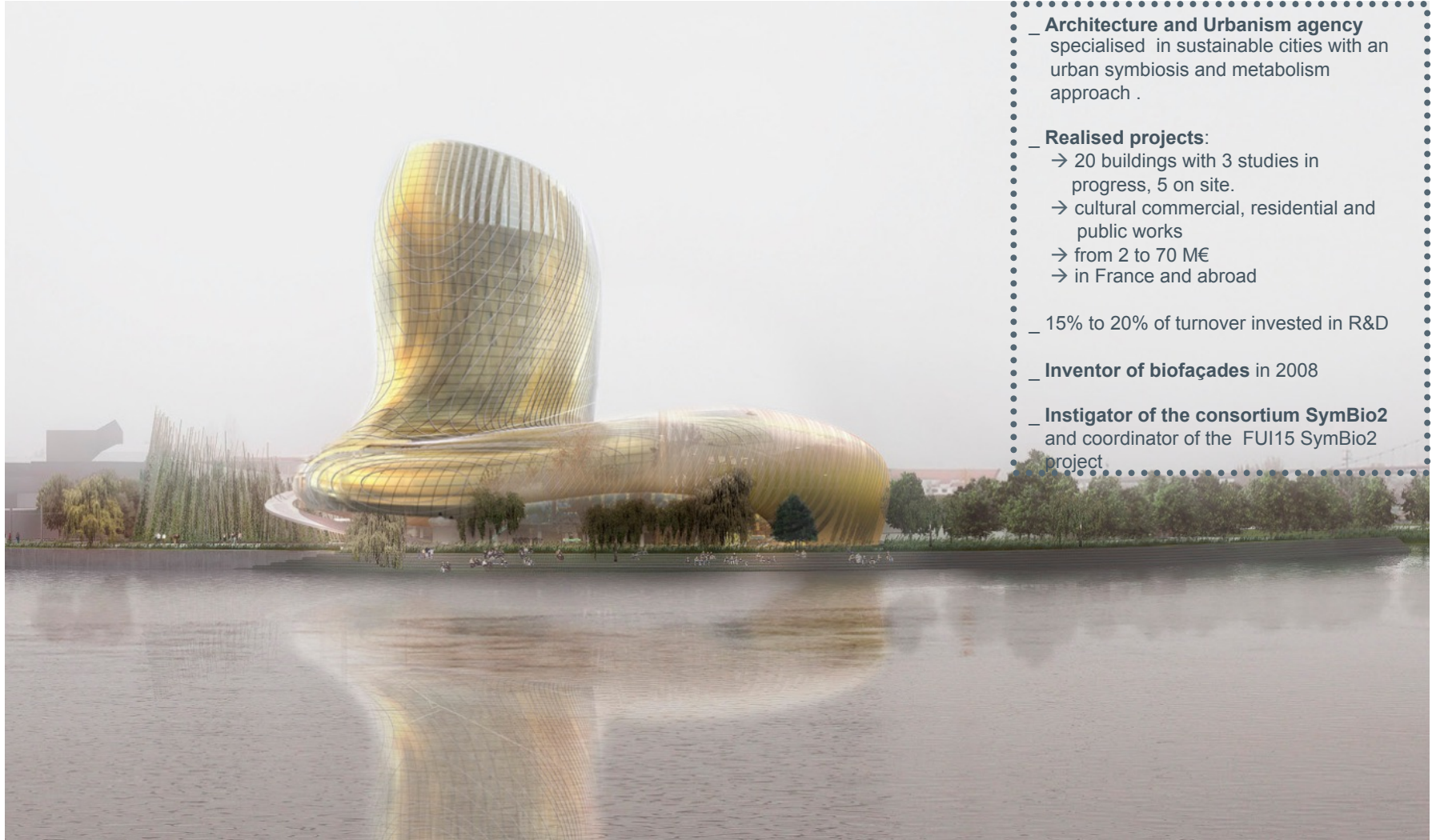


An Integrated system for the production of
microalgae in the urban environment in
symbiosis with building systems and their
envelope

