Decarbonizing industry sectors (Power, cement, refineries, steel, fertilizers,…)

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Mission Innovation Challenge #3-CCUS

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Who are we?

Our internationally recognised name is the IEA Greenhouse Gas R&D Programme (IEAGHG). We are a Technology Collaboration Programme (TCP) and are a part of the International Energy Agency's (IEA's) Energy Technology Network.

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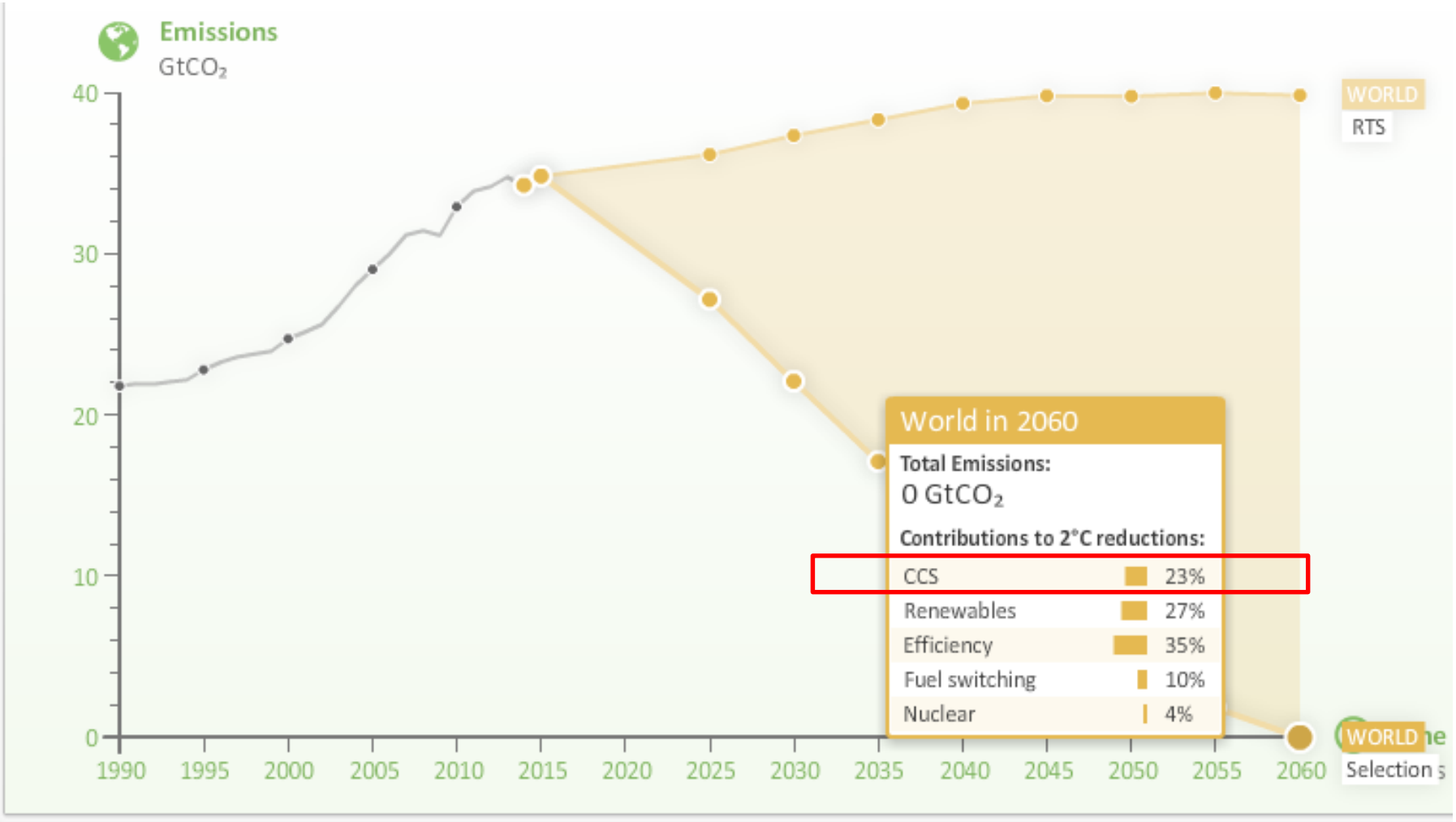
Potential Role of Industrial CCUS-power

