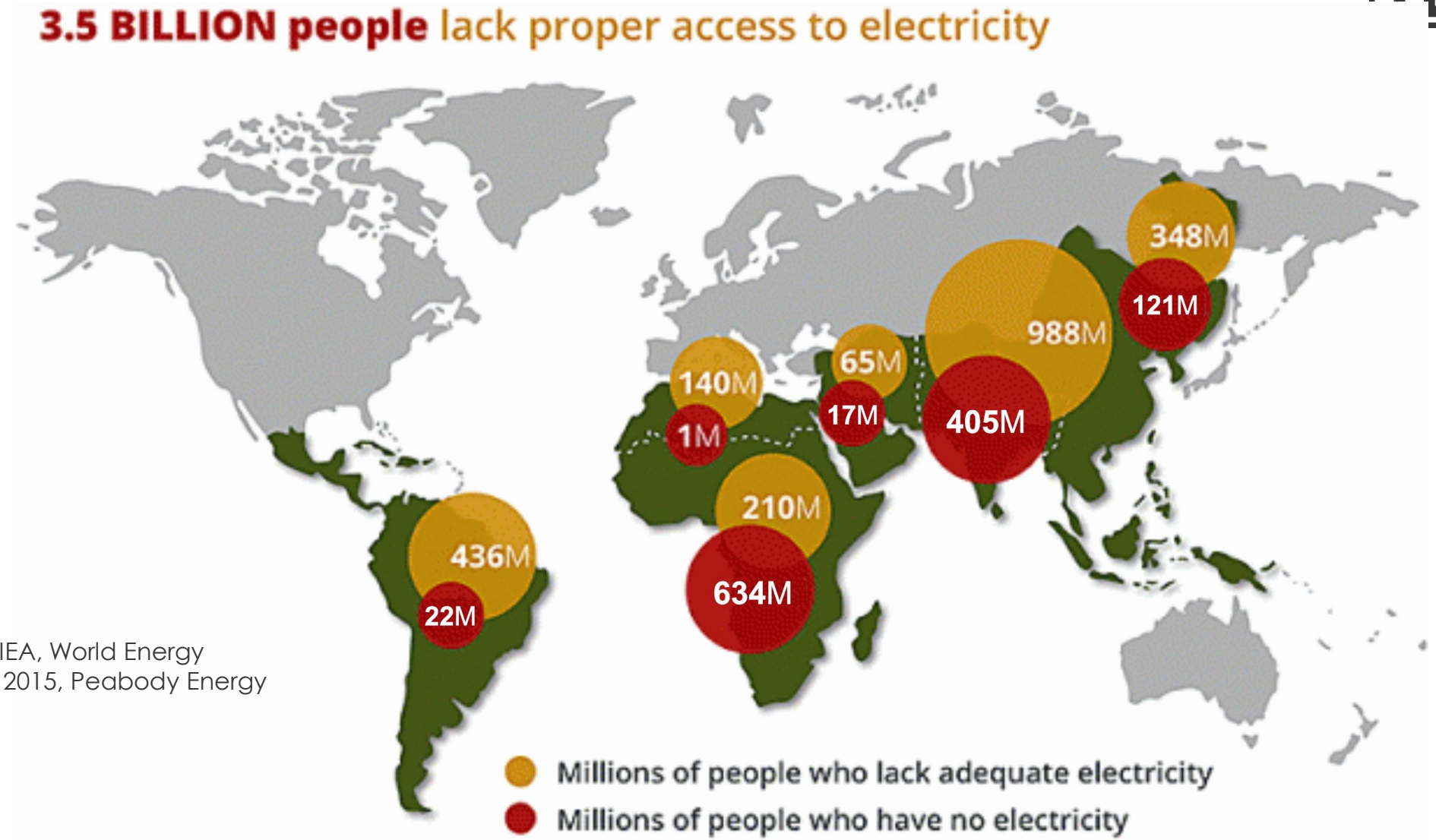
Efficient Energy Conversion

Discovering cleaner, cheaper, and more efficient energy conversion technologies for the production of high-value energy commodities

