Carbon Dioxide Removal Approaches/NETs and their Potential Role in Addressing Climate Change

Wil Burns, Co-Executive Director ICRLP
MIIS
May 2, 2019

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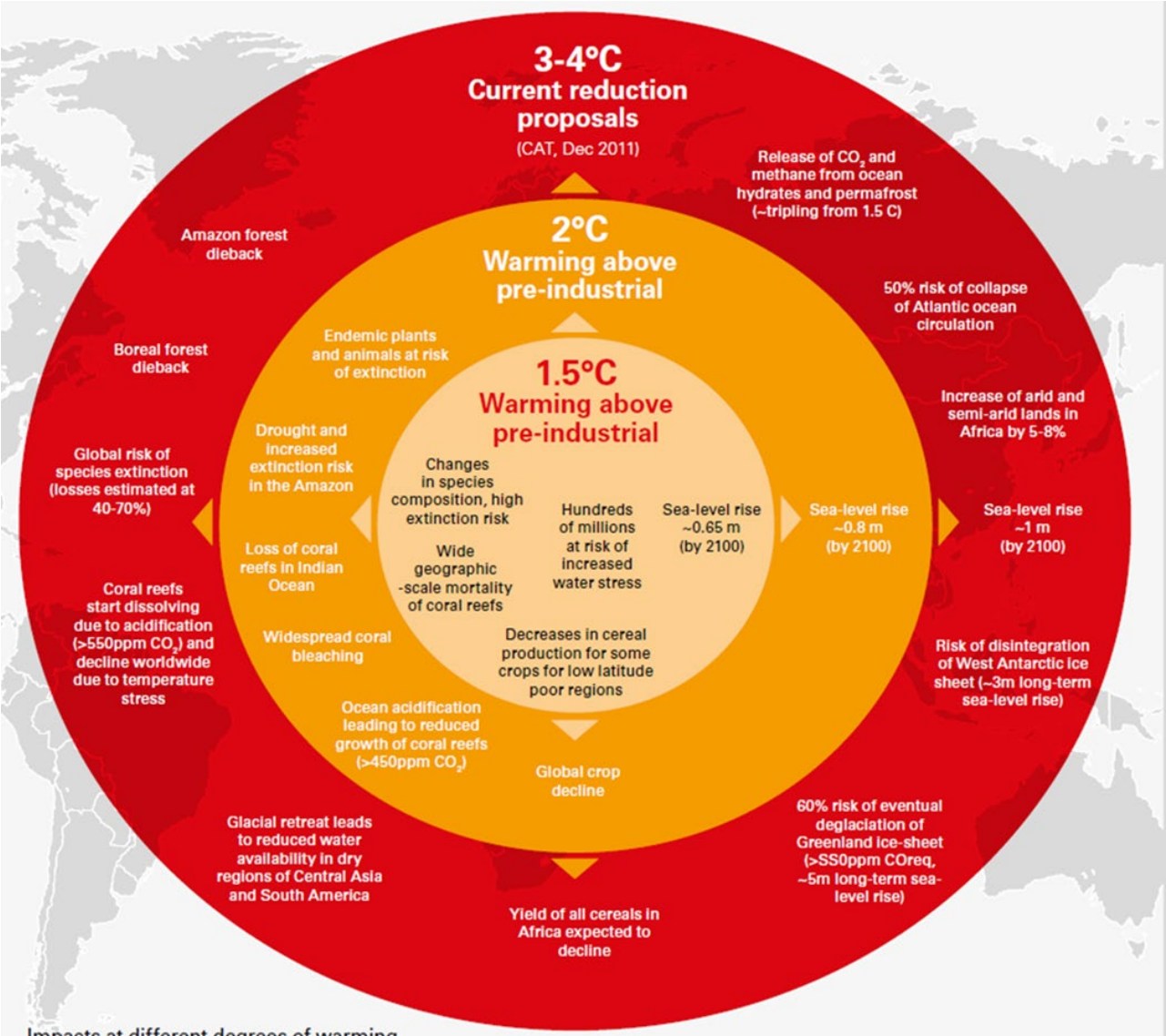

Impacts at different degrees of warming

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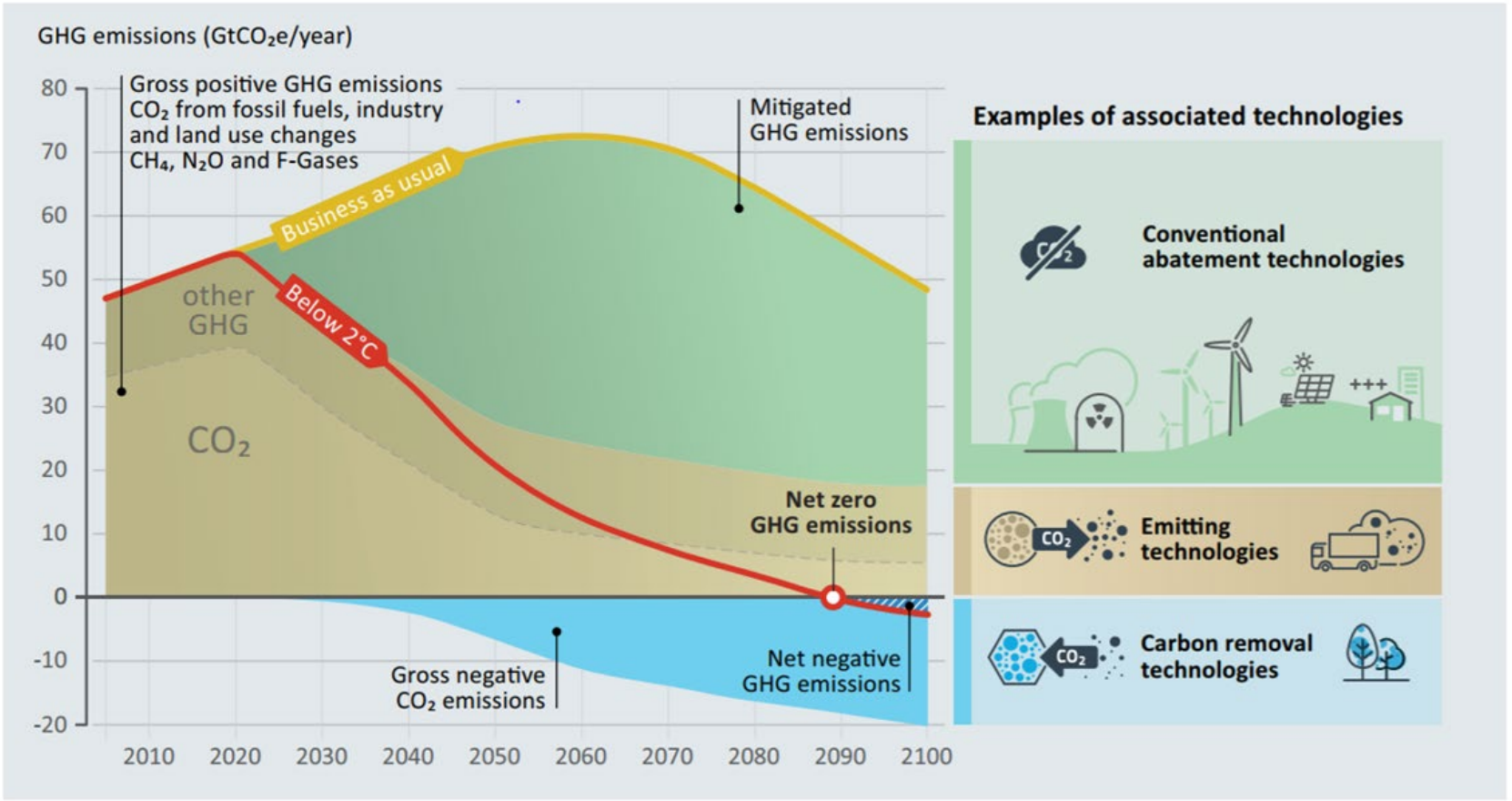
Carbon Dioxide Removal Options

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?



