

Overview of Carbon Dioxide Removal/NETs Options

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Transdisciplinary Research and Governance on Climate-related Geoengineering
C2G2 Meeting
Montreal, Canada
Dec. 17, 2017



FORUM *for*
CLIMATE ENGINEERING
ASSESSMENT



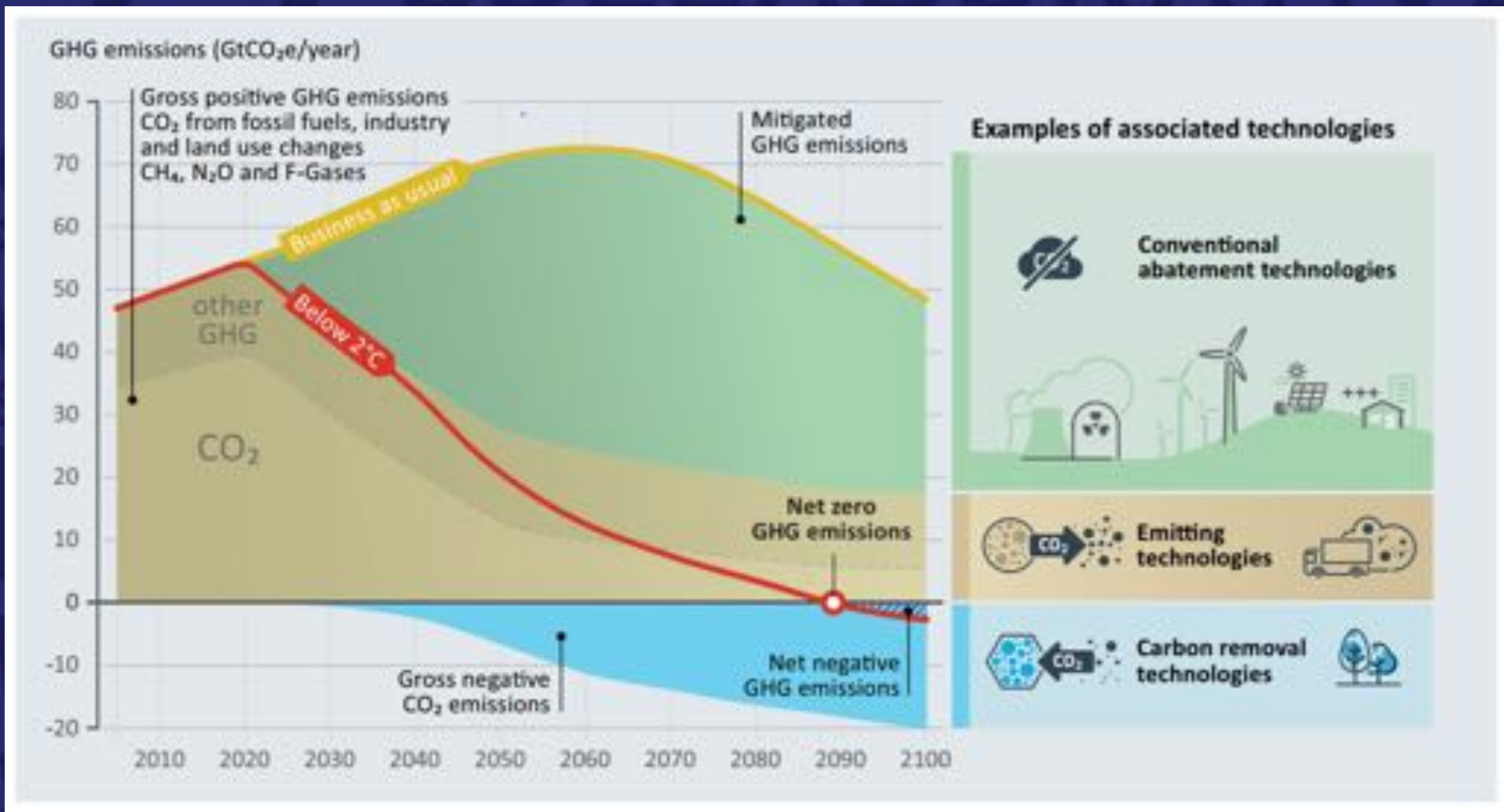
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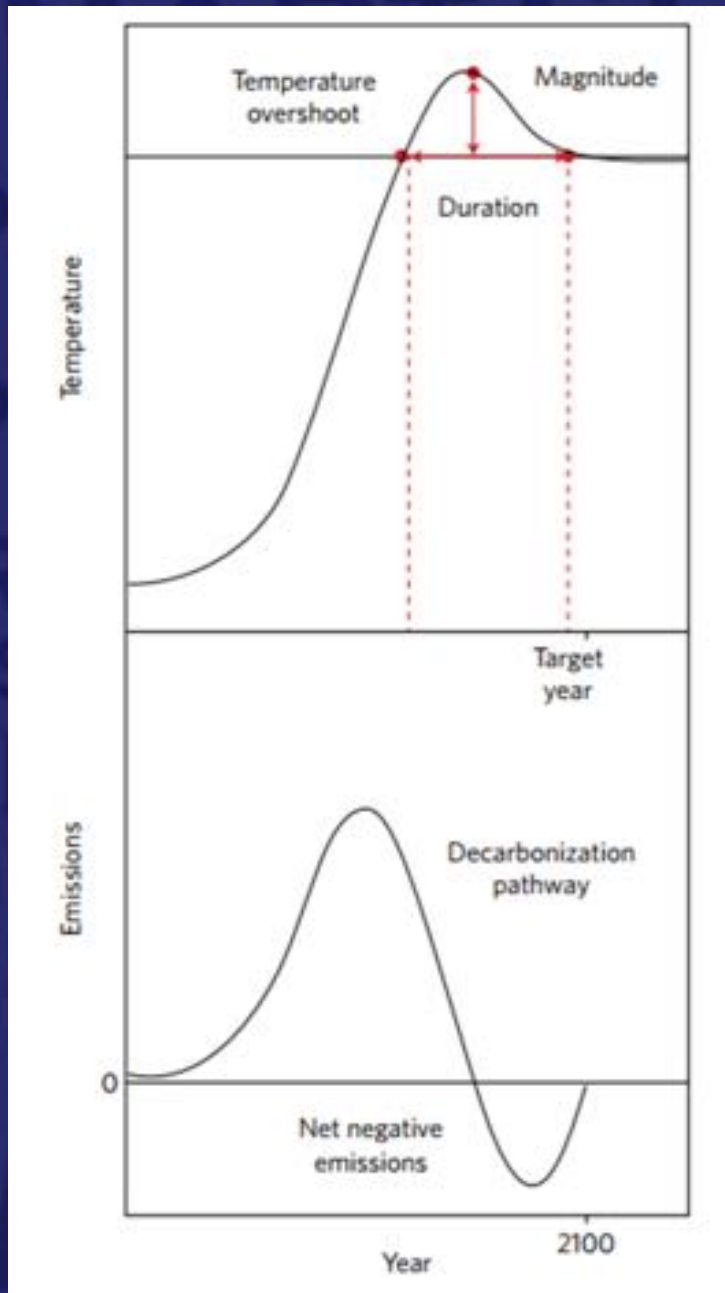
Carbon Dioxide Removal/NETs

