Steps towards a climate neutral steel sector

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Steps towards a climate neutral steel sector

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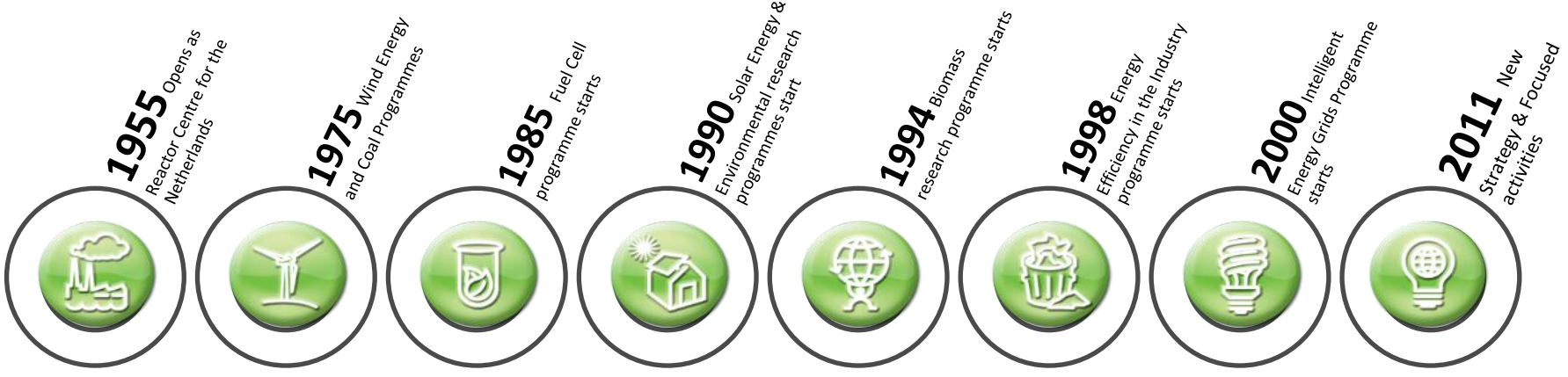
Tata, Velsen Noord
May 19, 2016

ECN : a rich and evolving history

~500 employees

~110 patents



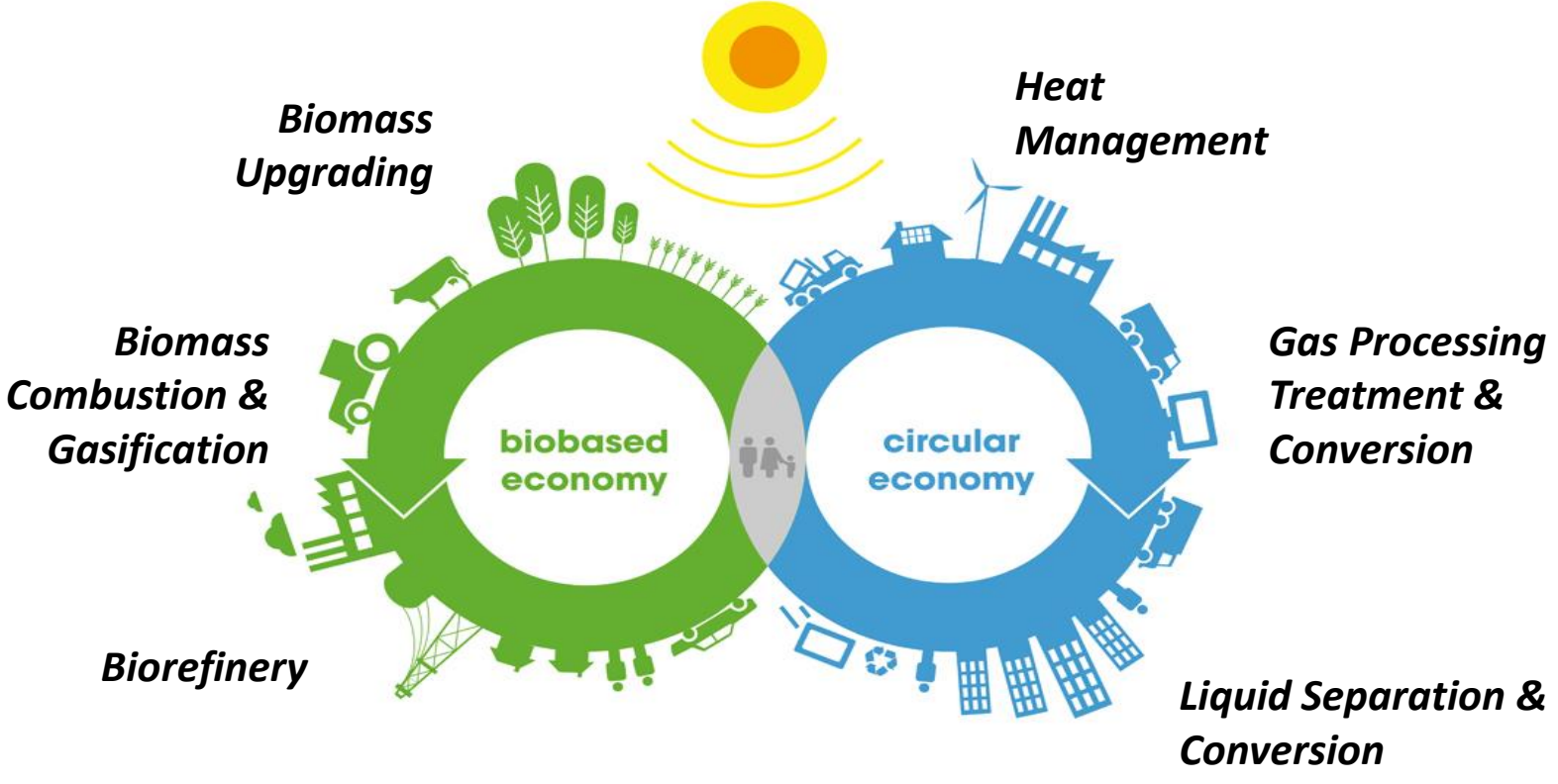
ECN technology can be found in

60% world wide solar modules

80% of EU off – shore wind farms

We have been pushing technology boundaries for over 60 years

Biomass & Energy Efficiency : six focus areas



Markets
Clients & Partners

- Gas Processing, Syngas Tuning, Refinery, Steel production
- End users, component manufacturers, system integrators
- Public Private Partnerships

Contents of today

- Changes in our energy, electricity, supply
- Role of CO_2
- Advanced carbon capture for the steel industry
- Creating more value out of blast furnace gas
- Keeping in line with current BAT steel making process so alternatives like Hisarna are out of scope

Electricity in a climate neutral society

Never let a good crisis go to waste

Great Horse Manure Crisis (1894)

MORTON STREET, CORNER OF BEDFORD, LOOKING TOWARD BLEECKER STREET, MARCH 17, 1893.

