PROGRAMME DE RECHERCHE
DÉCARBONATION DE L'INDUSTRIE

Annual conference of the PEPR B-BEST

(Biomass, biotechnologies and sustainable technologies for chemistry and fuels)

Tuesday 11 June 2024

Presentation of the PEPR SPLEEN (*Support innovation to develop new largely carbon-free industrial processes)* for decarbonization of industry

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Program Manager

An overview of the main issues of decarbonization of industry

Emissions from the industrial sector represented 17,4% of total national emissions in France in 2017.

CO_2 from the minerals, metallurgy & chemical industry represents 89,7% of the sector's greenhouse gas emissions.

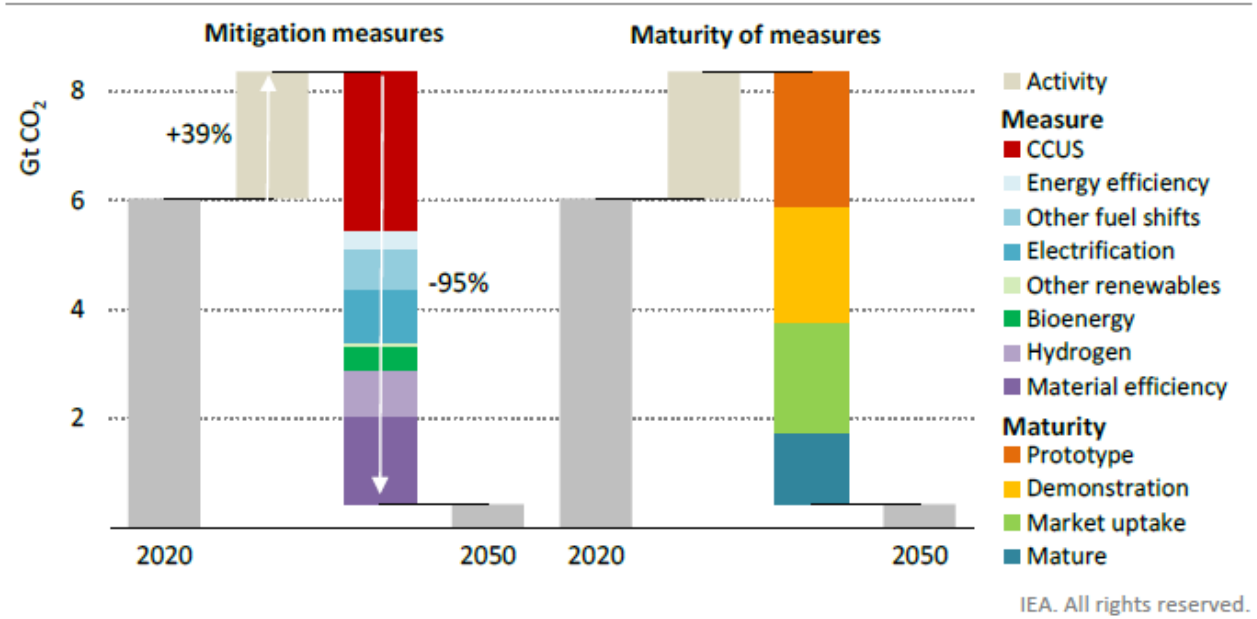
National Low-Carbon Strategy targets a 35% reduction in emissions from the industry sector in 2030 compared to 2015, and 81% by 2050

Net Zero roadmap by 2050 (NZE scenario) set-up by the IEA (International Energy Agency) in 2020 calls for a reduction of the CO_2 emissions from heavy industry of 20% by 2030 and 93% by 2050.

Amongst the recommendations of IEA, can be found the optimisation of the efficiency of equipment, the adoption of the best available technologies, and the improvement of material efficiency.

In the NZE scenario, hydrogen and CCUS technologies together could contribute to around 50% of the emissions reductions in heavy industry by 2050. High temperature heat can be provided by hydrogen, where electricity-based technologies fail, and CCUS should help, amongts others, to reduce process emissions from the chemical reactions inherent in some industrial production. Bioenergy also makes a contribution in a wide range of industrial applications.

