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Economics of new nuclear power plants – assessment of investments into Generation III, small modular reactors and non-light-water reactors

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Abstract. Given the need to combat climate change, as recently stressed again within the IPCC (2023) report, and the recent energy price increases for electricity and natural gas through the war in Ukraine (ECB, 2022), investments into new nuclear power plants are a considered option for future energy systems in some countries. In this paper, we discuss economic aspects of such investments, differentiating between three different types of reactor technology, as described in the following:

i. At present, the only viable option for an investment would be "Generation III" reactors, i.e., light-water reactors with high capacities (in the range of or above 1000 MW). The most recent projects of that type have been very expensive, though, and there is a controversy about whether future ones will become competitive (Wealer et al., 2021; Duan et al., 2022). Economic questions relate to economies of scale and the differences in costs between western reactors (USA, Europe) and those in Russia and China.

ii. In some countries, the development of and subsequent investments in light-water reactors of small power rating (< 300 MW) are pursued (e.g., in the US, Canada and the UK). These are sometimes called "small modular reactors" in the recent literature (Chu, 2010; IAEA, 2022). These concepts are surrounded by high uncertainty, and the paper proposes a methodology for economic analysis, based on previous literature (Rothwell, 2016; Roulstone et al., 2020; Boarin et al., 2021).

iii. A third option for newly built reactors is represented by non-light-water reactors, amongst which the classical sodium-cooled fast neutron reactor ("fast breeder") is the most advanced type as well as high-temperature reactors and molten-salt reactors. With the establishment of the GenIV International Forum in 2001, 14 member states, including the USA, China, Russia, the EURATOM states, and the United Kingdom, have joined forces with the shared objective of further developing non-light-water reactor concepts. The paper provides a methodology to assess the competitiveness of fast reactors and extends it to other non-light-water reactors.

The paper concludes with an assessment of the economics of new nuclear power plants going forward. Particular consideration is given to the aspects of decommissioning from the very outset, i.e., the planning of the new reactor. In that context, the paper will address the interdependencies between technology choices and storage issues, for example volume composition.

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