COP24 side event

Energy 24 Congress

Panel discussion:

How the Climate Challenge and Energy Policy can drive innovation

Contribution prepared by

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CRUDE OIL PRODUCTION: DAILY 94 M BARRELS, 204 B GJ ANNUALLY (11.473 USD/GJ)
(PRICE: 11.4 USD/GJ PEAK 2X)
NATURAL GAS PRODUCTION: 3500 B M³ 184 B GJ
(3 USD/GJ(US), 5.7 USD GJ EU, 9.52 USD/GJ CHINA, PEAK 2X)
COAL PRODUCTION 8 B TONNES ~119 B GJ
GERMAN OPEN PIT < 2.30 USD/GJ, 2.9 USD/GJ POLISH UNDERGROUND
2.8 USD/GJ ARA, 3.3 USD/GJ CHINA)(PEAK 1.5 X)
RENEWABLE ENERGY RESOURCES: ESTIMATED 76 B GJ (~15% OF THE TOTAL)

AROUND 80-90% MONOPOLY REGARDING HYDROCARBONS
COMMERCIAL TRADE AND COMMERCIAL PRICES

LESS THAN 40% MONOPOLY REGARDING COAL
COMMERCIAL TRADE IS LOW AND PRODUCER PRICES DOMINATE

RENEWABLES EQUIPMENT PRODUCERS (AVAILIBILTY SUN:15 % WIND 21 %)

CONCENTRATION
## Comparison of Coal production prices in the world

<table>
<thead>
<tr>
<th>Coal prices</th>
<th>USD/GJ</th>
<th>Correction for the energy efficiency gas/coal 55/43% 1,27 x</th>
<th>Price of natural gas USD/GJ/LNG ca. +70%/</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA Powder River Wyoming</td>
<td>0,4722</td>
<td>0,6</td>
<td>3(102 USD/1000 m3)</td>
</tr>
<tr>
<td>USA Illinois</td>
<td>1,372</td>
<td>1,74</td>
<td>3</td>
</tr>
<tr>
<td>USA Northern Appalache</td>
<td>1,638</td>
<td>2,08</td>
<td>3</td>
</tr>
<tr>
<td>USA Rocky mountains</td>
<td>1,638</td>
<td>2,08</td>
<td>3</td>
</tr>
<tr>
<td>USA Middle Appalache</td>
<td>1,638</td>
<td>2,08</td>
<td>3</td>
</tr>
<tr>
<td>China Shenhua at mine mouth</td>
<td>1,375</td>
<td>1,746</td>
<td>9,5(324 USD/1000 m3)</td>
</tr>
<tr>
<td>China Shenhua transported</td>
<td>2,06</td>
<td>2,61</td>
<td>9,5</td>
</tr>
<tr>
<td>China CECO purchase</td>
<td>3,41</td>
<td>(4,33) + only for chemicals</td>
<td>9,5</td>
</tr>
<tr>
<td>India</td>
<td>0,44</td>
<td>0,56</td>
<td>4,55</td>
</tr>
<tr>
<td>Europe ARA</td>
<td>3,71</td>
<td>7,71</td>
<td>6 (22 Euro/MWh)</td>
</tr>
<tr>
<td>Europe German open pit</td>
<td>1,72- 2,3</td>
<td>2,18- 2,92</td>
<td>6</td>
</tr>
<tr>
<td>Europe Polish deep mine</td>
<td>2,9</td>
<td>3,68</td>
<td>6 + no public data available</td>
</tr>
<tr>
<td>Hungarian open pit</td>
<td>&lt; 2,29</td>
<td>&lt; 2,90</td>
<td>6+ no public data available</td>
</tr>
<tr>
<td>Hungarian deep mine new opening estimate</td>
<td>3,44- 4,60</td>
<td>4,367- 5,84</td>
<td>6 + no public data available</td>
</tr>
<tr>
<td>Australia Victoria open pit</td>
<td>0,44</td>
<td>0,56</td>
<td>4,55</td>
</tr>
</tbody>
</table>
**Processing plants**

**Production of chemical products**
- Gasification, CO₂ sequest, crude gas cleaning
- Crude oil cleaning with solvent procedure
- Synthesis procedure

**Bacteria/enzyme processing**
- Biogas production, CO₂ sequestration

**CO₂ utilisation**
- Chemical processing
- Fireproof material cells

**H₂ production, O₂ production**
- Hydrolisis
- Natural gas decompos.
- Carbon reduction
- Air decomposition

**Waste material, slag use**
- Chemically bound construction material
- Chemical extraction

**Energy use**
- Renewables, collectors
- Catalytic oxidation

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**Unused carbonium sources**
- Agricultural biomass
- Sewage sludge
- Manure
- Waste
- Coal
- CO₂

**Unused energy and water sources**
- Power plant/industrial waste heat
- Solar/wind/geothermal energy
- Rivers
- Off-peak electricity

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**For all industrial units as required:**
- Electric energy supply
- Water supply/Water treatment
- Catalyser supply

