Generation IV International Forum

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Genesis of Generation IV Concept

- **In 1999, low public and political support for nuclear energy**
  - Oil and gas prices were low
- **USA proposed a bold initiative in 2000**
  - The vision was to leapfrog LWR technology and collaborate with international partners to share R&D on advanced nuclear systems
  - 9 Countries and EU joined USA in developing the initiative
  - Oil prices jumped soon thereafter
- **Gen IV concept defined via technology goals and legal framework**
  - Technology Roadmap released in 2002
    - 2 year study with more than100 experts worldwide
    - Nearly 100 reactor designs evaluated and down selected to 6 most promising concepts
  - First signatures collected on Framework Agreement in 2005; first research projects defined in 2006

"This may have been the first time that the world came together to decide on a fission technology to develop together."
William Magwood IV, First Chairman of the Generation IV International Forum

Generation IV Goals

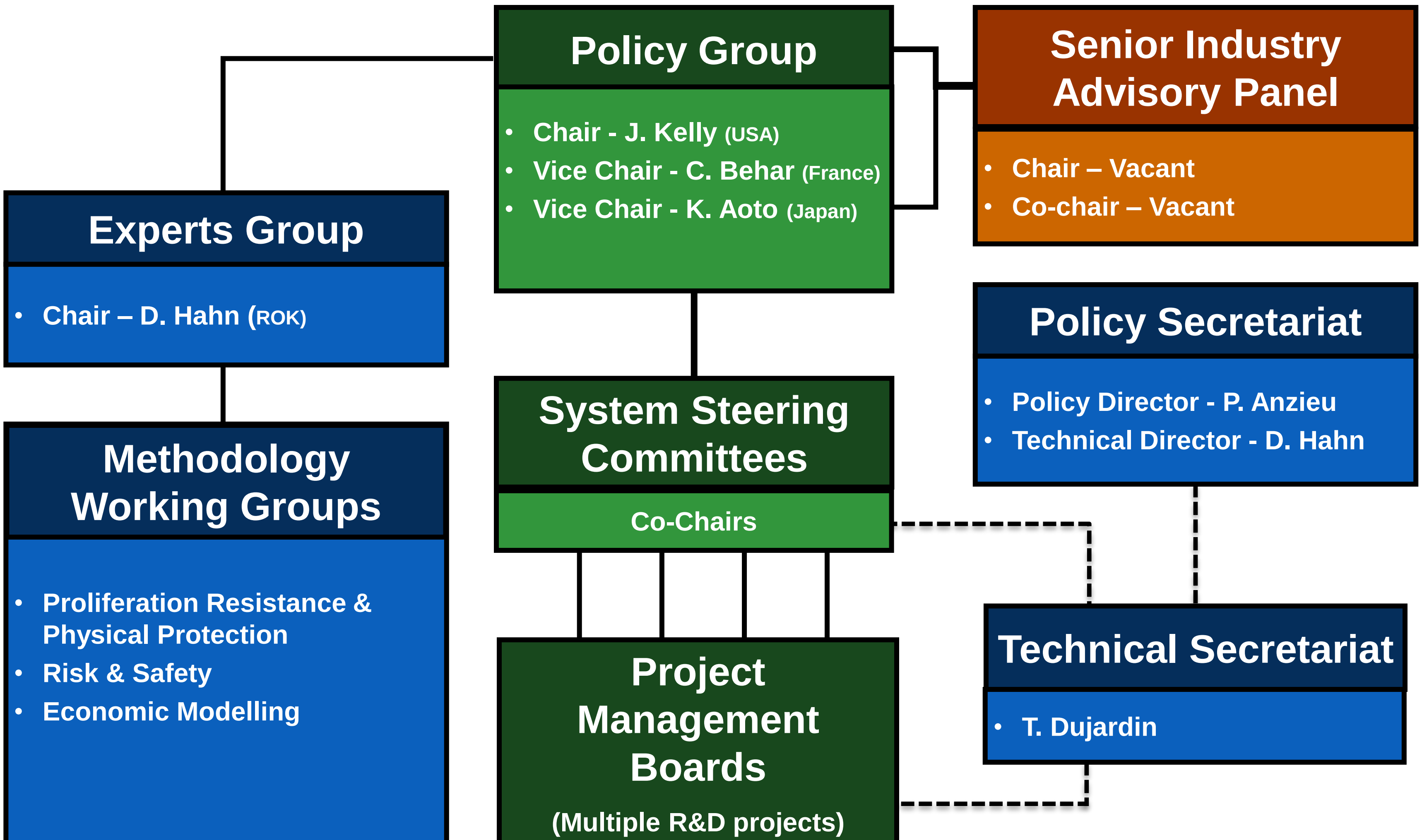
- **Sustainability**
  - Long term fuel supply
  - Minimize waste and long term stewardship burden
- **Safety & Reliability**
  - Very low likelihood and degree of core damage
  - Eliminate need for offsite emergency response
- **Economics**
  - Life cycle cost advantage over other energy sources
  - Financial risk comparable to other energy projects
- **Proliferation Resistance & Physical Protection**
  - Unattractive materials diversion pathway
  - Enhanced physical protection against terrorism

