Transmission Research for Clean Energy

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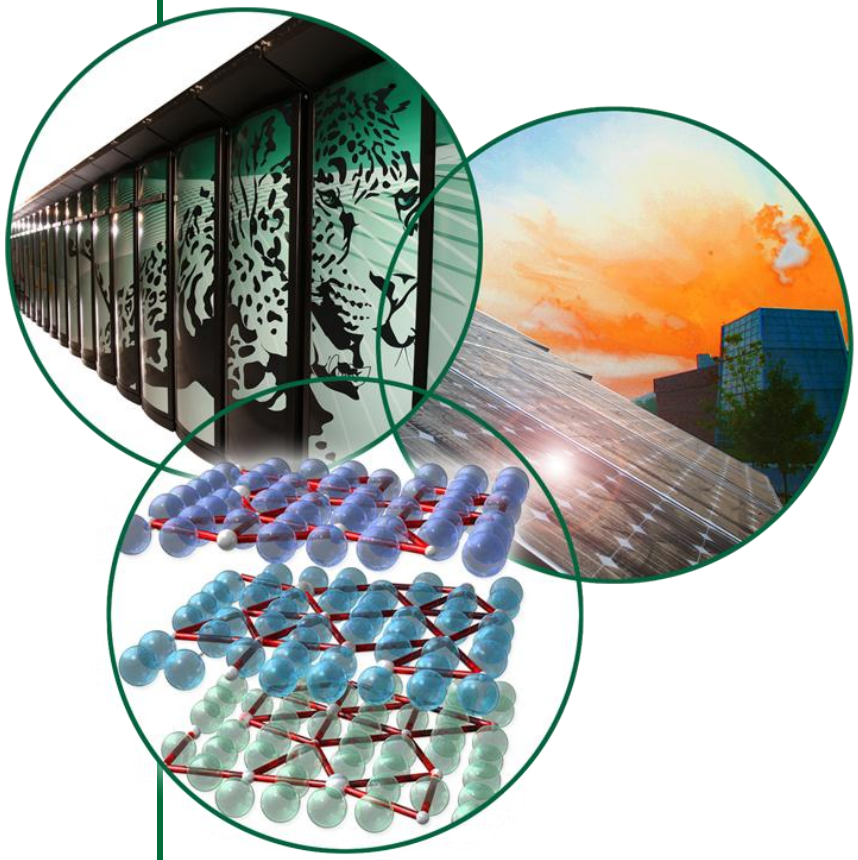
Power and and Energy Systems



U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

ORNL is DOE's largest science and energy laboratory

- $1.4B budget
- 4,500 employees
- 4,000 research guests annually
- $500 million invested in modernization

- Nation's largest concentration of open source materials research
- World's most intense pulsed neutron source and a world-class research reactor

- World's most powerful open scientific computing facility
- Nation's most diverse energy portfolio
- Managing the billion-dollar U.S. ITER project

