



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

CLEARgen Demo

⚡ CG Démo

Daniela Laursen

Ballard Power Systems Europe A/S

www.cleargen.eu

dla@ballardeurope.com

Programme Review Days 2018

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PROJECT OVERVIEW



- **Call year: 2011**
- **Call topic: SP1-JTI-FCH.2011.3.6 Field demonstration of large stationary fuel cell systems for distributed generation and other relevant commercial or industrial applications**
- **Project dates: 01/05/2012 – 30/09/2020**
- **% stage of implementation 01/11/2017: 60%**
- **Total project budget: 10.343.142,60 €**
- **FCH JU max. contribution: 4.590.095 €**
- **Partners: Ballard Power Systems Europe (DK); Hydrogene de France (FR); Aquipac (FR); JEMA Energy (ES); Centre National de la Recherche Scientifique (FR)**



PROJECT OBJECTIVES



- 1) The validation of the technical and economic readiness of the fuel cell system at the megawatt scale, and
- 2) The development and construction of a large scale fuel cell system, purpose-built for the European market
- 3) The field demonstration and development of megawatt scale system at a European chemical production plant.

The demonstration site was chosen for the ability to provide a strong reference case so as to convince future operators of the relevance of large scale stationary fuel cell applications.



CLEARgen Demo Site

Sara Refinery, Martinique (FR)



SARA owns a refinery in Martinique, as well as hydrocarbon deposits in Guadeloupe and Guyana. <http://www.sara-antilles-guyane.com/energies-nouvelles/>

This refinery is generating a large amount of by-product hydrogen

Will use the CLEARgen power generation system to produce electricity



State of the art

PEM for large stationary fuel cell



For large stationary fuel cell, three main technologies in place or under development are:

- MCFC: More than 100 installations until 3 MW power and more.
- SOFC: High efficiency especially for CHP (combined heat and power).
- PEMFC: Versatile solution adapted for different market (mobility, PtP).

No commercial product is available for high power (>1 MW) even if several demonstrations are performed: 1MW in Belgium and in US, 2 MW in China.



Application and market area

Hydrogen for energy market



Large stationary fuel cells systems are a key component for :

- Distributed power market
- Power to power solutions for mass storage energy (renewable sources)

