NEGEM

Quantifying and Deploying Responsible Negative Emissions

Newsletter
February 2022

IN THIS ISSUE

NEGEM work is in full speed

NEGEM project has been running for over one and a half years now, and all the work packages are in full speed, as we approach the midway point of this four years' project. The first half of the project concentrates on **understanding the characteristics and limitations of negative emission technologies and practices** (NETPs), to enable estimating their realistic deployment potentials. In the second half of the project, we will concentrate on **establishing sustainable and socially acceptable pathways** for climate neutrality and defining the role of NETPs in these pathways, while analysing also suitable governance frameworks.

Several NEGEM deliverables were submitted during autumn 2021. These deliverables are further introduced in this newsletter, with interesting results on the following topics:

- Overall sustainability assessments of terrestrial and marine negative emission technologies and practises
- Updates for models used in NEGEM (MONET) regarding e.g. limitations on biomass supply, and data on new negative emission technologies
- A public database bio-geophysics related to NETPs
- Study on several commercialisation mechanisms for negative emissions, as well as on specific features of nature based vs. engineered solutions
- Different burden sharing principles for carbon dioxide removal targets in EU Member States
- Analyses on social acceptance and stakeholder perceptions of NETPs
- Definitions and accounting rules for negative emissions

The conversation on negative emissions and carbon dioxide removals in the EU is also progressing at full speed as the EU Commission published its Communication on Sustainable Carbon Cycles at the end of 2021. The regulation on carbon dioxide removals will already be topical during spring 2022. NEGEM will closely follow these developments and aims to provide scientific support for example on issues such as **realistic and sustainable deployment potential for NETPs**, definitions and accounting principles for negative emissions, specific features of nature based and engineered solutions, and stakeholder perceptions on negative emission technologies. Wishing for very fruitful conversations on NETPs in 2022.

On behalf of NEGEM coordination team


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Sustainability Assessment of Marine NETPs

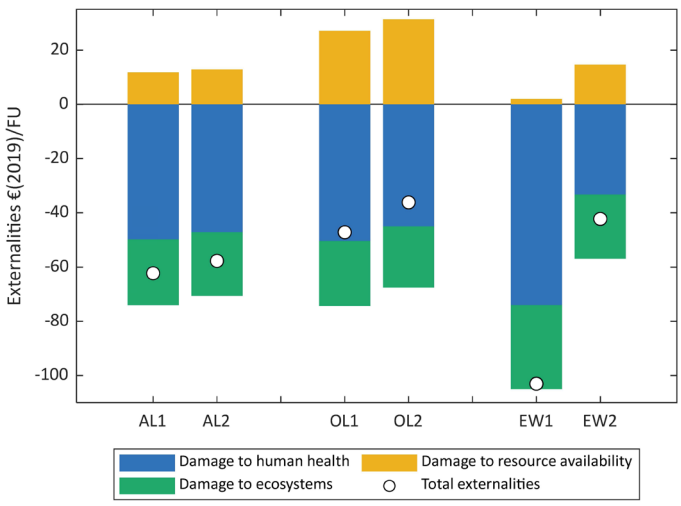
The IPCC scenarios mainly focus on bioenergy with carbon capture and storage and afforestation/ reforestation as Carbon Dioxide Removal (CDR) strategies. However, the conservation and restoration of marine ecosystems and other approaches such as ocean alkalinization can **enhance the ocean's natural CO_2 sequestration potential**. Marine NETPs are still emerging CDR strategies. Only recently, initiatives such as Project Vesta and Running Tide have launched pilot projects to assess the feasibility of CDR via coastal enhanced weathering and kelp farming and sinking.

Quantifying Performance

A sustainability assessment of Marine NETPs was performed by NEGEM partner NIVA, which applied an LCA methodology to derive a set of key performance indicators (KPIs) to quantify the performance in three scenarios:

- Kelp farming and sinking
- Ocean liming
- Coastal enhanced weathering

The assessment found that all the modeled scenarios can **prevent net climate change impacts** in the range of 836-980 kg CO2-eq per tonne of sequestered CO2. Coastal enhanced weathering was the best-performing marine NETP in terms of climate change impacts, whilst ocean liming scenarios based on the most pessimistic assumptions attained the highest climate change impacts, mainly driven by its high energy demand for the oxy-fuel limestone calcination process.



Externalities per tonne of sequestered CO2 for the studied scenarios: kelp farming and sinking (AL1, AL2), ocean liming (OL1, OL2) and enhanced weathering (EW1, EW2). Source

All the scenarios can prevent externalities, which were estimated in a range between 36 to 103 € per tonne of CO2 sequestered. In the case of coastal enhanced weathering the value of the averted externalities is up to 14 times greater than the costs of the technology, which could **incentivize the implementation of these NETPs**. On the contrary, in the case of kelp farming and sinking the value of prevented externalities constitutes less than 5% of the kelp selling price, which could make this solution less economically competitive than other marine NETPs.