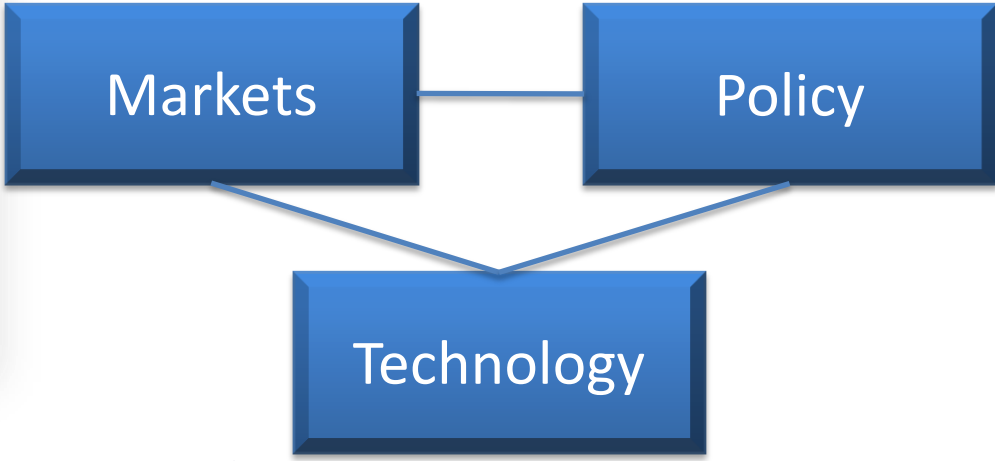
OAK RIDGE National Laboratory

Challenges for Modernizing the Grid must address the Nation's Energy Goals

Utilities focused on ensuring

- **Safety**
- **Reliability**
- **Cost**
- **Comply with regulatory mandates**

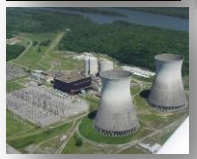
An integrated solution is required



Emerging National Energy Goals

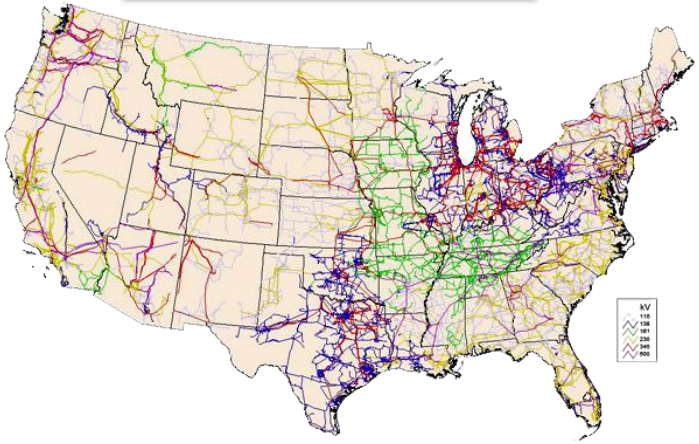
By 2025, renewable energy sources by 25%

Customer side integration gen, efficiency, storage



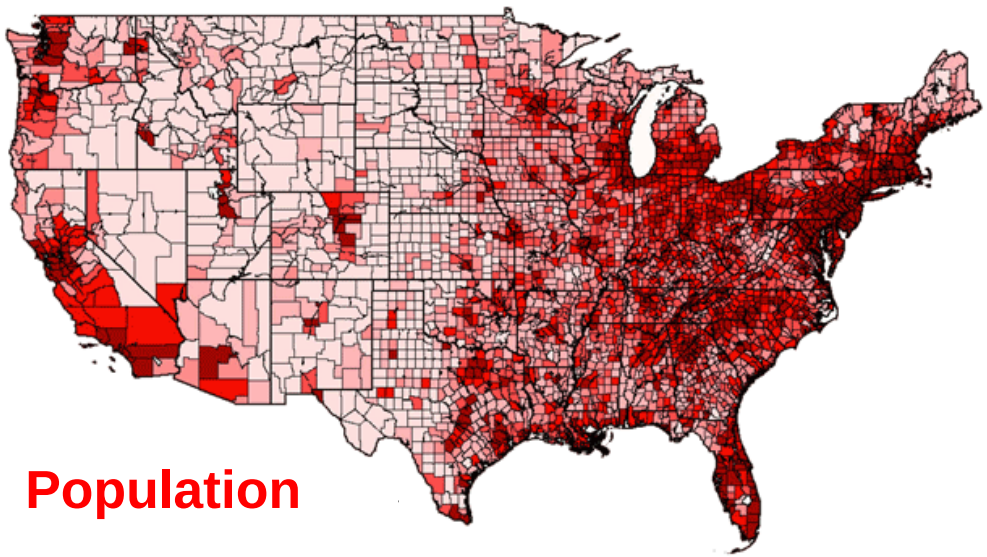
Environmental regulations and carbon constraints

