

Responsible Investment in Oil & Gas

What's in Store for CO₂?

FINDING PETROLEUM

The Geological Society, Burlington House, Piccadilly, London

Roberto Bencini, Greg Coleman

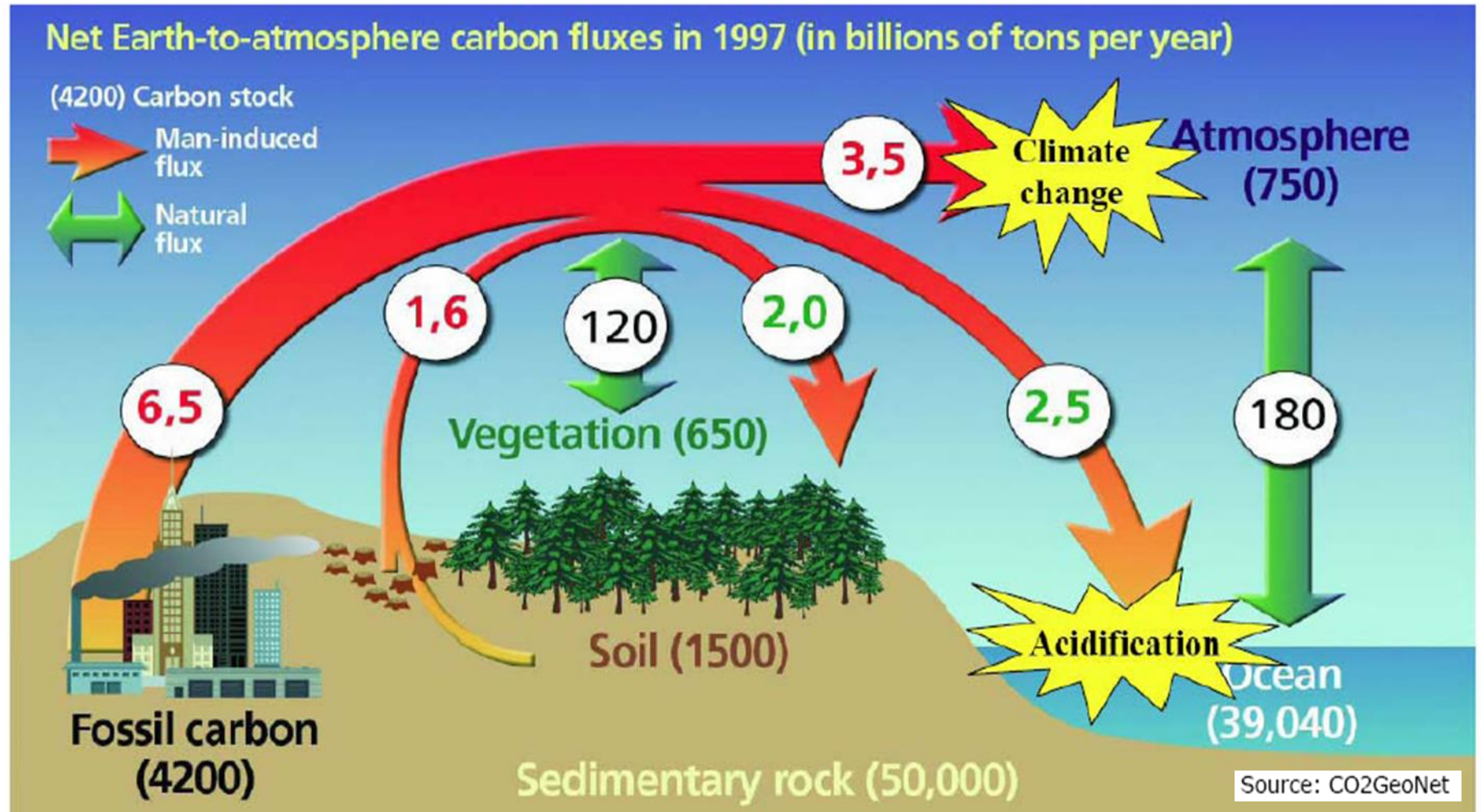
December 6th, 2019

“Carbon capture and storage (CCS) has lots of potential worldwide but also faces significant challenges”

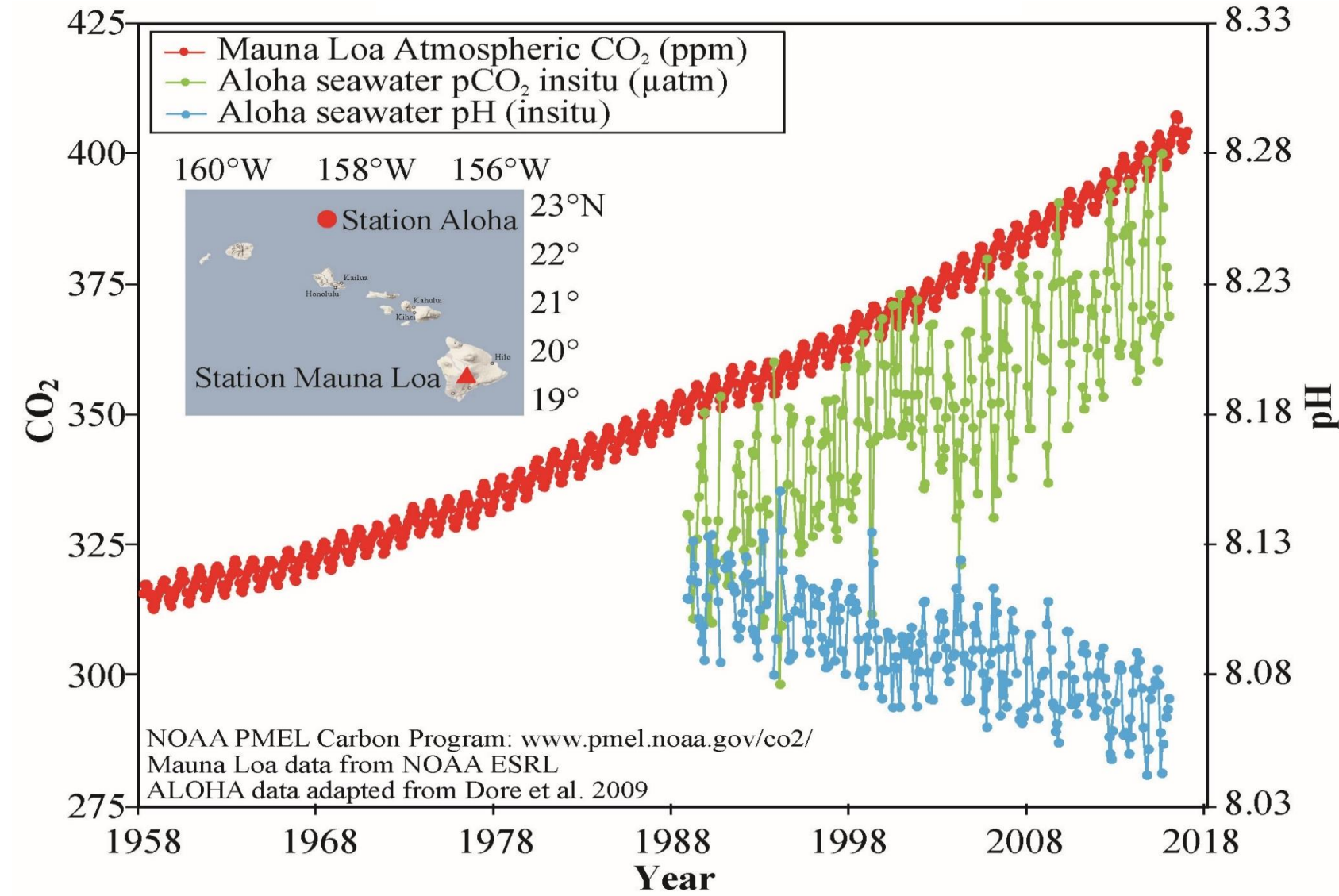
CO₂ GLOBAL CYCLE

Worldwide CO₂ emissions from fossil fuel use: 6.5 Gt C/y (or 24 Gt CO₂/y)

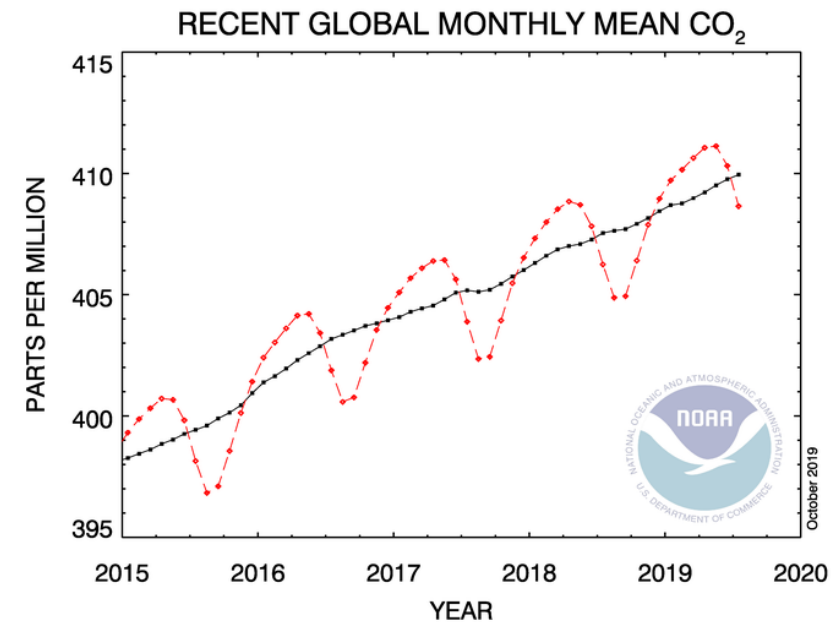
Excessive anthropogenic carbon dioxide (CO₂) emissions from the use of fossil fuels are contributing to global warming and climate changes.



