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2 minutes of reading

News

Fundamental Research

Economics | Economic modeling | Forecasting and scenario modeling

Following her PhD thesis at Imperial College London [1], Dr. Solène Chiquier has been sponsored by the CARMA Chair[1], hosted by IFP School, to conduct a postdoctoral research at the Massachusetts Institute of Technology (MIT), specifically working within the MIT Joint

Program on the Science and Policy of Global Change. This program focuses on interdisciplinary research combining science and policy to address global environmental changes.

Solène Chiquier

As a result of this research a paper was published [2]: in this study, Solène evaluates various carbon dioxide removal (CDR) strategies under various scenarios to achieve the climate goals of the Paris Agreement. The paper examines five CDR approaches: bioenergy with carbon capture and storage (BECCS), afforestation/reforestation, direct air carbon capture and storage (DACCS), biochar, and enhanced weathering. Using the MIT Economic Projection and Policy Analysis (EPPA) model, Solène and her co-authors assess the global and regional implications of these CDR strategies on land use, energy consumption, and policy costs.

Key findings from the study include:

- **Diversified CDR Portfolio** : implementing a mix of CDR approaches is the most cost-effective strategy for achieving net-zero emissions. This diversification reduces reliance on any single method, thereby minimizing negative impacts on land and energy resources.

- **Regional Customization**: the effectiveness of CDR strategies varies by region due to differences in technological, economic, and geophysical conditions. For instance, nature-based solutions like afforestation and reforestation are particularly beneficial in regions such as Brazil, Latin America, and Africa, where they not only sequester carbon but also preserve biodiversity and promote human health.

- **Timely Deployment**: delaying large-scale implementation of CDR strategies could lead to higher carbon prices and increased policy costs. Early and substantial deployment, supported by appropriate policy and financial incentives, is crucial to mitigate climate change effectively.

In summary, the study underscores the importance of a diversified and region-specific approach to CDR deployment, emphasizing that such strategies can achieve climate targets more sustainably and cost-effectively. It also highlights the need for prompt action to implement these measures to avoid escalating costs and climate risks.

[1] The aim of the CarMa chair is to advance knowledge and provide insights collaborating with a diverse group of partners from academia and industry. For more information, please visit the chair website.

This study is framed under the IFP School's Chair entitled "Carbon Management and CO_2 negative emissions technologies towards a low carbon future" (CARMA) supported by TotalEnergies OneTech in association with foundation Tuck.

References:

[1] Solène Chiquier, PhD Thesis, ***The Implications of the Paris Agreement on Carbon Dioxide Removal (CDR) - Techno-Economics, Potential, Efficiency and Permanence of CDR pathways***, Centre for Environmental Policy, Imperial College London, 2022.

[2] Solene Chiquier, Angelo Gurgel, Jennifer Morris, Yen-Heng Henry Chen and Sergey Paltsev, ***Integrated assessment of carbon dioxide removal portfolios: land, energy, and economic trade-offs for climate policy***, Environmental Research Letters, Volume 20, Number 2,
>> DOI: 10.1088/1748-9326/ada4c0

Scientific contacts: Maxime Schenkery, Carlos Eduardo Andrade Sandoval

LES BRÈVES

A RESEARCH PROGRAM TO DECARBONIZE INDUSTRY

IFPEN and the CNRS are leading the SPLEEN PEPR*, an upstream research component supporting the French national acceleration strategy relating to the decarbonization of industry.
> Read the press release
> Call for expressions of interest
**Programmes et équipements prioritaires de recherche (French research priority programs and infrastructure)*

Paving the way for a low-carbon future for industry

Research and development have a major role to play in supporting the decarbonization of French industry and the development of national industrial sectors for decarbonization solutions. This is a fundamental challenge, given that industry is responsible for around 20% of France's greenhouse gas (GHG) emissions. The National Low Carbon Strategy aims to reduce industry's greenhouse gas emissions by 35% by 2030 and 81% by 2050, compared with 2015 levels.

The SPLEEN research program in a few words
The PEPR "Supporting innovation to develop new, low-carbon industrial processes" (SPLEEN) is part of the France 2030 national acceleration strategy "Decarbonization of industry" and aims to prepare a technological offering and breakthrough solutions that will help France meet its climate commitments by 2050 and strengthen national sovereignty over technologies dedicated to decarbonization.
>> Read more about the SPLEEN PEPR

Key figures

- 10 targeted projects
- 40 partners (EPIC, EPST, Universities, Schools)
- 300 researchers, teacher-researchers and engineers
- 70 laboratories involved
- 70 million euros budget
- A 6-year program

IIFPEN is co-piloting 2 other PEPRs and is also participating in 4 other PEPRs backed by a National Acceleration Strategy, known as "PEPR-SNAs" (26 in total at national level) and 6 Exploratory PEPRs (17 in total at national level).

