Global Nuclear Futures Initiative

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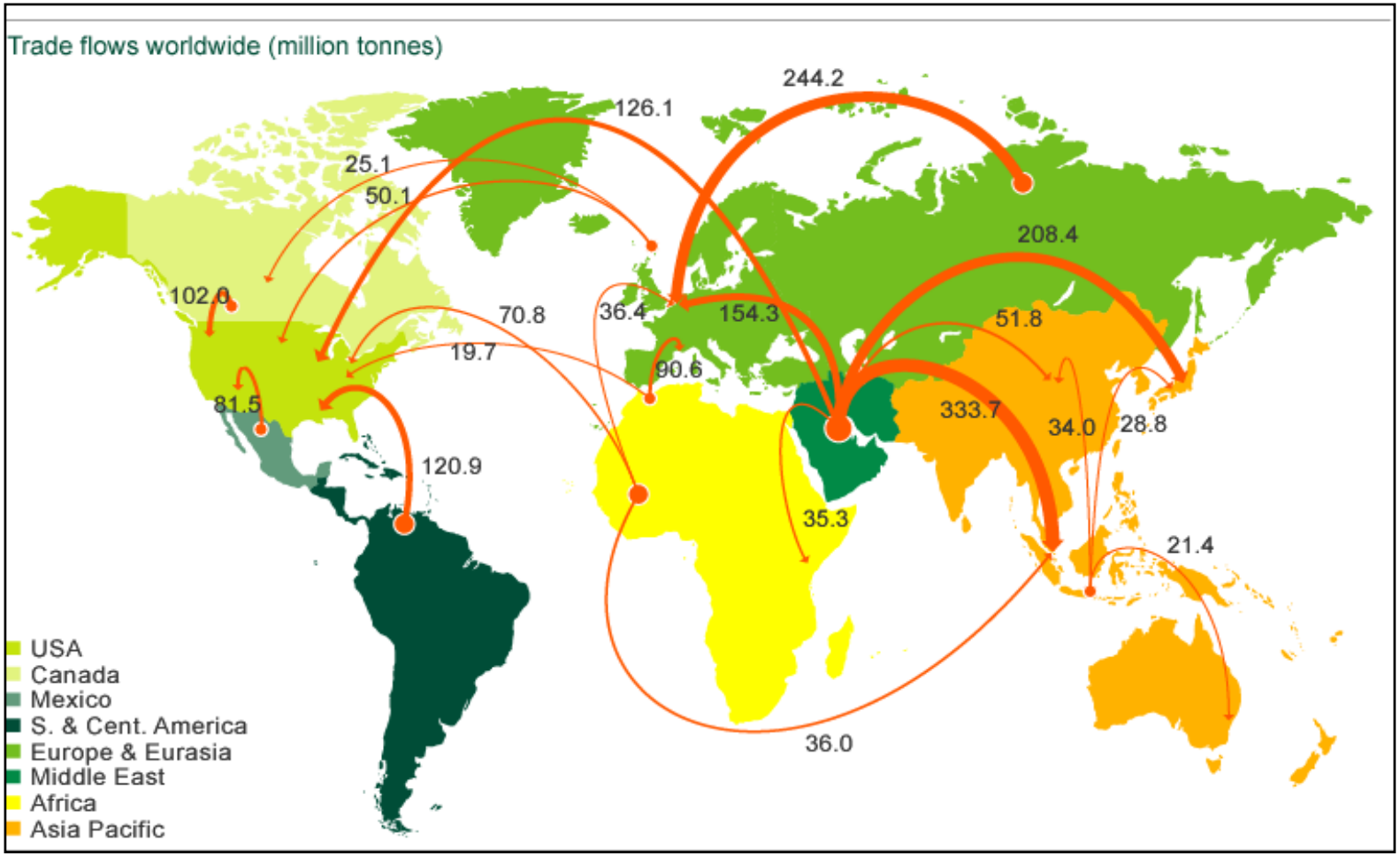
Scenario if Worldwide Dependence on Oil and Natural Gas Remains Unchanged

By 2025:

