Reaching Zero with Renewables: Capturing Carbon

Presenter:
• Martina Lyons, End-use sectors and Innovation, IRENA

TUESDAY, 25 JANUARY 2022 • 14:00-14:30 CET
SPEAKER

Martina Lyons
End use sectors and Innovation
IRENA
Reaching Zero with Renewables: Capturing Carbon

The status and potential of CCS, CCU and CDR technologies, and their synergies with renewables in the context of global pathways to net-zero emissions.
Holding the line at 1.5°C means we need to act now

- **2018**: Rapid phaseout of coal power and expansion of renewable power
  - RE power addition rate triples
  - Systemic flexibility policies worldwide enable VRE integration
  - Carbon pricing (with CBAM) is sufficiently high worldwide (> USD 75/tonne)
  - Rapid decline in ICE car sales worldwide
  - Ramp up clean hydrogen production
  - CCS in industry >1 Gt
  - Building efficiency renovation rate triples in North
  - Governments accelerate grid and hydrogen infrastructure investments
  - Supply of sustainable minerals and metals ramps up

- **2021-2030**: Rapid phaseout of oil for transport and feedstock
  - 28,000 GW RE power installed (x10), 90% RE power
  - 5,000 GW electrolysis installed
  - Biomass reaches 18% of final consumption
  - Cars and trucks are mostly electrified
  - Heat pumps play a crucial role in space heating
  - BECCS is deployed in power and industry to compensate remaining fossil fuel emissions
  - Electricity and renewables drive efficiency gains
  - Clean energy financing rises to USD 4.4 trillion/year

- **2031-2050**: Further emissions reductions
  - CCS and CCU in industry
  - BECCS and other carbon removal measures

**Energy conservation and efficiency**
- Renewables (power and direct uses)
- Electrification of end uses (direct)
- Process and non-energy
- Natural gas
- Oil
- Coal
- Hydrogen and its derivatives
Potential of CCS, CCU and CDR in 1.5C Scenario

20% abatement potential with CCS, CCU and CDR

- Renewables (power and direct uses) 25%
- Energy conservation and efficiency 25%
- Electrification in end use sectors (direct) 20%
- Hydrogen and its derivatives 10%
- CCS and CCU industry 6%
- BECCS and other carbon removal measures 14%

Total abatement potential: 36.9 GtCO₂/yr

4.5 Gtpa of CO₂ by 2050
- BECCS and other carbon removal measures and technologies | power/heat plants
- BECCS and other carbon removal measures and technologies | Industry

3.4 Gtpa of CO₂ by 2050
- CCS - blue hydrogen
- CCU/CCS - cement, iron and steel and chemicals for process emissions
- Hydrogen plants
- Cement
- Chemical and petrochemical
- Heat plants
- Power
- Iron and steel
CCS and CCU in hard to abate sectors

- CCS, CCU for fossil fuel and process emissions in industry aggressively scaled to reach 3.4 Gtpa by 2050 and
- Would require cumulative investment of around USD 0.9 trillion between 2021 and 2050
- CCS and CCU limited to the most essential applications, and excluded fossil-fuel based CCS for power production
- 2.3 Gtpa in 2050 for CCS applied in cement, chemical and iron and steel sectors
- 1.1 Gtpa in 2050 for the production of blue hydrogen from natural gas with CCS
A larger role for BECCS and BECCU

<table>
<thead>
<tr>
<th>Process group</th>
<th>Biogenic carbon capture potential in 2050 (GtCO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>4.45</td>
</tr>
<tr>
<td>Heat</td>
<td>1.29</td>
</tr>
<tr>
<td>Cement</td>
<td>0.37</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>0.03</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1.18</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>0.35</td>
</tr>
<tr>
<td>Food sector</td>
<td>0.30</td>
</tr>
<tr>
<td>Biorefinery</td>
<td>2.15</td>
</tr>
<tr>
<td>Total</td>
<td>10.12</td>
</tr>
</tbody>
</table>

