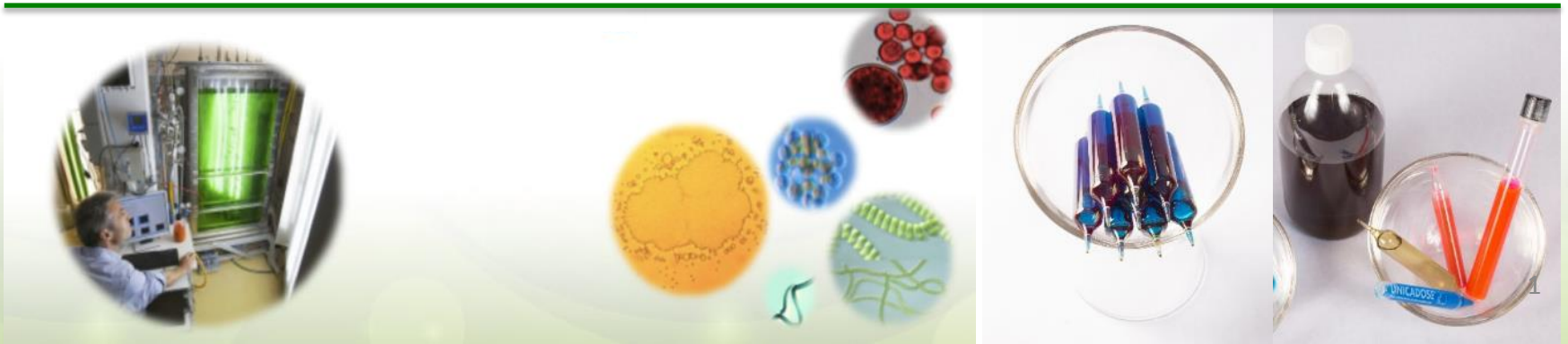
Christophe Lombard
Industrial integration manager

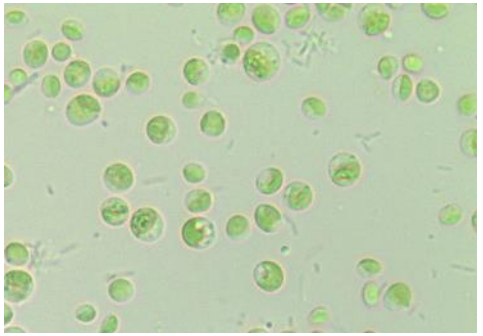
« CIMENTALGUE » PROJECT
Pilot & stage 1

Carbon4PUR

Carbon4Pur meeting – GPMM Fos – 20 mars 2019



AlgoSource
WWW.ALGOSOURCE.COM

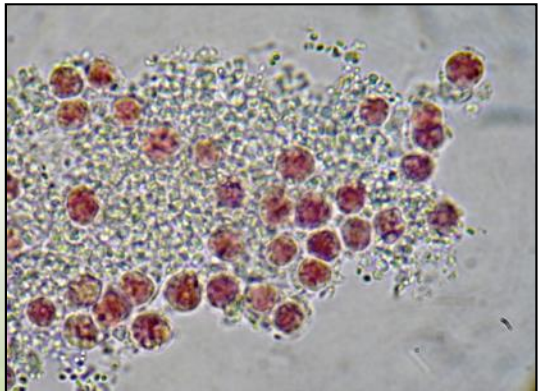


Chlorella vulgaris

Our field :

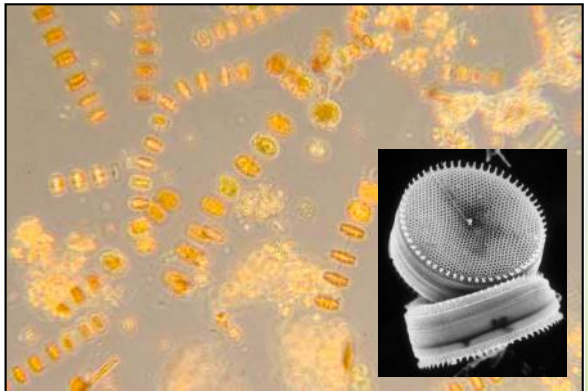
Microalgae

Porphyridium cruentum



Spiruline

Thalassiosira sp.



