Development and deployment of advanced nuclear power technologies to increase the use of low-carbon energy

Hideki Kamide[1], Sylvestre Pivet[2]

IAEA conference on Climate Change and the Role of Nuclear Power, Vienna, 9th October 2019

1: Japan Atomic Energy Commission – 2: French Atomic Agency (CEA)

Outline

- ***The Generation IV International Forum***
- ***Innovation for advanced reactors: what is on GIF's agenda?***
  - *Safety standards*
  - *Initiative towards private sector*
  - *Flexibility*
  - *Technical innovations*

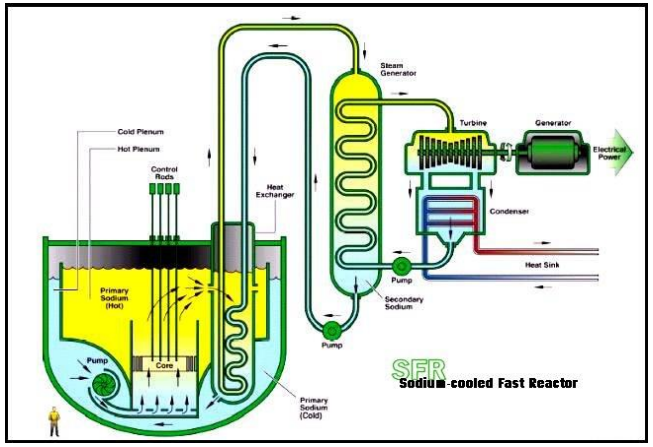
Generation IV International Forum

Chair PG: Mr Hideki KAMIDE (JAEA, JP)

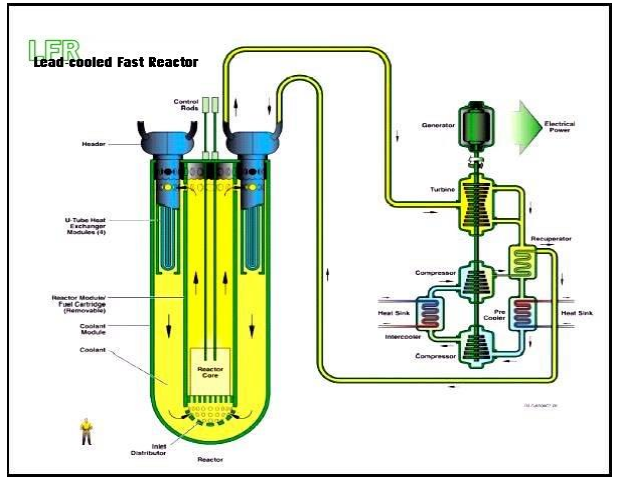
A framework for collaborative R&D on 6 advanced reactor systems

A set of high level goals as target to ensure relevance in the competitive market:

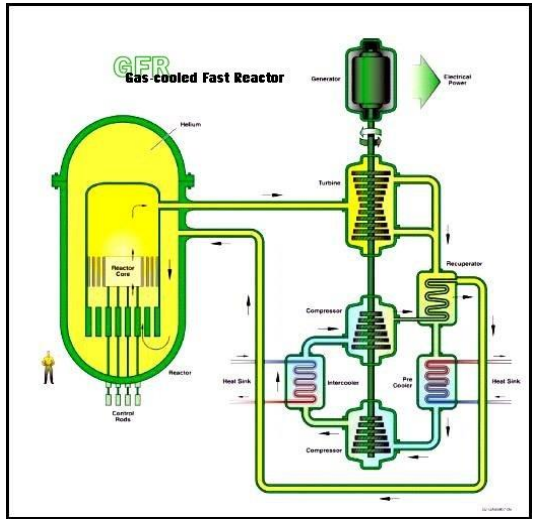
- Sustainability
- Economic competitiveness
- Safety and reliability
- Proliferation resistance and physical protection