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**Preparation plant**
- Separation/Concentration
- Cutting/Grinding
- Homogenisation
- Watering/Drying
- Torrefaction
- Bacteria/enzymes

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**Energy use / storage**
- Heat storage, heat pumps, ORC
- CHP
- Thermal max
- Hydropower use
- Accumulator farms

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**Electric energy**

**District heating**

**Agriculture**

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**MeOH, Further chemical compounds**
- Sulfur, Soil improving Fertiliser

**Biogas**

**Polyols, Hydrocarbons**

**H₂, O₂, N₂**
**H₂ chemical storage**

**Construction material, Rare Earth Element**

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**Catalyst supply**
- MeOH, Further chemical compounds
- Sulfur, Soil improving Fertiliser

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**Unused energy and water sources**
- Power plant/industrial waste heat
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- Rivers
- Off-peak electricity
Clean coal technologies and their possible application in existing infrastructure

- All technologies of coal use either as material direct dissolution or indirect gasification with subsequent cleaning and transformation
- Also technologies for CO2 capture and sequestration CCS or reuse CCR
- Selected technologies of the toolbox can be used to clean coal retrofit of existing infrastructure, hence strategy for CTC and coal to power overlapping
- Example: Gasification outside of the existing boiler than catalytic glowing of the gas instead of burning and transformation of the CO2 in the exhaust with the help of waste heat into alcohols (common research areas)
E-MRS research strategy

(source: presentation of Prof Jacques Amouroux)

European strategy for
A multicultural research

European ENERGY Hub
A Technology Initiative
(University, Industry)
Carbon Dioxide
& Energy Storage
Design Engineering for
Sustainable Processes
Heterogeneous Catalysis for
Selective Energy Storage
Carbon Recovery & Energy Efficiency
Chemical Storage Efficiency for
syngas / Electrical Grid Regulation

Decarbonated Electrical Sources

Biological scale up
For CO2 to CH4 hydrate
Sea water, cyanobacteria,
iron catalyst, and sun light
Heat and mass transfer for
CO2 reduction
Specific process from gas to solid (hydrate)

Technological Research
Hydrogen Production from
Decarbonated Electrical Sources
Synfuel Synthesis from CO2/N2
& Energy Storage
Plasma treatment of coal from CO2 / N2
Technical Reactor Design
(fixed bed, Electro Technical Catalytic bed)

Academic Research
Carbon Dioxide Purity
Catalyst Material with
Nanoparticles, Amorphous Deposit
Plasma Process for direct
Energy Storage on CO2
Solar Water Photolysis
Carbon Dioxide Energy Storage
for different Chemical Synthesis

Interdisciplinary researches
Bioengineering processes
OGN for methagenese, alcohol
or hydrocarbons
Coal to gas
CO2 to methane
Waste treatment
Scale up and efficiency
CO2 separation and Capture
(source : Prof. Suriya Prakesh)

**Sources of CO2**
- Geothermal Vents
- Fermentation Processes
- Natural Gas Wells
- Cement Plants
  - Fossil Fuel Burning Power Plants
  - Aluminum Plants
  - Air Itself

**CO2 separation and Capture technologies**
- Absorption
  - Chemical
    - MEA, DEA, KOH, NaOH, MgO, Etc.
  - Physical
    - Solexol, Rectisol, Etc.
- Adsorption
  - Alumina, Zeolite, Activated carbon
- Cryogenics
  - Dry ice formation at low temperature
- Membranes
  - Polymer based
    - Poly(phenylene oxide)
    - Poly(ethylene oxide)
    - Poly(ionic liquid)
  - Inorganic membranes
    - Ceramic based
    - Zeolite based
- Algal and microbial systems

Efficient capture from air remains challenging
CO2 utilisation roadmap
(from the presentation from Denis Clodic and others)

- Overarching issues
  - CO₂ purity
  - High value products
- Direct valorization
  - E0R
  - Mineralization
- Chemical transformation
  - Biogas dry reforming of CO₂ and CH₄
- Biological routes
  - Cyanobacteria and microalgae
- Photo-electrochemistry
  - H₂ generation by water Photo-electrolysis
  - Joint CO₂ and H₂O Photo-reduction

Blue Sky

State of the art
Direct and indirect GHG emissions from fossil fuels
Germany has 2.8% share in worldwide GHG emission
if the USA would reduce its per head GHG emissions to the present German level
7.2% could be saved

Fig. 2: Direct and indirect GHG-emissions (in CO₂-equivalents) of different fuel-types in comparison with the emissions from the natural gas life cycle under different assumptions and LCAs.
The role of the media

- Soren Kierkegaard:
  - „There are two ways to be fooled:
  - One is to believe what isn’t true, the other one is to refuse to accept what is true.”

- Mark Twain:
  - „It is easier to fool people, than to convince them, that have been fooled.”

- The media influences people, people influence politics
- Certain interest groups buy themselves media influence
Thank you for the attention

- www.calamites.hu
- www.kbfi.eu
- kalmari at calamites.hu