

# APOLLON SOLAR

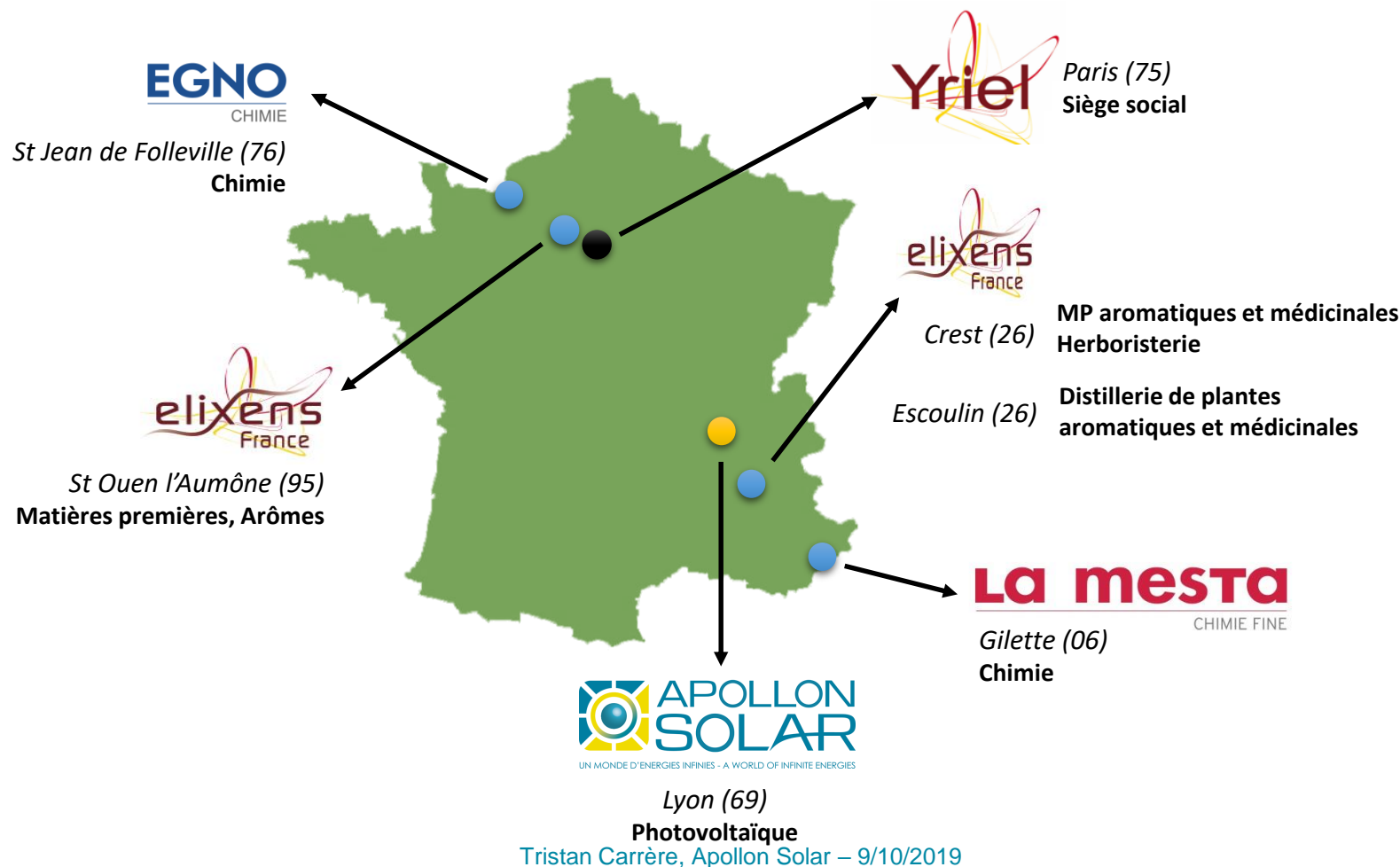
Solar Energy & Hydrogen

★ Témoignage d'un porteur de projet, les clés de succès !

