

# Welcome to Oak Ridge National Laboratory

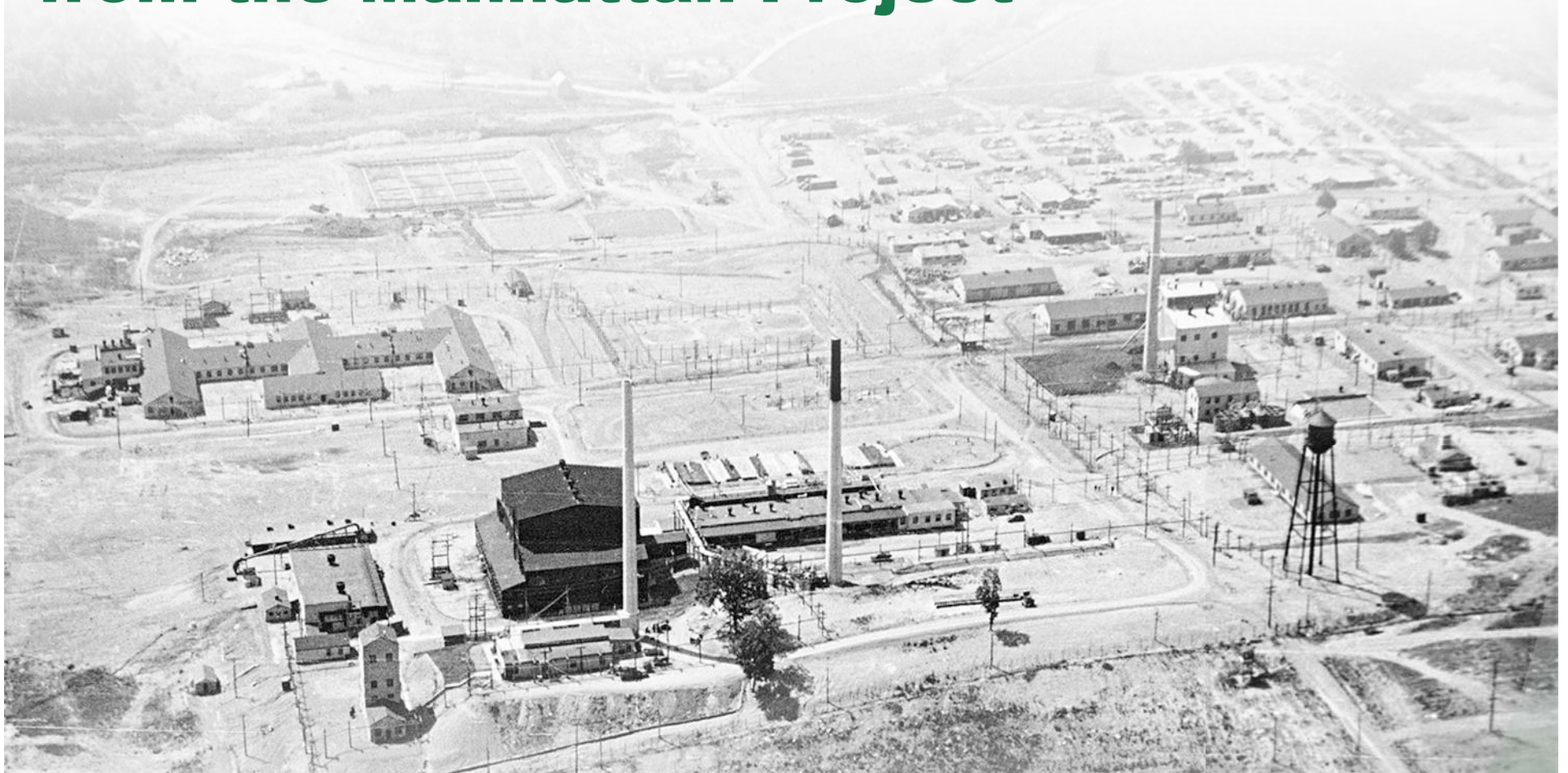
Presented to  
Fusion Power Associates

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Deputy for Science and Technology

December 4, 2007  
Oak Ridge, Tennessee



# Oak Ridge National Laboratory evolved from the Manhattan Project



**ORNL in 1943**  
The Clinton Pile was the world's first continuously operated nuclear reactor

# Today, ORNL is DOE's largest science and energy laboratory



- \$1.1B budget
- 4,200 employees
- 3,000 research guests annually
- \$300 million invested in modernization
- World's most powerful open scientific computing facility
- Nation's largest concentration of open source materials research
- Nation's most diverse energy portfolio
- Bringing the \$1.4B Spallation Neutron Source into operation
- Managing the billion-dollar U.S. ITER project

