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Interest in Supercritical CO_2 Power Cycles for Nuclear Energy Applications

4th International Symposium on sCO_2 Power Cycles

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Outline

- Nuclear energy “scene setter”
- Potential nuclear applications for sCO_2 power cycles
- Office of Nuclear Energy R&D on sCO_2
- Challenges to commercial deployment
- Path Forward
- Summary

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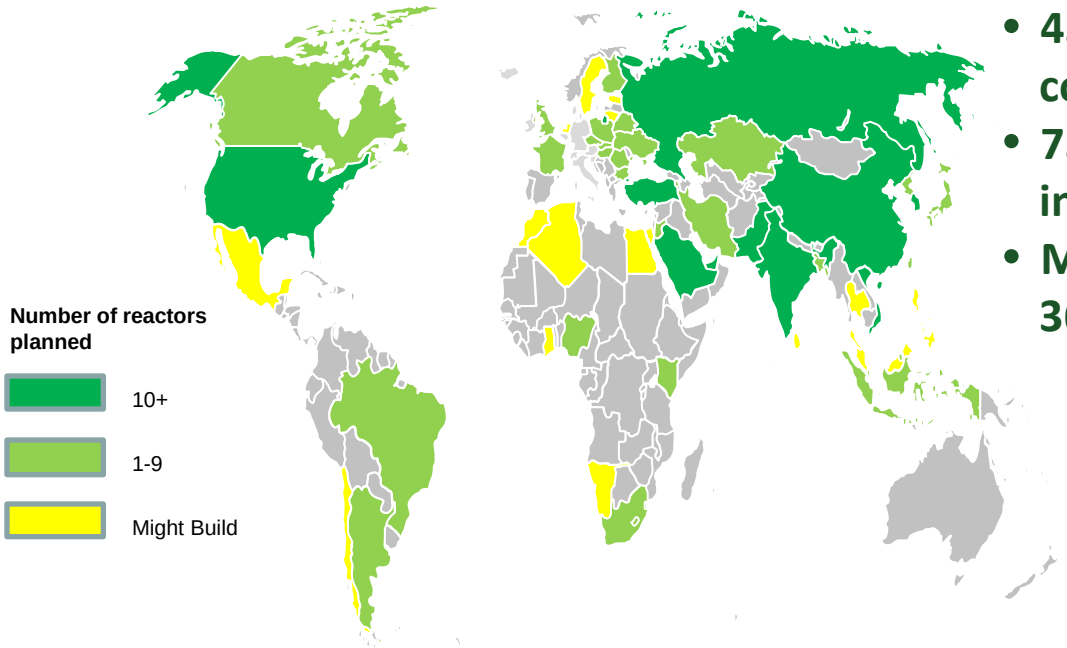
Global Nuclear Projections



- 434 nuclear reactors are operable in 31 countries
- 73 reactors currently under construction in 14 countries
- More than 300 reactors are proposed in 36 countries over the next 15 years

--- ***World Nuclear Association as of June 1, 2014***

I'm announcing a new national climate action plan…
….We're building the first nuclear power plants in more than three decades…
…A low-carbon, clean energy economy can be an engine of growth for decades to come. And I want America to build that engine.

