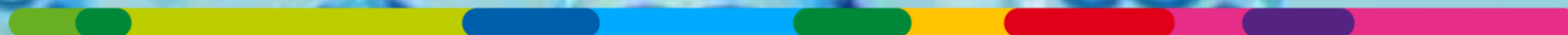


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From CO<sub>2</sub> Capture and Storage  
to CO<sub>2</sub> reduction and valorisation.

ECRA Chair Scientific Event  
Daniel Marenne - 09<sup>th</sup> November 2016

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# CONTENTS

## Background

Competences in CO<sub>2</sub> capture and storage

## Valorisation

CO<sub>2</sub> valorisation : Opportunities and Issues

## Collaboration

Collaborative projects are needed – CCU Association

# 01

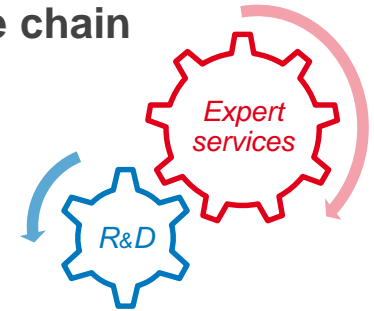
## Background competences CO<sub>2</sub> Capture and Storage



# ENGIE LAB LABORELEC

## in a nutshell

- The **Research & Expertise Center** of ENGIE for the **electricity value chain** as member of the **DRT family**
- Provider of **expert technical services** in electrical power technology



Power Generation



Exchange  
& Storage



Sustainable  
Use

- for **ENGIE** and **third companies**
- for power plants, grid operators, industry and end-users

- **Global presence**, activities in more than 60 countries
- Focused on **high value** delivery for its customers



**Based on our expert competences and research, we propose high-tech services so as to maximize the value delivered to our customers.**



# Historical support to ENGIE's Metiers enabling development of core competences in CCS.

- CO<sub>2</sub> capture and storage (CCS) was seen as having a major potential in the years 2005 – 2010.
- In 2005, ENGIE (formerly GDF SUEZ) Direction Research and Technologies launched a multiyear R&D program on CCS, to secure investment for new fossil fired assets and maintain flexibility, while operating in an increasingly restrictive regulatory environment.

## Competences developed in ENGIE Labs wrt Capture, Transport and Storage of CO<sub>2</sub>

- ENGIE Lab Laborelec, assessed the environmental impact of Post Combustion Capture (PCC) facilities. Operational expertise for PCC was also developed on degradation of solvent systems, corrosion resistance of metallic and non-metallic materials, behavioral study of PCC unit control loops.
- ENGIE Lab Crigen has developed expertise in Materials Selection, Pipeline Integrity, Safety assessment for CO<sub>2</sub> transport pipes, Process Modeling flow in CO<sub>2</sub> Wells and Pipelines, site selection and characterisation for the CO<sub>2</sub> storage.



# Materials and methods used to measure environmental impact of Post Combustion Capture (PCC) facilities :

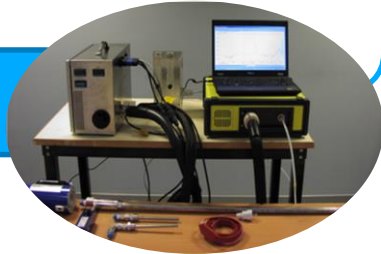
Off-line measurement of the gas phase: mostly used for  $\text{NH}_3$ , MEA, aldehydes, nitrosamines

## Manual sampling



On-line measurement of organics (MEA, aldehydes,...) and inorganics ( $\text{NH}_3$ ,  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ , ...) at ppm level

## FTIR



On-line measurement of PM/aerosol size distribution & concentration between 6 nm & 10  $\mu\text{m}$

## ELPI<sup>+</sup>



- Characterizing liquid, solid and gaseous PCC waste streams,
- Off-line and on-line emission monitoring systems for pollutants at ppb level as well as an evaluation of on-line solvent purification techniques.
- Impact of PCC on health and safety (nitrosamines)
- Research of aerosol formation and potential counter measures

On-line measurement of  $\text{CO}_2$  purity:

\*  $\text{O}_2$ ,  $\text{CH}_4$ ,  $\text{H}_2\text{O}$  at ppm

\*  $\text{H}_2$  at vol %

\* formaldehyde,  $\text{NH}_3$  at ppb

## Gas Chromatograph



# Support to projects with CO<sub>2</sub> transport and storage

- Design and selection of efficient materials for CO<sub>2</sub> pipes
- Safety and risk assessment (PHA/ST...)
- CO<sub>2</sub> flow metering (including multiphase flow)
- Soil monitoring (detect any CO<sub>2</sub> leakage at surface)
- CO<sub>2</sub> storage site identification.



