Energy transition in Belgium – Choices and costs

Press conference
30/01/2017
Energy system model – TIMES

Background

TIMES is a Model Generator for ‘techno-economic energy system models’

Developed by the
- Energy Technology Systems Analysis Programme (ETSAP)

Coordinated by the IEA (International Energy Agency, Paris)

Members of ETSAP and TIMES (or MARKAL) users all over the world

VITO/EnergyVille is a contracting partner of ETSAP for over 20 years

More information under http://www.iea-etsap.org
Energy system model – TIMES

Background

- Representation ‘reference energy system’ (by process)
Energy system model – TIMES
Building and using a TIMES model

The EnergyVille TIMES model for Belgium

- Belgium as geographic region with interconnections to neighbouring countries
- Energy Statistics from 2014 (corrected for 2016 data where available) as the base for the model
- Reporting years in the study are 2016, 2020 and 2030, but the model calculates outcome for every year over the horizon
- The model balances supply and demand during every moment in time. This applies to the whole energy system:
  - Electricity
  - Heat
- and sector:
  - Industry
  - Commercial
  - Residential
  - Agriculture
  - Transport
- To capture variations in balancing demand and supply a 2-hourly time resolution is used.
In collaboration with the Febeliec steering committee, EnergyVille defined base assumptions and scenario definitions.

EnergyVille calculates possible development paths (scenarios) of the energy system.

The model chooses for the overall energy system the cost-minimizing solution; for the central scenario and each sensitivity scenario till 2030.

Existing support mechanisms (subsidies, green certificates, ...) are not taken into account as these are a way of financing.
## Energy system model – TIMES

### Assumptions - Technologies

<table>
<thead>
<tr>
<th>Technology Name</th>
<th>Existing Capacity (GW, 2014)</th>
<th>Model Assumptions</th>
<th>Sensitivity Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Power Plants</td>
<td>4.54</td>
<td>• no restrictions</td>
<td></td>
</tr>
<tr>
<td>Coal Power Plants</td>
<td>0.56</td>
<td>• no new investments</td>
<td></td>
</tr>
<tr>
<td>Combined Heat &amp; Power (CHPs)</td>
<td>2.37</td>
<td>• no restrictions</td>
<td></td>
</tr>
<tr>
<td>Biomass Plants</td>
<td>0.39</td>
<td>• no restrictions</td>
<td></td>
</tr>
<tr>
<td>Solar PV</td>
<td>2.93</td>
<td>• no restrictions</td>
<td></td>
</tr>
<tr>
<td>Wind Onshore</td>
<td>1.51</td>
<td>• up to 8.6 GW total capacity possible</td>
<td></td>
</tr>
<tr>
<td>Wind Offshore</td>
<td>0.712</td>
<td>• &lt; 2.2 GW: existing grid infrastructure sufficient • &gt;2.2 GW: additional grid investments required</td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>5.93</td>
<td>• Complete nuclear phase-out according to Belgian policy from 2022 to 2025</td>
<td>Nuclear Extension Scenario: • 2.0 GW capacity till 2035</td>
</tr>
<tr>
<td>Interconnections to neighbouring countries</td>
<td>3.5</td>
<td>• Investments under execution: increase to 6.5 GW total capacity by 2020 (ALEGrO, NEMO, Brabo II and III) • Additional investment possible</td>
<td>Import Restriction Scenario: • max. 10% compared to Belgian generation allowed from electricity imports on every time period</td>
</tr>
</tbody>
</table>
### Other Assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Current status</th>
<th>Model Assumptions Central scenario</th>
<th>Sensitivity Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of renewable generation in final energy consumption (EU Policy goal)</td>
<td>Belgian target: 13% in 2020</td>
<td>• Target of 13% in 2020 and 2030</td>
<td></td>
</tr>
<tr>
<td>CO₂ price assumptions for ETS sector</td>
<td></td>
<td>• EU ETS: 17€/ton in 2020 and 33€/ton in 2030</td>
<td></td>
</tr>
</tbody>
</table>
| Natural gas and oil prices                                               | Observed market prices for 2014 and 2016 | • Prices projections based on World Energy Outlook 2015 (OECD):  
  • Crude oil: 60 €/bbl in 2020 and 85 €/bbl in 2030,  
  • Natural gas: 20 €/MWh in 2020 and 27 €/MWh in 2030 | Low Fuel Price Scenario:  
  • crude oil at 35 €/bbl in 2020 and 2030,  
  • natural gas at 13 €/MWh in 2020 and 2030 |
|                                                                           |                                     |                                             | High Fuel Price Scenario:  
  • crude oil at 90 €/bbl in 2020 and 2030,  
  • natural gas at 30 €/MWh in 2020 and 2030 |                                            |
Technology assumptions

EnergyVille screens international literature/papers to make use of the latest available cross checked figures (see also our fact checks)

Taking into account learning rates for technologies
Model Results

Central Scenario
Model Results Central scenario – the Big Picture

Electricity generation transition, 2016 to 2030:

- Fossil-fuel generation grows from 24 to 35 TWh
- Nuclear phases out from 43 (55% of the total) to 0 TWh
- Renewable generation increases from 11 to 36 TWh
- 50% of Belgian generation originates from renewable sources in 2030
Model Results Central scenario – the Big Picture

Electricity generation capacity, 2016 to 2030:

- Fossil-fuel generation capacity close to stable (mostly natural gas)
- Nuclear phases out
- Renewable capacity grows from 6 to 19 GW (x3)
Model Results Central scenario – the Big Picture