AlgoSource
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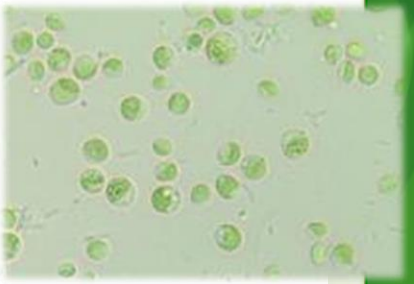
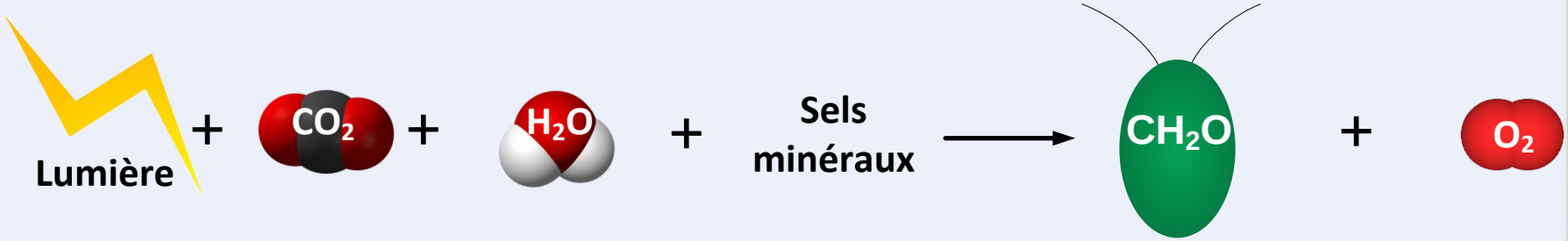
Global expert in the controlled production and biorefining of microalgae

- ❑ **Production of any kind of microalgae strains**
- ❑ **Scale-up** (from 1 liter to several m^3) / Production including biofixation of CO_2 / heat / water …
- ❑ **Refining** to extract value (polysaccharides, pigments, proteins, vitamins, lipids, original molecules)
- ❑ **R&D**
- ❑ **Management** of industrial projects



Context of projects

- Industrial ecology & Circular economy
- **Waste** of first industry ⇨ **Inputs** of the second industry
- Microalgae/cyanobacteria require **CO_2**, **heat**, water, N&P, surface, etc…



- **Advantage for industrial emitter** :
  - valorisation of waste (expensive waste in future) & creation of new value
  - additional valorisation of fatal heat (or other)
- **Advantage for microalgae producer** :
  - decrease of production costs
  - decrease of environmental impact of microalgae production
  - development of microalgae sector