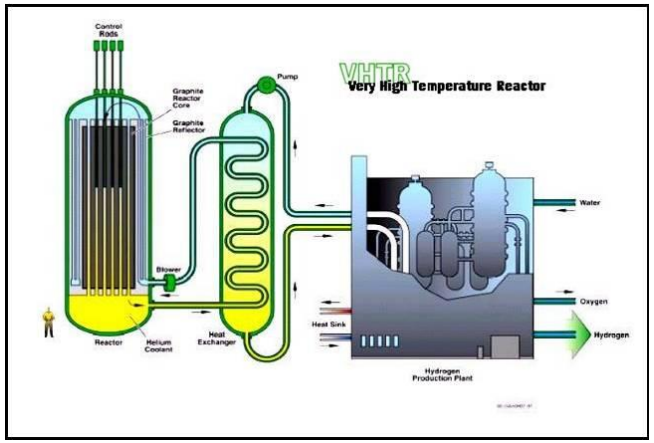
Sodium-cooled fast reactor (SFR)



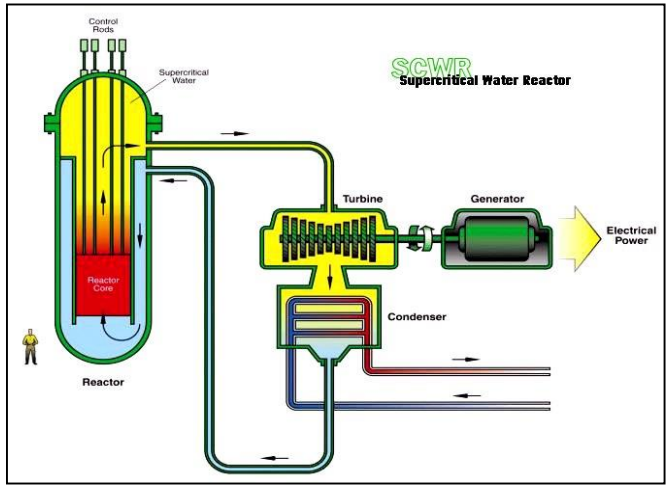
Lead-cooled fast reactor (LFR)



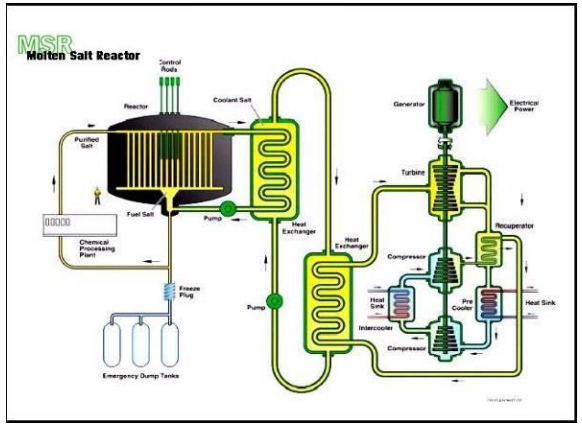
Gas-cooled fast reactor (GFR)



Very High Temperature reactor (VHTR)



Supercritical Water-cooled Reactor (SCWR)



Molten Salt Reactor (MSR)

GIF membership (2019)


Argentina*


Australia


Brazil*


Canada


China (People's Republic of)


Euratom


France


Japan


Korea


Russian Federation


South Africa


Switzerland


United Kingdom


United States

*Non-active member.

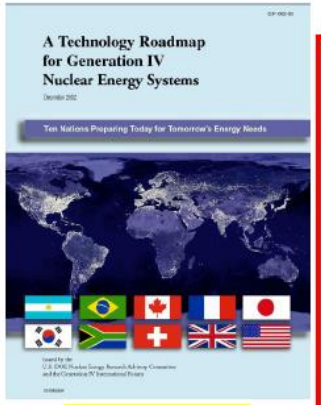
GIF members' involvement in Gen IV systems R&D

SFR			●	●	●	●	●			●	●	●
VHTR	●	●	●	●	●	●			●	●	●	●
LFR			Planned Oct 2019		●	●	●			●		●
SCWR		●	●		●		●					●
GFR				●	●							●
MSR	●	●		●			●		●	●		●

