



GIF R&D Outlook for Generation IV Nuclear Energy Systems: 2018 Update

Made by Alexander Stanculescu

Presented by Gilles Rodriguez

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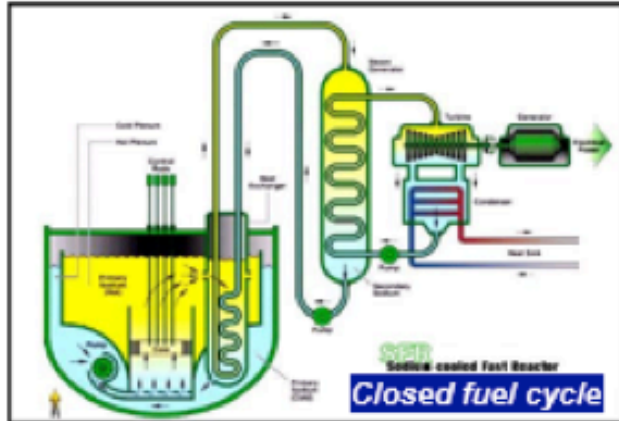
Preparing the Future through
Innovative Nuclear Technology:
Outlook for
Generation IV Technologies



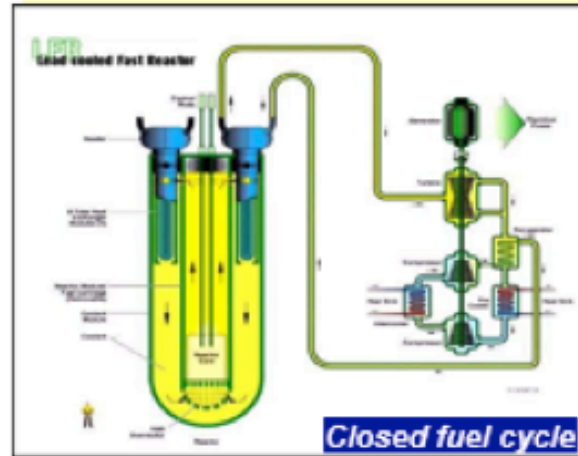
High Level Summary of the

GEN IV R&D Outlook for Generation IV Nuclear Energy Systems: 2018 Update

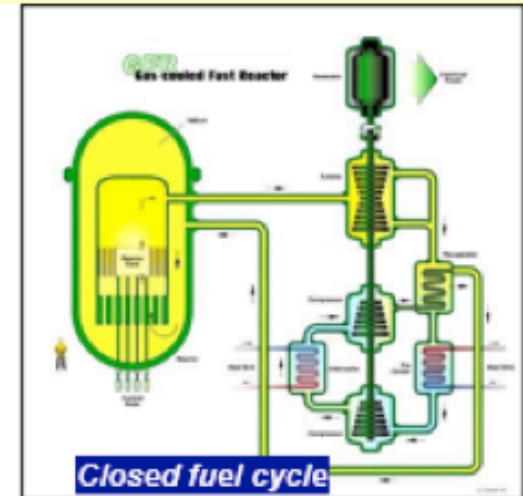
GIF Nuclear Energy Systems



Sodium Fast Reactor

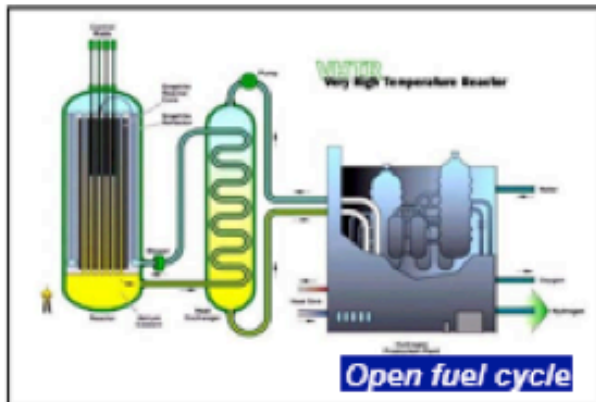


Lead Fast Reactor

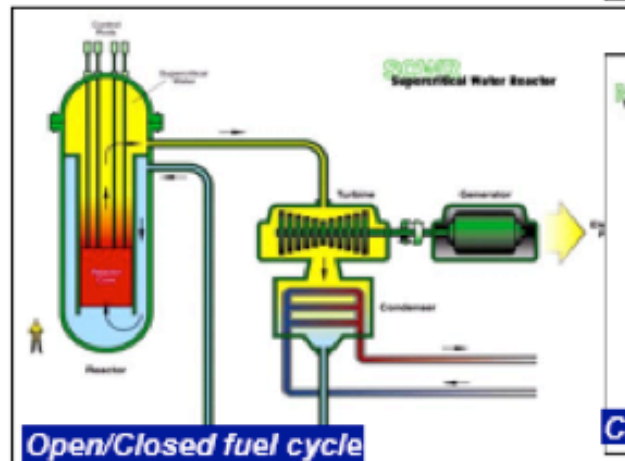


Closed fuel cycle

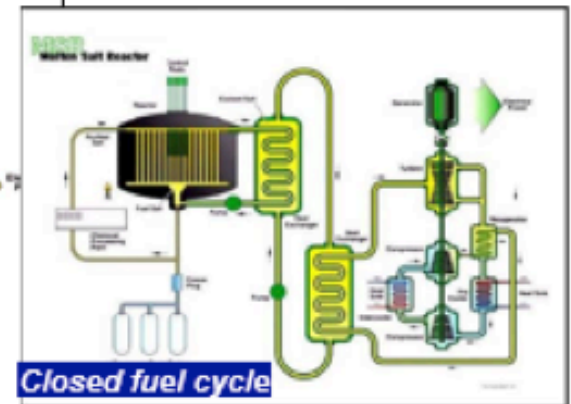
Gas Fast Reactor