## Project example :

### SarCO<sub>2</sub> project (Requirements for SAfe and Reliable CO<sub>2</sub> transportation pipeline)

**Project partners:** CSM (Italy), SZMF (Germany), Europipe (Germany), SMLP (Germany), V&M (Germany), Corinth Pipeworks (Greece), Eni S.p.A (Italy), ENGIE(France), National Grid (UK), DNV (Norway).

**Project aim:** To develop know-how to enable the determination of steel pipe requirements for CO<sub>2</sub> pipelines.

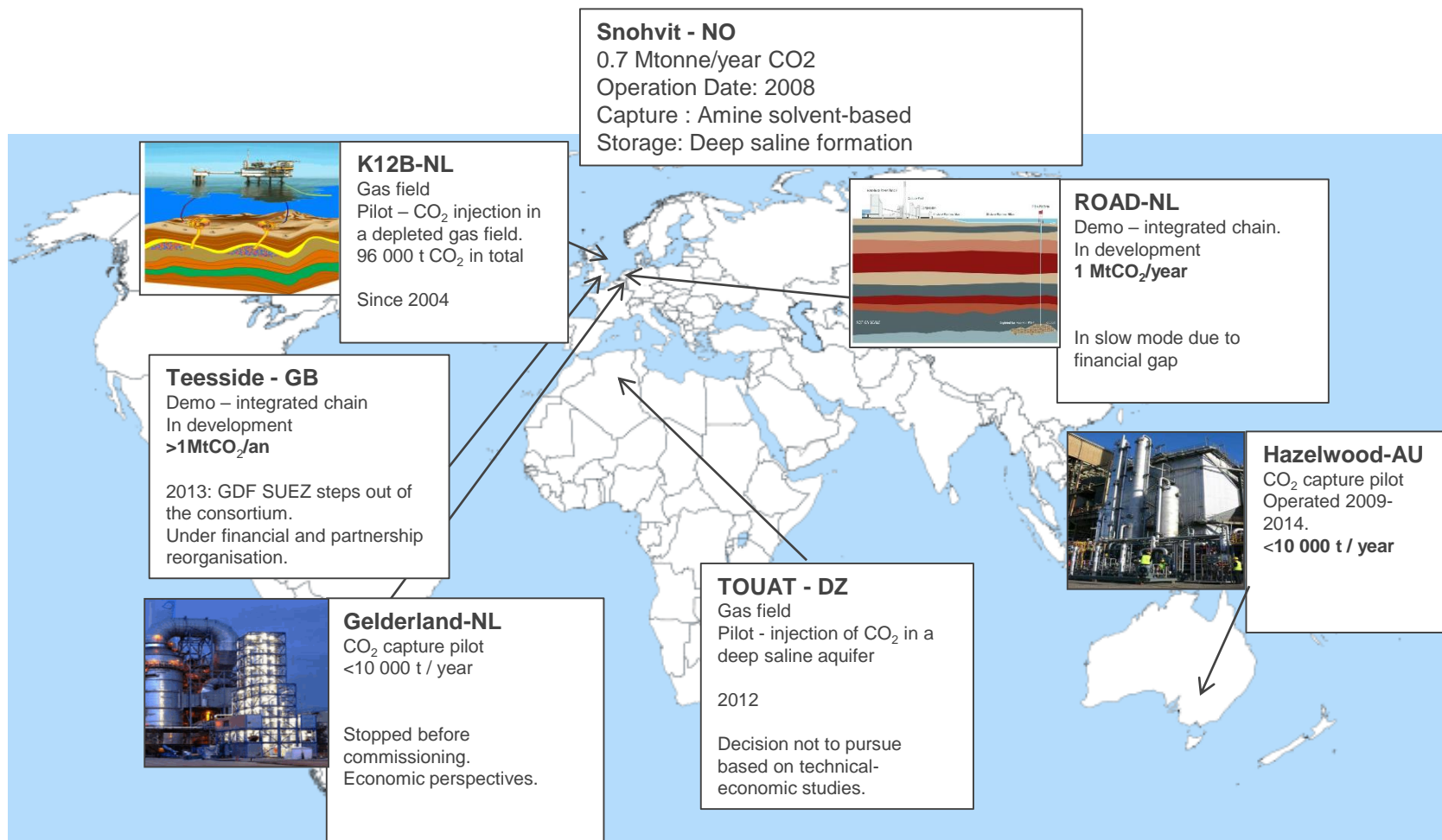
**Research areas:** Full-scale testing on real sections of pipeline is part of this project in order to address the following specific research goals:

definition of toughness requirements of base material to control running ductile fracture propagation

definition of requirements to control crack initiation event such as corrosion and stress corrosion cracking phenomena, and

collecting experimental data related to the release of CO<sub>2</sub> during a pipeline failure.