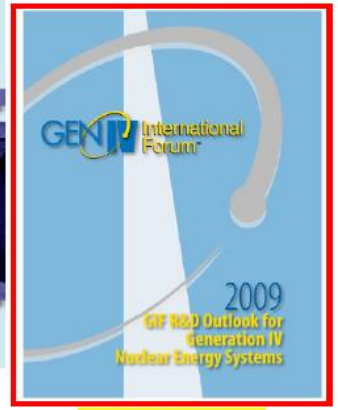
● : signatory of System Arrangement
● : signatory of Project Arrangement
● : signatory of MoU

As of October 2019

Technology Roadmaps

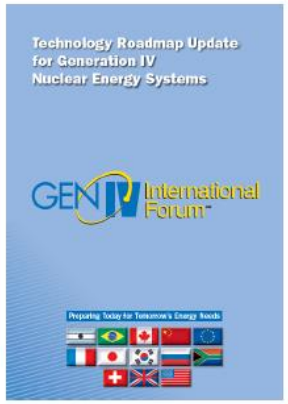


2002

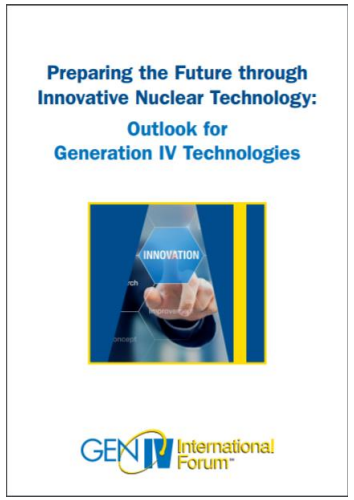


2009

1st GIF Symposium



2014



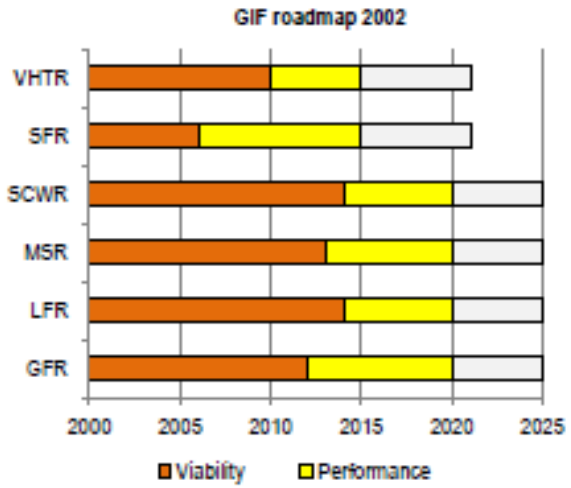
2018

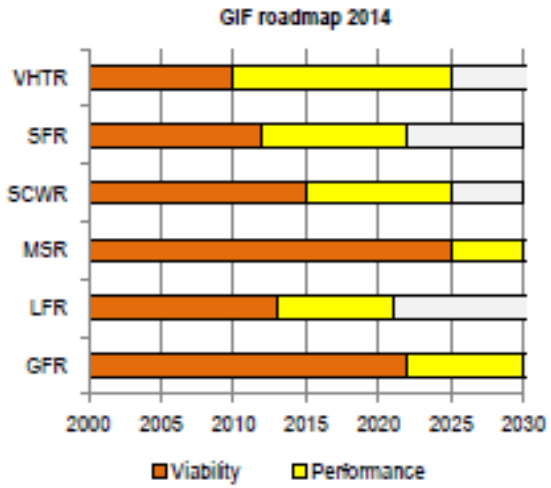
4th GIF Symposium

16-17 October 2018

at the 8th edition of Atoms for the Future

UIC Paris, France





TRL (Technology Readiness Level)

SFR

LFR (cf. BREST)

(V)HTR

SCWR

GFR

MSR

Innovation for advanced reactors: What is on GIF's agenda?