- **World oil demand will increase by half (an additional 40 million barrels per day)**
  - **China's demand doubles**
  - **U.S. imports 70% of its petroleum**
  - **Russia & 6 unstable Persian Gulf countries control 70% of proven oil reserves.**
- **World natural gas consumption will increase by more than half**
  - **U.S. imports ~25% of its natural gas**
  - **Russia & 2 unstable Persian Gulf countries control 60% of proven oil reserves.**

- **World electricity production from oil & natural gas will be 33%, up from 25%.**
- **Greenhouse gas production concerns will exert pressure on the U.S. to curtail use of coal.**
- **Worldwide competition for oil and natural gas and U.S. dependence on these fuels will pose an increasing threat to U.S. national and economic security**

Dependence on Oil from Unstable Regions Is High and Growing



Source: BP Statistical Review of World Energy June 2004

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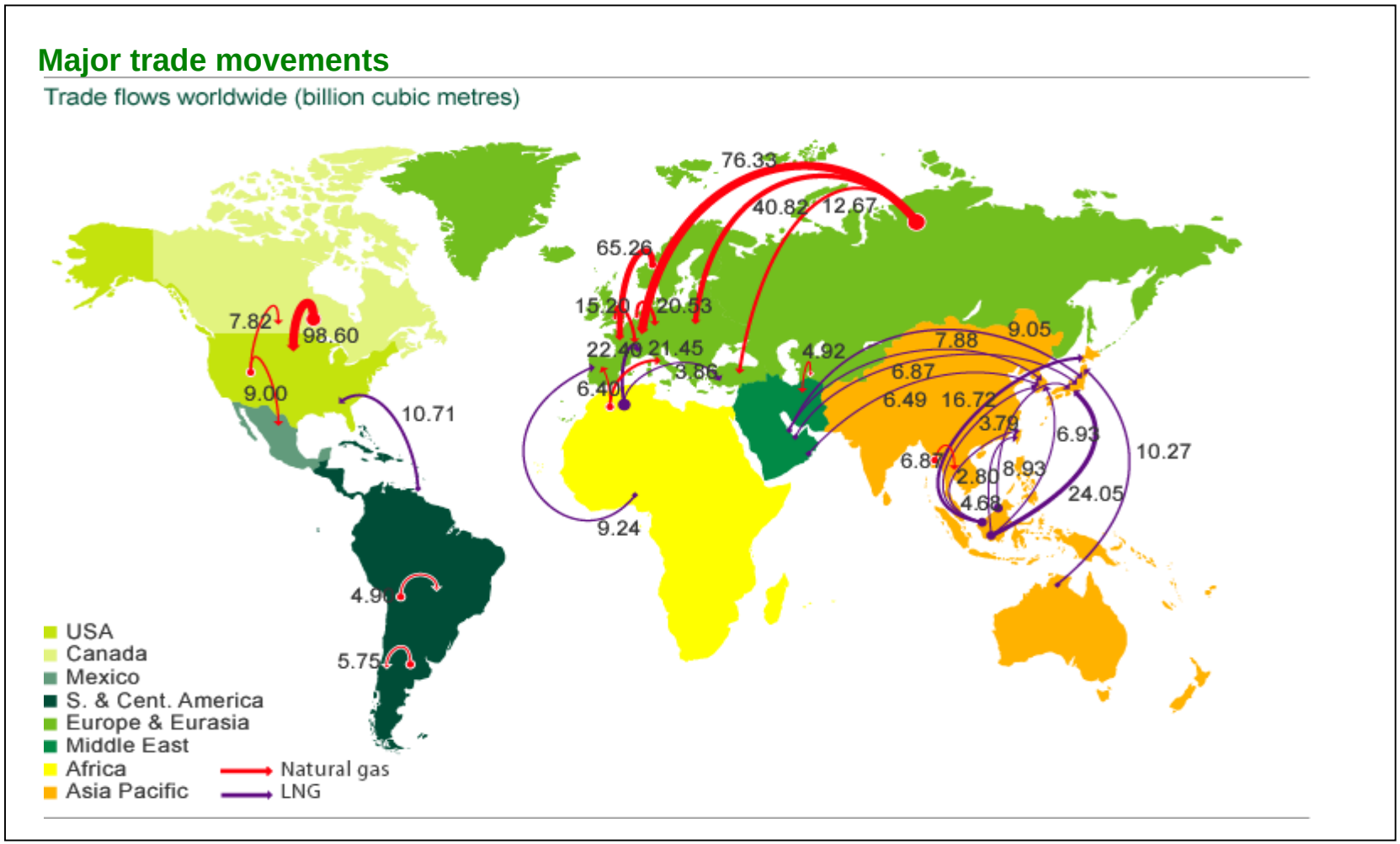
Natural Gas Dependency Is Growing