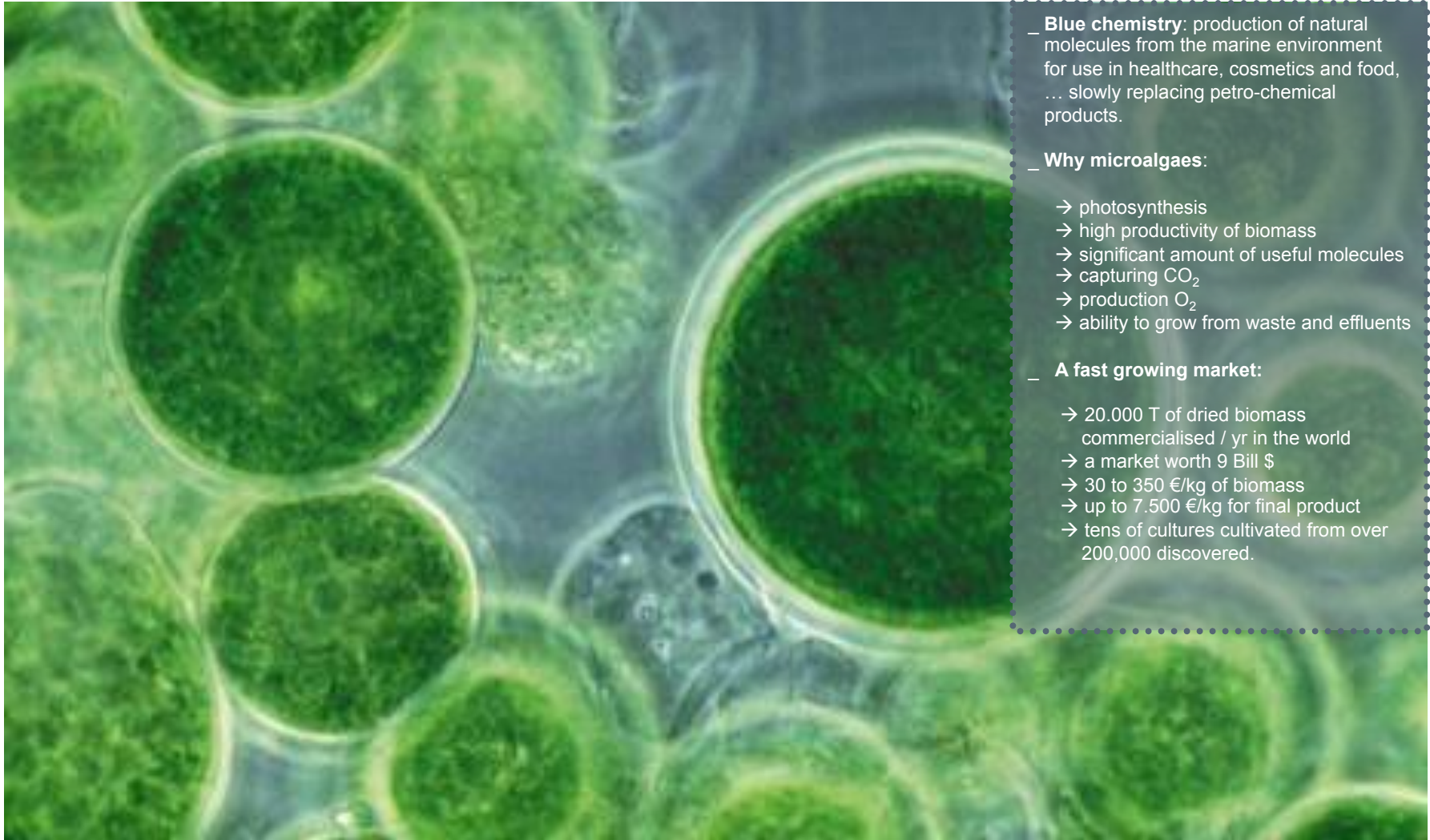




- **Architecture and Urbanism agency** specialised in sustainable cities with an urban symbiosis and metabolism approach .
- **Realised projects:**
 - 20 buildings with 3 studies in progress, 5 on site.
 - cultural commercial, residential and public works
 - from 2 to 70 M€
 - in France and abroad
- 15% to 20% of turnover invested in R&D
- **Inventor of biofaçades** in 2008
- **Instigator of the consortium SymBio2** and coordinator of the FUI15 SymBio2 project

A bio-resource of the future

μ-algales



– **Blue chemistry:** production of natural molecules from the marine environment for use in healthcare, cosmetics and food, ... slowly replacing petro-chemical products.