Georgetown University - June 25, 2013

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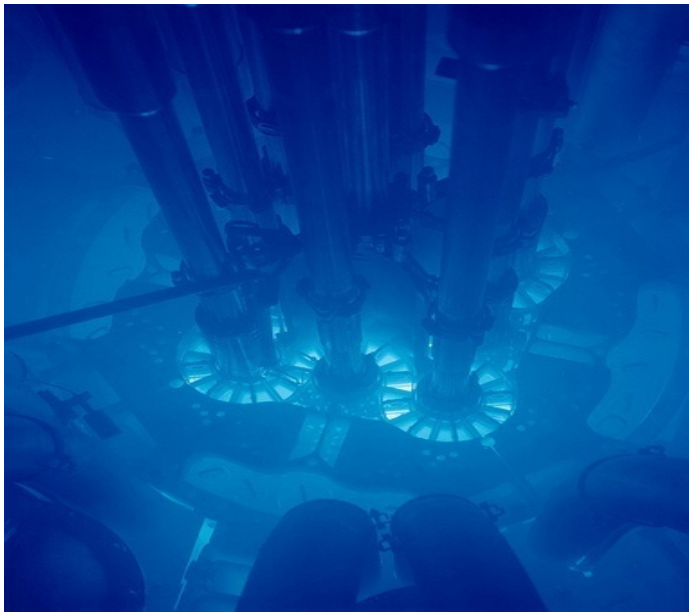
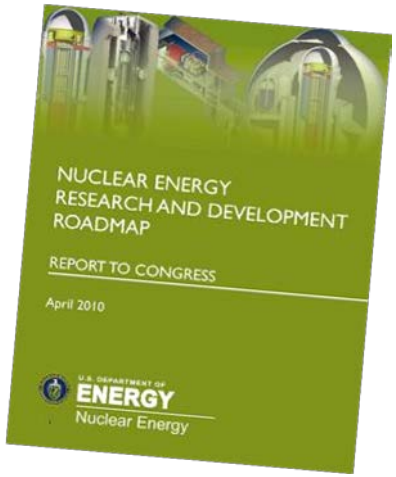
Office of Nuclear Energy (NE) Mission



- **The primary mission of NE is to advance nuclear power as a resource capable of making major contributions in meeting the Nation's energy supply, environmental, and energy security needs by resolving technical, cost, safety, security and regulatory issues, through research, development, and demonstration.**

- **Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals**



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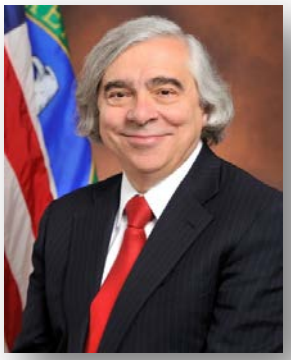
Potential Nuclear Applications for sCO_2

- **Advanced Reactor Designs (Temperature Range 350 – 800^{0}C $^+$)**
  - Sodium Fast Reactors, High Temperature Reactors (gas, molten salts)
- **Small Modular Reactors (compact configurations, dry cooling)**
- **Light Water Reactors**
- **Space power and propulsion**



"I believe small modular reactors could represent the next generation of nuclear energy technology, providing a strong opportunity for America to lead this emerging global industry."

-- Secretary of Energy, Dr. Ernest Moniz

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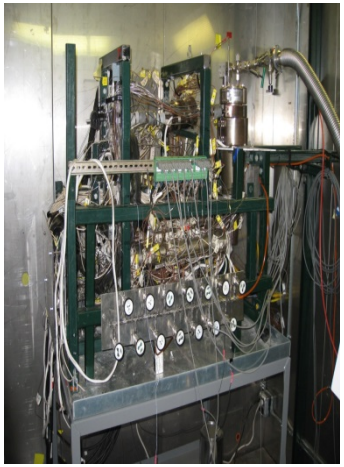
Current Activities to Develop sCO_2

- **Recompression Closed Brayton Cycle Test Article at Sandia National Laboratories (since early 2010)**
- **Component development and testing**
  - Compact Heat Exchanger, plugging, chemical interaction
- **Dynamic plant modeling and validation**
- **Analytical studies (performance, cost, system integration)**
- **Stakeholder engagement and workshops**
- **Proposed Supercritical Transformational Electric Power Generation (STEP) Initiative**