Source: BP Statistical Review of World Energy June 2004, P. 29

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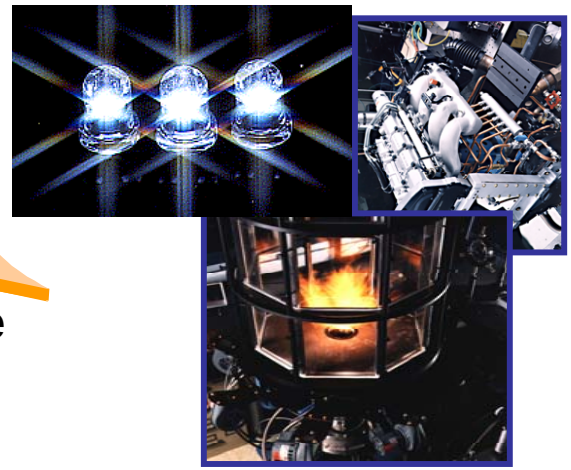
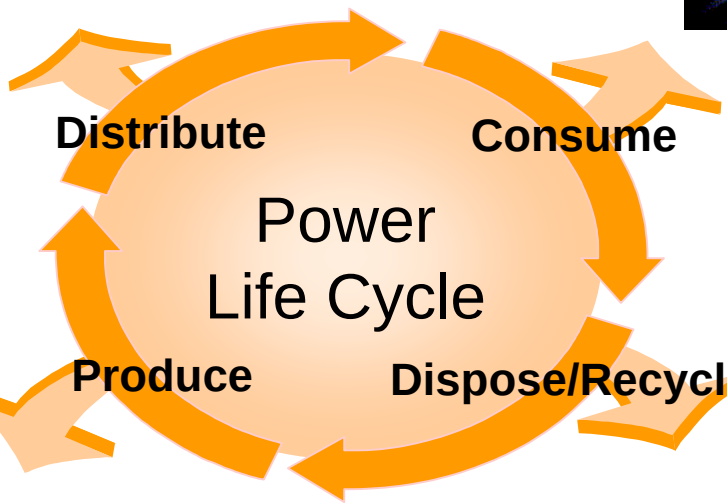
“Secure Clean Power for Peace & Prosperity”

Safe, Secure, Reliable
Systems Infrastructure



Efficiency / Productivity



Portfolio of Power Sources

Environmental
Stewardship

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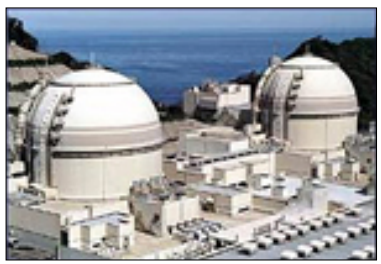
Affordable Zero Emissions Technology and Energy Independence Are Synergistic Goals

Today → Transition → Future State

Carbon Economy

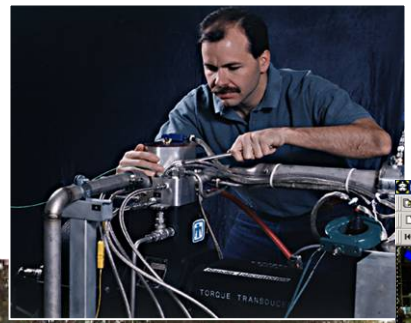
Energy Efficiency
Fuel De-carbonization
Carbon Sequestration
Hydrogen Infrastructure
Atmospheric Science

