

Meeting 21st Century Challenges: The Role of Oak Ridge National Laboratory

Annual Report to the Community

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Oak Ridge, Tennessee

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Three closely linked global challenges call for a broad response



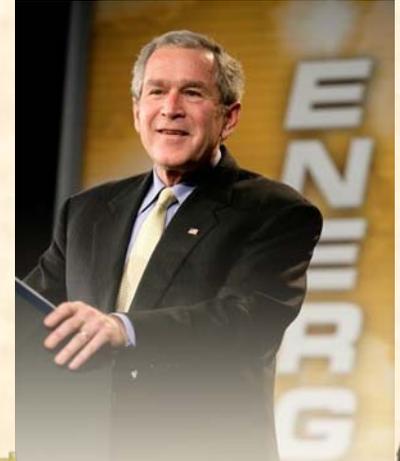
The President has articulated a new vision for U.S. leadership

- **American Competitiveness Initiative:**

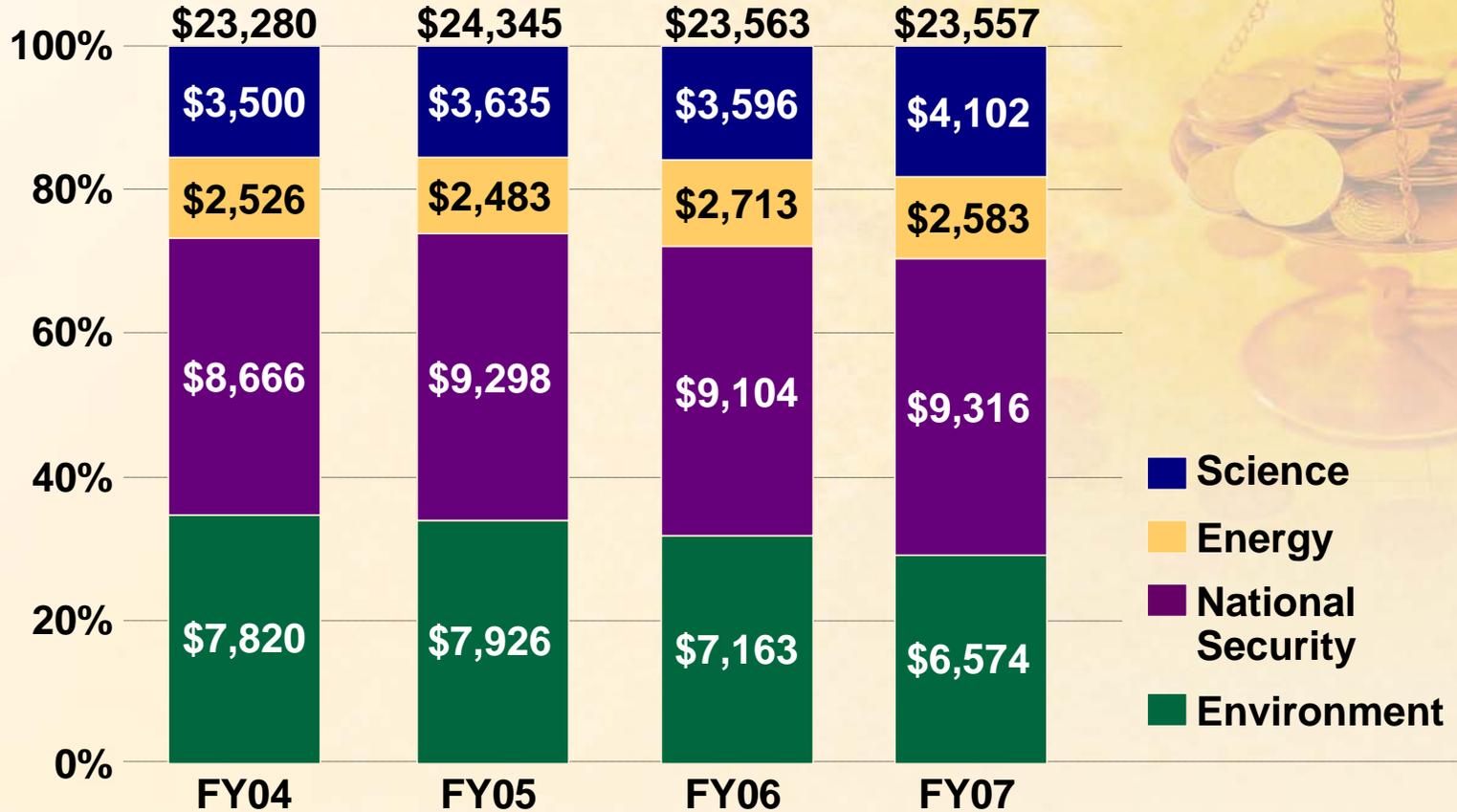
- Double funding for physical sciences
- Explore “promising areas such as nanotechnology, supercomputing, and alternative energy sources”