Very High Temperature Reactor (thermal spectrum)



Super Critical Water Reactor (only thermal concept in GIF)



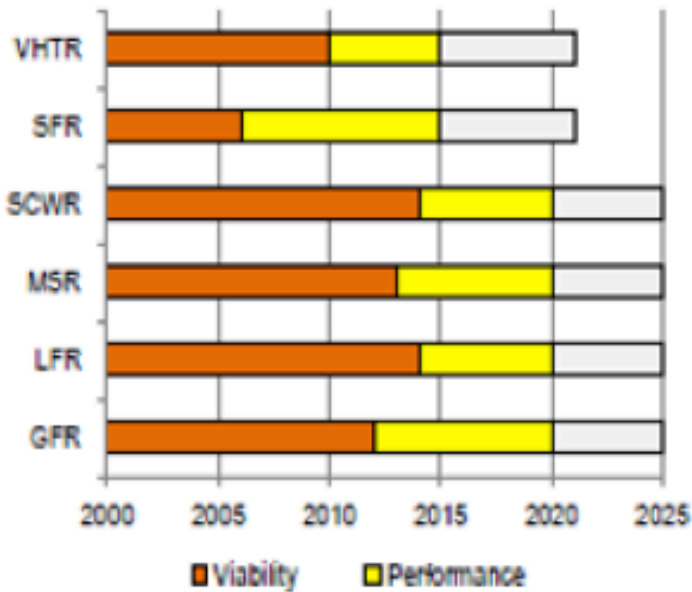
Molten Salt Reactor (Fast or thermal spectrum)

GIF Systems Development Phases

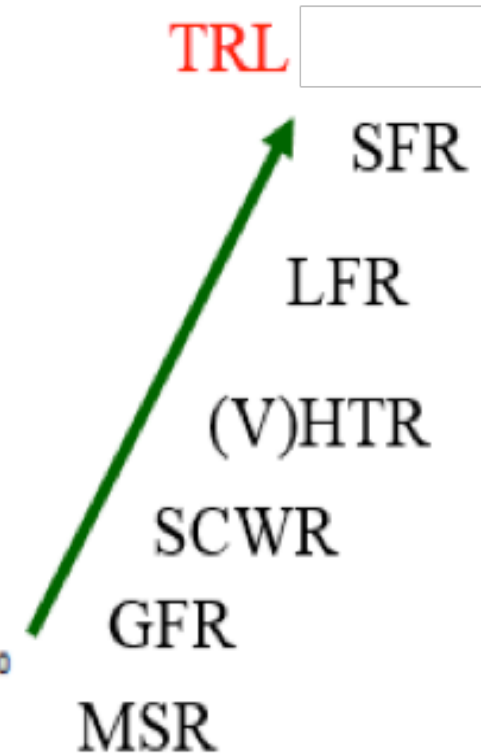
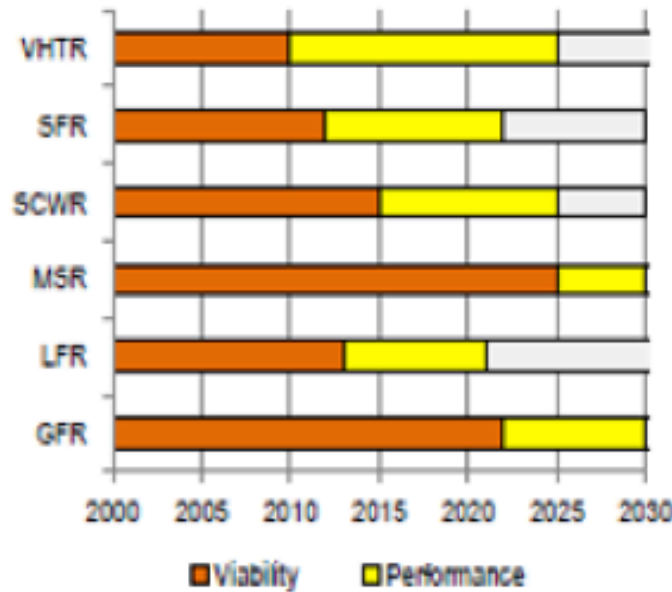
- ***Viability***
 - ***Basic concepts tested under relevant conditions and all potential technical show-stoppers identified and resolved***
- ***Performance***
 - ***Engineering-scale processes, phenomena and materials capabilities verified and optimized under prototypical conditions***
- ***Demonstration***
 - ***Detailed design finalized and licensing, construction and operation of the system are carried out, with the aim of bringing it to the commercial deployment stage***

