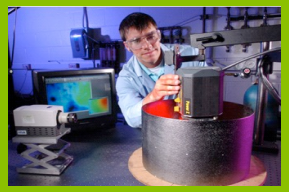
OVERARCHING TECHNICAL ISSUES:

NATIONAL LABORATORY PERSPECTIVE



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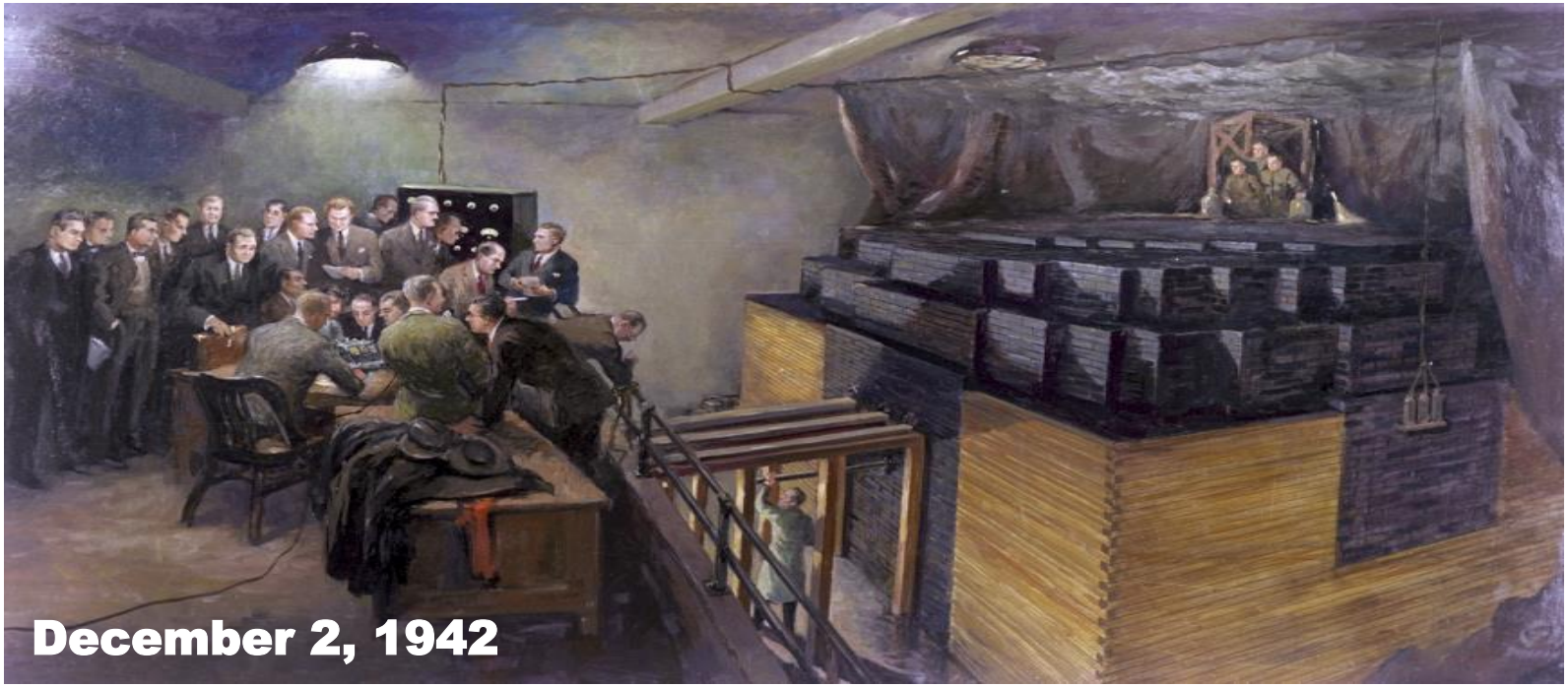
Argonne National Laboratory

Advanced Reactor Technical Summit IV
February 8, 2017
Argonne National Laboratory

THE ORIGIN OF NUCLEAR ENERGY



Dec. 2 this year will be the 75th anniversary of CP-1

Chicago in late Jan. 2014 (First USNIC AR Summit)

CONTEXT FOR TECHNICAL ISSUES

- **Nuclear energy already a major energy source**
  - Excellent record of safety and reliability
  - Great potential to meet energy needs for many millennia
- **Its use is expanding in developing economies needing clean, secure energy sources**
  - Affordability and access to financing are key
  - National competencies require time and investment
- **Economics challenged in deregulated markets by less capital-intensive and/or subsidized alternatives**

