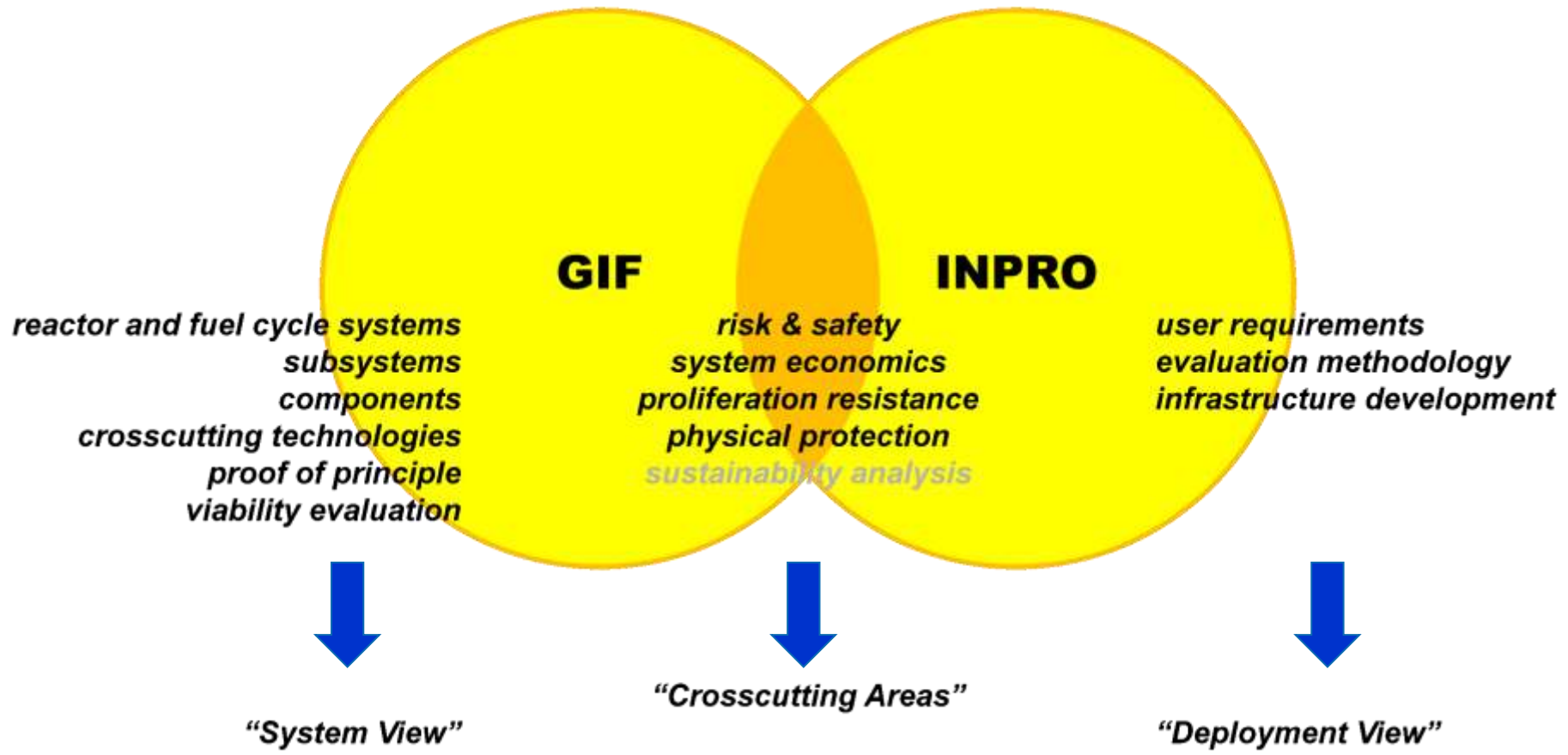


# INPRO-IAEA and GIF Collaboration and Current activities

**Hideki KAMIDE**  
GIF Chair

# 20 years successful collaboration GIF-INPRO-IAEA



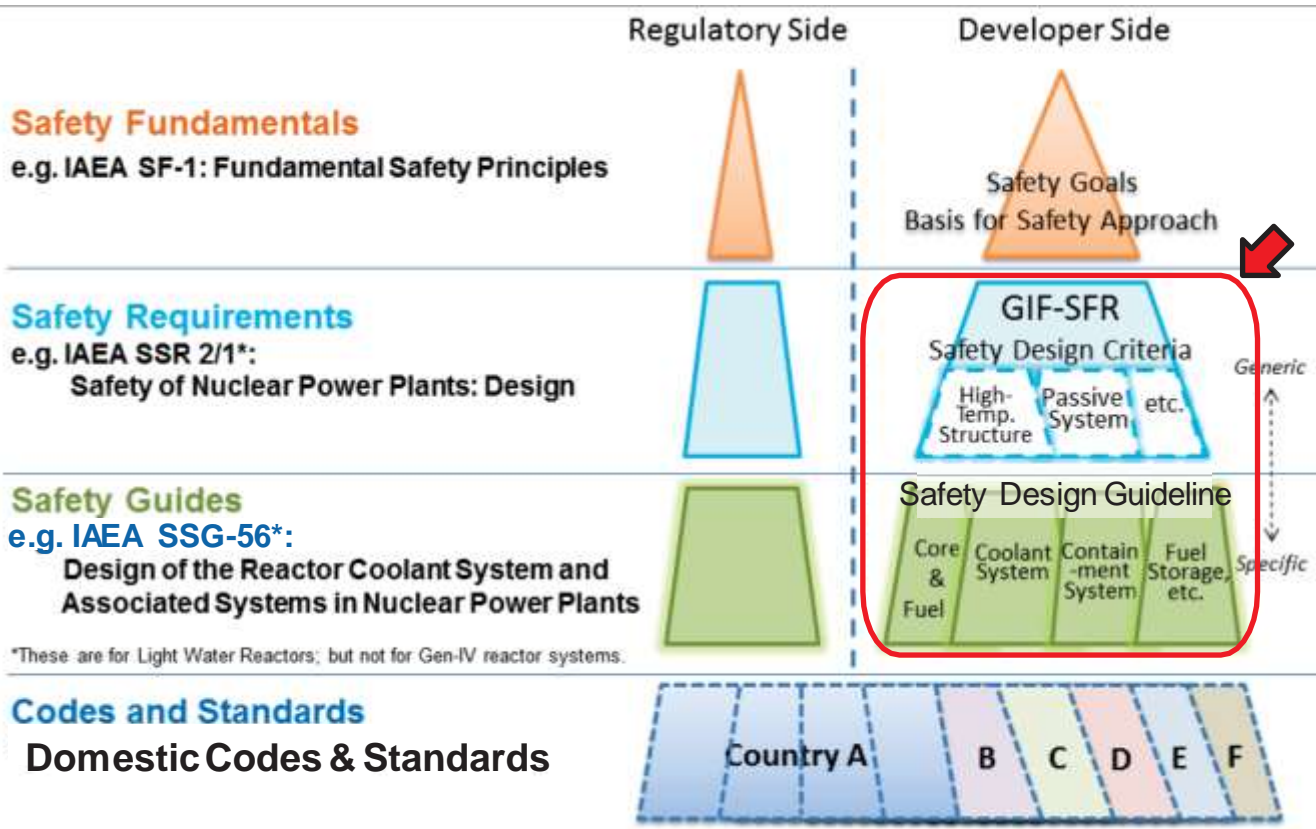
# 20 years successful collaboration GIF-INPRO-IAEA



Permanent Observer of GIF



# Safety Design Criteria and Guideline of Sodium cooled Fast Reactor



- SFR Safety Design Criteria (SDC) development was proposed at GIF Policy Group in 2010
- Realization of enhanced safety designs common to SFR systems,
- Preparation for the forthcoming licensing in the near future
- SDC Task Force (TF) started in 2011
- SDC was formulated in 2013, external review and update are continuously conducted.
- Safety design guidelines (SDG) for GIF SFR started in 2013.

# Safety document development for GIF reactor systems

- SDC/SDG are extended to the other reactor systems.

	White Paper on ISAM Implement.	System Safety Assessment	Safety Design Criteria/Guidelines
SFR	Completed	Completed	SDC-Completed 1 <sup>st</sup> SDG-Completed 2 <sup>nd</sup> SDG-under review
VHTR	Completed	Completed	GIF is observing IAEA-CRP for SDC
LFR	Completed	Completed	SDC-under preparation Report submitted to IAEA for review
SCWR	Completed	Completed	Not needed
GFR	Completed	Completed	SDC-under preparation
MSR	Under preparation	Under preparation	Under planning

# Cooperation with IAEA on SFR SDC, SDG

## Contributions of IAEA Specialists

- IAEA expert (Nuclear Safety and Security) has been a member of SDC TF.
- IAEA Department of Nuclear Energy, joins GIF, a yearly Workshop of safety of SFR and later of LMFR
- ✓ Comments on SDC were provided in April 2014
- ✓ Comments on SDG were provided in March 2018