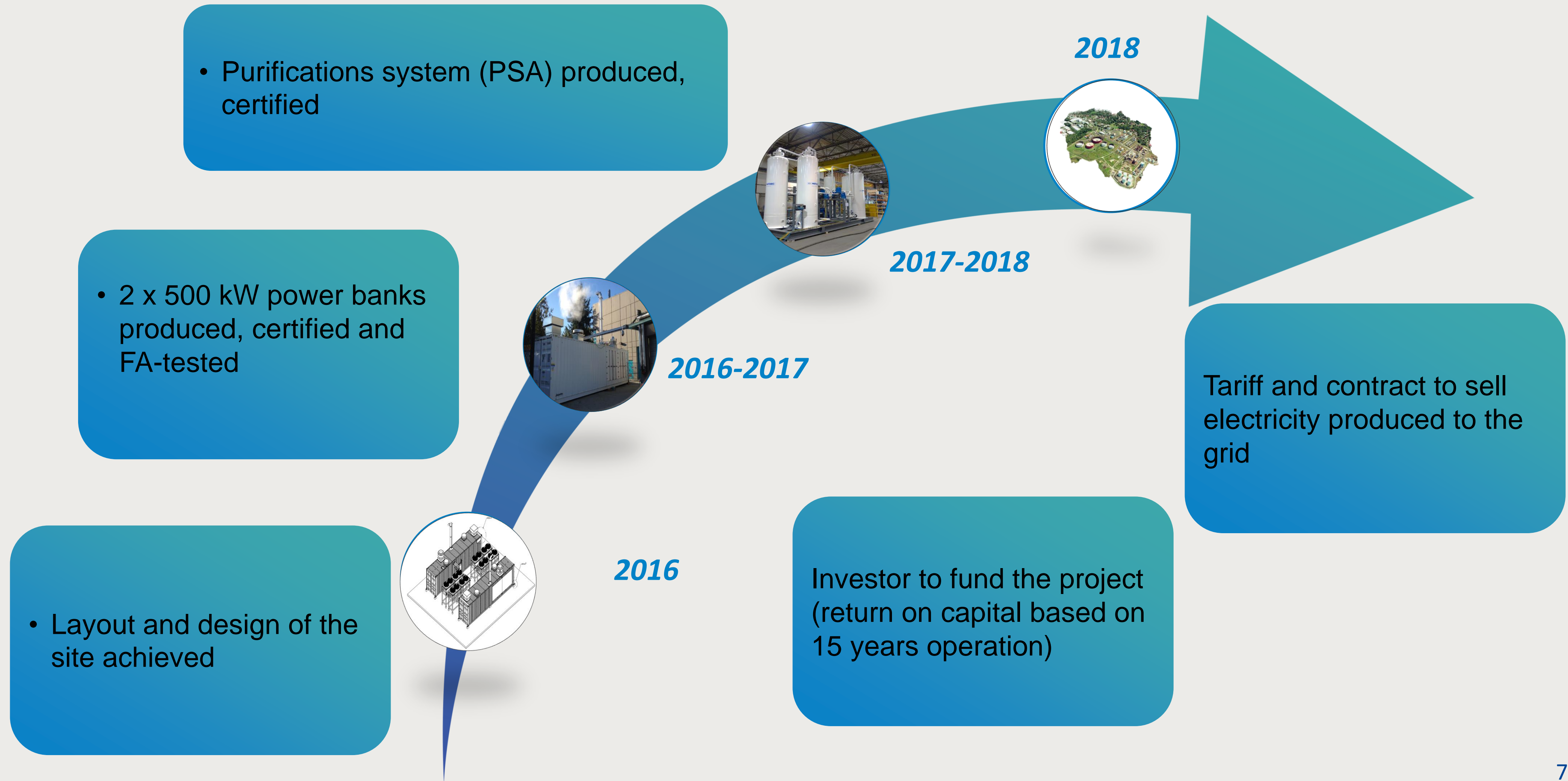
The project demonstrates the ability of fuel cell to provide adapted solution and the readiness of the technology by:

- Supplying purification system of hydrogen (=> opportunity to use any hydrogen source)
- Integrate strong standards of a refinery site (=> ability to suit high standard)
- Cumulating site constraints (wind, seismic, safety) (=> possibility to be implemented evrywhere)
- Connecting the fuel cell to a public grid (=> following standard requirments for electricity)



Achieved results

2016 - 2018



CLEARgen targets

Against SP1-JTI-FCH.2011.3.6 Objectives



| <i>Large stationary FCH systems</i> | <i>FCH JU project's results 2018</i> | <i>SP1-JTI-FCH.2011.3.6</i> | <i>SP1-JTI-FCH.2011.3.6 Objectives</i> |
|-------------------------------------|--------------------------------------|-----------------------------|--|
| Lifetime (between FC refurbishment) | | > | 10.000 h |
| Electrical Efficiency | | = | 50% (long term goal) |
| Cost | | < | 3.0 Mil €/MW |
| Performance Loss | | < | 3% |
| Availability | | NA | NA |
| Service and Maintenance Cost | | NA | NA |

- ✓ >40.000 targeted
- ✓ Cost of the unit= 3 Mil €/MW
- ✓ > 48% electrical efficiency targeted
- ✓ 0% Performance loss targeted
- ✓ Availability 90-95% targeted
- ✓ < 4.5 € cents/kW*h targeted



