CCUS technologies activities in France

Focu the industries

Aïcha EL KHAMLICHI- Industry Department
ADEME

Chatou, CSLF meeting- 4-5 november 2019

French Agency of Environment and Energy Management

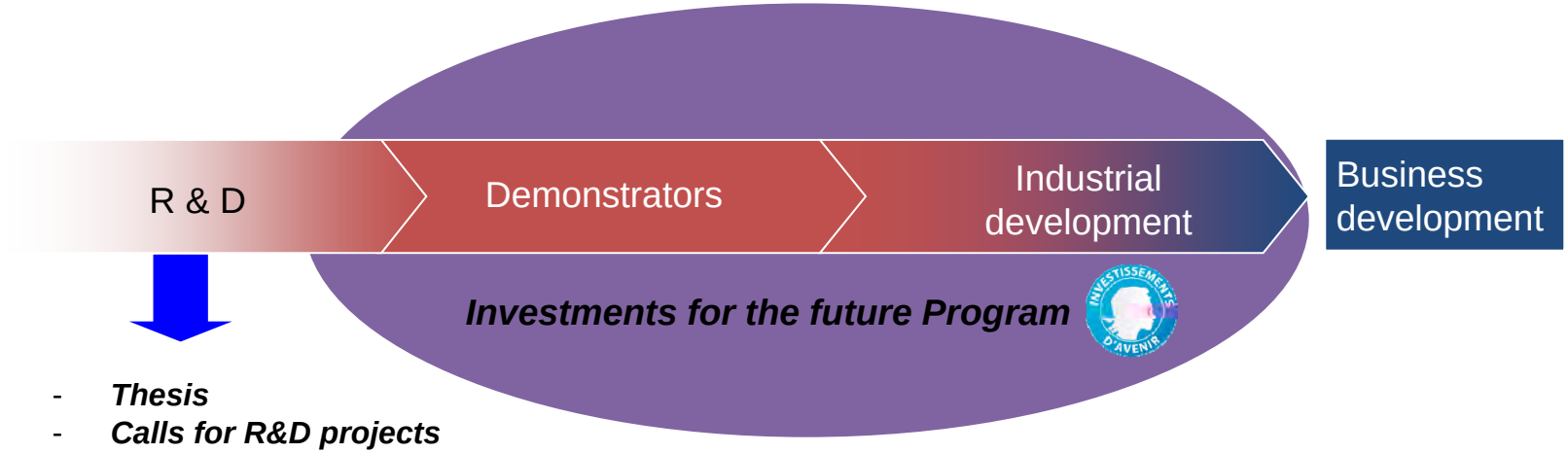
- Created in 1992, **ADEME is under the joint authority of the Ministry in charge of Sustainable Energy & Ecological Transition and the Ministry in charge of Research**
- **ADEME's objectives**
  - Program, finance and develop research and technological innovation
  - Give advice and expertise to companies, public authorities and individuals
  - Develop practical tools and disseminate best practices
  - Finance decision-making assistance, exemplary operations and dissemination projects
  - Share information, provide training and conduct communication campaigns
- **Organization**
  - ~ 900 employees in 3 central services (Angers, Paris, Valbonne), 13 regional offices + 3 TOM and 1 office in Brussels
- **Budget:**
  - Incentives (2019): 647 M€
  - Investments for the future (2010-2020): 4 bn€ -> on behalf of the government

~9 000 contracts / year

ADEME: tools for financing innovation at different stages

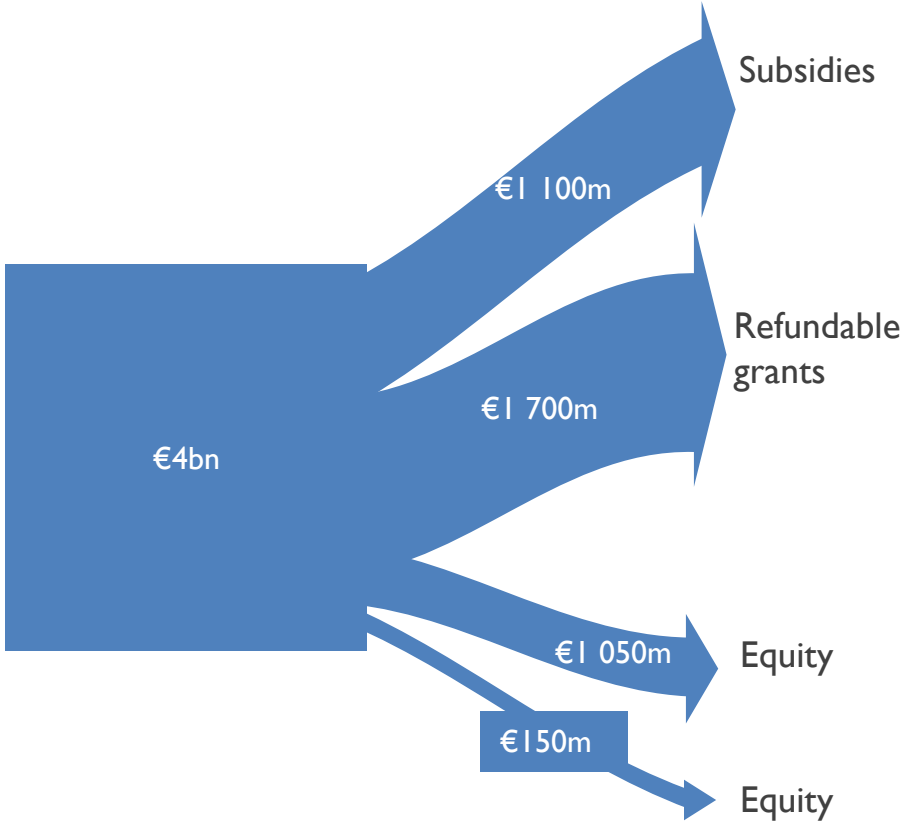
- **R&D phase:** ADEME thesis, calls for R&D projects, contribution to European calls