## IAEA comments

- Consistency of definition with revised SSR 2/1 and IAEA glossary
- Terminology “initiating event”
- Recommendations regarding containment integrity
- Reactivity characteristics of SFRs including sodium void
- “Subchannel blockage”



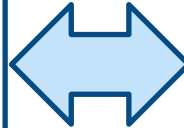
- SDC report, Rev 1, 2017
- Safety Approach SDG report, Rev 1, 2020  
[https://www.gen-4.org/gif/jcms/c\\_93020/safety-design-criteria](https://www.gen-4.org/gif/jcms/c_93020/safety-design-criteria)

# GIF Contributions to IAEA safety issues

- Contributions to IAEA safety standards for SMRs, most of which overlap with Gen-IV design tracks

## Risk and Safety WG of GIF

- Basic Safety Approach
- Integrated Safety Assessment Methodology
- Technology-inclusive risk-informed approach
- System Safety Assessments for six systems
- SDC development for six systems



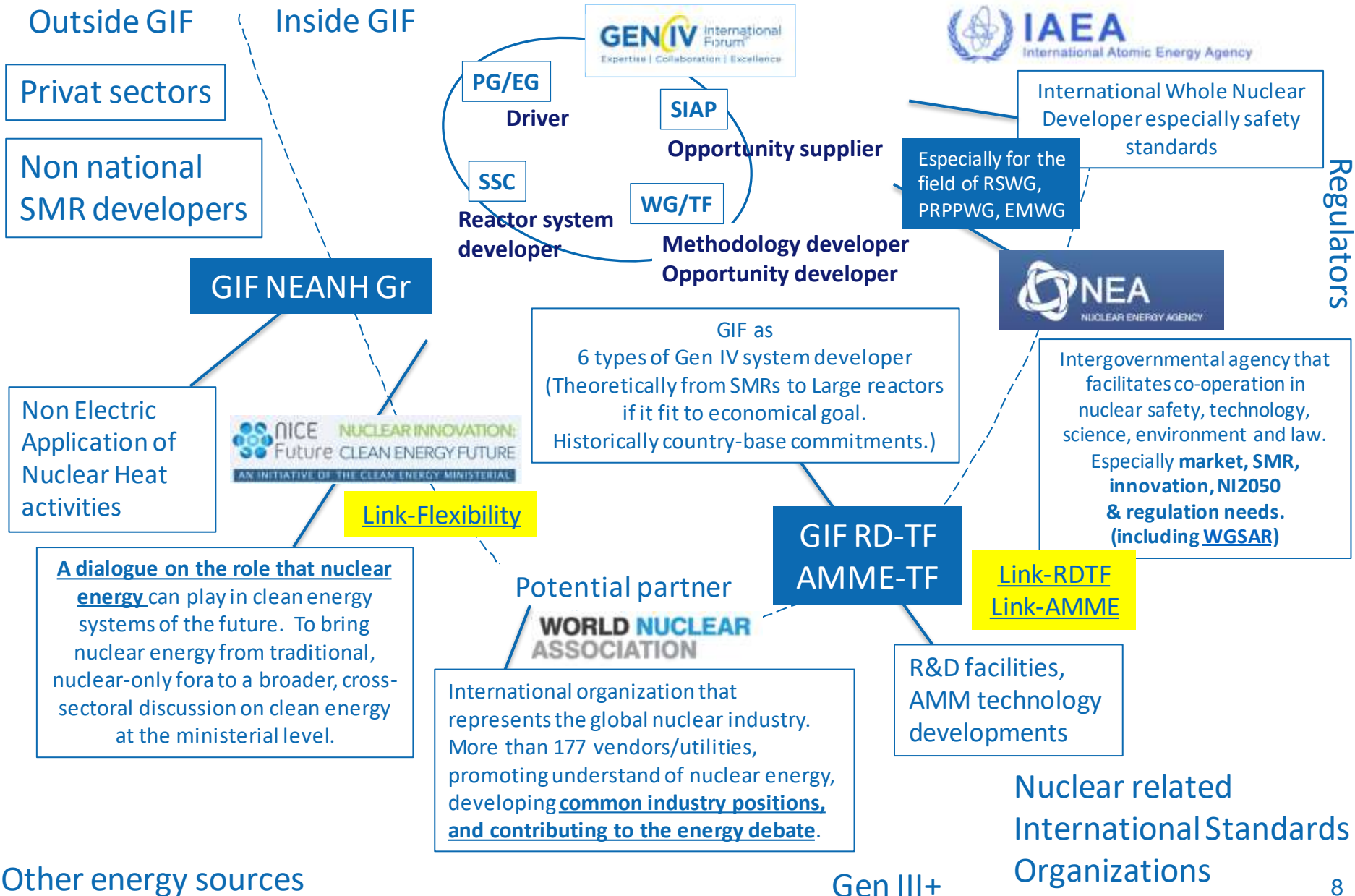
## Developments of TECDOC by IAEA

- Approaches and methodology for development of regulatory safety requirements for SMR design
- Safety assessment and analysis for SMR Technologies
- Applicability of IAEA's safety guidance on design safety for NPPs in SMR technologies (LWRs, HTGRs, LMFRs, MSR)
- .....

Safety document development in IAEA for SMRs