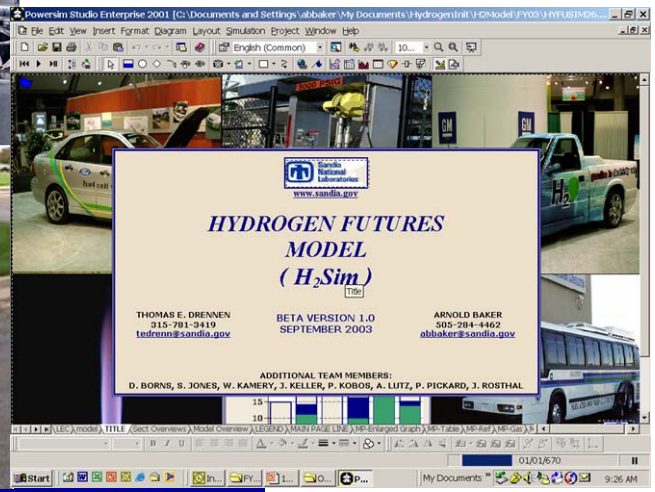


Hydrogen Economy
Renewable Energy
Nuclear Power
Clean Coal

Increasing Hydrogen Use in Transportation and Electricity Systems Increases Energy, Economic, and Environmental Security

A Hydrogen Economy Promises a Cleaner Energy Future





Production

Lawrence Livermore National Laboratory

Los Alamos NATIONAL LA

NREL

UCDAVIS

Ford

Utilization

Infrastructure

Storage

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Energy Secretary Spencer Abraham Outlines Administration's Clean Energy Strategy

06/25/04

6 Principal Energy R&D Areas:

1) Hydrogen
2) Clean Coal
3) Safe Nuclear Power
4) Fusion
5) Energy Efficiency
6) Renewable Energy

