Modelling net zero emissions

Common findings to German, Nordic and French examples

Technical Dialogue 3
Copenhagen, 27 February 2019
1. Evolution of GHG emissions

Gross CO2, non CO2 emissions & sinks in (almost) neutral year 2050, indexed to gross GHG emissions of the historic year of reference*

<table>
<thead>
<tr>
<th>Gross CO2</th>
<th>Non CO2</th>
<th>Sinks</th>
<th>Gross CO2</th>
<th>Non CO2</th>
<th>Sinks</th>
<th>Gross CO2</th>
<th>Non CO2</th>
<th>Sinks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 95 (Germany)</td>
<td></td>
<td></td>
<td>Nordic (Denmark, Sweden, Norway)</td>
<td></td>
<td></td>
<td>nW 2017 (France)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

-94% \hspace{2cm} -61% \hspace{2cm} -58% \hspace{2cm} n.a. \hspace{2cm} -94% \hspace{2cm} -60% compared to historic year of reference*

* For Nordic, gross CO2 emissions only. The historic reference year is respectively: 2010 (CS 95, Nordic), 2015 (nW 2017).

** For Nordic, included in energy industries.

*** For Nordic, included in industry.

Legend:
- Energy industries incl. fugitive emissions
- Industry incl. process emissions
- Buildings
- Transport incl. international air and maritime
- Waste**
- Agriculture***
- LULUCF (Sink)
- BECCS

Germany
Lukas Emele, Öko-Institute

France
Yves Marignac, Ass. négaWatt

Denmark
Stefan Petrovic, DTU
2. Energy carriers / primary energy sources

Share of energy sources / carriers in primary / final energy consumption in (almost) neutral year 2050*

- For Nordic, primary energy used for exported electricity is included.
# 3. Energy demand

<table>
<thead>
<tr>
<th></th>
<th>CS 95 (Germany)</th>
<th>Nordic (Denmark, Sweden, Norway)</th>
<th>nW 2017 (France)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year of reference</strong></td>
<td>2010</td>
<td>2010</td>
<td>2015</td>
</tr>
<tr>
<td><strong>Primary energy, compared to historic reference</strong></td>
<td>-55%</td>
<td>-26%</td>
<td>-65%</td>
</tr>
<tr>
<td><strong>Final energy, compared to historic reference</strong></td>
<td>-53%</td>
<td>-23%</td>
<td>-57%</td>
</tr>
<tr>
<td>… in industry</td>
<td>-43%</td>
<td>-23%</td>
<td>-51%</td>
</tr>
<tr>
<td>… in residential</td>
<td>-58%</td>
<td>-23%</td>
<td>-63%</td>
</tr>
<tr>
<td>… in tertiary</td>
<td>-57%</td>
<td>-23%</td>
<td>-54%</td>
</tr>
<tr>
<td>… in transport</td>
<td>-57%</td>
<td>-23%</td>
<td>-60%</td>
</tr>
</tbody>
</table>
4. Common challenges for modelling

- **Extending the models:**
  - broaden the scope to all GHG emissions, starting with energy system / market models
  - integrate more cross-sectorial and “life cycle” analysis
    (especially when taking into account sustainability issues beyond climate change)

- **Shifting in optimisation:**
  - beyond meeting net zero, need to minimize the cumulative amount of emissions (carbon budget)
  - consider the need for prolonged negative emissions afterwards
  - assess the potential for increasing natural sinks and/or deploying artificial ones (CCS, BECCS)

- **Taking care of footprint issues:**
  - integrate international airplane and ship transport (usually not accounted for)
  - discuss the need and conditions for mutualizing resources (biomass) and energy security (grid)
  - consider the impact of domestic changes on global emissions
    (ideally, develop a model of the carbon footprint of good and services)
5. Potentials and options

- **Various balance of action** on demand (reducing the need for GHG emitting processes) and supply (substituting low or non emitting resources and processes to emitting ones)

- **Energy demand:**
  - Some energy efficiency is needed to allow for low-carbon energy supply to meet demand
  - Further effort, including sufficiency, can reduce the technological challenge of substituting supply

- **Energy supply:**
  - Balancing the use of energy carriers according to the availability of sustainable renewable resources and the potential for substituting in different sectors (focus on transports)
  - Developing electric renewables (wind and PV) is generally less constrained than developing bioenergy, which remains however much needed

- **GHG emissions:**
  - CO₂ in the energy system can generally be more reduced than other GHG emissions
  - Non energy emissions (agriculture, industrial processes) become prioritary
  - Carbon sinks are needed, but various visions about removal by LUCLUF and/or CCS and BECCS