# GIF and GIF partners

Link-GIF-Partners  
Link-Partners-activities



Regulators



# GIF-IAEA relationship

## Common actions

### To commonly develop/review methodologies for advanced reactors

- ⇒ Safety standards like SDC/SDG (SFR, LFR, VHTR, SMR) , INPRO methodologies, related TECDOCs about risk-based approach, etc.
- ⇒ R&D facilities (Infrastructure needs and data base)
- ⇒ PRPP methodologies like IAEA NE-series documents on Safeguards by design
- ⇒ Economic codes (GIF G4-ECONS, IAEA-NEST tool)

### To share strategies of Non-electric applications of Nuclear Heat



International Whole Nuclear Developer especially safety standards



IAEA TECDOC SERIES

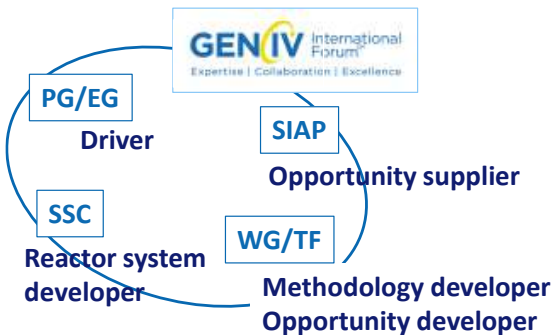
Standards



Tools, databases, and Coordinated Research Projects



International country groups developing Gen IV reactors.  
12 active countries, with 6 Reactors SCs, 7 Methodology/Opportunity WG/TFs and SIAP.



## Common interests

Steering meeting : GIF-IAEA interface meeting with cooperate matrix including reactors / education & Training fields

Webinars/ Publications : List

Interested Meetings : GIF PG meeting, GIF RSWG ,PRPPWG, EMWG meetings  
IAEA TWG-FR, TWG-GCR, IAEA-INPRO Steering Committee