IFPEN is participating in **nine of the ten targeted projects**, including two as project coordinator.

The 4 strands of the SPLEEN research program

Area 1 : new prediction and monitoring tools
Area 2 : integration of low carbon energies and efficiency
Area 3 : processes decarbonisation and intensification
Area 4 : CO_2 storage and valorisation

IFPEN, bringing knowledge and expertise essential to decarbonization

IFPEN draws on several of its research fields essential for the decarbonization of industry, including :
- **Catalysis and separation**, crucial fields in the design of innovations favorable to the transition in the chemicals and energy sectors
- **CO_2 conversion**, particularly chemical and photocatalytic
- **The development and application of life cycle analysis (LCA) methodologies**
- **Data processing and real-time management** of processes

> "While this PEPR, like all the rest of them, relates to low-TRL research, from the laboratory scale through to proof of concept, our aim is not only to innovate but also to integrate the industrial purpose of the R&D and its societal impact upstream. This impact is therefore taken into account from the outset of projects and industry is a stakeholder in the PEPR's consultative bodies" , underlines António Pires da Cruz, the PEPR's co-director for IFPEN.

IFPEN's participation falls within the framework of its scientific approach and its different research problems: Understand, on a molecular or adapted scale, chemical, catalytic or enzyme reaction mechanisms (challenge 2), understand the effect of confining fluids on their dynamics and reactivity in porous media (challenge 3), model closely coupled phenomena with a view to simulation scale change (challenge 6) and evaluate the economic and environmental impacts of energy transition innovations (challenge 9).

YOU MAY ALSO BE INTERESTED IN

IFPEN and the MOBIDEC PEPR

IFPEN is leading the MOBIDEC PEPR, an upstream research component supporting the French national acceleration strategy for the digitalization and decarbonization of mobility, alongside Gustave Eiffel University, joint leader of the research program. Integrated in the France 2030 objective, it is aimed at developing an efficient, sovereign and resilient mobility sector.

Sustainable mobility | Connected Mobility

IFPEN and the B-BEST PEPR

IFPEN and INRAE are leading the B-BEST PEPR*, the research component supporting the French national acceleration strategy relating to “Bio-based products and industrial biotech - sustainable fuels”

Renewable energies **Bio-based chemistry**

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IFPEN and the SPLEEN PEPR

Tackling climate change necessarily involves reducing greenhouse gas emissions resulting from human activities, primarily carbon dioxide and methane. The problem is global and the actions required must be implemented within the framework of a systemic approach, with scale effects that are difficult to fully understand. Nevertheless, **the Paris Agreement reflects the determination of nations to correct the current trajectory while respecting the legitimate aspirations of emerging countries to raise their living standards**.

In addition to reducing emissions at source, **one lever available to limit climate impact is to extract CO_2 from the atmosphere** (i.e. negative emissions), using solutions that are environmentally-friendly, that protect biodiversity and that are both deployable and accepted by our societies. **The main difficulties lie in the complexity and interdependence of the phenomena to be considered**, requiring expertise and tools in a variety of fields, such as energy, land use planning and forest management, as well as human sciences. Although such expertise exists in all these fields, partial and poor solutions may emerge if there are not sufficient interactions to solve the problem in a global way.

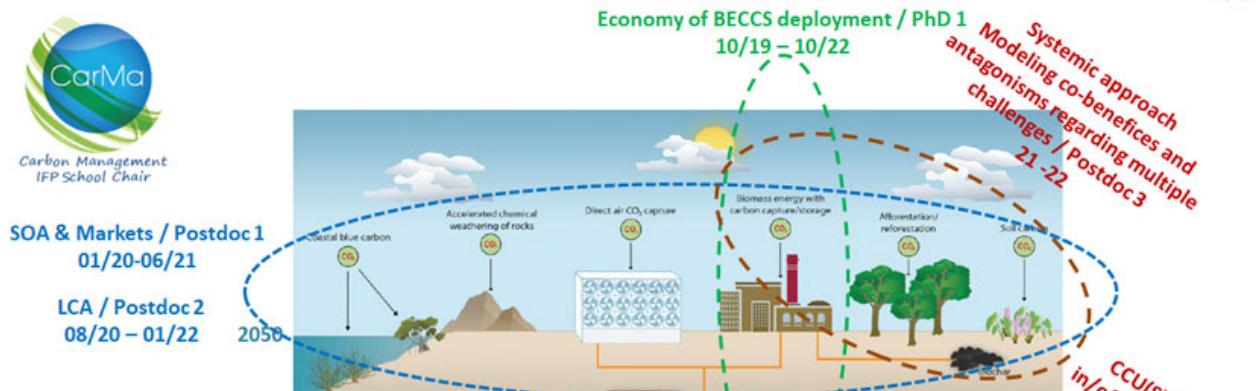
The ambition of CarMa[1], a teaching and research Chair sponsored by Total, **is to explore and analyze the field of negative CO_2 emissions**, using a very broad approach, **in order to identify which options could be deployed by 2050**. **In line with the principle of sustainable development** , the approach adopted focuses on **three solutions that may increase CO_2 sequestration capacities:** direct capture of CO_2 in the atmosphere (DACCS), soil sequestration and biomass energy extraction combined with CO_2 capture, storage and utilization (BECCS).