Context of projects

- Numerous R&D programs about such CO_2 biofixation

Project/Company	Location	Flue gas	Photobioreactor	Size	Strain	Results	Status
Pond Biofuels/St Mary	Ontario, Canada	cement plant	?	pilot scale 25 m^3	*local strain*		on going since 2009
A4f/Galp/Secil	Portugal	cement plant	tubular horizontal	10000 m^2	*local strain Chlorella*		on going since 2009
BioFuelSystems/Cemex	Spain	cement plant	tubular vertical	100 m^2	*marine*	impossible	on going since 2010
Lafarge	Austria	cement plant	tubular vertical	lab scale	*Chlorella from Portugal*	no difference between CO_2 / fg	stopped
Lafarge	France	cement plant	closed	pilot scale			2010
AST/Italcementi	France	cement plant	tubular vertical / inclined flat	lab scale	*Chlorella & Spirulina*	10 g/m^2/d	2011 - 2015
Seambiotic	Askhelon, Israël	coal power plant	raceway	3000 m^2	*Nannochloropsis*	20 g/m^2/d	2004 / 2013
ENI	Gela, Italy	refinery	raceway	10000 m^2	*Tetraselmis*	20 g/m^2/d	2008 / 2011
Subitec/Eon	Bremen/Hamburg Germany	natural gaz	flat panel	1,44 m^3	*marine*	15 g/m^2/d	on going since 2008
Subitec/Vattenfall	Senftenberg, Germany	coal power plant	flat panel	2,16 m^3			2010 / 2015
Novagreen/RWE	Bergheim, Germany	coal power plant	plastic bags under GH	600 m^2	*Nannochloropsis*	1,6 g/m^2/d	2010 / 2012
Ingrepro/Akzo Nobel	Delfzijl, Netherlands	power plant	2 open raceway	200 m^2	*Chlorella vulgaris*		2008 / 2012
Cyanotech	Hawaï, USA	Diesel generator	raceway	12000 m^2	*Spirulina*	10 g/m^2/d	1997 / 2010
Salinalgue/Compagnie du v	Gruissan , France	Air Liquide	raceway	10000 m^2	*Dunaliella salina*		2010 / 2014
Linnaeus University/ HeidelbergCement	Degerhamm, Suède	cement plant	closed	pilot scale	*local strain*		on going since 2014
Setec Environnement/ Syctom	Saint Ouen, France	waste incinerator		pilot scale (bioplastics,			2016 - 2021

Story of our projects

PILOT tests

- **2011 – 2015**
- within cement plant near Paris
- test of 2 strains
- demonstration of biocompatibility between flue gas and microalgae

CIMENTALGUE project

Stage 1

- **2016 – 2018**
- laboratory step
- University of Nantes
- development of processes (protocols of culture, recycling of culture medium, precarbonation of culture medium with flue gas)
- LCA of culture systems, LCA assessment about industrial symbiosis

Stage 2

- **2019 – 2021**
- 800 m^2 demonstrator
- within Montalieu cement plant - VICAT
- recycling of CO_2 and fatal heat

ADEME

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

Pilot tests (2011 – 2015)

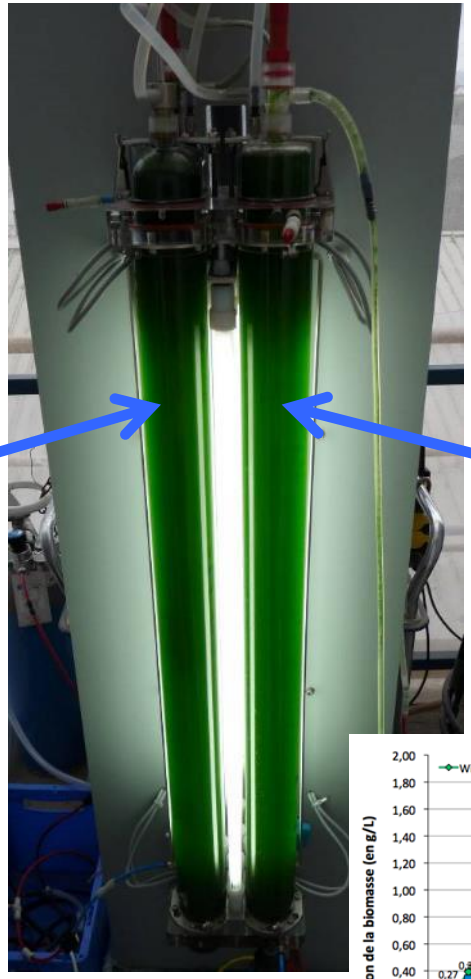
Tests plateform

Samples line

Tests plateform

Pilot tests (2011 – 2015)