# Flexibility: Non-Electric Application of Nuclear Heat (NEANH)

## Reactor Types



SFR, LFR, GFR  
VHTR, SCWR, MSR

## Reactor Size

Power Reactor  
SMR  
Micro Reactor

X

X

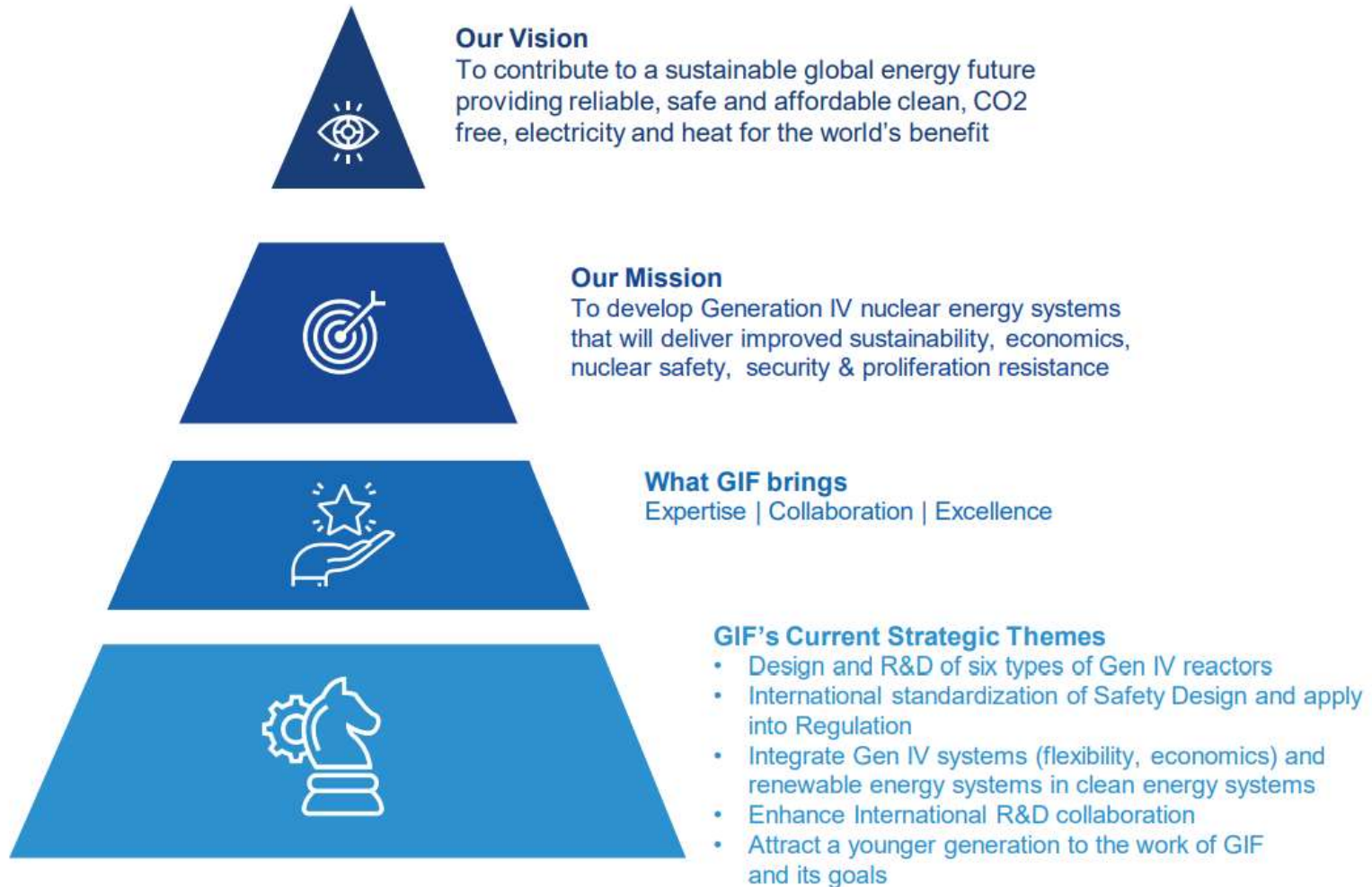
## Applications

- ✓ Cogeneration application
- ✓ Hydrogen production
- ✓ Seawater Desalination
- ✓ Process heat
- ✓ Synthetic Fuel and Chemicals
- ✓ Cooling application

IAEA Source

Matrix of 6 x 3 x 6

# GIF vision based on GIF goals and organizations



GIF organization activities by SSCs/PMBs/WGs/TFs  
See <https://www.gen-4.org/gif/>

## Featured Recent GIF Publications

- [2019 Annual Report](#) (2020 Annual Report is coming soon with References)
- [2018 GIF Symposium](#) (We are planning Forum GIF INDUSTRY 2022)
- [GIF R&D Outlook for Generation IV Nuclear Energy Systems: 2018 Update](#)
- [Handbook of Generation IV Nuclear Reactors, 2016](#) (Presently updating)
- [The High Temperature Gas-Cooled Reactor, 2020](#) (M. Fütterer, et al., Reference Module in Earth Systems and Environmental Sciences, <https://doi.org/10.1016/B978-0-12-409548-9.12205-5> )
- [LFR Safety Design Criteria \(SDC\), 2021](#)
- [Lead-cooled Fast Reactor \(LFR\) System Safety Assessment, 2020](#)
- [Sodium Fast Reactor: Safety Design Guidelines on Safety Approach and Design Conditions \(SA SDG\), 2020](#)
- An Update of the GIF Proliferation Resistance and Physical Protection White Papers for the Six Gen IV Systems, 2019 (Cipiti, B. et al, 9th INMM/ESARDA/INMMJ Joint Workshop. See PRPPWG-BIBLIOGRAPHY Rev. 8 April 2021)
- The GIF Proliferation Resistance and Physical Protection methodology applied to GEN IV system designs, 2019 (Cheng, L. et al., ESARDA'19: ESARDA Symposium 2019 - 41st Annual Meeting See PRPPWG-BIBLIOGRAPHY Rev. 8 April 2021)
- [NICE Future Initiative/ Flexible Nuclear Energy for Clean Energy Systems, Chapter 13: Generation IV International Forum: Delivering Next-Generation Nuclear Systems, 2020](#)
- [Impact of Increasing Share of Renewables on the Deployment of Generation IV Nuclear Systems, 2018](#)
- [GIF workshop on R&D Infrastructures needs and opportunities, 2020](#)
- [R&D Infrastructure Task Force Final Report, 2021](#)