GIF Nuclear Systems: Development Phases & TRLs

GIF roadmap 2002



GIF roadmap 2014



R&D Outlook for Gen IV Nuclear Systems

- ***Numerous challenges faced by nuclear energy since the publication in 2009 of the Gen IV R&D Outlook, e.g.***
 - ***Unstable electricity prices in a liberalized market***
 - ***Electricity market structures that do not provide investment signals for low-carbon technologies***
 - ***Insufficient carbon pricing to promote nuclear investments***
 - ***Explicit governmental support for renewables in some countries***
 - ***Uncertain and changing political support***

R&D Outlook for Gen IV Nuclear Systems, cont'd

- Unstable licensing framework***
- Poor social and political perception of nuclear energy safety characteristics (impact of the Fukushima accident)***
- Nuclear new build budget and schedule overruns***
- Long-term nature of capital investments and large financing costs***

R&D Outlook for Gen IV Nuclear Systems, cont'd

- ***Purpose of the 2018 update of the Gen IV R&D Outlook report***
 - ***Present major results and outcomes achieved by GIF partners in pursuing the R&D objectives as specified in the 2014 updated GIF Technology Roadmap***
 - ***Identify remaining or new challenges and the R&D efforts needed to overcome them on the path to viability, performance or demonstration/deployment of the respective Gen IV system***
- ***Time horizon of the 2018 update of the Gen IV R&D Outlook report: next decade***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways

- ***Gen IV concepts complement existing and evolutionary Gen III/III+ reactors, expected to be deployed throughout the century, by providing additional options and applications***
 - ***Optimisation of resource utilisation***
 - ***Multi-recycling of fissile materials/used fuel and reducing the footprint of geological repositories for high level waste***
 - ***Low-carbon heat supply for cogeneration and high-temperature industrial applications (process steam, synthetic fuels, hydrogen production, etc.)***
 - ***Enhanced integration of nuclear and other low carbon sources***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways, cont'd

- ***The Gen IV systems are taking into account the lessons learnt from the Fukushima Daiichi accident by***
 - ***Reinforcing the defence in depth approach against external events***
 - ***Promoting the robustness of the safety demonstration***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways, cont'd

- ***R&D work focuses on enhancing the safety characteristics of the Gen IV systems, aiming at***
 - ***Excluding harmful impacts of radioactive releases to the environment in case of accidents***
 - ***Eliminating the need for emergency measures***
 - ***Minimizing the impact on population***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways, cont'd

- ***Crosscutting R&D activities will be pursued collaboratively to address common needs and advance the technology in areas such as***
 - ***Safety design methodologies***
 - ***Decay heat removal systems***
 - ***Advanced fuels and materials***
 - ***Advanced manufacturing***
 - ***Modelling and simulation, and Verification, Validation and Qualification tools (VV&Q)***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways, cont'd

- The GIF will continue and strengthen its efforts in education and training on advanced nuclear systems***
- The GIF will continue to engage with regulatory authorities and technical support organisations with the long term goal of reaching harmonization of requirements and a better understanding of licensing approaches***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways, cont'd

- ***To support Gen IV systems that might enter the demonstration/deployment phase in the next decade the GIF will***
 - ***Ensure best use of available experimental R&D infrastructures***
 - ***Support the coordination of national programs among GIF countries to avoid unnecessary duplication of facilities and ensure availability of key experimental infrastructure***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways, cont'd

- Ensure best use of multi-scale/multi-physics simulation, as well as Verification, Validation and Qualification tools as a complement to experimental programmes to expedite the demonstration phase***
- Ensure best use of digital and Product Life Management tools (PLM) to support the licensing phase and reduce time-to-market of innovative designs***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways, cont'd

- At the design stage, support technical and methodological innovation to reduce investment costs (Overnight Capital Cost), shorten and master the duration of construction (Financing Cost), optimize the licensing costs, the operational and maintenance costs, the fuel cycle and waste management costs, and decommissioning costs, aiming at becoming competitive in the market***

2018 Update of the Gen IV R&D Outlook Report: High Level Takeaways, cont'd

- Promote the synergy between non-proliferation, physical protection, and a robust safety design, thus strengthening a safety culture that aims at an optimal integration of safety, security, and safeguards for advanced reactor concepts and fuel cycles, with the goal of increasing societal acceptance of the nuclear energy option***