Options that aim to remove carbon dioxide from the atmosphere and sequester or utilize it, directly countering the greenhouse effect.



The Exigency of Negative Emissions?





Overshoot Scenarios and Negative Emissions Technologies



Afforestation and reforestation

Additional trees are planted, capturing CO₂ from the atmosphere as they grow. The CO₂ is then stored in living biomass.



Bioenergy with carbon capture and sequestration (BECCS)

Plants turn CO₂ into biomass, which is then combusted in power plants, a process that is ideally CO₂ neutral. If CCS is applied in addition, CO₂ is removed from the atmosphere.



Biochar and soil carbon sequestration (SCS)

Biochar is created via the pyrolysis of biomass, making it resistant to decomposition; it is then added to soil to store the embedded CO₂. SCS enhances soil carbon by increasing inputs or reducing losses.



Enhanced weathering

Minerals that naturally absorb CO₂ are crushed and spread on fields or the ocean; this increases their surface area so that CO₂ is absorbed more rapidly.



Ocean fertilization

Iron or other nutrients are applied to the ocean, stimulating phytoplankton growth and increasing CO₂ absorption. When the plankton die, they sink to the deep ocean and permanently sequester carbon.



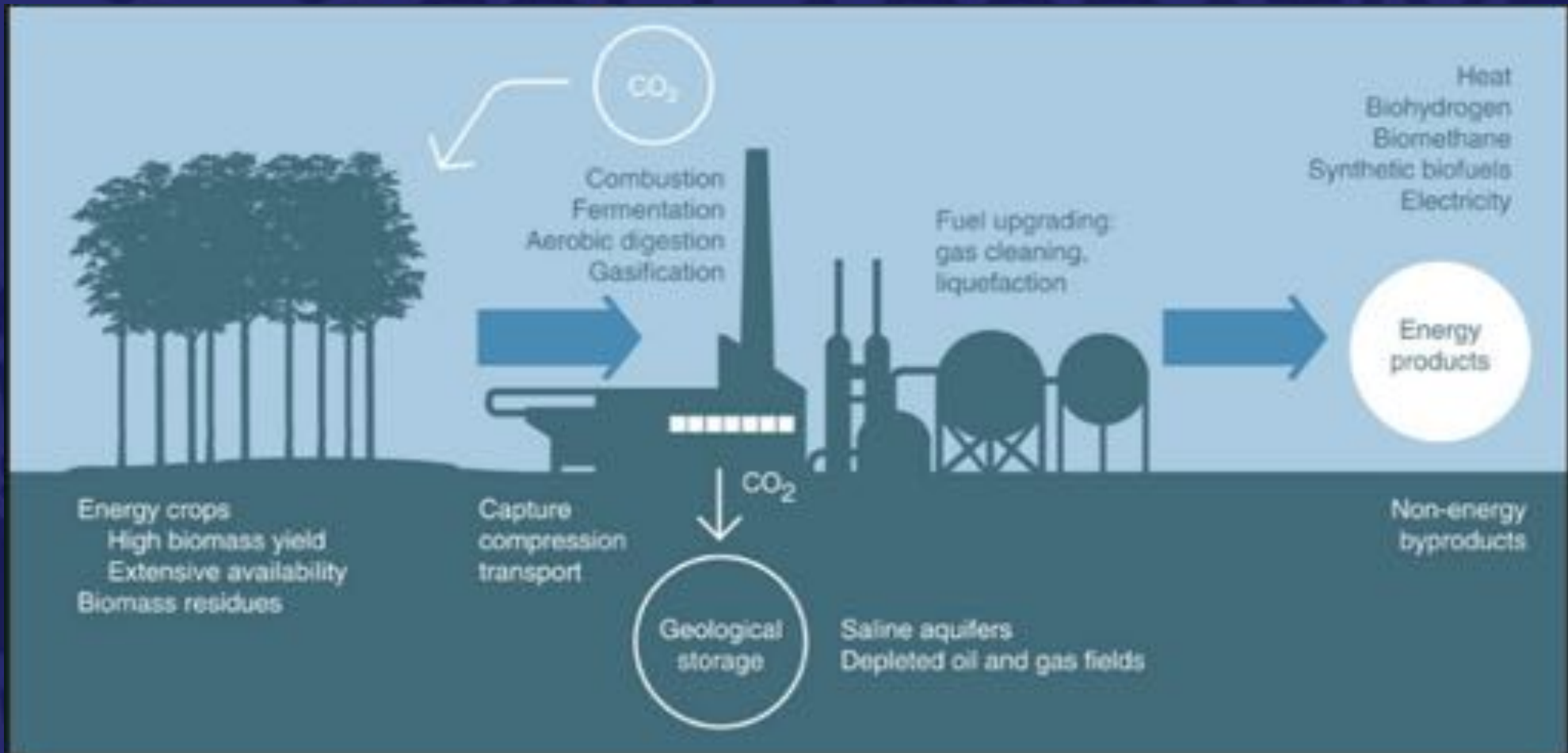
Direct air capture (DAC)