- **"Investments for the future" program**
  - Demonstrators and industrial development
  - A ten-years program
  - Budget of € 4 bn operated by ADEME
  - Two ways of funding: State aid according to the European framework (subsidies and refundable grants) and capital investment



- ***Thesis***
- ***Calls for R&D projects***
- ***European calls for projects***

ADEME is managing a €4bn program dedicated to environment and renewable energies sectors

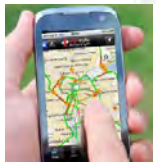
"Investment for the future program" amounts split by financial tool	Financial tool	Comments
	Subsidies	State-aid combining grants and refundable loan attributed mainly to companies (SME, medium size companies, large corporates) for their R&D projects ➔ *Limited to €15m by project (EU regulation about state-aid)*
	Refundable grants	
	Equity	Co-investments with corporates or financial partners in project companies ("SPVs") ➔ *ADEME invests as "market investor" without ticket size for "First of a kind"*
	Equity	Co-investments with venture funds in SME's companies ➔ *Through The Ecotechnologies Fund, co-managed with BPI France*

Environment and renewable energies sectors covered





Demonstrators for energy and ecological transition	Transport for the future
▪ Geothermal energy ▪ Marine energy ▪ Solar energy ▪ Wind energy ▪ Bioresources ▪ Buildings ▪ **Carbon capture, utilisation and storage** ▪ Green chemistry ▪ Industries and agriculture ▪ Energy storage ▪ Hydrogen vector ▪ Smart grid ▪ Waste and industrial ecology ▪ Polluted sites remediation ▪ Water and biodiversity	▪ Electric vehicle and reloading infrastructure ▪ Hybrid and thermal power train ▪ Vehicle lightening ▪ Heavy trucks and buses ▪ Mobility and logistic ▪ Boats of the future ▪ Rail transportation


CCUS in France: national background

- **European Climat- Energy Policy:**
  Target 4 for France: 75% of GHG emissions reduction by 2050

- **National policy:**
  - 2012: France transposed the European geological storage directive
  - 2015:Energy Transition Law for Green Growth, Circular Economy Roadmap

- **After Paris agreement: Revision of National Low Carbon Strategy to reach « carbon neutrality »**

  - Include CCUS for Industry and CCU for Transport
  - CCS for residual emissions in industries: 5 $MtCO_2$ by 2050
  - BECCS: could help to reach the target of neutrality: potential of 10 $MtCO_2$ by 2050

