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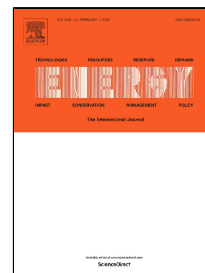
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Nuclear contribution to the penetration of variable renewable energy sources in a French decarbonised power mix

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Abstract

With the aim of targeting low-carbon energy mixes, variable renewable energy sources, i.e. wind and solar, are broadly promoted worldwide. In France, nuclear is the first contributor to today's low-carbon power mix and it will, tomorrow, be challenged by the increase of variable renewable energy sources. This paper develops a prospective approach to examine the solicitations that nuclear will have to face, for several scenarios. Results show that, with the penetration of renewable energy sources, the number of extreme nuclear power ramps and amplitudes variations increase, as well as the number of annually required shut-downs/start-ups events per reactor, even if the nuclear capacity was to be lowered. Beyond 30% wind and solar penetration, complementary flexibility options will have to be leveraged.

Keywords

flexibility; nuclear power plant; variable renewables; prospective; load-following; power system

1. Introduction

The transition towards low-carbon energy mixes is implemented through country-specific pathways. Greenhouse gases are mostly caused by energy production, which generates over than the two-thirds of greenhouse-gas emissions [1]. As a result, electricity production could be a key enabler towards lower carbon energy mixes. This is pointed out by the SET Plan Integrated Roadmap of the European Commission, which expects that electricity will have a greater role to play in the years to come [2]. Deeply reducing the carbon footprint of the energy system will require both decarbonising the power sector and promoting the role of electricity, especially through sector coupling (e.g. power-to-heat or power-to-mobility).

The decarbonisation of the power system is promoted by the general 3X20 European directive, with specific renewable penetration targets [3]. A binding target of at least 27% of renewable energy in the final energy consumption at the European level by 2030 will promote such a development [4].

In France, the power system is very specific. Indeed, it is a low-carbon one, mostly thanks to nuclear power which supplies approximately the three quarters of the demand. In 2015, the French nuclear plants supplied 87% of the domestic demand, 76% of the total demand,

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