Environmental Sustainability

Accelerating the development of transformative and enabling solutions to protect our air, land, and water for future generations

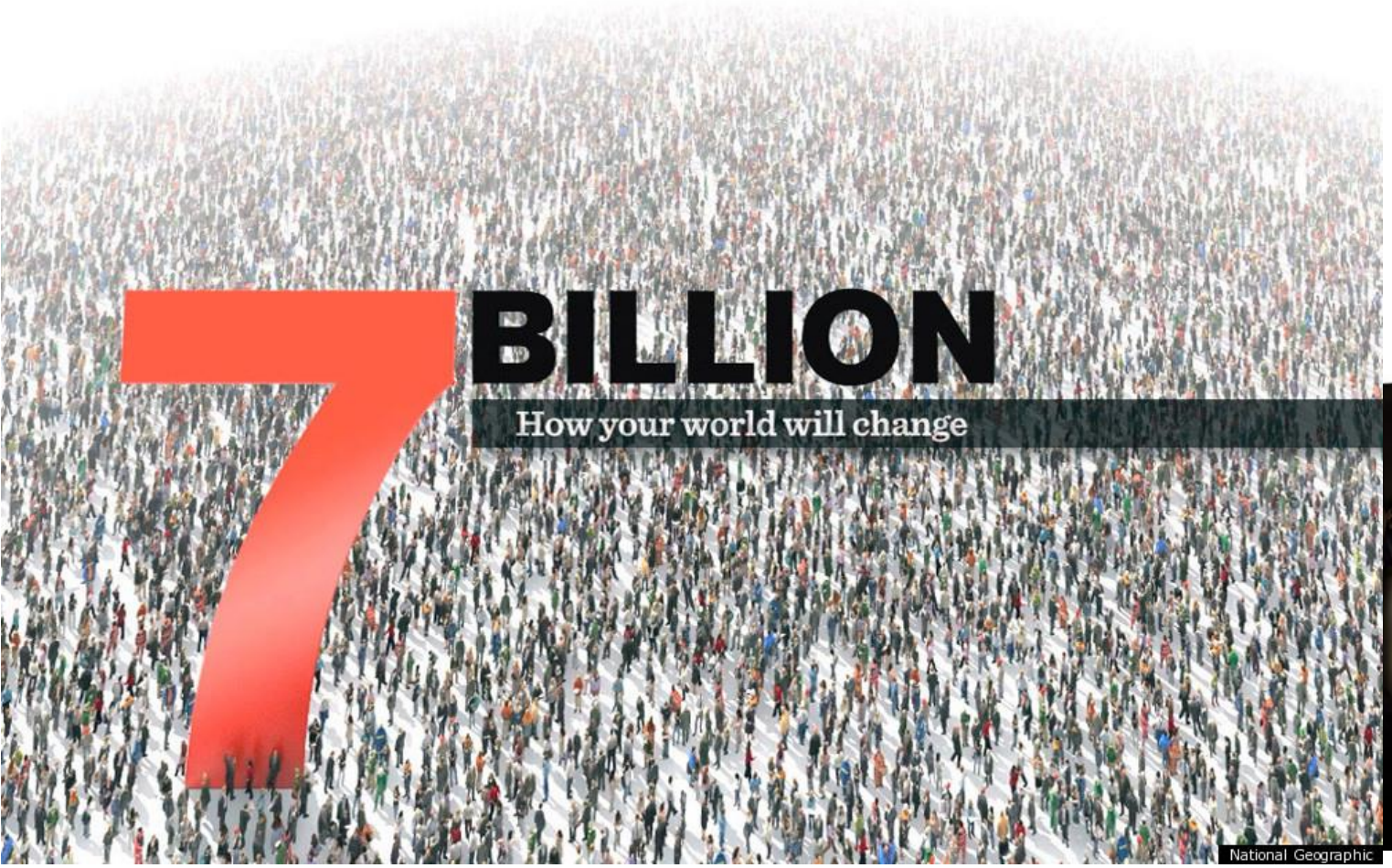
Energy Poverty

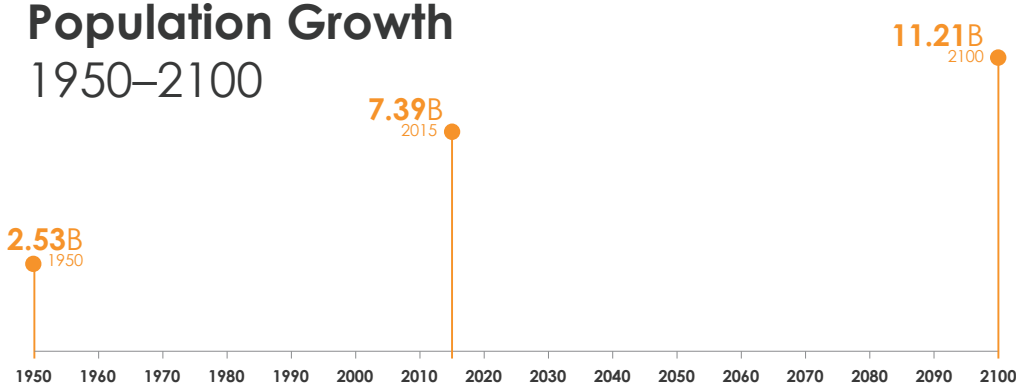


Source: IEA, World Energy Outlook 2015, Peabody Energy

Global Drivers