– **Why microalgae:**

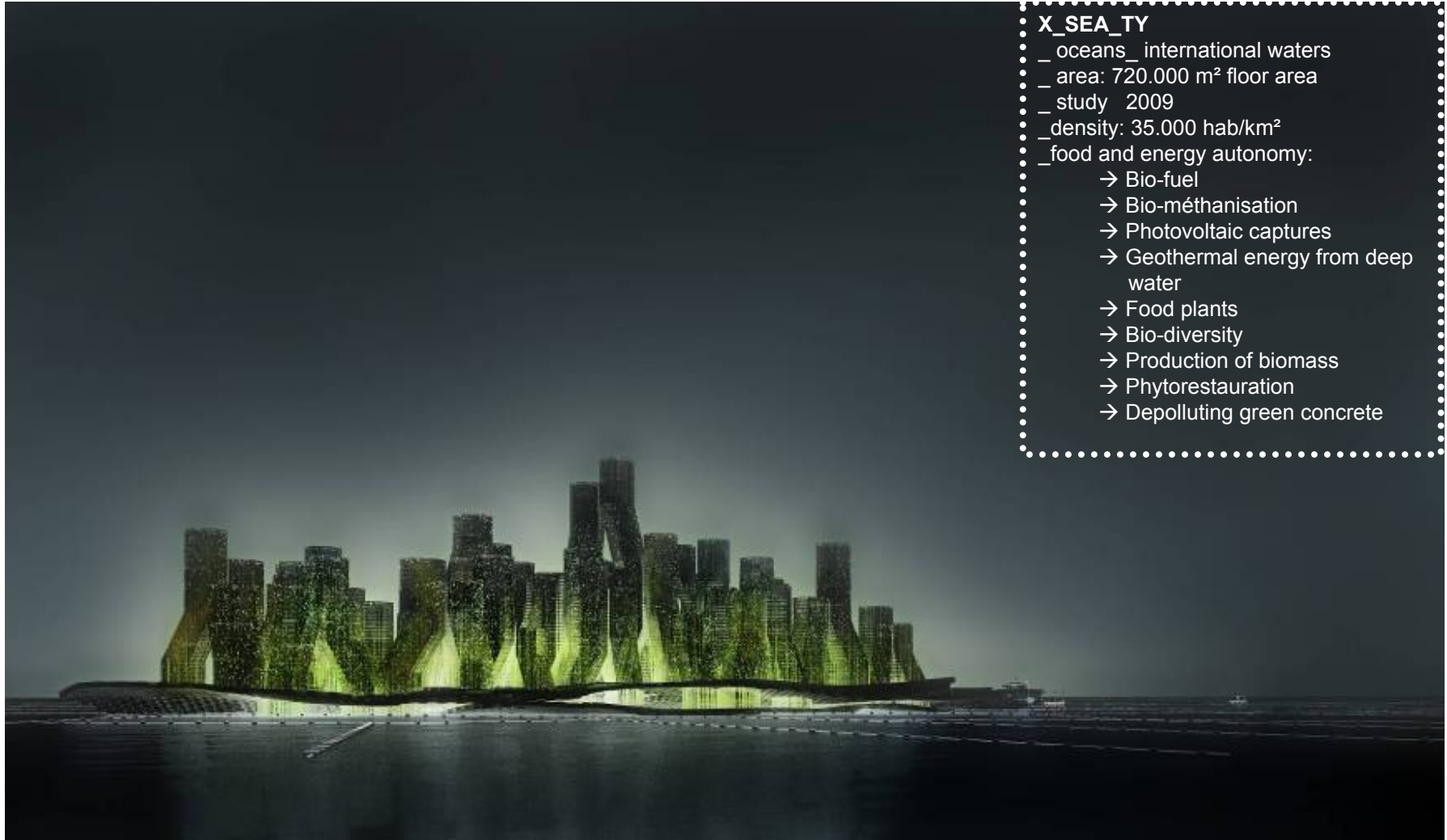
- photosynthesis
- high productivity of biomass
- significant amount of useful molecules
- capturing CO₂
- production O₂
- ability to grow from waste and effluents

– **A fast growing market:**

- 20.000 T of dried biomass commercialised / yr in the world
- a market worth 9 Bill \$
- 30 to 350 €/kg of biomass
- up to 7.500 €/kg for final product
- tens of cultures cultivated from over 200,000 discovered.