Thirteen Current Members of Generation IV

Argentina*	Republic of Korea
Brazil*	Russian Federation
Canada	Republic of South Africa
People's Republic of China	Switzerland
Euratom	United Kingdom*
France	United States
Japan	

*Non-active member

Generation IV Organization



Chairs as of January 2014

Methodology Working Groups

Methodology Working Groups

Proliferation Resistance & Physical Protection

- Co - Chair – R. Bari (USA)
- Co - Chair – J. Whitlock (Canada)

Risk & Safety

- Chair – R. Nakai (Japan)

Economic Modelling

- Acting Chair – R. Sadhankar (Canada)

Chairs as of March 2014

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System Steering Committees

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Sodium-Cooled Fast Reactor

- Chair – P. Dufour (France)
- Co-Chair – R. Hill (USA)
- Co-Chair – H. Kamide (Japan)

Supercritical-Water Cooled Reactor

- Chair – T. Schulenberg (EURATOM)
- Co-Chair – H. Matsui (Japan)

Lead Fast Reactor

- Chair – A. Alemberti (EURATOM)

Molten Salt Reactor

- Chair – J. Serp (France)

Gas-Cooled Fast Reactor

- Chair – R. Stainsby (EURATOM)

Very High Temperature Reactor

- Chair – F. Li (China)
- Co-Chair – C. Sink (USA))