Further Research

These results are subject to the uncertainty linked to data and modeling assumptions, experimental research is required to validate some of the assumptions and uncover potential side-effects not accounted for here, at the same time, the insights gained from this work **could help underpin future research activities** and highlight the importance of considering all the sustainability dimensions to guide future decisions. Further research should investigate the implications of countering ocean acidification with the addition of alkaline materials to the seawater, the potential methane emissions associated with macroalgae cultivation and the effects on the local biodiversity.

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Comprehensive sustainability assessment of marine NETPs

You may also like

Comprehensive sustainability assessment of terrestrial biodiversity NETPs

Comprehensive sustainability assessment of Bio-CCS NETPs

Available at negemproject.eu

A global review of NETPs scaleup and commercialization mechanisms

Mechanisms that support NETPs are an important part of scaling up the removal capacity required in the majority of net zero modelling scenarios.

A recent report published by the University of Oxford as part of its activities in NEGEM, provides the first quantitative survey of commercialization mechanisms for NETPs at a global level, cataloguing their current cost and scale, reviewing proposed mechanisms in academic literature and in draft and actual legislation, assessing their relevance for the EU and forecasting the financial resources necessary to sustain them in 2030 and 2050.

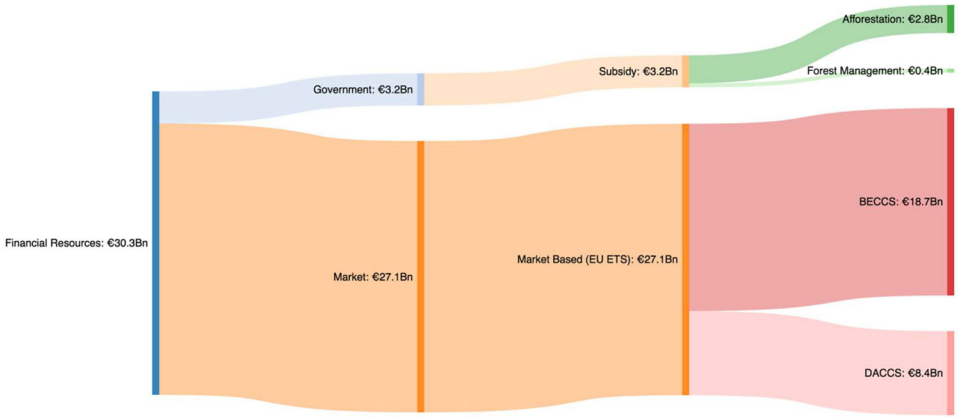
In this analysis, **mechanisms are categorized on a scale between fully market-based or dependant on fiscal incentives.** Market-based mechanisms encompass those in which polluters pay the direct cost of adhering to a regulation, standard or participate in a carbon market (e.g., ETSs) and were found to pay between 1-166 €/tCO2. Market-based incentives consist of incentives within market-based mechanisms that target a policy outcome which is not achievable without state support. (e.g., results-based payments) and pay between 10-28 €/tCO2. Finally, fiscal incentives (e.g., subsidies, tax credits) pay between **0.6-54 €/tCO2.**

Governments contribute most financial resources in all scenarios in 2030, but the market surpasses them by 2050 due to the EU ETS price exceeding the cost of removals. By 2050 engineered removals make up the vast majority of financial resource requirements across scenarios.

Incentivisation

Europe's ETS is predicted to generate revenues up to €100 billion by 2030 with the **inclusion of new sectors and higher prices**. In these circumstances, the EU ETS could have the financial resources to support the required level of NETPs in some capacity.

In addition to price signals, NETPs will likely need market-based incentives. Mechanisms from different regions **may not match the risk preferences of European investors and capital markets**. The study argues that for Europe a carbon Contract for Difference may be a valid mechanism for BECCS and subsidy type payments are more likely for land-based NETPs.
The Commission's proposal of the CAP 2021-27 budget, including an "economic recovery" envelope, amounts to €352 billion, with an expectation that



Distribution of Financial Resources by Mechanism Type 1.5 Scenario 2030. Source

Scaling Up

The report highlights that in Europe mechanisms to incentivize the scale up of NETPs do not currently exist, and outside of Europe the existing mechanisms generally tend to support established afforestation and soil carbon sequestration methods and do not pay enough to incentivize investment in Direct Air Carbon Capture & Storage (DACCS) and Bio Energy with Carbon Capture and Storage (BECCS).

According to the three scenarios to reach net zero emissions, in 2030 mechanisms to scale NETPs could require financial resources of between **€4.8 and €6.7 billion annually**, which may rise to between **€9.8 and €30 billion annually by 2050.**

40% of the CAP budget will be climate-relevant. The subsidies needed to reach the land sink target estimated in the study equal to below €4 billion per annum. Therefore it is possible that the CAP in combination with the forestry strategy could support land-based NETPs to ensure the agricultural sector reach's its 2035 net zero target.

