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Security of supply in a carbon-free electric power system: the case of Iceland

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Abstract— Security of supply and progressively climate change are guiding countries' energy policy worldwide. Iceland is a paradigmatic example of gaining energy independence and decarbonizing the power sector while meeting its growing demand. In this paper, we focus on some of the main generation and transmission expansion alternatives that the country is considering for the next decade in an environment dominated by an increasing demand and a generation mix with virtually zero variable cost. We assess the medium- to long-term dimensions of security of supply as determinants of the system configuration and resources utilization. Based on a stochastic hydrothermal scheduling model that includes DC power flows and generation expansion decisions, our analysis indicates that hydro, geothermal and wind renewable resources are more competitive than fossil fuels, while demand flexibility can also contribute to gain security of supply at comparable costs. In addition, our methodology incorporates a detailed bilateral contracting structure typically used by Icelandic generators and consumers to agree on power prices and negotiated curtailments. The modeling and security evaluation could be of interest in other countries and regions where inflexible thermal generation and hydro resources create a market characterized by prices that are close to zero during long periods, but spike when resources are scarce.

Index Terms— Security of supply; Energy independence; Decarbonization; Renewable energy; Hydrothermal scheduling

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