Street

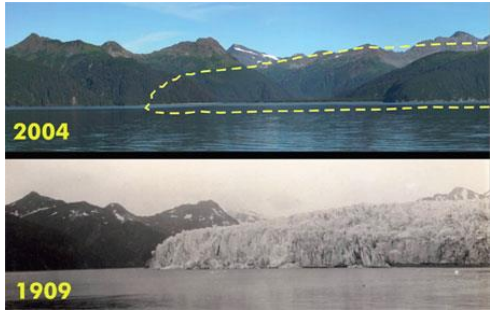
The London Smog disaster (1952-53)

County

Acid Rain (1970s)

Continent

Climate (21st century)

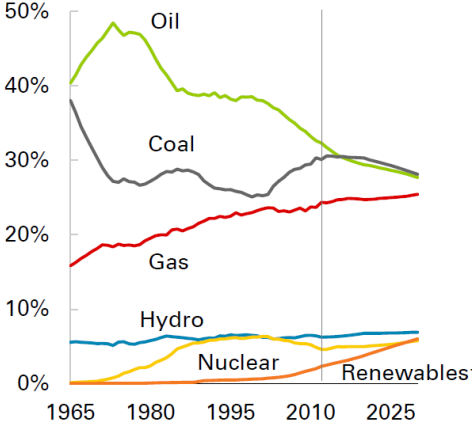


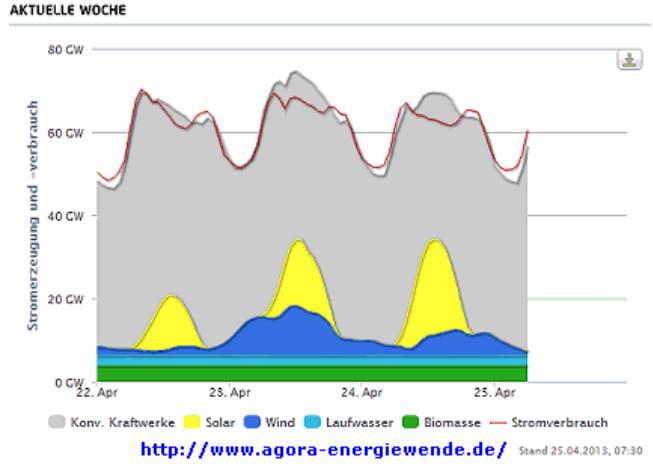
Global

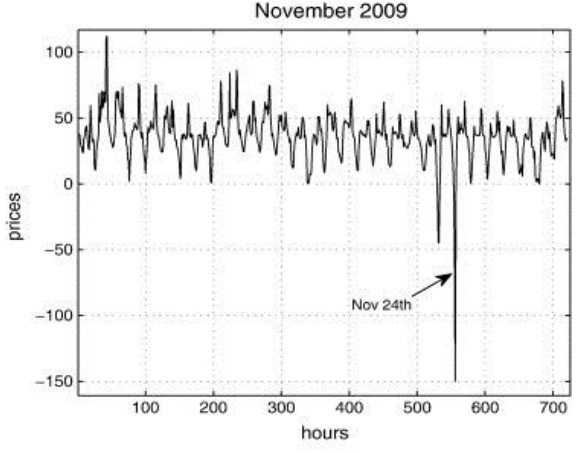
Need for level playing fields

The electricity sector is changing…

- Rapidly increasing renewable electricity *(wind and solar).*
- Intermittency, supply and demand mismatch