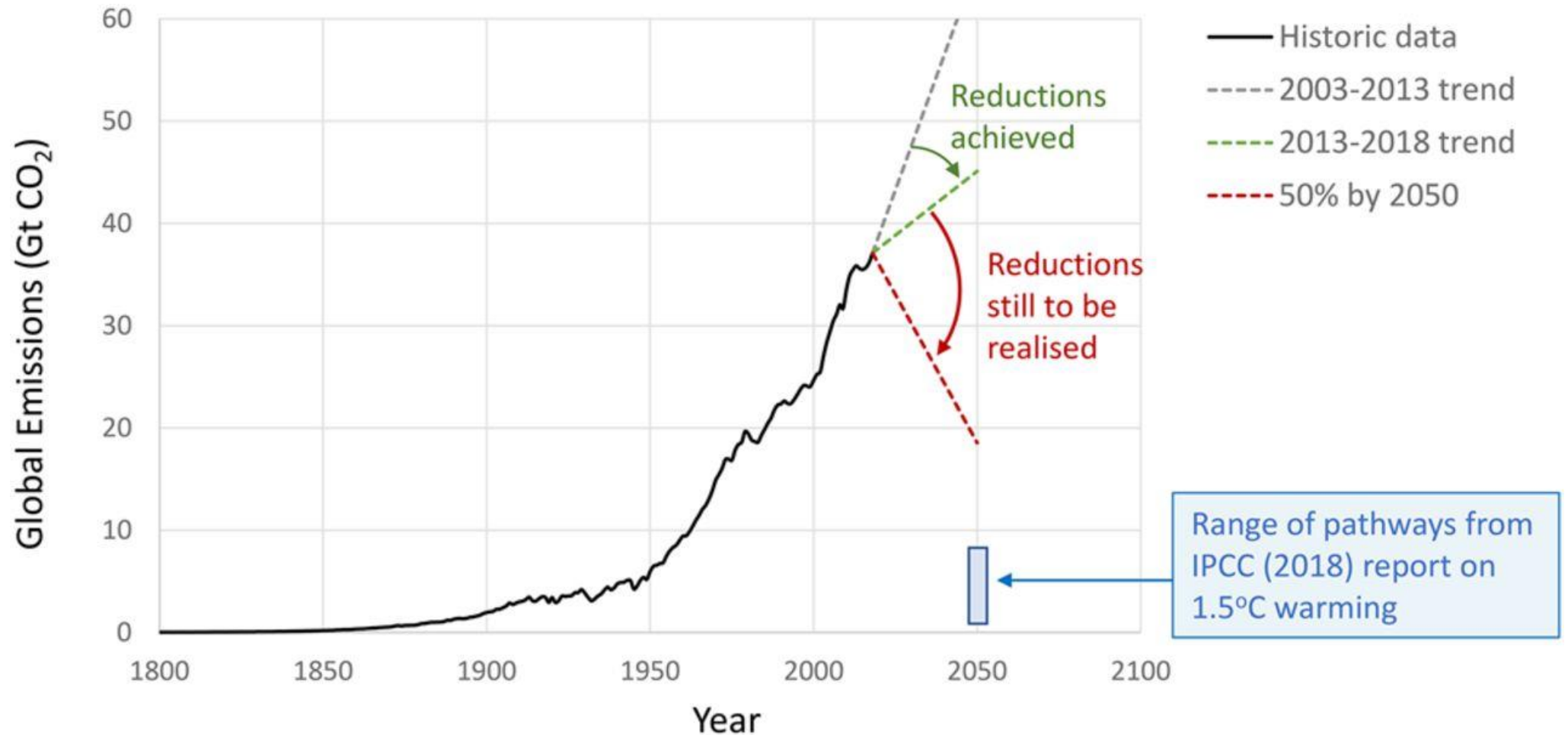
CONTINUOUS GROWTH



As a society we should aim to abate CO₂ emissions despite the prospect of a rise in energy consumption.



A LOT OF WORK TO BE DONE



From: **Stephenson, M.H.**, et al., “Geoscience and decarbonization: current status and future directions”. Petroleum Geoscience, 29 August 2019, <https://doi.org/10.1144/petgeo2019-084>

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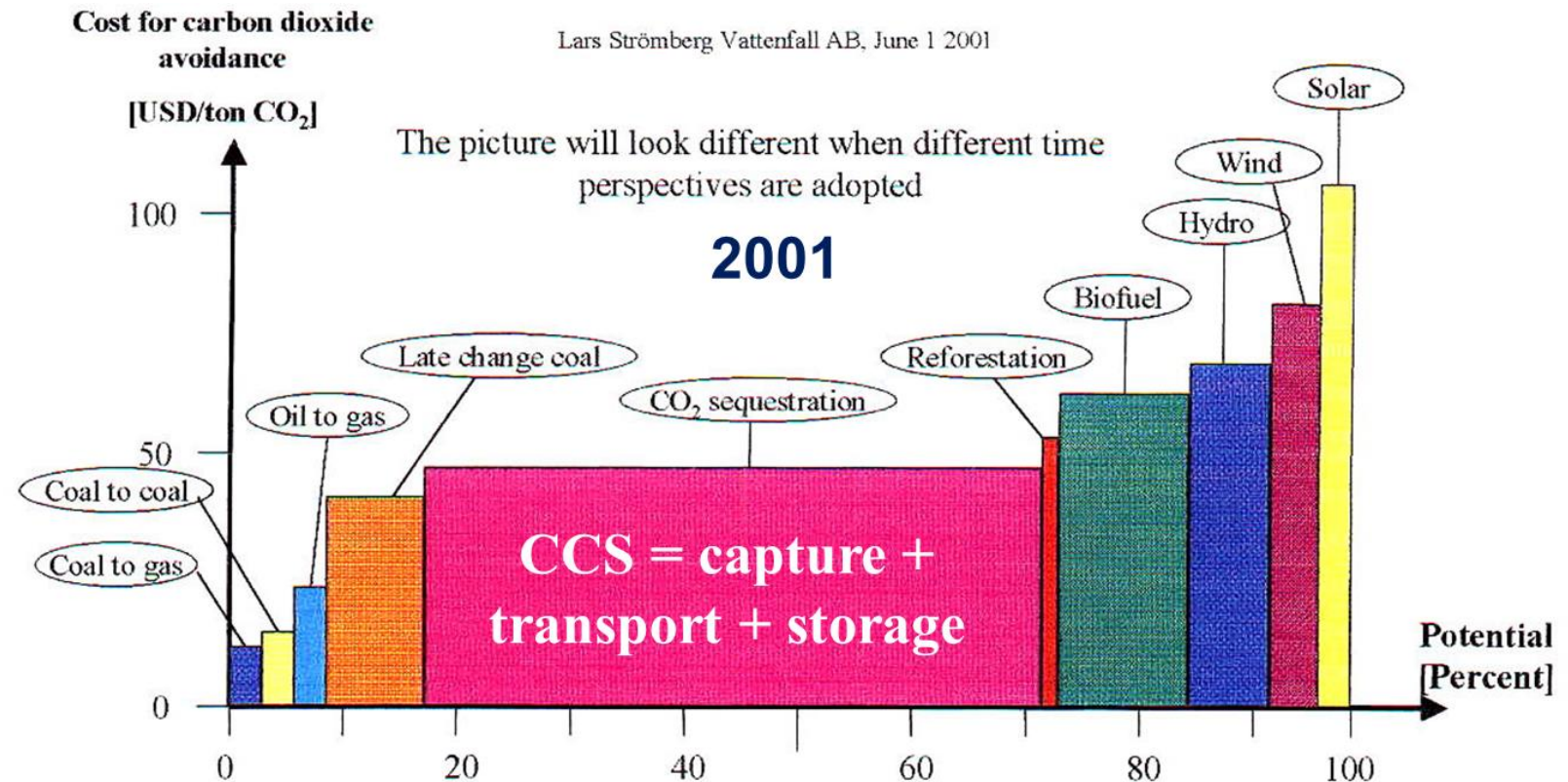
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BRIDGE TO RENEWABLES