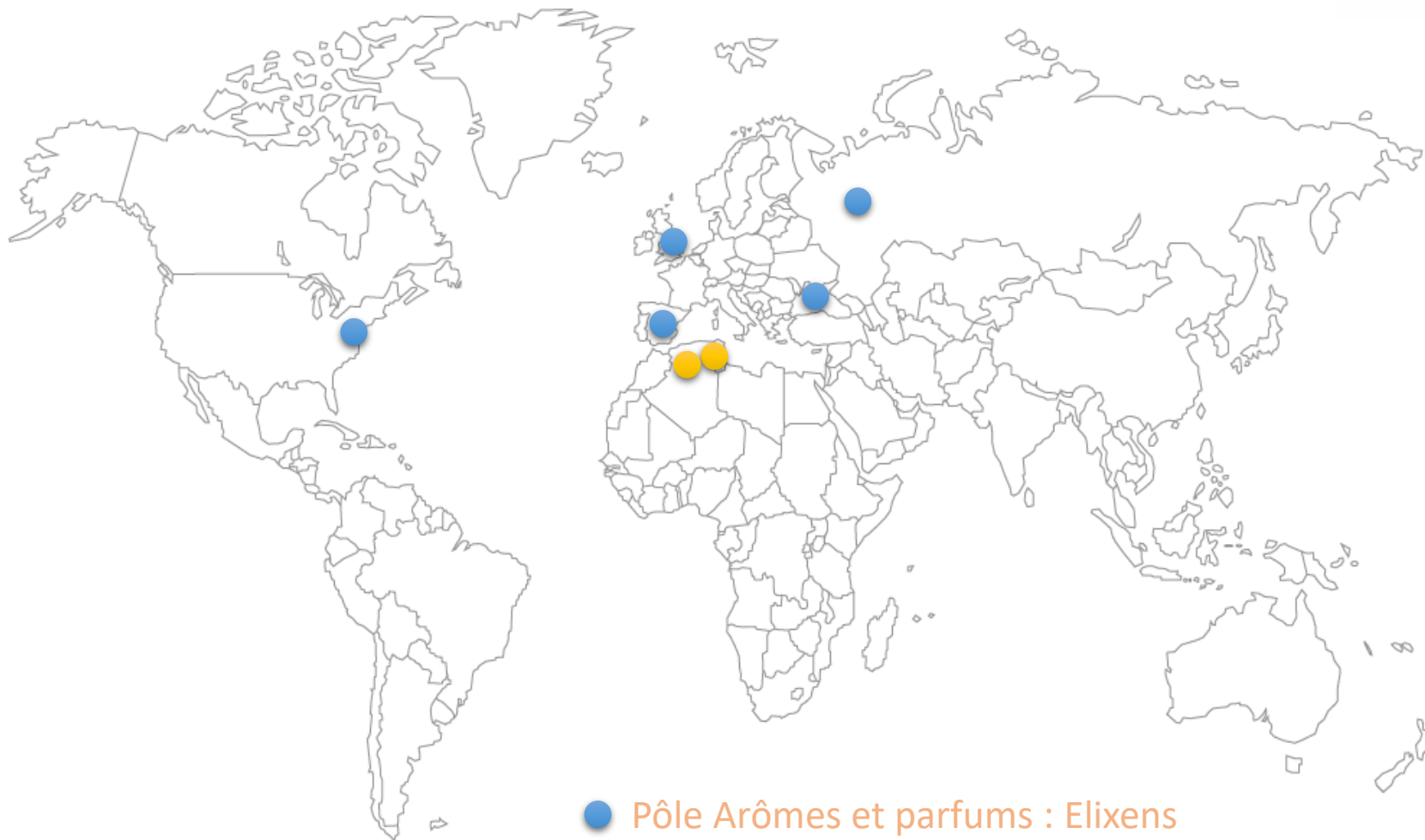


# YRIEL GROUP - France

- YRIEL group, created in 1987 by Emmanuel Alves
- 15,5M€, 246 employees
- Fine chemistry, aromatic substances/perfumes and renewable energies



# YRIEL GROUP - Worldwide



- Pôle Arômes et parfums : Elixens
- Pôle énergie

# APOLLON SOLAR, since 2001

Renewable energy technologies  
Environmental values



**COST  
REDUCTION**



**REDUCTION OF  
ENVIRONMENTAL IMPACT**



**VALORISATION  
OF WASTE**

Private company created in 2001 and based in Lyon, France

Capital 2,7M€

9 engineers

Turnover 2017 : 2,2 M€

8 patents portfolio



# ACTIVITIES



## PHOTOVOLTAICS

- Patented technology N.I.C.E™ : Innovative PV modules and manufacturing process
- At the center of our R&D activities for 18 years
- Robotised, industrial production line



## SILICON

- Advanced expertise in silicon purification and crystallisation
- Physico-chemical purification processes for Silicon
- Crystallisation of multi- and mono-crystalline Silicon ingots
- Silicon wastes valorization



## HYDROGEN

- Patented technology for autonomous Hydrogen production
- Principal target: Mobility and isolated applications
- Pocket generator for fuel cells



## TRADING

- PV roofs, shades and pergolas
- PV green houses
- Flexible PV Modules
- Batteries

# N.I.C.E.™ module technology

- French technology ; in-house development by Apollon Solar
- Important PI Portfolio
- Mature technology at industrial level
- Core activity for 18 years