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Quantitative survey of commercialisation mechanisms

Interactions and trade-offs between nature-based and engineered climate change solutions

In the last two years a growing number of companies announced ambitions to achieve net zero emissions across their activities and supply chains and, in many cases, some or all of the emissions associated with the use of their products. This is leading firms to turn to **active enhancement of carbon sinks (nature-based solutions) or active carbon dioxide removal and storage** to compensate for those emissions they cannot eliminate.

Emission compensation challenges

A report by the Imperial College of London addresses some of the challenges to be considered in relying on emissions compensation, focusing on the physical differences between different carbon dioxide removal and storage options. The study provides an in-depth review of the relative merits of **geological versus nature-based negative emission techniques and practices**, from the perspective of the private sector-oriented voluntary carbon "offset" market.

Despite their low cost and, if well designed, substantial co-benefits, there are a number of concerns with the widespread use of biological ("nature-based") carbon removal, to offset continued fossil fuel use. One of these is the **limited global capacity and potential for supporting the most ambitious climate goals**. Optimistic estimates of nature-based climate solutions suggest they could shave 0.1°C off global temperatures by 2050. The high risk of **physical and indirect carbon leakage is also a challenge**, as well as the carbon accounting to the time trees take to grow, in addition to the implications for international and intergenerational equity.

Hence despite their low cost, these considerations introduce a substantial reputational and financial risk for any company relying on biological carbon storage to offset continued use of fossil fuels.

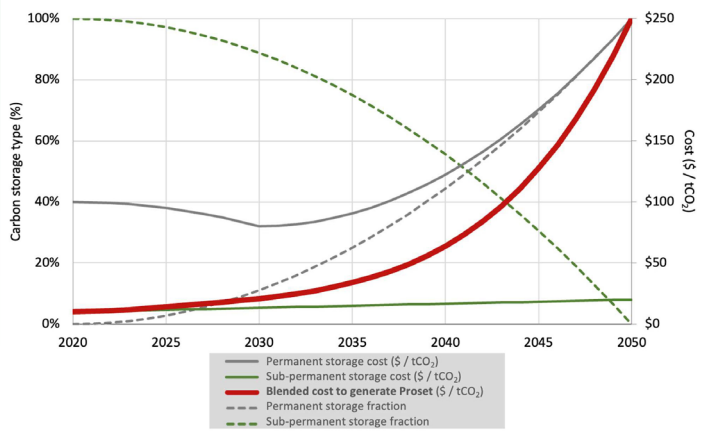
Accounting for different solutions

The widely-held view that "a tonne of CO2 is a tonne of CO2", and that the primary distinguishing features of different carbon removal options are costs and co-benefits, is incorrect. **Not all carbon removals are equal from a climate perspective**, and they are primarily distinguished by the characteristics of the CO2 storage solution employed, not the removal technology.

Therefore, there is a clear need to design policy instruments that allow to take advantage of the significant opportunities for nature-based climate solutions, without undermining the case for investment in more permanent carbon storage solutions.

Policy recommendations

The study provides some policy recommendations, such as having separate quantitative targets for high-reliability carbon dioxide storage, complementing the need for separate targets for both reductions and removals in the European climate policy. It also formulates a proposal for "jointly incentivizing the development of high-potential high-reliability negative emissions technologies (typically engineered solutions) as well as limited-potential low-cost measures (such as many typical nature-based climate solutions)".



CO2 storage method and cost for a 2020-2050 2nd-order proset. Source

The instrument termed as "Proset" (for Progressive Offset) is a specific approach to for the integration of nature-based and geological carbon storage in a single offsetting product, consistent with the transition to a sustainable net zero future. **Proset is designed as a new form of composite offset** in which the fraction of carbon allocated to geological-timescale storage options increases progressively, reaching 100% by the target net zero date, generating predictable demand for effectively permanent CO2 storage, while making the most of the near-term opportunities provided by nature-based climate solutions, all at an affordable cost to the offset purchaser. In its initial form this instrument is designed for the voluntary carbon market but analogues may have a role in compliance markets in future. The detailed proposal of Proset is detailed in a publication in second-round review with the journal Climatic Change and is available as an annex to the report.

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Interactions and trade-offs between nature-based and engineered climate solutions

Setting 'Fair' Member States Targets

To achieve the ambitious global changes set out in the latest IPCC report an "equitable and fair" allocation of carbon reduction and carbon removal targets is necessary. However, there is uncertainty in how countries should take action as the Paris Agreement's nationally determined contributions (NDCs) do not include carbon dioxide removal (CDR) activities, only those of carbon reduction.

Including carbon dioxide removal activities

Most economic transition pathways rely on CDR technologies in the quest to limit the rate of global warming. The amount of CDR deployment varies widely across modelled scenarios, with the latest projections suggesting a cumulative global CDR requirement of between 348 and 1,218 Gt CO2 by 2100 to limit warming to 1.5°C, demonstrating the importance to include CDR targets in the NDCs. A challenge in the inclusion of CDRs is the **lack of clarity on responsibility and efforts required by individual nations** towards meeting a global cumulative target. Furthermore, modelled scenarios typically use technologies which may be more expensive than emission reduction measures, or could generate adverse impacts, therefore the allocation of an overall CDR target is likely to be a **sensitive issue that requires a great degree of cooperation amongst nations**.