NATIONAL GEOGRAPHIC MAGAZINE

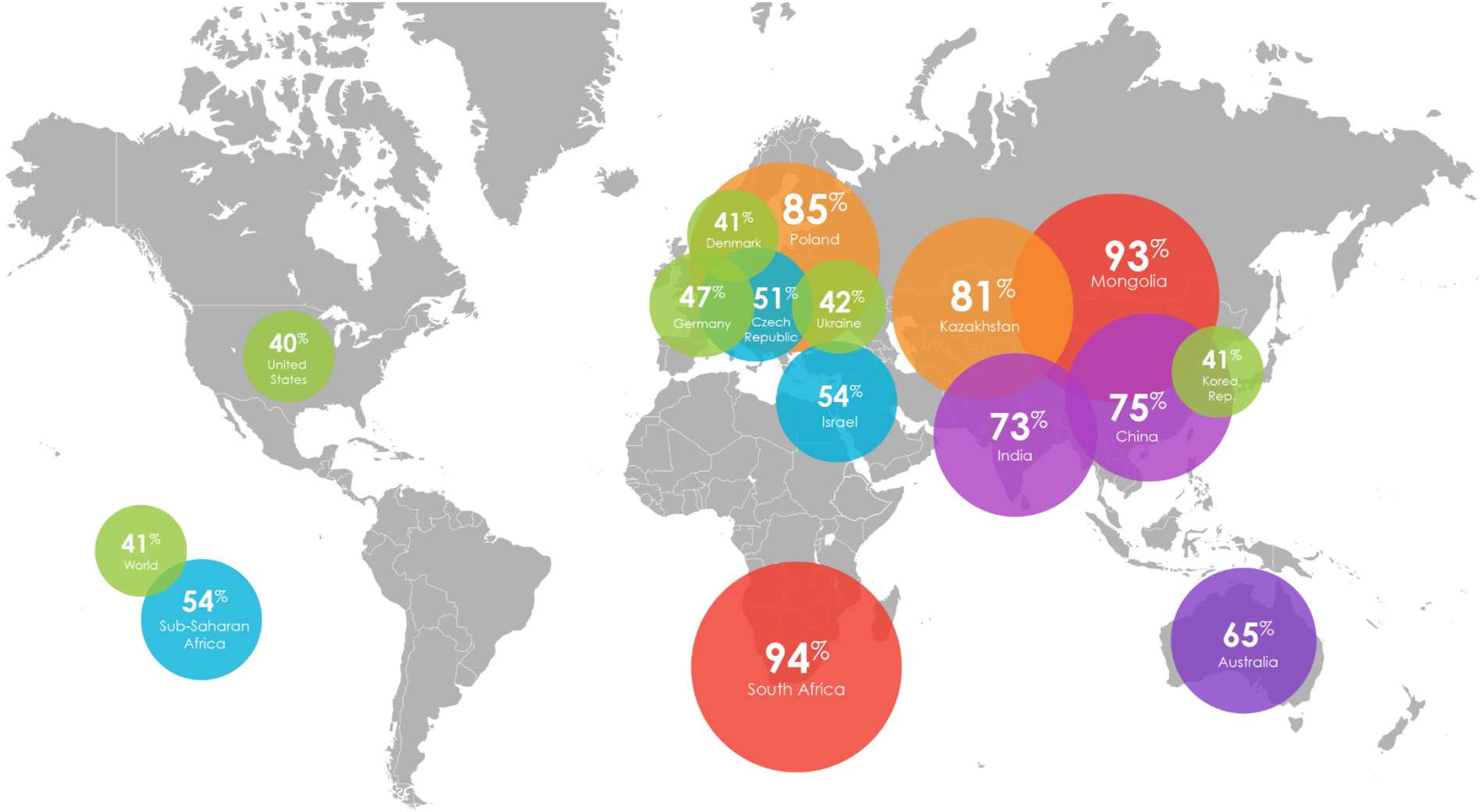




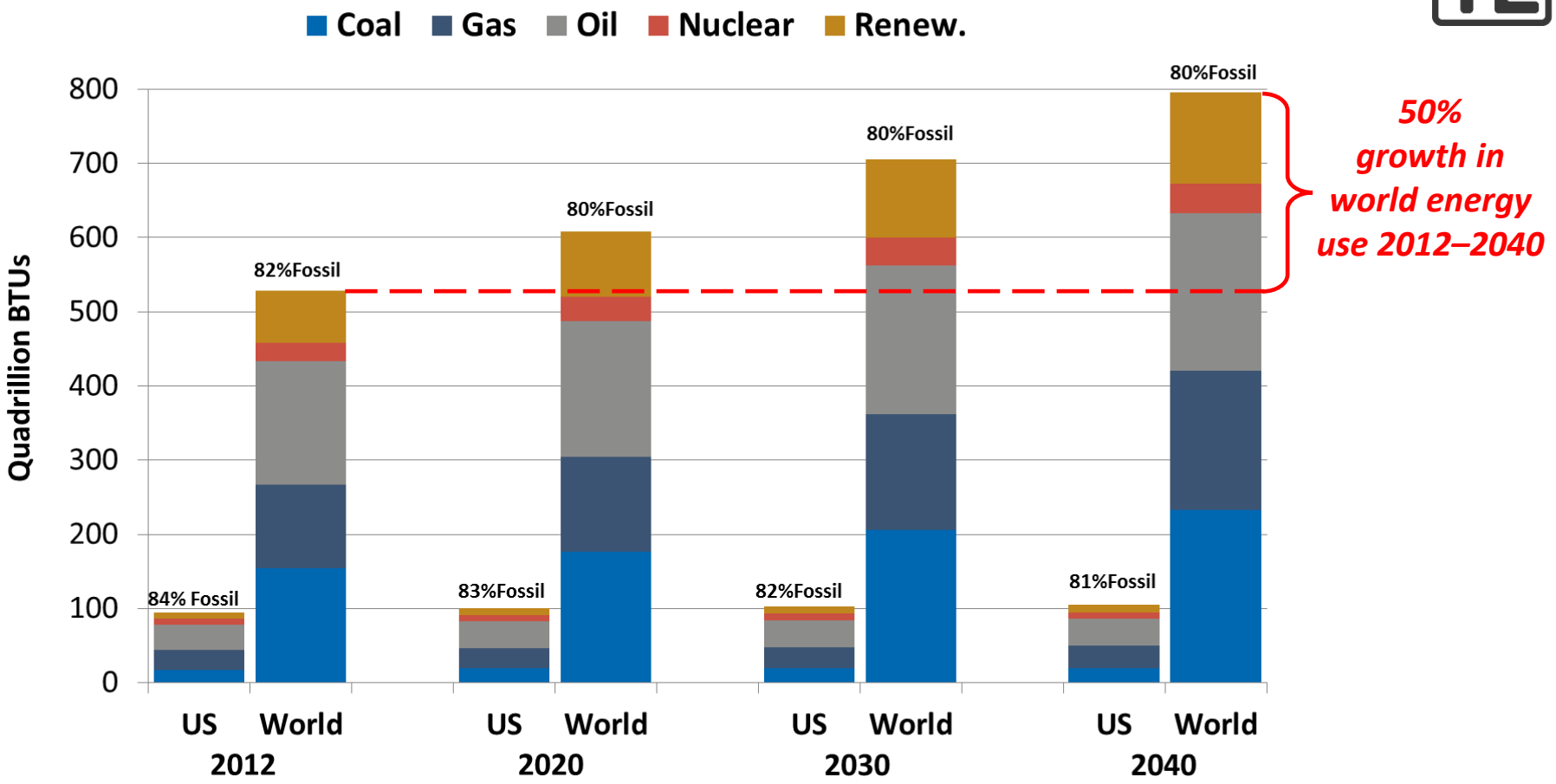
Electricity Production from Coal Sources