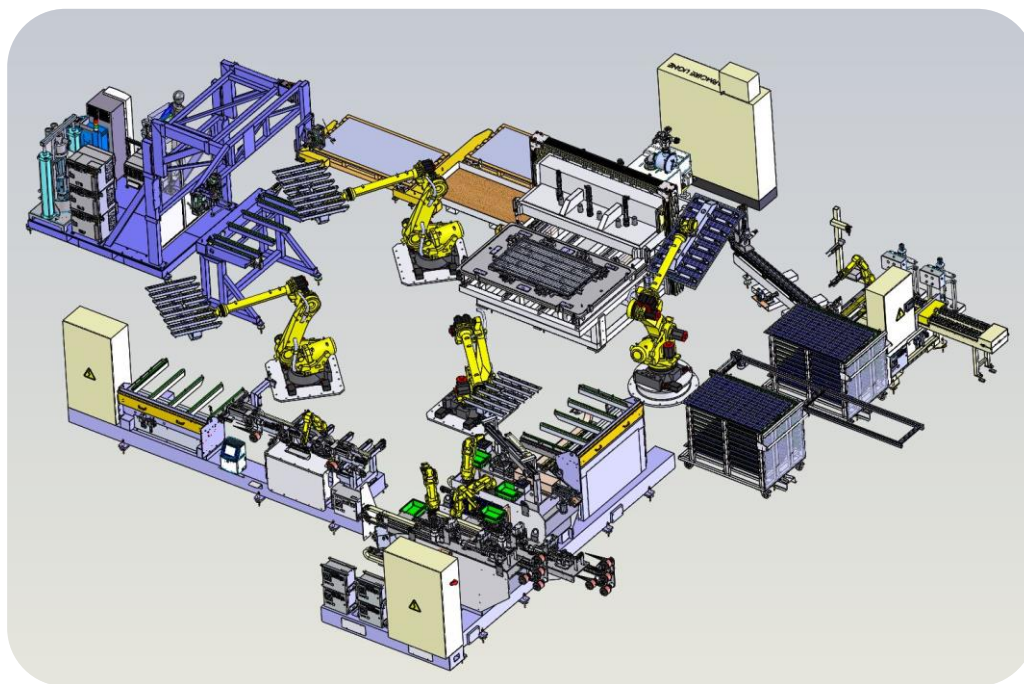
## N.I.C.E.™

### Photovoltaic module



## N.I.C.E.™

### Production Line



# N.I.C.E.™ module technology



## Top-class performances

## Esthetic

## Ultra high durability

- Glass-glass
- Solder-free
- High-quality double edge sealing
- No encapsulant

## Environmental value

- Eco-designed
- Low environmental impacts
- Most recyclable module of the market





# H2020 R&D projects

**ECO-SOLAR Factory: 40%+ eco-efficiency gains in the photovoltaic value chain with minimised resource and energy consumption by closed loop systems**

- **Finished (2015 – 2018)**
- **11 partners**
- **Budget**
  - Total = 6 M€
  - Apollon Solar = 630 k€
  - Support : 100% - Subsidies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 679692



**SUPER PV - Cost reduction & enhanced performance of PV systems**

- **October 2019 = M18/36M**
- **26 partners**
- **Budget**
  - Total = 12 M€
  - Apollon Solar = 450 k€
  - Support : 70% - Subsidies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 792245



**PV ADAPT - Combined Innovation in Modular Construction**

- **October 2019 = M13/48M**
- **18 partners**
- **Budget**
  - Total = 11 M€
  - Apollon Solar = 450 k€
  - Support: 70% - Subsidies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818342