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The Exigency for CDR in 1.5°C Scenarios

"As almost no cases have been identified that keep gross CO2 emissions within the remaining carbon budget for a one-in-two chance of limiting warming to 1.5°C, and based on current understanding of the geophysical response and its uncertainties, the available evidence indicates that avoiding overshoot of 1.5°C will require some type of CDR in a broad sense, e.g., via net negative AFOLU CO_2 emissions " [medium confidence]

IPCC, 1.5C Report (2018)

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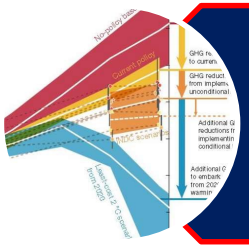
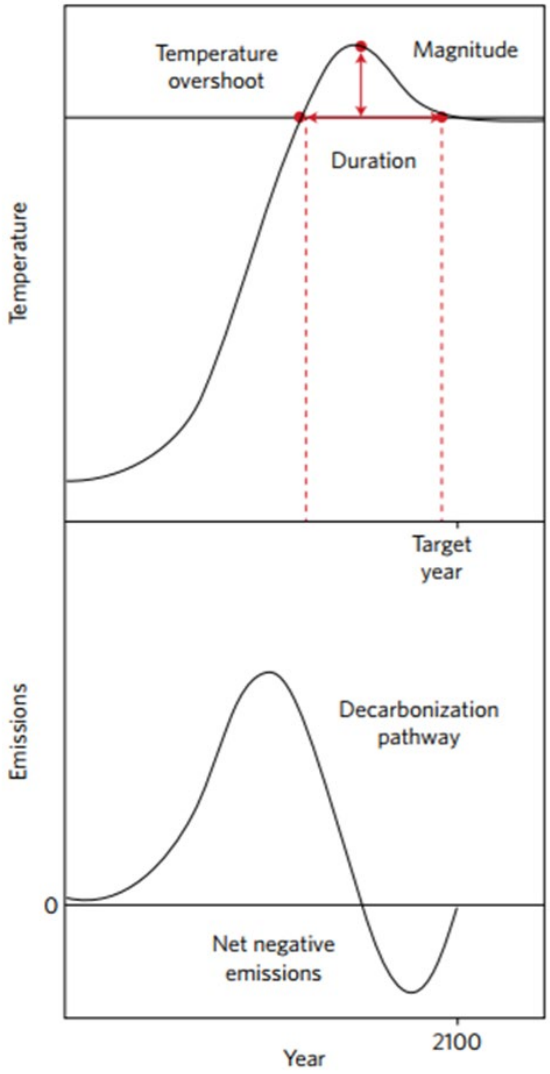


Overshoot Scenarios and NETS



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Roadmap

- Carbon dioxide removal/NETs options: potential benefits and risks;
- Governance options for CDR/NETs approaches

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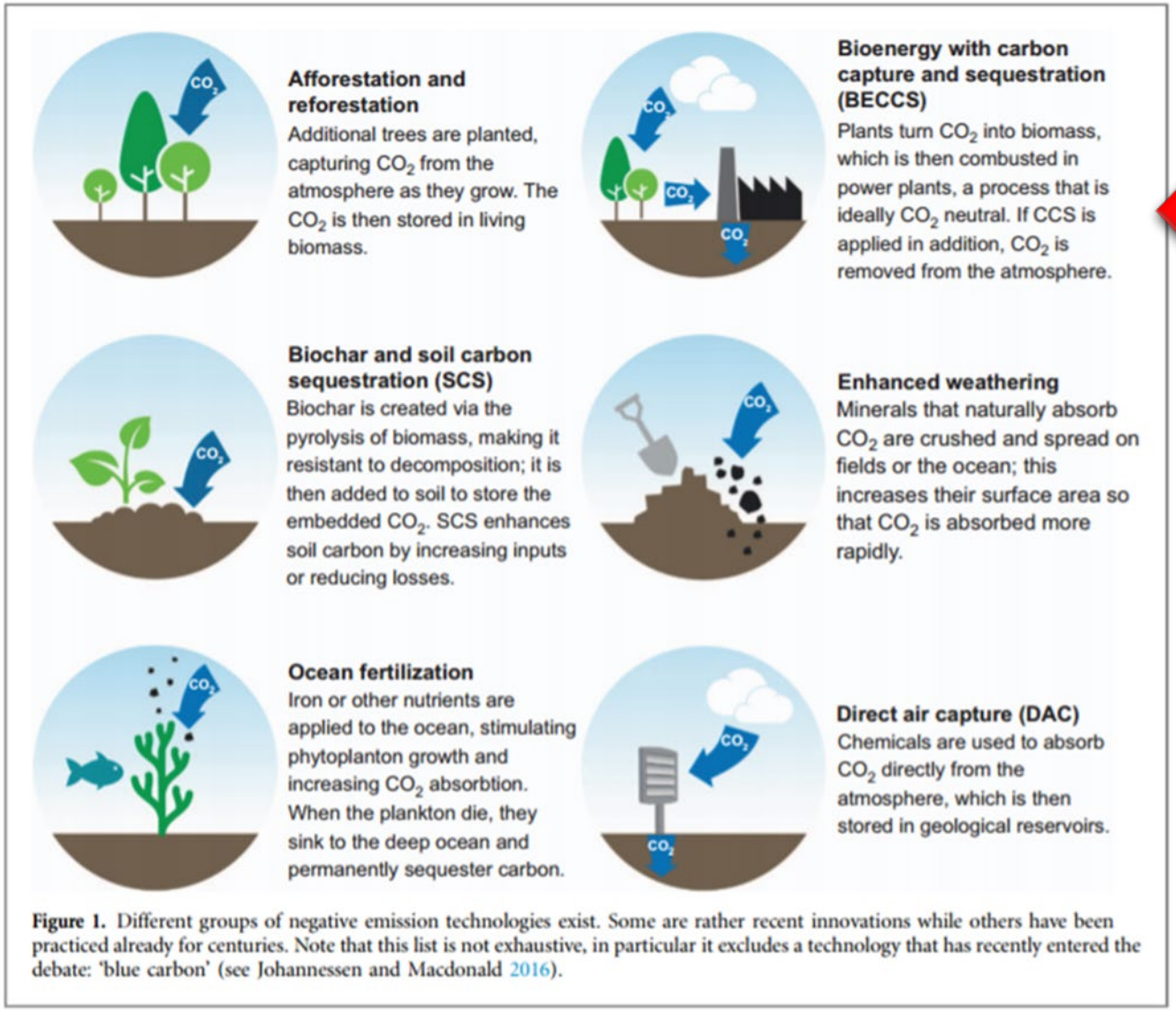