Chemicals are used to absorb CO₂ directly from the atmosphere, which is then stored in geological reservoirs.

Figure 1. Different groups of negative emission technologies exist. Some are rather recent innovations while others have been practiced already for centuries. Note that this list is not exhaustive, in particular it excludes a technology that has recently entered the debate: 'blue carbon' (see Johannessen and Macdonald 2016).



BECCS





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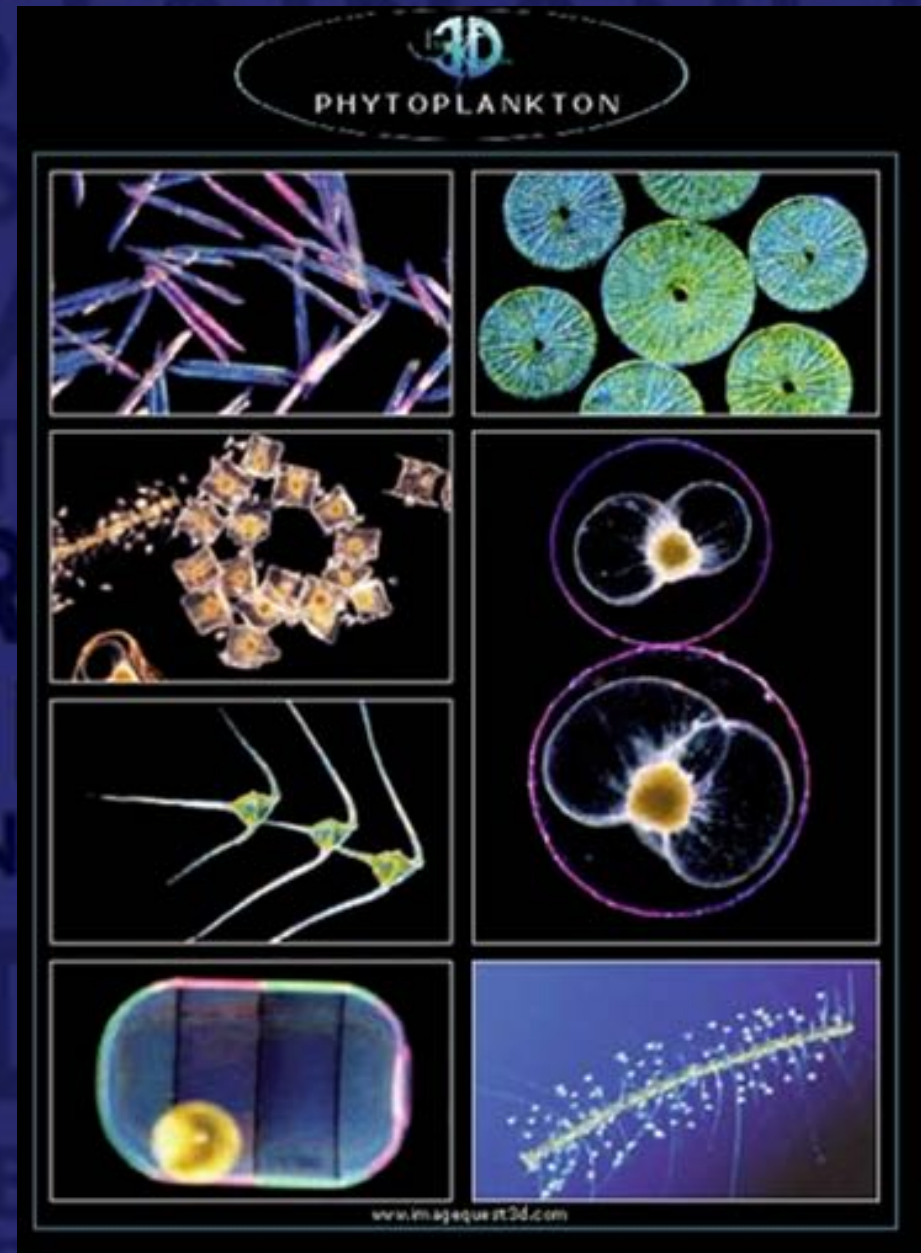
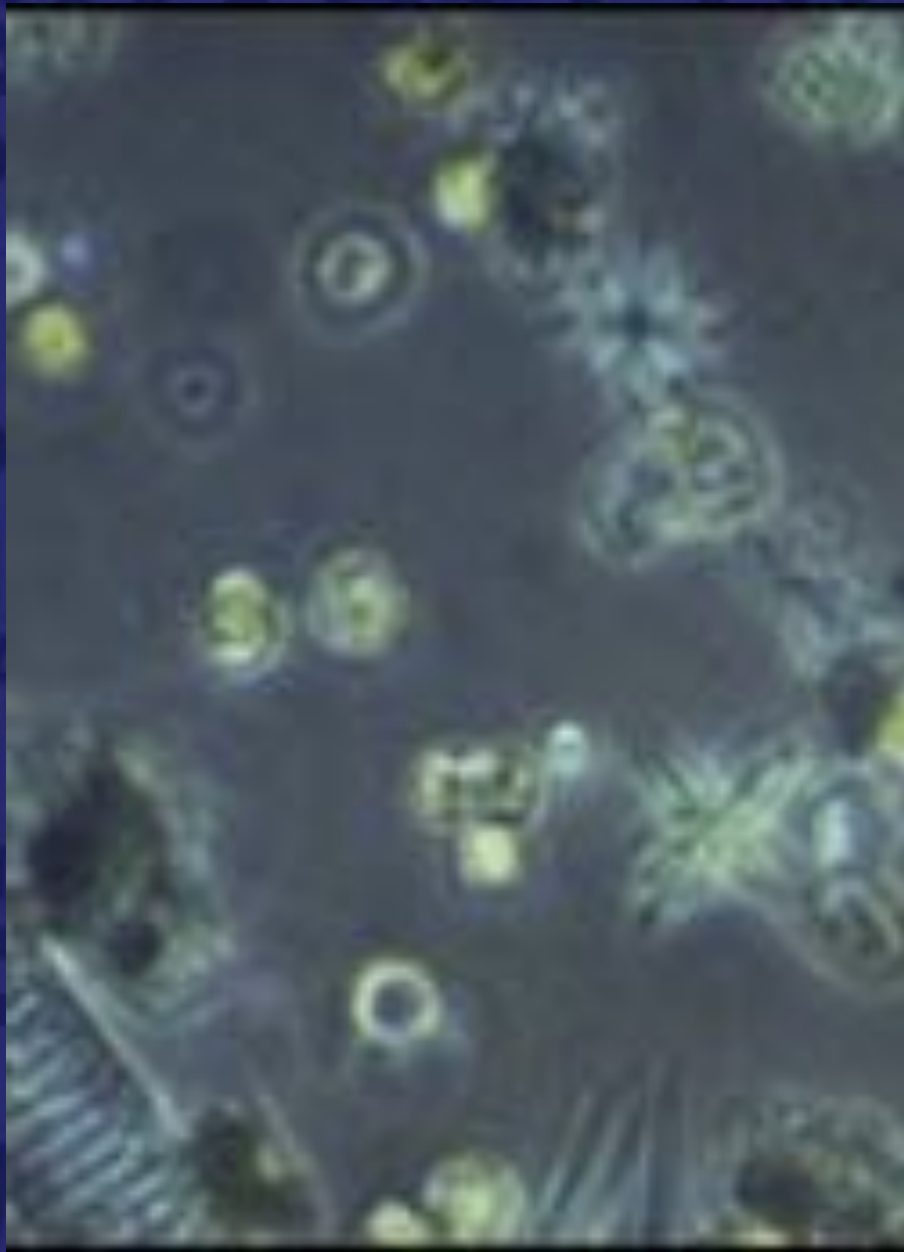