Nuclear Power Deployment Issues

1) Safety

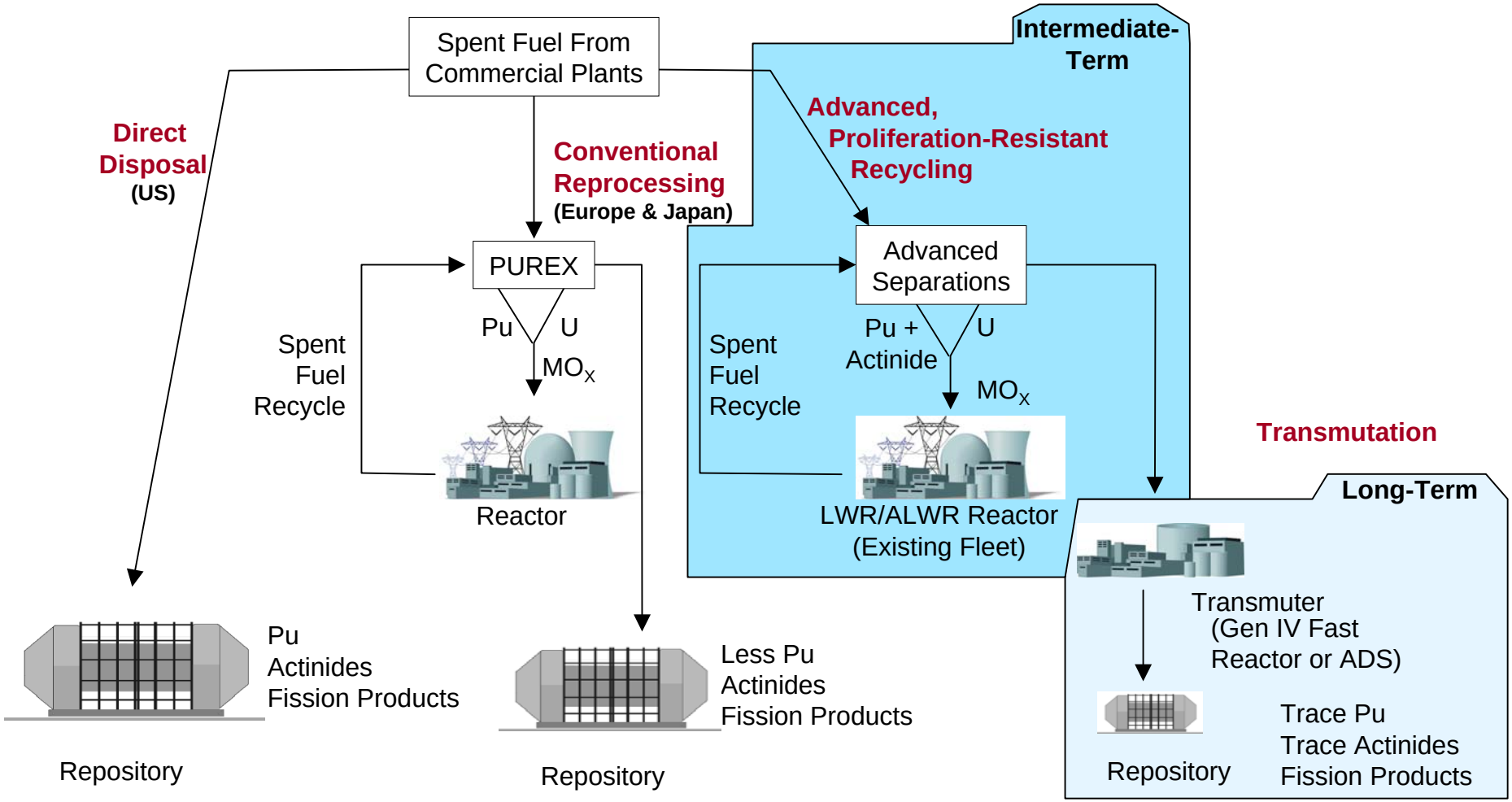
2) Proliferation Control

3) Waste Management

4) Investment Economics

Source: 2003 MIT study, *The Future of Nuclear Power*

Advanced Fuel Cycle Initiative



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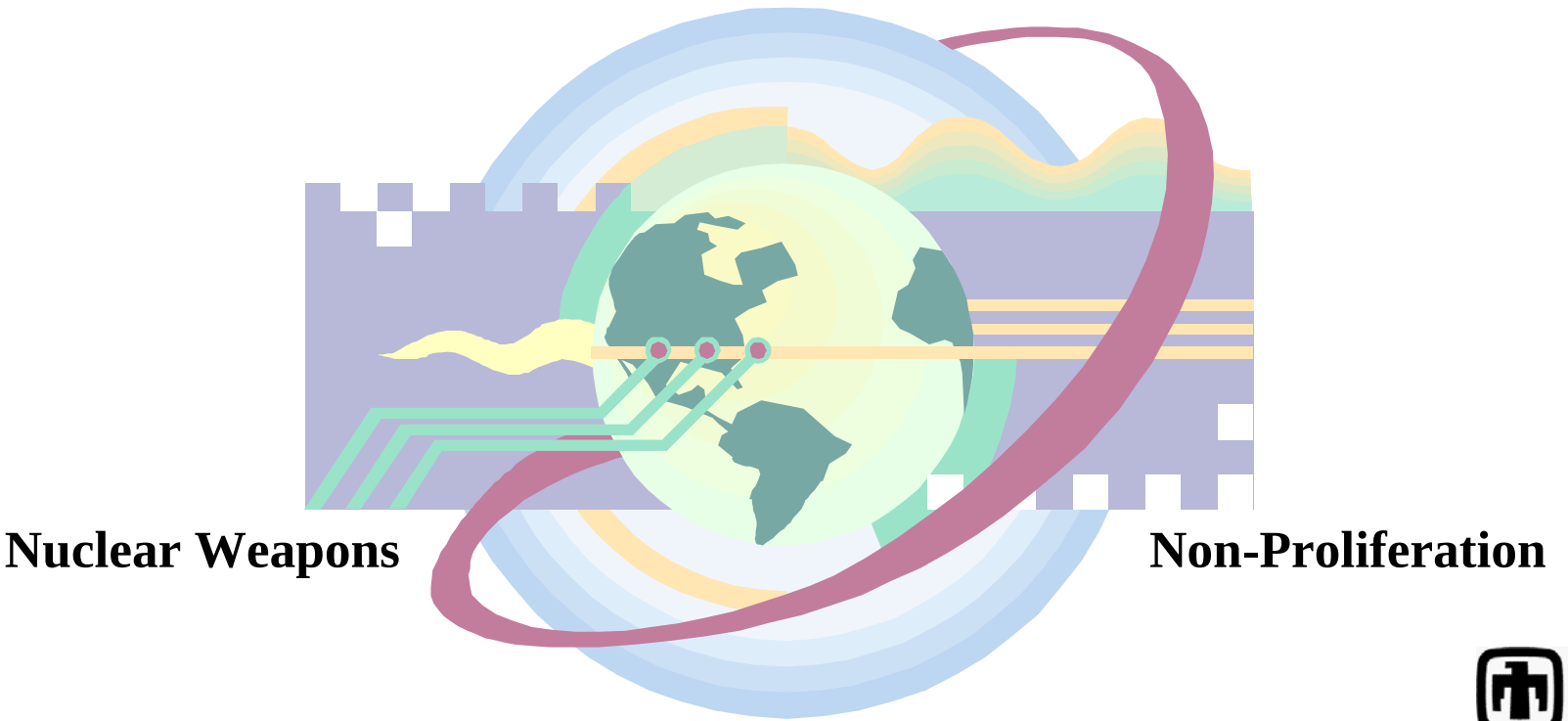
The Global Nuclear Futures (GNF) Initiative Now Unites 7 DOE Labs