➔ **Competitive economics a key goal for technology advances**

KEY 21ST CENTURY DEVELOPMENTS FOR ADVANCED REACTOR TECHNOLOGY

- **U.S. led Generation IV initiative provided a vision and identity**
  - Articulated technology goals for future systems
  - Identified technologies and R&D pathways to meet these goals

System	Neutron spectrum	Coolant	Outlet coolant Temp. °C	Fuel cycle	Size (MWe)
VHTR (Very high temperature reactor)	thermal	helium	900-1 000	open	250-300
SFR (Sodium-cooled fast reactor)	fast	sodium	550	closed	30-150, 300-1 500, 1 000-2 000
SCWR (Supercritical water cooled reactor)	thermal/fast	water	510-625	open/closed	300-700 1 000-1 500
GFR (Gas-cooled fast reactor)	fast	helium	850	closed	1200
LFR (Lead-cooled fast reactor)	fast	lead	480-800	closed	20-180, 300-1 200, 600-1 000
MSR (Molten salt reactor)	Epithermal/fast	fluoride salts	700-800	closed	1 000

GEN IV TECHNOLOGY GOALS

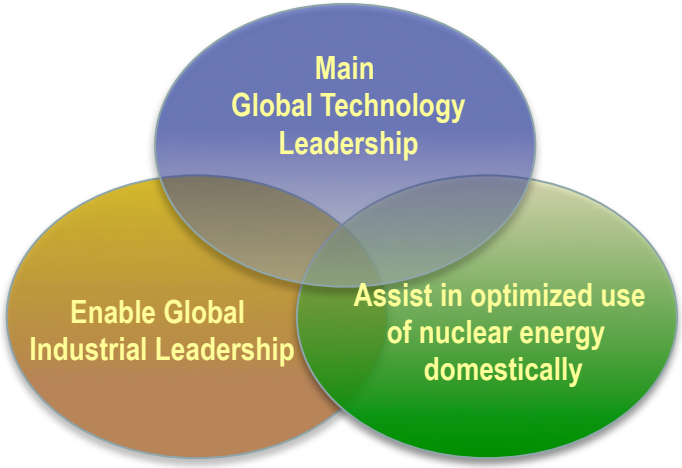
Economics	▪ Clear life-cycle cost advantage over other energy sources ▪ Level of financial risk comparable to other energy projects
Safety & Reliability	▪ Excellence in safety and reliability ▪ Low likelihood and degree of reactor core damage ▪ Eliminate the need for offsite emergency response
Sustainability	▪ Long-term availability of systems and effective utilization of fuel resources ▪ Minimize and manage nuclear waste and notably reduce the stewardship burden in the future
Proliferation Resistance & Physical Protection	▪ Very unattractive route for diversion or theft of weapons-usable materials; increased physical protection

KEY 21ST CENTURY DEVELOPMENTS FOR ADVANCED REACTORS, CONT'D

- **DOE R&D investment helped revitalize the national R&D infrastructure**
- **Major technology demonstrations initiated but not sustained**
  - via GNEP and the NGNP project
  - Based on comparatively mature SFR and HTGR systems
- **Recent surge of interest from entrepreneurial firms and investors in the potential of advanced non-LWR systems**
  - Extending beyond SFR and HTGR, to MSR, GFR, and LFR
  - Range of TRL and variety of markets/applications
  - DOE awards for Xe-100 (PB-HTR) and MCFR (MSR) development
- **GAIN launched to accelerate the commercial deployment of innovative nuclear technologies**
  - In response to market needs/opportunities and supporting industry initiatives

GAIN
Gateway for Accelerated Innovation in Nuclear

INL Idaho National Laboratory
Oak Ridge National Laboratory
Argonne National Laboratory



DOE Laboratories

Develop and test innovative technologies and methods/tools

Develop RD&D infrastructure and expand knowledge base

Facilitate access by industry to RD&D facilities and expertise

Vendors/Suppliers

Provide commercial nuclear energy products and services

Develop proprietary nuclear technologies and methods/ tools

Utilities

Deploy and utilize technology in commercial operation

Specify user requirements on new systems & technologies
- Performance, safety, economic
- Market and public acceptance

Inform requirements on technology advances and RD&D infrastructure

Develop and demonstrate technology for commercial use

Address safety and security goals for US and foreign deployment

Advance technology-inclusive, risk informed licensing framework with NRC

Secure licensing approval for design, construction and operation

Validate benefits of new technology, provide feedback to technology developers and suppliers