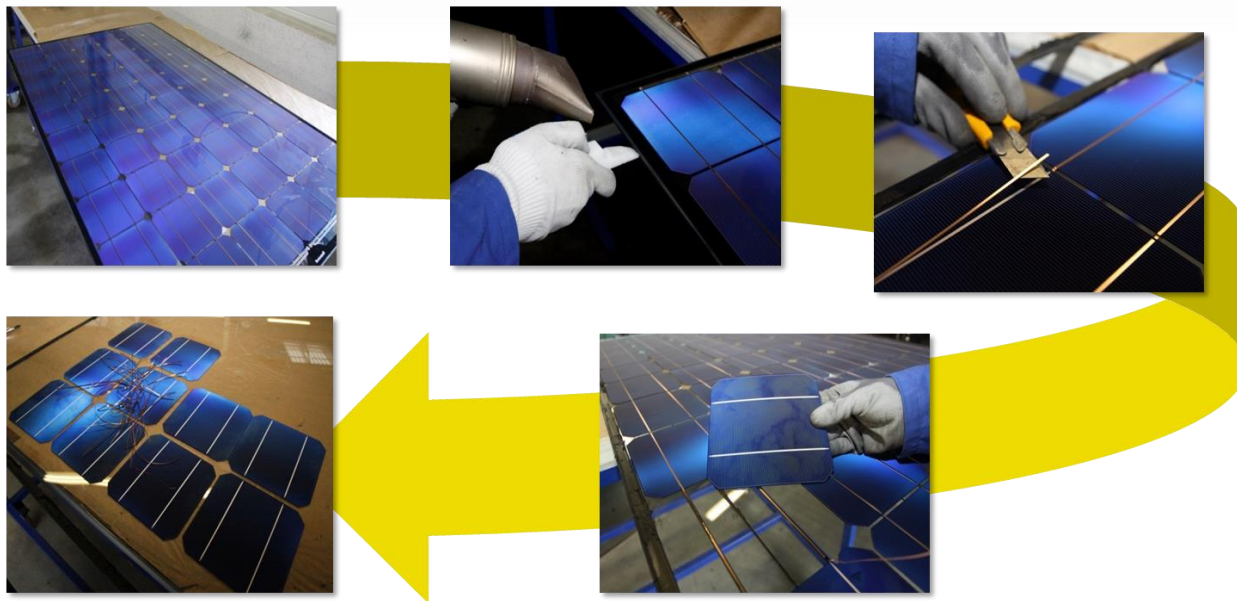
# ECOSOLAR

## Objectives

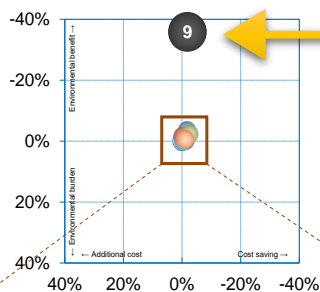
- Increase **resource and energy efficiency** over the entire photovoltaic value chain, while simultaneously **maximising recycling and remanufacturing possibilities**, by introducing **design for recovery, repair and reuse**, and collaborating for improvements in **waste reduction**

## Apollon Solar

- Optimization of environmental aspects of the N.I.C.E. photovoltaic module design
- Development of N.I.C.E module recycling process (module dismounting)
- Design of disassembly line for N.I.C.E. modules

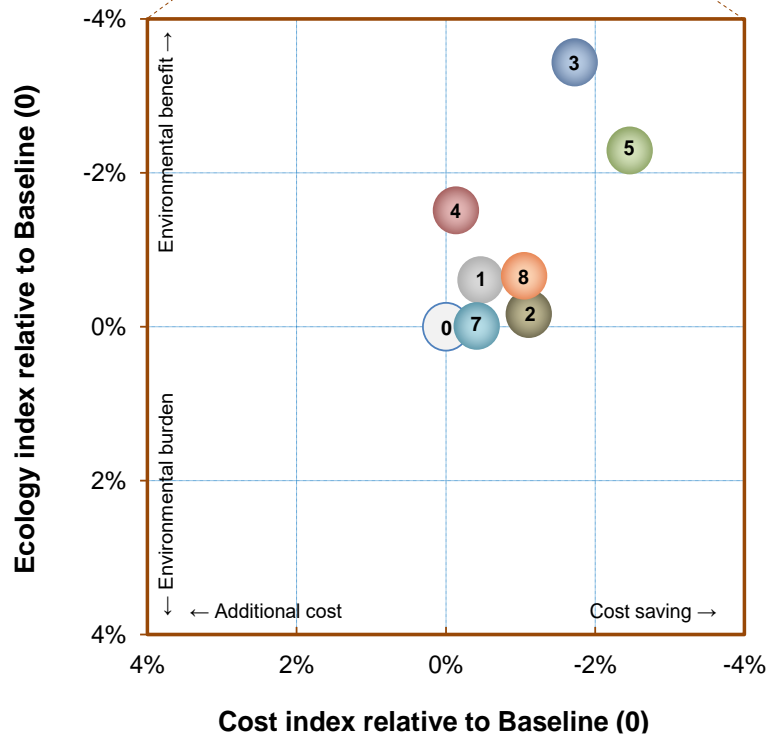


# ECOSOLAR



N.I.C.E. module technology result (relative to baseline)

- Ecology Index -40% → environmental benefit
- Cost Index -5.2% → Cost saving



## Scientific and technical results

- Setting-up a complete recycling process
- Life cycle analysis of the N.I.C.E photovoltaic module
- Assessment of N.I.C.E module environmental benefits
  - Eco-designed
  - Bill-Of-Material reduction
  - Full recyclability
- Environmental analysis performed by a renowned institute (*Bifa Umweltinstitut*)

# SUPER PV

## Objectives

- Development of superior quality PV systems, based on a hybrid combination of **technological innovations and business operation solutions**.
- 3 innovations developed for c-Si PV module

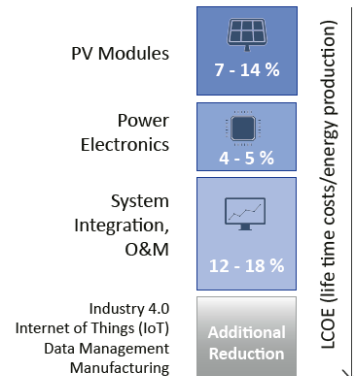
## Apollon Solar

- Integration of developed innovation in N.I.C.E. PV modules
- Production of innovative PV modules for demonstration