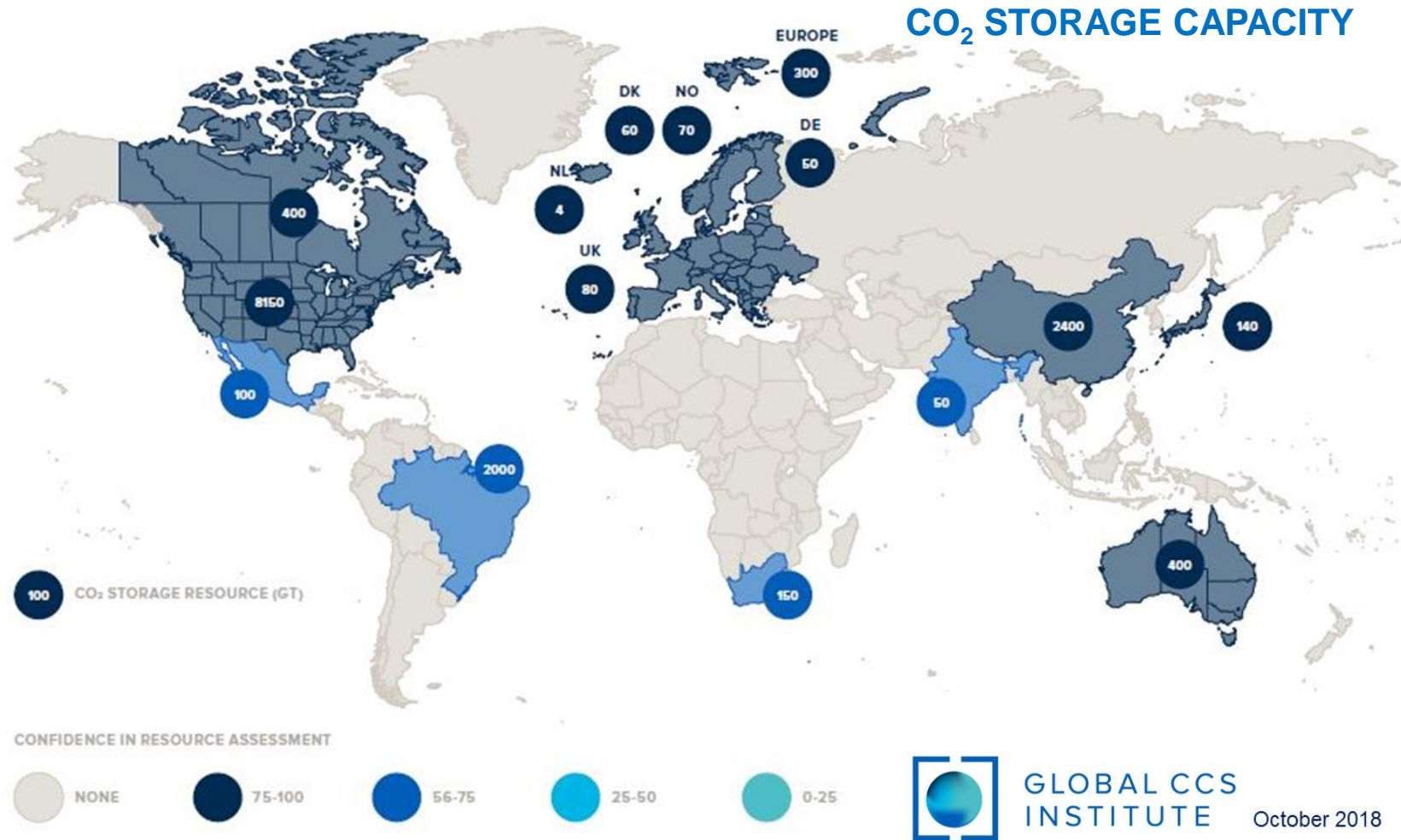
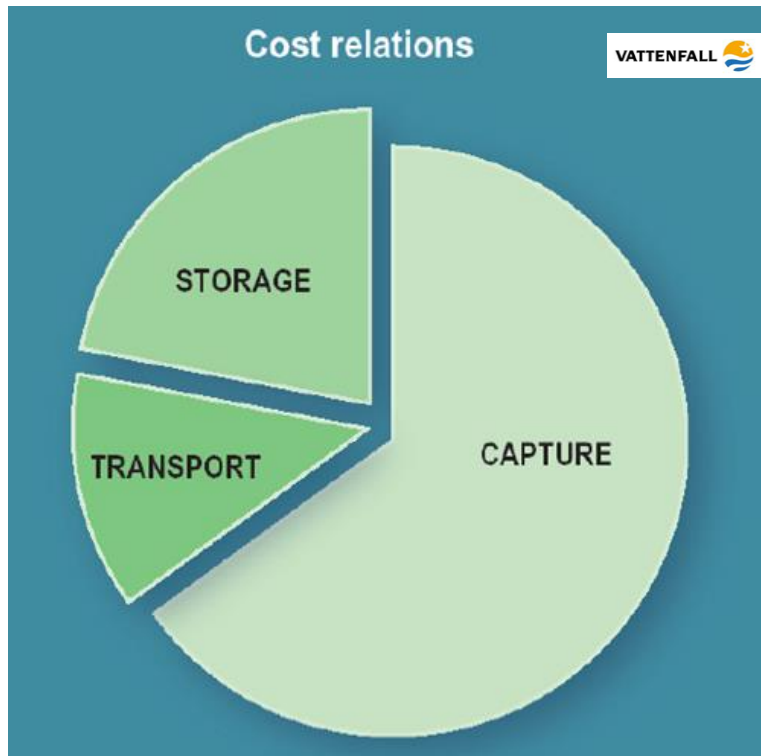
CCS and its variations, carbon capture, usage and storage (**CCUS**) and bio-energy carbon capture and storage (**BE CCS**), represent a powerful solution to the problem of excessive anthropogenic CO₂ emissions, acting as bridging technology for energy transition to a decarbonised world.

CO₂ AVOIDANCE TECHNIQUES



CCS COST /FEASIBILITY

CO₂ capture is the more costly element of the CCS chain. But CO₂ storage can be carried out safely and relatively cost effectively in suitable subsurface sites.