- **Advanced Energy Initiative:**
Increase funding for clean energy R&D

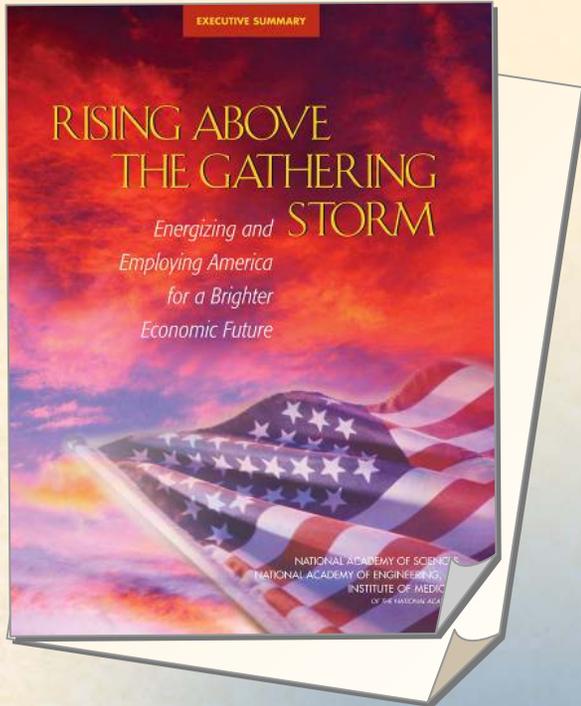
- **Power:** Clean coal, wind and solar energy, nuclear energy
- **Transportation:** Batteries, hydrogen, and ethanol



However, the DOE budget is a zero-sum game



Congress is also confronting the challenges of globalization



- **Senate:**
 - SMART Grants program
 - National Innovation Act
 - PACE Act
- **House:**
 - 10,000 Teachers, 10 Million Minds Science and Math Scholarship Act
 - ARPA-E Act
 - Sowing the Seeds through Science and Engineering Research Act

ORNL is ready for these challenges

New East Campus



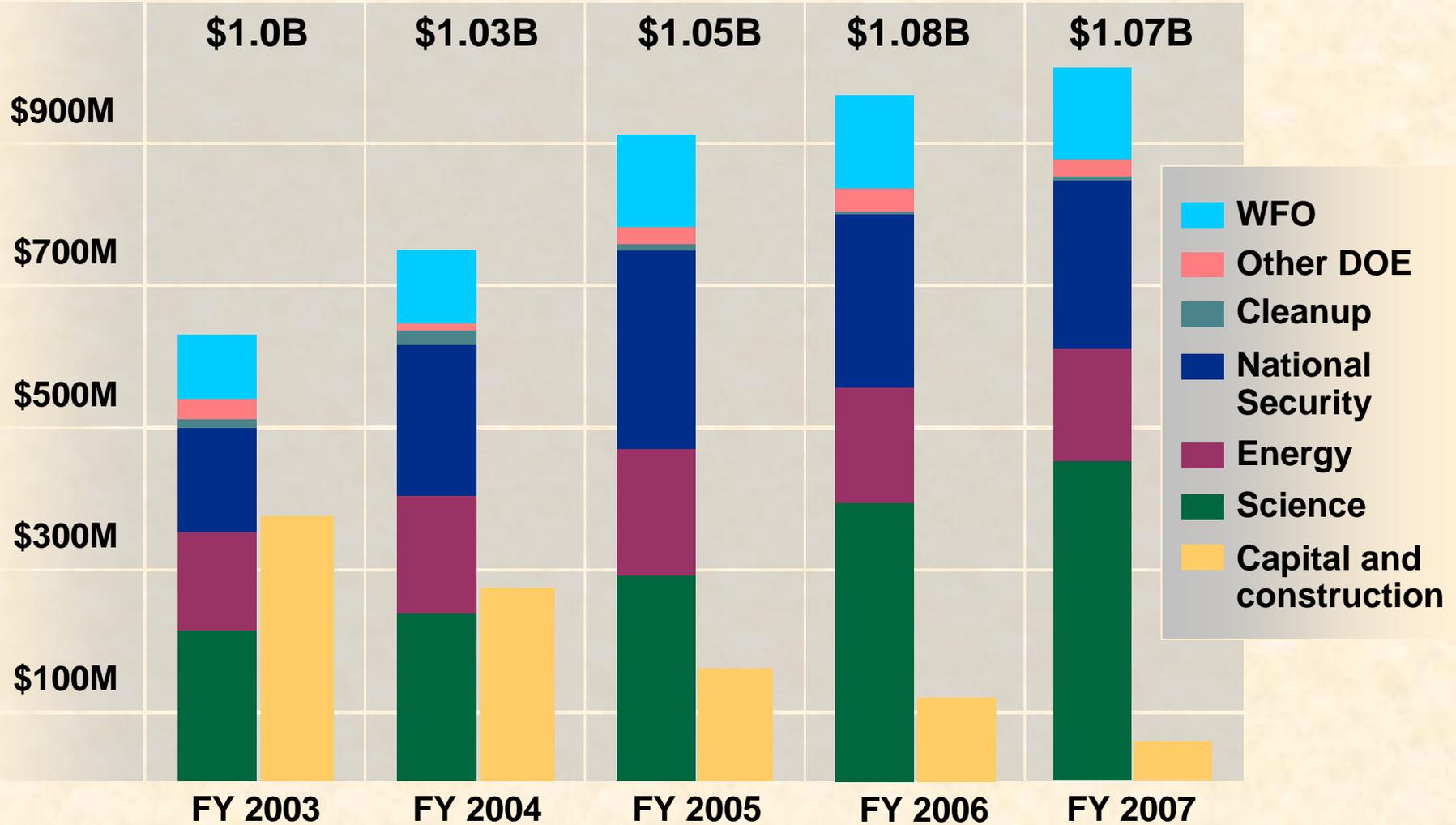
Chestnut Ridge



New West Campus



ORNL budget trends (operating and construction)