# UT-Battelle has managed ORNL since April 2000



**The University of Tennessee  
Knoxville, Tennessee**



**Battelle  
Columbus, Ohio**

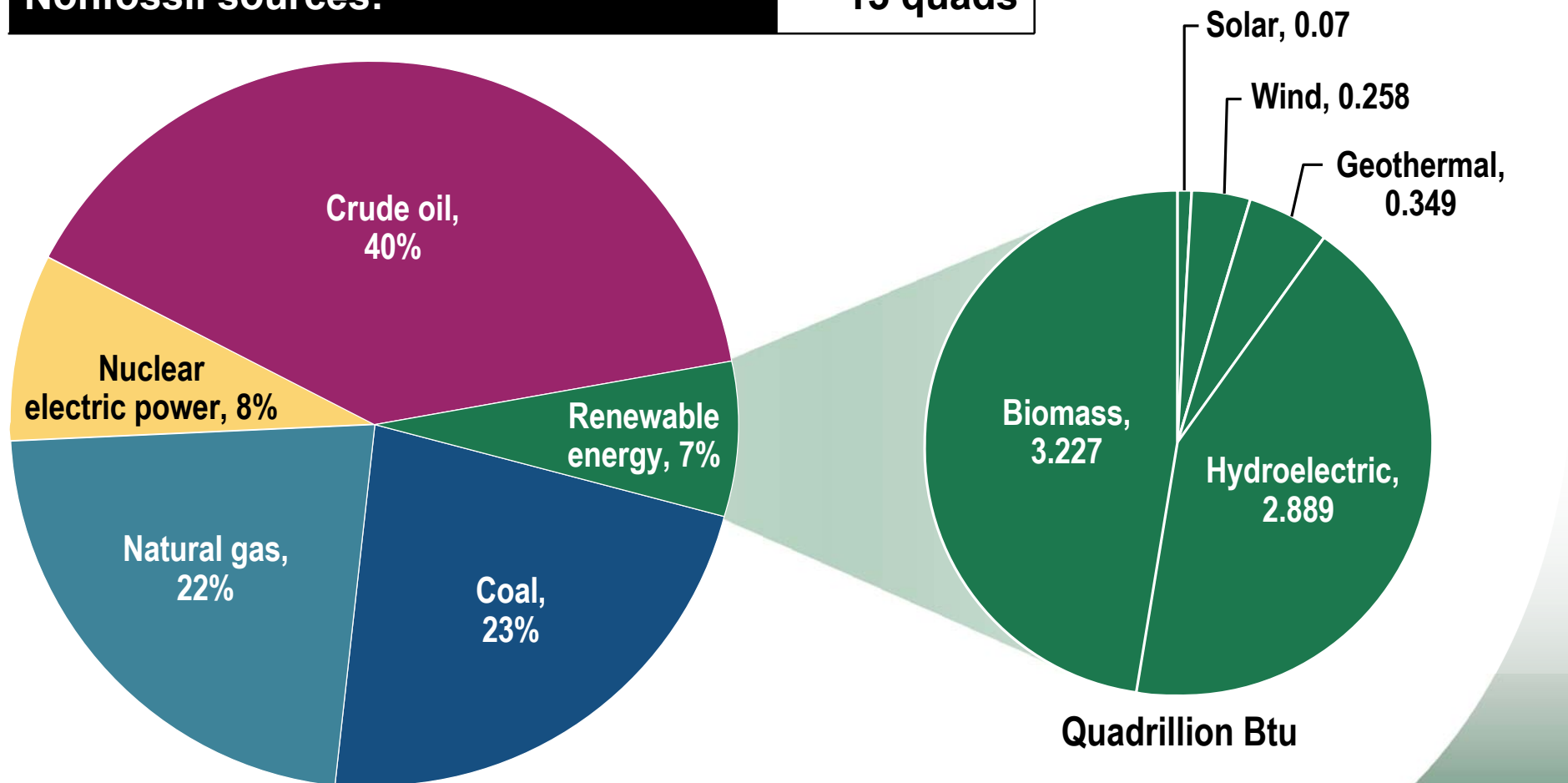


# Energy has moved to the top of the international policy agenda

- **Public and policy dialogue are increasingly focused on energy, broadly defined**
  - Energy generation, distribution, and consumption
  - Environmental impacts of energy use
  - National security implications
  - Economic consequences
- **Addressing these issues provides an enduring mission for the DOE national laboratories**
  - A “very big and difficult problem” (Weinberg)
  - Similar to the national security mission that resulted in the birth of the DOE complex
  - Critically dependent on the best science and technology