Figure 1. Different groups of negative emission technologies exist. Some are rather recent innovations while others have been practiced already for centuries. Note that this list is not exhaustive, in particular it excludes a technology that has recently entered the debate: 'blue carbon' (see Johannessen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

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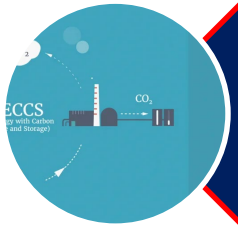
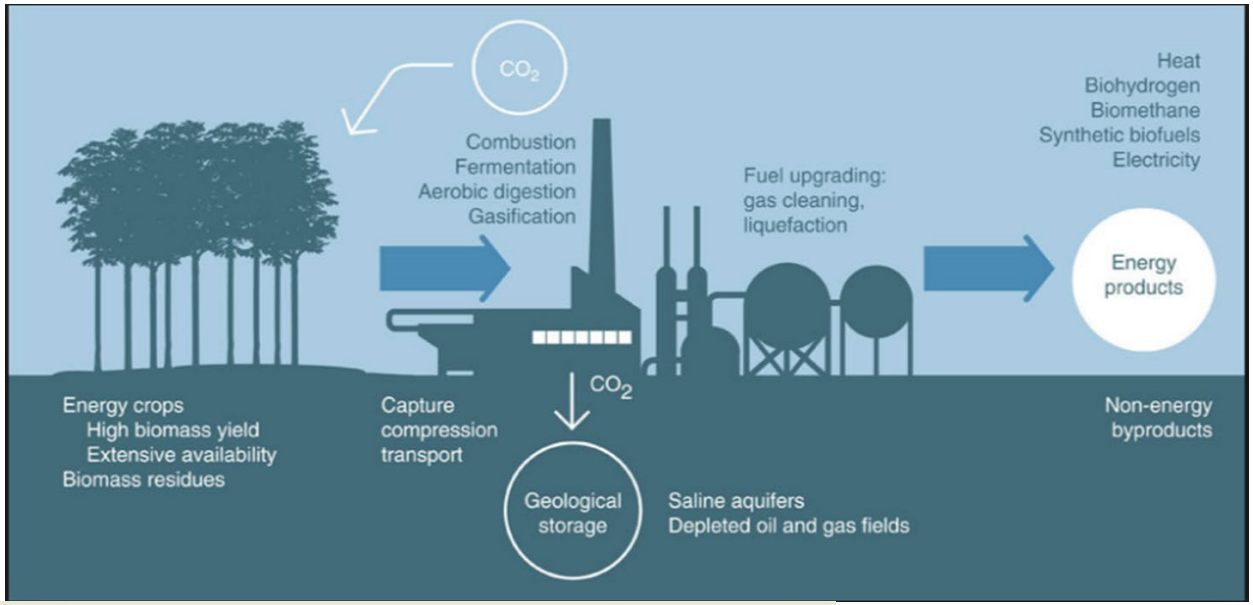
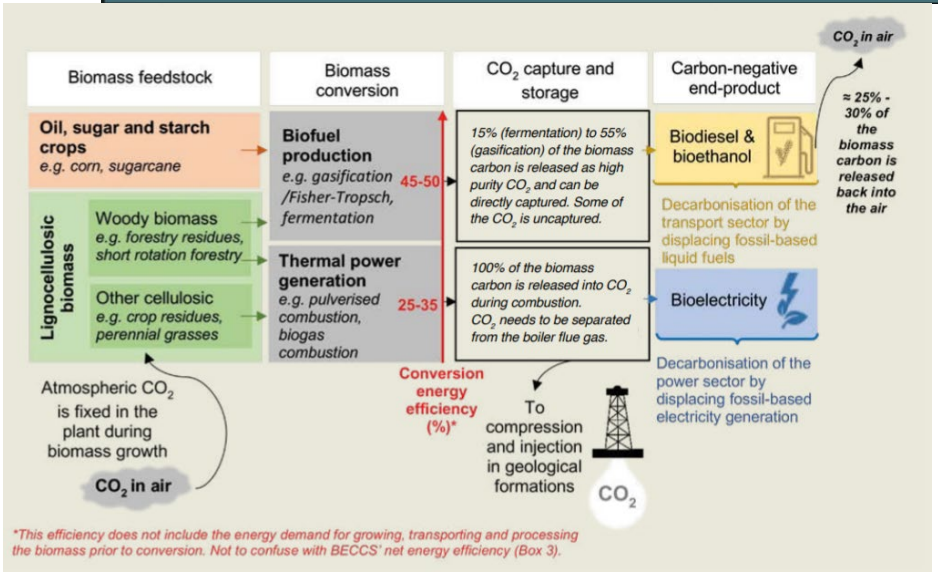


BECCS





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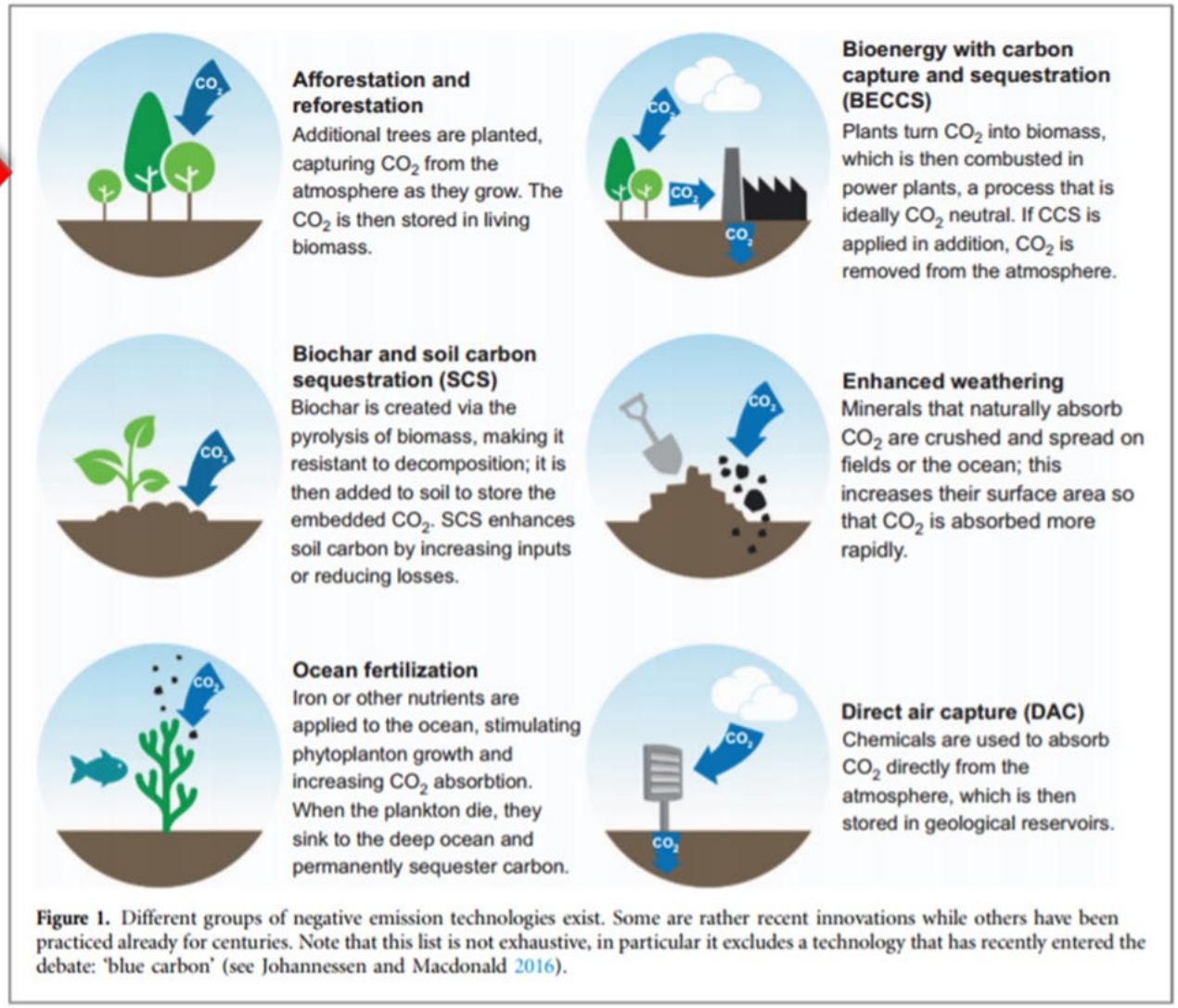