The contract between DOE and UT-Battelle has been extended

Under Secretary David Garman announced the contract extension on December 1, 2005

“UT-Battelle has made significant contributions to the Oak Ridge community and to the Department”

“ORNL’s world-class facilities and scientific talent are indispensable to the energy, economic, and national security of the nation”

“This extension demonstrates the Department’s commitment to scientific research and also our confidence in the people of Oak Ridge National Laboratory”

The contract now runs through March 31, 2010



The Spallation Neutron Source

With beam delivered to the target, construction is officially complete

The SNS project was completed on scope, under budget, and ahead of schedule

We have begun the transition to user mode operations

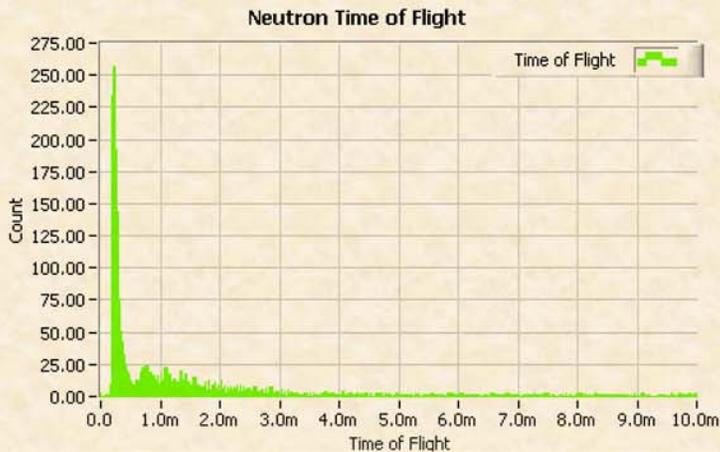
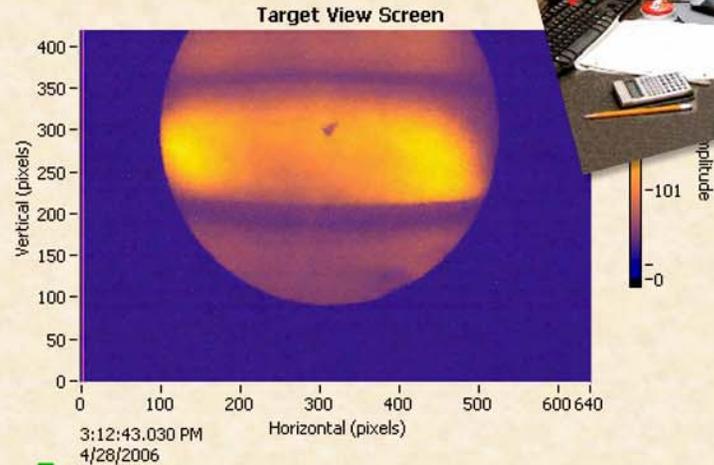
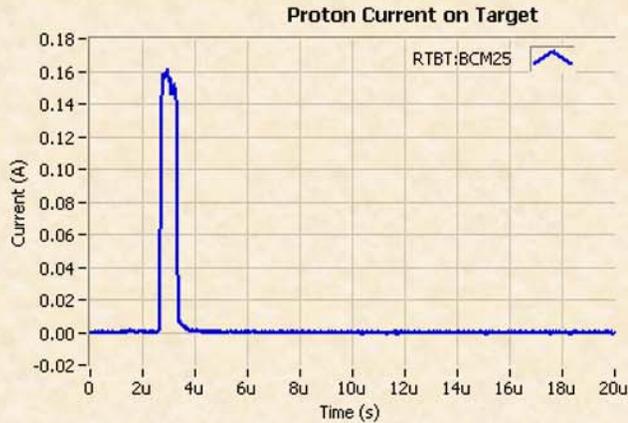
We will have a high-level celebration later this year

**First neutrons produced:
April 28, 2006**

We are ready to begin doing science

SNS Channel 4

Last Update: 4/28/2006 3:12:49 PM



Protons	629G	Goal 10T
Total Protons	141T	
Charge (C)	101n	
1-eV Moderator Coupling (n/ster/eV/p)	513u	
PEP-Specified Neutronics Units (n/ster/p)	9.90m	5m Achieved

ORNL's other billion-dollar facility: The High Flux Isotope Reactor will soon have a cold neutron source

- All major cold neutron source components have been installed
- Operation with supercritical hydrogen cooling and production of cold neutrons should begin in October
- With 9 new and upgraded instruments, HFIR's capabilities complement those of SNS



The Center for Nanophase Materials Sciences is attracting users

- **First of five DOE Nanoscale Science Research Centers**
- **Integrating nanoscale science with three highly synergistic national needs:**
 - **Neutron science**
 - **Synthesis science**
 - **Theory, modeling and simulation**