Chairs as of January 2014

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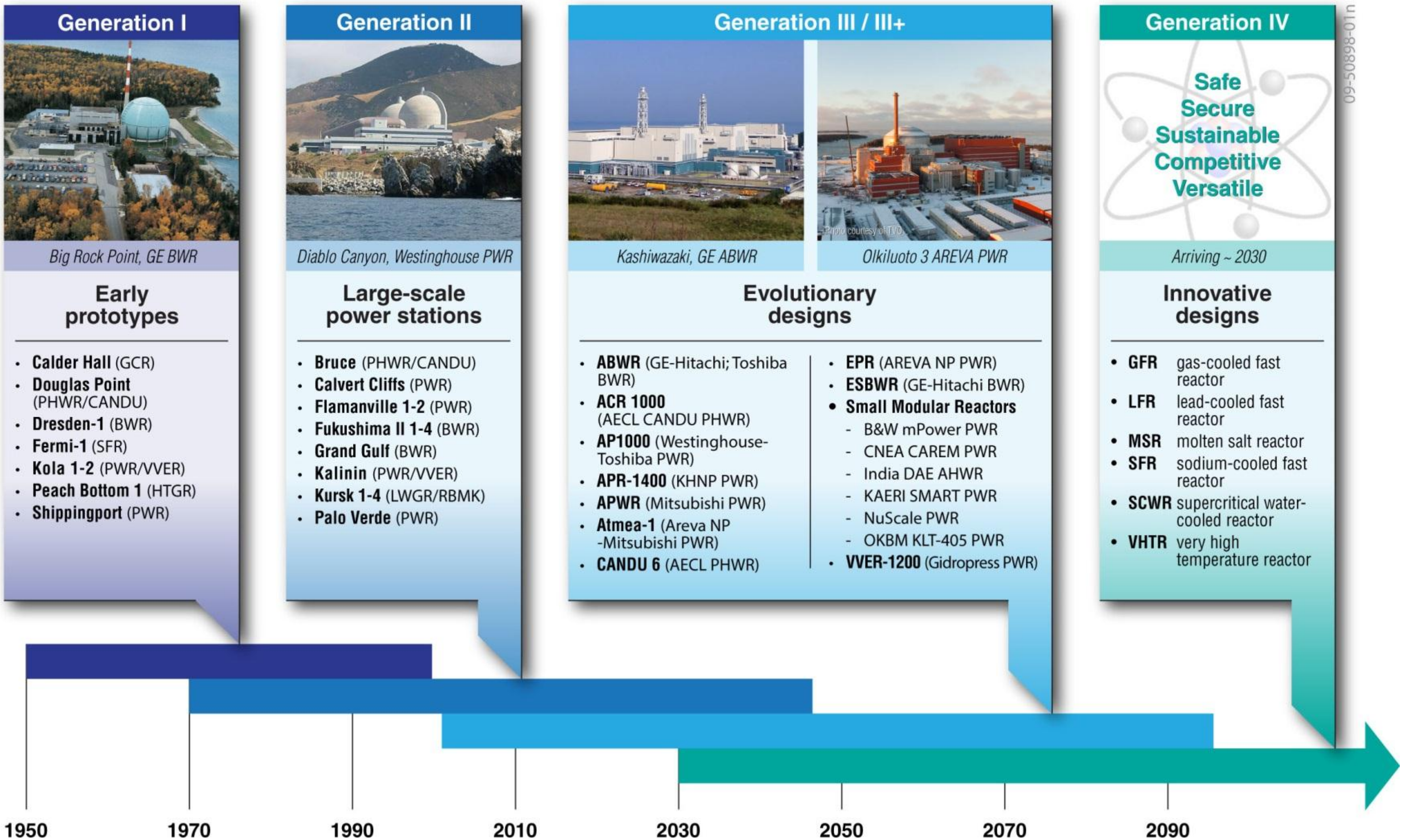
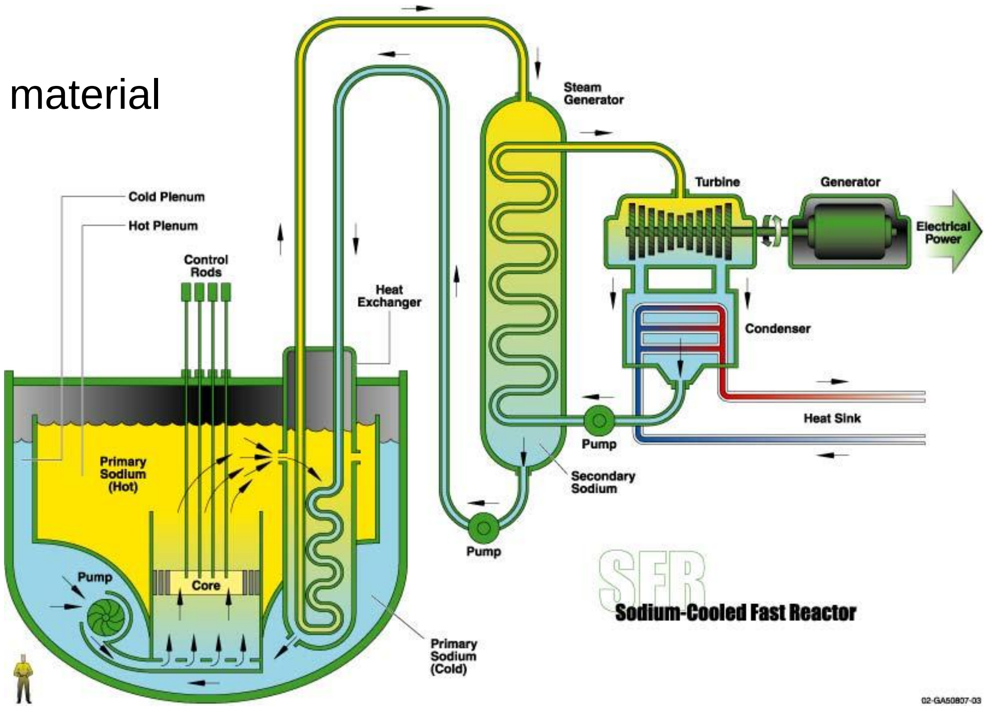
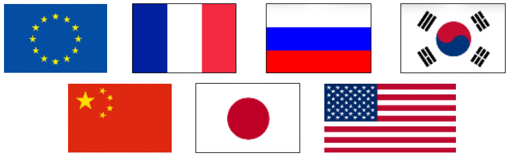


