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A Study on Smooth Transition to the Gen-IV System

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1. Introduction

This paper aimed at looking for a way to implement the Generation IV nuclear energy system. To achieve this purpose, three main topics have been chosen as focal points for the discussion:

- The reason why we should do Generation IV system.
- Policy for a smooth transition to a Gen IV system.
- Public confidence for Generation IV system.

2. Why do we Gen IV?

By the year 2050, the world population is expected to increase from 6 billion inhabitants to 10 billion. Consequently, the energy demand will follow this increase, and the increase in living standards in many countries will not ease this situation. It has been predicted in the World Energy Outlook that fossil fuels will account for more than 80% of the increased energy demand. This will consequently lead to an increase in carbon dioxide emissions, accelerating the changes in the green house effect and causing a global warning.

Considering the enormous increase in energy demand in the coming decades, efforts are being put into research and development of new reactor types. These reactors are supposed to be safe, economical, proliferation resistant and to use nuclear fuel in a sustainable way. Since the reactors currently in operation are categorized as the second generation of nuclear reactors and their evolutionary designs, the new reactor of today, are referred to as the third generation of nuclear reactors, this concept of reactors for the future has been named Generation IV[1].

Besides electricity production, some of the Gen IV reactor concepts will be able to provide high temperature process heat. 66% of global CO_2 emissions are generated in the industrial and transport sectors and hence nuclear energy needs to play a greater role in these energy sectors if it wants to successfully combat global climate changes. High temperature process heat can be used in various industrial applications for hydrogen production. The use of nuclear process heat would lower the need for the use of fossil fuels. In a well developed future hydrogen society, the nuclear produced hydrogen can be used for transportation, representing one third of today's consumption. Moreover, the process heat can be used for water desalination, which may locally help to reduce water shortages around the world. The process heat can be used for other industrial applications as well.

A continued once-through fuel cycle use in a future nuclear intensive scenario will, however, result in the production of huge amounts of nuclear waste. In order to reduce the number of final disposal repositories and to use the fuel in a sustainable way, fast breeder reactors must be employed in a closed fuel cycle. In this way, plutonium and minor actinides produced in thermal reactors can be incinerated, reducing the radiotoxicity and the volume of a material in the fuel cycle and the waste stockpile.

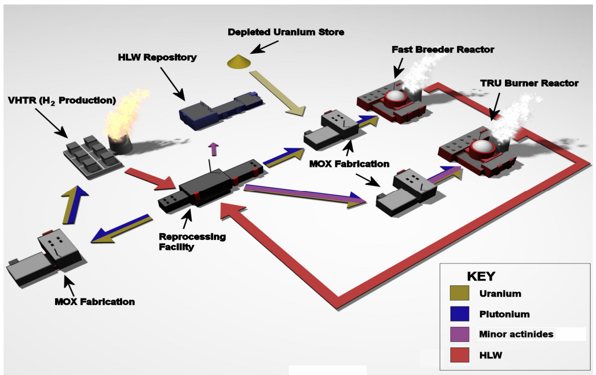

Figure 1 General symbiotic Gen IV fuel cycle.

3. Policy for a smooth transition to the Gen IV

The transition toward the extensive deployment of the Gen IV nuclear energy systems and the completion of the Gen IV fuel cycle is obviously determined by the present situation in the major nuclear countries and by their development strategies.

French has an active policy to implement a closed fuel cycle. The used fuel from the PWR reactor fleet is reprocessed, the spent U is stored for future use, the Pu is converted into MOX fuel by blending it with depleted U, while the minor actinides (MA) and fission products (FP) are sent into a vitrified waste form and stored till the final disposal. The fabricated MOX fuel is recycled into the reactors while the used MOX fuel bundles are sent to an interim storage as they are intended to be recycled into Gen IV fast reactors only. The French policy on the development of a nuclear policy is mainly determined by the research initiated by the 1991 Act on a HLW management and by the guidelines set by the new June 2006 Act after 15 years of research. On the long term French studies suggests the complete replacement of the French PWR fleet with EPR type Gen III reactors between 2020 and 2040 and the commercial introduction of Gen IV fast reactors from 2040. With the deployment of the fast reactors the multi-recycling of the Pu and MA starts to remove them from the final waste and ensures a better utilization of uranium.