These topics are already being examined from a regulatory and economic perspective, including a "carbon life cycle analysis (LCA)", **in two post-doctoral research projects and one thesis**. Three additional young researchers will be recruited in 2021 to work on the societal aspects of BECCS deployment and on the antagonisms and co-benefits of land allocation in the context of biomass energy use. The research areas addressed during the first two years (some in partnership[2]) lie within the perimeters illustrated in the diagram.

The very first results, currently being published[1] [3], **present the economic analysis of a concrete case** in Sweden involving the collection, transport and use of biomass, combined with the capture, transport and storage of the CO_2 produced by its combustion. In this analysis, the concepts of cooperative game theory are mobilized in order to identify conditions for cooperation between different emitters connected to a common infrastructure, a pre-requisite considered essential for the large-scale deployment of this combination of technologies.

In order to raise awareness of this crucial issue for the 21st century, **a website has been set up to facilitate the dissemination of the Chair's results**. The "BECCS" theme has also been included in the 2020 edition of the "***Energy Transition***" MOOC offered by IFP School.

Click on the picture to enlarge



CarMa Chair: research perimeters (years 1 and 2) concerning negative CO2 emissions approaches

1- CarMa: “Carbon Management and negative emissions technologies towards a low carbon future”, created in July 2019 in partnership with the Tuck Foundation.
2- For example with the CNRS, the University of Pau and Pays de l’Adour and INRAE.
3- The article currently submitted[1] can be accessed on City Research Online and in Les Cahiers de l’économie, published by IFPEN - IFP School (issue 135 – August 2020).

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[1] E. Jagu et O. Massol. ***Building infrastructures for Fossil- and Bio-energy with Carbon Capture and Storage: insights from a cooperative game-theoretic perspective****, 2020, submitted to Environmental and Resource Economics.*
>> https://openaccess.city.ac.uk/id/eprint/25034/

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Training and Careers
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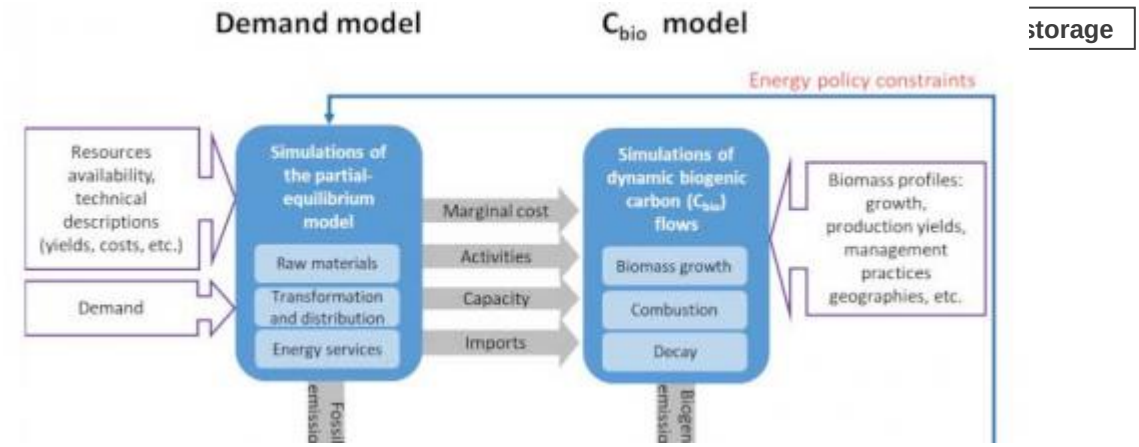
Launch of the new CarMa Chair website



Fundamental Research

News April 2020

Dynamic modeling to help achieve genuine carbon neutrality

Climate, environment and circular economy | Environmental monitoring | Life cycle analysis (LCA)

Economics | Environmental impact evaluation & LCA

CarMa Chair: negative CO2 emissions by 2050

Carbon dioxide removal strategies: a diversified and region-specific approach
06 May 2025

Link to the web page :