Analysing the role of fusion power in the future global energy system

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ABSTRACT

In a global energy system threatened by climate change, depletion of conventional energy resources, increasing instability in historical energy regions, and a continuing demand growth, nuclear fusion comes out as an alternative technology with a potential role in the future global sustainable energy system. In order to analyse this potential role, a prospective analysis over a long time has to be performed.

The EFDA Times Model (ETM), developed within the European Fusion Development Agreement (EFDA), aims at providing the optimum energy system composition in terms of social wealth and sustainability including fusion as an energy option. Two framework scenarios are defined as follows:

- Base case scenario: there is no limit to CO_2 emissions
- 450ppm scenario: a limit of 450ppm in CO_2 concentrations is set by 2050

For these framework scenarios, conservative assumptions on fusion costs, energy demand and Uranium resources have been taken. Technical and economic data for fusion technology in the model are based on detailed studies within fusion research during the last three decades. New technology options and constraints have been added to the model for sensitivity analyses to the framework scenarios such as infrastructure for long-distance transmission of electricity from wind and solar from deserts, and large-scale urban heat networks are considered for regions with cold climate, e.g. Europe, North America and China.

Moreover, benchmarking analysis has been carried out to check the ETM model results alignment with some of the most important long and medium term scenarios (IPCC B1 and A1C, IIASA A1, IEA ETP 2008 and WEO 2008 reference scenarios).

Preliminary results show that in a base case scenario, with no measures for CO_2 emission reductions, coal technologies play a dominant role in the global power production in 2100. Fission technologies supply also an important amount of the global electricity by 2100 experiencing a big increase from 2040. Wind and hydro are the only renewable technologies, having a very small share in the global power generation. In this scenario, fusion does not enter the energy system.

When CO_2 emission restrictions are imposed, the global energy system composition changes completely. In a 450ppm scenario, coal technologies disappear in a few decades, being mainly replaced by nuclear fission technologies which experience a great increase when constrained only by Uranium resources exhaustion. Fission technologies are then gradually replaced by fusion power plants that become responsible of almost half of the global electricity production by 2100. Also wind and hydro play an important role in 2100.

To conclude the work, a sensitivity analysis will be presented on the key parameters that affect the possible role of fusion in the future global energy system.