- **Culture with tubular photobioreactors (PBR)**

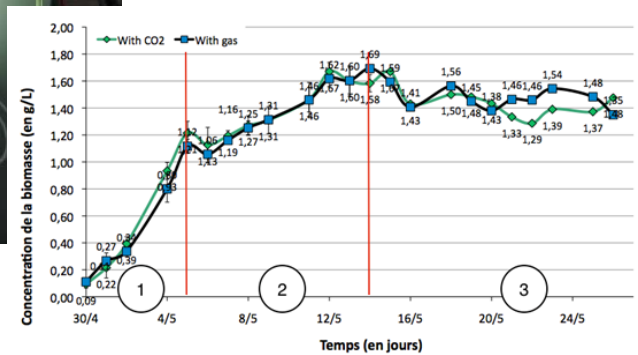


CO_2 pur

Reference

Flue gaz

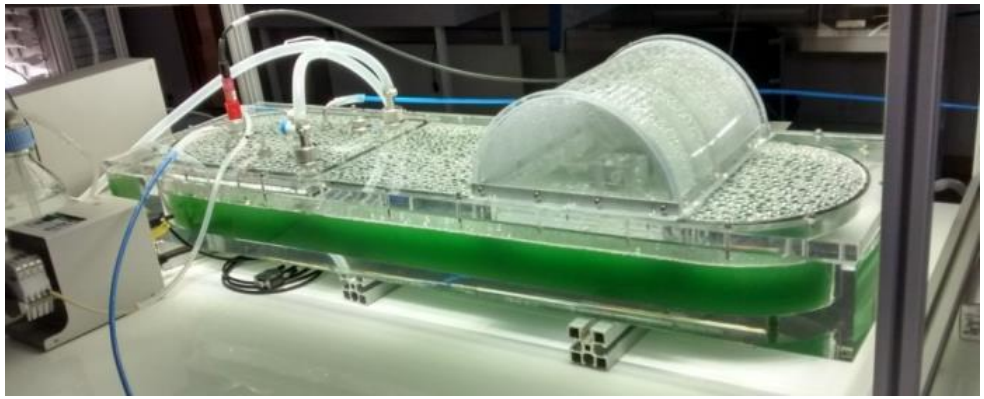
Test

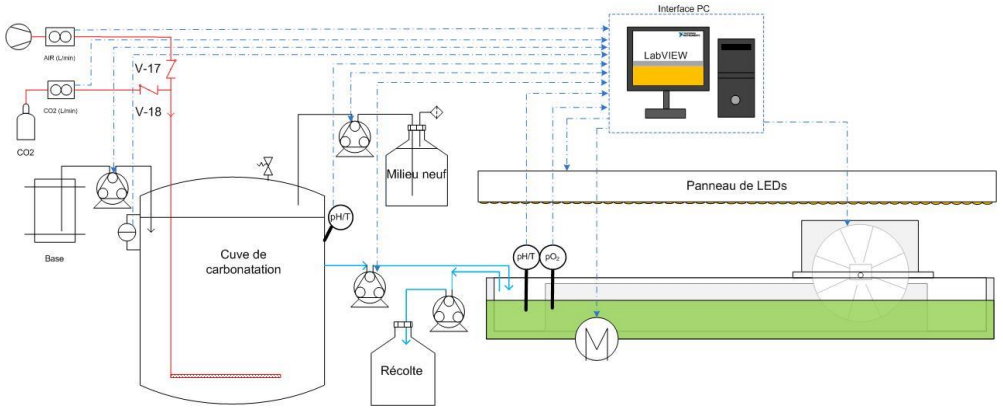


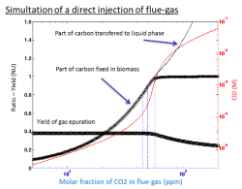
- **Culture with flat (PBR)**

CIMENTALGUE stage 1 (2016 – 2018)

- **Optimisation of design of chemical engineering steps** : carbonation of culture medium – recycling of culture medium – definition of robust protocols – intensified culture system "AlgoFilm"







CIMENTALGUE stage 1 (2016 – 2018)

- **Environmental impact analysis** : design and operation of metering devices and control of processes – assessment of culture technologies and integration of environmental aspects in processes design