Total : CO_2 emissions reduction with BECCS/CCS: 15 $MtCO_2$ by 2050

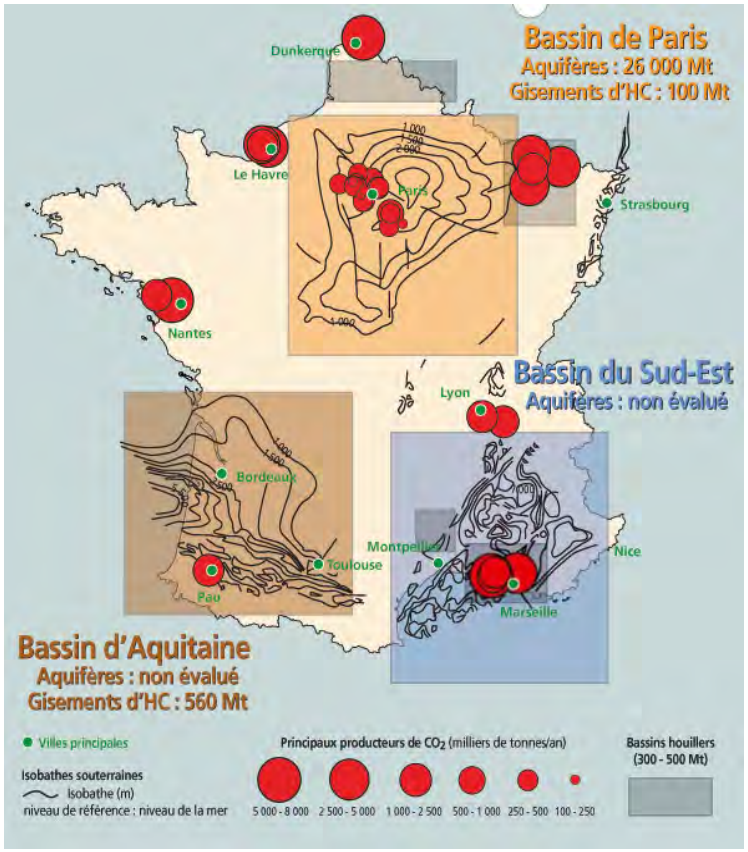
CCUS in France: storage capacity

Storage site : capacity estimated around 1200 Gt by IPCC over the world

- Saline aquifer -> the higher capacity and the most distributed around the world
- Depleted gas/oil field
- Depleted coal bed

In France: capacity estimated around 27 Gt

- Saline aquifer : Paris bassin (Trias and Dogger) and Aquitain Bassin and South-East
- Depleted gas/oil field: Paris Bassin (Trias and Dogger)
- Depleted coal bed



CCUS in France: storage projects

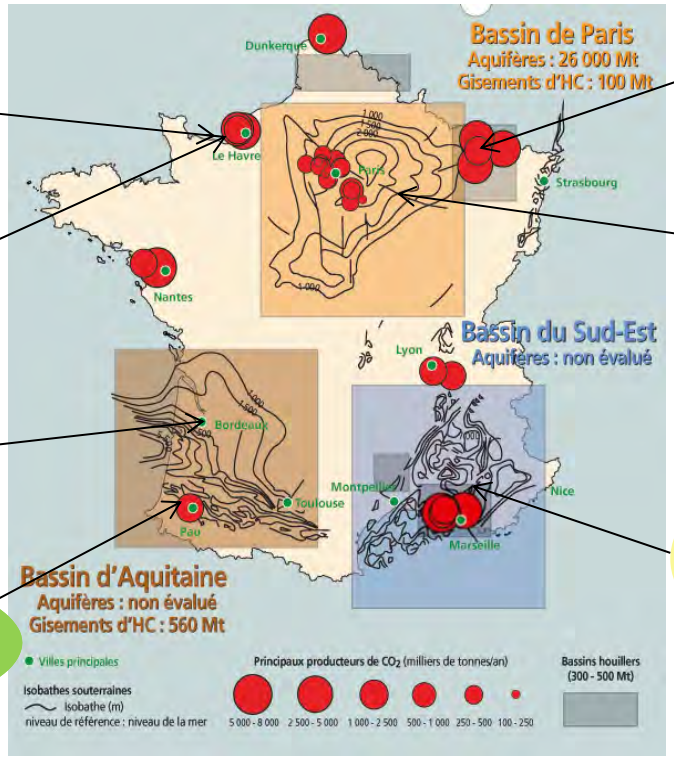
ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

CTSC

Study on prefaisability of CCUS integrated chain in Le Havre

DEMOCO2
Development of monitoring tools for geological storage
Univ of Bordeaux

Lacq-Rousse
Integrated CCTS pilot-
60 000 tCO_2 stored
Total



TGR – BF
Feasibility of Capture, transport and storage of CO_2 from Steel industry
ArcelorMittal

France Nord
Storage in saline aquifer
Total

VASCO
Study on prefaisability of CCUS integrated chain in Marseille area

Source BRGM
(projet européen GESTCO)

R&D

Demonstrator fund

Investment for future

Focus: France Nord Project

- Joint Industry Project
  - Funded by ADEME
  - 4 public research institutes
  - 7 industrial partners

- Main goal:
  - Feasibility of CCS in the Northern part of Paris Basin (France)

Qualify, on the basis of available data a site to store at least 200Mt of CO_2 in the deep saline aquifers of the Paris Basin

All the result were largely under the objectives of the France Nord project

Comparison with previous estimations

	JOULE II (1996)	Projets GESTCO (2003) et EU GEOCAPACITY (2009)			France Nord (2009-2011)
	Traps	Traps	Total	Conservative	Flow models
Dogger	189 Mt (E=0.18%)	9 Mt (E=0.01%)	4320 Mt (E=6%)	1440 Mt (E=2%)	Potential Conflict with geothermal resources
Keuper	529 Mt (E=0.18%)	130 Mt (E=0.18%)	4331 Mt (E=6%)	72 Mt (E=0.1%)	90-180 Mt
Buntsandstein	Conflict with fresh water	529 Mt (E=0.18%)	17640 Mt (E=6%)	5880 Mt (E=2%)	~ 90 Mt
Other fm.	91 Mt	-	845 Mt	530 Mt	-
TOTAL	809 Mt	668 Mt	27136 Mt	7922 Mt	180-270 Mt