Burden-sharing principles

In order to address the inclusion of CDRs in the derivation of targets, a burden-sharing principle can be applied to ensure "fair" targets are set. **The most popular principles are based on "Responsibility", "capability", and "equality".** With these principles in focus, the NEGEM project has reviewed recent academic literature to provide indicative bounds for CDR targets in Europe.

From this initial research but many points of discussion and directions for further research. To start with, further regional specific appraisals are needed to derive the technical potential for CDR in each country, by accounting for the carbon removal efficiency, and permanence of removal, of each CDR activity.

Domestic CDR potential

Another area for further research regards domestic CDR potential (ie. reforestation) against the three principles. Domestically there may be insufficient potential to meet targets determined by Responsibility and Capability principles, but sufficient potential to meet those set by the Equality principle.

Example frameworks such as the greenhouse development rights (GDR) framework seeks to balance obligations assigned to nations based on a **combination of responsibilities (contributions) and capacities (ability to pay)**. This particular framework introduces a Responsibility and Capacity Indicator (RCI) in which equal weightings have been given to both responsibility and capacity in the view that those who pollute more and/or who are more wealthier should contribute more. This framework also uses a **'development threshold' concept** which is used to identify exempted individuals due to low incomes. The latter requires further justification and regular updating. Nonetheless, the assumptions and the accounting methodology must be consistent as the same underlying principles have been applied in literature with a divergent set of results.

Conclusions

There is an obvious need for principles to be agreed and accepted by national bodies and governments to negotiate CDR targets due to the differences in regional shares of the global target. This deliverable concludes that targets should be set using burden-sharing principles, but **due to the subjective nature it is recommended that several weighting methods should be used in conjunction to derive 'fair' CDR targets.**

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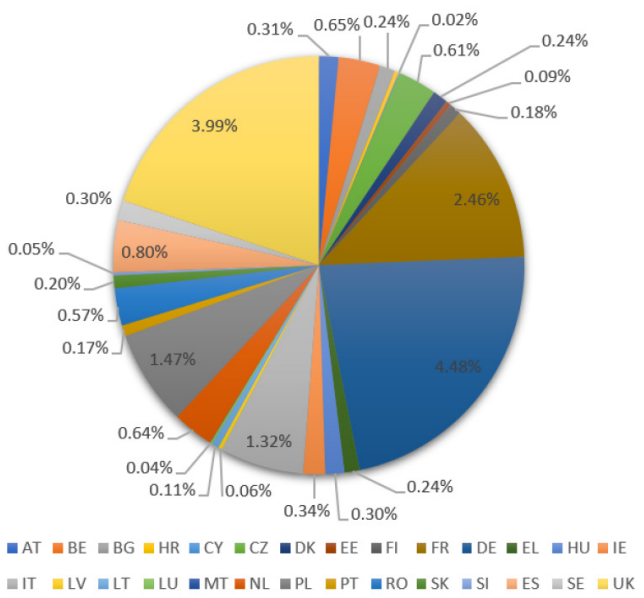
Member States Targets



Shares of cumulative GHG emissions between 1750 – 2019 in countries across Europe based on the PRIMAP-hist dataset.
Source

NETPs Social Licence to operate

In order to successfully contribute to net-zero, NETPs will need to secure social license to operate (SLO), defined as an "**ongoing approval and broad acceptance of society to conduct its activities**", at local, national, and European scales. Previous research has shown that there is currently low public awareness of NETPs, meaning that the public at large, and indeed many key stakeholders, may be still forming opinions of carbon dioxide removal (CDR) as a whole as well as of individual NETPs.

Analyzing stakeholder perceptions

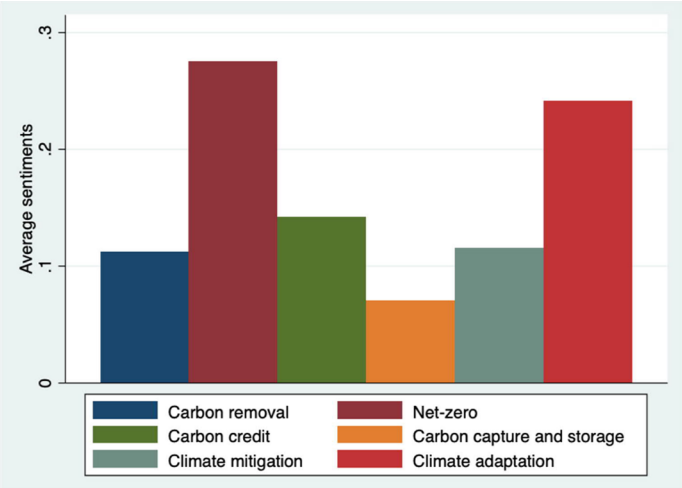
A recent report by the University of Cambridge shows the results of a study carried out as part of NEGEM activities to analyze stakeholder perceptions of NETPs across sector, time, and geographies. To assess the state of policy discourse around CDR in Europe, the study has used text mining and sentiment analysis on roughly 200 documents regarding NETPs from a wide range of actors. This method allowed to identify the polarity of stakeholder opinions on carbon removal strategies as a whole, compared to other related concepts, as well as specific NETPs.