Nanoscale S&T will produce breakthrough innovations

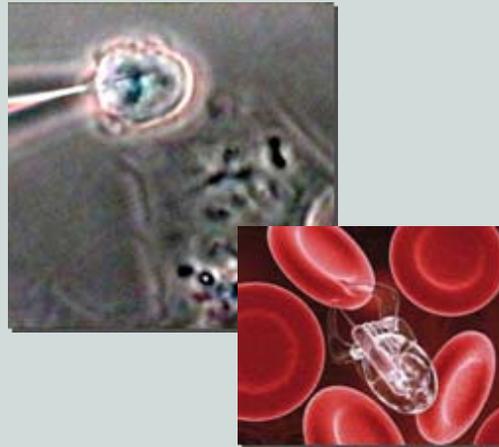
Energy

- Long-lasting rechargeable batteries
- High-efficiency, cost-effective solar cells
- Improved fuel cells
- Efficient conversion of water to hydrogen



Health

- Point-of-care medical diagnostics
- Targeted drug therapy
- Enhanced medical imaging
- Drug delivery through cell walls

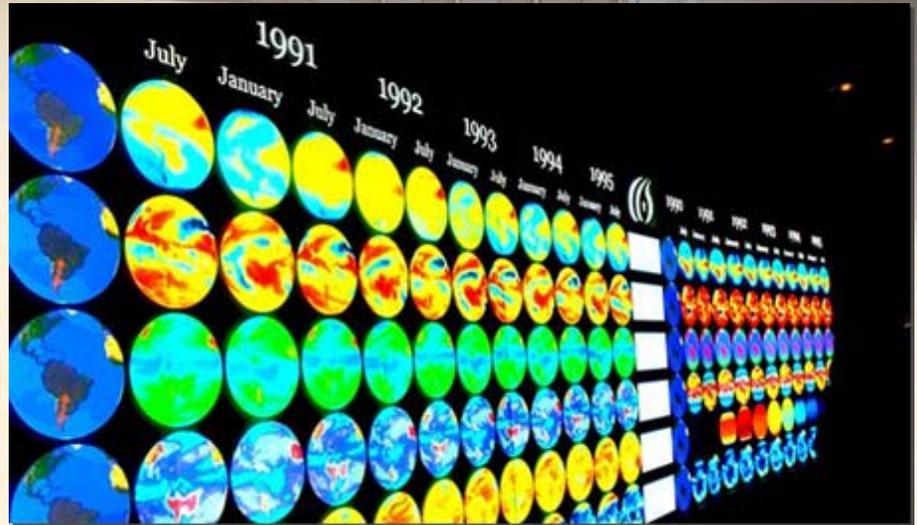
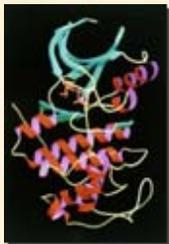
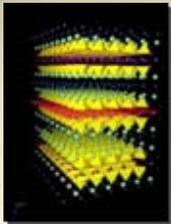


Manufacturing

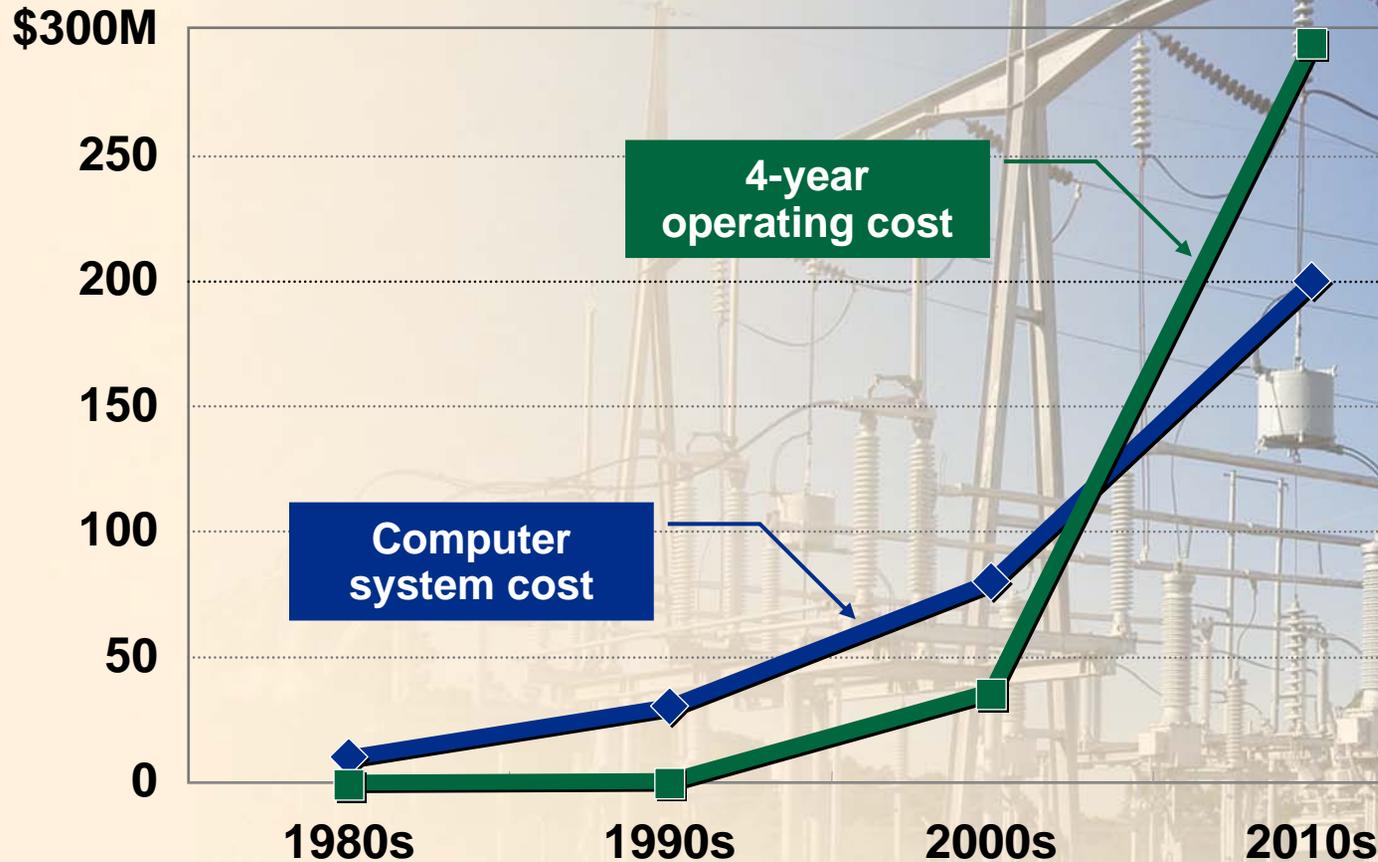
- Better existing materials: high strength, light weight, corrosion resistance
- New materials: Polymers, thin films, superconducting magnets
- Manufacturing processes that generate less waste



