Energy Technology Perspectives 2017
The Role of CCS in Deep Decarbonisation Scenarios

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How far can technology take us?

Technology area contribution to global cumulative CO₂ reductions

Global CO₂ reductions by technology area

Pushing energy technology to achieve carbon neutrality by 2060 could meet the mid-point of the range of ambitions expressed in Paris.
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## Tracking Clean Energy Progress: only 4 technologies “on track”

### Power
- Renewable power
  - Solar PV
  - Onshore wind
  - Offshore wind
  - Hydropower
  - Bioenergy
  - Geothermal
  - Concentrating solar power
  - Ocean
- Nuclear power
- Natural gas-fired power
- Coal-fired power
- CCS in power

### Industry
- Cement
- Chemicals
- Steel
- Aluminum
- Pulp and paper
- CCS in industry

### Transport
- Electric vehicles
- International shipping
- Fuel economy
- Trucks
- Transport biofuels
- Aviation
- Rail

### Buildings
- Building envelope
- Heating
- Cooling
- Lighting
- Appliances & equipment
- Data centres and networks

### Energy Integration
- Energy storage
- Smart grids
- Demand response
- Digitalization
- Hydrogen
- Renewable heat

Carbon capture, utilisation and storage remains far off track from the 2030 goal.
ETP modelling framework

Primary energy
- Renewables
- Fossil
- Nuclear

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

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
Remaining CO₂ emissions in the 2DS and B2DS

The power sector is virtually decarbonised by 2060; Industry (57%) and transport (36%) are the largest sources of emissions in 2060

The remaining CO₂ emissions in industry and power must be targeted for the B2DS
Negative emissions are necessary to achieve net-zero emissions in 2060
The remaining CO₂ emissions in industry and power must be targeted for the B2DS. Negative emissions are necessary to achieve net-zero emissions in 2060.
Role of CCS in CO₂ emission reductions in the B2DS

CCS crucial for tackling process emissions in industry, while BECCS in power and fuel transformation provides negative emissions to offset hard-to-decarbonise parts in transport and industry.
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.
With higher capture rates, CCS with coal gets more hours

The B2DS calls for higher capture rates lowering the remaining emissions from generation with fossil CCS.
CCS: a cross-cutting strategy of increasing importance in B2DS

Global CO₂ captured and stored as a share of total produced direct CO₂

Key energy-intensive industrial sectors approach the 70-80% level of CO₂ emitted being captured and stored by 2060 in the B2DS
More CCS in B2DS, but from smaller sources

More CO₂ is captured from more expensive, lower-concentration and smaller sources in the B2DS.
Negative emission technologies, such as BECCS, needed to reach globally net-negative emissions in the second half of the century.

Source: Rogelj et al., (2018) Scenarios towards limiting global mean temperature increase below 1.5 °C
**BECCS or BECCU?**

### Bioenergy with CCS + Fossil fuel use

- Bioenergy feedstock → Bioethanol plant → Ethanol ➔ Fossil kerosene ➔ Airplane
- CO₂ captured and stored = “negative” emissions
- CO₂ balance
- Substitution

### Bioenergy with carbon capture and use (BECCU)

- Bioenergy feedstock → Bioethanol plant ➔ Ethanol
- CO₂ captured ➔ Fischer-Tropsch synthesis ➔ Synthetic kerosene ➔ Airplane
- Carbon-free electricity ➔ Electrolysis ➔ Hydrogen
- CO₂ emitted from fossil carbon
- CO₂ balance

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**BECCS or BECCU?**

### Bioenergy with CCS + Biofuel (or offset fossil fuel) use

- **Bioenergy feedstock** → **Bioethanol plant** → **Ethanol** → **Airplane**
- **Bio-kerosene or offset fossil kerosene** → **CO₂ emitted from biomass carbon**
- **CO₂ captured and stored** = "negative" emissions

### Bioenergy with carbon capture and use (BECCU)

- **Bioenergy feedstock** → **Bioethanol plant** → **Ethanol** → **Fischer-Tropsch synthesis** → **Synthetic kerosene** → **Airplane**
- **CO₂ emitted from biomass carbon**
- **Carbon-free electricity** → **Electrolysis** → **Hydrogen**
- **CO₂ balance**
Conclusions

• Lack of progress in deployment of CCS:
  - 17 large-scale CCUS projects in operation today, with an annual capture capacity of around 30 MtCO₂.
  - Only one large-scale project has taken a final investment decision since 2014 (Yanchang CCS project in China).
  - CCUS investment accounted for 0.1% of global investment in clean energy in 2016.

• Current trends in stark contrast to the need for CCS with increasing climate ambition, with CCS providing 17% of cumulative CO₂ reductions by 2060 (relative to RTS):
  - Very few alternatives to CCS for hard-to-decarbonise industrial processes.
  - Coal with CCS in power becomes at some point too carbon-intensive in the B2DS; R&D aiming at higher capture rates could allow for an extended operation.
  - BECCS needed to offset emissions in parts of the energy system more difficult to decarbonise and to potentially turn emissions net negative in the second half of the century, but availability of sustainable biomass limiting factor.

• More CO₂ captured in B2DS, but from more diluted and smaller sources, in particular industry:
  - Often more isolated locations, presenting a challenge for transport and storage.
  - Innovation is needed to improve the performance of capture technologies with small and diluted sources of CO₂.
Explore the data behind ETP

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