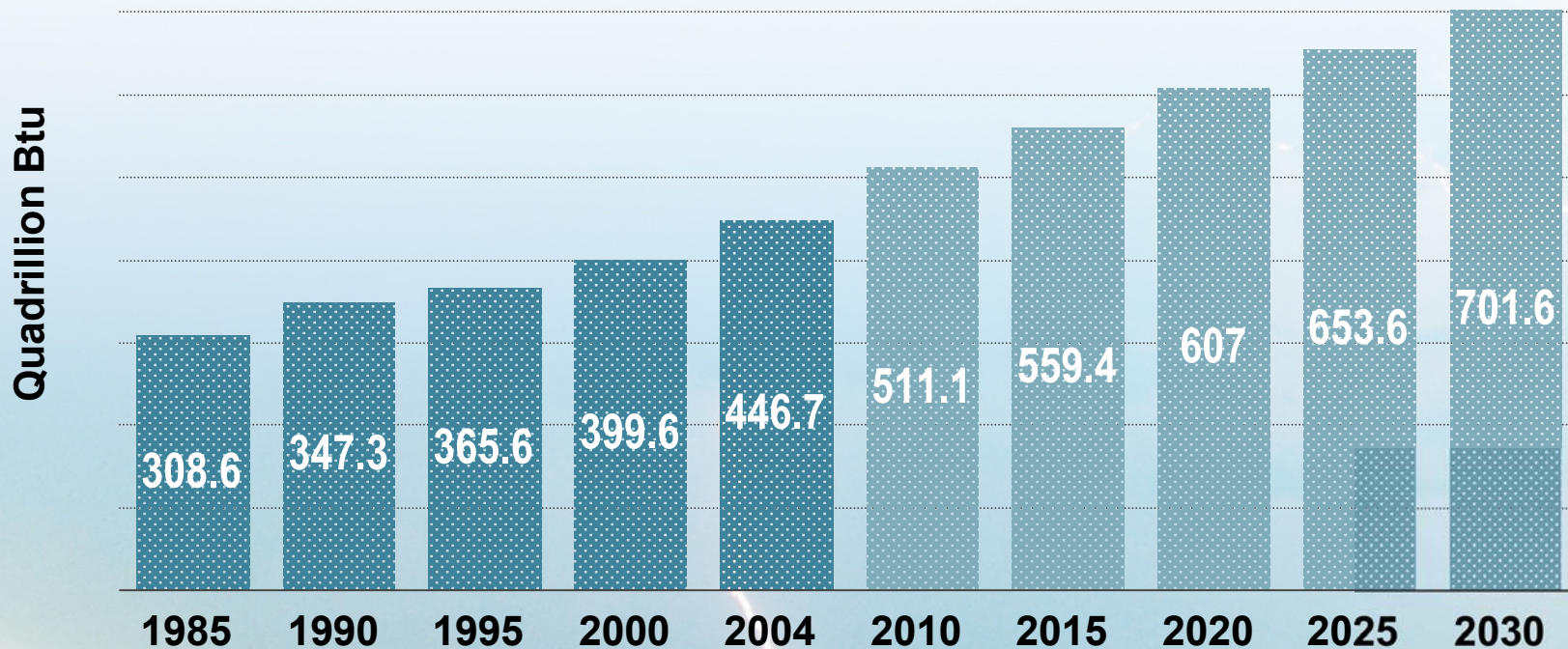
# Fossil fuels are the source of most of the nation's energy

<b>Total U.S. energy consumption, 2006:</b>	<b>~100 quads</b>
<b>Nonfossil sources:</b>	<b>~15 quads</b>