We are DOE's lead laboratory for open scientific computing

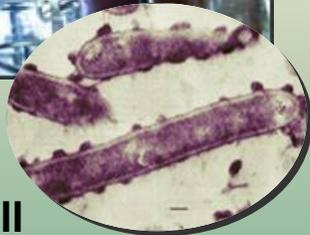


Computing infrastructure could soon cost more than the hardware



Our systems biology research extends from the molecule to the ecosystem

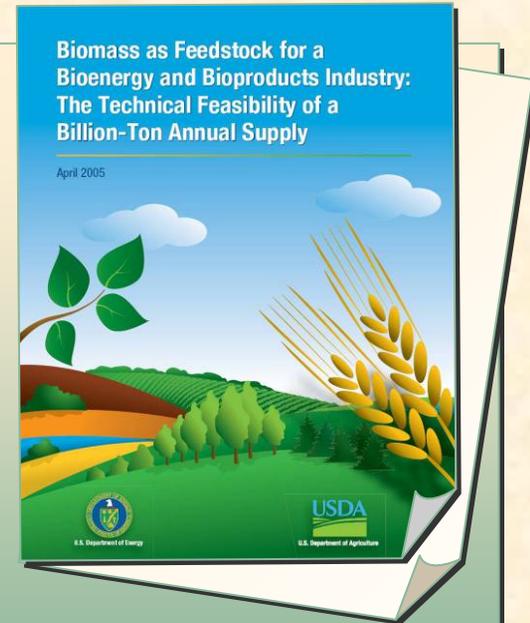
Our work in genetics, biotechnology, process chemistry, and engineering supports bioenergy development



***Clostridium thermocellum* breaks down cell walls to enable ethanol production from cellulose**



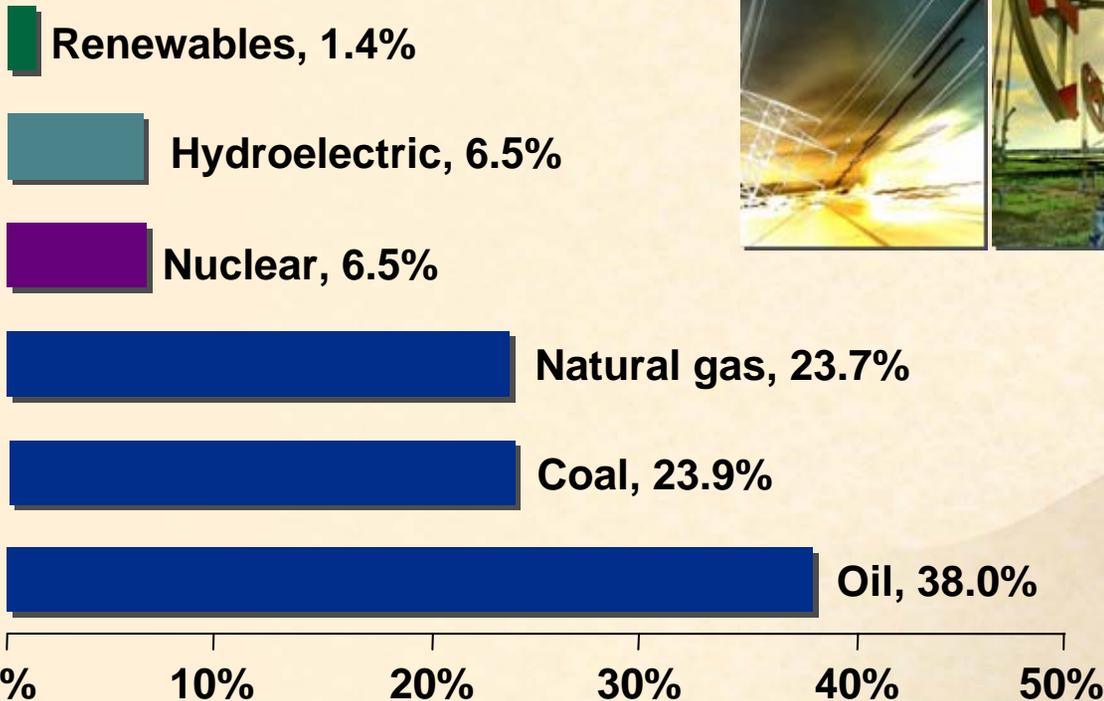
Sequencing of poplar genome will lead to trees that produce more biomass for conversion into fuel