- ***Safety standards for the licensing of advanced reactors***
- ***GIF initiative towards private sector***
- ***Flexibility of Generation IV systems***
- ***GIF initiatives for technical innovations***

Safety standards

- *Sharing feedback and best practices*
- *Helping regulators become familiar with the technical characteristics of Generation IV systems*
- *Developing safety design criteria and guidelines*

Safety standards

	White Paper on ISAM application (integrated safety assessment methodology)	System Safety Assessments	Safety design & guidelines development
SFR	☑	☑	SDC and SDG ☑
VHTR	☑	On-going	On-going (SDC TEC DOC will be released by IAEA CRP)
LFR	☑	On-going	SDC on-going
SCWR	☑	☑	To be investigated for fast core version
GFR	☑	On-going	SDC on-going
MSR	On-going	Planned	Specific approach to be developed

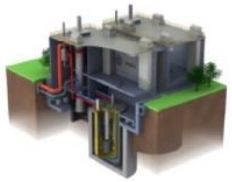
Initiative towards private sector

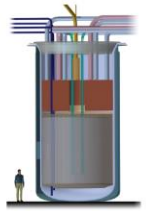
- *Huge interest for advanced and innovative reactors, SMR*
- *The GIF is exploring the way to establish a win-win relationship with the private sector for deployment of Generation IV systems*
- *Private sector companies can participate in GIF R&D projects*

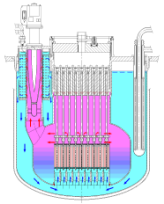
Initiative towards private sector

Meeting in Vancouver, May 2019

- ***Topics discussed and to be further discussed:***
  - *R&D challenges, participation in GIF R&D activities*
  - *Access to infrastructures*
  - *Economics*
  - *Safety design criteria / guidelines - licensing*
  - *Deployment*







Flexibility

- ***Position paper issued by the Economics and Modelling working Group, on the impact of increasing share of renewables on the deployment of Gen IV systems*** *(2018 May)*
  - *Gen IV systems need to be flexible for integration into low-carbon electricity grids*
  - *Co-generation and hybrid systems improve economics*
  - *Flexibility requirements have to be considered as part of R&D*

Flexibility

Operational flexibility

maneuverability, ramp rates,
minimum power level, frequency control,
island mode, fuel flexibility

Deployment flexibility

scalability,
siting requirements,
modularity

Product flexibility

possible non-electrical applications such as cogeneration and heat applications

Survey of the 6 GIF systems by the EMWG in 2019

- *Gen-IV systems capabilities in terms of flexibility*
- *Flexibility-related R&D needs depend on the level of technological maturity of the systems*

GIF initiatives for technical innovations

- ***Interim task force on Advanced Manufacturing and Materials Engineering***
  - *Modular construction*
  - *Advanced concrete solutions*
  - *Innovative fuels and materials*
  - *3D printing*
- ***Experimental data: task force on R&D infrastructures***
  - *Identify key facilities and potential gaps,*
  - *Facilitate access to facilities within the international community.*

Task Force Education & Training - webinars

Series 28: European Sodium Fast Reactor: An Introduction

15 April 2019
Presenter: Dr. Konstantin Mikityuk, PSI, Switzerland

Watch WEBCAST | DOWNLOAD PRESENTATION

Series 29: Formulation of Alternative Cement Matrix for Solidification/Stabilization of Nuclear Waste

22 May 2019
Presenter: Mr. Matthieu De Campos, Universite de Lille 1, France

Watch WEBCAST | DOWNLOAD PRESENTATION

Series 30: Interactions between Sodium and Fission Products in Case of a Severe Accident in a Sodium-cooled Fast Reactor

19 June 2019
Presenter: Mr. Guilhem Kauric, CEA, France

Watch WEBCAST | DOWNLOAD PRESENTATION

Series 31: Security Study of Sodium-Gas Heat Exchangers in Frame of Sodium-cooled Fast Reactors

31 July 2019
Presenter: Ms. Fang Chen, CEA, France

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Wrap-up

- ***Further progress*** *are underway to* ***increase the technology readiness level*** *of the six Generation IV systems*
- ***New areas***
  - *Interest from the private sectors for advanced reactors,*
  - *Flexibility requirements*
- *Advanced nuclear energy systems and innovative applications of nuclear technologies can provide* ***solutions underpinning economic growth***
- *Generation IV systems offer* ***additional features*** *in terms of* ***performance and sustainability*** *compared to existing concepts*
- *The GIF calls on policymakers to* ***acknowledge the real contribution that nuclear energy is making today to the mitigation of carbon emissions*** *from the power sector, and to consider* ***supporting the deployment of advanced reactors and innovative applications of nuclear technologies.***