- CCUS can bring flexibility to the electricity grid (Flexeval). Important to see the System Value (SV)
- Incorporating CCS to the power sector is a cheaper solution in the long run

Potential Role of Industrial CCUS-production industries

- Industries are essential on the economy. Expected to grow mainly in countries on development. Perhaps global market
- Industrial CO_2 emissions must be reduced by 50% in 2050 in the 2DS and more than 70% in the B2DS.
- Non-CCS options are important, perhaps will not supply the reduction fast and large enough to solve the climate change matters. Some industries CANNOT be decarbonised without CCUS (process emissions)

Potential Role of Industrial CCUS

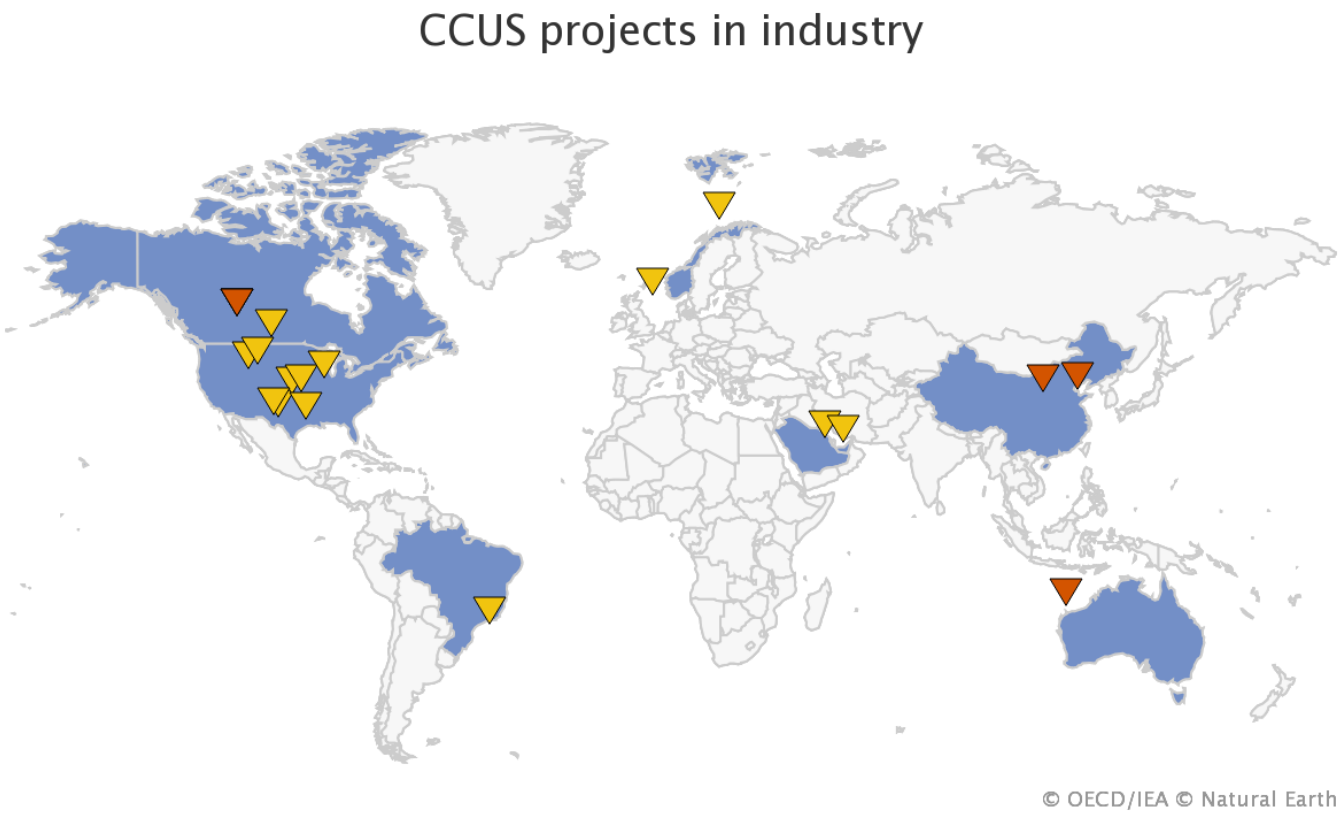


Emissions in the RTS and B2DS. Source: IEA ETP website (visited in May 2019)