## Scientific and technical results

- Development of innovative and cost-efficient PV modules
- Substantial PV module performance demonstration

**IMPACT**  
Expected **Reduction of LCOE** for proposed innovations:



  
**SUPER PV**

## DEMO SITES

Temperate (cold/wet) climate



- Norway
- Lithuania: Vilnius

Tropical (hot/wet) climate

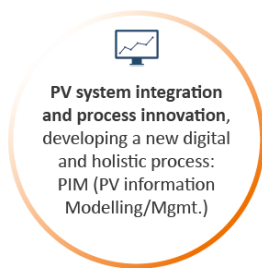
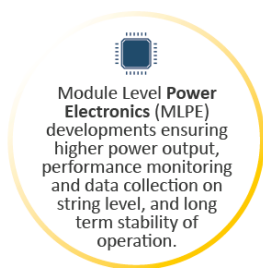
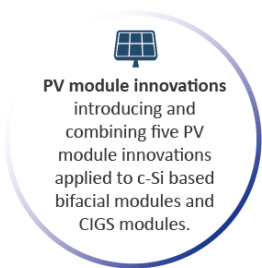


- Spain: Sevilla

Desert (hot/dry) climate



- Morocco
- Tunisia: Tozeur



# PV ADAPT

## Objectives

- Provide a **cost-effective, smart, sustainable** and **multifunctional Building Integrated PhotoVoltaics system**(BIPV), empowered by a **smart energy management** system and a **circular-bydesign approach**.
- Design of a PV-T product with standard components : PV & Heat-Mat (Flint Engineering)

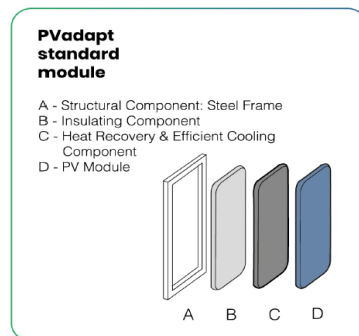
## Apollon Solar

- Design and fabrication of PVT integrated modules
- Production of innovative BIPVT modules for demonstration

## Scientific and technical results

- New product (BIPVT module) for a promising market
- Large scale BIPVT module demonstration

- 1 PV/T: integration of flat heat pipes with PV Module
- 2 Prefabrication and Modularity: customizable and flexible system tailored to the end-users' needs
- 3 Smartness: Smart Envelope System for load prediction and shifting and for predictive maintenance
- 4 Circularity: promoting environmentally and financially viable technology by closing loops and giving new value to waste





# Other advantages

Such large R&D projects always bring important additional values

- Close **partnership**

- Access to external competences
- Highly skilled and complementary partners ★
- Third-party technology assessment

- Performing **demonstrations** on large scale

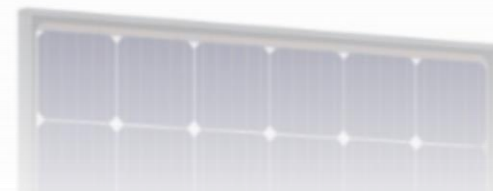
- Mutual test platforms
- Demonstrate bankability ★
- Demonstrate replicability

- Creating **business opportunities** ★

- New clients and customers (e.g. R&D N.I.C.E. module line)
- New partners (e.g. PV recycling company)

- **Gaining knowledge** in other fields (new markets ?)

- PV systems
- Building integration
- Electrical safety



# Conclusion – H2020 projects

## • **Very incentive funding** (> 70% - subsidies)

- Accelerate R&D
- Ambitious research can be done
  - ✗ Large scale demonstration
  - ✗ Non-technical and economical aspects : environmental, social, ...
- Allow EU partners to work with you (especially research labs)

## • **Large consortiums** require important management efforts

- Strong efforts (time and cost) for project building and management
- Remain as simple as possible ! - WP number, reporting (externally and internally), ...

## • **High-quality** scientific and technical results

- Find highly-skilled partners
- Multidisciplinary and diversified projects

## • **Other important advantages**

- R&D network
- Creating business opportunity
- Production of independent results
- Skill and market knowledge over value chains