Sodium Fast Reactor

- **Integral part of the closed fuel cycle**
  - Can either burn actinides or breed fissile material
- **Designs being developed**
  - ASTRID (France)
  - JSFR (Japan)
  - PGSFR (Korea)
  - BN-1200 (Russia)
- **BN-800 (Russia)**
  - 2014 - Start-up expected
  - 2015 - Fully operational
- **R&D focus**
  - Analyses and experiments that demonstrate safety approaches
  - High burn-up minor actinide bearing fuels
  - Develop advanced components and energy conversion systems

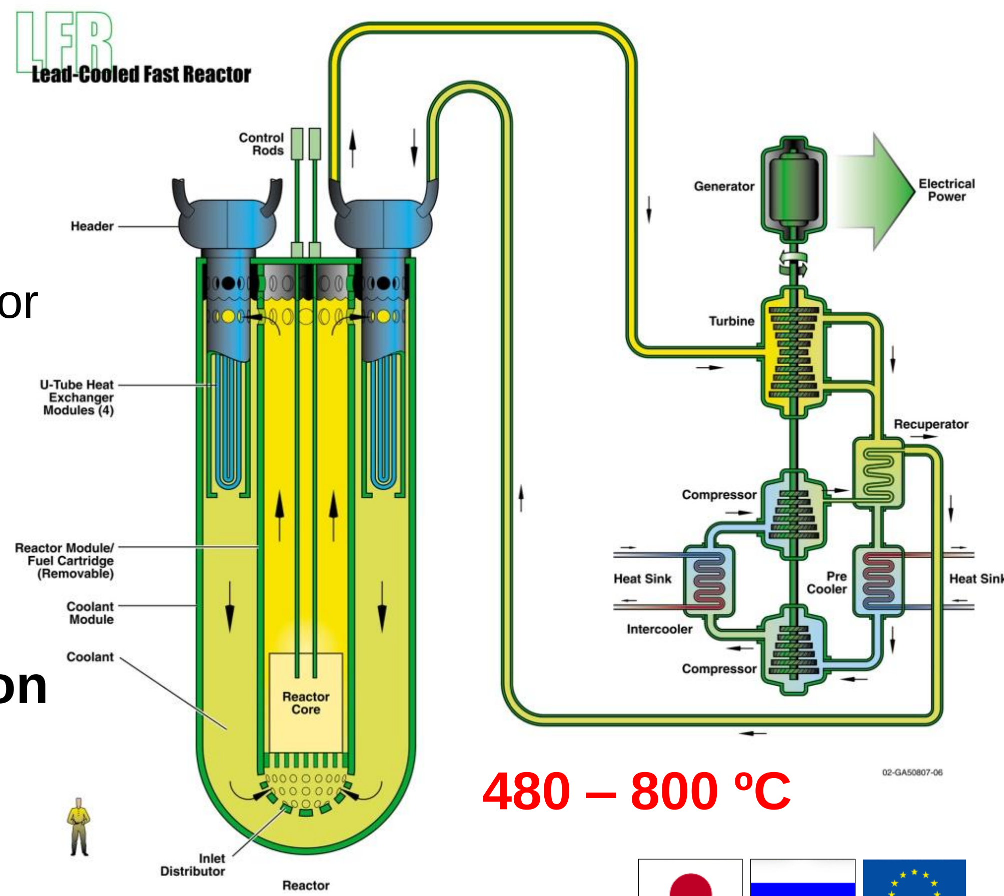


500 - 550 ºC



Lead Fast Reactor

- **Lead is not chemically reactive with air or water and has lower coolant void reactivity**
- **Three design thrusts:**
  - European Lead Cooled Fast Reactor (Large, central station)
  - Russian BREST-OD-300 (Medium size)
  - SSTAR (Small Transportable Reactor)
- **R&D focus on materials corrosion and safety**