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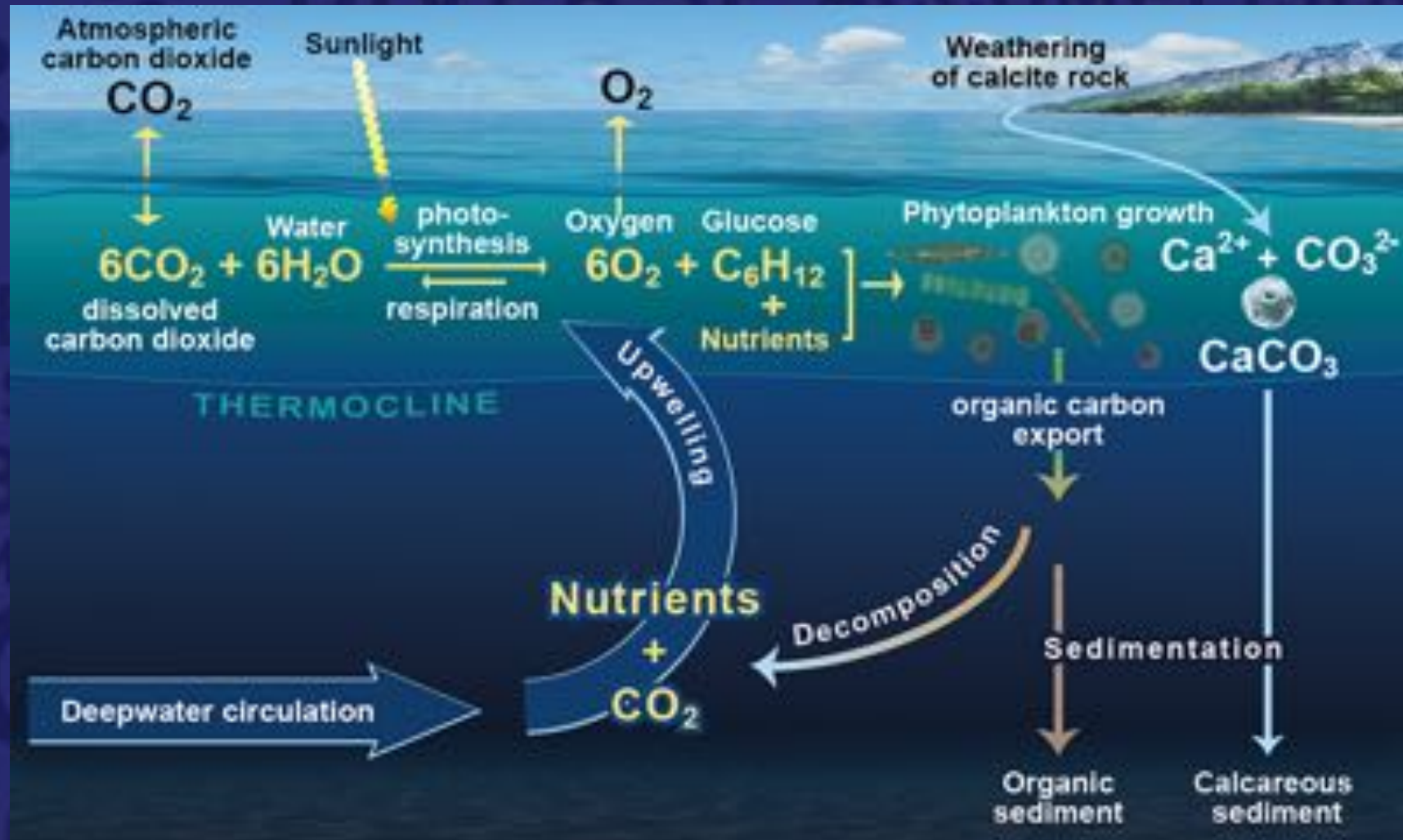
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INNOVATIVE