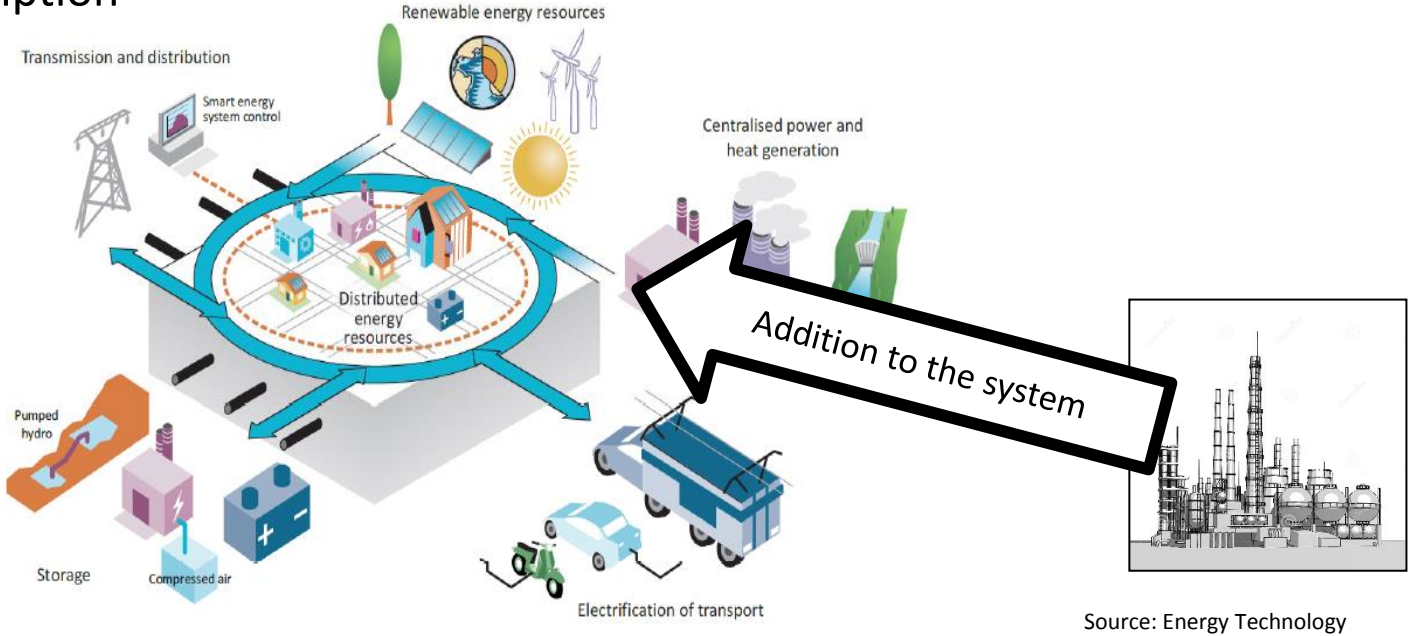


Source: BP Energy outlook 2013

Note: Worldwide renewable electricity capacity, excl. hydro, will increase from 4% (2011) to 12% (2030)

… demanding for a new Energy System

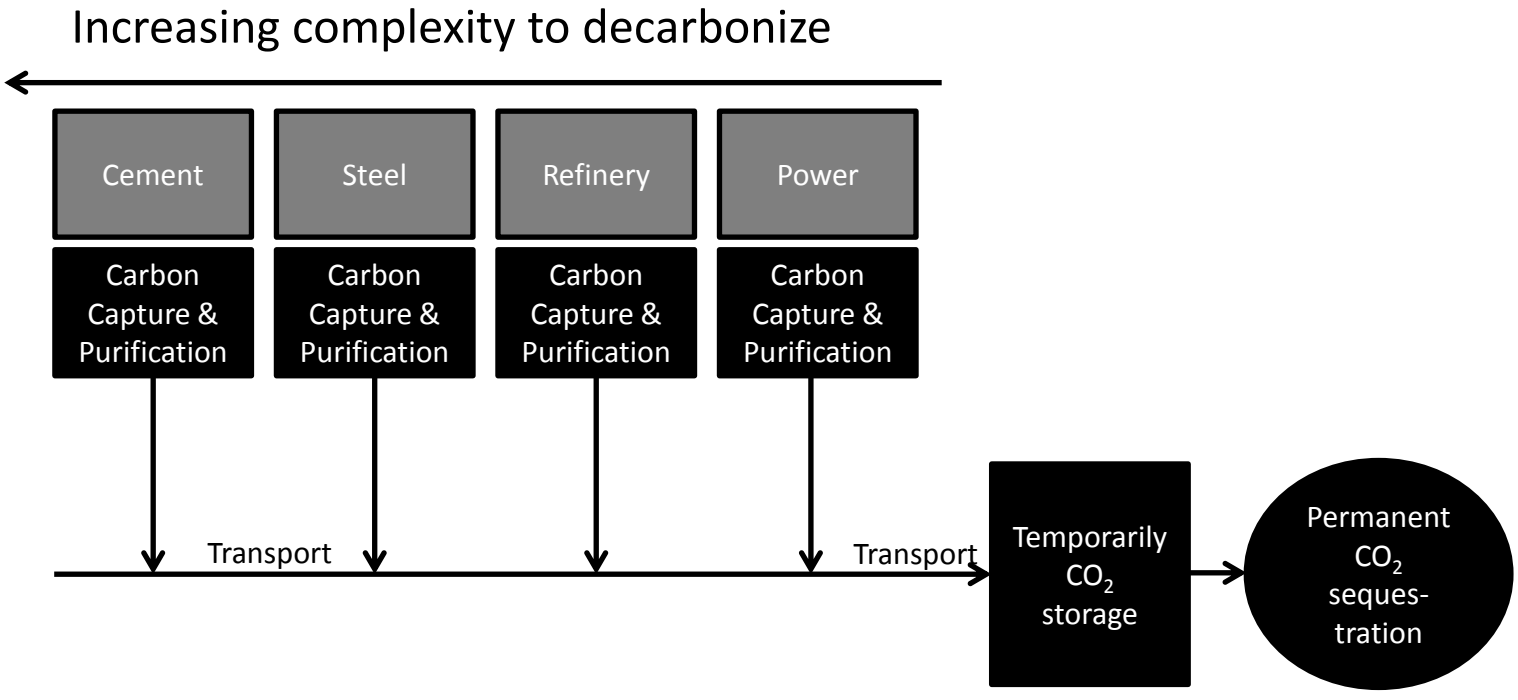
- Electricity will play an increasingly important role in energy systems
- Sustainable generation, smart distribution, and smart end-use consumption