Almost 60% of emissions reductions in 2050 could be achieved using technologies that are under development today, and even not on the market today (large prototypes or demonstrators). **This clearly shows that the solutions of today are not sufficient and that there is an absolute necessity to undergo breakthrough research actions to prepare future innovative decarbonisation technologies**.



General framework

PEPR SPLEEN: Priority Research and Equipment Program aiming to **Support innovation to develop new largely carbon-free industrial processes**

Framework of the National Low Carbon Strategy (*Stratégie nationale Bas-Carbone, SNBC*) and of the Industry Decarbonization Acceleration Strategy

This programm is intended tu support upstream research (TRL 1 to 4) and have a budget of €70 million (duration: 6,5 years).

The scientific management of this programm has been entrusted to CNRS and IFPEN.

Two directors, Fabrice Lemoine (CNRS/Université de Lorraine) & Antonio Pires da Cruz (IFP Energies Nouvelles)

40 partners, 70 laboratories

Development of new processes minimising CO_2 emissions, tools for predicting and modeling, post-treatment of effluents (in particular through the development of energy-efficient CO_2 capture methods, either associated with CO_2 storage, or with CO_2 utilisation), the research for new monitoring, performance and management indicators of industrial processes and the strengthening of the role of life cycle analyses and eco-conditionality criteria

General objectives

- Providing french competitive solutions for the decarbonization of industry
- Developing transversal actions to demonstrate the scientific and technological feasibility of the decarbonization of industrial areas (carbon capture, synergies at local level)
- **Encouraging and promoting the decarbonization of industry (public procurement, rules, label, legal barriers)**
- Developing future breakthrough decarbonization technologies to reach carbon neutrality by 2050
- Creating and increasing training offer to address challenges linked to the decarbonization of industry