The report points out that documents published by organizations on NETPs are largely concentrated in the past two years compared to the last decade, thus **suggesting a recent surge in interest among stakeholders in carbon removal as a whole and in specific approaches.**

Positive average sentiment scores were found overall for both Carbon Dioxide Removals in general and the individual NETPs, except for enhanced weathering which presents a net negative score (possibly due to the low number of reports discussing it – indicating lower stakeholder awareness and interest).

Positive sentiments

Afforestation/reforestation had higher positive sentiments than most NETPs, especially BECCS, which is seen less favorably. However, AR also had the highest and negative values, suggesting that the opinions on this solution are more strongly polarized than others. This could be explained by the fact the **afforestation/ reforestation was also the most discussed NETP in the analyzed documents.** Since this NETP has been discussed as a climate solution for decades, there is probably greater awareness of its associated pros and cons, compared to other NETPs.



Average sentiment score for carbon dioxide removal and related concepts.
Source

The study also found that CDR is perceived more positively than the precursor concept of CCS, but more negative than Net-Zero, despite the concept of net-zero implies the use of removals. This finding illustrates the importance of framing in shaping stakeholder perceptions. Net-zero is often presented as a bold, ambitious target we should aim for, and it is therefore perceived more favorably than the less-discussed concept of carbon dioxide removal, despite **the two concepts being two faces of the same coin.**

Variation in sentiments

There was considerable geographic and sectoral variation in organisations' sentiments. Western European and Northern European reports showed the most negative sentiment overall, however, these actors are also the ones discussing NETPs more often in their documents, while other European regions had the fewest documents about NETPs (there were ten times as many documents from Western Europe as Southern Europe).

Understanding sentiments toward carbon removal more broadly, as well as individual approaches, will be especially important in shaping policy at national and EU scales.

Further research will build upon these findings to include more documents and perspectives, and to identify specific **linguistic structures being used to discuss NETPs** in public discourse. As the number of reports and organizations covering NETPs expands, it may also be possible to identify a temporal evolution in the sentiment score, on top of more accurate predictors. A further assessment of stakeholders perceptions will also be conducted in the coming months, through qualitative interviews and a pan-European survey to better understand how individuals within organizations are shaping their opinions, and to identify which factors they perceive to be important in helping them shape these positions.

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NETP analogues and Social License to Operate

Stakeholder views on NETPs governance

NETPs include a vast array of practises and technologies that capture CO2 through biological and/or geological storage, that are currently at **different levels of readiness, efficiencies, costs and scalability, leading to differing levels of uncertainty.** All of these factors impact on the social aspect of the deployment which is related to the perception and interaction of key stakeholders that ultimately influences decision making. As such wide scale deployment of NETPs remains a contested prospect.

Understanding Perceptions

NEGEM project aims to understand the perceptions of different stakeholders in relation to NETPs and their potential role in achieving the European climate targets. To analyse the different aspects of perception - logical/scientific and emotional/moral - a series of five workshops were carried out between June to October 2021, involving more than 100 stakeholders, mostly from environmental NGOs and private sector backgrounds. Each workshop included a pre and post workshop survey to monitor how discussions and framing changed perceptions.

The main results highlighted the **deep-rooted differences between stakeholders in the perception of NETPs**. NGOs favour ecological solutions over geological ones and have a greater skepticism towards the use of NETPs to reach European targets, whilst the private sector participants are found to be more enthusiastic towards NETPs overall and particularly those that involve technologies that produce industrial co-benefits, such as Bioenergy with Carbon Capture and Storage (BECCS).

Implications

The first implication of this result is the differing perceptions of an ideal path to meet climate targets; solely reducing carbon favoured by NGOs versus deployment of carbon capture and storage technology favoured by private sectors. This result may be attributed to the lack of knowledge of new technologies, as such a clear implication for policy is therefore the need to improve awareness of less mainstream NETPs, which may improve their perception.

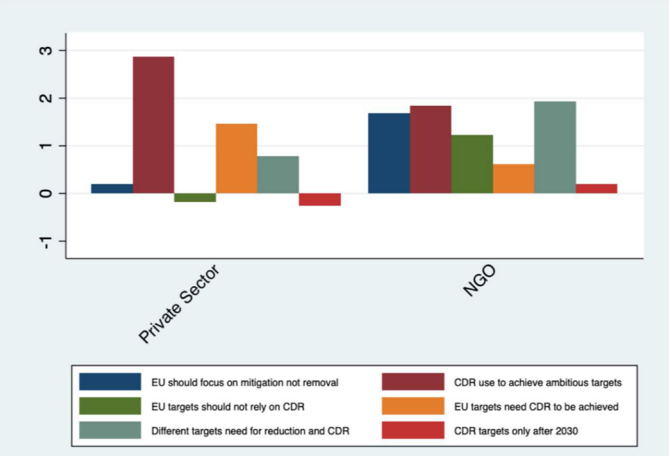
In addition, **differences emerged between different European countries, underlining how homogeneous policies within the European Union could fail** not only because of the different economic needs and resources of the territory, but also because of the different degree of acceptance of NETPs in different geographical areas.