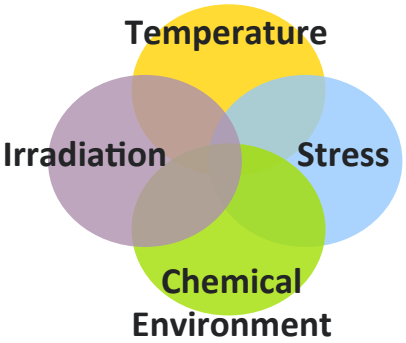
THIS PANEL, IN 2 PARTS:
THE PROMISE OF TECHNICAL ADVANCES

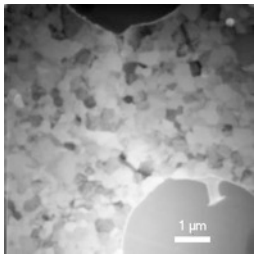
For meeting key goals in nuclear energy development and use

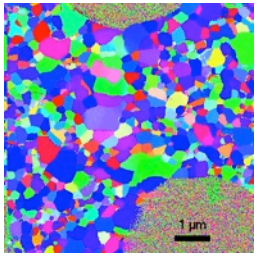
- **Competitive economics**
- **Enhanced safety and security**
- Spent fuel management and waste minimization
- Facilitate safeguards against proliferation

THIS PANEL:
KEY AREAS OF ADVANCEMENT

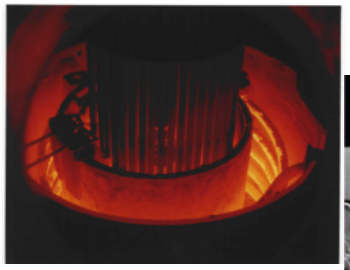
- **Reactor Materials**
  - Target increased resistance to damage from demanding service conditions, over longer operating times
  - Great potential to reduce cost and expand safe operating range

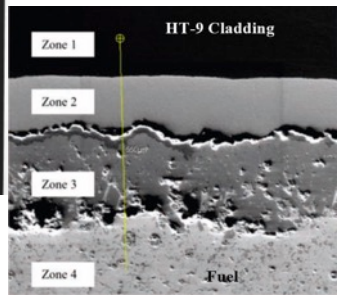






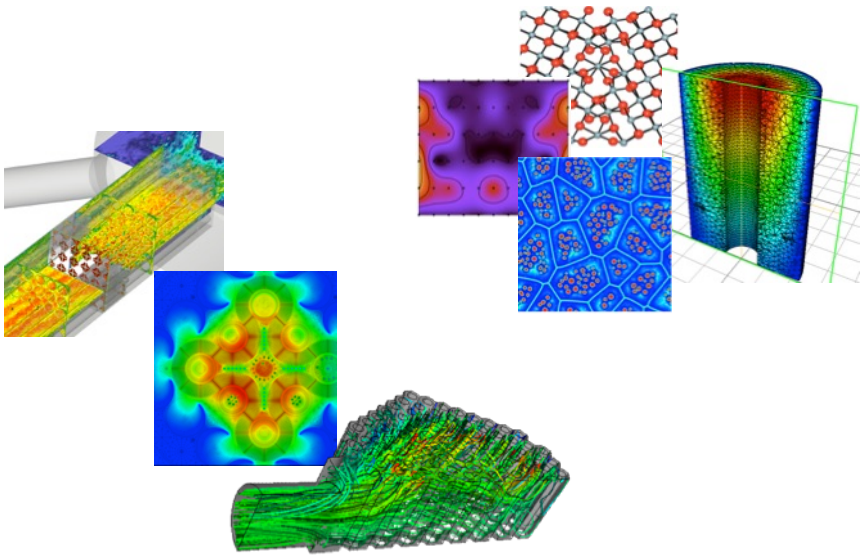
- **Nuclear Fuels**
  - Key to performance, confinement, safety, radioactive waste
  - Target increased reliability & operational flexibility, reduced fuel cycle cost, and more efficient resource use





KEY AREAS OF ADVANCEMENT, CONT'D

- **Computational modeling & simulation (with validation)**
  - Improve prediction of reactor behavior and performance
  - Uncertainty reduction enables improved design
  - Limit and better optimize costly integral experiments



- **Instrumentation, information and control systems**
  - Improve knowledge and communication of plant conditions
  - Support improvement of operation & maintenance
  - Advance performance, safety and economic goals

KEY AREAS OF ADVANCEMENT, CONT'D

- **Safety and Security**
  - Target reduction of risk from internal and external threats
  - Further enhance protection of public, environment, and plant investment
  - Advances may increase societal and market acceptance