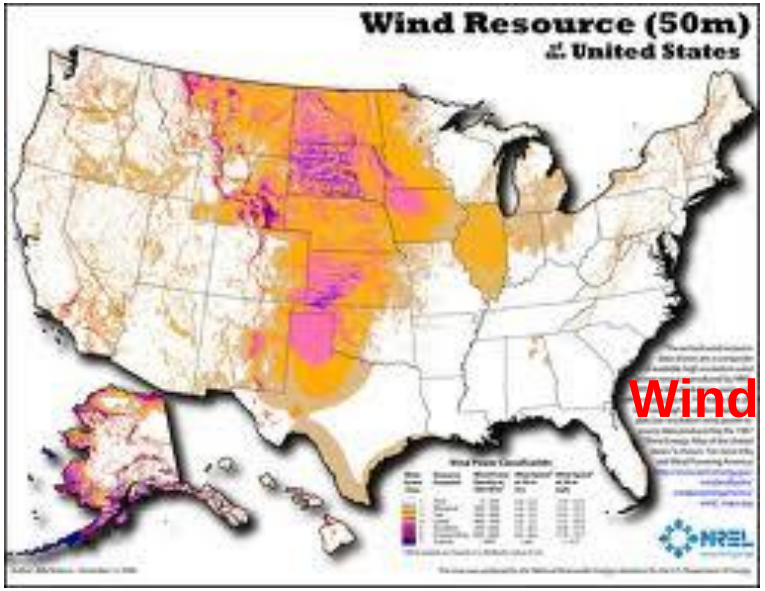
Electrification of vehicles to reduce oil dependency



Monitoring, Modeling & Analysis will provide the foundation to understand implications of emerging trends and identify pathways to solutions

Renewable Resources Need Transmission

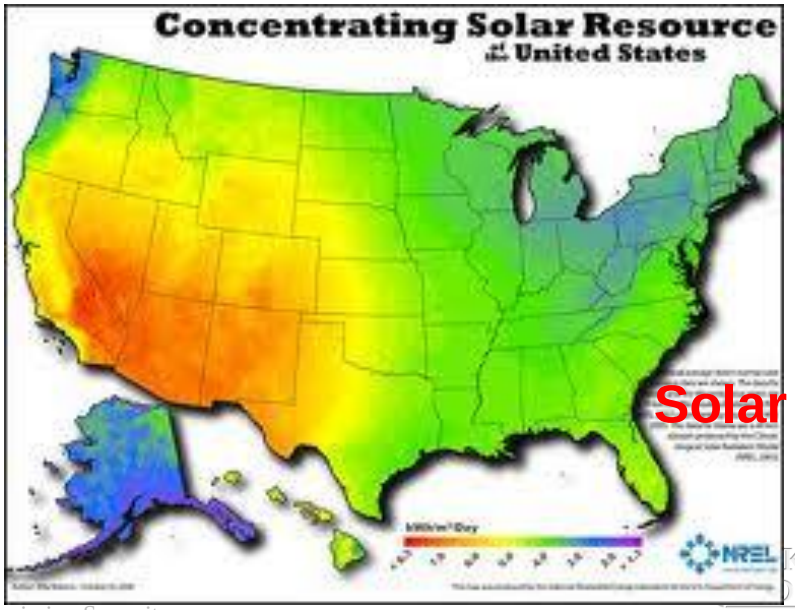




Best wind and solar sources are far from load centers.

Distance provides diversity of sources.