GNF Vision:

The US has a unified policy for all aspects of nuclear weapons, energy, proliferation, and waste disposition and has re-established international leadership in nuclear policy and technology.



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Nuclear Energy Action Plan
A Technology Leap to Power for the 21st Century

In July 2002, six National Lab Directors wrote Secretary Abraham urging the DOE to implement a plan to develop nuclear energy and manage nuclear materials. The six Lab Action Plan sets three goals:

- **Goal #1: Reduce air pollution and global climate risk and improve energy security by meeting an increasing fraction of future US and world energy needs through safe and economic nuclear energy solutions.**

Demonstrate hydrogen production in an advanced reactor by 2010-2012

Provide incentives to encourage industry to order a new nuclear power plant by 2008

One pound of nuclear fuel = 250,000 gallons hydrogen equivalent

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Reduce Waste by 90%

- **Goal #2: Achieve a 90% reduction of reactor waste requiring repository disposal by 2050 by significantly reducing the amount of uranium, plutonium, and minor actinides in disposed waste.**

Construct a fast-spectrum reactor prototype by 2020 for electricity production and nuclear materials management

Construct pilot recycle and waste form facilities by 2010 to reduce waste

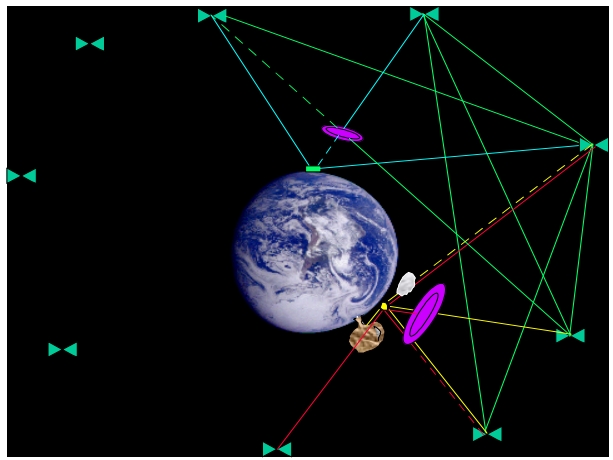
Reduce Proliferation Risk

- **Goal #3: While expanding the use of nuclear technology world wide, reduce the threat of nuclear weapons proliferation.**

Enable cradle-to-grave services through advanced materials management and very efficient exportable reactors

Demonstrate nuclear fuel recycle in an advanced reactor by 2020

Demonstrate a global nuclear materials management system by 2020



National Lab Directors Support a Strong U.S. Nuclear Energy Program

ARGONNE NATIONAL LABORATORY
INEEL
OAK RIDGE NATIONAL LABORATORY
Lawrence Livermore National Laboratory
Los Alamos
Sandia National Laboratories

Enabling A Global Nuclear Future

Energy is vital to human civilization. It underpins national security, economic prosperity, and global stability.

Accelerating growth in worldwide energy demands, coupled with increasingly stringent environmental constraints, requires significant use of nuclear energy now and well into the 21st century. To serve humanity, nuclear energy must be safe, proliferation-resistant, economically viable, abundant, clean, and reliable.

