Three scenarios to explore the energy transition

**CO₂ emissions from energy use**

- **Rapid**
- **Net Zero**
- **Business-as-usual**
- **IPCC 2°C Median**
- **IPCC 1.5°C Median**

Ranges show 10th and 90th percentiles of IPCC scenarios, see pp 150-151 of *Energy Outlook* for more details.
Key questions

1. What DO we know?
2. How has Covid-19 affected the outlook?
3. How might oil demand be affected by the mobility revolution?
4. What role could natural gas play in the energy transition?
5. Just how quickly will renewables grow over time?
6. How will electricity and power markets shape the future?
7. What role for hydrogen and bioenergy?
8. What are the dangers of delaying the energy transition?
Changing structure of global energy demand

**Fossil fuels**

<table>
<thead>
<tr>
<th>Shares of primary energy</th>
<th>2018</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2045</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business-as-usual</td>
<td>100%</td>
<td>90%</td>
<td>80%</td>
<td>70%</td>
<td>60%</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>Rapid</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Net zero</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
</tbody>
</table>

**Renewables***

<table>
<thead>
<tr>
<th>Shares of primary energy</th>
<th>2018</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2045</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Net zero</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Business-as-usual</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
</tbody>
</table>

**Electricity**

<table>
<thead>
<tr>
<th>Share of total final consumption</th>
<th>2018</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2045</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Net zero</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
</tbody>
</table>

*Renewables includes wind, solar, geothermal, biomass, biomethane and biofuels and excludes large-scale hydro.
Changing structure of global energy system

Shares of primary energy in Rapid

*Nuclear and hydroelectricity
Key questions

1. What DO we know?
2. How has Covid-19 affected the outlook?
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Impact of Covid-19 in *Rapid*

Alt case*: Greater impact from Covid-19

% change as a result of Covid-19

-2%  -4%  -6%  -8%  -10%  -12%

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP</th>
<th>Primary energy</th>
<th>Oil demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td>-12%</td>
<td>-10%</td>
<td>-8%</td>
</tr>
<tr>
<td>2050</td>
<td>-12%</td>
<td>-10%</td>
<td>-8%</td>
</tr>
</tbody>
</table>

*Alternative case showing the impact if Covid-19 leads to higher economic losses
Key questions

1. What DO we know?
2. How has Covid-19 affected the outlook?
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Outlook for oil demand

Oil consumption

Change in oil demand, 2018-2050

1) includes 2/3 wheelers
2) trucks and buses
3) aviation, marine and rail
Mobility revolution: electrification, shared-mobility and autonomy

Share of car and truck VKM¹ electrified²

- **Rapid**
- **Net Zero**
- **Business-as-usual**

Robotaxi share of passenger car VKM¹ powered by electricity

---

¹ vehicle kilometres
² includes buses
Key questions

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Outlook for natural gas

Natural gas consumption

- **Rapid**
- **Net Zero**
- **Business-as-usual**

Bcm

- 0 1000 2000 3000 4000 5000 6000


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Supporting role of natural gas

Rapid vs. Business-as-usual: India and Other Asia

Differences in shares of primary energy

- Non-fossil*
- Oil
- Coal
- Natural gas

*Renewables, nuclear and hydroelectricity
Natural gas as a source of near-zero carbon energy

Share of natural gas abated¹ and unabated

- **Rapid**
  - Unabated: 100%
  - Abated: 0%

- **Net Zero**
  - Unabated: 80%
  - Abated: 20%

- **Business-as-usual**
  - Unabated: 60%
  - Abated: 40%

Natural gas with CCUS as a share of primary energy

- **Rapid**
  - Blue hydrogen²: 8%
  - Direct energy use: 92%

- **Net Zero**
  - Blue hydrogen²: 6%
  - Direct energy use: 94%

- **Business-as-usual**
  - Blue hydrogen²: 2%
  - Direct energy use: 98%

1) Direct use of natural gas with CCUS plus natural gas as input to blue hydrogen

2) Blue hydrogen is extracted from natural gas (or coal), with the carbon dioxide by-product being captured via CCUS.
Key questions

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Renewable energy in power

Renewable energy used in power sector*

Cost of wind and solar energy

*On a primary energy basis (see Energy Outlook p154 for more details)
Key questions

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Electricity demand

Share of electricity in total final consumption

Change in electricity demand by sector, 2018-2050

- **Rapid**
- **Net Zero**
- **Business-as-usual**

<table>
<thead>
<tr>
<th>Year</th>
<th>Rapid</th>
<th>Net Zero</th>
<th>Business-as-usual</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td></td>
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<td></td>
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<td>2040</td>
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<tr>
<td>2050</td>
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</tbody>
</table>

- Transport
- Industry
- Buildings

TWh

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Energy Outlook / bp week: September 2020
Global power generation

Share of global power generation by energy source

Rapid

Net Zero

Business-as-usual

Wind & solar
Coal
Natural gas
## Technologies to help balance the power sector

<table>
<thead>
<tr>
<th></th>
<th>Seconds</th>
<th>Minutes</th>
<th>Hours</th>
<th>Days</th>
<th>Weeks</th>
<th>Seasons</th>
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</thead>
<tbody>
<tr>
<td>Batteries</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pumped Hydro</td>
<td></td>
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<tr>
<td>Demand response and rescheduling</td>
<td></td>
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<tr>
<td>Hydro with high-capacity reservoirs</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Gas (or coal) with CCUS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bioenergy with or without CCUS</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- **Not applicable / expensive**
- **Less advantaged**
- **Most advantaged**
Key questions

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Consumption and production of hydrogen

Hydrogen use by sector

Hydrogen production by type

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Wind and solar capacity

Annual average increase in wind and solar capacity

- **Rapid**
- **Business-as-usual**
- **Net Zero**
- **Net Zero with 100% green hydrogen**

GW

0 200 400 600 800 1000 1200 1400

Bioenergy in *Rapid* and *Net Zero*

### Shares of primary energy

**Rapid**
- By sector:
  - Power: 6%
  - Transport: 6%
  - Buildings: 2%
  - Industry: 2%
  - Biomethane: 4%
  - Biomass: 4%
  - Biofuels: 2%

**Net Zero**
- By sector:
  - Power: 8%
  - Transport: 8%
  - Buildings: 2%
  - Industry: 2%
  - Biomethane: 4%
  - Biomass: 4%
  - Biofuels: 2%

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Key questions

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Delayed and Disorderly scenario

Carbon emissions

- **Rapid**
- **Business-as-usual**
- **Delayed and Disorderly**

Primary energy consumption

- **Rapid**
- **Delayed and Disorderly (before rationing)**
- **Delayed and Disorderly**