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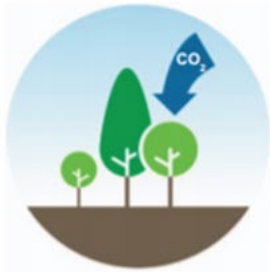
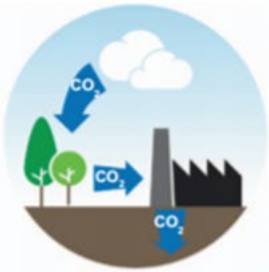


Afforestation and reforestation
Additional trees are planted, capturing CO_2 from the atmosphere as they grow. The CO_2 is then stored in living biomass.



Bioenergy with carbon capture and sequestration (BECCS)
Plants turn CO_2 into biomass, which is then combusted in power plants, a process that is ideally CO_2 neutral. If CCS is applied in addition, CO_2 is removed from the atmosphere.

Biochar and soil carbon sequestration (SCS)
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Enhanced weathering
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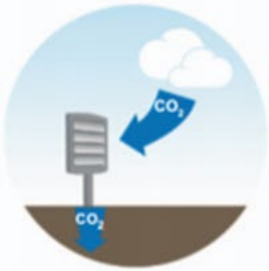
Ocean fertilization
Iron or other nutrients are applied to the ocean, stimulating phytoplanton growth and increasing CO_2 absorbtion. When the plankton die, they sink to the deep ocean and permanently sequester carbon.



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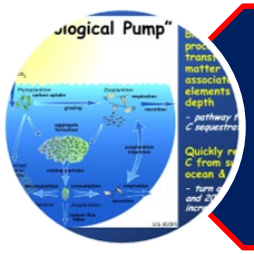
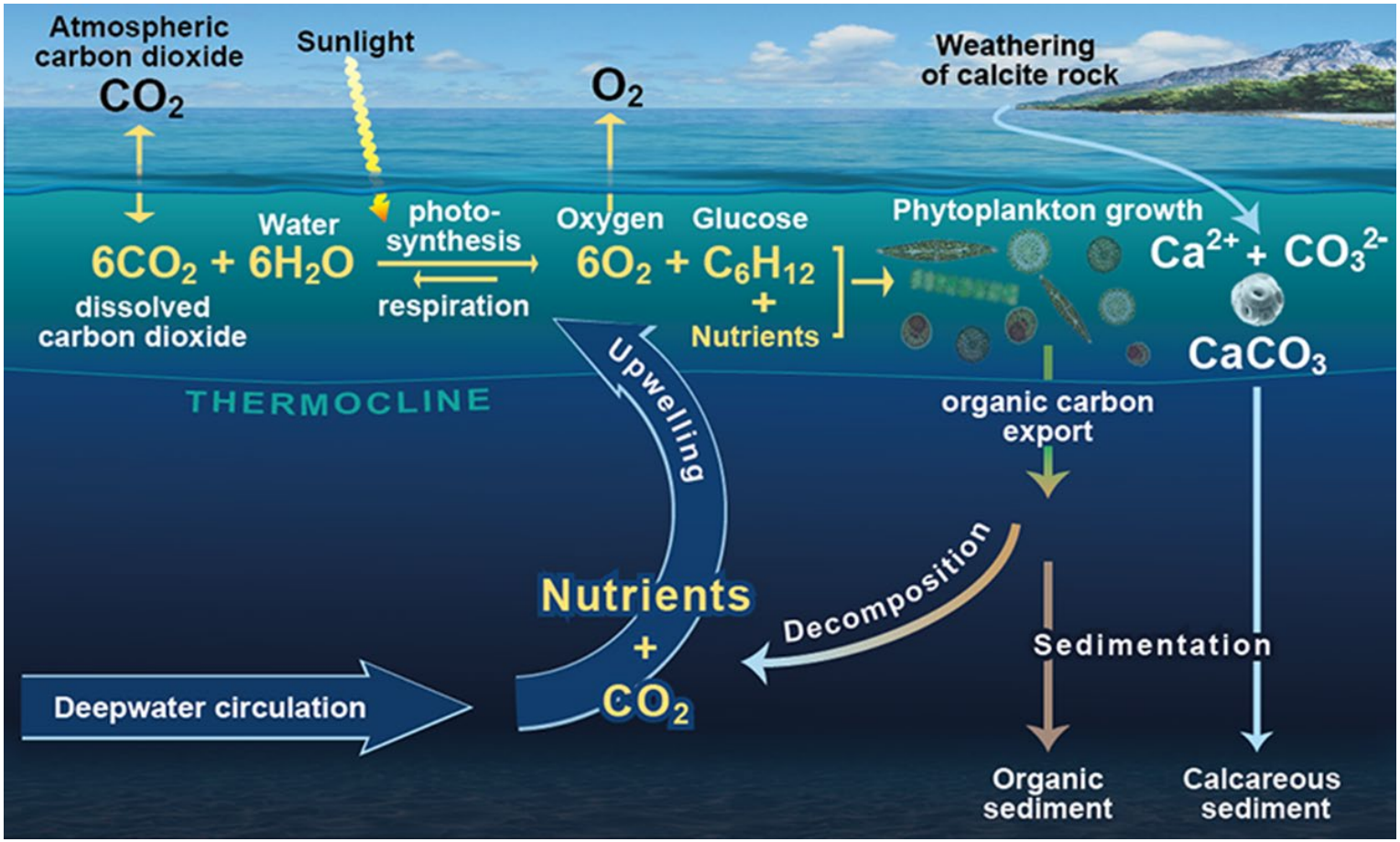