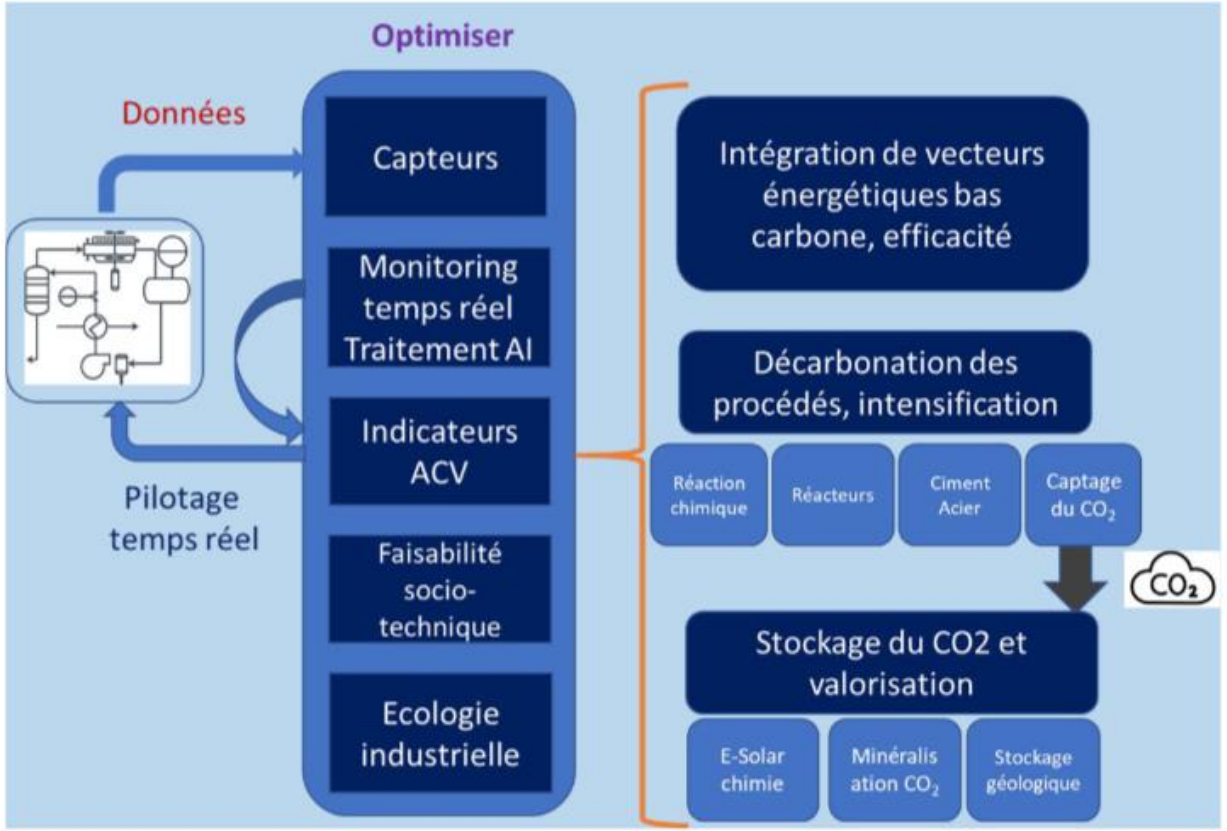
4 research axis

Axis 1 - New prediction and monitoring tools

Axis 2 – Integration of low carbon energies and efficiency

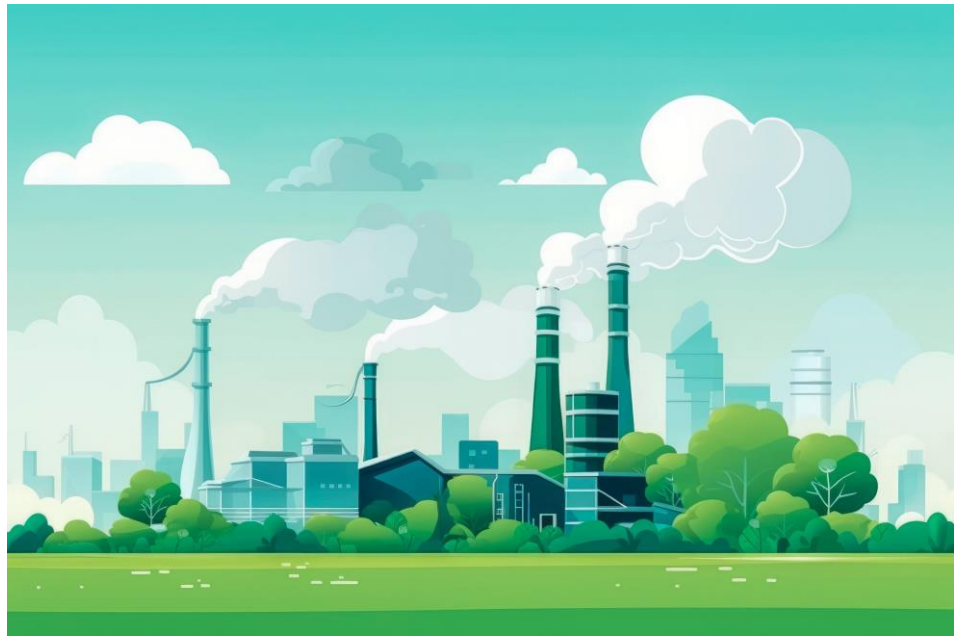
Axis 3 – Processes decarbonisation and intensification

Axis 4 – CO_2 storage and valorisation



4 research axis

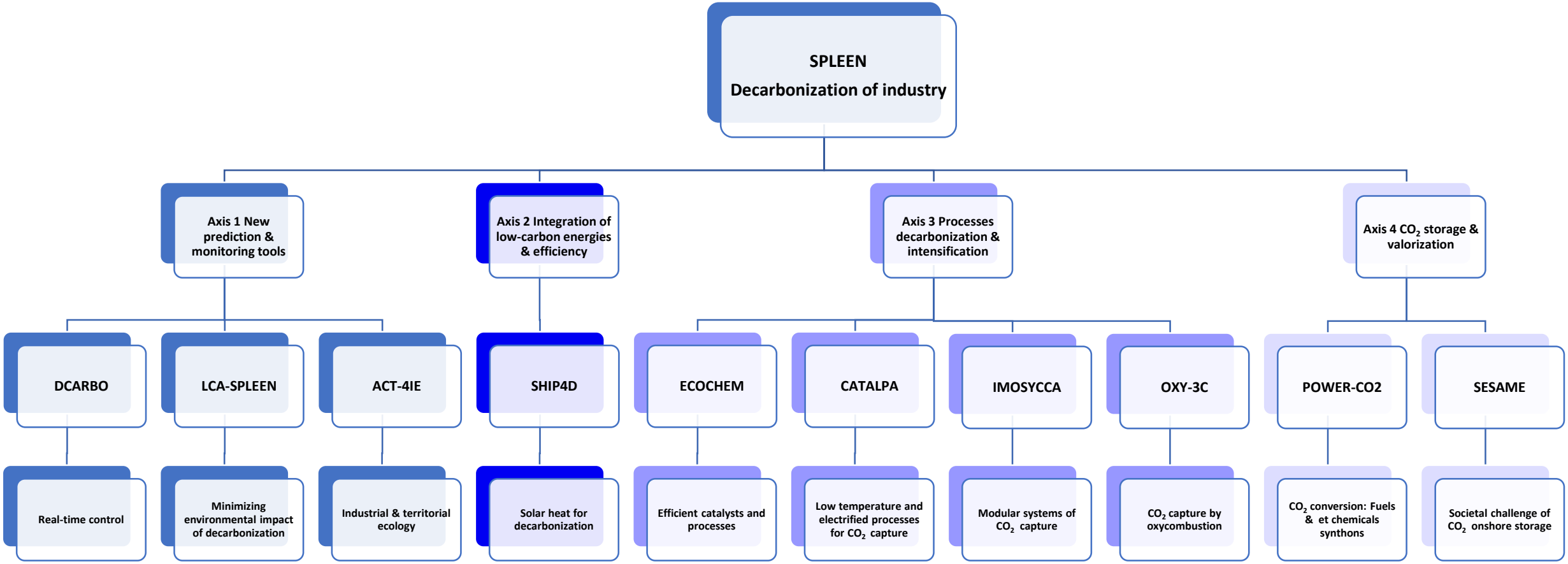
Expected impacts	PEPR axes and sub-axes providing answers
Development of decision support tools driven by energy and environmental performance	**Axis 1 - New prediction and monitoring tools** #1.1 Real time monitoring of processes emissions and environmental impact #1.2 Evaluation and prediction of industrial systems emissions and environmental impact #1.3 Life cycle analysis (LCA), Coupling social, economic and technical issues
Emergence of new technological bricks for low in materials and energy processes	**Axis 2 – Integration of low carbon energies and efficiency** #2.1 Decarbonisation of energy vectors #2.2 Heat management
Proposal of new axes to formulate disruptive compounds	**Axis 3 – Process decarbonisation and intensification** #3.1 Intrinsic decarbonisation of industrial processes
Proposal of new of CO_2 capture / utilisation processing, positioning France as a leader	**Axis 3 – Process decarbonisation and intensification** #3.1 Intrinsic decarbonisation of industrial processes #3.2 CO_2 capture #3.3 Coupling CO_2 capture and conversion processes **Axis 4 – CO_2 storage and valorisation** #4.1 CO_2 utilisation #4.2 Enabling long-term CO_2 storage



10 targeted projects launched in 2023

Upcoming projects (two calls for projects in 2024 & 2025, one call for expression of interest in 2024)

10 Targeted projects, launched in 2023



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« ECOCHEM »

Eco-friendly and intensified chemical reactions

Objectives of this targeted project

ECOCHEM aims to **design cutting-edge technologies paving the way for more eco-efficient catalytic reactions/processes** in terms of atom economy, energy saving, selectivity to reduce CO_2 emissions from fine chemicals processes.

Methodological approach

Task 1

New methodologies for the synthesis of mono- and multi-functional catalysts

Challenges:
- The criticality of some metals
- Batch to continuous,
- Selectivity, recyclability, activity

Task 2

Assisted catalysis (sono-, photo-, mechano-, magneto- et electrocatalyse)

Challenges:
- Selectivity, productivity
- Energy use
- Intensification/scale-up

Performance criterias

- Energy consumption
- Productivity of reactors
- E-factor
- CO_2 emissions
- Lifetime of catalysts
- Distillation resistance

Targeted reactions

Activation of small molecules (N_2, NH_3, CH_4, H_2, CO_2 (in relation to the project POWERCO2), small alcools, etc.

Expected final outcome

Expected productivity of reactors> 50 $kg/m^3/h$, expected CO_2 balance < 2,5$kg_{CO2}/kg_{product}$

Multifonctional catalysts for chain reactions: (expected catalyst consumptions' of < 1$g/kg_{product}$)

To define market opportunities of assisted catalysis (potential, limits)

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« ACT-4-IE»

A systemic and territorial approach to decarbonise activity areas with industrial ecology

Objectives of this targeted project

ACT-4-IE aims to implement a systemic approach to **evaluate**, **diagnose** & **optimise** resources of industrial zones.

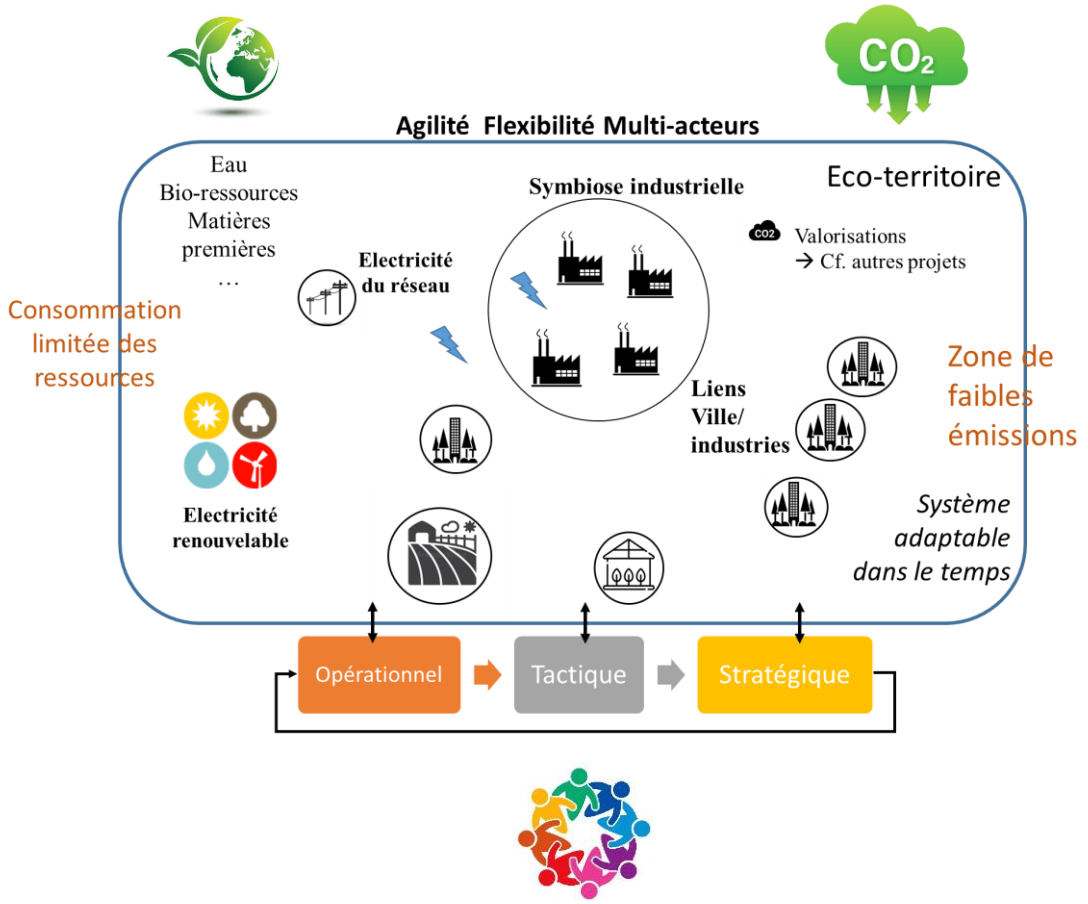
Methodological approach

Coupling various modeling, simulation, optimization and decision support methods to reconcile the different scales of the systems: power grids, thermal networks, material networks, water networks, etc.

Multi-actor modeling methods will be developed.

Expected major outcome

Development of an integrated digital tool for making resource management decisions on a strategic scale, taking into account major operational constraints.



Synergies with the PEPR B-BEST

- Developing industrial ecology approaches to facilitate the development of some energy inputs like biomass: a collaboration with local actors has to be set to limit the GHG impact of the resource.
- Developing more efficient processes and catalysts to decarbonize the biochemical industry & biorefining technologies.

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Thank you for your attention