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Biological Pump



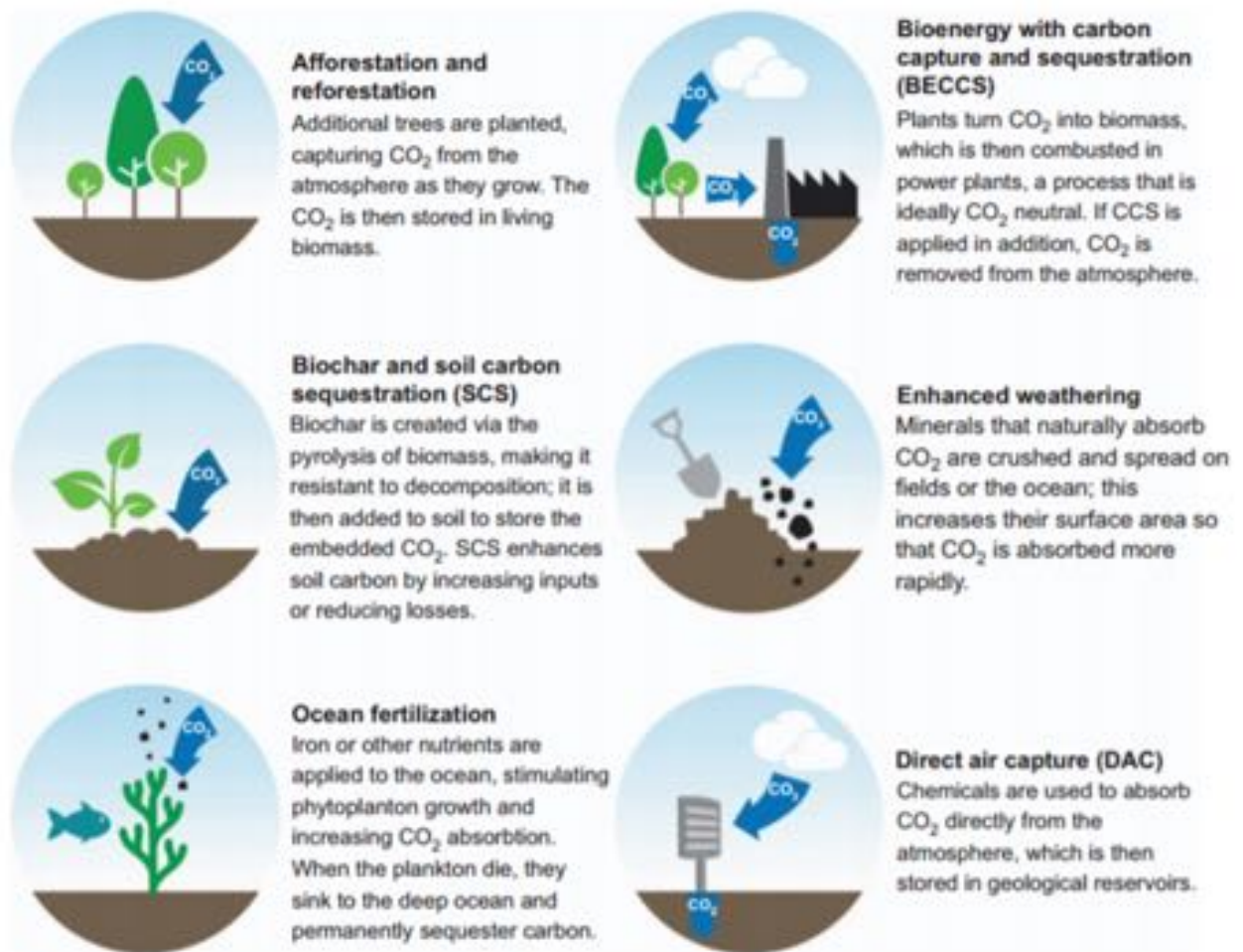
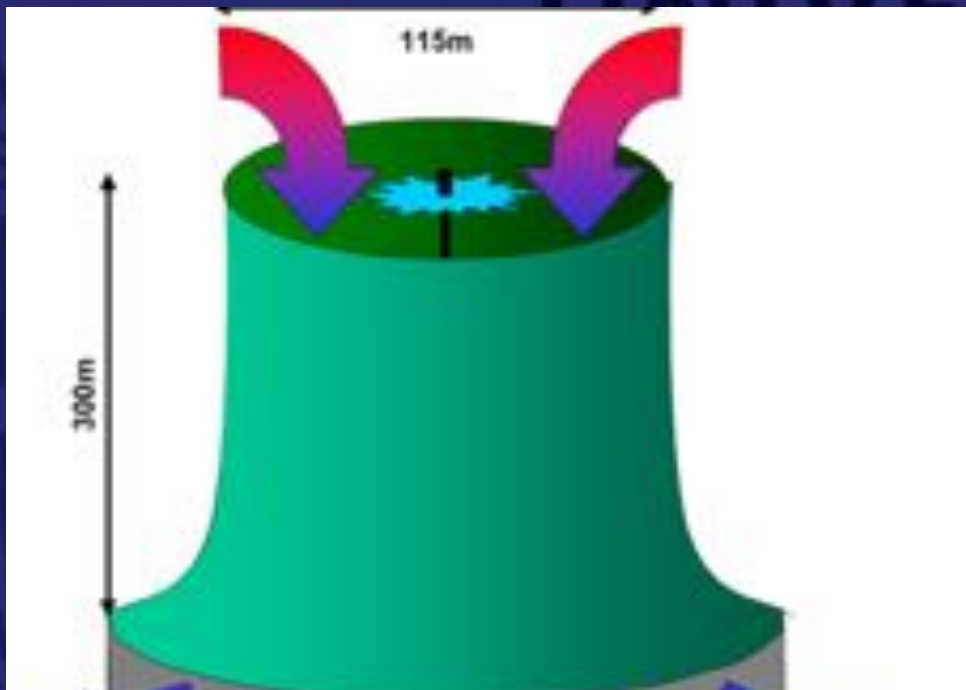


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BIOCHAR PRODUCTION



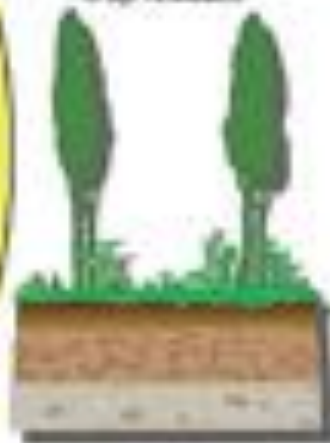
International
Biochar Initiative

FEEDSTOCKS

Biochar production processes utilize cellulose biomass such as wood chips, corn stover, rice and peanut hulls, tree bark, paper mill sludge, animal manure and most urban, agricultural and forestry biomass residues.

Biomass

- manure
- organic waste
- bioenergy crops (grasses, willows)
- crop residues



(C) 70%

Returned to soil as Biochar



OUTPUTS

Besides biochar, bioenergy is also produced in the form of either synthetic gas (syngas), or bio-oils, which can be used to produce heat, power or combined heat and power.



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Thank you!



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