A productive and depolluting city

Vision



X_SEA_TY

- _ oceans_ international waters
- _ area: 720.000 m² floor area
- _ study 2009
- _ density: 35.000 hab/km²
- _ food and energy autonomy:
 - Bio-fuel
 - Bio-méthanisation
 - Photovoltaic captures
 - Geothermal energy from deep water
 - Food plants
 - Bio-diversity
 - Production of biomass
 - Phytorestauration
 - Depolluting green concrete

Urban algoculture in sustainable cities

Symbiosis

- **Problems:** climate change, ecological imprint of cities, world food scarcity, end of fossil fuels.
- **Solution:** grow microalgae cultures on buildings
- **Why:** complementarity between micro-algae cultures and the functioning of a building.
 - CO₂ capture emitted from boilers
 - local treatment of effluent
 - valuing dead heat and heat losses from a building
 - production of algae biomass for healthcare, cosmetics and food industry.
 - environmental services
 - renewable energy

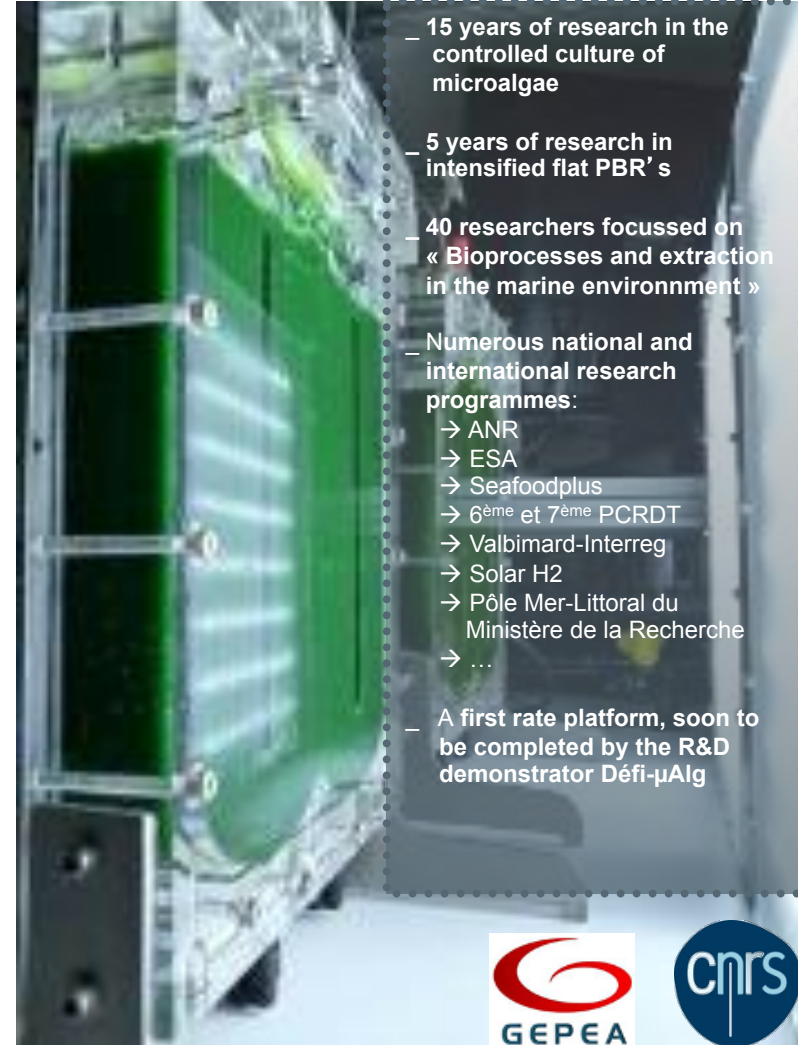


Hybrid buildings from X-TU with PBR's from GEPEA

Genesis

- **Inventor** of the concept « biofaçade » in 2008
- **Anteriority**: international patent applied for in 2008 European patent granted.
- **Studies previously realised**:
 - Bio₂ Tower for ICADE, La Défense (2008-2010)
 - B3A Tower for ICADE, Paris 13^{ème} (2010-2011)
- **Mounting and coordination of SymBio2 consortium**(2011)
- **R&D framework signed with GEPEA** (2012)
- **Construction of first prototypes of biofacades and test pavillion « SymBio2-BOX »** (2012-2013)
- **Mounting and coordination of FUI15 SymBio2** (2012-2017)
- **Around 650 K€ invested in R&D on biofaçades since 2009, on average more than 10% of turnover**