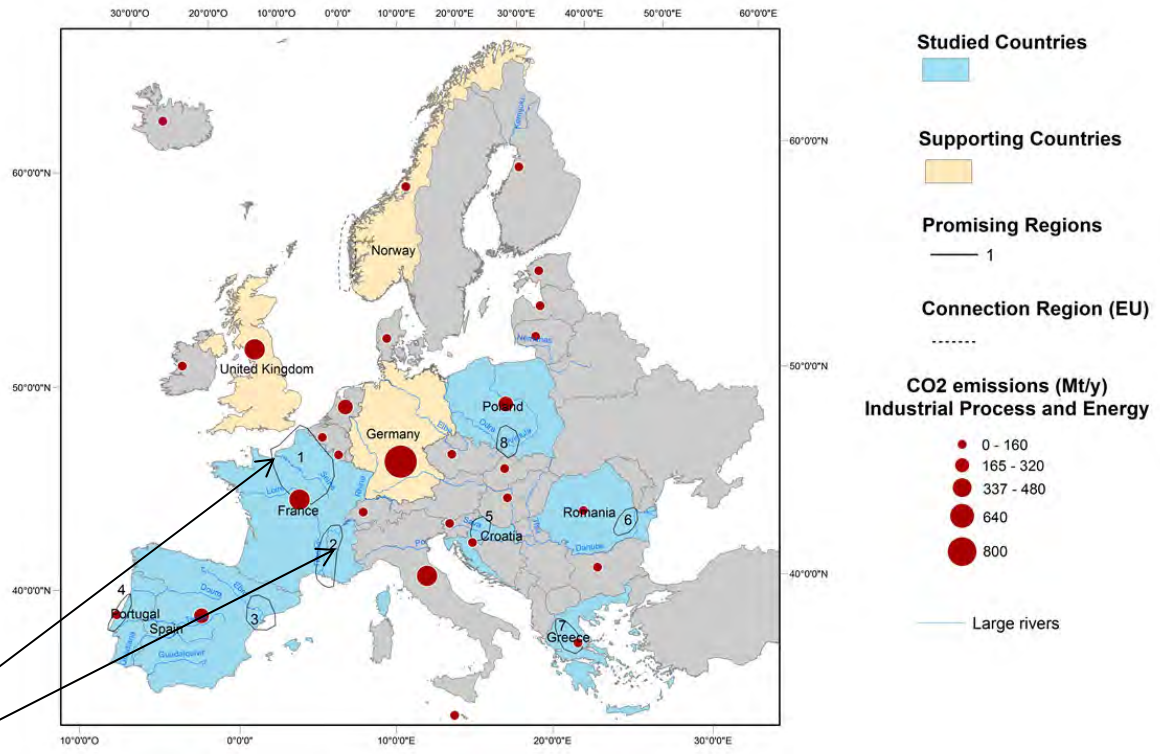
Update: H2020 project- Strategy CCUS project (2019-2022)

STRATEGY CCUS
A viable solution for a sustainable future

Objective:

The project focuses on eight regions identified as promising for CCUS development.
The aim is to encourage and support initiatives within each region by producing local development plans and business models tailored to industry's needs.

Assessement of storage capacity for 8 promising regions



CCUS in France: capture projects

CRYOCAPT™
CO_2 cold capture system on hydrogen production plant
100 000 tCO_2 /year
Air liquide

IGAR
Validation at demonstrator scale of reducing gas steel injection in blast furnace
ArcelorMittal

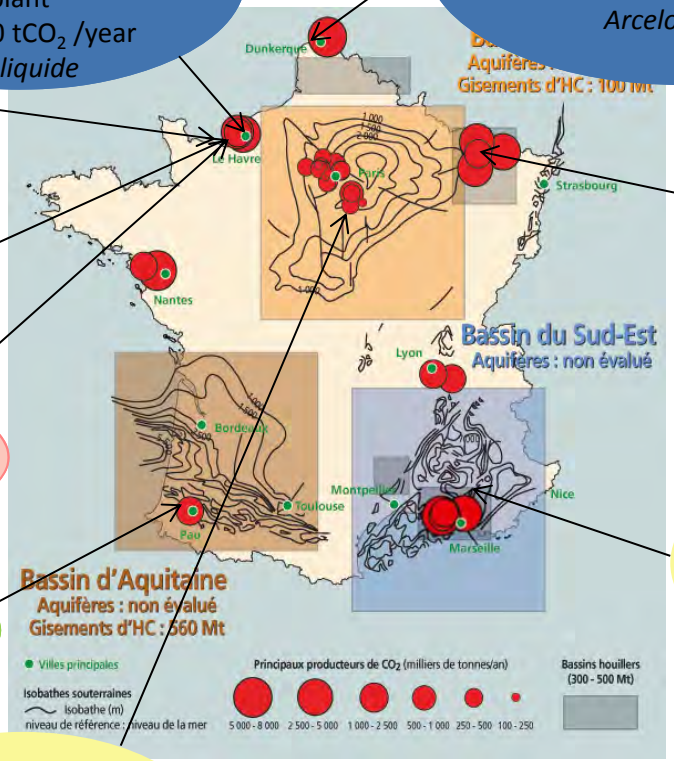
TGR – BF
Feasibility of Capture, transport and storage of CO_2 from Steel industry
ArcelorMittal