Transmission networks must play a central role in integration.



http://www.eia.doe.gov/cneaf/solar.renewables/ilands/fig12.html

Translating science and technology into sustainable energy solutions at ORNL

Clean and affordable electricity

Solar Photovoltaics

Wind & Hydropower

Geothermal Technologies

Modernized electricity infrastructure

Transmission Reliability

Energy Storage

Smart Grid

Energy Security

Systems integration

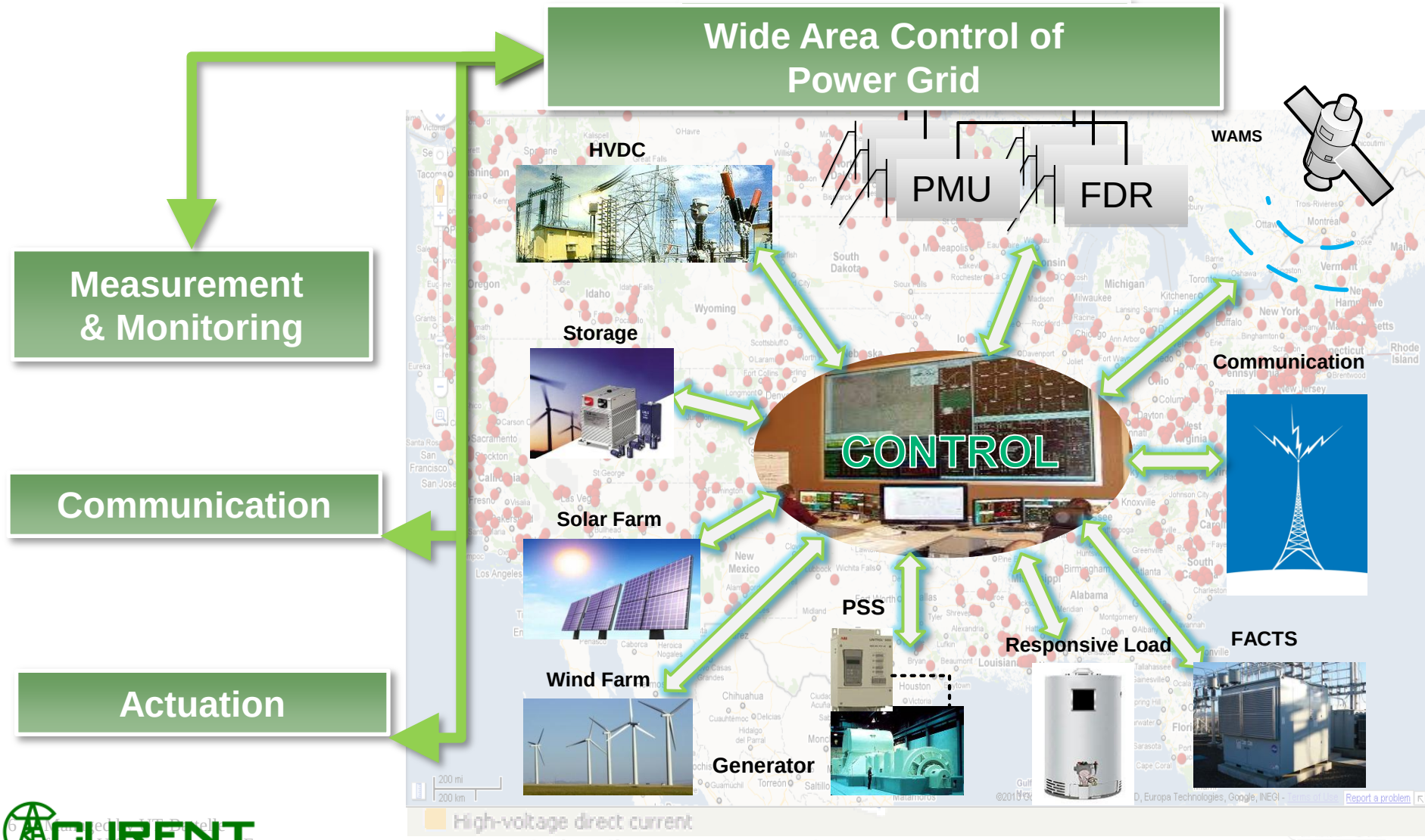
Buildings Integration

Vehicle Electrification

Industrial Loads

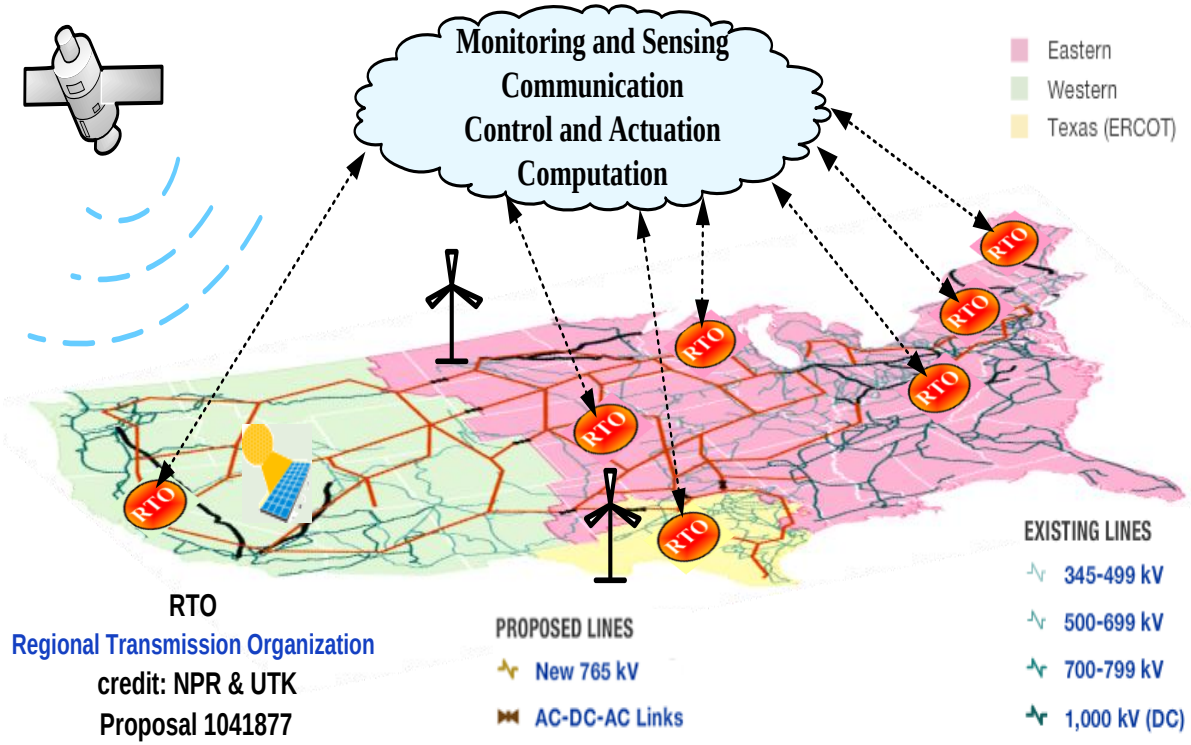
CURENT

Joint NSF/DOE Engineering Research Center led by UT-Knoxville that focuses on wide area situation awareness and controls



CURENT Vision

- A nation-wide transmission grid that is fully monitored and dynamically controlled for high efficiency, high reliability, low cost, better accommodation of renewable sources, full utilization of storage, and responsive load.
- A new generation of electric power and energy systems engineering leaders with a global perspective coming from diverse backgrounds.



RTO
Regional Transmission Organization
credit: NPR & UTK
Proposal 1041877

System Level Focus – Key Thrust Areas

- System-level topics identified through industry feedback and formulation principles
  1. AC-DC Transmission Architecture & Phasor Measurement Unit based remedial action scheme
  2. Measurement based wide-area voltage security
  3. Frequency Regulation and Control with Large Renewable Penetration & Inverter Control
  4. Measurement based dynamic state estimation & cyber security
  5. Measurement based On-line Grid Condition Assessment Toolbox
- Critical to have industry engaged in the R&D and to provide technical input