# Summary

Our significant cooperation:

- Long and successful history of cooperation between GIF and INPRO-IAEA
- Messages of peaceful and sustainable use of Nuclear toward the world
- International standards of safety design for Gen-IV reactors
- Enlargement of Nuclear heat use for Carbon neutral



Expertise | Collaboration | Excellence



**Thank you.**

# The goals of Generation IV reactors

## Sustainability

- ✓ Long term fuel supply
- ✓ Minimize waste and long term stewardship burden

## Safety & Reliability

- ✓ Excel in safety in 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

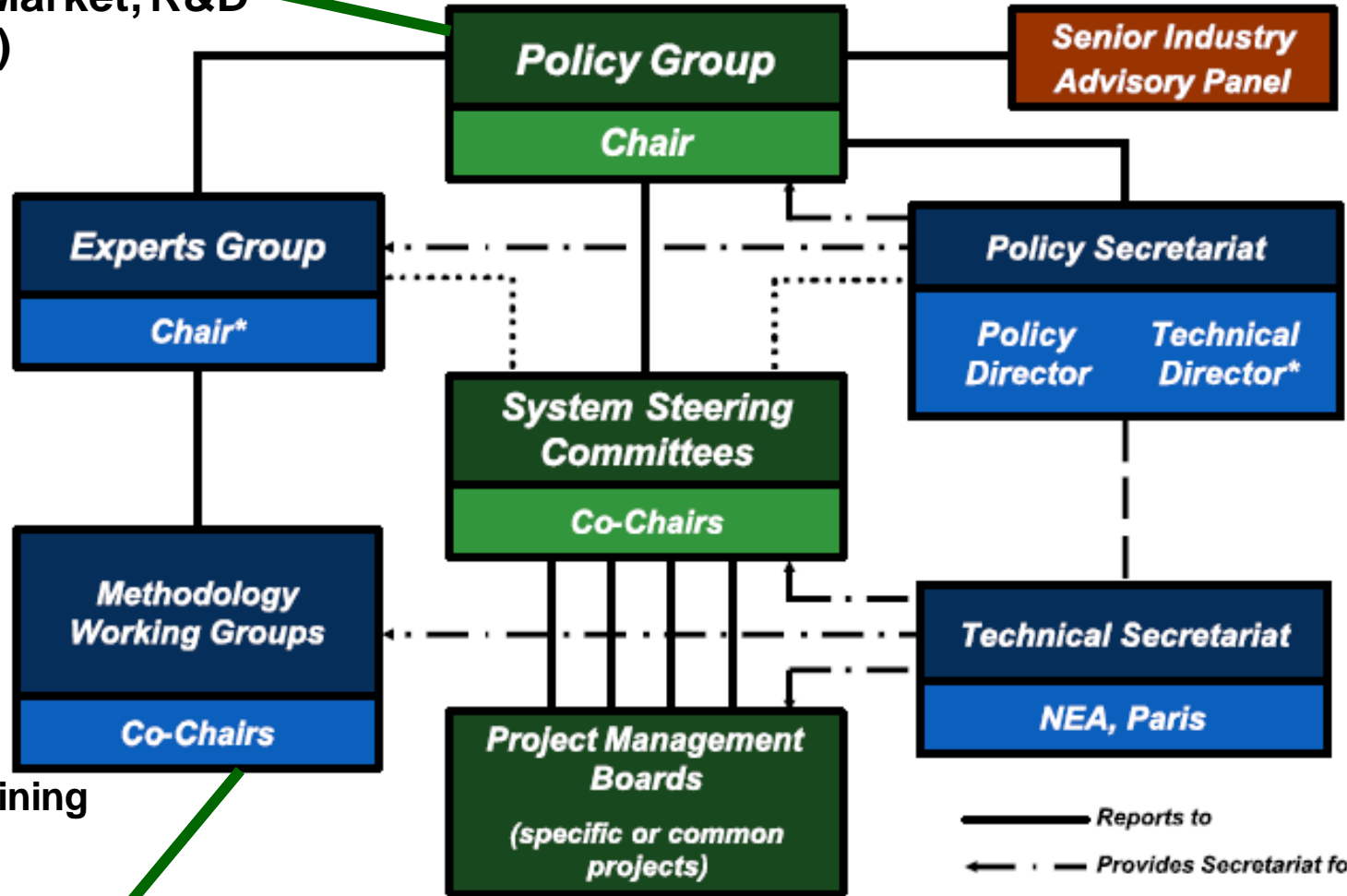
## Proliferation Resistance & Physical Protection