Biofuels can displace 30% of imported oil

Meeting world energy demands: No silver bullet and no free lunch

World energy
production, 2003



ORNL is contributing to discussions of national energy goals



Establish a top-level national energy goal (e.g., “energy freedom within this generation”)	President
Clarify the goal by setting a few high-level targets with direct metrics	Independent bipartisan commission, supported by the S&T community
Commit to reaching the goal by a set date	Broad national effort

- **Senator Lamar Alexander challenged us:**
 - To articulate the national energy challenge
 - To describe how ORNL would contribute
- **We responded with recommendations on what is needed to move the nation toward “energy freedom”**

Nuclear power will play a central role in a sustainable energy future

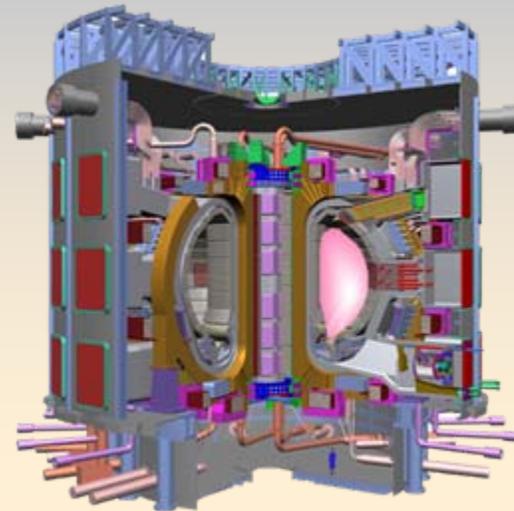
Fission

The most efficient, most affordable source of emission-free energy that is now available



Fusion

The ideal solution: Plentiful, safe, and environmentally benign energy for the world



Global Nuclear Energy Partnership: Closing the nuclear fuel cycle

Advantages

- **Extends the nuclear fuel supply**
- **Reduces long-term nuclear waste storage requirements by a factor of 100**
- **Reduces nuclear proliferation risk**



**Global
Nuclear
Energy
Partnership**

Near-term activities

- **FY07 budget request: \$250M (total cost: \$20B to \$60B)**
- **DOE national laboratories are developing a 5-year technology plan**
- **Contacts have been made with key leaders around the world**
- **Secretarial decision in June 2008**

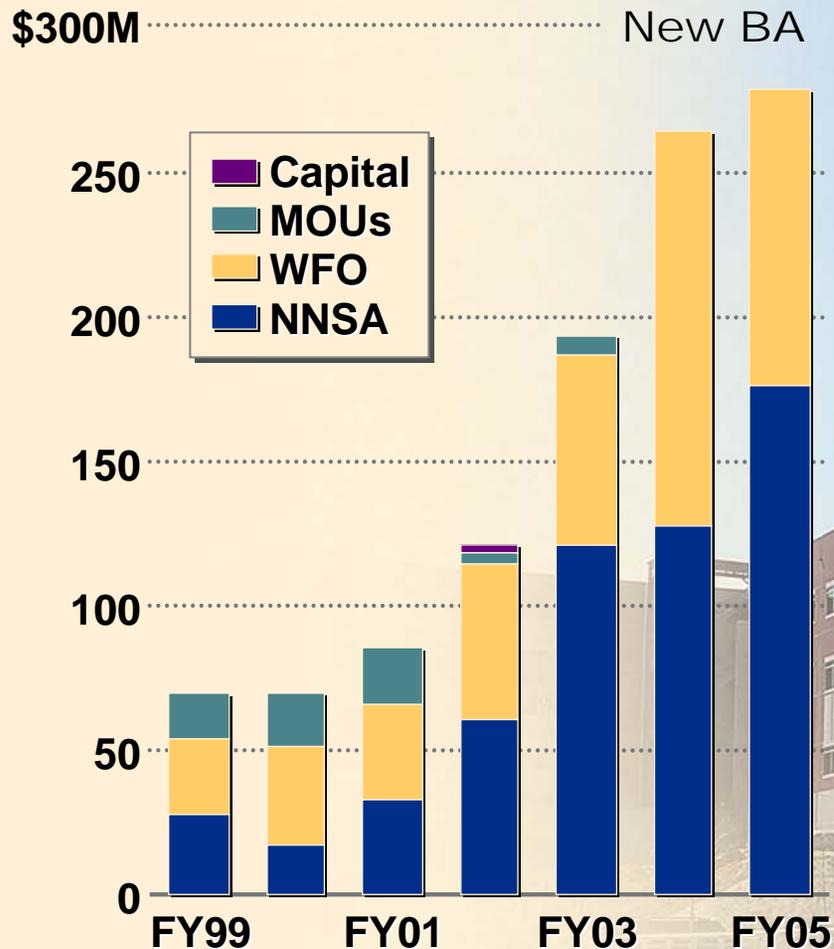
ORNL roles

- **Organizing a DOE workshop on basic research needs for advanced nuclear energy systems (July 2006)**
- **Participating in development of 5-year plan**
- **Signature capabilities: Materials, fuel processing, advanced fuels, and computing**
- **Critical infrastructure: HFIR and hot cells**