CURENT is engaging companies of various size and markets

Region

Utility

System

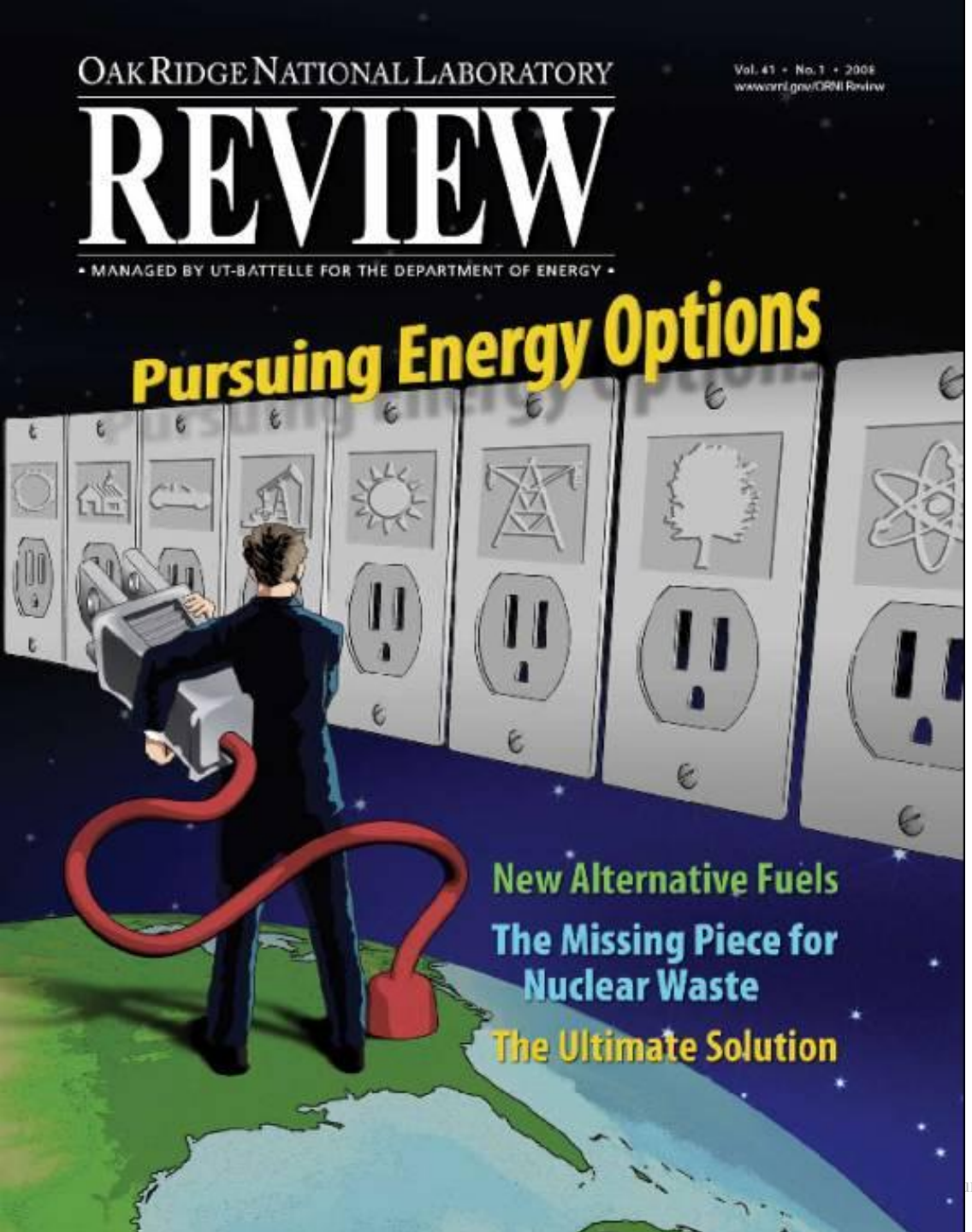
Vendor

NGO, Lab

Over 10 companies have signed or in process of signing

Start-up | Small | Large Company

Company Type



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