UN MONDE D'ÉNERGIES INFINIES - A WORLD OF INFINITE ENERGIES



**PHOTOVOLTAICS**



**SILICON**



**HYDROGEN**



**TRADING**

***carrere@apollonsolar.com***



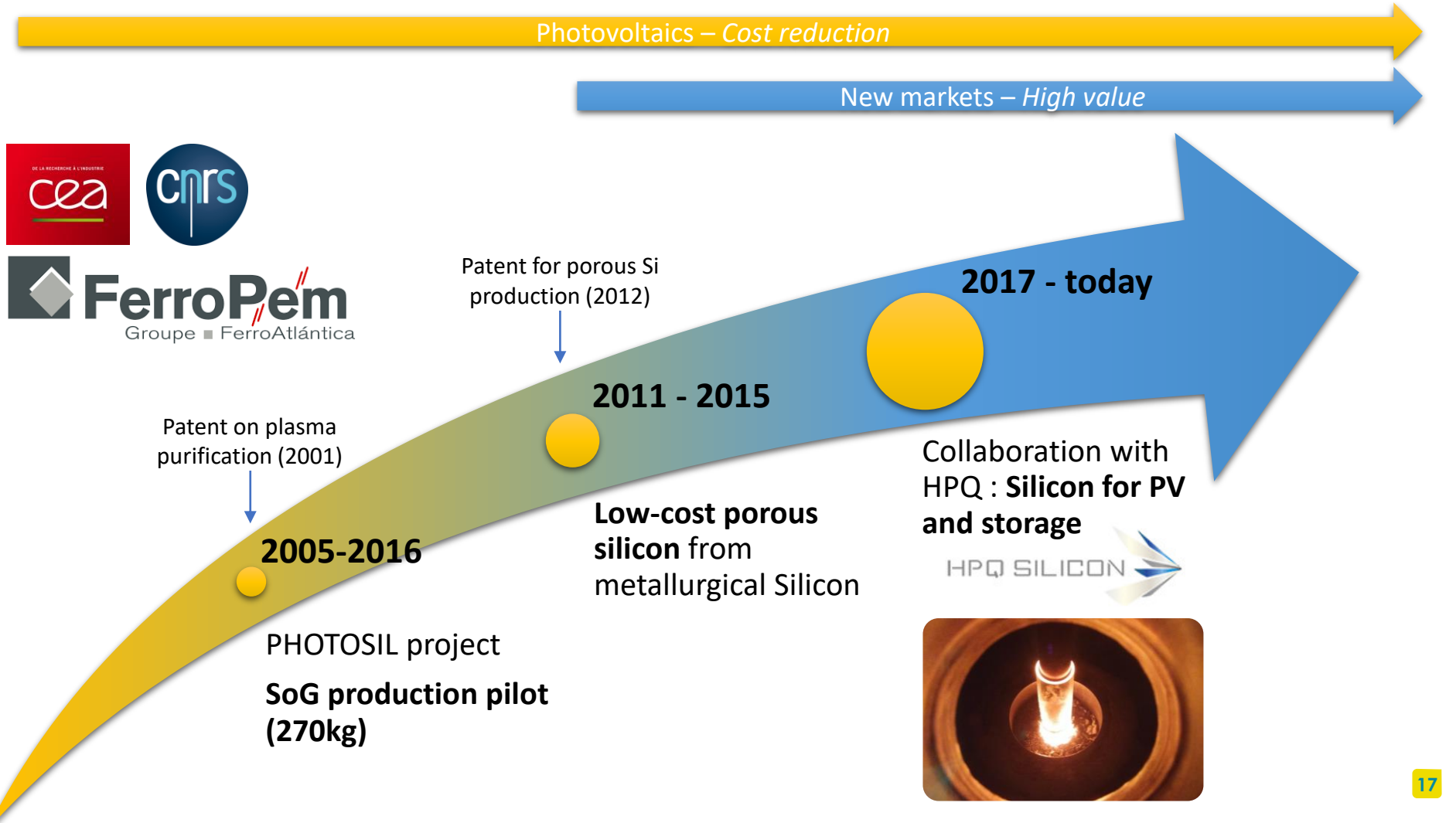


# Silicon



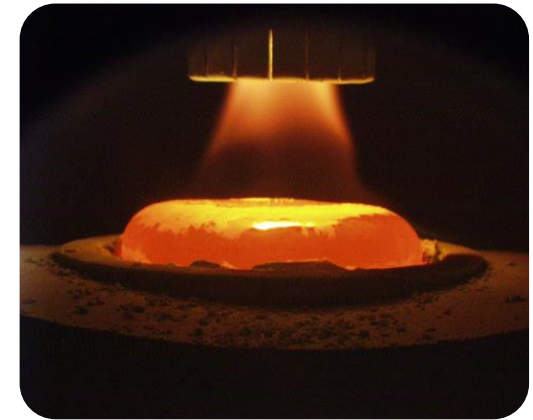
# History

- Strong background in **silicon processes for photovoltaic**
- Diversification strategy: from photovoltaics to **new applications**



# Solar Silicon Expertise

- Silicon **metallurgy**: from raw materials to solar silicon
- Silicon **purification**
  - Plasma, solidification
  - Technology assessment (HPQ, Canada)
- Silicon **crystallization**
  - Cast, Cz, crucible
  - Doping engineering and specification



# Solar Silicon Technologies

- **6 patented technologies**
  - Plasma purification (2001)
  - Quartz crucible (2003)
  - Crystallization furnace (2006)
  - Co-doping (2010, 2012)
  - Porous silicon (2012)