Coal Use is Critical to Global Energy Requirements

South Africa	94%
Mongolia	93%
Poland	85%
Kazakhstan	81%
China	75%
India	73%
Australia	65%
Israel	54%
Czech Republic	51%
Germany	47%
Ukraine	42%
Korea, Rep.	41%
Denmark	41%
United States	40%
Sub-Saharan Africa	**54%**
World	**41%**



The World and U.S. Energy Future



≥80% Fossil Energy Today AND Tomorrow
Dominated by Global Growth

The Imperative of Coal Research

- Coal R&D will define the future of coal use
- Without innovative coal R&D, global energy needs will not be met
- Coal R&D leads to sustainable solutions

R&D Success is Foundation of Current Coal Demand

Mercury Removal from Flue Gas

Mining Safety/Mechanization

Emissions Controls for Acid Rain Gases

Continued Success Requires Vision, Courage and Perseverance

- We must continuously fill the pipeline with innovative technology
- We must take on large investments as R&D moves forward
- We must accelerate maturation of technologies

Filling the Pipeline

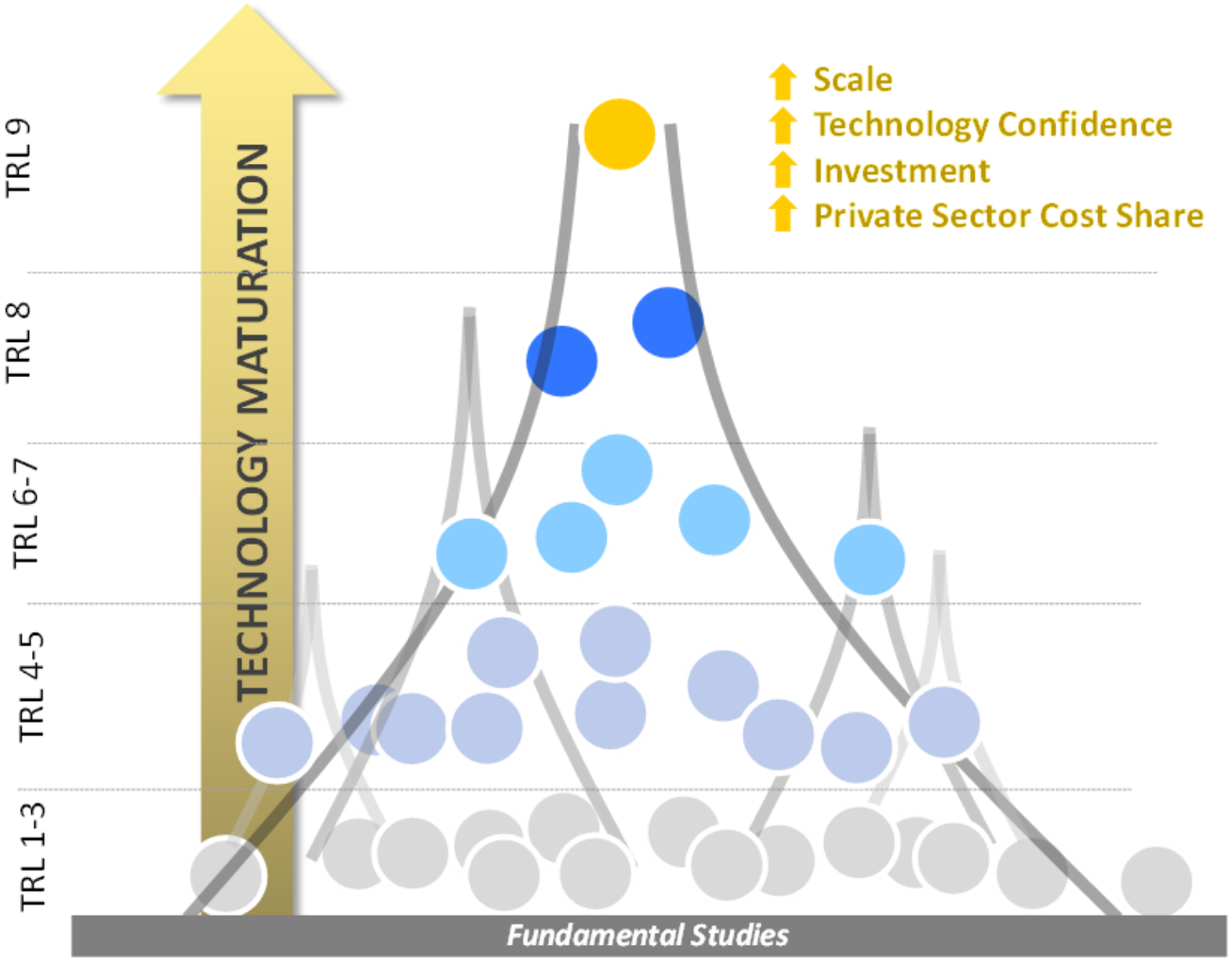
COMMERCIALIZATION
Technology available for wide-scale market use

