Engineering Assessment of Alternative Greenhouse Gas Removal Technologies

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Introduction

Environmental Challenge From 1995 to 2015, CO₂ emissions have increased from 20.6 to 32.3 GtCO₂. At this pace, the International Energy Agency's suggested emission limit of 450 ppm will be exceeded in 20 years.

Background Developments of Carbon Capture and Storage (CCS) technology have essentially stalled, and more than 20 large-scale projects have been cancelled worldwide between 2010 and 2016. Given that we will almost certainly fail to meet our greenhouse gas emission target, the focus is now on alternative technologies:

- CCS
- Biochar pyrolysis
- Forest restoration
- Enhanced weathering
- Solar updraft tower
- K₂CO₃ modified potassium feldspar

Methodology

- Literature review
- Calculations & performances
- Ranking
- Feasibility study

- Review of existing technologies
- Figures & data research
- Compilation in comparison table
- Pre-sorting
- Estimations of non-available figures & data
- Technologies marking
- Selection of optimal technologies for further study

- Ranking of technologies based on technical, commercial and physical parameters
- In-depth study of previously selected technologies
- Validation or denial & justification

Ranking Criteria Listing of criteria with weighting coefficients (where relevant) used to compare Greenhouse Gas Removal (GGR) technologies with each other.

- Materials required
- Cost
- Does it obey laws of physics?
- Optimal GGR solution
- Operational scale
- Side effects
- Location
- Annual CO₂ savings
- Co-Benefits
- Lifetime
- Energy involved

Conclusions

- No appropriate low TRL technology currently at a large-enough scale to significantly reduce CO₂ emissions because of:
  - Economical non-viability
  - Insufficient availability of resource
  - Insufficient operational scale

However, currently the most promising alternative technology appears to be Enhanced weathering as:

- Storage is permanent
- Cost ranges from $15 to $361 per tonne of CO₂
- CO₂ saving potential range is around 3.7 billion of tonnes of CO₂ equivalent per year [2].

Further work

- Complete Life Cycle Assessment (currently unavailable) to determine accurately lifetime, cost and total CO₂ emissions from construction to final decommissioning of each technologies.
- Methodical Risk Assessment like hazard and operability study (HAZOP) or failure mode, effects and criticality analysis (FMECA).
- Wide Scale Implementation studies.
- In a more general perspective, to raise awareness of policymakers.

References


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