Study on prefaisability of CCUS integrated chain in Le Havre

C2A2
Coal - Advanced amine capture
1t CO_2/hour
EDF, ALSTOM

Lacq-Rousse
Integrated CCTS pilot-
60 000 tCO_2 stored
Total

VASCO
Study on prefaisability of CCUS integrated chain in Marseille area



Source BRGM
(projet européen GESTCO)

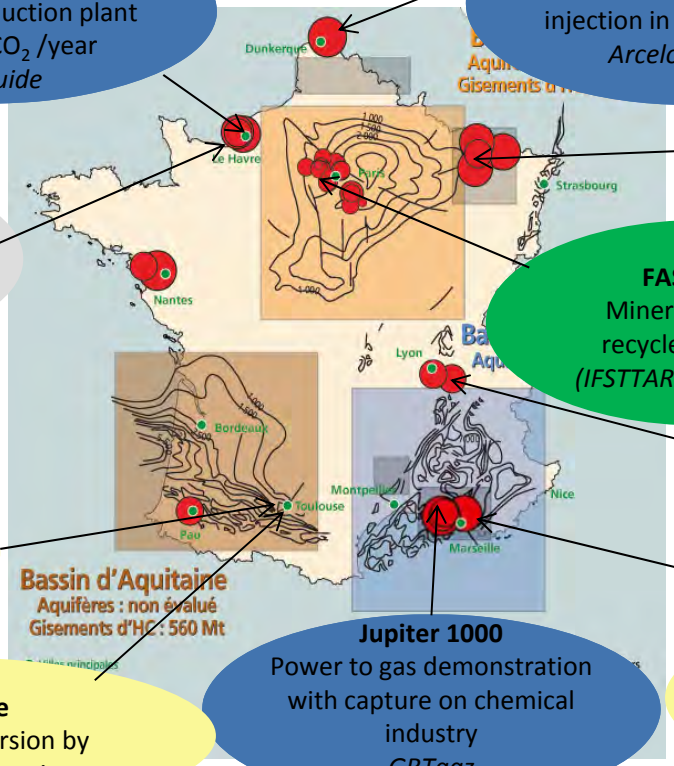
R&D

Demonstrator fund

Investment for future

CALICE
New capture technology using porous materials
BRGM

CCUS in France: CO_2 utilisation projects



CRYOCAPT™
CO_2 cold capture system on hydrogen production plant
100 000 tCO_2 /year
Air liquide

IGAR
Validation at demonstrator scale of reducing gas steel injection in blast furnace
ArcelorMittal

VALORCO
Reduction of emissions and utilisation of gas steel
ArcelorMittal

Study on prefaisability of CCUS integrated chain in Le Havre

FASTCARB
Mineralisation of recycled concrete
(IFSTTAR-22 partners)

CIMENTALGUE
Production of algae from CO_2 flue gas from cement plant
VICAT

CARBOVAL
Mineralisation of waste from minerals industry
Univ of Toulouse

Jupiter 1000
Power to gas demonstration with capture on chemical industry
GRTgaz

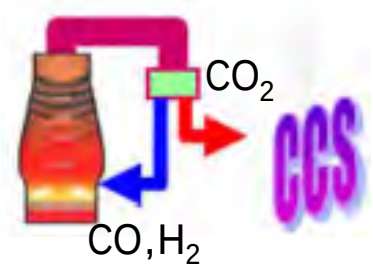
VASCO2
Production of algae from different CO_2 emitters
Port of Marseille

HyCaBioMe
H_2 and CO_2 conversion by BIOlogical Methanation

R&D

Investment for future

Focus: CCUS R&D projects for steel industry



VALORCO (17 M€)
Reduction of emissions and utilisation of gas steel
ArcelorMittal

next

3D Project
Demonstration of a capture technology at pilot scale (DMX)
ArcelorMittal+IFPEn

TGR-BF (16 M€)
Feasibility of Capture, transport and storage of CO_2 from Steel industry
ArcelorMittal

TGR-BF SOLRE (300 k€)
RD project on technical hurdles from TGR-BF project[1]
ArcelorMittal

IGAR (21 M€)
Validation at demonstrator scale of reducing gas steel injection in blast furnace
ArcelorMittal