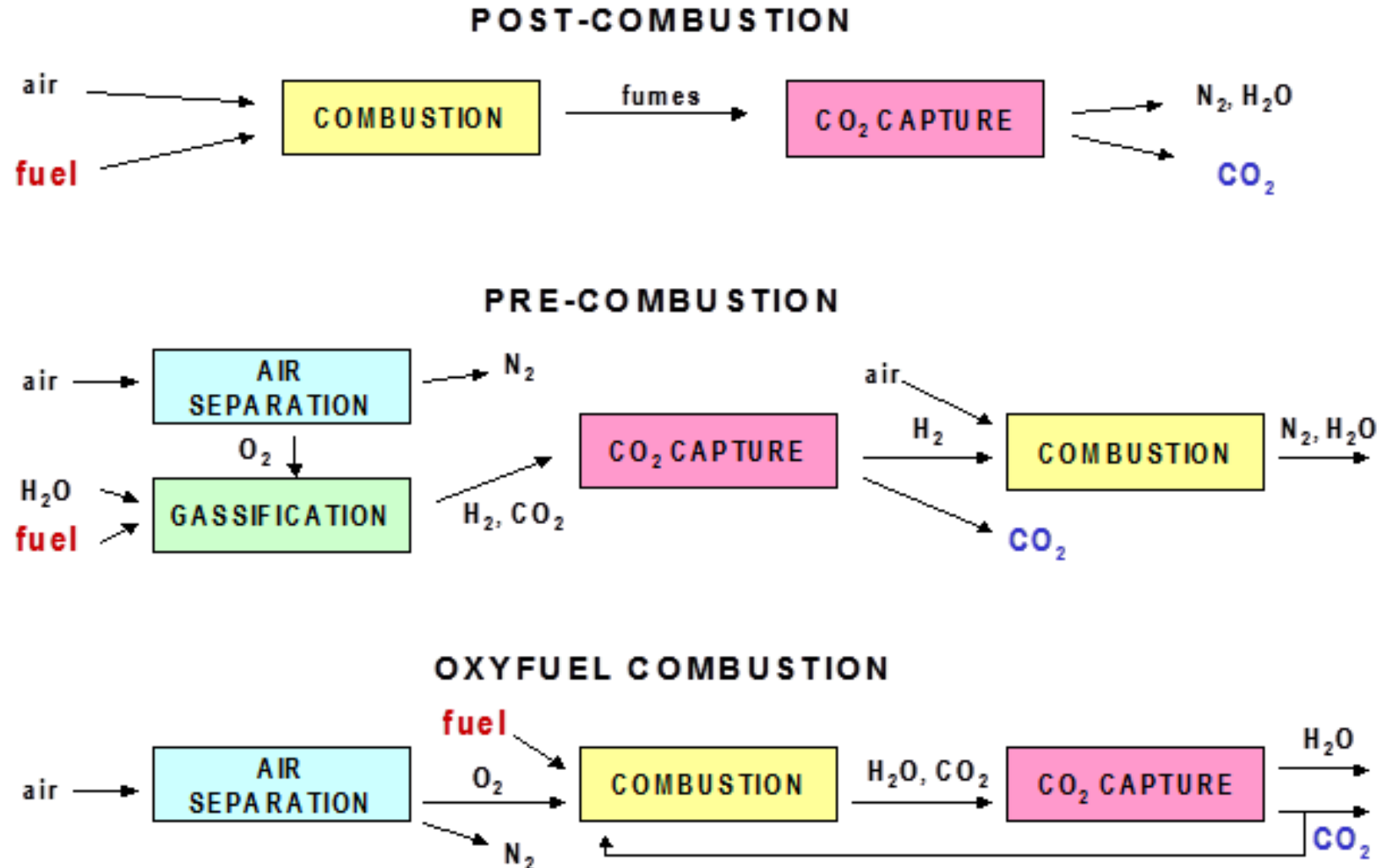


CARBON CAPTURE

Carbon Capture can be done using established technologies such as:

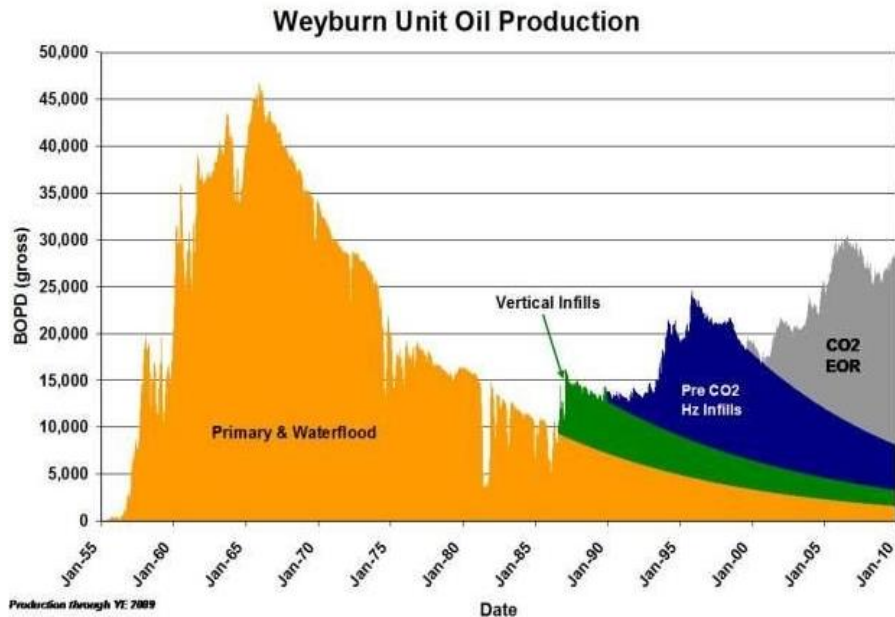
- post-combustion CO₂ scrubbing from fumes,
- pre-combustion CO₂ separation from a hydrogen-rich gasification stream,
- oxy-combustion.

While solid fossil fuel gasification is currently the cheapest option for capturing CO₂, oxy-combustion has the best chance of gaining industry favour in the near future.

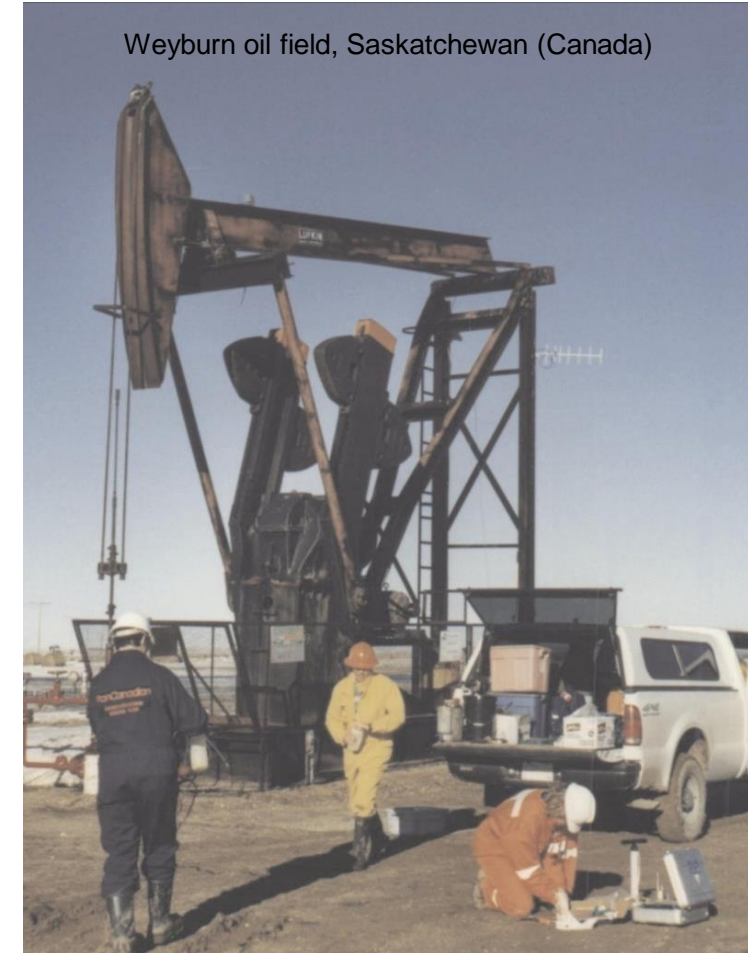
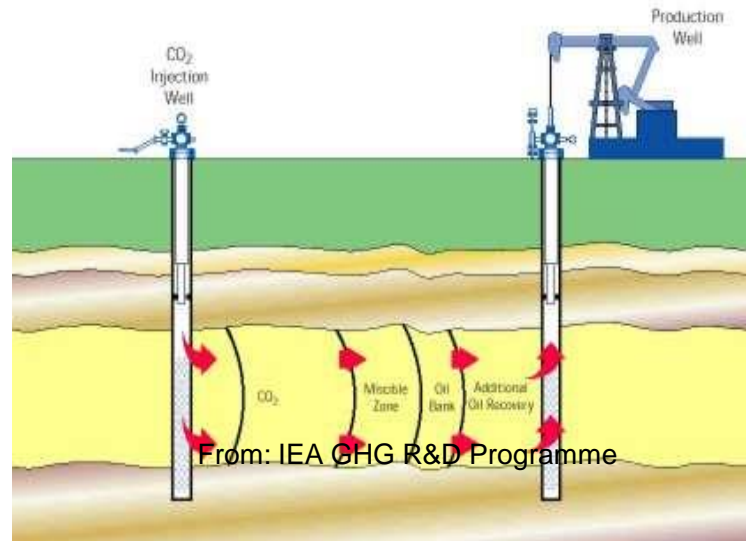


CARBON CAPTURE / USE

CCUS (Carbon Capture Usage and Storage) is a technological scheme where the CO_2 is used in an economic way in an industrial process. For example, large amounts of CO_2 can be used for enhanced oil recovery (EOR) (using CO_2 to get more out of oil reservoirs) at many sites in the US and could be deployed elsewhere. CCUS has not yet gained much attention in the North Sea, mostly because the costs to enable existing platforms to safely handle CO_2 are still perceived as high.