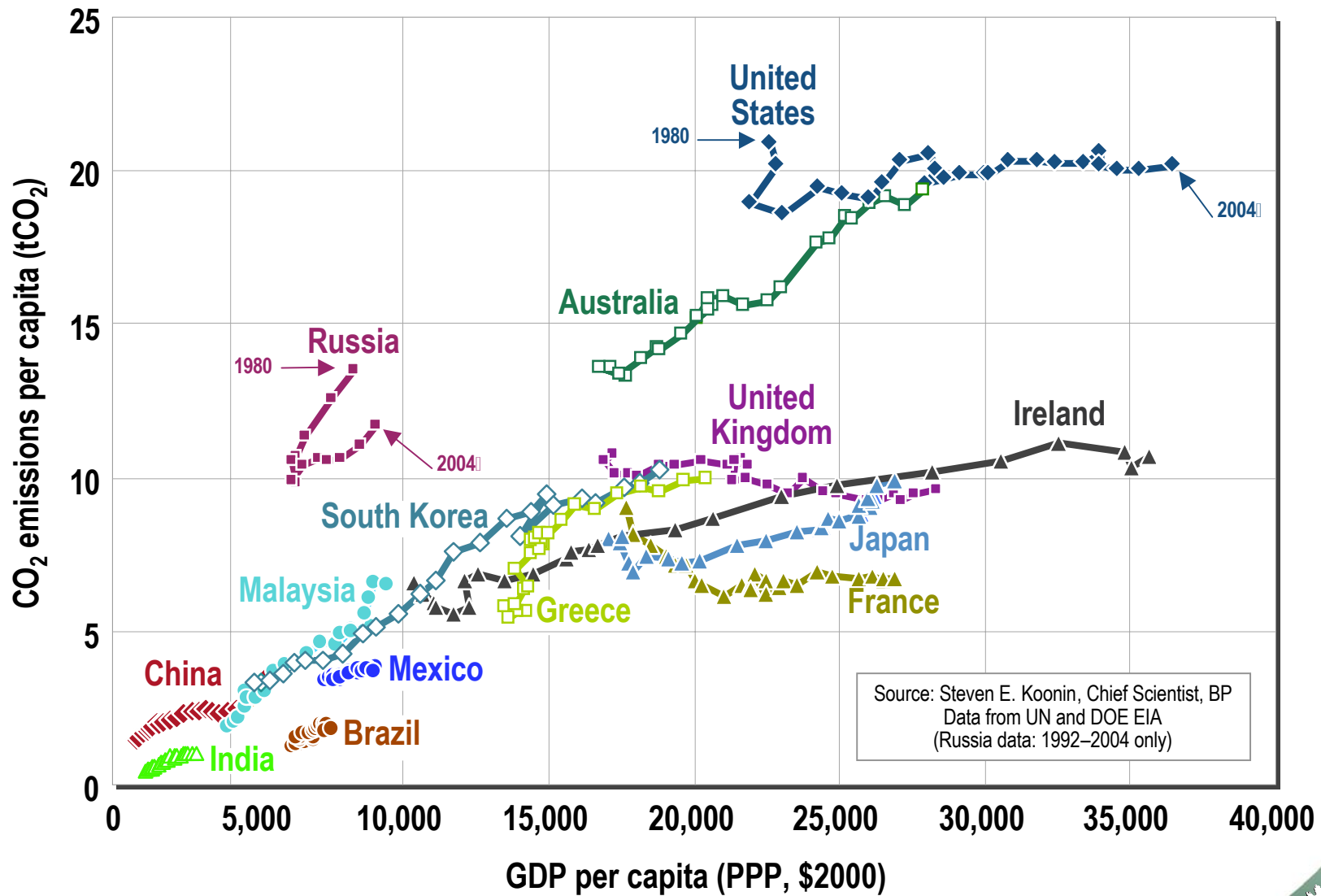
Source: Annual Energy Review 2006,  
Energy Information Administration

# World energy consumption is projected to increase by 57% from 2004 to 2030



Source: International Energy Outlook 2007, DOE/EIA-0484(2007), Energy Information Administration, May 2007

# CO<sub>2</sub> emissions and GDP per capita (1980–2004)





# How can we meet the energy challenge?

## Energy diversity

Increase our energy options and reduce dependence on oil

## Environmental impacts of energy

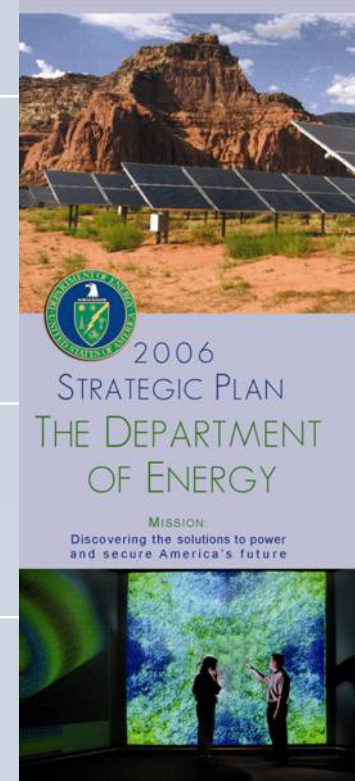
Improve environmental quality by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use