Biological Pump



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Southern Ocean

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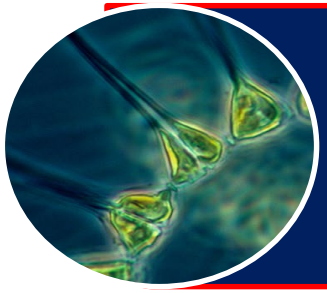
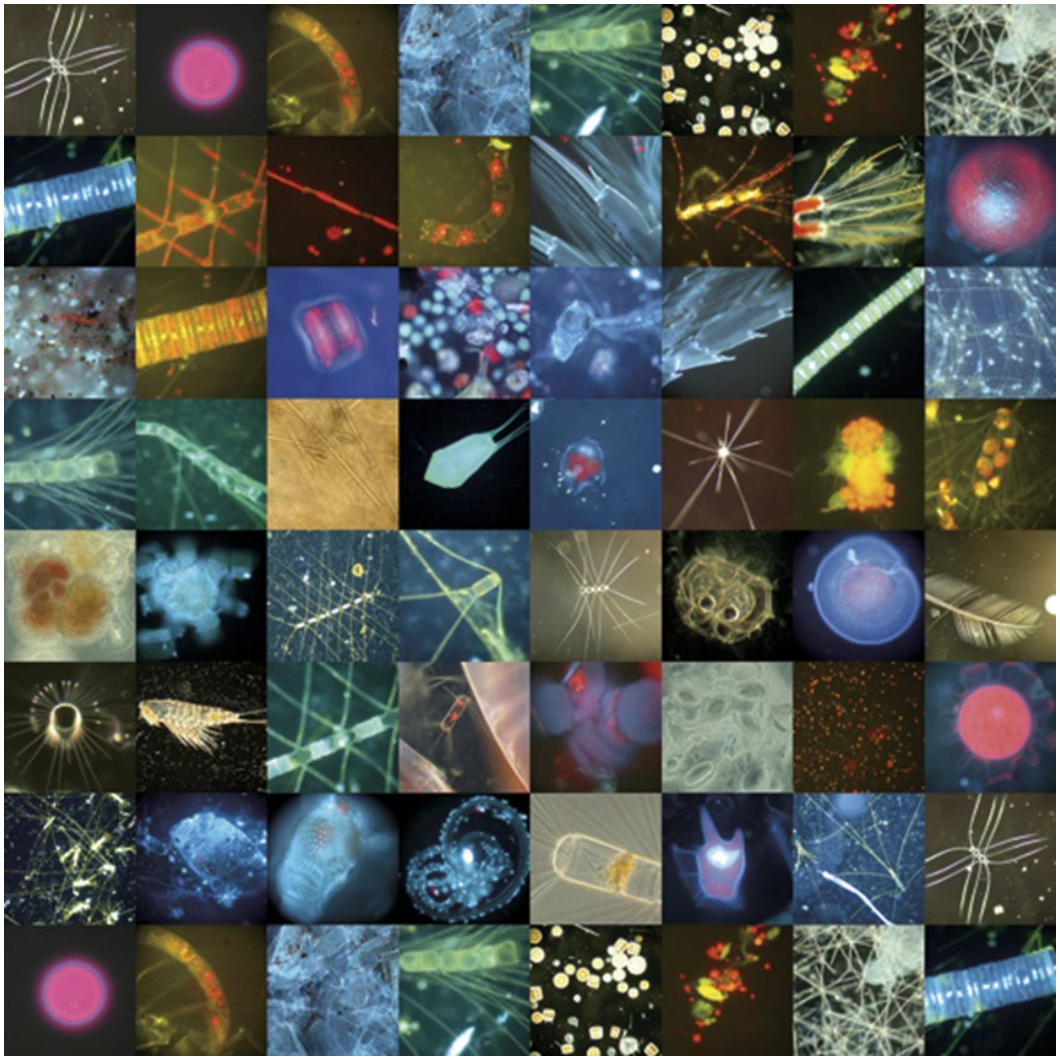


Planktonic Collage: What Plankton Species Might Ocean Iron Fertilization Favor?



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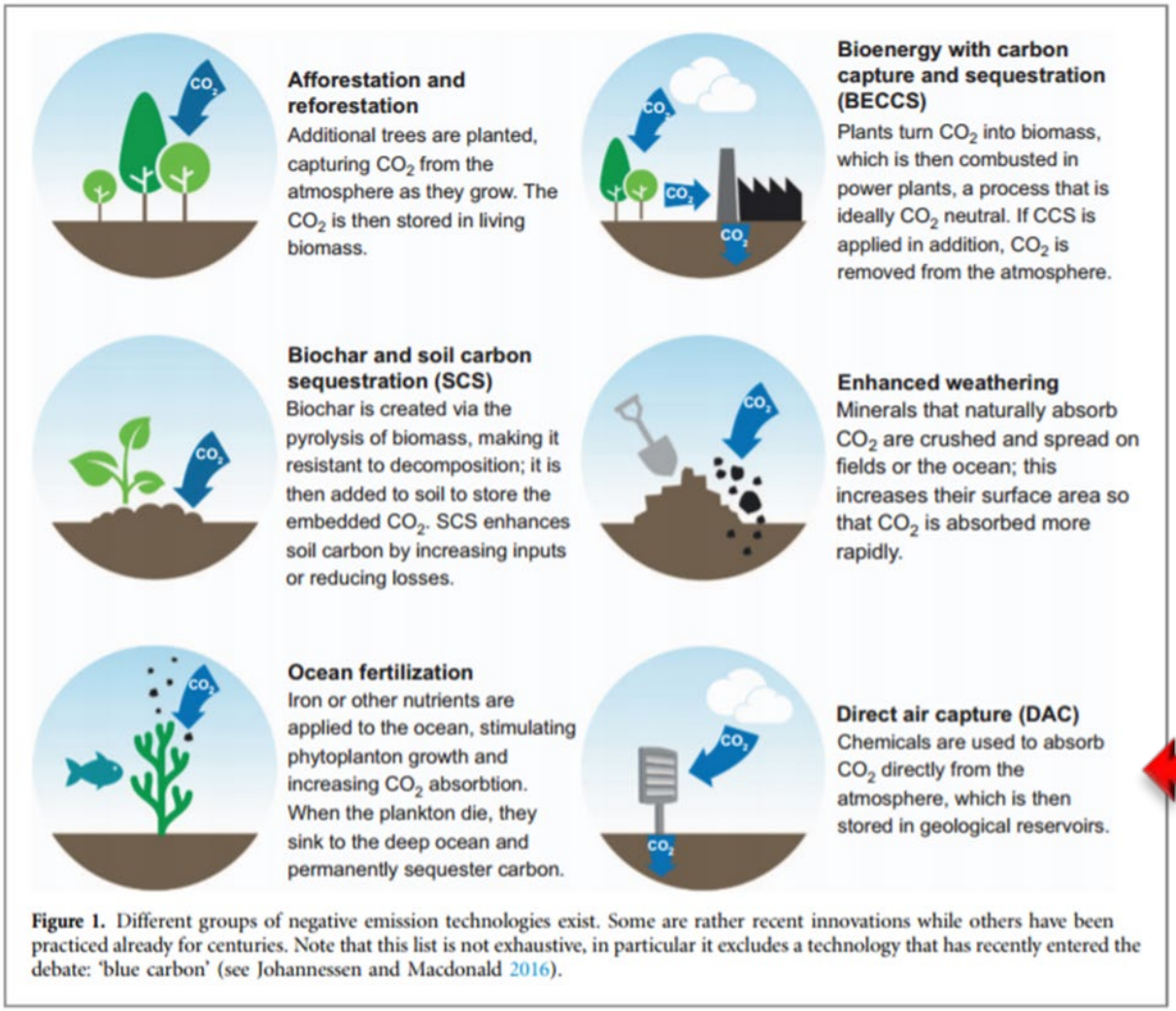

