

“THE GLOBAL VIEW”

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Rising energy demand, effects of global warming, and volatile prices of natural resources, are issues which largely shape today's world economy.

In what appears as growing awareness of this twenty-first century challenge, governments in increasing numbers throughout the planet are embracing nuclear energy as vital to their strategies of national energy independence and global environmental duties.

Sustainable development of nuclear energy

However, even if nuclear energy is increasingly recognized as indispensable, it is important to ensure its sustainable use and development.

Such is the aim of the Generation IV International Forum (GIF), for which sustainability goals are defined according to criteria linked to safety, economics, resource utilization, waste management, proliferation resistance and physical protection, as well as the use of nuclear energy to applications wider than electricity production.

While the safety levels and economic competitiveness of Generation IV systems will be targeted to be at least as good as those of Generation III plants, Generation IV, as described in the 2002 Technology Roadmap, improves upon current reactors in several ways. Four of the designs are fast reactors, allowing the reactors to potentially exploit the full energy potential of uranium both fissile and fertile isotopes.

Generation III reactors extract energy from a much smaller fraction of fissile uranium in the fuel, where Generation IV reactors can extend the uranium resource by about a factor of 50 beyond this. Another benefit for Generation IV is to improve on current designs by recycling all actinides not only the bred plutonium-239, but the other actinides found in the waste as well. This revolution in fuel utilization would not only dramatically reduce the long-term radiotoxicity and heat generated by the waste by transmuting it to shorter-lived fission products, thus making it easier to dispose, but also enhance the system's resistance to proliferation, by rendering the fuel more difficult to handle.

Two of the Generation IV designs are high-temperature reactors, which can generate not only electricity but also provide high-quality process heat for industrial purposes. Process heat is useful in a wide range of industries, from petroleum refineries and chemical plants to large-scale hydrogen production that could revolutionize transportation.

The GIF: a forum for multilateral R&D cooperation

Ever since the launch of the GIF, about a decade ago, its member countries have met regularly, to discuss the research required to support the development of next-generation reactors: it has resulted in a tremendous brainstorming effort, from R&D teams from over twelve countries and EURATOM, on a scale rarely matched in history, which, in turn,

produced numerous collaborative projects in reactor and fuel technologies. Even if the six nuclear systems studied within the GIF correspond to concepts already known, their development within the GIF has benefited from the exchanges between technical experts representing most of the main world nuclear actors, originating from both academia as well as industry sectors.

Though technical exchanges started long ago, especially on a bilateral level, multilateral cooperation was given a clear boost after negotiations led in 2006, to principles, accepted by all, which duly recognize background property information and deal satisfactorily with all property rights (intellectual, commercial...). The GIF thus appears as the only existing large scale international structure enabling multilateral cooperation within a sound legal basis that ensures that its R&D activities are carried out in an equitable manner between partners.

This major step was followed by the signing of a series of Project Arrangements, for most of the six GIF nuclear systems, such as, for example, that on Advanced fuel, Global Actinide Cycle International Demonstration for the Sodium-Cooled Fast Reactor (SFR) concept, Hydrogen Production, Fuel and Fuel Cycle for the Very High Temperature Reactor (VHTR) concept... Additional projects are to be finalized soon on the Gas-Cooled Fast Reactor (GFR), Super-Critical Water Reactor (SCWR) systems.

Scope of the GIF

It is very important to reiterate the scope of the work carried out within the GIF. The R&D performed focuses on both the viability and performance phases of system development: the former phase examines the feasibility of key technologies, such as, for example, adequate corrosion resistance in lead alloys or supercritical water, fission product retention at high temperature for particle fuel in the very high temperature gas cooled reactor... The latter phase focuses on the development of performance data and optimization of the system.

Conversely, the scope of GIF activities does not extend to demonstration phase, which involves the detailed design, licensing, construction and operation of a prototype or demonstration system in partnership with industry.

To help prepare for future commercialization of Generation IV systems, a Senior Industry Advisory Panel (SIAP) provides advice on GIF R&D priorities and strategies. Specifically, this panel contributes to discussion on strategic review of R&D progress and plans for the GIF systems from the industry perspective, by addressing issues such as industrial interest, technical viability, economics, licensing, risk management, project management and industrial infrastructure. The SIAP contributes valuable views on system deployment, future nuclear fuel cycles, and international frameworks for nuclear safety standards and regulations.

Concerning safety issues, a specific Working Group has been formed to promote a consistent approach on safety, risk and regulatory issues among Generation IV systems. More specifically, Generation IV safety goals and evaluation methodologies are being developed for use in system design and for guiding R&D plans. Interaction with the nuclear safety regulatory community, the IAEA and relevant stakeholders is also organised.

Experimental Reactor or Prototype

Though commercial deployment of Generation IV reactors cannot be foreseen before the 2030s, studies are already advanced enough for a few of the six Generation IV concepts, to start planning for the construction of experimental reactors or prototypes. The two such concepts are namely the fast spectrum ones, using gas or sodium as coolants. In the case of gas-coolant, studies underway in Europe may stimulate sufficient common interest that would in turn lead to the construction of an experimental reactor. As for sodium-coolant, it clearly appears that it corresponds to the most mature Generation IV technology. Even though final technical choices and policy decisions have

not been made yet, SFR technology is a strong candidate for the construction plans of Generation IV fast reactor prototypes in France, Japan, and possibly other countries... A trilateral collaborative project was launched in 2007 by France, Japan and the US, which seeks to facilitate the commercial deployment of SFR technology by 2040 through cooperative research, shared infrastructure and joint prototype development. This project will heavily rely on the R&D results obtained within the framework of the GIF.

Interaction with other initiatives

Synergies exist and are currently being examined between the GIF and the IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), mainly in the fields of safety and non proliferation. In these areas, the GIF and INPRO can be mutually complementary, the former being an R&D framework, while the latter brings together technology holders and users in view of joined actions for achieving desired innovations in

nuclear reactors and fuel cycles. As for the US-led Global Nuclear Energy Partnership initiative (GNEP), the GIF is prepared to examine the possibility of providing it with the required R&D to develop, demonstrate and deploy advanced fast reactors, and their fuel cycles.

Conclusion

The road to commercial deployment of Generation IV systems still appears to be long, and paved with numerous technological challenges, which will require major breakthroughs. This situation motivates timely joint efforts by GIF Members. GIF has demonstrated political willingness to support and promote the development of sustainable nuclear energy systems, as well as enthusiasm on the part of the researchers involved in the Forum's collaborative R&D to surmount these challenges. Already, major achievements have been accomplished within the GIF's Project Arrangements, which now allow us to set some major milestones for what will be accomplished by the Forum over the next five years.