## Energy infrastructure

Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure

## Energy productivity

Cost-effectively improve the energy efficiency of the U.S. economy



**We need transformational discoveries and truly disruptive technologies**

# ORNL is uniquely positioned to deliver science and technology for energy

## We have an extraordinary set of assets

- Outstanding tools for materials R&D
- World's most powerful system for open scientific computing
- New Bioenergy Science Center
- The nation's broadest portfolio of energy programs
- Unique resources for nuclear technology
- Robust national security programs

**Our challenge:**  
Use these assets to deliver results that are significant on both the national and the international scale



# Studying materials with the world's best resources for neutron scattering

The \$1.4 billion Spallation Neutron Source is the world's most powerful pulsed neutron source

The High Flux Isotope Reactor offers complementary capabilities including the world's brightest cold source

Thousands of researchers will come to Tennessee each year to use these facilities

The UT-ORNL Joint Institute for Neutron Sciences provides a user gateway for SNS and HFIR



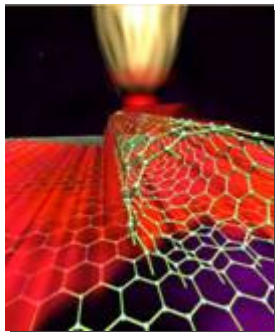
# High Flux Isotope Reactor



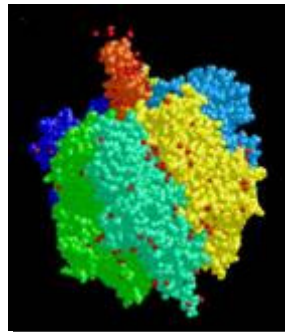
- One of two high-flux reactors for neutron scattering worldwide
- Unique in the western world for transplutonium element production
- National resource for isotope production, materials irradiation, and neutron activation analysis
- Recently refurbished (new cold source, reflector, cooling tower, beam tubes, guide hall and instruments, etc.)
- Complementary to SNS

# Leadership Computing

- Currently operating at 119 teraflops (250 TF later this year, 1000 TF in 2008)
- Focus on computationally intensive projects of large scale and high scientific impact
- Teamed with UT to win a second petaflop computer funded by NSF



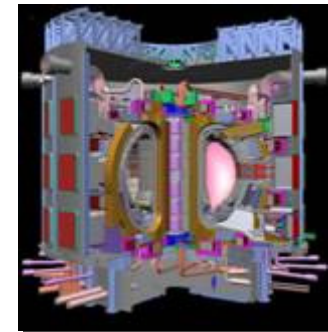
**Design of innovative nanomaterials**



**Understanding of molecular systems**



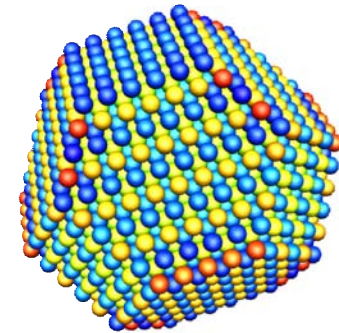
**Climate simulations to support policy decisions**



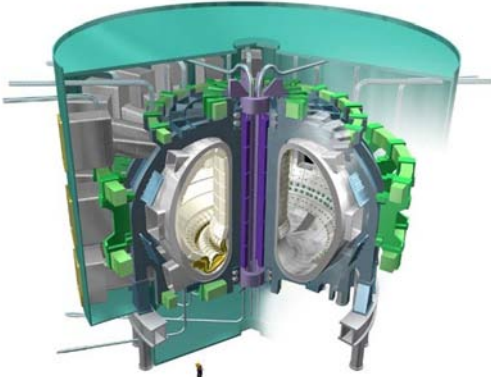
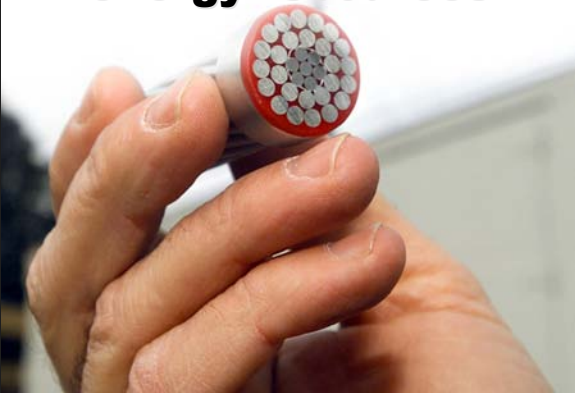