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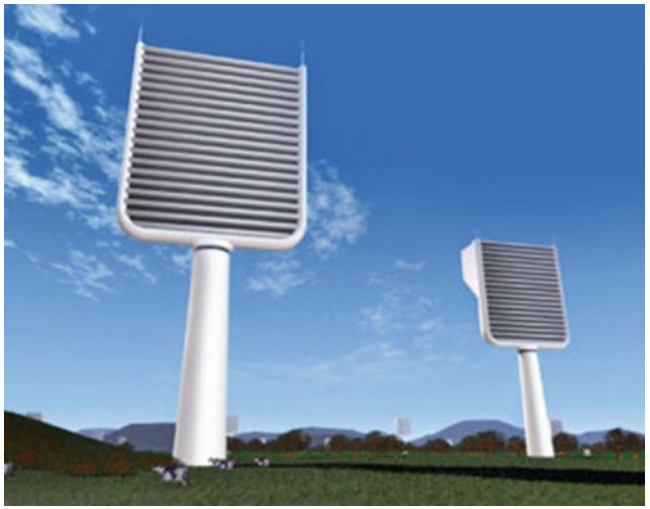
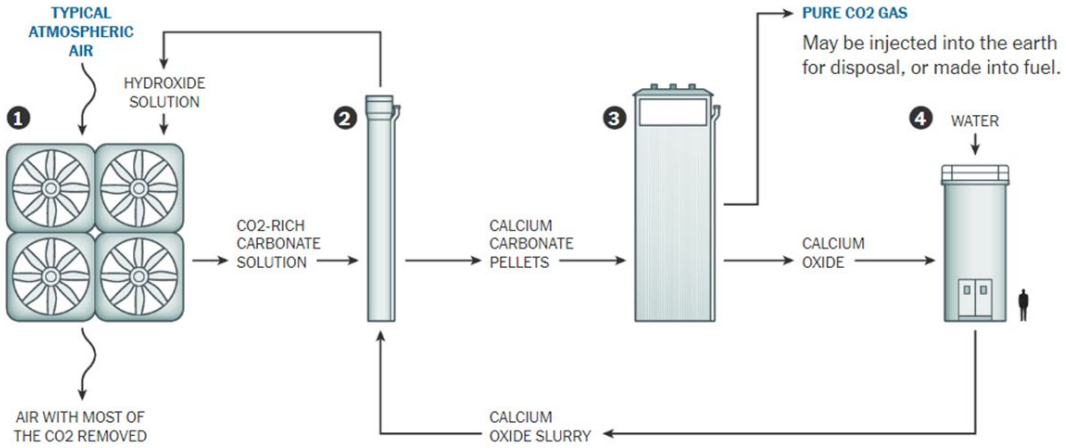


Direct-air-capture technology



1. Air intake
Large fans draw in air, which is run through a mesh coated with a hydroxide solution. The hydroxide binds with the carbon dioxide to convert it into a carbonate solution.

2. Pellet reactor
The carbonate solution is converted into small, dry pellets of calcium carbonate.

3. Calciner
The calcium carbonate pellets are heated until they break into their component parts — pure carbon dioxide gas and solid lime, or calcium oxide.

4. Slaker
Water is added to the calcium oxide, and the resulting slurry is returned to the pellet reactor, to regenerate the hydroxide solution used in the process.

By The New York Times | Source: Carbon Engineering

Direct Air Capture

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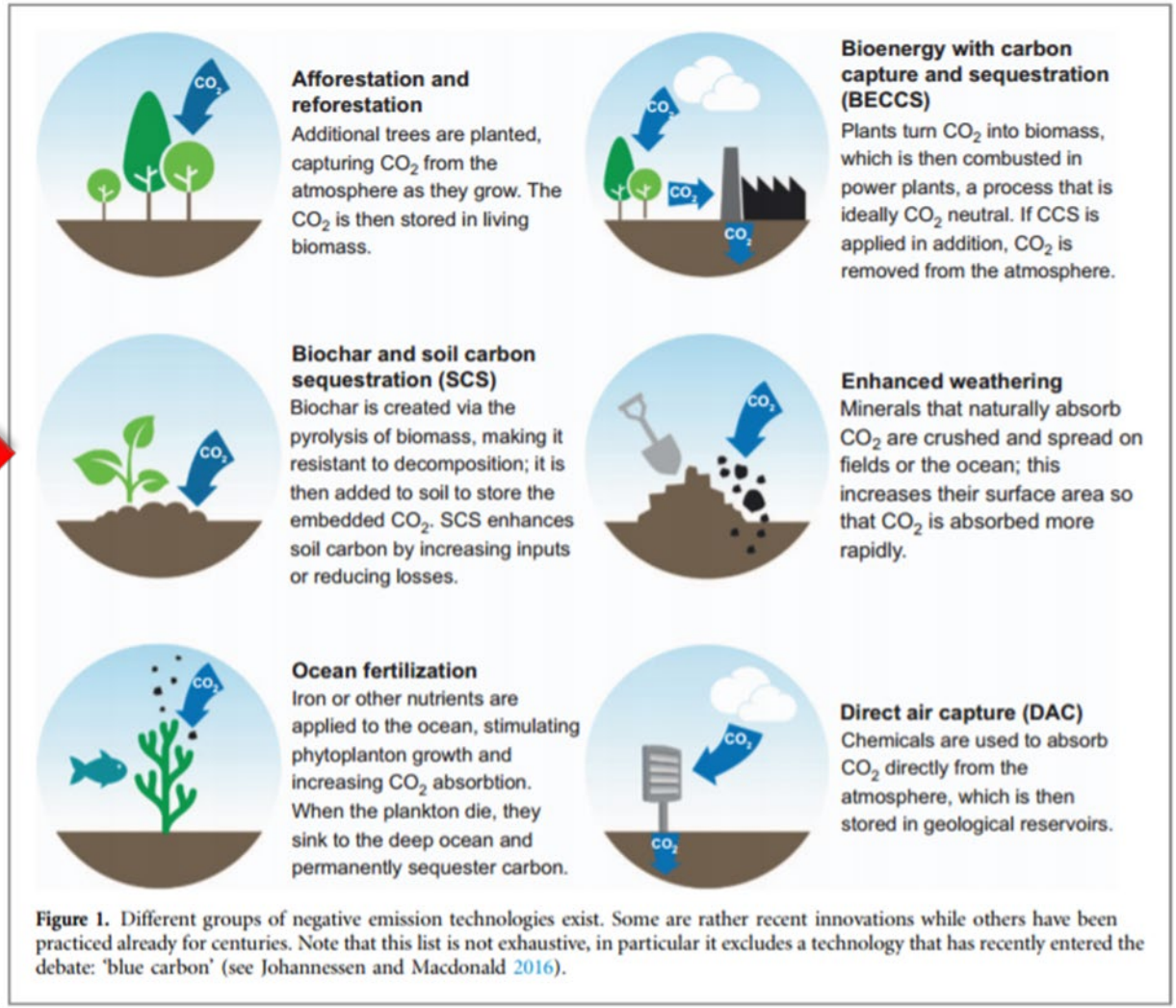

