Potential Role of Fusion Power Generation in a very long term Electricity Supply perspective: case of Western Europe

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Abstract

The objective of this paper is to explore the potential role of fusion power in future electricity supply mixes in global scale and to quantify its advantages and possible drawbacks. A general assessment of the electricity system in Western Europe is performed at its current and anticipated state, estimating generic technical and economical performances of existing and prospective power generation technologies, and building on this basis consistent electricity markets scenarios for the time horizon 2100. Various types of scenarios are examined, including "business as usual" and several explorative scenarios presuming different market shares of fusion, nuclear fission and clean coal with CO_2 capture and sequestration. Evaluation of different technology mixes is carried out from technical, economical and environmental (CO_2) points of view.

The methodology includes the use of the PLANELEC-PRO least cost electricity systems planning model developed by LASEN / EPFL. It determines the expansion plans of the power generating system, which adequately meet electricity demand at minimum cost while respecting constraints given by the user, such as CO_2 emissions and quality of service. Competitiveness of fusion power generation is estimated through two indicators: the impact of various market shares of fusion power on the levelised electricity production cost and the total accumulated CO_2 emissions along the period of study.

It is found that deployment throughout the period 2040 – 2100 of total 90 GW of fusion power in Western Europe is capable to reduce approximately up to 10 % of the total system CO_2 emissions by the end of the century compared to a baseline case. This limited introduction of fusion power causes a slight increase of the system levelised electricity production cost of the order of magnitude € 0.001/kWh. The estimated incremental CO_2 abatement cost of fusion power is € 11.5 / t CO_2. These results, however, are significantly dependent on the assumptions of future fuel prices and parameters of the candidate power generation technologies.