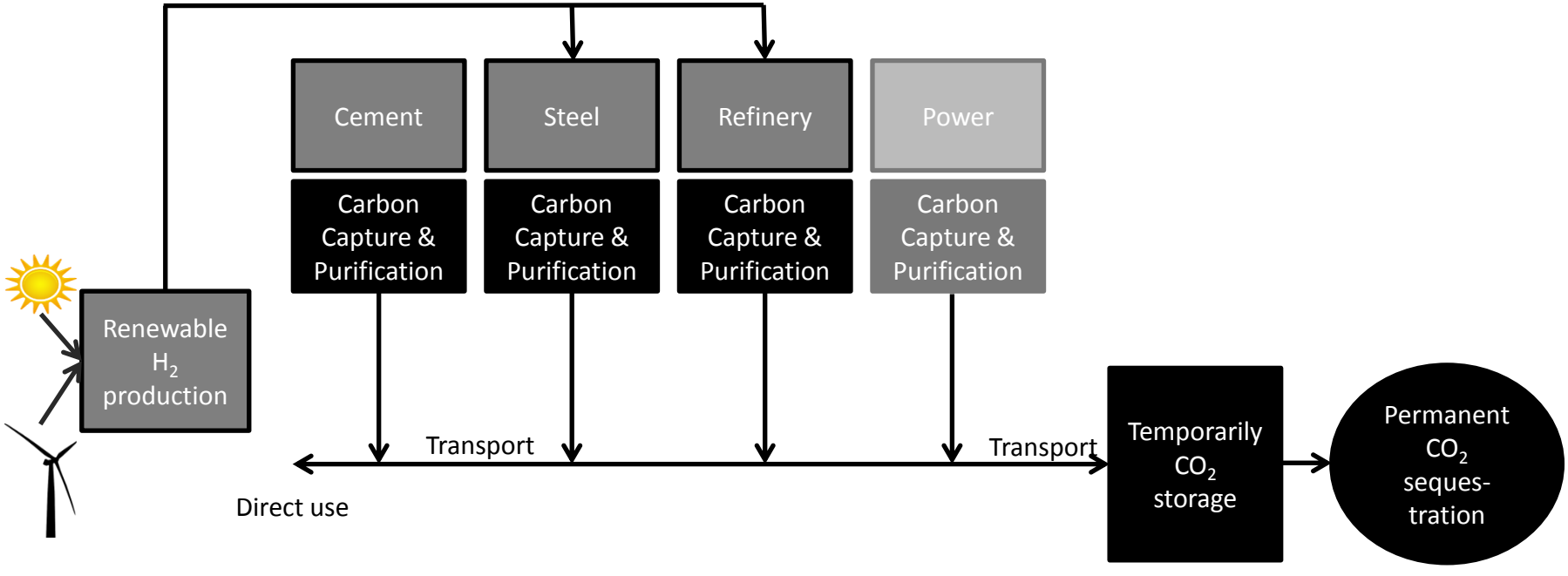
Source: Energy Technology Perspectives 2014 - Harnessing Electricity's Potential.

Role of CO_2

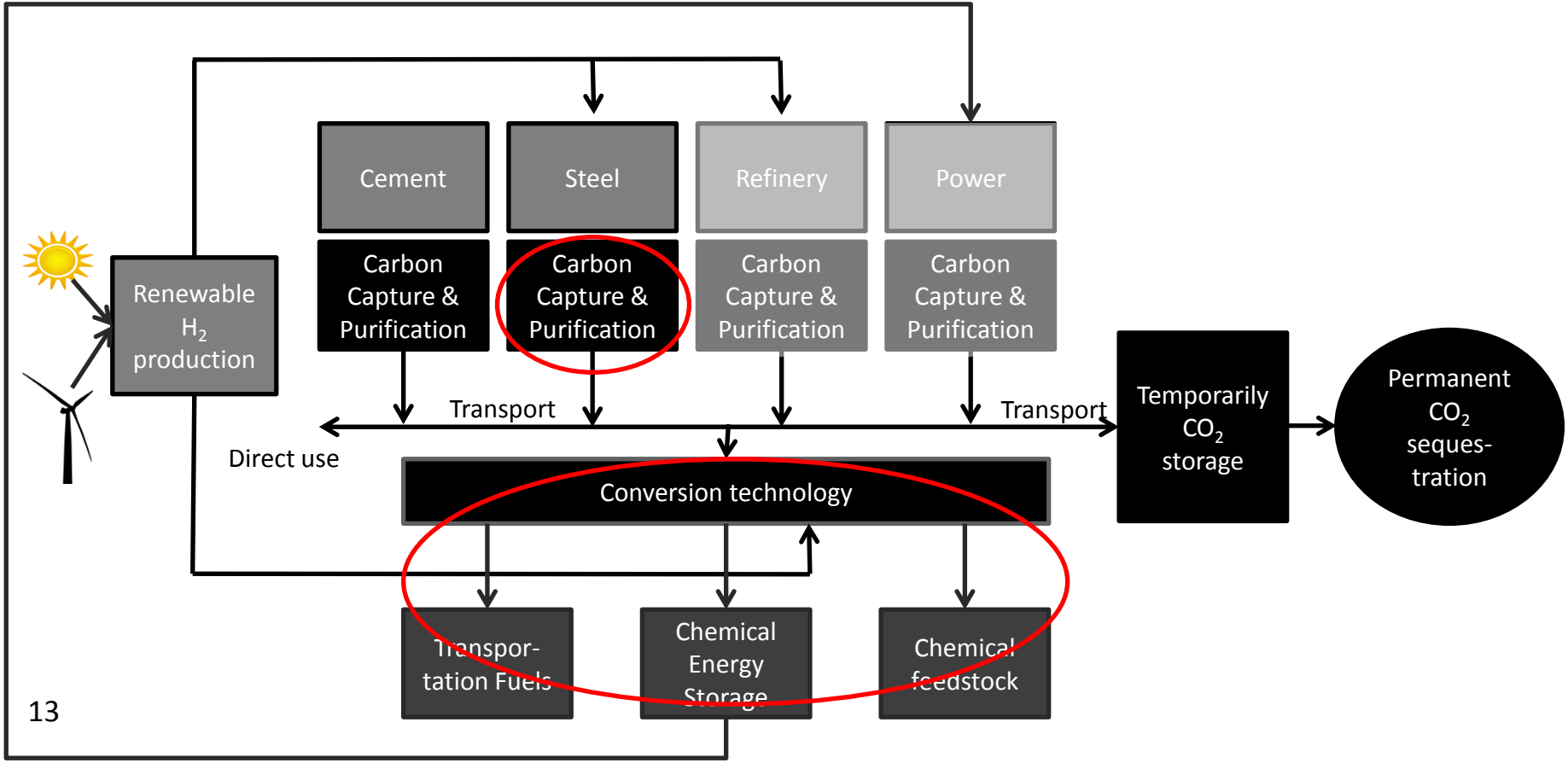
Conventional Carbon Capture and Sequestration



Increasing renewable electricity



Renewable electricity dominates the energy market



Advanced capture technology for the steel industry

Safeguarding the steel sector

- In Netherlands (Western Europe)
- Healthy financial situation
- Significant employment
- Innovative
- Highly efficient