DEPLOYMENT
System demonstrated in operational environment

SYSTEM TESTING
System performance confirmed at pilot-scale

DEVELOPMENT
Technology component validated/integrated

DISCOVERY
Concept identified/proven at laboratory-scale

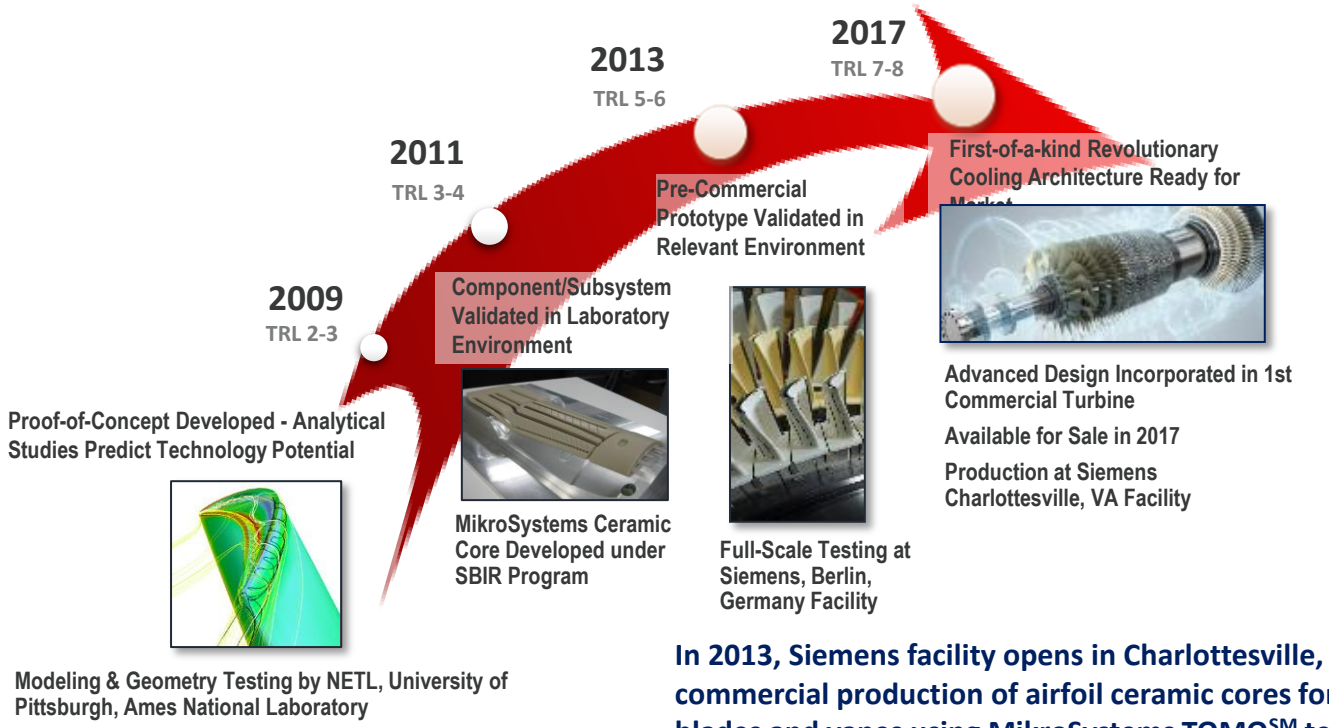


RD³ – Research Development, Demonstration, Deployment

Foundation to NETL's Mission Success

Advanced Combustion Turbine - Airfoil Design

From Concept to Market Readiness



In 2013, Siemens facility opens in Charlottesville, VA for commercial production of airfoil ceramic cores for gas turbine blades and vanes using MikroSystems TOMO℠ technology

For decades, NETL's mission-unique resources and facilities have been used to develop and nurture technology from concept to market readiness

Commercial sales generated in technologies supported by FE/NETL's Demonstration Program **total in excess of $62 billion** in environmental and advanced power generation industries

Development of the TRIG™ for Power and Chemical Production