Potential Role of Industrial CCUS- Power

- Large projects: Boundary Dam (Cansolv), Petranova (KM-CDR), Shand (planned, KM-CDR). It works!
- IEAGHG update on emerging technologies TRL: chemical absorption is still leading (with updated benchmark solution), 2nd generation will not wait for others. Potential for fuel cells, membranes. More research in others

Potential Role of Industrial CCUS- Production industries



Industrial CCUS projects in construction (red) and running (yellow). Source: IEA website (last update on 2018)

Potential Role of Industrial CCUS

- Industries: steel, cement, chemicals, refining, hydrogen, natural gas, heavy oil, fertilizers, waste to energy. Interaction
- Aiming to transfer the experience from the power sector (to note TRL is not the same!). Traditional chemical absorption is the “less risky”, perhaps specific industries can have advantages for others and/or traces
- IEA perspective: out of track to reach decarbonisation objectives

Status- Progress

- Industries have a good potential for partial CO_2 capture. Opportunity for integration and cost reduction
- Cement
  - Several CO_2 capture technologies tested
  - Norcem, LEILAC (TRL 7ish), ECRA?
  - Others (TRL 7ish): CLEANKER, CEMCAP (TRL4)

Norcem facilities (Norway)

Status- Progress

- Steel
  - Heterogeneity in production process. Several CO_2 stacks, several technologies
  - Abu Dhabi (DRI, TRL 9ish). H_2 potential
  - STEPWISE (BF+BOF, TRL 7ish), COURSE50

Al Reyadah facilities (Abu Dhabi)

Status- Progress

- Waste-to-energy
  - Japan, Norway and Netherlands projects, all based in chemical absorption
  - Seasonal integration with district heating, heat integration with the facility
- Refining (familiar)
  - Interaction with H_2
  - Chemical absorption on stacks (Finland), oxy-firing in burners, pre-combustion on the gasifiers.
  - RECAP, suggesting non-steam technologies

Status- Progress

- Hydrogen
  - Low carbon electricity+CCS
  - Air Products' Port Arthur, Tomakomai, Air liquid (SMR)
  - Chemical/physical absorption, sorbents, PSA, membranes
- Fertilizers
  - 2 plants in USA, Yara (cancelled): opportunity of using ammonia
  - Linked to chemicals, H_2 (SMR, POX)

Yara facilities (Norway)

Status- Progress

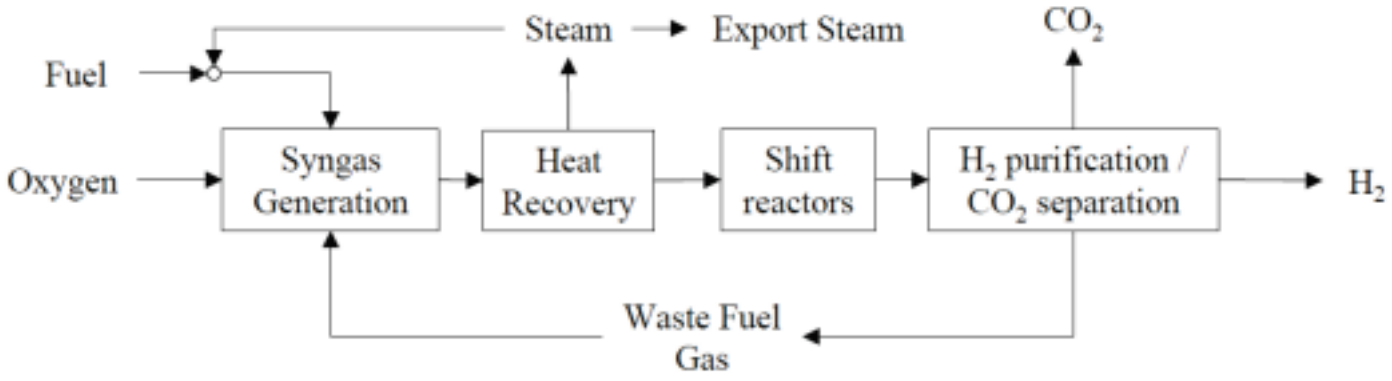
- Chemicals
  - Heterogeneous sector
- Natural Gas
  - Sleipner and Snohvit, Terrl , Shute Creek, Century Plant, Salah, Gorgon.
  - Commonly sorbents, CCUS
- Heavy oil
  - Linked to H_2
  - Diluted CO_2