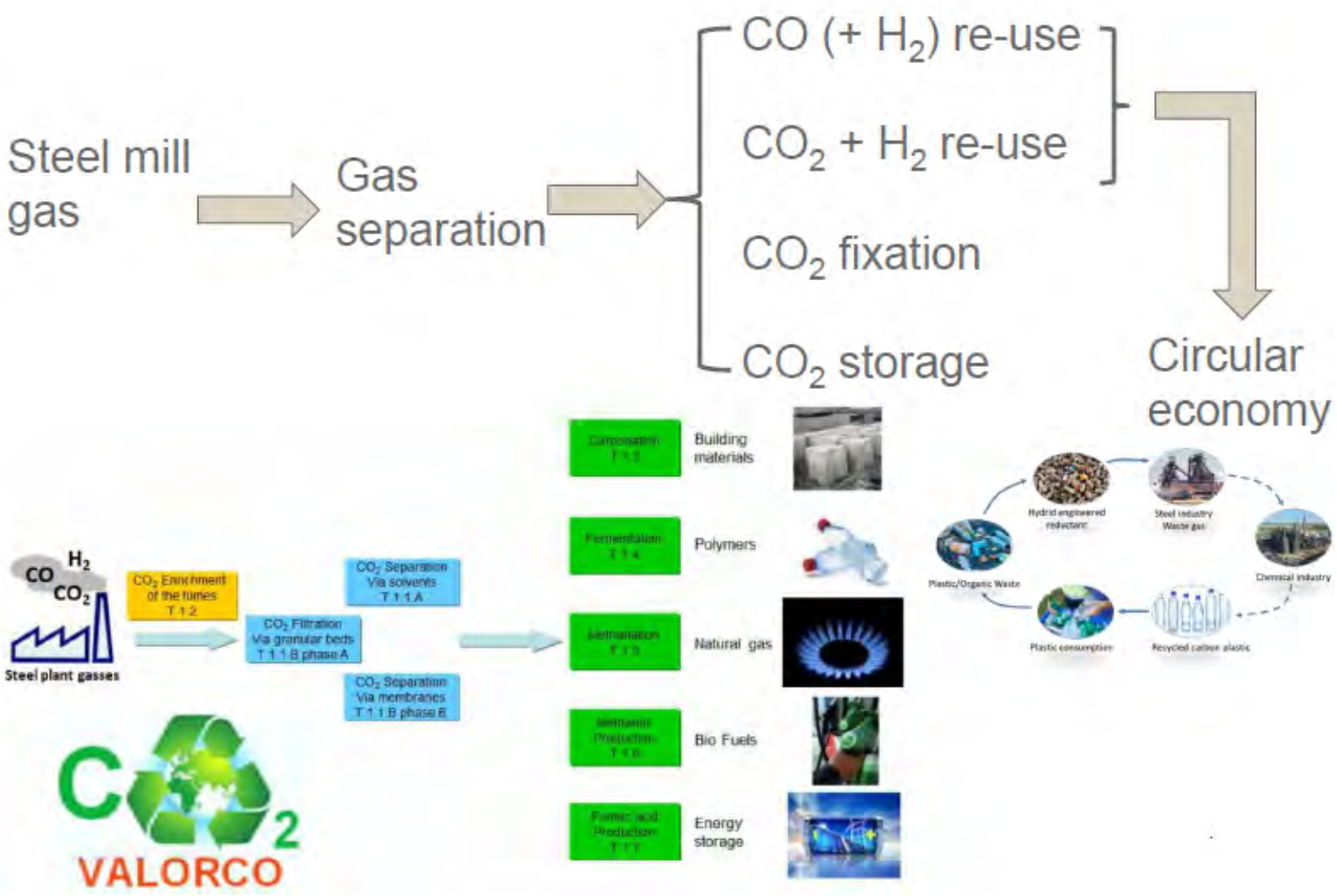
2009-2012	2013-2016	2018-2022	2019-2023
Florange	Centre RD Maizières	Dunkerque	Dunkerque

[1]: TGR-BF SOLRE-Two main hurdles:

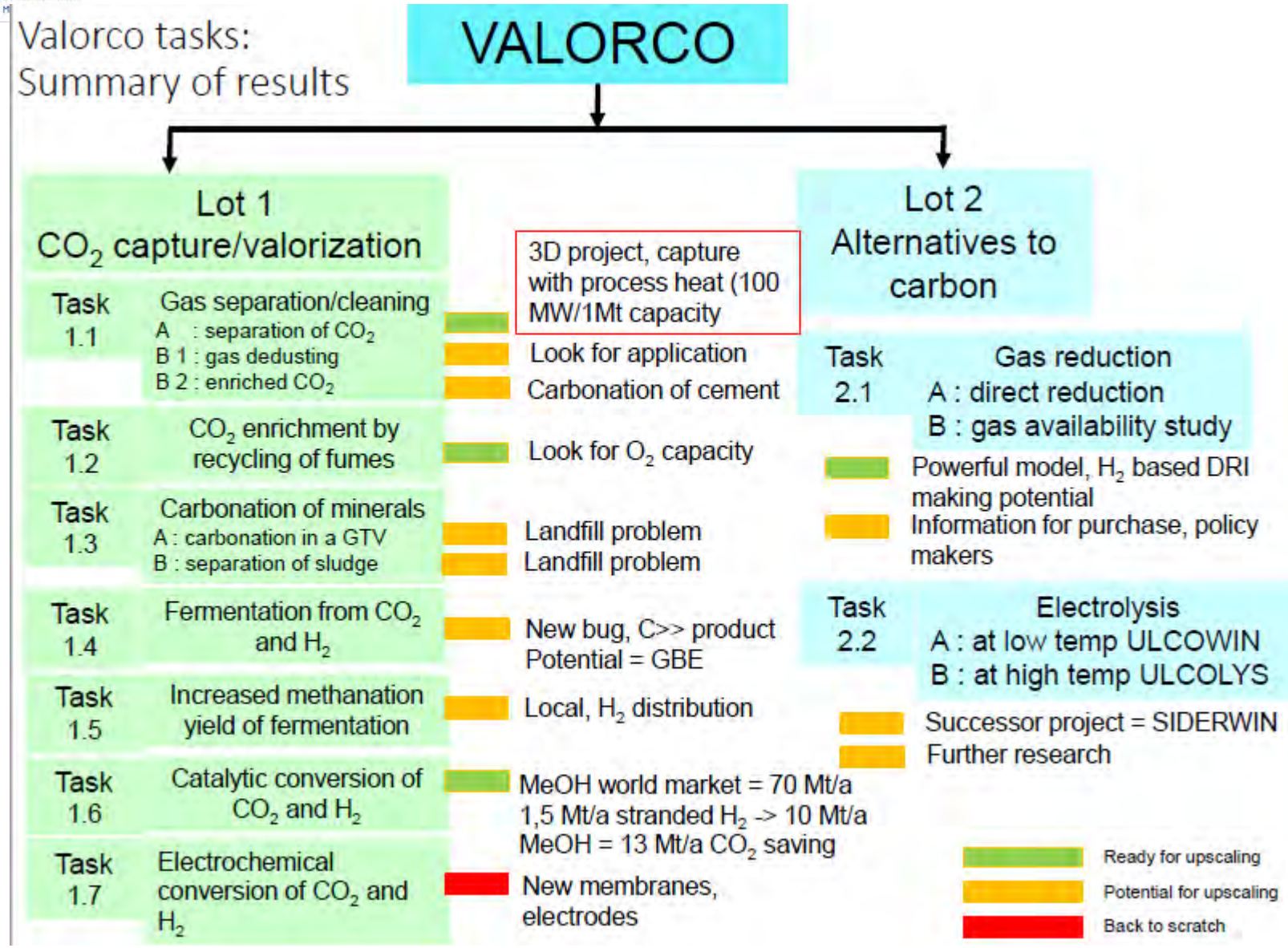
- Optimisation of the design for the injection tuyere/nozzle
- New refractories materials able to resist to the TGR conditions

R&D | Demonstrators fund | *Investment for future*

Focus: VALORCO project



Focus: VALORCO project



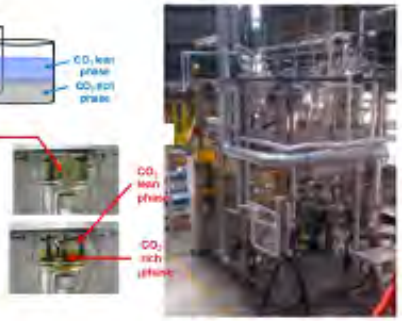
Focus: From VALORCO to 3D project

Carbon capture : from the lab (VALORCO) to the AMAL plant (3D): overview

DMX™ process

Use of solvents capable of demixing under specific conditions

Stage 0 : lab
Parameter
check of DMX



IFPEN mini-pilot in Solaize

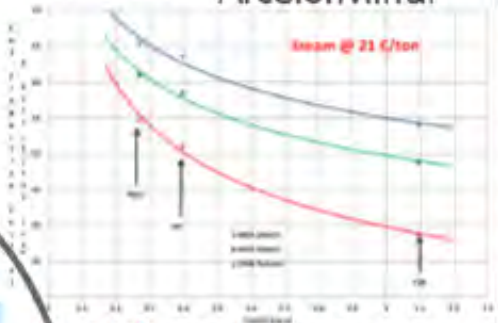
Stage 1 : lab pilot
Check of DMX on
syn BF Gas

ifp Energies nouvelles

ArcelorMittal

Stage 2 : 3D
Industrial pilot
0,5 t/h CO_2

Conclusion : ArcelorMittal



DMX requires less energy (2,4 GJ/t) than MEA (3 GJ/t) to capture CO_2 from BF Gas. Hence cost decrease of 10 – 15 €/t CO_2