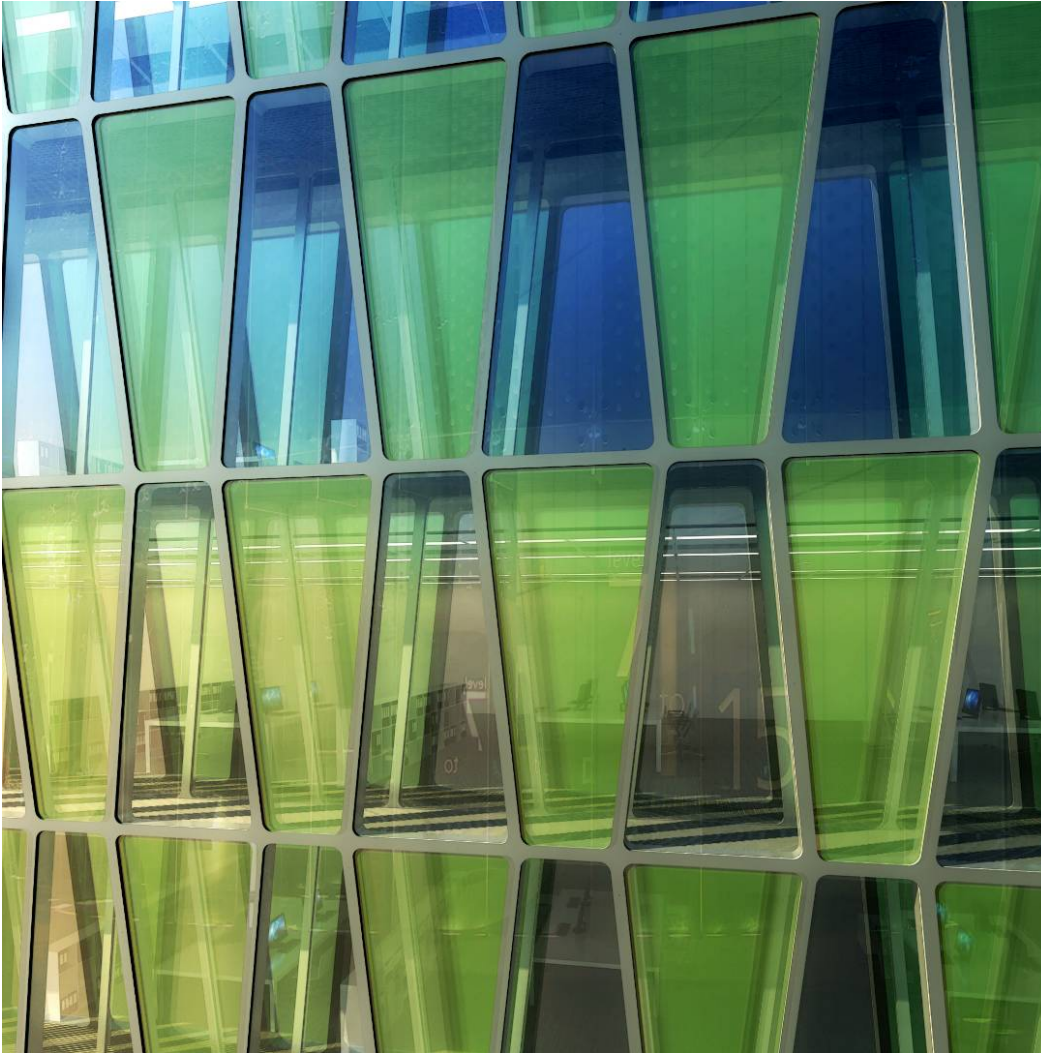
X-TU



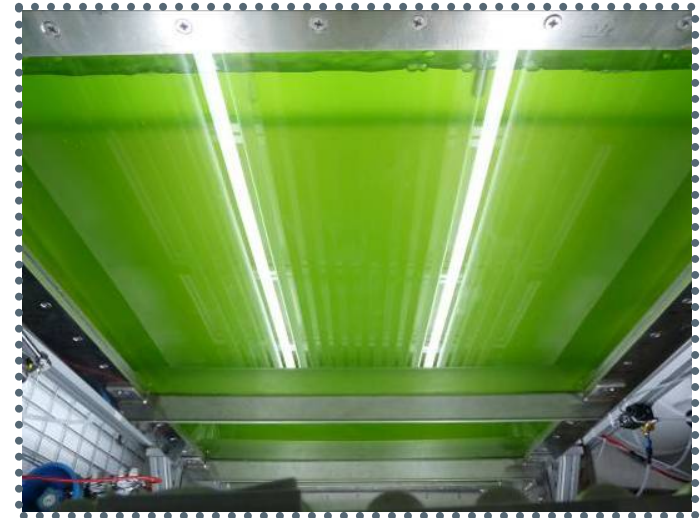
- **15 years of research in the controlled culture of microalgae**
- **5 years of research in intensified flat PBR's**
- **40 researchers focussed on « Bioprocesses and extraction in the marine environment »**
- **Numerous national and international research programmes**:
 - ANR
 - ESA
 - Seafoodplus
 - 6^{ème} et 7^{ème} PCRDT
 - Valbimard-Interreg
 - Solar H2
 - Pôle Mer-Littoral du Ministère de la Recherche
 - ...
- **A first rate platform, soon to be completed by the R&D demonstrator Défi-µAlg**



« biofaçade » and « solar biological panels »



- _ integration of « **solar biological panels** » (photobioreactors with high yields and low water consumption)
- _ at the heart of the **biofaçade** concept **high environmental performance**, acts as « vertical greenhouse » (thermal regulation)
- _ and maximisation of **energy and chemical exchanges with the host building** (CO₂, dead heat, effluents,...)
 - - **80%** energy consumption for the **thermal regulation** of microalgae compared to traditional raceway production
 - - **50%** energy consumption on **heating and cooling** compared to buildings conforming to the latest French energy regulation RT 2012



1st Integrated biofaçade



- _ **1st worldwide** integrated flat panel photobioreactor in ventilated double skin facade.
- _ 3 curtain wall prototypes integrating PBR' s for residential, office and industrial programs
- _ on a building/ test unit with heavy insulation
- _ equipped and instrumented by GEPEA and the LHEEA
- _ delivered in May 2013 and **tested successfully** during the summer