Furthermore, the results reveal that interaction and dialogue among stakeholders had an effect in changing stakeholders' perceptions. It will be important to allow for dialogue between key constituents as this allows for the development and consolidation of stakeholder perceptions and favours their contribution in informing policies.

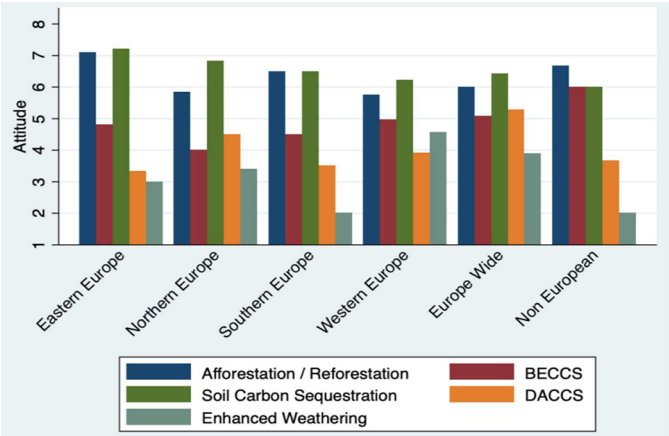
Next steps

In conclusion the interaction between different stakeholders and the ensuing dialogue is fundamental to the development of perceptions about NETPs and their potential deployment – **perceptions should not be understood as static and crystallised but as dynamic and evolving via discussion.**

The next exciting steps for NEGEM focus on triangulating and deepening the results obtained in this series of workshops with other data collections, including interviews with different stakeholders, large pan-European surveys, and analysis of reports from different organisations.



Policy Attitude by Stakeholder Group. Source



NETPs Attitude by Stakeholder Region. Source

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Stakeholder views on NETP governance

Principles for carbon negative accounting

The science is clear that we will most likely need to remove large quantities of carbon from the atmosphere this century, and many countries and companies are making pledges, claims, or setting targets that implicitly or explicitly rely on Carbon Dioxide Removal.

EU Climate Law requirements

In Europe, **the EU Climate Law states that GHG removals and emissions need to be balanced at the latest by 2050.** A number of legislative proposals are directly related to CDR, such as the LULUCF Regulation and its proposed revision, and the EC Communication on 'Restoring Sustainable Carbon Cycles' published in late 2021, that presents a long-term vision for 'sustainable carbon cycles' including carbon removals.

President Ursula von der Leyen announced a legislative proposal on carbon removal certification, during her 2021 State of the Union address, which would set up a **regulatory framework for certifying carbon removals, based on robust and transparent carbon accounting.**

Need for rules

However, there is still a lack of clear and consistent rules for CDR and an accurate carbon accounting is a necessity for the creation and operation of a coherent CDR policy framework.

In November 2021, a report released by NEGEM partner Carbon Market Watch described the principles that should guide process for shaping an effective accounting for carbon dioxide removal, that builds on upon two overarching criteria:

1) Only count real removals

A removal process must actually deliver net-negative emissions. Carbon must be sourced from the atmosphere, and be intended to be stored for at least several centuries and ideally much longer. In addition, all emissions and removals throughout the full value chain of the process must be comprehensively estimated and included in the emission balance - and removals should end up larger than associated emissions.

2) The accounting of emissions reduction and carbon removals must be kept separate

Emission reduction and carbon dioxide removal accounting and targets need to be kept strictly separate to ensure removals can play the roles science says they need to: 'compensate' for the very last emissions to be abated and slash atmospheric GHG concentrations. Separate accounting frameworks mitigate the risk of mitigation deterrence, i.e. removals slowing down decarbonisation efforts, and the potential for false equivalency. Failing to distinguish removals from reductions by allowing for offsetting between both risks undermining political and public acceptance for removals. On the other hand, separation creates a space for development and deployment of removals without undermining emission reduction efforts.

Following these two principles will help avoid the pitfalls related to CDR accounting. However, although

A timely arrival of the NEGEM Project

The European Union, and its institutions, is going full steam ahead with its European Green Deal, having proposed a raft of new and revised climate legislation in 2021 with the overarching goal of reaching climate neutrality by 2050. It now sits on the mammoth 'Fit-for-55 package' to implement this goal, by reviewing the EU's climate architecture and proposing additional measures which bring us closer to climate neutrality.

The package initially sought to cautiously address the topic of Carbon Dioxide Removal, focusing on a Carbon Removal Certification Mechanism to monitor, report and verify the removal of carbon from the atmosphere. However, negative emissions fever seems to have caught Brussels by storm. Of the three pillars which regulate the entirety of the EU's greenhouse gas emissions, all have been targeted with amendments by the European Parliament to include carbon dioxide removal in some form or another.