**Predictive simulations of fusion devices**

# World-class tools for nanoscale R&D

- Recently completed the \$65M Center for Nanophase Materials Research
- Leverages unique neutron scattering and leadership computing capabilities at ORNL
- Unique facilities for:
  - Nanofabrication
  - Nanoscale characterization
  - Materials synthesis
- Broadly accessible to universities and industry



# Addressing the energy challenges of today . . . and tomorrow

Generation	Distribution	Consumption
<p><b>Fossil</b> <b>Fission</b> <b>Renewables</b> <b>Fusion</b></p> 	<p><b>Transmission technology</b> <b>Hydrogen</b> <b>Distributed energy resources</b></p> 	<p><b>Buildings</b> <b>Industry</b> <b>Transportation</b></p> 
<p><b>International fusion experiment</b></p>	<p><b>Superconducting cable</b></p>	<p><b>Net-zero-energy houses</b></p>

# Transforming the new biology into bioenergy

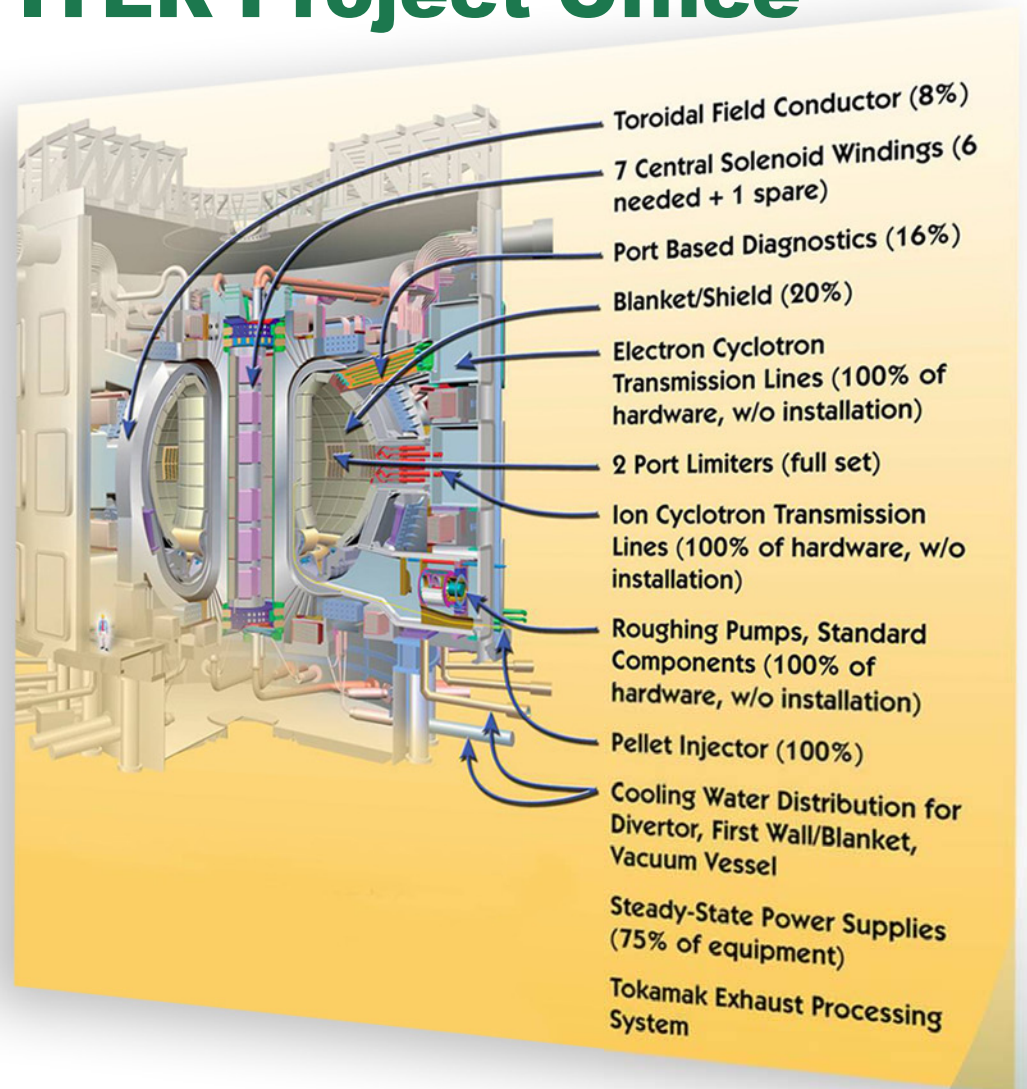
- Developing bio-based solutions for energy, the environment, and carbon sequestration
- Recently won a \$125M DOE grant for cellulosic ethanol research
  - One of three Bioenergy Science Centers nationwide
- A \$73M investment in bioenergy by the state of Tennessee brings ORNL, UT, and industry together
  - Includes bioenergy research, a 5M gal/yr pilot plant, and agricultural incentives for switchgrass