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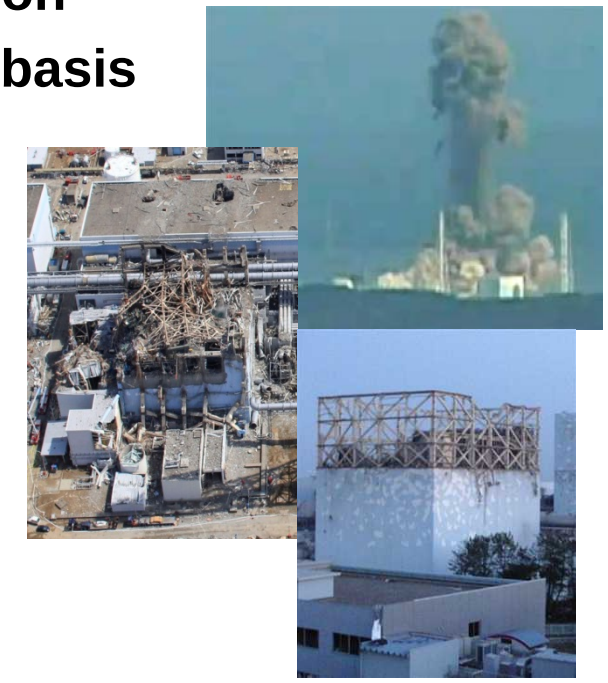
Challenges

- Highly regulated industry with significant public interest
- Plant owners are somewhat “conservative” with respect to emerging/innovative technologies
- Need to demonstrate performance, cost, operability, reliability
- Material performance and code qualification
- System interaction can not impact safety basis (normal/transient conditions)



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International Cooperation

- DOE has long recognized the importance of international collaborations
- International organizations such as Generation IV International Forum (GIF) leverage our investments
  - Working with CEA (France), JAEA (Japan) and KAERI (Republic of Korea) on sCO_2 Brayton cycle development for SFRs under GIF

- Papers on sCO_2 Brayton cycle development for SFRs and other advanced nuclear power reactors
  - France – Dube et. al., #16
  - Japan – Muto et. al., # 50
  - Republic of Korea – Park et. al., # 49, 50, 51
  - U.S. – Sienicki et. al., # 69, Moisseytsev et. al., # 44, 45

GIF Policy Group
November 2012

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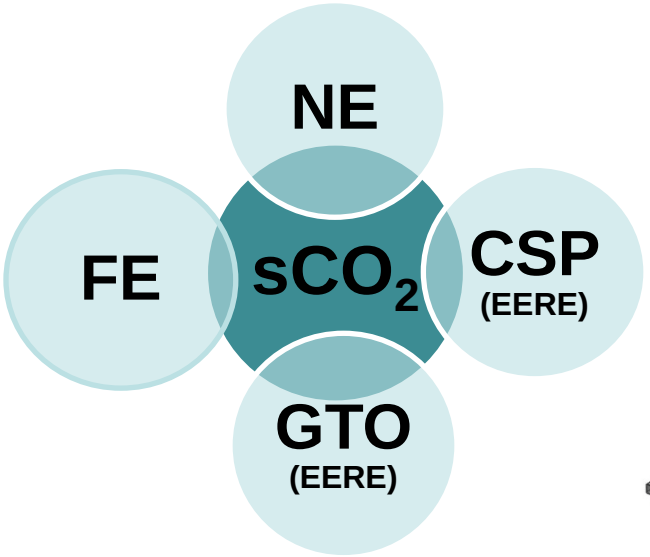
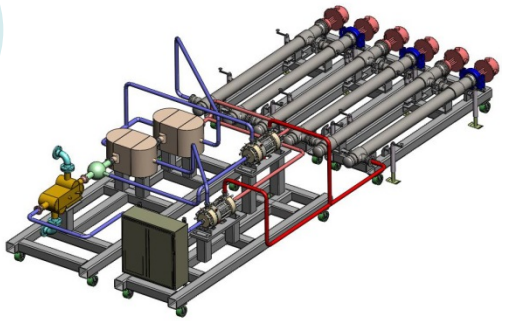
Path Forward

- Continue Office of Nuclear Energy base R&D program
- Work across DOE to integrate/coordinate related efforts in Fossil Energy and Energy Efficiency/Renewable Energy
- Continue stakeholder engagement and establish an effective partnership with industry





Prototype Sodium/CO_2 PCHE

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Summary

- The potential benefits of sCO2 Brayton Cycle for nuclear power applications have been explored for over a decade
- There are technical as well as non-technical challenges
- Private sector engagement and involvement is essential
- This technology offers an opportunity to dramatically change the energy landscape
- Successful development and adoption would help to meet U.S. clean energy goals