The NEGEM project is therefore extremely timely and relevant, and will serve as a reminder that, despite the clear need for CDR, research on its realistic deployment potential is ongoing. While the potential for CDR is significant, we must be wary not to overpromise and under deliver at the expense of our climate goals. The NEGEM consortium will ensure that the political conversation on negative emissions, often vulnerable to misinformation, **remains grounded in reality and the laws of physics.**

Mark Preston Aragonès,
Bellona Europa

getting the accounting of carbon dioxide removals right is crucial, the authors remind that removals can supplement emissions reductions, but cannot replace them, and carbon accounting has to reflect that simple truth. **Emissions reductions must enjoy clear primacy, the risks and uncertainties related to the large-scale deployment of removals makes a strong case for making emission reductions the clear political priority.**

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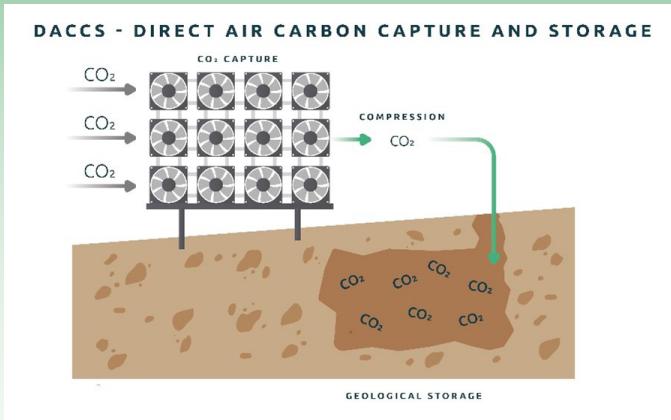
Principles for carbon negative accounting

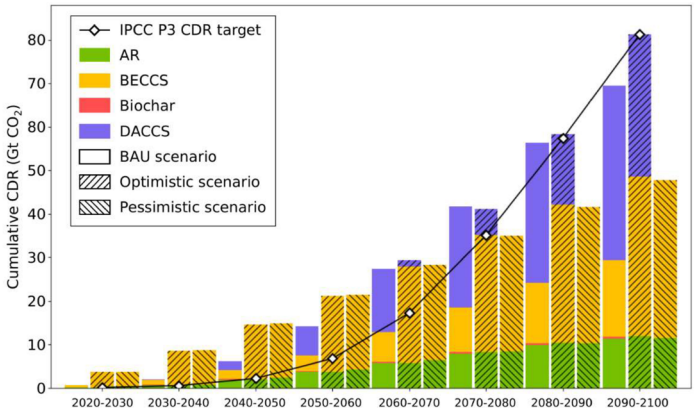


In DACCS atmospheric carbon is used for long term storage through mineralization (respecting principles 1 and 2). Source

Modelling system analysis of CDR pathways with MONET-EU

Integrated Assessment Models (IAMs) extensively feature mainly bioenergy and carbon capture and storage (BECCS) and afforestation as potential carbon dioxide removal (CDR) options. The reliance on a single or restricted portfolio of NETPs to reach these global mitigation targets triggers potential ecosystems impacts and hinders the simultaneous implementation of other carbon mitigation strategies.

MONET-EU is a spatio-temporal explicit model providing a whole-system analysis of a least cost portfolio of CDR pathways, in a ten-yearly time-steps, subject to a range of sustainability and biogeophysical constraints. Specifically, CDR targets are specified at country or at regional level (EU), and sustainability limits — land and biomass supply availability, maximum water stress— are imposed in the model, in addition to maximum deployment constraints for each CDR option.



Cost-optimal CO2 removal, from 2020 to 2100, for each CDR option in the EU. BAU: country level CDR targets, Optimistic: EU level CDR target (cooperation) and Pessimistic: country level CDR targets without DACCS. Costoptimal CDR pathways are primarily comprised of BECCS, and then AR. Source

Extending MONET-EU capabilities

In its initial formulation, MONET-EU included exclusively BECCS within its technological database but as part of NEGEM activities, researchers at the Imperial College of London are working to extend the model database to include other NETPs, specifically afforestation/reforestation (AR), solid and liquid sorbent Direct Air CO2 Capture and Storage (DACCS) systems and biochar production via slow pyrolysis.

In addition, the default input data for biomass yields based on statistical databases were replaced by climate- and scenario-specific yields simulated by the process-based biosphere model LPJmL (Lund-Potsdam-Jena managed land). **This allowed further exploitation into the impacts of climate change on the yields of the feedstock for biomass based NETPs which were previously not considered in MONET.**

In order to validate the model and to investigate the contribution of these NETPs in reaching regional and country level CDR targets with the European Union, the MONET-EU framework was applied to a range of policy scenarios, characterized by a varying degree of collaborations between EU states, assuming that EU countries would either meet their national CDR target in isolation, or that each country would contribute to meet the regional CDR target based on its geophysical, economic, and technical capabilities.

