Energy scenarios
A review of IEA's World Energy Outlook
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Introduction
What does methodology and model

- Authoritative reference document
  - Van de Graaf (2012)
  - Heubaum and Bierman (2015)
- Scenario approach to energy
- Debate and dispute
  - Midttun and Baumgartner (1986)
  - Gaede and Meadowcraft (2016)
- Methodology and model
Model and methodology

IEA's World Energy Model (WEM): General overview

- Supply
  - Coal
  - Oil
  - Gas
  - Biomass

- Primary demand
  - Coal
  - Oil
  - Gas
  - Nuclear
  - Hydro
  - Bioenergy
  - Renewables

- Conversion
  - Coal upgrading
  - Refining
  - Gas processing
  - Power generation
  - Heat production
  - Biomass process

- Final demand
  - Industry
  - Feedstock
  - Transport
  - Residential
  - Services
  - Agriculture

- Demand drivers
  - Value added
  - Person kilometer
  - Ton kilometer
  - Household size
  - Floor space
  - Appliances ownership

Energy and the macro economy

Energy demand allowed to diverge between scenarios...

- Drivers of energy demand
  - Economic growth
  - Technological change
  - Structural change
  - Prices and policies

Energy and the macro economy
... but economic growth is the same across scenarios

- Drivers of energy demand
  - Economic growth
  - Technological change
  - Structural change
  - Prices and policies
- Exogenous economic growth
  - No variation across scenarios

Primary energy demand and GDP
Average annual growth (per cent)

<table>
<thead>
<tr>
<th>Year</th>
<th>Current Policies</th>
<th>New Policies</th>
<th>450 Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013-2020</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2021-2040</td>
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<td>2013-2040</td>
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</tbody>
</table>


Energy technology
“Black swan” - or “Slow train coming”?

<table>
<thead>
<tr>
<th>Technology</th>
<th>Change 2014-2040 (per cent; New Policies Scenario)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar energy (PV)</td>
<td>-60</td>
</tr>
<tr>
<td>Onshore wind</td>
<td>-40</td>
</tr>
<tr>
<td>CCS</td>
<td>-20</td>
</tr>
<tr>
<td>Vehicle batteries</td>
<td>0</td>
</tr>
<tr>
<td>Efficient lighting</td>
<td>20</td>
</tr>
<tr>
<td>Upstream oil and gas</td>
<td>60</td>
</tr>
</tbody>
</table>


- Means to an end
- Modelling strategy
- Prices and policies
- Economic behaviour
- Role of uncertainty
New renewable energy

Installed capacity (GW), New Policies Scenario

Solar energy

Wind power

The gravity of status quo

Potential bias in data generation, modelling, and application

- Broadness & detail have a cost
- Model short on flexibility
- Assumptions are crucial
- Stakeholder interests
- Transparency is key

Primary energy demand by carrier
2000-2040 (bn toe, New Policies Scenario)