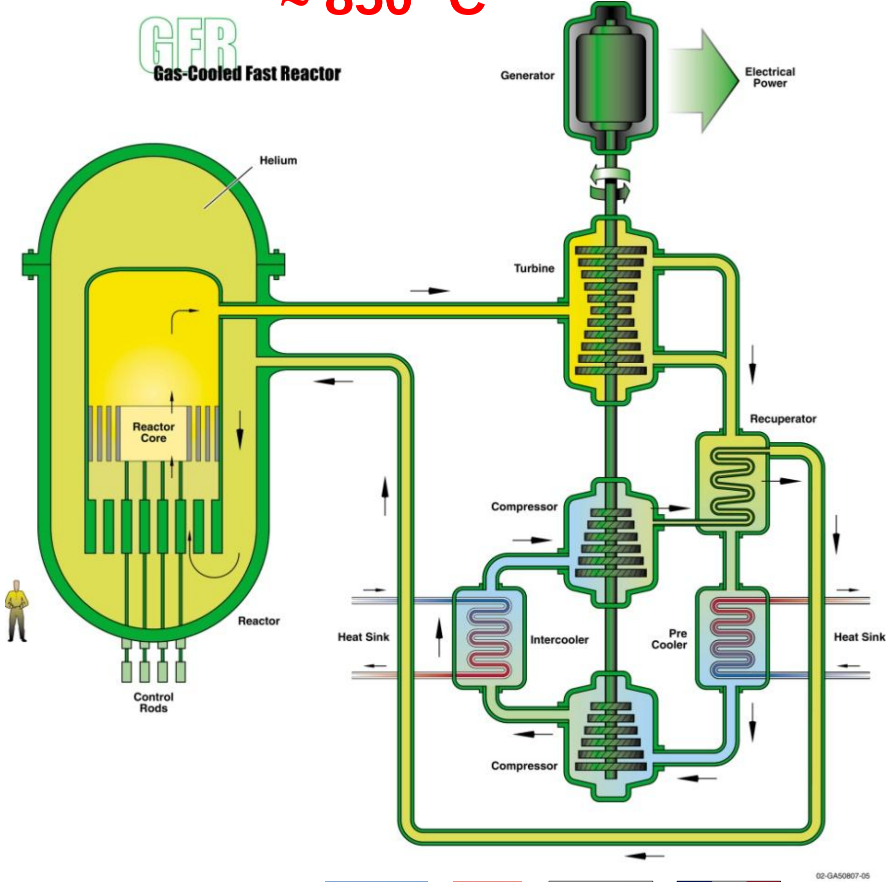


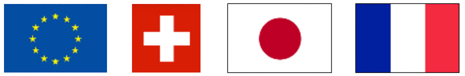
480 – 800 ºC

Gas-cooled Fast Reactor

- **High temperature, inert coolant and fast neutrons for a closed fuel cycle**
  - Fast spectrum enables extension of uranium resources and waste minimization
  - High temperature enables non-electric applications
  - Non-reactive coolant eliminates material corrosion
- **Very advanced system**
  - Requires advanced materials and fuels
- **Key technical focus:**
  - SiC clad carbide fuel
  - High temperature components and materials

~ 850 ºC





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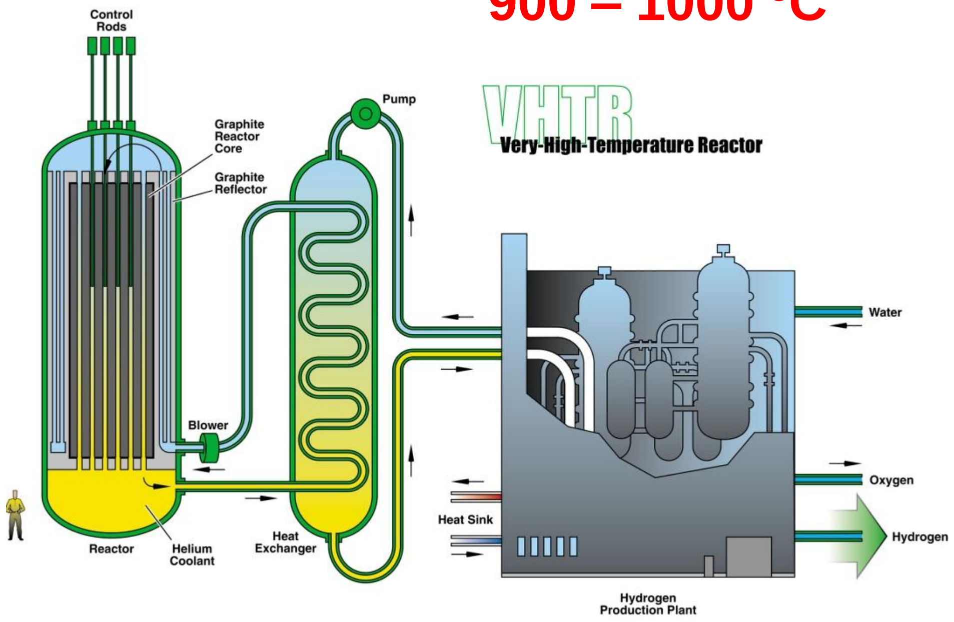
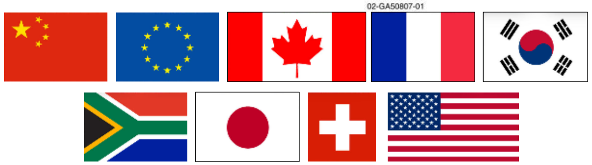
Very High Temperature Reactor

