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Key Assets for a Sustainable Low Carbon Energy Future

FRANK CARRE, French Commission for Nuclear and Alternative Energies, CEA - Research Centre of Saclay, 91191 Gif-sur-Yvette, Cedex, France

Since the beginning of the 21st century, concerns of energy security and climate change gave rise to energy policies focused on energy conservation and diversified low-carbon energy sources. Provided lessons of Fukushima accident are evidently accounted for, nuclear energy will probably be confirmed in most of today's nuclear countries as a low carbon energy source needed to limit imports of oil and gas and to meet fast growing energy needs. Future challenges of nuclear energy are then in three directions: i) enhancing safety performance so as to preclude any long term impact of severe accident outside the site of the plant, even in case of hypothetical external events, ii) full use of Uranium and minimization long lived radioactive waste burden for sustainability, and iii) extension to non-electricity energy products for maximizing the share of low carbon energy source in transportation fuels, industrial process heat and district heating. Advanced LWRs (Gen-III) are today's best available technologies and can somewhat advance nuclear energy in these three directions. However, breakthroughs in sustainability call for fast neutron reactors and closed fuel cycles, and non-electric applications prompt a revival of interest in high temperature reactors for exceeding cogeneration performances achievable with LWRs. Both types of Gen-IV nuclear systems by nature call for technology breakthroughs to surpass LWRs capabilities. Current resumption in France of research on sodium cooled fast neutron reactors (SFRs) definitely aims at significant progress in safety and economic competitiveness compared to earlier reactors of this type in order to progress towards a new generation of commercially viable sodium cooled fast reactor. Along with advancing a new generation of sodium cooled fast reactor, research and development on alternative fast reactor types such as gas or lead-alloy cooled systems (GFR & LFR) is strategic to overcome technical difficulties and/or political opposition specific to sodium. In conclusion, research and technology breakthroughs in nuclear power are needed for shaping a sustainable low carbon future. International cooperation is key for sharing costs of research and development of the required novel technologies and cost of first experimental reactors needed to demonstrate enabling technologies. At the same time technology breakthroughs are developed, pre-normative research is required to support codification work and harmonized regulations that will ultimately apply to safety and security features of resulting innovative reactor types and fuel cycles.