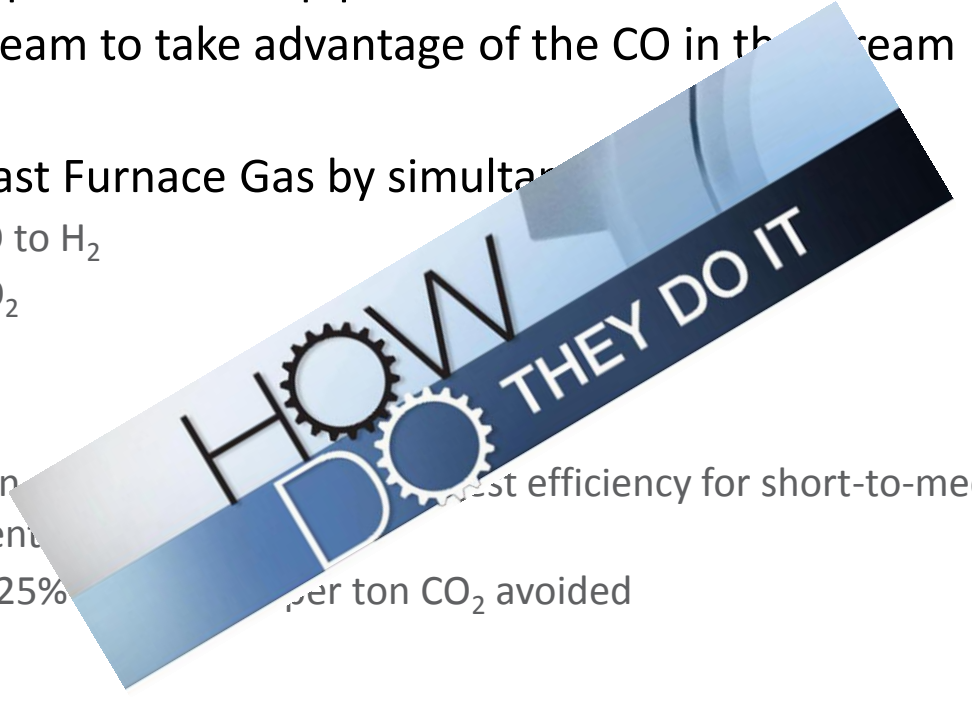
- Healthy balance between societal costs and benefits

CO_2 capture from Blast Furnace Gas

- Avoid sub-optimal end-of-pipe solutions
- Move upstream to take advantage of the CO in th… eam

- Upgrade Blast Furnace Gas by simulta…
  - convert CO to H_2
  - remove CO_2

- Result:
  - High carbon … st efficiency for short-to-medium term development
  - Estimated 25% … er ton CO_2 avoided



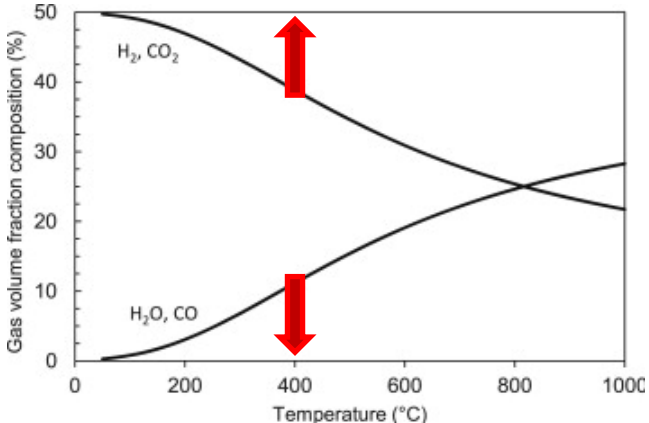
Sorption Enhanced Water-Gas Shift

- Applications in carbon capture and hydrogen production

$$CO + H_2O \leftrightarrow CO_2 + H_2 \qquad \Delta H = -41\ kJ/mol$$

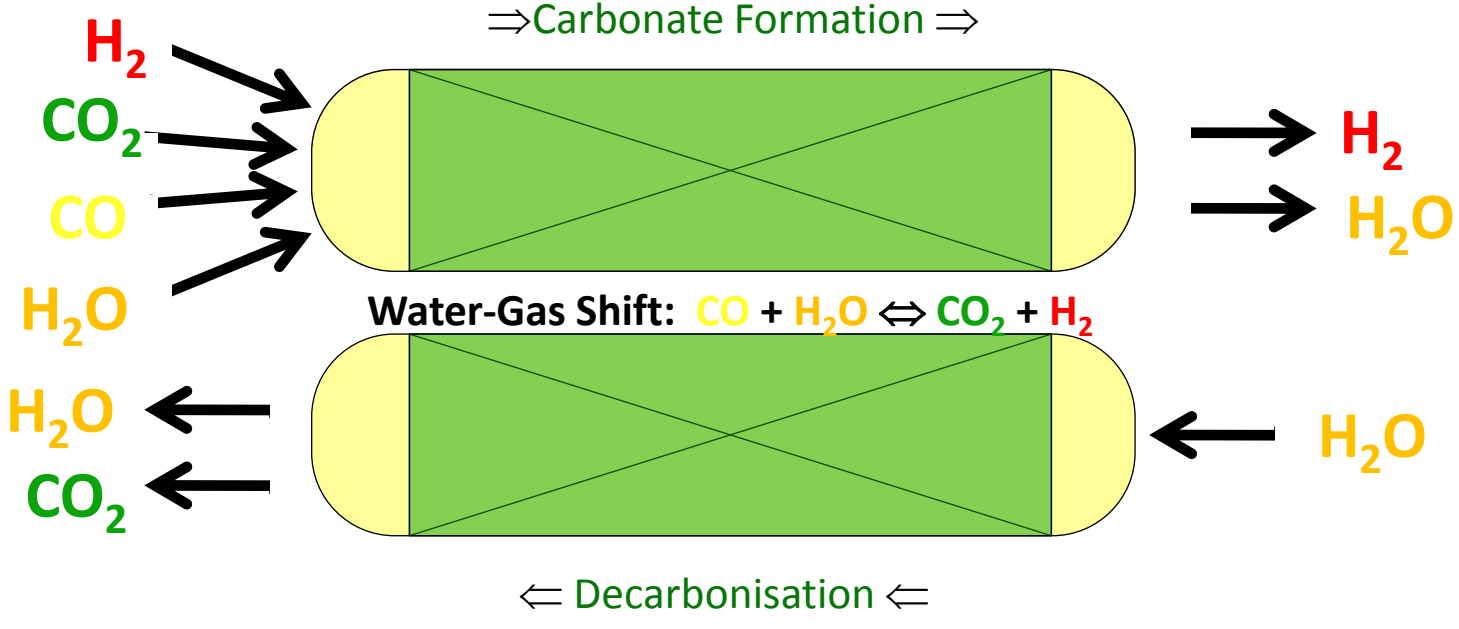
In situ removal of a reaction product

- Normal Reaction Conditions
  - Two stage conversion of CO
    - 12% → 3% → 0.5%
    - 350-400°C → 180-250°C
  - 20-30 bar