# ENGIE is/was involved in 3 industrial CCS projects, with a position on the whole value chain



Projects are developed, operated, some are on hold due to the financial context

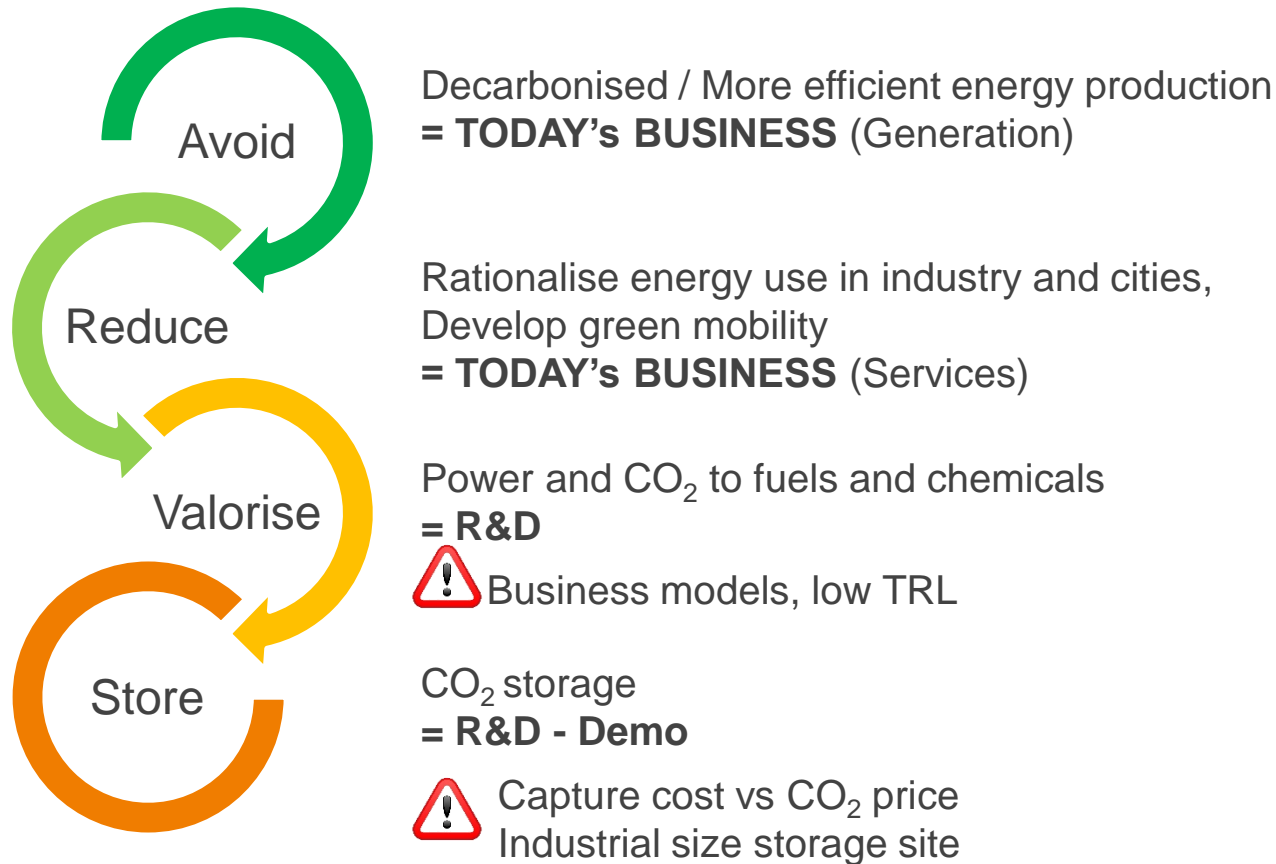




# CO<sub>2</sub> valorisation Opportunities and Issues



# ENGIE's approach to CO<sub>2</sub> mitigation options



## CO<sub>2</sub> reduction potential

LARGE ~ 40 % (\*)  
CO<sub>2</sub> NOT emitted (direct)