Key research and innovation challenges

- Identified areas of research in the previous report :
  - C1-solvents
  - C2-sorbents
  - C3-membranes
  - Targeted application: industrial sector
  - Hydrogen

Key research and innovation challenges

- Hydrogen: PRD C-8, linked to CO_2 capture technologies challenges
  - Gasification challenges (high TRL)
  - Reforming with O_2 via high-temperature membranes and integrated with H_2 production
  - Combustion and reforming: microchannel reactors
  - Challenges related to operation , turbines, flames



Key research and innovation challenges

- Development of CO_2 capture technologies as for the power sector. Some are still at low TRL. Explore opportunities (higher CO_2 concentration, partial capture, energy/heat integration)
- To make the difference between power and industrial sectors
- Increase CCUS deployment

Steps towards, closing gaps for deployment and industrial opportunities

- Thera are many challenges for the deployment of industrial CCUS, but those can be successfully addressed to enable a decarbonised industry (BEIS, 2018)

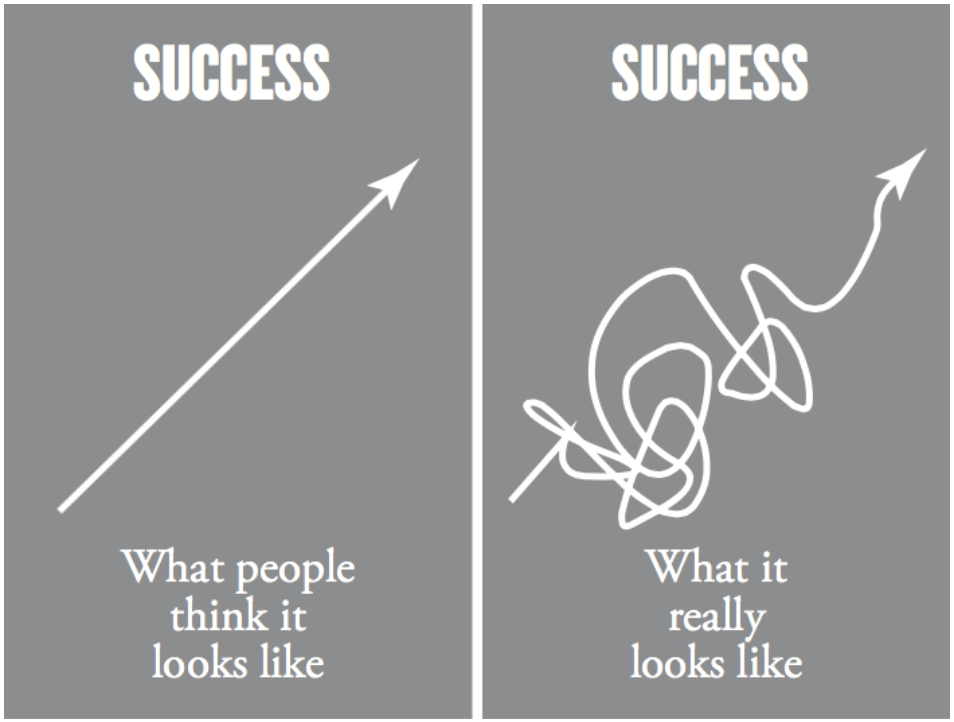


Image from:
https://leanb2bbook.com/blog/the-real-odds-of-success-for-b2b-entrepreneurs/

Relevant documents

- CSLF Task Force for Large Emitting Industries (Technical Group)
- IEAGHG studies
- *Industrial carbon capture business models*, BEIS (October, 2018)

Questions?

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