- ✓ Unattractive materials diversion pathway
- ✓ Enhanced physical protection against terrorism

See: [https://www.gen-4.org/gif/jcms/c\\_9502/generation-iv-goals](https://www.gen-4.org/gif/jcms/c_9502/generation-iv-goals)

# GIF Governance Structure

Led by Chair and Vice Chairs  
(Regulation, Market, R&D  
collaboration)



WGs:  
Economics,  
PRPP,  
Risk & Safety,  
Education & Training

TFs:  
R&D infrastructure,  
Advanced Manufacturing  
and Materials Engineering

Six reactor systems &  
R&D projects

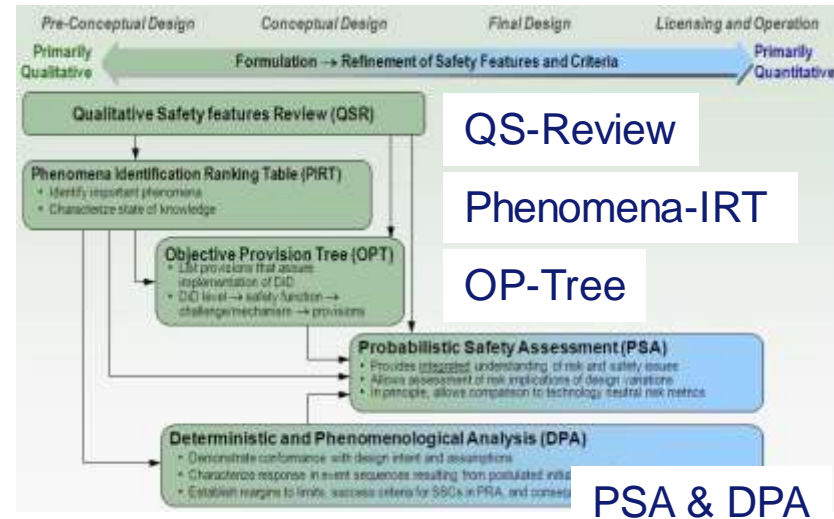
- Reports to
- ← . — Provides Secretariat for
- ..... Communicates closely with
- - - Coordinates with



# GIF Methodologies

## RSWG – Risk and Safety WG

- Develop “Basis for the Safety Approach for Design and Assessment of Generation IV Nuclear Systems”
- Developed an Integrated Safety Assessment Methodology (ISAM)
- Developed white papers on ISAM implementation & safety systems



See: [https://www.gen-4.org/gif/jcms/c\\_9366/risk-safety](https://www.gen-4.org/gif/jcms/c_9366/risk-safety)

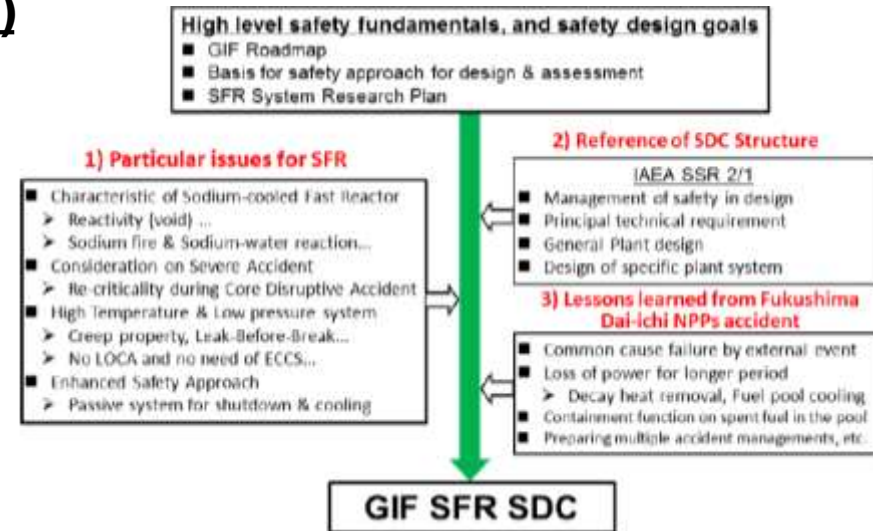
Including “ISAM Guideline”, “System Safety Assessment”, “Safety Assessment White Paper”,

