Session 2: Overview on Social Research on Fusion

Modelling future Energy Scenarios: EFDA TIMES

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Some questions about the future global electricity system

What will be the Global Electricity System composition in 2100?

What will be the share of the electricity generated by fusion power plants in 2100?

Would fusion be competitive in the future electricity market?

At what extent will fusion contribute to meet the global environmental targets?

Energy models and scenarios

Energy models are computer tools to analyse the behaviour of the energy system at a medium and long term under different environmental and energy policies.

Scenarios are not predictions either forecasts. Scenarios explore the future and discuss how to shape it with a rational discourse [1]

EFDA Times Model (ETM)

The EFDA Times model (ETM) has been built in the framework of the European Fusion Development Agreement, within the Socio-Economic Research on Fusion project (SERF)

ETM uses the TIMES model generator developed by IEA-ETSAP (IEA Energy Technology Systems Analysis Programme Implementing Agreement)

First version was produced in 2004. Last version in 2012
Model description

The EFDA Times Model is a

✓ Multi-regional, global, and long-term energy model of economic equilibrium, covering the entire energy system from mining to final consumption

✓ Optimization model which aims at providing the optimum energy system composition in terms of social wealth and sustainability at the minimum cost

✓ Bottom-up, technology rich model with thousand of technologies well defined by technical, economic and environmental data
Model structure

The Reference Energy System
Main ETM objective

To develop consistent long-term energy scenarios containing fusion as an energy option, and showing the potential benefits of fusion power as an emission free energy source

What makes ETM singular?

Unlike other global energy models, ETM describes the whole fusion sector from Lithium extraction to electricity production by fusion plants

Advanced nuclear fission fuel cycle although described in detail into the model
Market equilibrium

Source: ETSAP (http://www.etsap.org/Images/MT_Results.jpg)
- 17 world regions: Africa, Australia-New Zealand, Brazil, Central Asia and Caucasus, Canada, China, Europe, India, Japan, Middle East, Mexico, Other Developing Asia, Other Eastern Europe, Other Latin America, Russia, South Korea, and United States
- Time horizon: 2100
- Six time slices: three seasons (winter, summer and intermediate), and day/night
- Demand sectors: residential, commercial, agriculture, industry, and transportation
- Supply sectors: electricity and heat production, and upstream/downstream
- Demand scenarios: energy demand driver projections from the general equilibrium models GEM-E3 and Gtap
- Trade: inter-regional exchange process (trade of commodities) among the different regions
Fusion technologies in the model

Fusion power plants economic data [2] [3]

<table>
<thead>
<tr>
<th></th>
<th>Start</th>
<th>Life</th>
<th>AF</th>
<th>INV (€/kW)</th>
<th>FIXOM (€/kW)</th>
<th>VAROM (€/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic plant</td>
<td>2050</td>
<td>40</td>
<td>85%</td>
<td>3940 (10th) 2950 (100th)</td>
<td>65.8</td>
<td>2.16 (2050) 1.64 (2060)</td>
</tr>
<tr>
<td>Advanced plant</td>
<td>2070</td>
<td>40</td>
<td>85%</td>
<td>2820 (10th) 2170 (100th)</td>
<td>65.3</td>
<td>2.14 (2070) 1.64 (2080)</td>
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Other technologies

✓ Current and future Nuclear Fission Fuel Cycle technologies including spent fuel reprocessing
✓ Concentrating Solar Power with energy storage
✓ New biofuels and electric vehicles
✓ .....