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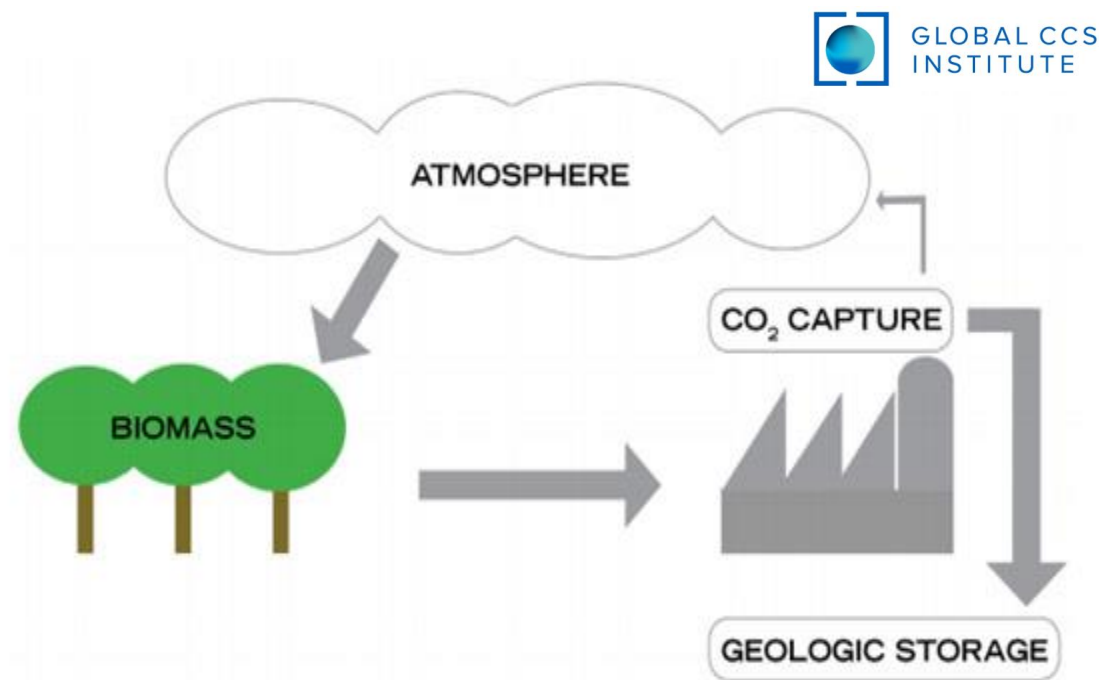


BIO-ENERGY CCS

Bio-Energy CCS (**BE-CCS**) is a clever idea. If the source of carbon for CO₂ capture is vegetable material, the geological storage of the captured CO₂ will result in the incremental removal of CO₂ from the atmosphere. Such integrated technology is more efficient than direct capture from air, an energy intensive technology currently being studied, and is an attractive solution to simple CCS from use of fossil fuels.

BE-CCS, however, is likely to be applicable at a smaller and more local scale than fossil fuel CCS. The vegetable carbon source for BE-CCS can be fuel crops (sorghum, maize, etc.) or managed forestry, *spirulina* group algae (biofuel, biodiesel), or other types of algae (*chlorella*, *dunaliella*, *scenedesmus*, etc.). Such bio-energy sources can be grown in many parts of the world, and the CO₂ can be captured and stored, to offset CO₂ emissions elsewhere.

BE-CCS



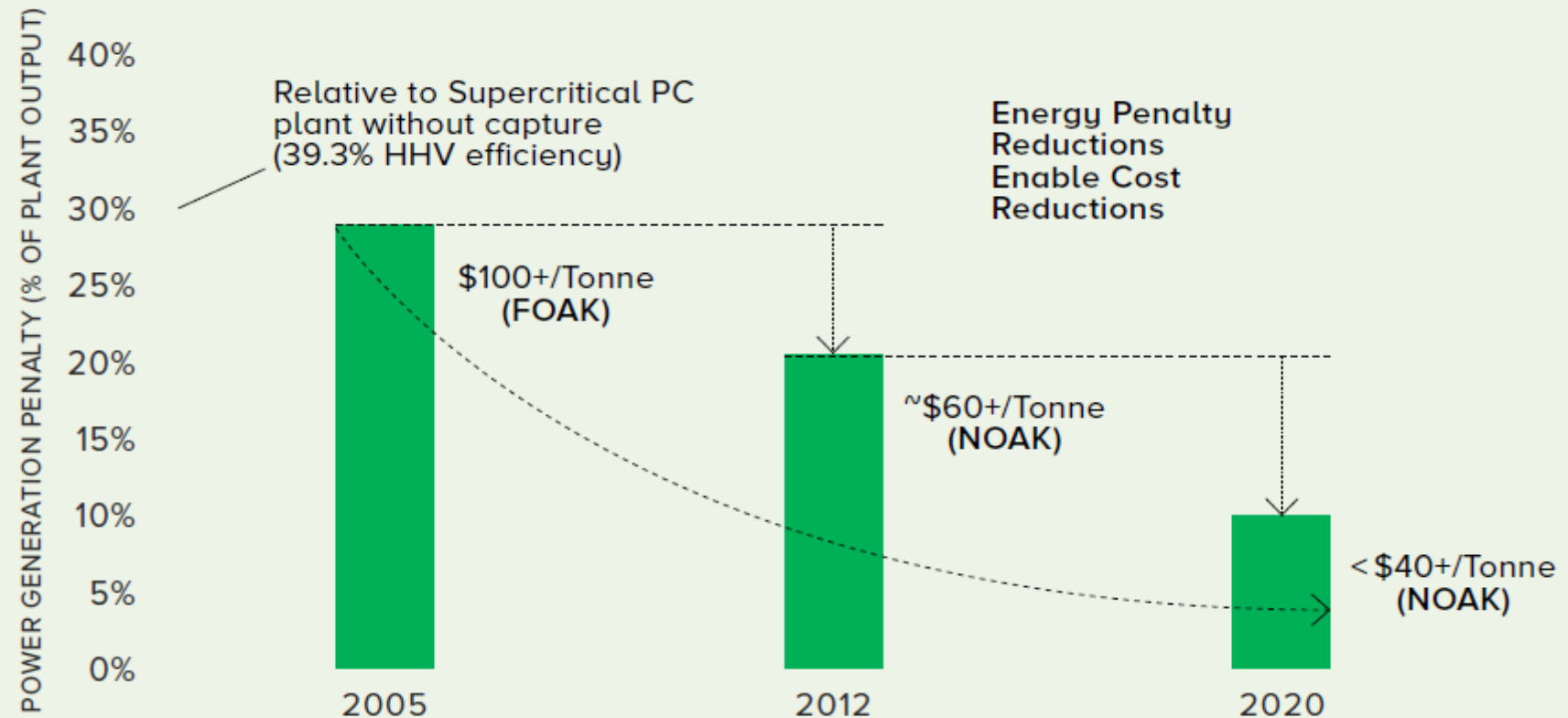
CAPTURE COST REDUCTION

The key challenge of CCS is reducing the capture cost, which represents two thirds or more of the total cost of CCS.

The current anticipated CCS cost, measured pro-rata per tonne of CO₂ avoided, is less than the European penalty, that is currently set at €100/t of CO₂, for emitting CO₂ above the given (and ever reducing) regulatory threshold.

The CCS cost is, however, still higher than the current cost of the European emission certificates.