## SDC-TF - Safety Design Criteria TF (Closed)

- develop safety design criteria and guidelines for the sodium-cooled fast reactor
  - reviewed by IAEA, WGSAR; national regulators
- Extension to other GIF systems

See: [https://www.gen-4.org/gif/jcms/c\\_93020/safety-design-criteria](https://www.gen-4.org/gif/jcms/c_93020/safety-design-criteria)

Including “SFR SDC” “LFR SDC” & “Safety Approach and Design Conditions, SFR SDGs”

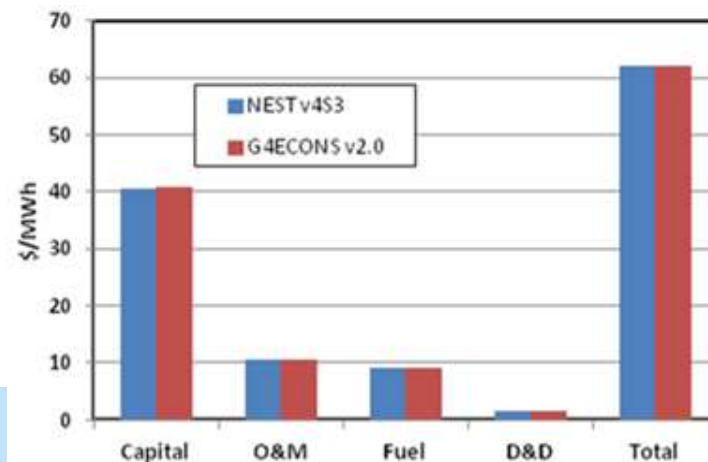


# GIF Methodologies

## EMWG – Economics Modelling WG

- Developed the **G4ECONS** software (freely available) to estimate six reactor systems.
- Cost Estimation **Guidelines** can be used to assess the costs of Gen IV designs and identify cost drivers

See: [https://www.gen-4.org/gif/jcms/c\\_9364/economics](https://www.gen-4.org/gif/jcms/c_9364/economics)  
Including “Cost Estimating Guidelines” & “Impact of Increasing Share of Renewables”



Benchmarking (G4ECONS vs. IAEA NEST)

## PRPPWG – Proliferation Resistance and Physical Protection WG

- Through a case study, developed a methodology to evaluate & facilitate the introduction of PRPP features at the earliest possible stage of design
- With SSCs, white papers on the six GIF systems

ACCIDENT INITIATORS → SYSTEM RESPONSE → CONSEQUENCES

THREATS → SYSTEM RESPONSE → OUTCOMES

- *Safety and PR&PP should be considered from the earliest stages of design*
  - *Flow diagrams: preliminary safety hazard and PR&PP target identification and categorization*
  - *Physical arrangement: external events shielding, access control*

See: [https://www.gen-4.org/gif/jcms/c\\_9365/pr-pp](https://www.gen-4.org/gif/jcms/c_9365/pr-pp)  
Including “Evaluation Methodology Report”, “Workshop materials” & “Case Study Report of ESFR”

# Education and Training activities

## Working Group on Education and Training (ETWG)

The GIF Task Force on Education and Training (ETTF) was launched in November 2015 and was elevated to a Working Group in November 2019. It provides a platform to enhance open education and training (E&T) and facilitates communication and networking of individuals and organizations that support GIF activities.

- ETWG organizes monthly webinar series on Generation IV systems and cross-cutting methodologies.
- ETWG identifies stakeholder groups, assessing their need for Generation IV E&T and has made available an outreach flyer describing ETWG initiatives.
- ETWG establishes co-operation with other E&T networks (ENEN, AFRO-NEST).
- ETWG maintains a social media platform through which information and ideas are exchanged on general Generation IV R&D topics as well as Generation IV E&T activities.
- ETWG structures and disseminates open E&T materials via social media and the GIF website.
- ETWG proposes, organizes and supports Generation IV E&T workshops, seminars and schools.

[https://www.gen-4.org/gif/jcms/c\\_97306/education-and-training](https://www.gen-4.org/gif/jcms/c_97306/education-and-training)