The Intensification Step

- Combines the Water-Gas-Shift reaction with sorbent material to simultaneously produce H_2 at high temperature whilst also capturing CO_2



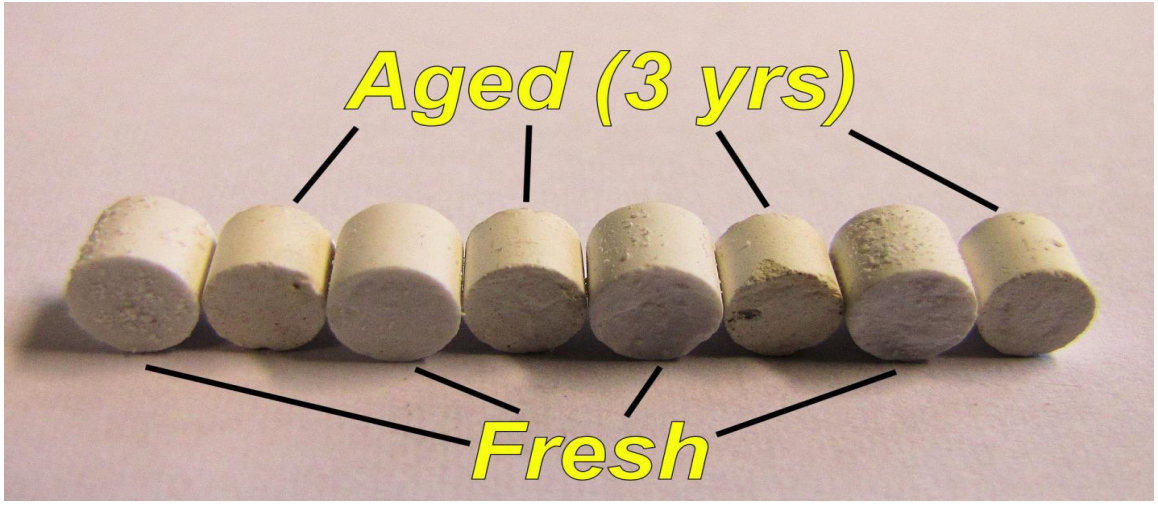
SEWGS advantages

- Low cost sorbent
  - Synthetic clay industrially produced
  - Robust material

- Low energy consumption for CO_2 removal
- Efficient removal of H_2S
- Low steam consumption
- Both high purity CO_2 and high capture rate, low loss of H_2

Sorbent “stress test”

- Stability of the CO_2 sorbent ALKASORB
  - Combined adsorbing and catalytic activity of material for more than 5000 cycles
  - No deterioration was observed