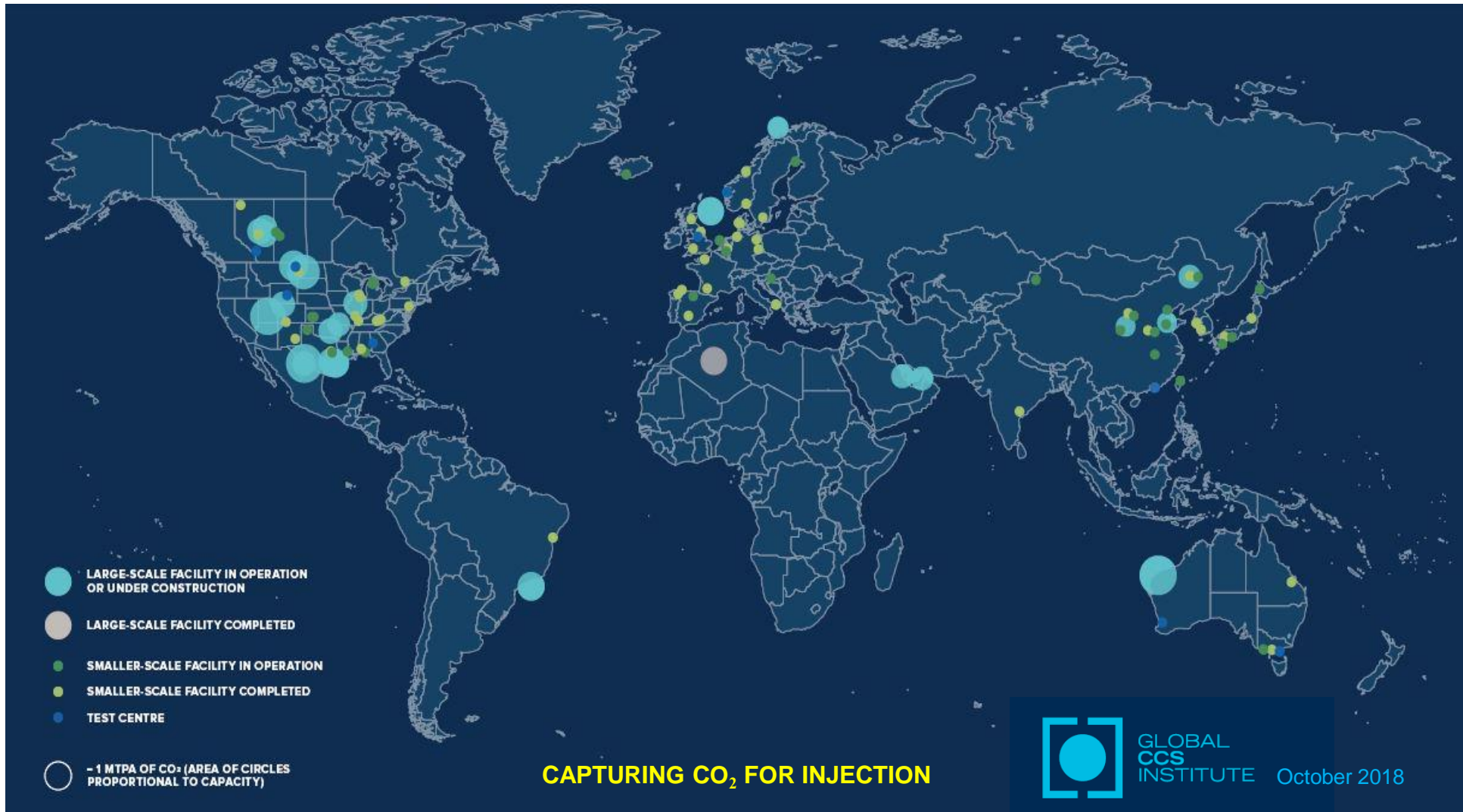
R&D driving costs reductions



Source: Michael Matuszewski. "DOE/NETL CO₂ Capture R&D Program". 2014 NETL CO₂ Capture Technology Meeting, Pittsburgh, PA, 29 July–1 August 2014

Note: HHV = Higher Heating value, FOAK = First of a Kind, NOAK = Nth of a Kind.

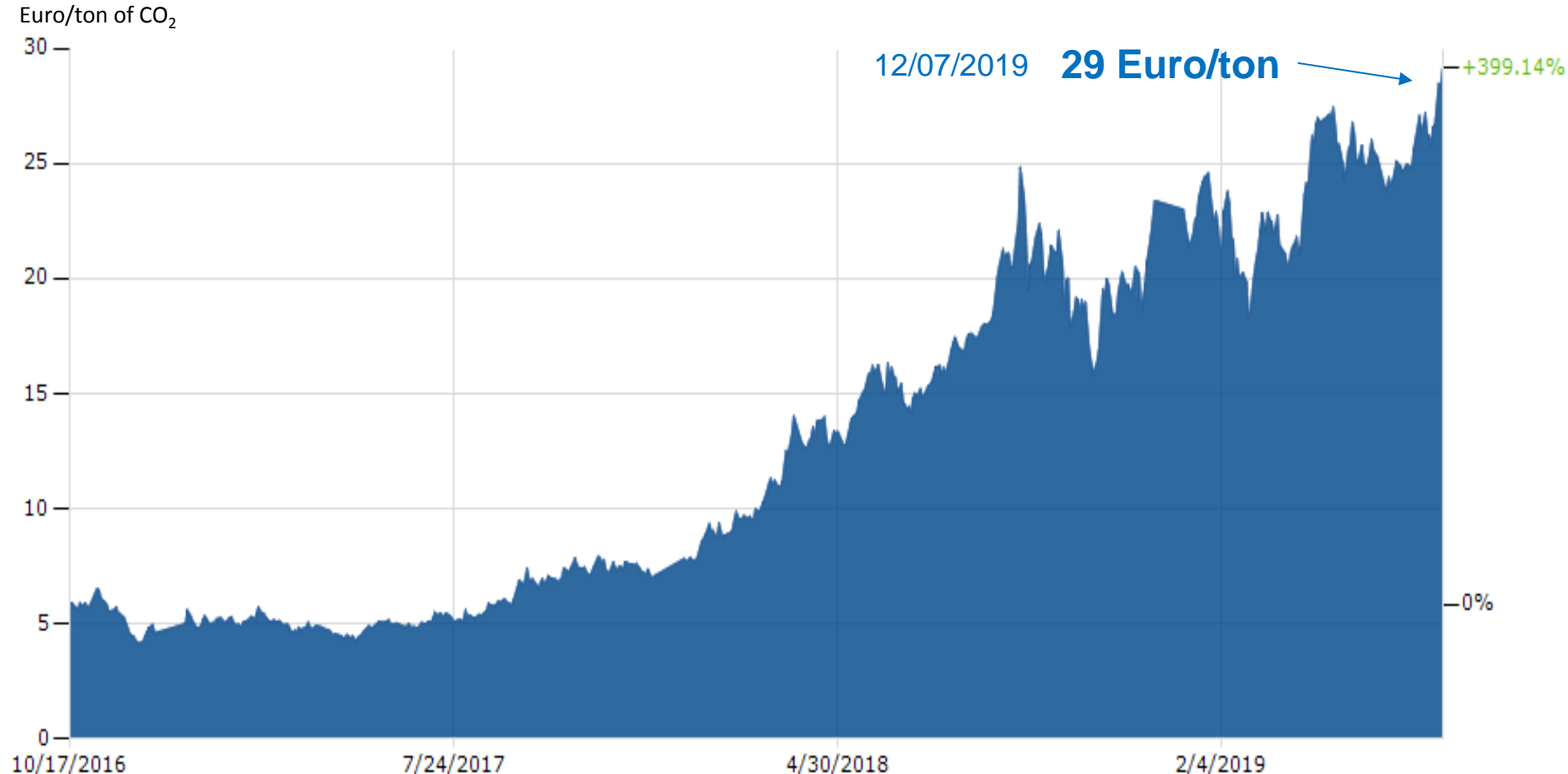
CAPTURE DEVELOPMENT



CO₂ EMISSION COST

Until it is cheaper to buy CO₂ emission certificates to avoid heavy penalties, CCS is unlikely to take off as a new industry.

On the other hand, if capturing, transporting and storing CO₂ underground steadily becomes cheaper than buying standard CO₂ emission certificates, there is a strong chance that CCS can develop worldwide.

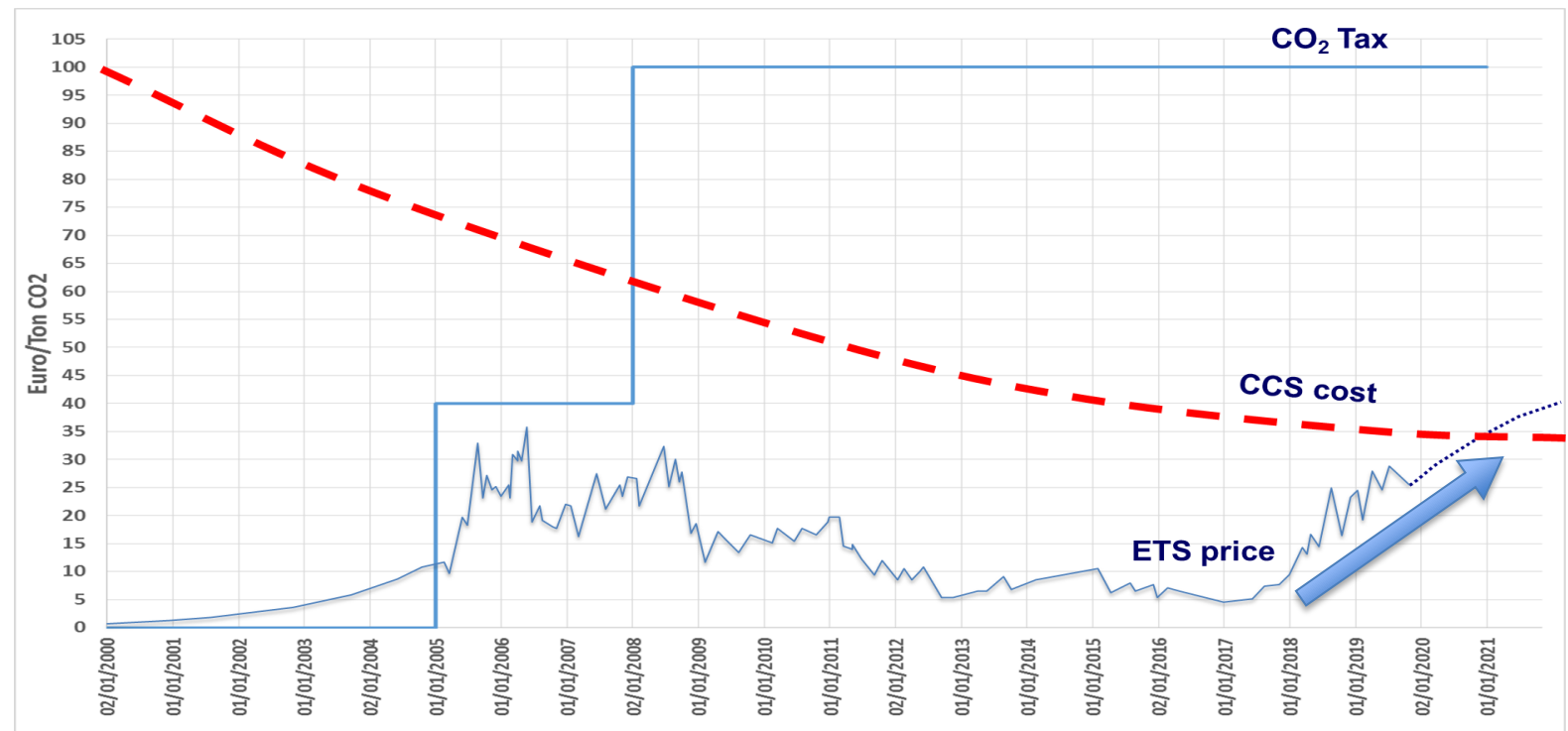


CROSSING CURVES ?