The scenarios indicate that BECCS starts to be deployed at scale and in different countries already in 2020 owning to its lower removal costs compared to other technologies, followed by afforestation, while biochar deployment is very limited across the timescale, contributing with less than 1% to the total CO2 removed by 2100. The role of DACCS is more prominent during the second half of the century.

The Results

The results show that **the cost-optimal way to meet the Paris Agreement, strongly relies on international cooperation, especially when the availability of biomass resources is restricted** (for example by excluding biomass imports to EU from the scenario). When nations act in isolation, not only the deployment of these technologies at scale is more costly, but some of the EU countries are not able to meet their own targets, due to lack of access to CO2 storage or limited biomass and land availability.

To overcome this challenge, the study suggests that NETPs should be integrated into an international market for negative emissions trading, in which nations capable of generating CDR surplus, relatively to their individual CDR targets, could provide this as a service to other nations with lower biomass and resource availability. In such market, CDR surplus would generate negative emissions credits (NECs), that could be traded between nations, thus enable meeting the Paris Agreement target in the most cost-efficient manner. However, how, and at which price should NECs be allocated from a nation to another represents an open question.

The study argues that **the later a market for negative emissions trading would be implemented, the more expensive delivering the Paris Agreement's CDR objectives would be.** Therefore, immediate action towards the establishment and deployment of a multi-regional, or possibly international, geopolitical and economic framework for NE trading will be key in delivering the Paris Agreement's CDR objectives, supported by robust governing bodies that enable monitoring, verification and accreditation.

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Extended MONET-EU

NETPs and Bio-geophysics databases

As part of its NEGEM activities, Imperial College of London is developing two databases of NETPs and of biogeophysics data sources, to support mathematical analyses of different greenhouse gas removal technologies.

The objective

The biogeophysics database provides a range of different open access data sources and links to spatially indexed data on regional boundaries, climatologies, land cover and availability, soil-water balance, global ecological zones and protected areas, crop yields and irrigation requirements, mineral availability, CO2 storage availability, and other parameters.

The final form of this deliverable at the end of the project will detail a **comprehensive, member state-specific database of negative emissions technologies,** which build on existing knowledge by scaling the costs by social license to operate.

Features

The NETPs database features an initial set of technologies including bioenergy with CO2 capture and storage (BECCS), direct air capture and storage (DACCS), afforestation (AF), and enhanced weathering (EW). **The database represents the techno-economics of different negative emission technologies using both unit and system-level data.**

The type of operations presented for each technology varies due to their nature and location-specific data are required for the accurate characterisation of some process. Future updates of the database may include additional negative emissions technologies.

DOWNLOADS

Bio-geophysics database

NETP database

NEGEM at International Conference on Negative CO2 Emissions

The 2nd International Conference on Negative CO2 Emissions will be held at Chalmers University of Technology, (Gothenburg, Sweden), June 14-17, 2022. The event will bring together scientists, experts and stakeholders discussing about technologies, climate modelling, policy and incentives. NEGEM will participate in the conference with five presentations:

Sustainability assessment of marine negative emissions technologies and practices
Selene Cobo, Gonzalo Guillén Gosálbez (ETH Zurich)

Understanding NETP Social License to Operate
Celina Scott-Buechler (Stanford University.),
Lucrezia Nava, David Reiner (University of Cambridge)

Stakeholder perception of NETPs: The effects of discussion and framing
Lucrezia Nava (University of Cambridge),
Celina Scott-Buechler (Stanford University.),
David Reiner (University of Cambridge)

Exploring Negative Emission Potentials within Planetary Boundaries: Limits and Opportunities of BECCS, PyCCS and Reforestation
Johanna Braun, Constanze Werner, Wolfgang Lucht, Dieter Gerten (Potsdam Institute for Climate Impact Research)

Land-neutral negative emissions through biochar sequestration
Constanze Werner, Wolfgang Lucht, Dieter Gerten (Potsdam Institute for Climate Impact Research), Claudia Kammann (Hochschule Geisenheim University)

More information and program details at negativeco2emissions2020.com

About NEGEM

NEGEM is a Horizon 2020 Research and Innovation Action started in June 2020 that will continue through May 2024, to assess the realistic potential of Negative Emission Technologies and Practices (NETPs) and their contribution to climate neutrality, as a supplementary strategy to emissions mitigation.

Learn more

NEGEM Deliverables and Resources available at negemproject.eu

- Comprehensive sustainability assessment of terrestrial biodiversity NETPs
- Comprehensive sustainability assessment of marine NETPs
- Comprehensive sustainability assessment of Bio-CCS NETPs
- Quantitative survey of commercialisation mechanisms
- Interactions and trade-offs between nature-based and engineered climate solutions
- Upgraded LPJmL5 version
- NETP database
- Bio-geophysics database
- Member States Targets
- NETP analogues and Social License to Operate
- Stakeholder views on NETP governance
- Principles for carbon negative accounting
- Extended MONET-EU
- Stocktaking of scenarios with negative emission technologies and practices

NEGEM

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This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 869192.