TRIG™ Leverages Long History of KBR Fluid Catalytic Cracking (FCC) Expertise

1980's	1990	1996	1996	USA 2016
Design Based on FCC Technology	Pilot Plant Tech Center	Grand Forks, ND 2,600 Hours Test Run	PSDF at Wilsonville, AL.	TRIG™ In Kemper County, MS, USA

Simulation-Based Engineering

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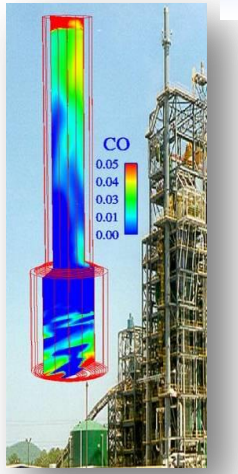
CCSI Carbon Capture Simulation Initiative

NRAP National Risk Assessment Partnership



iDAES

MFiX Multiphase Flow with Interphase eXchanges

C3M™ Carbonaceous Chemistry for Computational Modeling

Technical Knowledge

Collaborative Partnerships

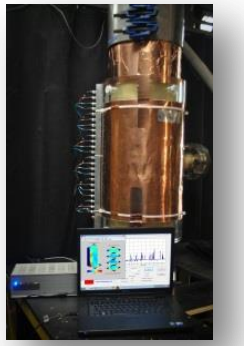
Code & Software Development

Accelerated solutions for complex power systems

Experimental Facilities

Computational Power

Data Repository



Designing Advanced Energy Systems

Simulation-Based Engineering

Benefits

Accelerate innovation in order to:

- **Enable COP21 goals**
- **Halve technology maturation cost and deployment time**
- **Increase energy sector efficiency by 50%**