Now is the time to implement a comprehensive and integrated plan to further the development and deployment of nuclear energy and the management of nuclear materials that will meet these challenges. This plan will be an essential ingredient in enabling nuclear power to play its appropriate, significant role in the world's energy mix. This vision can be accomplished while at the same time diminishing the risks of nuclear weapons proliferation, nuclear terrorism, or adverse environmental and public health impacts.

A future is possible where the world can achieve global prosperity and stability. Nuclear energy is key to this future; the Department of Energy and its national scientific laboratories stand in a unique position to provide the leadership for implementing this vision.

Principles

- At the global level, energy security and national security are strongly linked. Energy supply impacts international relations, the environment, and global prosperity. Advanced nuclear systems can provide energy to significantly mitigate the impact of carbon energy sources on the environment and to enable important industrial processes (e.g., hydrogen production, water desalination).
- An integrated, comprehensive systems approach is essential to a global architecture that incorporates a diversity of reactor designs, fuel cycles, reprocessing, and waste management with appropriate safeguards and proliferation-resistant features.
- Multi-government cooperation and partnerships with industry, national laboratories, and universities are required.
- The US and Russia as the founders of the nuclear era have a special responsibility for nuclear materials management and nonproliferation. Advanced fuel cycle approaches and already separated weapons-capable nuclear materials can be secured and managed to reduce the dangers of nuclear proliferation.

Senators Craig and Domenici discussed these recommendations with Vice President Cheney

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President Bush Announces New Measures to Counter the Threat of Weapons of Mass Destruction—National Defense Univ., February 11, 2004

- **Key Points:**
  - **Proliferation Security Initiative (Interdiction of Illegal Trade)**
  - **Expand "Nunn-Lugar" to Other Parts of the World**
  - **Cradle-to-Grave Nuclear Supply Concept Implemented Between Receiving and Supplying Nations**
  - **Implement the IAEA's Additional Protocol**

Proliferation Resistance & Transparency Through Intelligent Fuel Cycles

Proliferation Resistance

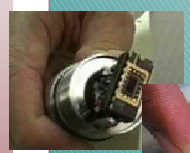
- **Advanced Manufacturing through SMART Process Controls**
  - **Fuel Fab**
  - **Reactors**
  - **Storage – Transport**
  - **Fast Reactors**
  - **Reprocessing**
  - **Repository**

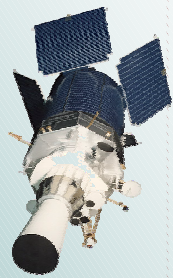
Enabling Technologies

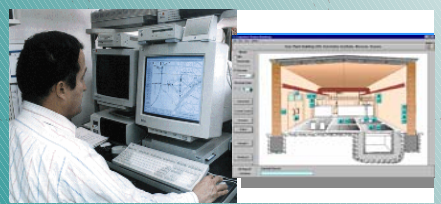
MESA
Microsystems and Engineering Sciences Applications

RMSEL
Robotic Manufacturing Science & Engineering Laboratory

CMC
Cooperative Monitoring Center







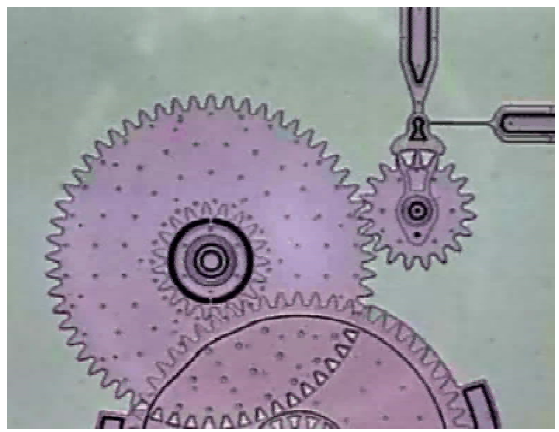
Systems Analysis and Integration

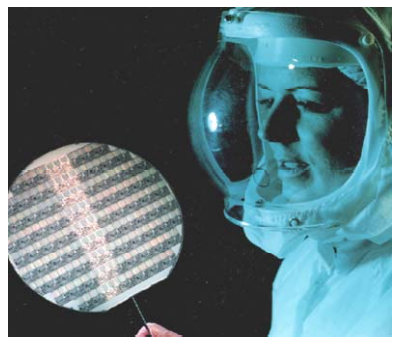
Transparency

- **Real-Time Interrogation**
  - **Redundant Sensors**
  - **Data Mining**
  - **Augmented Cognition**
  - **Knowledge Generation**
  - **Satellite Communication**
  - **Etc.**