Many fundamental factors are currently changing. The economic crisis that started hitting the western world in 2008-2010 is relenting and energy generation and consumption from fossil fuels is resuming its growth despite the rocketing rise of renewable power generation (particularly photovoltaic and wind power). Consequently, the gradual reduction of CO₂ allowances on the market is pushing the emission certificates price higher and higher.

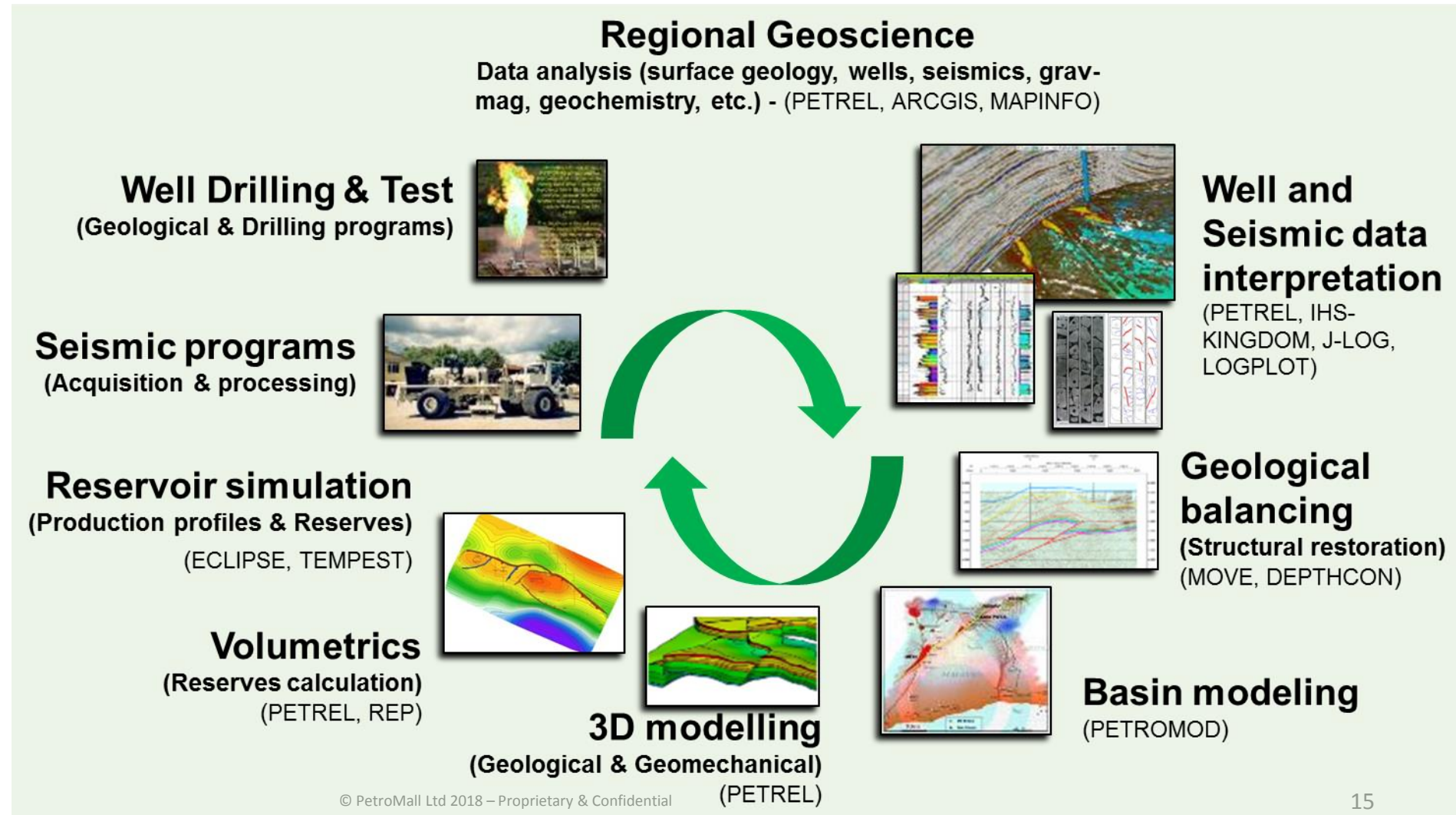
Since early 2018, after some ten years of stagnation, the ETS CO₂ emission certificate price has been growing with moderate oscillations from approximately €5/t to approximately €29/t more recently.

It is likely, therefore, that the two curves, lowering capture cost and rising certificate price, will cross in the near future, allowing CCS to progress and grow worldwide.



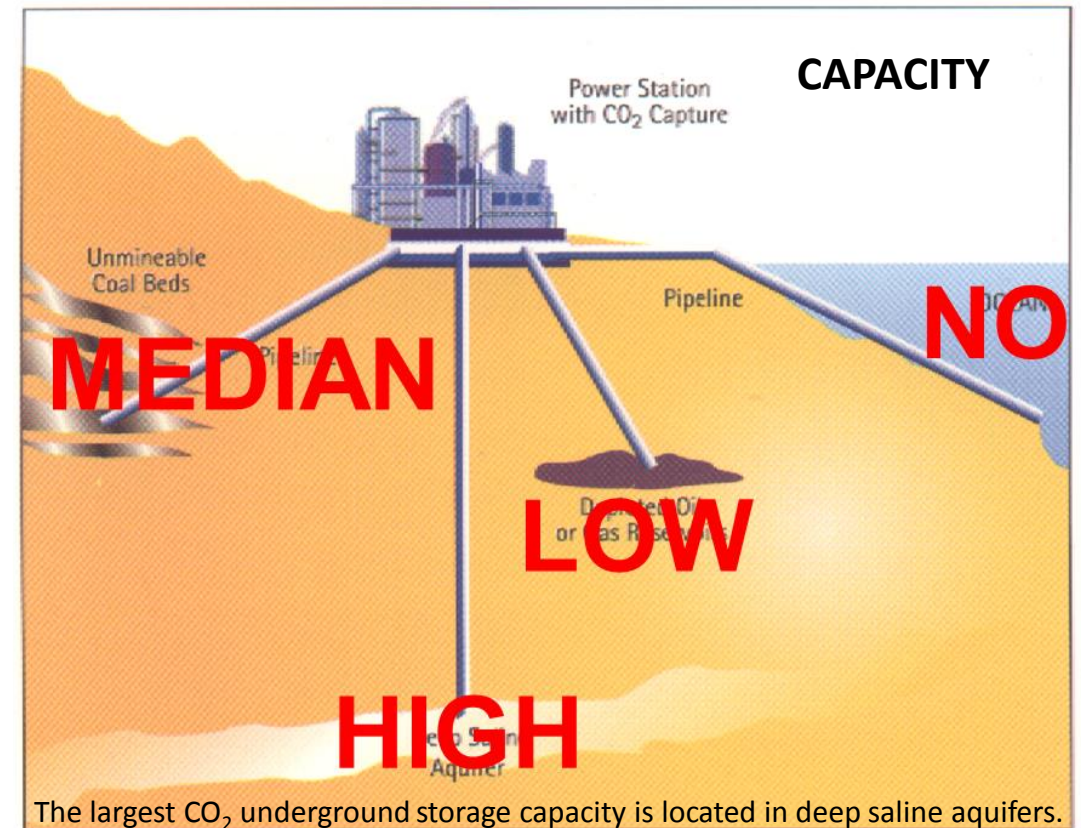
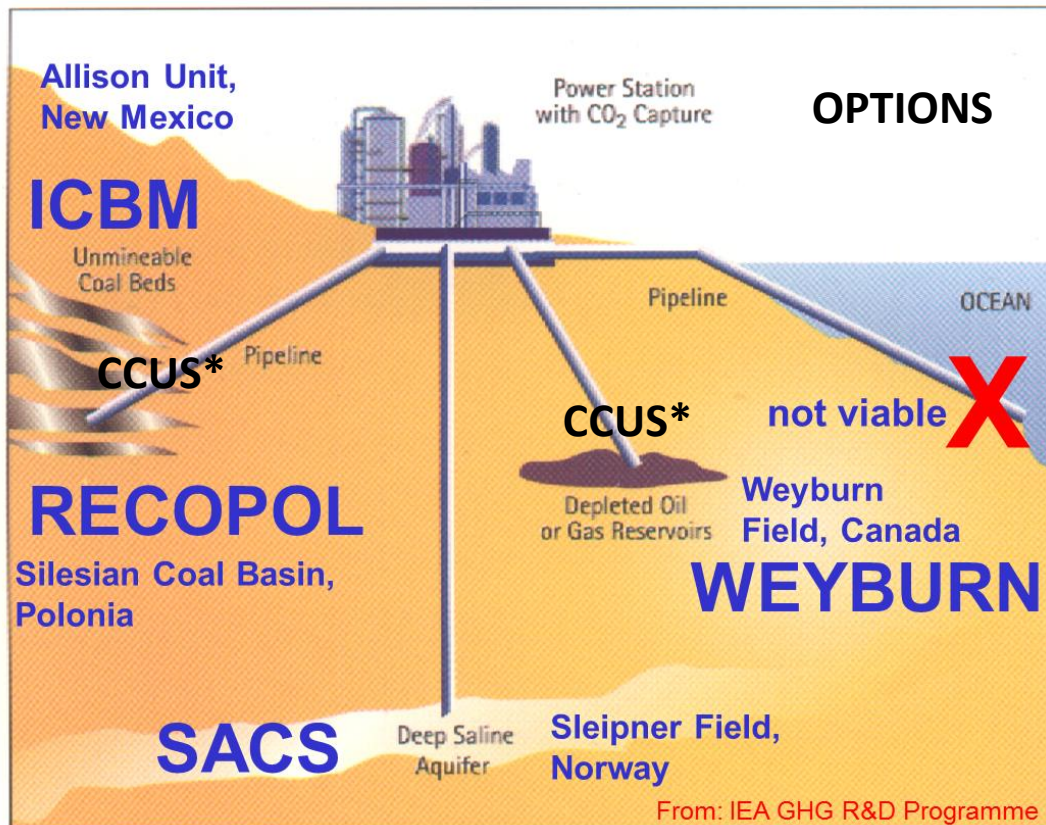
FINDING STORAGE SITES