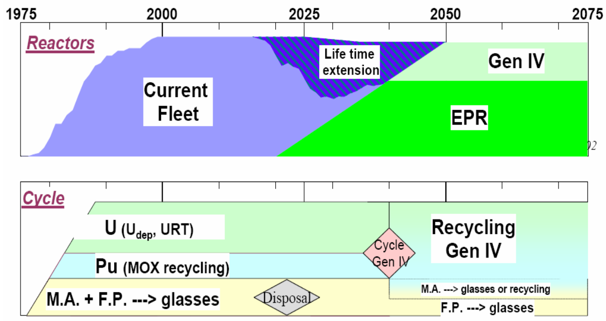

Figure 2 France transition scenarios between LWRs and Fast Neutrons system (source: EDF, ENC 2002).

For a longer time scale, the US faces a need for a sustainable nuclear fuel cycle, not only for economical, but for political reasons. The US has shown concerns about the nuclear fuel cycle globally. Especially there is a concern that know-how and nuclear material might spread to new regions of the world, leading to an increased risk of a misuse of the technologies. To face this risk and initiative called Global Nuclear Partnership (GNEP) has been taken. GNEP aims to be a fast track approach to form a global nuclear fuel cycle with actinide recycling relying partly on Gen IV technology. This obviously can help the Gen IV development, but only in this limited area. Other Gen IV goals such as a better uranium utilization, non-electric application are not major concerns in the GNEP.

4. Building public confidence for the Gen IV

Numerous surveys of nuclear issues over the last decades have generally concluded that the publics' major concerns with nuclear programs lie with serious reactor accidents such as Chernobyl; the deployment of nuclear weapons in global conflicts; and the long-term fate of the radioactive waste from nuclear power plants.

Gen IV reactors are designed to be even safer than the previous generations. Lessons have been learnt from the past, and they continue to be learnt even when no accidents occur. Gen IV reactors will be as simple as possible, and provide inherent safety. Also Gen IV 'fast breeder reactors' and a 'closed fuel cycle' will greatly improve the radioactive wastes. The reprocessing will produce more low and intermediate level waste, which we will try and minimize. The reduction of the total amount of radioactive material, resulting from the closed fuel cycle, makes it more difficult for a terrorist to get the material for a dirty bomb. At the same time, fast breeder reactors can be used to burn the existing plutonium, reducing the risk for proliferation.

Most of all, public involvement and public communication are key to public confidence. The methodology and techniques for providing information to the desired audiences very from country to country, according to social and economic factors, the degree of development of mass communications media, the literacy of the population, the credibility of certain groups or organizations either providing information or opposing the proposal, etc. However, certain principles are applied more or less universally when planning a communications program. The standard formula that encompasses these facts is often referred to as the R.A.C.E formula, an acronym for Research, Analyze, Communicate and Evaluate.

Firstly, **Research** what the public knows about Gen IV and then what their opinions are in relation to Gen IV is required before formulating any plan to inspire confidence in the Gen IV concept. To this end, varied and numerous polls and surveys are required to gauge and probe the public's opinion. In **Analyzing** the data from the relevant Research the concerns of the public must be taken at face value and all concerns, how ever illogical or ill-founded, should not be discounted. Within the realm of **Communication**, the appropriate information materials containing condensed and simplified technical details of the concept are prepared. This ensures that the level of familiarity with the Gen IV concept is raised in the general public and these in-turn aides in a people's confidence on the concept. Quantifying the actual impact of a program on public opinion is difficult statistically, thus a program needs to establish a baseline survey of public opinion before undertaken any program. Following on from this, program coordinators must seek to **Evaluate** the changes in public opinion.

5. Conclusion

We have discussed throughout this paper the need, for a smooth transition to and public confidence in Gen IV system.

Concerns over energy resource availability, climate change, air quality and energy security suggest an important role for Gen IV system in future energy supplies. To transit toward the extensive deployment of the Gen IV system, some major nuclear countries carry out their development strategies. Public involvement and public communication are key to public confidence of the Gen IV system. Some formula such as R.A.C.E could used to establish the building public confidence for the Gen IV system.

I hope this paper will contribute to the diffusion of knowledge and will be helpful in the development strategy about the Gen IV system.

REFERENCES

[1] 'A Technology Roadmap for Generation IV Nuclear Energy Systems Technical Roadmap Report', Nuclear Energy Research Advisory Committee by the Subcommittee on Generation IV Technology Planning.