Building now

14 ton CO_2/day

- At ECN laboratory
- 100 kg of sorbents

swerea | MEFOS

Partners: supply chain

ECN

Johnson Matthey

KISUMA CHEMICALS

swerea MEFOS

SSAB

TATA STEEL

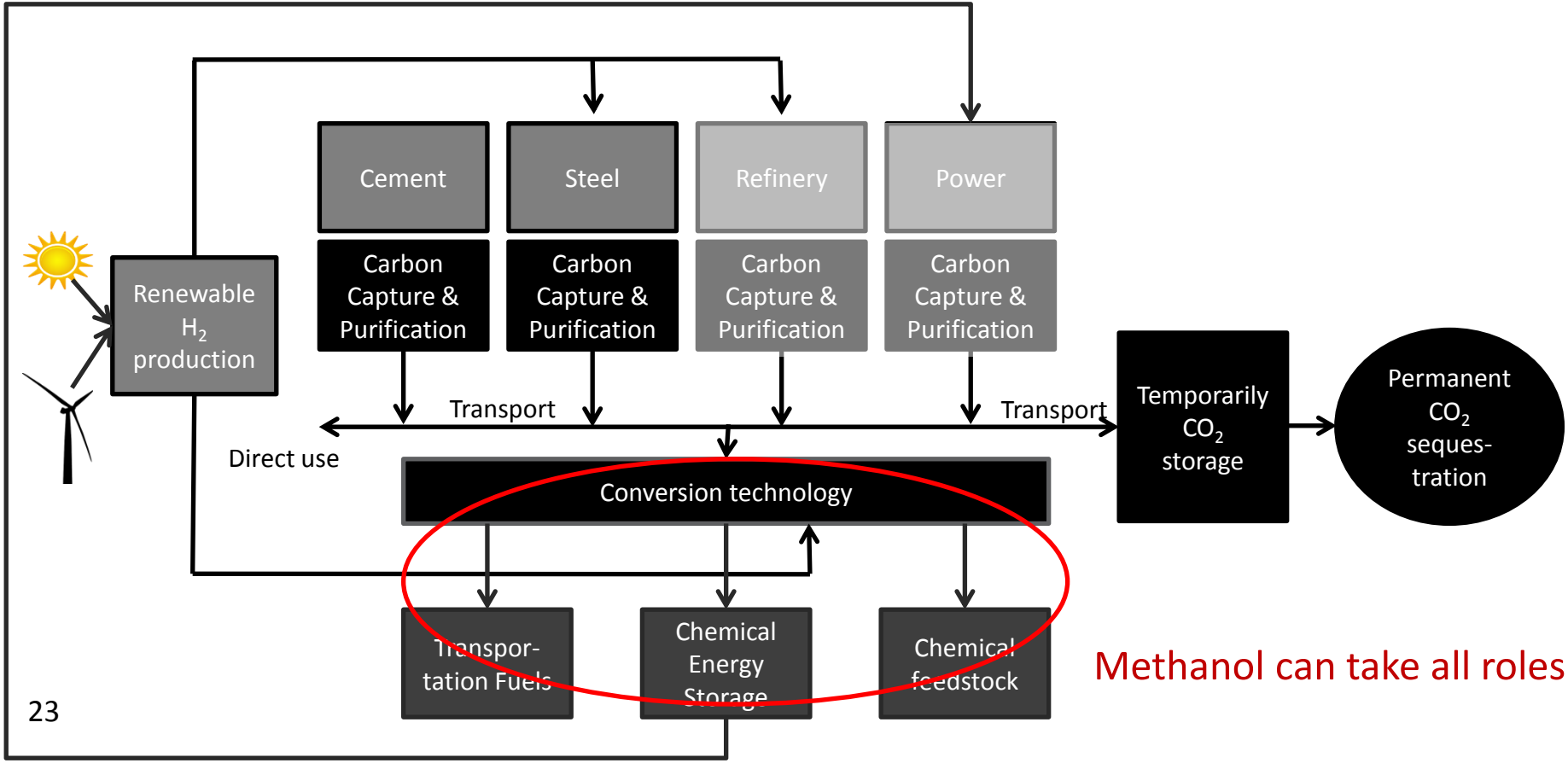
POLITECNICO MILANO

amec foster wheeler

UNIVERSITAS NAPOCENSIS ROMANIA BABEŞ-BOLYAI

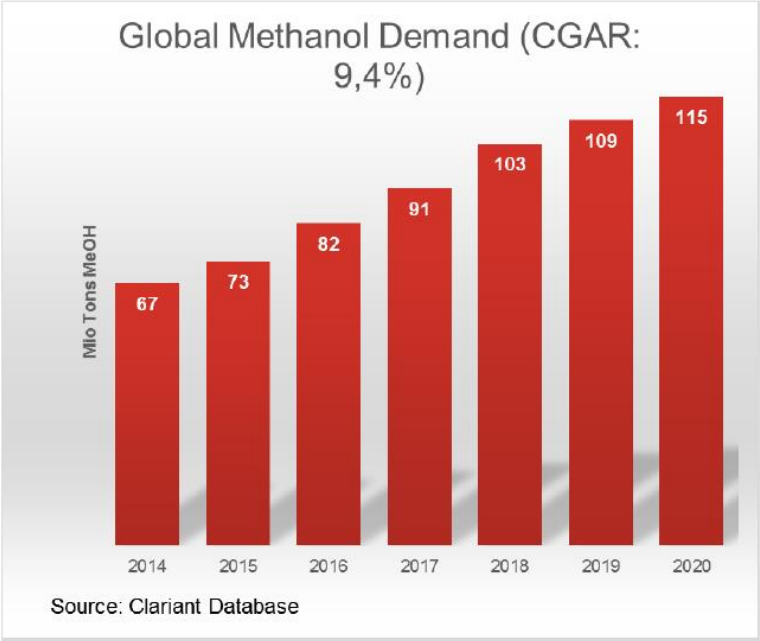
Value from BFG: Methanol synthesis

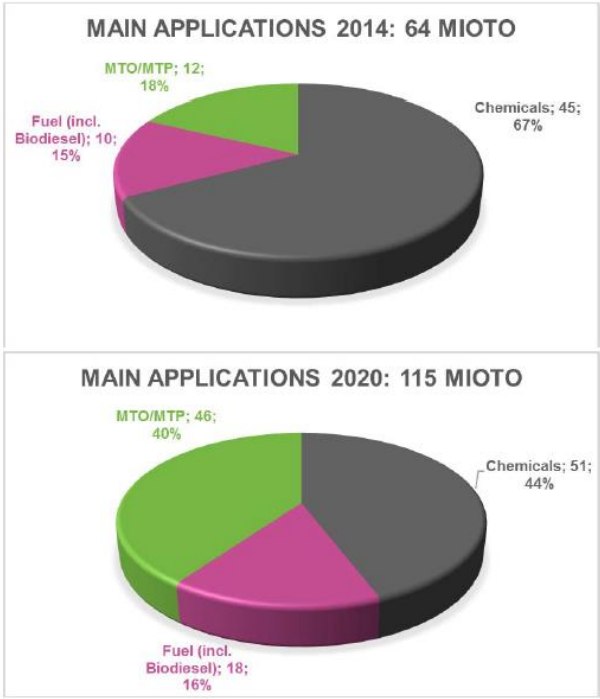
Renewable electricity dominates the energy market



Methanol can take all roles!