- _ an **investment of 220.000 €** by X-TU Architects, financed by up to 93.200 € from the Région Ile-de-France
- _ **Design team:**
 - Conception PBR: X-TU, GEPEA, R.F.R
 - Conception Double-skin: X-TU, R.F.R, OASIS
 - Conception BOX: X-TU

- _ **Construction team:**
 - Photobioreactors: Etablissements Pinier, SIKA
 - Façade: Oues^t A11
 -



1st Industrial Demonstrator of biofaçades



- _ Laureat of the 15th call for projects by the Unique Interministerial Fund, France, led by Séché Environnement and certified by the competitiveness poles Valorial and Advancity
- _ First worldwide biofaçades on waste to energy plant (ALCEA / Nantes)
- _ biofaçade of several hundred m²
- _ culture of microalgae for high value specialised natural products (green chemistry)
- _ in **symbiosis with the plant**: valorisation of CO₂, of the low temperature waste heat, of effluents, recuperation of rain water, mutualisation of the space.
 - reduce cost of biomass production
 - viability of markets growing fast
- _ demonstrate the pertinence of biofaçades for other buildings (commercial, residential, public works,...)
- _ delivery estimated for 2015

New 3rd generation types of buildings



_ For buildings of all types offices, residential or industrial or ideally mixed use buildings.

_ A strong interest from numerous actors in cities (mayors, C.T., SEM, developers, constructors)

_ The market estimated in 2030 :

→ microalgae biomass in biofaçades:

10 Bill €

→ biofaçades (design and construction):

19 Bill €

_ **Thousands of jobs in the future:**

→ more than 10 000 in construction

→ numerous new actors for the

exploitation of microalgae.

Thanks

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