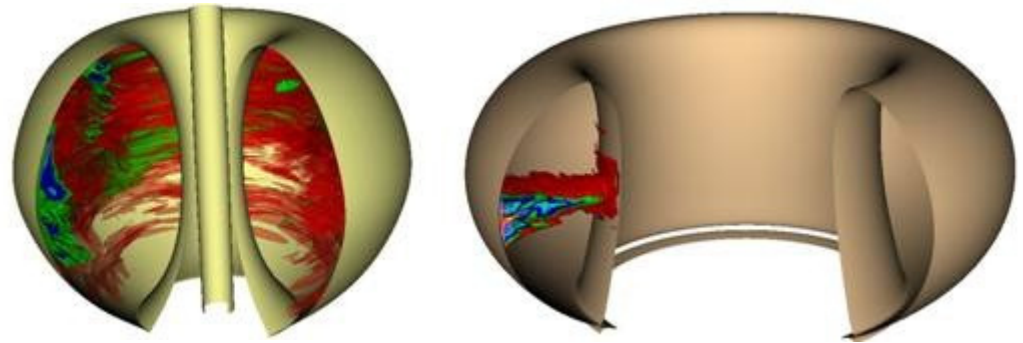
# ORNL hosts the U.S. ITER Project Office

- **U.S. Domestic Agency is the first to be established**
- **U.S. ITER budget growing:**
  - FY07: \$60M
  - FY08: \$160M (President's request)
  - FY09: \$214.5M (proposed)
- **ITER-led design review is completed**
- **Current U.S. ITER Project activities:**
  - R&D, prototyping, and design in all areas of U.S. responsibility
  - Follow-up on international design review
  - Providing the ITER Organization with staff and project management support

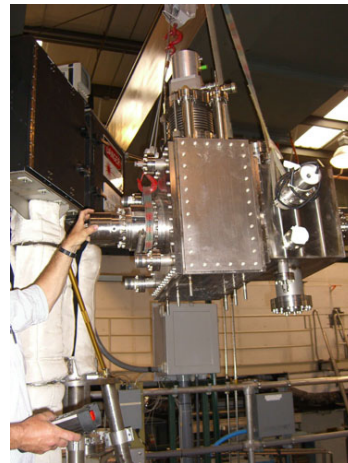


# ORNL also makes key contributions to the national program in fusion science and technology

- Materials development
- Plasma theory and modeling
- Fueling and RF technologies
- Atomic physics
- Advanced concepts
  - Spherical torus
  - Compact stellarator



SciDAC simulations of RF heating efficiencies in NSTX and ITER



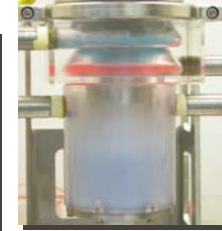
Pellet pacing system for mitigating disruption forces and ELMS



High-power ELM-resistant RF antenna

# ORNL is uniquely positioned to support advanced nuclear fuel cycle research

- Coupled End-to-End (CETE) Demonstration delivers advanced nuclear fuel cycle S&T
- TVA/ORNL/IBM Advanced Fuel Cycle Demonstration concept
- Participation in NRC “4-Lab Consortium” supports NRC’s new reactor licensing activities
- USEC CRADA to develop centrifuge technology
- Nuclear research facility infrastructure (REDC, HFIR, etc.): \$3B+ national asset

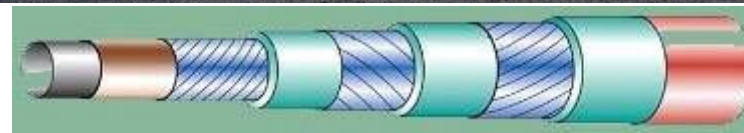


# ORNL has a large and growing energy efficiency, renewable energy, and electricity delivery portfolio

- Over \$100M in FY 2007
- Largest national lab effort in transportation and industrial technologies (EERE) and superconductivity (OE)
- Significant growth in fuel cells, biomass, and grid visualization/modeling
- Major national facilities including the High Temperature Materials Lab, National Transportation Research Center, and Buildings Technology Center