Electricity demand, 2016 to 2030:

- Fairly stable demand for electricity
- Projections see slight reduction in commercial and residential sector
  - Mostly due to energy savings measures, in contrast with projected growth
- By 2030 demand of 4 TWh for electrical road transport (electrical cars)
Model Results Central scenario – in depth

Renewable electricity generation, 2016 to 2030:

- **Wind Onshore:** from 3.2 to 18.2 TWh (x5.7)
- **Wind Offshore:** from 2.5 to 7.8 TWh (x3)
- **PV Solar:** from 2.9 to 7.8 TWh (x2.7)
Model Results Central scenario – in depth

Renewable generation capacity, 2016 to 2030:

- **Wind Onshore:** from 1.5 to 8.6 GW (x5.7)
  - 8.6 GW set as a max. capacity expansion limit (and selected 100%)
- **Wind Offshore:** from 0.7 to 2.2 GW (x3)
  - 2.200 MW = current concessions
- **PV Solar:** from 3.0 to 7.9 GW (x2.7)
- 74% of generation capacity is mainly intermittent renewable based by 2030
Model Results Central scenario – in depth

Fossil fuel electricity generation, 2016 to 2030:

Natural gas plants increase generation from 21 to 32 TWh
Model Results Central scenario – in depth

Fossil fuel generation capacity, 2016 to 2030:

- Natural gas plant capacity remains above 6 GW
  - Same capacity provides more generation output (= more operating hours)
Model Results Central scenario – in depth

Electricity Net import, 2016 to 2030:

- Interconnection capacity increases from 3,5 to 6,5 GW till 2020
- Increase of electricity net import from 6,3 to 15,6 TWh (x2.5)
  - See 10% import scenario for sensitivity analysis
Model Results Central scenario – in depth

CO₂ emissions, 2016 to 2030

CO₂ Emissions for public electricity & heat generation (IPCC, CRF sector 1.A.1.a)

- Decreases from 15 to 12 Mton/y CO₂ emissions till 2020
- Increase to 19 Mton/y in 2030 due to increased natural gas usage
  - CO₂ reduction due to electrification in other sectors not shown
Model Results Central scenario – in depth

Annual costs electricity production + import, 2020 - 2030

- Total cost increase from 2.7 (2020) to 6.1 (2030) billion Euro (x2.3).
- Highest cost increases in
  - Fuel costs (x3)
  - Electricity import costs (x3)
  - Investment costs (x2)
## Comparison of scenarios in 2030

<table>
<thead>
<tr>
<th>Scenario Power sector</th>
<th>2016</th>
<th>Central</th>
<th>10% Import restriction</th>
<th>Fuel price high</th>
<th>Fuel price low</th>
<th>Nuclear extension 2 GW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacities (GW)</td>
<td>19,9</td>
<td>25,8</td>
<td>27,2</td>
<td>27,7</td>
<td>25,3</td>
<td>25,8</td>
</tr>
<tr>
<td>RES total</td>
<td>6,1</td>
<td>19,1</td>
<td>18,2</td>
<td>23,5</td>
<td>17,4</td>
<td>18,9</td>
</tr>
<tr>
<td>solar PV</td>
<td>3,0</td>
<td>7,9</td>
<td>7,0</td>
<td>12,1</td>
<td>6,2</td>
<td>8,3</td>
</tr>
<tr>
<td>wind onshore</td>
<td>1,5</td>
<td>8,6</td>
<td>8,6</td>
<td>2,5</td>
<td>8,6</td>
<td>5,6</td>
</tr>
<tr>
<td>wind offshore</td>
<td>0,7</td>
<td>2,2</td>
<td>2,2</td>
<td>0</td>
<td>2,2</td>
<td>8,6</td>
</tr>
<tr>
<td>nuclear</td>
<td>5,9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2,0</td>
</tr>
<tr>
<td>fossil</td>
<td>7,9</td>
<td>6,7</td>
<td>9,0</td>
<td>4,1</td>
<td>7,9</td>
<td>4,9</td>
</tr>
<tr>
<td>net import</td>
<td>6,5</td>
<td>6,5</td>
<td>6,5</td>
<td>7,5</td>
<td>6,5</td>
<td>6,5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Production Belgium (TWh)</th>
<th>78,3</th>
<th>71,0</th>
<th>79,1</th>
<th>55,7</th>
<th>78,0</th>
<th>72,2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RES</td>
<td>11,0</td>
<td>35,8</td>
<td>34,9</td>
<td>40,9</td>
<td>34,2</td>
<td>34,2</td>
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<tr>
<td>nuclear</td>
<td>43,0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15,0</td>
</tr>
<tr>
<td>fossil</td>
<td>24,3</td>
<td>35,1</td>
<td>44,2</td>
<td>14,8</td>
<td>43,9</td>
<td>23,2</td>
</tr>
<tr>
<td>net import</td>
<td>6,3</td>
<td>15,6</td>
<td>6,2</td>
<td>28,4</td>
<td>7,9</td>
<td>14,4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional costs electricity (to 2016) (billion Euro)</th>
<th>/</th>
<th>4,38</th>
<th>4,39</th>
<th>4,60</th>
<th>3,02</th>
<th>3,68</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ emissions (Mton)</td>
<td>15,4</td>
<td>19,3</td>
<td>22,5</td>
<td>11,6</td>
<td>22,9</td>
<td>14,7</td>
</tr>
</tbody>
</table>