Enabling Technology: Microsystems and Engineering Sciences Application (MESA) Complex

- The MESA Complex will accelerate the scientific investigation and application of integrated microsystem technologies.
- Integrated microsystems will be used to minimize the number of weapons components and fault points.
- Advanced energy systems can apply the same technology.
- The MESA Complex will be completed in 2008 and will house 648 researchers in 391,000 square feet of space.





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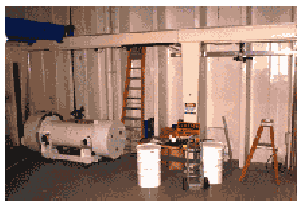
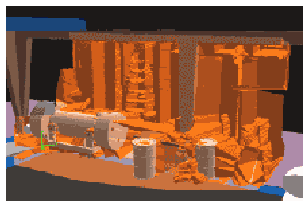
Enabling Technology: Robotic Manufacturing Science & Engineering Laboratory (RMSEL)

Sandia's Intelligent Systems and Robotics Center designs, develops, & delivers complex micro- to macro-sized automated systems to ensure the national security.

RMSEL

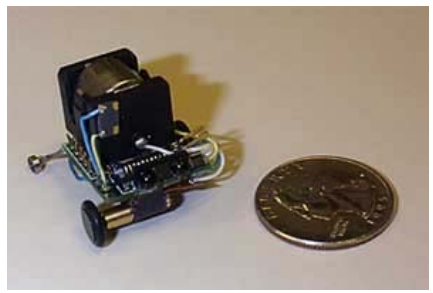
Large Complex Systems Analysis





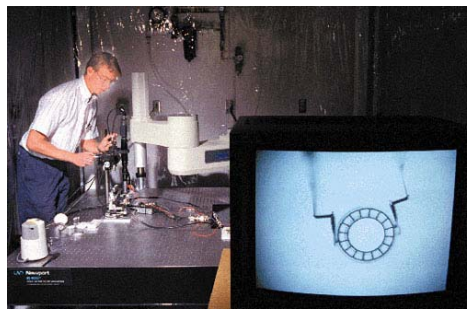
Rapid World Modeling
Solutions for site characterization, automated handling, waste cleanup, and other environmental problems

Collectives/Distributed Systems



Small Smart Machine
Hazard impact reduction in a variety of dangerous civil and military environments

TechWorks



Micro Assembly Laboratory
Technology for designing robotic workcells to assemble MEMS parts into tiny machines for use in weapons components & surveillance devices

Mechatronics

Automated Gas Generator Disassembly System (AGGDIS):
Dismantlement of nuclear weapons faster, safer

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Enabling Technology: Cooperative Monitoring Center

Technology integration, testing, demonstration, and operation

Technical collaborations and experiments

System analysis, modeling, and simulation for design and evaluation

The CMC Averages 100 Tours Per Year From 121 Countries

Visiting scholars program, research, and analysis

Technology training courses and workshops

procurement, export control, foreign travel/visits

International business infrastructure

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Suggested Action Plan

1) **Safety**

Charter the NRC, in cooperation with the international regulatory and scientific community, to develop standards for licensing a new generation of nuclear power plants.

2) **Proliferation Control**

Work with the IAEA and other countries to implement advanced-technology safeguards and to develop policy regimes against the diversion of materials.

3) **Waste Management**

Investigate and deploy domestic and/or international technologies to reduce the volume and risks associated with fuel and high-level waste destined for Yucca Mountain.

4) **Investment Economics**

Create tax incentives or loan guarantees to ensure short-term, corporate market forces alone don't shape our energy future by defaulting to fossil fuels.

Effective International Collaboration Is Essential to a Robust Global Nuclear Future

Global Goal:

- Provide a basis for world peace and prosperity
- Reduce tension over access to finite resources
- Improve developing world health and well being
- International participation in converting “swords to plowshares”
- Proliferation resistance through partnerships and transparency

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