Discovering suitable CO₂ storage sites is much like discovering oil or gas fields, and requires the same set of tool, techniques, knowledge and technical know-how.



CO₂ STORAGE SITES

Safe CO₂ underground geological storage can be done in depleted or semi-depleted oil & gas fields, deep coal seams unsuitable for mining and deep saline aquifers (with or without structural closures).



ESG AWARENESS

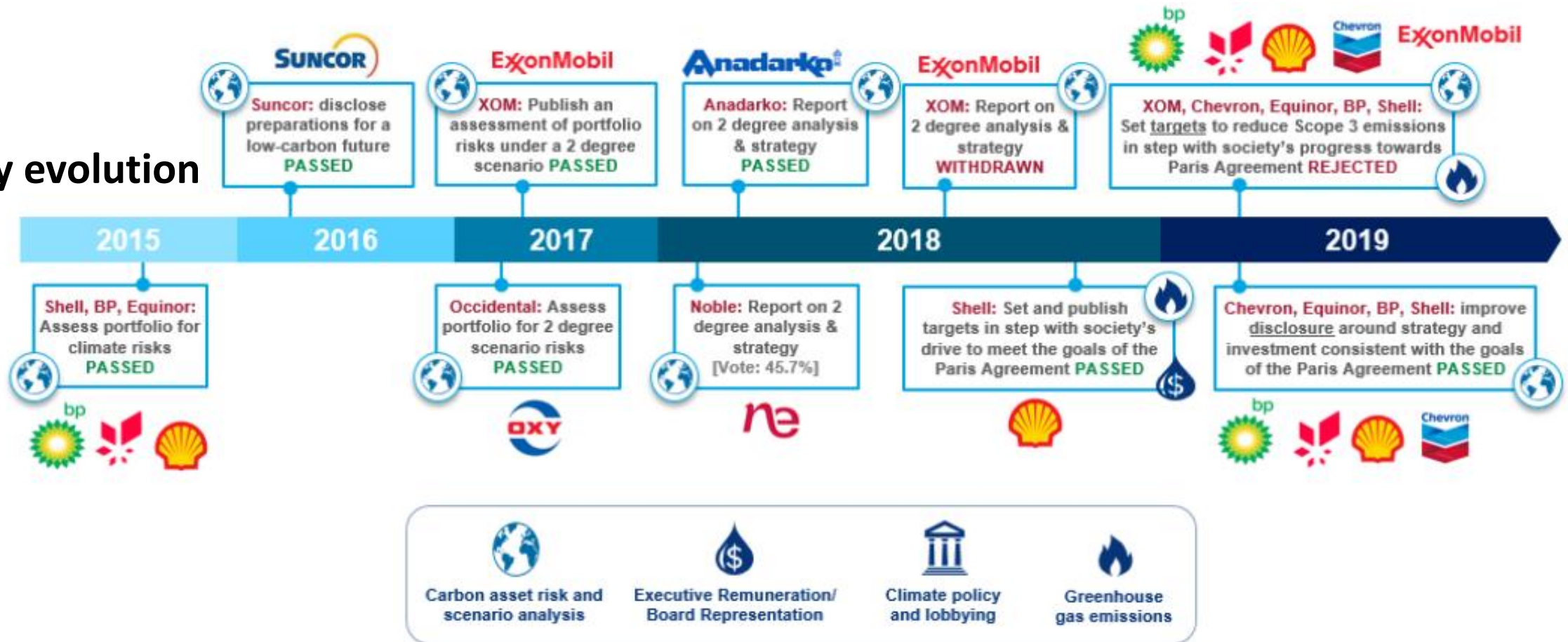
“**ESG investment funds** are portfolios of equities and/or bonds for which environmental, social and governance (ESG) factors have been integrated into the investment process.”

Can CO₂ capture and storage count as ESG factor for E&P companies?

Time for a **scorecard scheme**, which can be called
Petroleum ESG Assessment (PESGA)

ESG AWARENESS

Policy evolution



Time for a **scorecard scheme**, which can be called Petroleum ESG Assessment (PESGA)

CONCLUSIONS

- Every industrial product consumes materials and energy. If the materials are entirely re-cycled and all the energy comes from renewable sources, there is no CO₂ emission problem to take care of. If, however, new raw materials are inserted in the productive cycle, and non-renewable energy is used, as most commonly is the case for years to come, then the full lifecycle CO₂ emission can be calculated for every single industrial item sold worldwide.
- Producers of industrial products should calculate a total life-cycle CO₂ emission amount for that item and offset such CO₂ quantity with CO₂ emission certificates (that will increasingly come from permanently storing CO₂ underground in a certificated way). This information should be clearly printed on the packaging, so that consumers can choose.
- There is an opportunity for the leading oil and gas companies to evolve into leading CO₂ storage companies due to the techniques, technology and challenges entailed. Equinor (formerly Statoil) is an example of this, as it operates the oldest CCS project (the Sleipner gas field which involves producing a CO₂-rich gas stream) and promotes the technique in other projects (e.g. Snøhvit, In Salah, as well as the Mongstad test facility for CO₂ capture).
- We predict the birth and rise of dedicated CO₂ underground storage companies that could prosper selling guaranteed CO₂ emission certificates to whoever needs them, from petrol stations to power suppliers or food retailers.

Overview of PetroMall

PetroMall is an energy consultancy dedicated to ensuring the supply of natural resources required is undertaken in a responsible and professional manner across different countries and improving the economics of prospective and existing projects.

The company was set up in 2012 by senior industry executives and academics. We consider the risks faced by today's energy environment are going to require inspired acts of leadership and technical skill to solve, in order to prosper as an industry in a sustainable way.

The PetroMall proposition brings together:

- A highly experienced team and associates,
- Proven track records in project design and execution,
- The best in asset management,
- Extensive experience in planning and negotiating development projects,
- Experienced with global standards and regulations
- Practical knowledge of the global energy supply chain



PetroMall prides itself on technical and commercial excellence in selected fields; we supplement business management and leadership in order to mitigate emerging risks.

PetroMall

Putting relevant science and engineering back
into every decision made!

Contacts

Greg.Coleman@petromall.org Phone +447788566028

David.Bamford@petromall.org Phone +447776226951

Website: www.petromall.org