Identifying technology solutions in the context of the full energy portfolio

Framework applicable to any multi-dimensional & complex challenge

Simulation-Based Engineering of Energy Devices

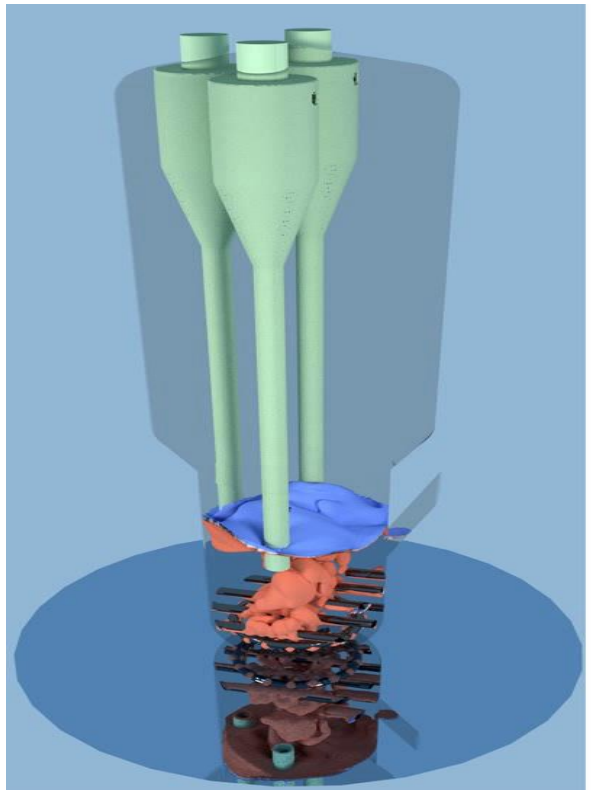
NATIONAL ENERGY TECHNOLOGY LABORATORY

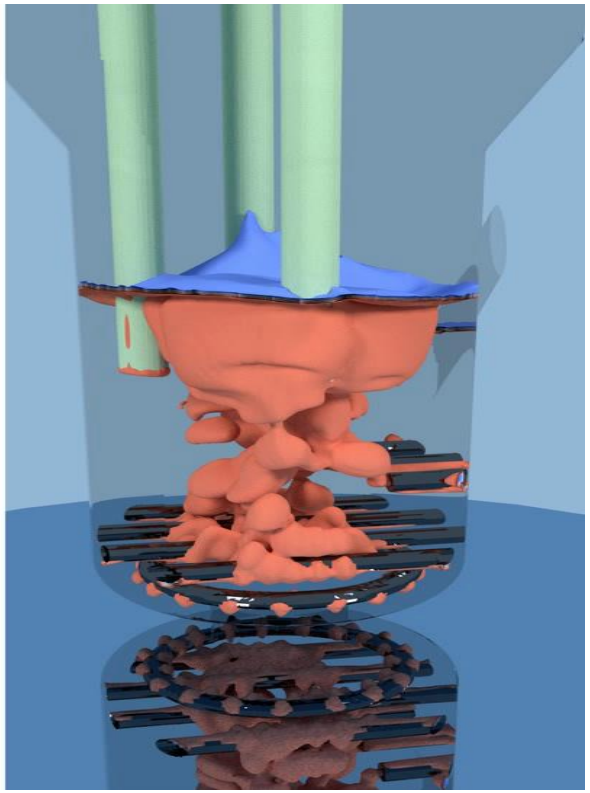
Foster device-scale innovation in energy transformation technology, pushing the limits of thermodynamics … and imagination

Benefits

- **Pushing thermodynamic limits**
- **Radically new device designs**
- **Reducing time for optimization**
- **Reducing the technical and financial risk of maturing technology**

Identifying device solutions in context of process needs





NETL R&D Initiatives are Defining the Future

NATIONAL ENERGY TECHNOLOGY LABORATORY

- Accelerated technology development
- Improved CO_2 removal costs
- Expanded coal markets
- Innovative coal technologies

Post-Combustion Test Facility, National Carbon Capture Center, Wilsonville, AL

Solutions for Today
Options for Tomorrow

For More Information, Contact NETL

www.netl.doe.gov

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY