Plasma Physics Laboratory (LPP), CNRS - Ecole Polytechnique - Sorbonne Université UMR7648





### THE PROBLEM ADDRESSED

With the ongoing **climate crisis**, reducing our carbon emissions is a vital need. Renewable energies offer part of the solution; however, their production is often irregular, and we are lacking scalable and reactive solutions to store their untimely production. This technology solves both problems by using CO2 as raw material upcycled into carbon-neutral fuels.

The *Cycles* project aims at **recycling the CO2** emitted by industrial facilities into methane (CH4).

CO2 plasma for sustainability has been a target of Ecole Polytechnique's Laboratory of Plasma Physics (LPP) since 2015. LPP has longstanding expertise in nonthermal plasma creation and applications (validated through several spin-off companies). This project builds on fundamental results from the "PIONEER" Horizon2020 European collaboration.

#### TECHNOLOGY

• Cycles uses a novel plasma source based on low pressure (target 0,1bar) radiofrequency discharge. Using metal-based catalyst, the system aims at achieving low-temperature (target ≤200°C), homogeneous and energyefficient methanation of CO2 through the Sabatier process (CO2 + 4H2  $\rightarrow$  CH4 + 2H2O).

 The non-equilibrium characteristics of the plasma allow efficient energy deposition in the molecule, avoiding energy waste in heating and compressing.

#### **COMPETITIVE ADVANTAGES**

- The low-pressure discharge enables homogeneous treatment of effluents, opening the way to rapid conversion of large volumes of exhaust gases.
- The prototype has a strong potential for treating effluents straight at the industry output, avoiding the separation step required with existing treatments.
- Plasma is an easy on-off solution: It can follow factories discontinuous emissions; or the emitted CO2 can be stored and converted at the next excess energy production's peak. This solves the irregular outputs of renewable energies.
- Methane is a more compact energy storage solution than hydrogen, with a pre-existing mature market and large scope of applications.

# APPLICATIONS

• Cycles converts CO2 pollution into valuable and usable methane (CH4)

### **DEVELOPMENT STATUS**

• TRL 2/3: novel conversion of CO2 achieved at low pressure in an RF discharge, prototype for methanation in construction

### **INTELLECTUAL PROPERTY**

• 2 Priority Patent Applications underway

# **INVENTORS & CONTACTS**

- Olivier Guaitella, olivier.guaitella@lpp.polytechnigue.fr
- Edmond Baratte, edmond.baratte@polytechnique.edu
- TTO: Anne-Laure Doireau, anne-laure.doireau@polytechnique.edu
- SATT: Sebastien Vanneste, sebastien.vanneste@satt-paris-saclay.fr

### PUBLICATIONS

Dissociation of CO2 in a low-pressure RF plasma:

- Modelling: J.of CO2 Utilization 53(2021):101719
- Experimental tests: J. Phys. Chem. C 2020,124,32

### LOOKING FOR

- Industrial users and large CO2 producers to establish specifications
- Collaborations with:
  - experts on excess heat recapture/ valorization
  - methane chemistry experts