ORNL is now managing the U.S. contributions to ITER

- **Negotiations and design began more than 20 years ago**
- **Construction of this \$11 billion magnetic fusion research experiment will soon begin in Cadarache, France**
- **U.S. contributions will total \$1.122 billion**
- **Management of the U.S. ITER Project Office was transferred from Princeton Plasma Physics Laboratory to ORNL in February**
 - **Builds on our experience with SNS**

ORNL is a preferred provider for national and homeland security



- Expanding role in safeguarding Russian nuclear material
- DOE lead supporting DoD efforts to defeat improvised explosive devices (IEDs)

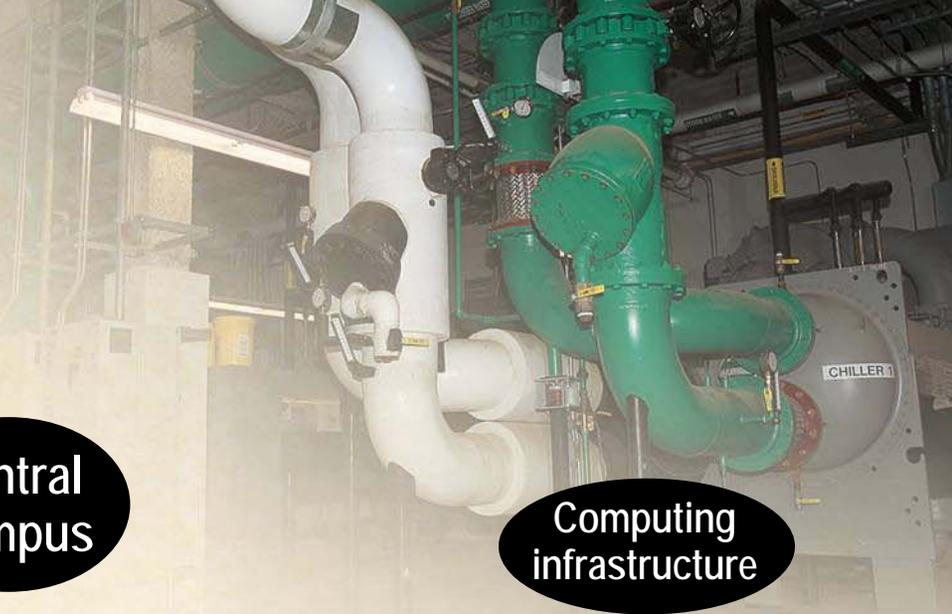


We have transformed
ORNL's research campus . . .