- **Key achievements**

**Processes development**  
for segregation and  
directional solidification

**100% mono Cz-ingot with  
UMG (Upgraded  
Metallurgical Grade) silicon**

State-of-the-art **multi-Si  
solar cell** performance  
with UMG silicon

**World cell efficiency  
record** of 22,6% with Solar-  
grade silicon

2007-2009

2010

2013

2016- 2019



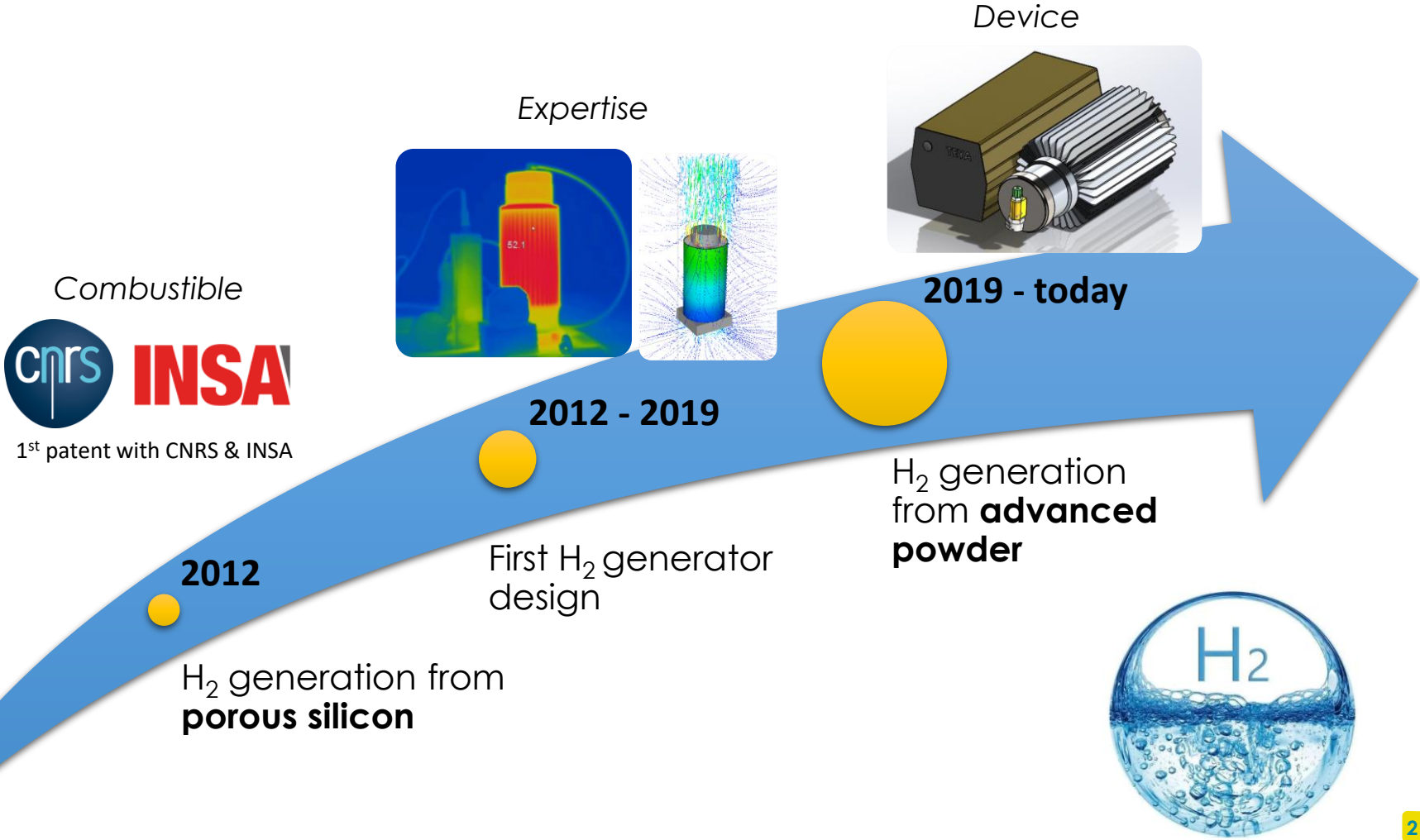


# Hydrogen



# History

- Proprietary technology: **H<sub>2</sub> generation from advanced powder**
- Diversification strategy: from silicon to hydrogen



# Advantages and markets

- Very high energy density
- Ultra-high storage lifetime
- Easy-to-transport
- Low risks
- Ecological H<sub>2</sub>
- 10W – 1kW systems