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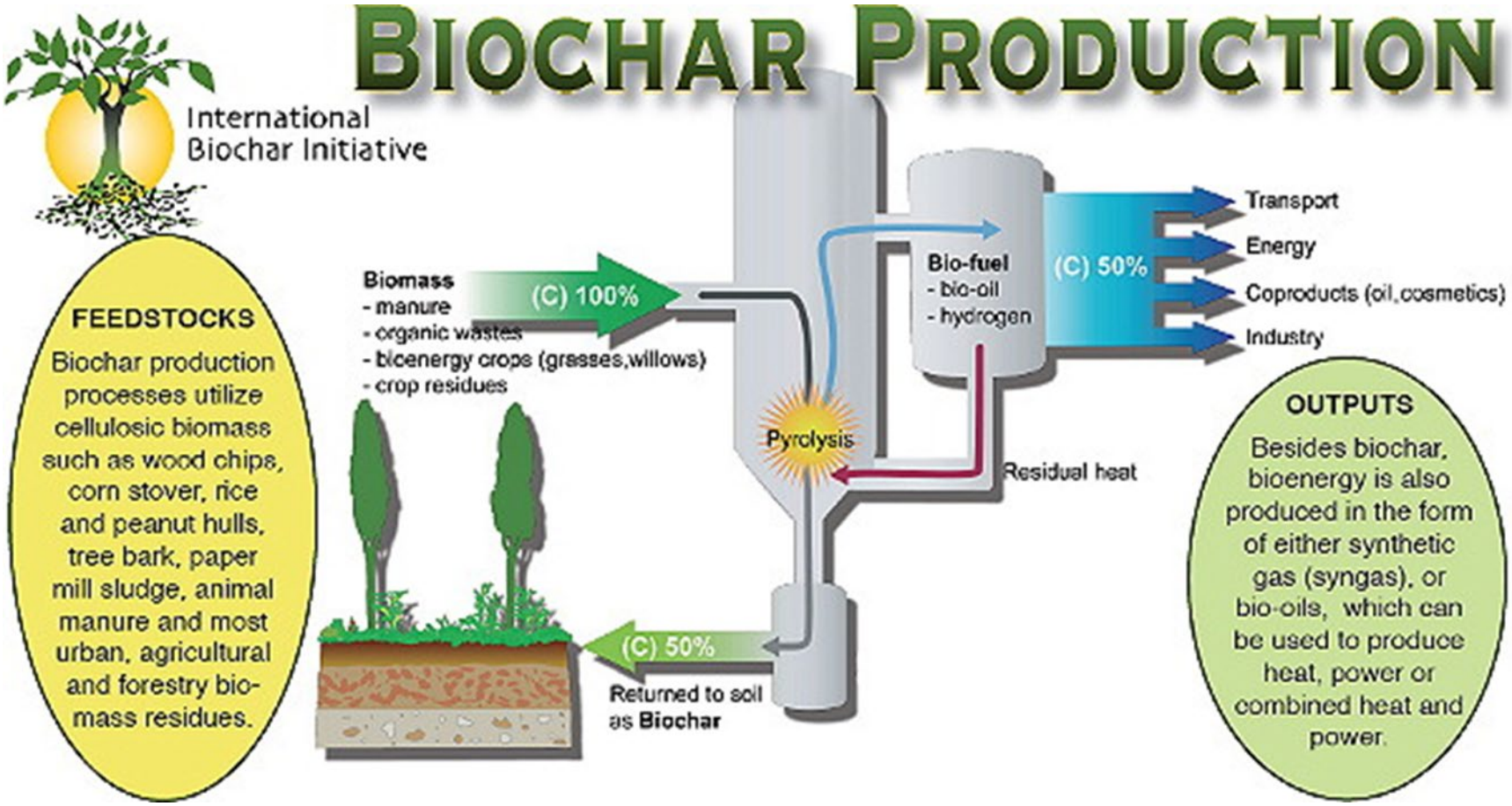
BIOCHAR PRODUCTION



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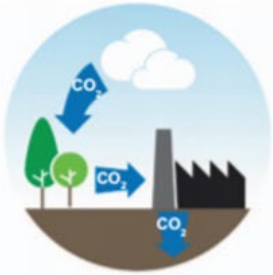

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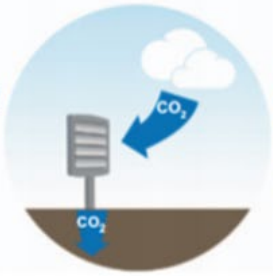

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Natural Mineral Weathering Process

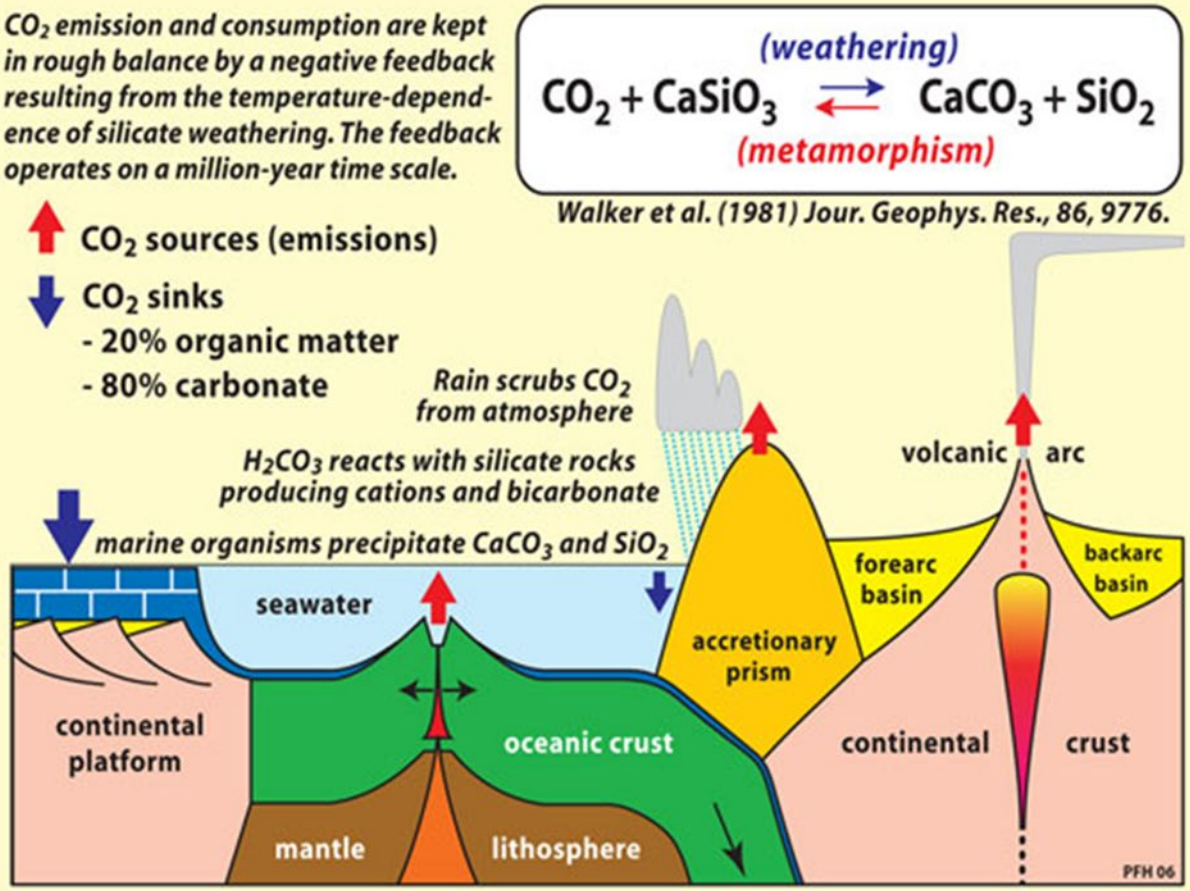
CO_2 emission and consumption are kept in rough balance by a negative feedback resulting from the temperature-dependence of silicate weathering. The feedback operates on a million-year time scale.