... but we have more work to do



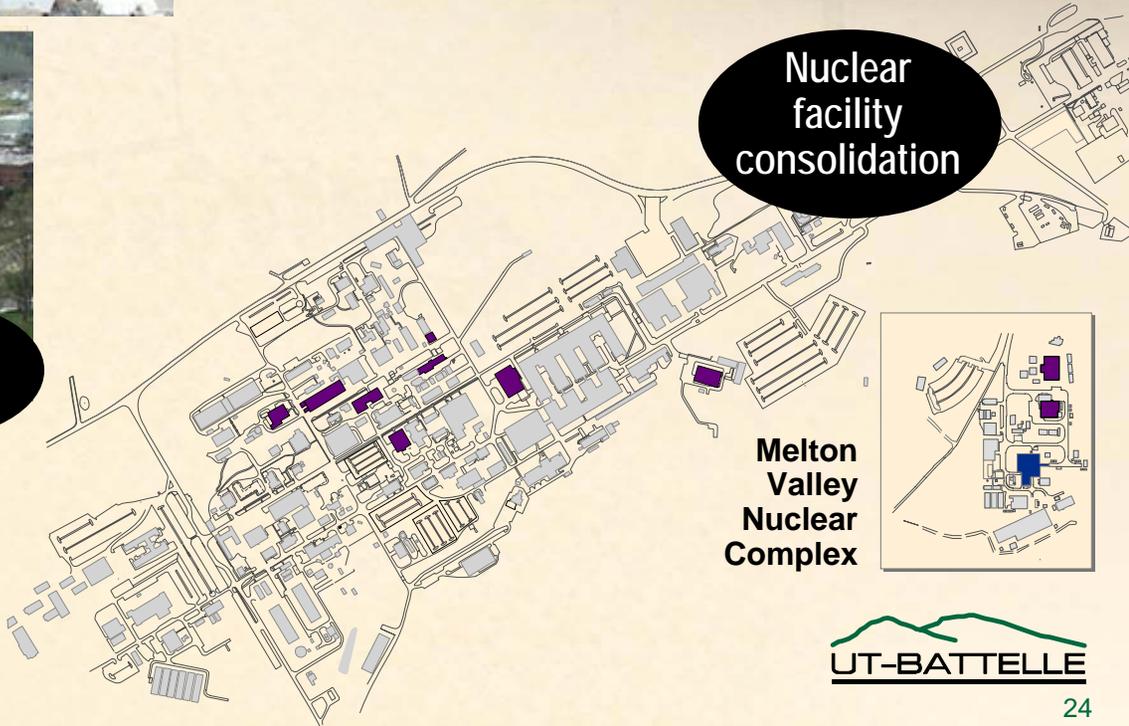
Central Campus



Computing infrastructure



4500 N/S upgrade



Nuclear facility consolidation

Melton Valley Nuclear Complex

ORNL's recruiting challenge

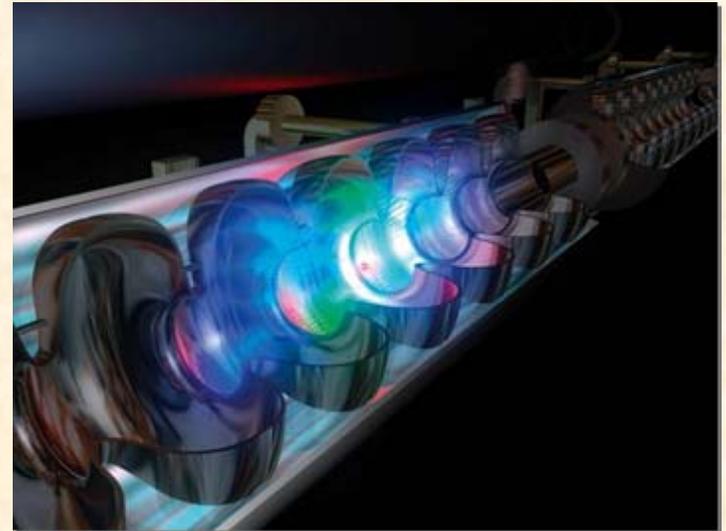
- **We need to recruit and retain the world's best scientific talent**
- **Our partnership with the University of Tennessee is a real advantage**
 - Joint appointments
 - Distinguished Scientists
 - Governor's Chairs



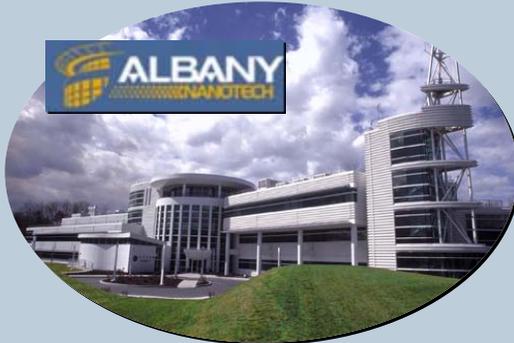
The international R&D landscape is changing

Major scientific experiments are no longer the exclusive domain of the United States

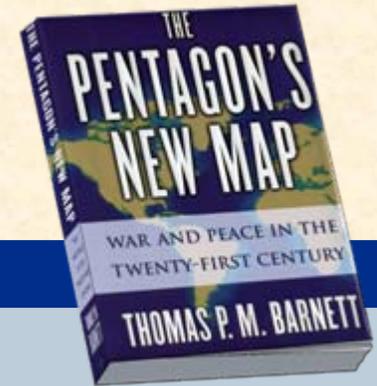
- **Very large facilities for basic research, such as ITER and the International Linear Collider, are likely to be built by big international teams**
- **Large single-purpose facilities (\$1 billion to \$2 billion) will remain national-level investments**
- **For enterprises with a lower price of entry, competition will be intense and increasingly globalized**



The price of entry determines who the players are

International picture	
Neutron scattering	<ul style="list-style-type: none"> • ORNL has the lead today • Japan, Europe, China, and Korea are investing now (payoff expected in ~10 years)
Nanoscale R&D	<ul style="list-style-type: none"> • National government investments worldwide: ~\$4B (10× in 8 years) • ~2,000 “centers” in Europe alone • State, university, and private investments (e.g., \$80M center at Tsinghua University) 
Ultrascale computing	<ul style="list-style-type: none"> • 30 nations represented on the Top500 list • Top500 entry level is >1 TF (world’s best in 1998)
Systems biology	<p>Many nations are investing — as are states, universities, and individuals</p>

National laboratories have new competition in DOE's mission space



International picture

National, global, and homeland security

Diplomacy and war:
The Pentagon's New Map

Energy

Rising/renewed interest worldwide; the President of India has called for energy independence by 2030

Fission

- Reactors under construction in China, India, Russia, Taiwan, Ukraine
- Planning for Pebble Bed Modular Reactor in South Africa

Fusion

- Leaders: Russia, France (ITER), Japan, China, Korea, India

Competing in a global economy requires a well-trained work force

Nationally:

- **Senator Frist has created the SMART Grants program**
- **The PACE Act supports programs that would expand student and teacher access to ORNL**
 - Distinguished scientists
 - Early career research grants
 - Scholarships and fellowship
 - Specialty high schools



Locally:

- **Investing in area schools**
 - ORHS renovation
 - Project GRAD in Knox County
 - Science laboratories for Tennessee schools
 - Signing bonuses for science and math teachers
- **Supporting Governor Bredesen's proposal to launch a "high school of the future" for science and math**
- **Seeking "Distinguished Professionals" to teach in area schools**
- **Working with UT, ORAU, and our core university partners**

Oak Ridge National Laboratory: Ready for the challenges of the 21st century