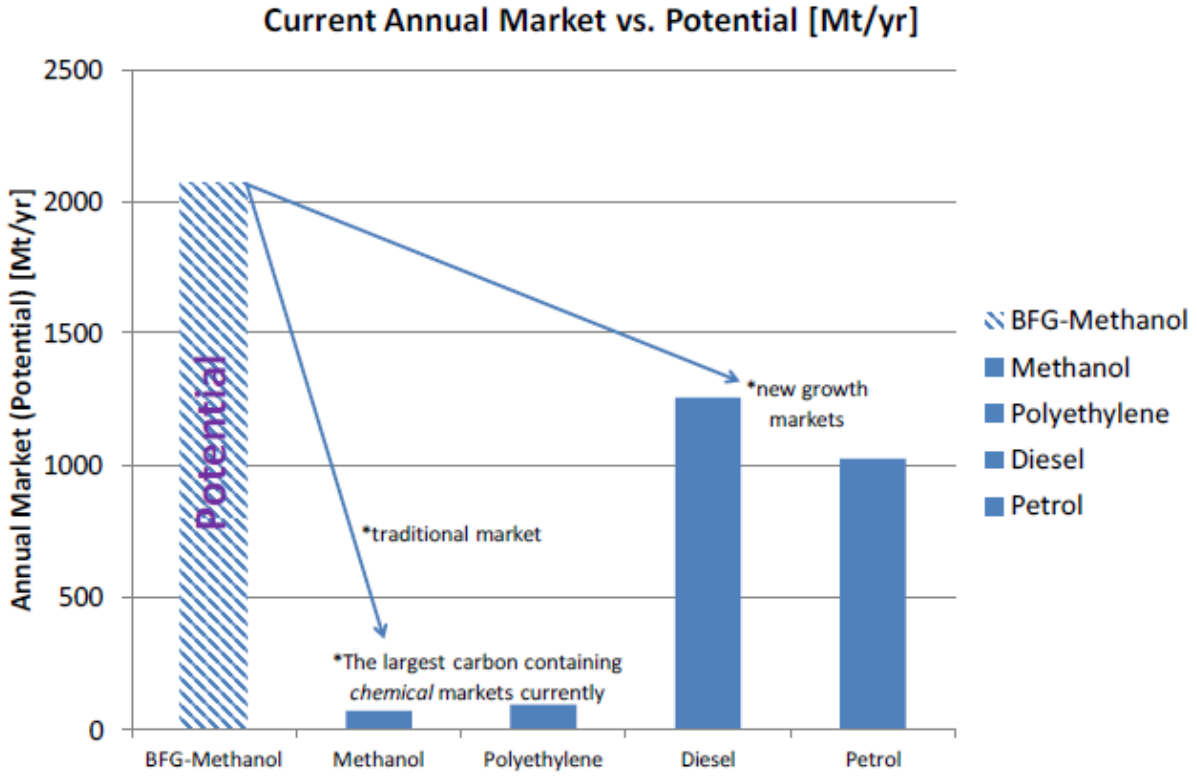
Methanol a growing market





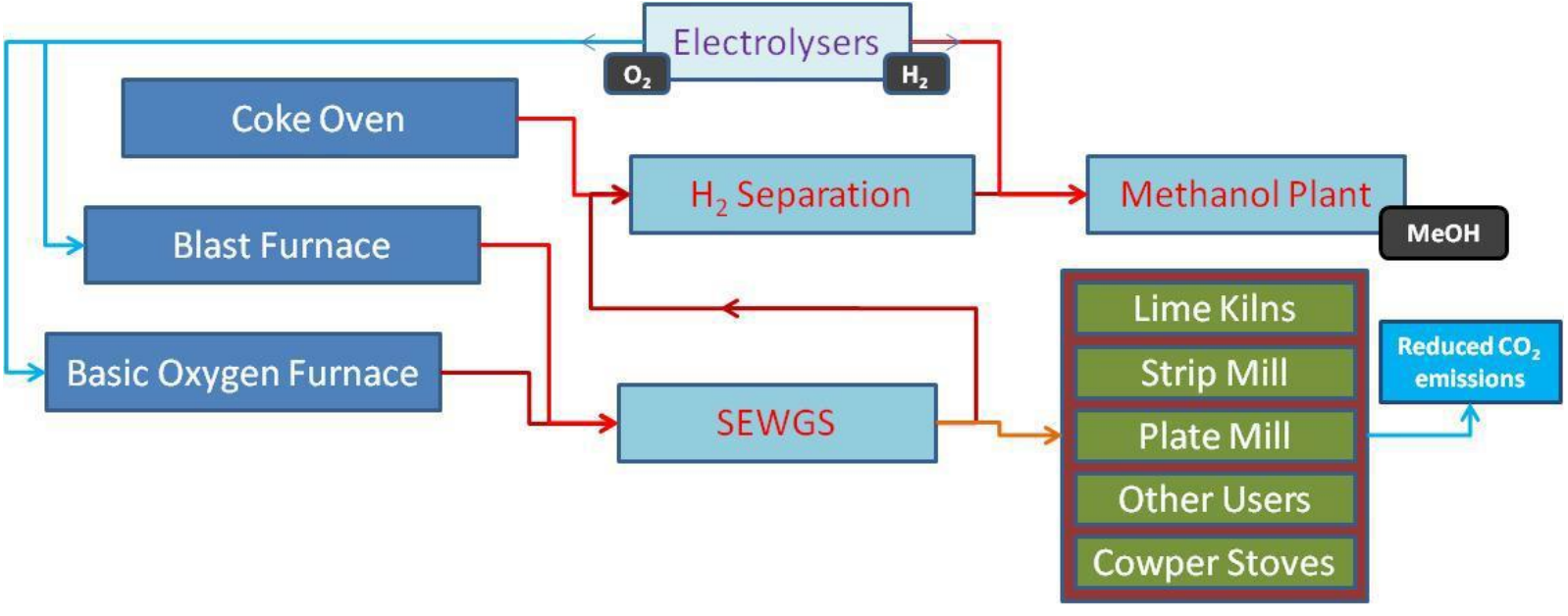
U. Flessner (Clariant)
Industrial Methanol Catalysts Oct 2015

Future potential MeOH market



FReSME: From residual steel gases to methanol

- Simplified view on integrated MeOH and steel plant



- Various streams omitted for simplicity

FreSMe consortium

Result of grant application expected in the coming months

Universities

CRO's

Companies

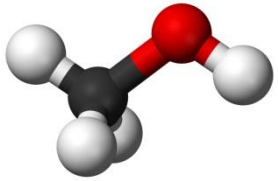
Steel

CO_2 capture

MeOH Synthesis

Use

Ambition



Construction and operate

FEED 20 kton MeOH/y

FRESME design

MeOH pilot production

Construction and operate

TRL 7 or 8?

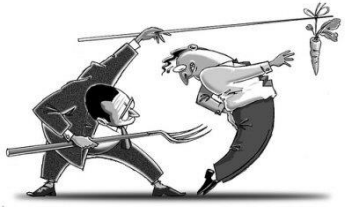
FEED 35 kton CO_2/y

STEPWISE campaigns

2017 2018 2019 2020 2021 2022

Concluding remarks

- Climate is important to the global society at large
  - solution should come from the global society at large
- Financial instruments alone are unlikely to be productive in the long run
  - pressure from the society combined with a willingness to pay may be more effective



- Reducing CO_2 levels in the atmosphere should be achieved through
  - Increasing energy efficiency
  - Reducing use of fossil fuels
  - Capturing and storing CO_2 from large point emitters → important role for the industry
  -
  -
  - capturing CO_2 from air

More information:
caesar.ecn.nl/the-sewgs-process
http://www.stepwise.eu/

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Timber storage in Sweden after “Gudrun” storm, 2005, max 1 month fuel for SSAB blast furnace

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