Energy Technology Perspectives 2017
Catalysing Energy Technology Transformations

Dr. Uwe Remme, IEA
wholeSEM Annual Conference, 3 July 2017, London
Scenarios and Modelling
- Where do we need to go?

Statistics and trends
- Where are we today?

Technology Roadmaps
- How do we get there?
Global CO₂ emissions flat for 3 years – an emerging trend?

IEA analysis shows that global CO₂ emissions remained flat in 2016 for the third year in a row, even though the global economy grew, led by emission declines in the US and China.
How far can technology take us?

Pushing energy technology to achieve carbon neutrality by 2060 could meet the mid-point of the range of ambitions expressed in Paris.
The potential of clean energy technology remains under-utilised

<table>
<thead>
<tr>
<th>Technology</th>
<th>Status</th>
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<tbody>
<tr>
<td>Solar PV and onshore wind</td>
<td>On track</td>
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<tr>
<td>Energy storage</td>
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<td>Electric vehicles</td>
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<tr>
<td>Nuclear</td>
<td>Accelerated improvement needed</td>
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<tr>
<td>Transport – Fuel economy of light-duty vehicles</td>
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<td>Energy-intensive industrial processes</td>
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<tr>
<td>Lighting, appliances and building equipment</td>
<td></td>
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<tr>
<td>More efficient coal-fired power</td>
<td>Not on track</td>
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<tr>
<td>Carbon capture and storage</td>
<td></td>
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<tr>
<td>Building construction</td>
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<tr>
<td>Transport biofuels</td>
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Recent progress in some clean energy areas is promising, but many technologies still need a strong push to achieve their full potential and deliver a sustainable energy future.
IEA energy modelling and scenarios

- **Forecasts (next 5 years)**: Medium-term Market Reports

- **Market-based scenarios (out to 2040)**: World Energy Outlook

- **Long-term planning scenarios (out to 2060)**: Energy Technology Perspectives

- **System Integration**: Analysis of flexibility resources/market design for vRE
ETP modelling framework

Primary energy
- Renewables
- Fossil
- Nuclear

Conversion sectors
- Electricity and heat generation
- Fuel conversion
- Fuel/heat delivery
- Electricity T&D

Final energy
- Electricity
- Gasoline
- Diesel
- Natural gas
- Heat
- etc.

End-use sectors
- Industry
- Buildings
- Transport
- Mobility Model (MoMo)

Service demands
- Material demands
- Space heating
- Water heating
- Lighting
- Passenger mobility
- Freight transport

ETP-TIMES Supply model (bottom-up optimisation)

- Four soft-linked models based on simulation and optimisation modelling methodologies
- Model horizon: 2014-2060 in 5 year periods
- World divided in 28-42 model regions/countries depending on sector
- For power sector linkage with TIMES dispatch model for selected regions to analyse electricity system flexibility
Decarbonising electricity

Renewables dominate electricity generation in the 2DS and B2DS. Thanks to bioenergy with CCS, the average global CO₂ intensity falls below zero after 2050.
Systems Integration is essential for a sustainable energy future

We need to move away from a one-directional energy delivery philosophy
Systems Integration is essential for a sustainable energy future

We need to move away from a one-directional energy delivery philosophy to a digitally-enhanced, multidirectional and integrated system that requires long-term planning for services delivery.
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Modelling challenges

- Temporal resolution, e.g. variable renewables
- Uncertainties, e.g. technology development
- Looking beyond the energy system: water, materials,…
- Consumer behavior, e.g. demand response, new services
- Spatial location of supply and demand, e.g. transmission needs for renewables, decentralised generation
Spatial analysis of renewable potentials: Example onshore wind

- Analysis of onshore wind potential

- Onshore wind potential differentiated by capacity factor, distance to cities and population size
Spatial analysis of renewable potentials: Onshore wind in China

<500km from cities
Can we change the landscape of transport?

The transportation sector already experiences technological change, but won’t shed its oil dependency without assertive policies.

<table>
<thead>
<tr>
<th>Year</th>
<th>Light-duty Vehicles (millions)</th>
<th>Heavy-Duty Vehicles (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Gasoline ICE</td>
<td>Gasoline ICE</td>
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<td></td>
<td>Diesel ICE</td>
<td>Diesel ICE</td>
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<tr>
<td></td>
<td>CNG/LPG</td>
<td>CNG/LPG</td>
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<tr>
<td></td>
<td>Hybrids</td>
<td>Hybrids</td>
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<tr>
<td></td>
<td>Electric &amp; FCV</td>
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</tr>
</tbody>
</table>

The transportation sector already experiences technological change, but won’t shed its oil dependency without assertive policies.
Around 145 EJ of sustainable bioenergy is available by 2060 in IEA decarbonisation scenarios, but gets used differently between the 2DS and the B2DS.
Conclusions

- Early signs point to changes in energy trajectories, helped by policies and technologies, but progress is too slow

- An integrated systems approach considering all technology options must be implemented now to accelerate progress

- Each country should define its own transition path and scale-up its RD&D and deployment support accordingly

- Achieving carbon neutrality by 2060 would require unprecedented technology policies and investments

- Innovation can deliver, but policies must consider the full technology cycle, and collaborative approaches can help
Explore the data behind ETP

www.iea.org

www.iea.org/etp

www.iea.org/statistics