**H<sub>2</sub> bike**

## Autonomous battery charger

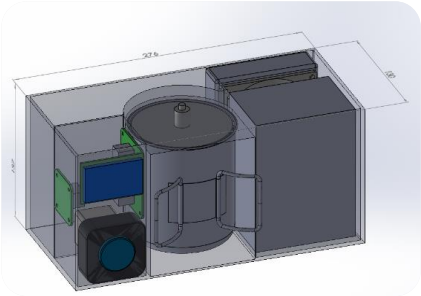
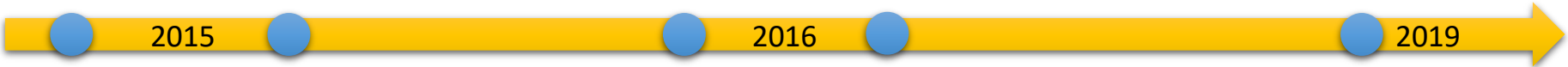
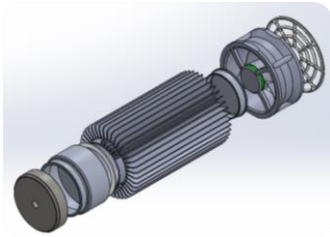


## Electric motorbike



# H<sub>2</sub> generators

- **H<sub>2</sub> generation from silicon**
  - Project “Waste-2-Gas”: Static hydrogen generator from photovoltaic silicon waste
  - Project “Jet d’impact” : improved silicon reactivity and control
- **H<sub>2</sub> generation from advanced powder** (autonomous applications)



# Trading



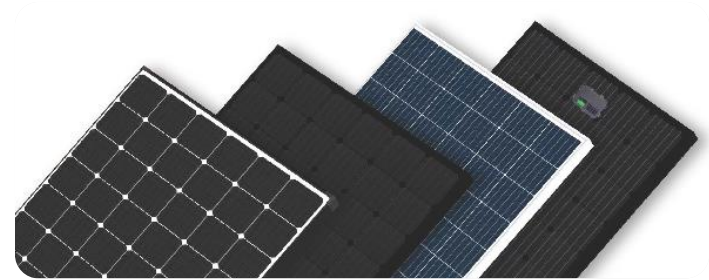


# PV products

**Double glass modules**



**High-quality modules**



**Flexible & ultra-light modules**



**Solar awning**



# PV and storage solutions

Transportable cases



Domestic storage



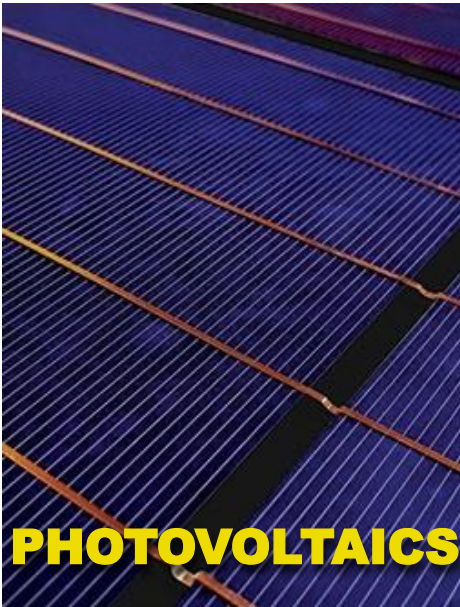
Large volume storage







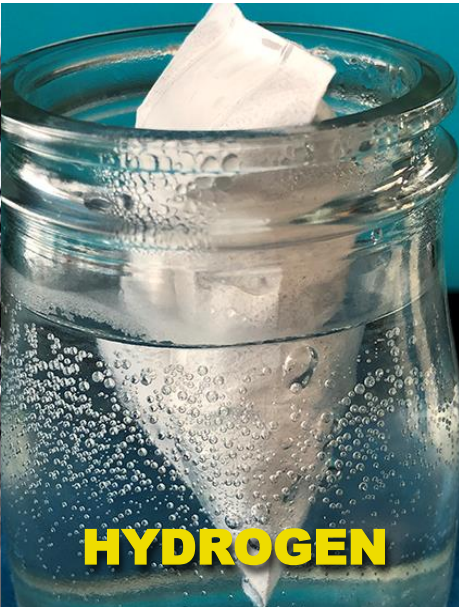
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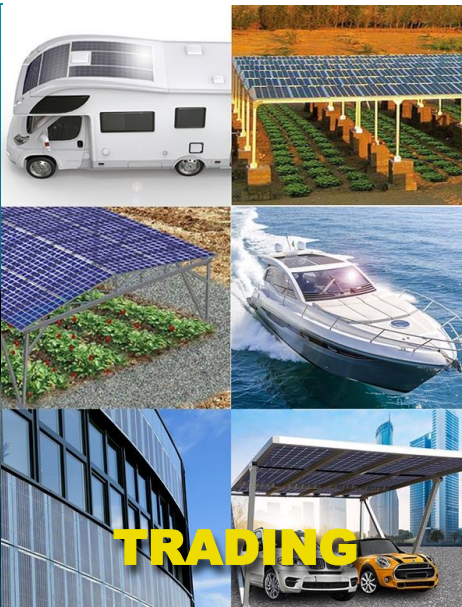
**PHOTOVOLTAICS**



**SOLAR SILICON**



**HYDROGEN**



**TRADING**