LARGE ~ 35% (\*)  
CO<sub>2</sub> NOT emitted (direct)

? Low volumes CO<sub>2</sub>  
(direct)  
Potential high  
displacement (indirect)

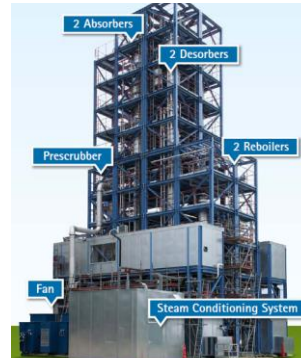
Long term CO<sub>2</sub> removal  
Will be necessary to  
achieve target < 2°C

(\*) Source : ETP 2014 – IEA  
Reduction potential by sector from 6°C to 2°C

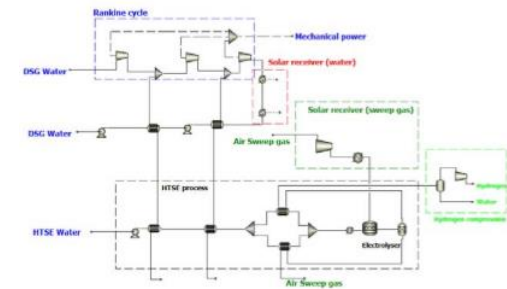
# ENGIE labs and the key bricks in CO<sub>2</sub> reduction and valorisation (CRV) chain



Energy production & storage



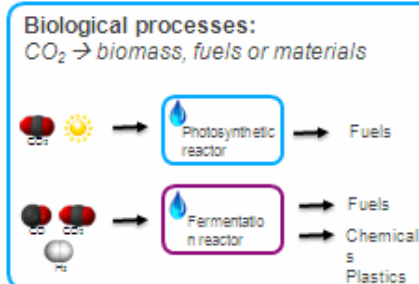
Capture



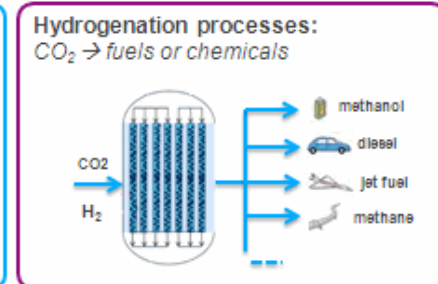
Modeling & LCA



Energy systems



Biological valorisation



Hydrogenation

# Skills in Power System Economics (CEEME)

## Market Analysis & Outlook



*Analysis of the current state of the market, generation capacity, interconnection, RES penetration, energy policy.*

## Scenario Design



*Designing scenarios, accounting for policy targets (RES, nuclear) view on future developments based on expected capex and opex costs of technologies*

## Power system Simulation



*Simulation of the power sector with the necessary level of detailed on plant characteristics, required by the business question.*

## Power system Calibration



*Fine tune the simulation settings and the inputs to reproduce historically observed dispatch and the economics of various generation technologies.*

## Interpretation



*Provide a sound economic interpretation of the simulation results, highlight drivers of the results, provide relevant sensitivities on input assumptions, ...*

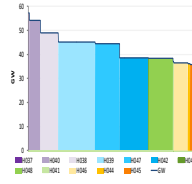
## Tools

### Database



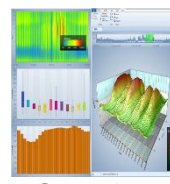
European database of electrical system details

### Phoenix



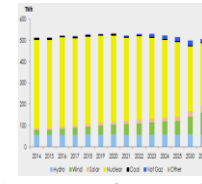
Long term capacity expansion model

### Plexos®



Unit Commitment & dispatch model

### SDDP



Hydropower focused simulation model

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# 03

Collaboration is key

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## Collaborative projects : opportunities for a broader network and development of new competences

- The last 2 years ENGIE Labs are participating or submitting proposals to EU projects on CRV. Usually valorising existing measurements or modeling capacities, REX of CCS projects and Life Cycle Analysis.
- Reference projects :
  - KIC Climate EnCO2re (ongoing)
  - E-Co : Efficient Co-Electrolyser for Efficient Renewable Energy Storage H2020-JTI-FCH-2015-1 (ongoing)
  - SMARTCats (ongoing)
  - ANR CHOCHCO
  - ADEME GRHYD
  - KIC MINERVE
  - FCH-JU SOPHIA
- Several other projects still awaiting validation.
- Seeking new opportunities.

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**Thank you for your attention**

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