- **BECCS currently unproved** in most contexts
- Need for **40-50 EJ of biomass used with BECCS** (~1/3 of total biomass used in the energy systems)
- **BECCS utilized in a range of processes**, optimum application requires more detailed investigation of costs, logistics and sustainable biomass supply chains
- IRENA 1.5C Scenario: biomass-based processes from which **10.12 GtCO₂ could be potentially** captured and stored. Of that, the Scenario assumes **44% actually captured and stored**
- **Cumulative investment of around USD 1.1 trillion** between 2021 and 2050
DACCS/DACCU needs further development & validation

- DACCS/DACCU in early stages of development
- Current capture: 0.9 ktpa of CO2 capture, other plant under development would add an additional 21 ktpa of CO2 capture
- Early experience: projects face high energy, water and land requirements, but offer flexibility in terms of their location
- Frequently quoted estimate at USD 600-800 t/CO2 avoided, newer studies lower costs USD 94-232/tCO2 avoided and needs to be demonstrated
- Large financial commitments to speed-up DACCS deployment - would allow offset some of the need for BECCS and capture historical emissions elsewhere
Progress in capturing CO2 is far too slow

- Current capture ~ 0.04 Gt/a
- Equal to 0.01% of total global energy and process related emissions
Commercial and pilot/demo projects now

Current volume of capture 0.04 Gtpa

- **CCS/CCU:**
  - Commercial plants: over 20 in operation, 30 at various stages of development
  - Pilot and demonstration projects: almost 60 (closed, operating, in development)

- **BECCS/BECCU:**
  - Commercial: 3 in operation, 7 under development
  - Pilot and demonstration projects: 20 in various stages of development

- **DACCS/DACCU:**
  - Commercial: 2 in operation, 1 in development
  - Pilot and demonstration projects: 15 at various stages of development

With all commercial plants under development it may reach **0.1 Gtpa in 2030**
Renewables outcompete fossil fuel-based power plants with CCS
Costs are uncertain and vary by application.
FIGURE 4: Carbon chain

1. Storage
   - Saline formations
   - Depleted oil and gas fields

2. Utilisation and storage
   - EOR
   - Plastics
   - Materials

3. Utilisation
   - Fuels
   - Fertilisers

Source of CO₂
- Fossil fuels
- Industrial processes
- Biomass
- Atmosphere
- Oceans

Capture
- Pre-combustion
- Post-combustion
- Oxy-combustion
- Direct air capture

Transport
- Pipelines (incl. compression)
- Ships (incl. liquefaction)
- Trucks
- Rail
Increasing role of carbon capture and utilisation

- **Utilisation has a role** in a net-zero pathway, **but** should be limited to applications that do not lead to later release of CO₂ back to the atmosphere.
- Improves **economic feasibility** of CO₂ capture by creating a revenue stream and compensate for a lack of readily available and accessible CO₂ storage sites.
- **Applications:**
  - CO₂ to fuels (largest opportunity)
  - Enhanced commodity production
  - Enhanced hydrocarbon recovery
  - CO₂ mineralization
  - Chemicals production
- **Requires:** maturation of technologies, proximate location of capture and utilisation plants, potential commercial market, social acceptance.
Re-emission of utilised CO$_2$ and its time-scale

- Poses **questions about the long-term consequences** and difficult to trace CO$_2$ across multiple end-uses
- **Aim to lock-in CO$_2$** emissions for extended period of time
- **Conflicting** – plastics or EOR lock-in effect, but detrimental to the environment
A lot needs to be done on multiple fronts in the next decade

**Scaled-up RD&D**
- Encourage public-private international RD&D
- Build FOAK, demonstration and lighthouses projects everywhere
- Study and understanding public perception

**Enabling conditions**
- Develop policies, regulations and standards
- Institutions & organisations
- Financial support
- Hub-transport/storage networks models
- Open access to information
- Deployment of clusters with hard-to-abate industry

**Sustainability**
- Sustainability of biomass for BECCS
- Consider LCA of emissions
Thank you for your attention!

MLyons@irena.org
Q & A
10 min
THANK YOU FOR JOINING US!

SEE YOU IN OUR NEXT WEBINARS
www.irena.org/events/2020/Jun/IRENA-Insights