- **High temperature enables non-electric applications**
- **Goal - reach outlet temperature of 1000ºC, with near term focus on 700-950˚ C**
- **Reference configurations are the prismatic and the pebble bed**
  - Designed to be “walk away safe”
- **R&D focus on materials and fuels**
  - Develop a worldwide materials handbook
  - Benchmarking of computer models
  - Shared irradiations
    - Confirmed excellent performance of UO_2 TRISO
- **Japan HTTR in operation**
- **China HTR-PM demonstration plant under construction**

900 – 1000 ºC

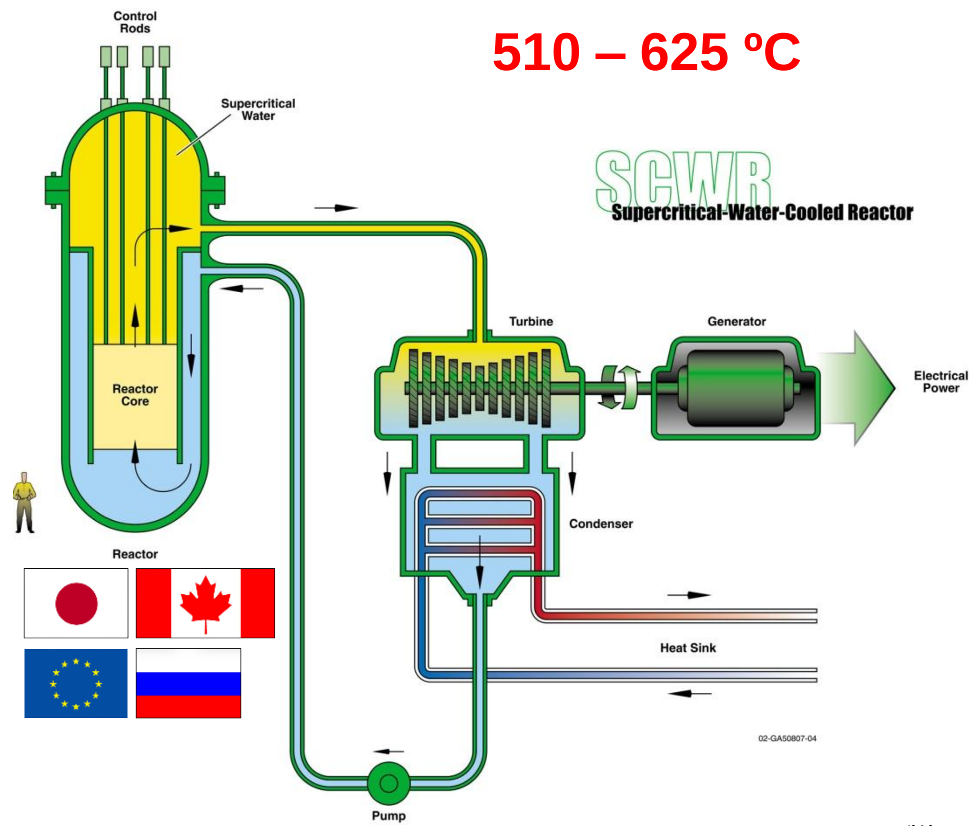




Supercritical Water-Cooled Reactor

- **Merges GEN-III+ reactor technology with advanced supercritical water technology used in coal plants**
- **Operates above the thermodynamic critical point (374° C, 22.1 MPa) of water**
- **Fast and thermal spectrum options**
- **Key technology focus:**
  - Materials, water chemistry, and radiolysis
  - Thermal hydraulics and safety to address gaps in SCWR heat transfer and critical flow databases
  - Fuel qualification