(weathering)

$$CO_2 + CaSiO_3 \rightleftharpoons CaCO_3 + SiO_2$$

(metamorphism)

Walker et al. (1981) Jour. Geophys. Res., 86, 9776.



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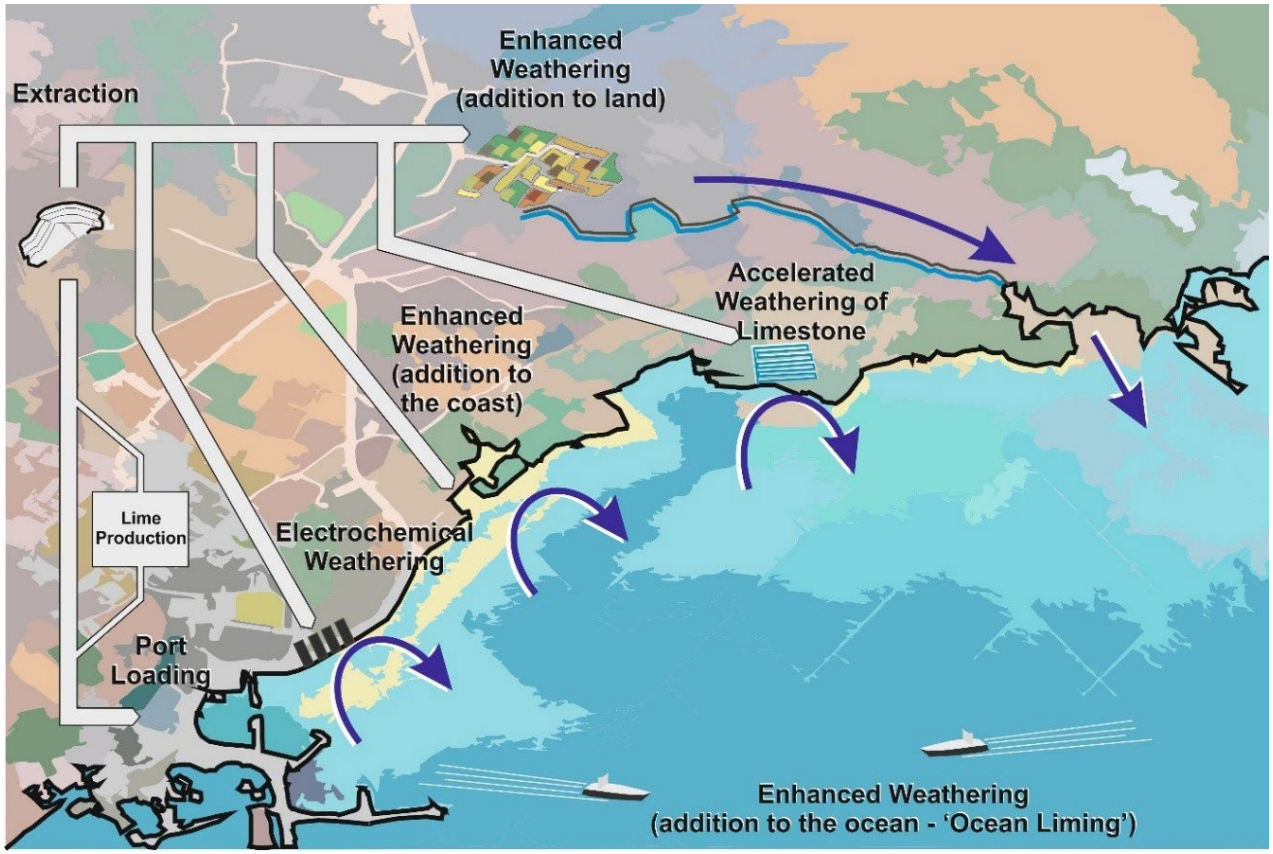
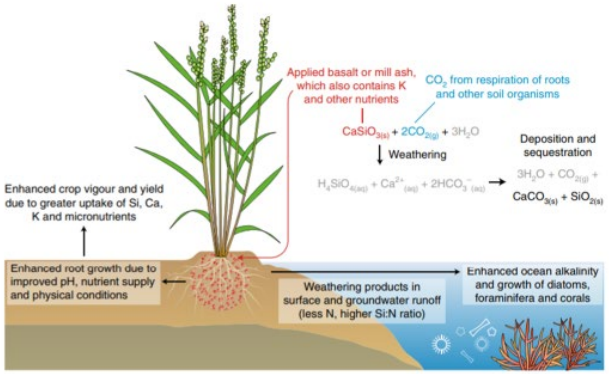


Mineral Weathering with Crushed Basalt



Enhanced Mineral Weathering

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CBD, 10th COP 10 (2010)

(w) Ensure, in line and consistent with decision IX/16 C, on ocean fertilization and biodiversity and climate change, in the absence of science based, global, transparent and effective control and regulatory mechanisms for geo-engineering, and in accordance with the precautionary approach and Article 14 of the Convention, that no climate-related geo-engineering activities that may affect biodiversity take place, until there is an adequate scientific basis on which to justify such activities and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts, with the exception of small scale scientific research studies that would be conducted in a controlled setting in accordance with Article 3 of the Convention, and only if they are justified by the need to gather specific scientific data and are subject to a thorough prior assessment of the potential impacts on the environment;

London Dumping Convention (1972)

ASSESSMENT FRAMEWORK FOR SCIENTIFIC RESEARCH INVOLVING OCEAN FERTILIZATION (2010)

Elements of environmental assessment:

Problem formulation

Site selection and description

Exposure assessment

Effects assessment

Risk Characterization

Risk Management

Decision Making

Results of Monitoring

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London Protocol (1996)

Resolution LP.4(8), Annex 4 (2013)

Article 6bis

1. Contracting Parties shall not allow the placement of matter into the sea from vessels, aircrafts, platforms or other man-made structures at sea for marine geoengineering activities listed in Annex 4, unless the listing provides that the activity or the subcategory of an activity may be authorized under a permit …

Annex 5: Assessment Framework for Matter that May be Considered for Placement Under Annex 4.

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Paris Agreement (2015)

Article 4

2. Each Party shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.

Scope of "Mitigation"

UNFCCC, Article 4: Commitments

2. The developed country Parties and other Parties included in Annex I commit themselves specifically as provided for in the following:

(a) Each of these Parties shall adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs. [emphasis added]

UNFCCC Secretariat: Fact Sheet (2009)

Mitigation involves human interventions to reduce the emissions of greenhouse gases by sources or enhance their removal from the atmosphere by "sinks" [emphasis added]

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Paris Agreement (2015)

Preamble

Acknowledging that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity . . . [emphasis added]

Paris Agreement (2015)

Article 2

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty . . . [emphasis added]

Preamble:

Emphasizing the intrinsic relationship that climate change actions, responses and impacts have with equitable access to sustainable development and eradication of poverty . . . [emphasis added]

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Paris Agreement (2015)

Preamble

Noting the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth . . . [emphasis added]