Stage 3 : 3D
Industrial demonstrator
100 – 120 t/h CO_2

INNOVATION FUND

C_2 VALORCO

HORIZON 2020

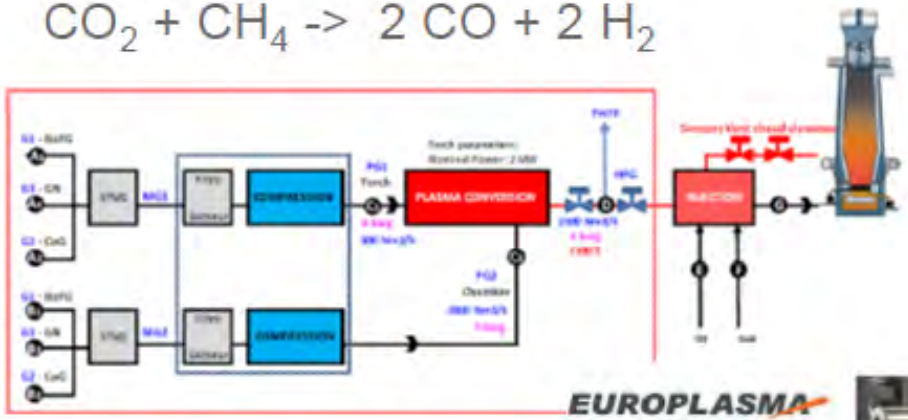
20/03/2019

Different stages :

Focus: From TGR-BF to IGAR project

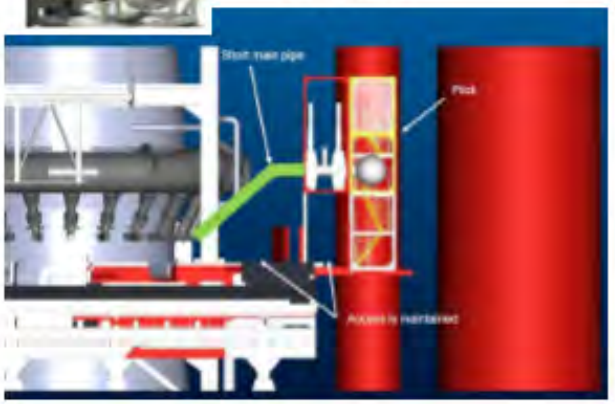
IGAR project at AMAL Dunkirk

$$CO_2 + CH_4 \rightarrow 2\,CO + 2\,H_2$$



DK HF2 Situation – Outside view

View of BoFG, CoG, O2 connections (pipes to be installed)



CCUS in France: international collaboration

Key actors at policy level

- **DGEC: French Energy ministry : member of Mission Innovation – funding projects**
- **MESR: French Research ministry via participation to:**
  - ERANET ACT (CCS and CCU)
  - Initiative Phoenix on CCU (Germany, Netherlands, France and Spain):

  Main goal of PHOENIX is to build a business case with respect to CO_2 utilisation to ensure an optimal use of public funding and private investment

  - ANR (French Research Agency)-> funding CCUS projects via specific R&D program or generic program (energy or circular economy)
- Involvement in the ISO/TC265 from French partners (Club CO2 and academics)

CCUS in France: international collaboration

- ADEME : member of **ERANET ACT** on behalf of MESR
- 12 **projects (4 with French partners) submitted for the Second ACT call were selected covering a wide range of the CCUS area:**
  - 6 CO_2 capture
  - 3 storage and monitoring
  - 1 storage and wells
  - 1 storage combined with CO_2 use
  - 1 mineralisation

Projects	Activities	ACT, M€	France (ADEME)	Germany (PtJ)	Greece (GSRT)	Netherlands (RVO)	Norway (RCN and Gassnova)	Romania (UEFISCDI)	Spain (AEI)	Switzerland (DETEC)	Turkey (TUBITAK)	UK (BEIS)	USA (DoE)
AC2COM	Oxyfuel technology in cement production	3,0	x	x	x		x			x			
ACTOM	Offshore monitoring	1,5				x	x					x	x
ANICA	Carbonate looping process in cement industry	2,4		x	x							x	
DIGIMON	Digital monitoring of CO2 storage projects	5,0		x	x	x	x	x				x	x
FUNMIN	CO2 mineralisation into anhydrous MgCO3	0,7	x						x			x	
LAUNCH	CO2 capture in various industries	5,1		x		x	x					x	x
MemCCSea	Membrane systems for CO2 capture and storage at sea	1,7		x	x		x						x
NEWEST-CCS	Negative emissions in the waste to energy sector	2,2		x		x	x					x	
PRISMA	Sorbent materials for energy efficient carbon capture	2,1					x			x		x	x
REX-CO2	Reusing existing wells for CO2 storage	2,5	x			x	x	x				x	x
SENSE	CO2 storage sites - ground surface monitoring	2,7	x	x			x		x			x	x
SUCCEED	CO2 storage coupled with geothermal energy deployment	2,5				x					x	x	
		31,5											

Club CO_2: the French team of CCUS

- **Club CO_2** is a forum for exchanges of information and initiatives concerning CO_2 capture, transport, underground storage and re-use (CCUS) between industrial, research and local government players in France

Website: http://www.captage-stockage-valorisation-co2.fr/

Thank you for your attention

Questions?

Projects ‘ descritpion are available on the website of ADEME:

www.ademe.fr

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