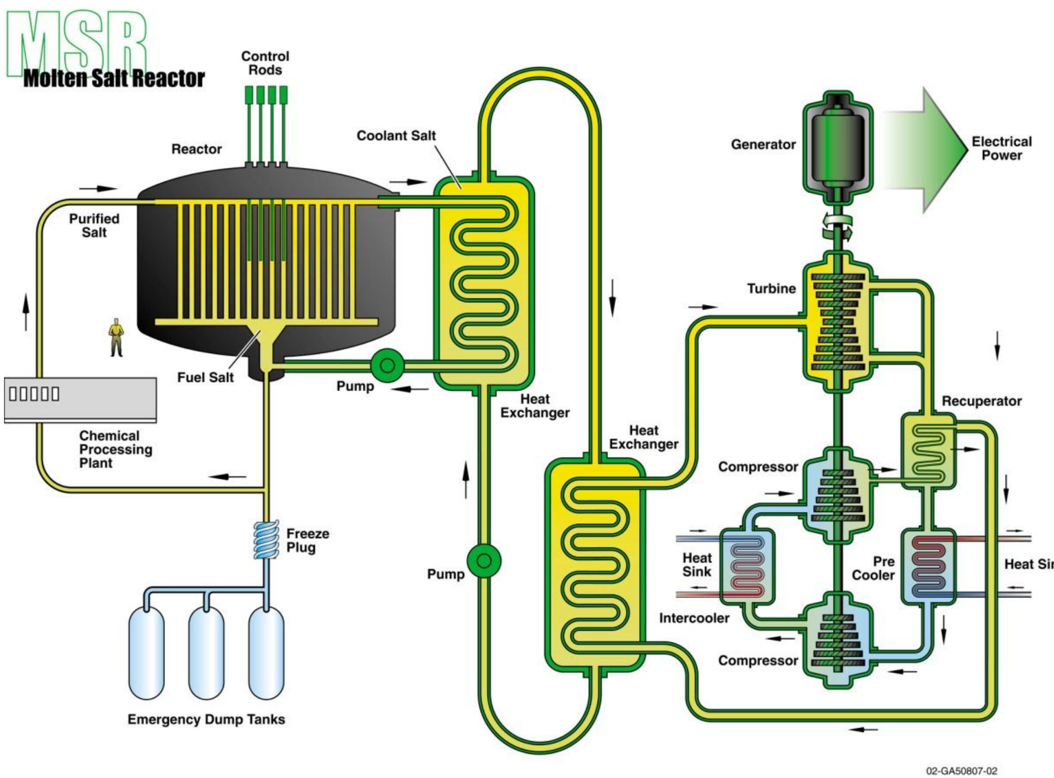
510 – 625 ºC

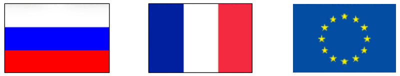


Molten Salt Reactor

- **High temperature system**
  - High temperature enables non-electric applications
- **On-line waste management**
- **Design Options**
  - Solid fuel with molten salt coolant
  - Fuel dissolved in molten salt coolant
- **Key technical focus**
  - Neutronics
  - Materials and components
  - Safety and safety systems
  - Liquid salt chemistry and properties
  - Salt processing

700 – 800 ºC





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Generation IV system development in the period through 2013

Generation IV Systems	Canada	China	France	Japan	Korea	Russia	South Africa	Switzer-land	USA	EU
Sodium-cooled Fast Reactor (SFR)		●	●	●	●	●			●	●
Very-high Temperature Gas-cooled Reactor (VHTR)	●	●	●	●	●		●	●	●	●
Gas-cooled Fast Reactor (GFR)			●	●				●		●
Supercritical-water cooled Reactor (SCWR)	●			●		●				●
Lead-cooled Fast Reactor (LFR)				●		●				●
Molten Salt Reactor (MSR)			●			●				●

● Participating member, signatory of a System Arrangement or a Project Arrangement at some point during the period. This table does not necessarily reflect the status of participation as of 1 January 2014.

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Future of Generation IV

- **Over the last decade Gen IV has had major accomplishments**
  - Legal framework established for collaboration
  - Collaborative projects started with significant R&D investment worldwide
  - Prototype demonstrations are being designed and/or built
    - SFR (France and Russia)
    - VHTR (China)
- **Much still needs to be done before Gen IV systems are a reality**
  - Continue R&D on Gen IV systems
  - Develop advance research facilities
  - Engage industry on the design of Gen IV systems
  - Develop the workforce for the future

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