“Zero-energy” homes



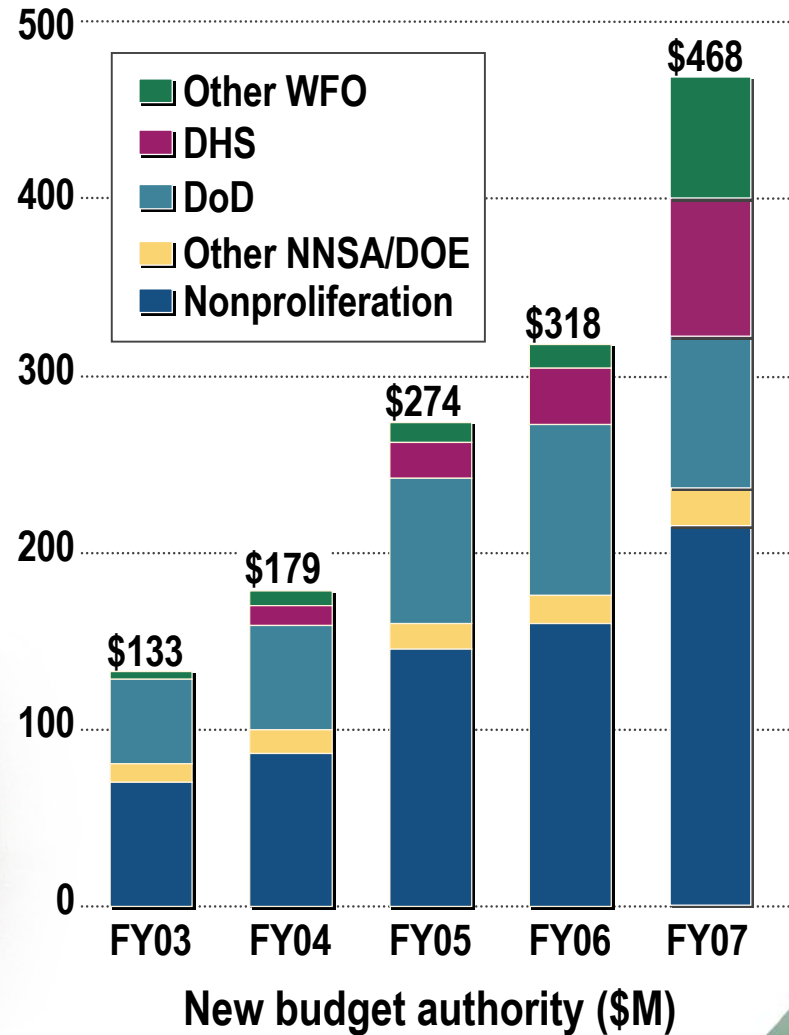
Tri-axial superconducting cable installed at AEP Bixby



Light-weight carbon fiber materials from lignin

# National security S&T has become a major business line at ORNL

- We are a leading lab for nuclear nonproliferation
- We have a growing role with the Department of Homeland Security
- National security S&T builds upon and complements our DOE missions



# We are committed to strong university partnerships



## Major projects

- Bioenergy Science Center
- NSF Track 2 computer
- 4 SNS instruments led by university consortia

## Collaborative research

- More than 200 universities

## Joint hiring

- 58 joint faculty with 8 universities

## Joint institutes

- Heavy ion research
- Neutron sciences
- Biological sciences
- Computational sciences
- Materials sciences

## User facilities

- Thousands of university users



# We use our R&D assets to create economic growth

Technology portfolios

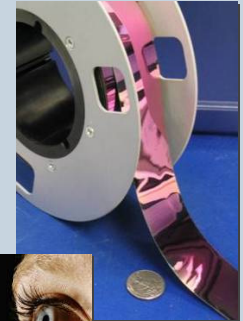
Entrepreneurial support

Partnerships with industry and universities

New tools for commercialization

Local and regional economic development

- Technology transfer royalties of \$18 million
  - Reinvested in innovation
- 115 active technology licenses
- 74 new companies since April 2000
- Strategic partnerships
  - UT, TVA, Southern Growth Policies Board, Tech 2020, Tennessee Valley Corridor, ETEC, Battelle Ventures, Innovation Valley Partners, and many others
  - S&T Park at ORNL
  - Working with over 600 industries annually



 **BATTELLE VENTURES**

# We are transforming the laboratory

**East Campus**



**Chestnut Ridge Campus**



**Science and Technology Park**



**West Campus**



# **Oak Ridge National Laboratory: Science and technology for the 21st century**