Coming milestones

Pictures can be added according to the content



Commissioning and Operation

Apr.-
May
2019

Installation on site

Dec.
2018

Shipping og FC Power Banks and Purification System

Oct.
2018

Finalizing the civil work

Dec.
2018



PROJECT PROGRESS – Supply fuel cell for European market



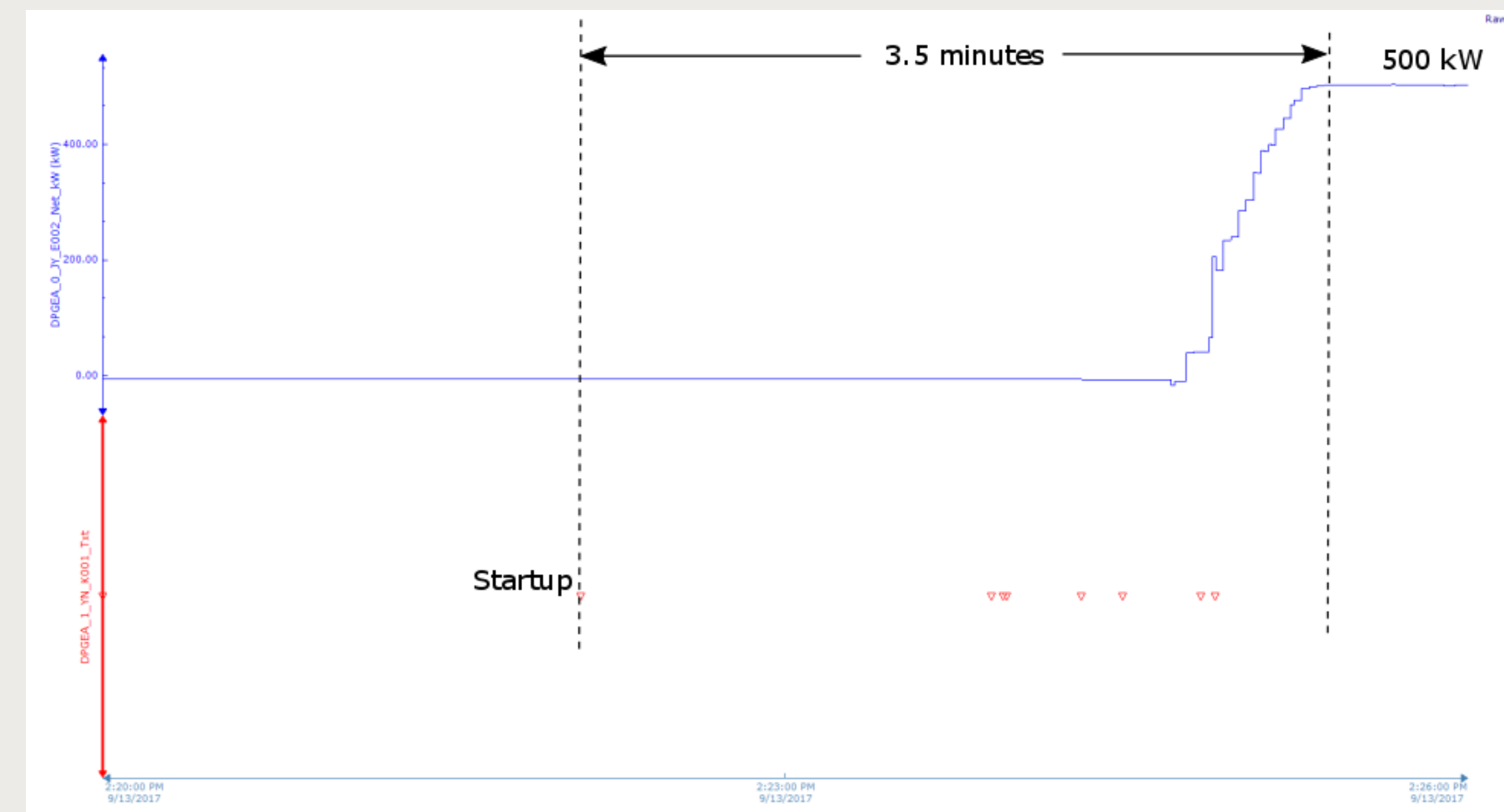
Achievement to-date

333 kW
test bank



1 MW Fuel cell,
CE marked, on site

- 1MW fuel cell was built (compound of 2 x 500 kW power bank)
 - Start up time : 200 kW
 - Efficiency : 46,8 % for bank 1 and 46,4 % for bank 2 (at full load)
 - An efficiency above 50% is measured at lower load
 - CE certified
- ⇒ The system is being shipped to Martinique



PROJECT PROGRESS – Integration of large stationary fuel cell



Achievement to-date

Refinery site



25%

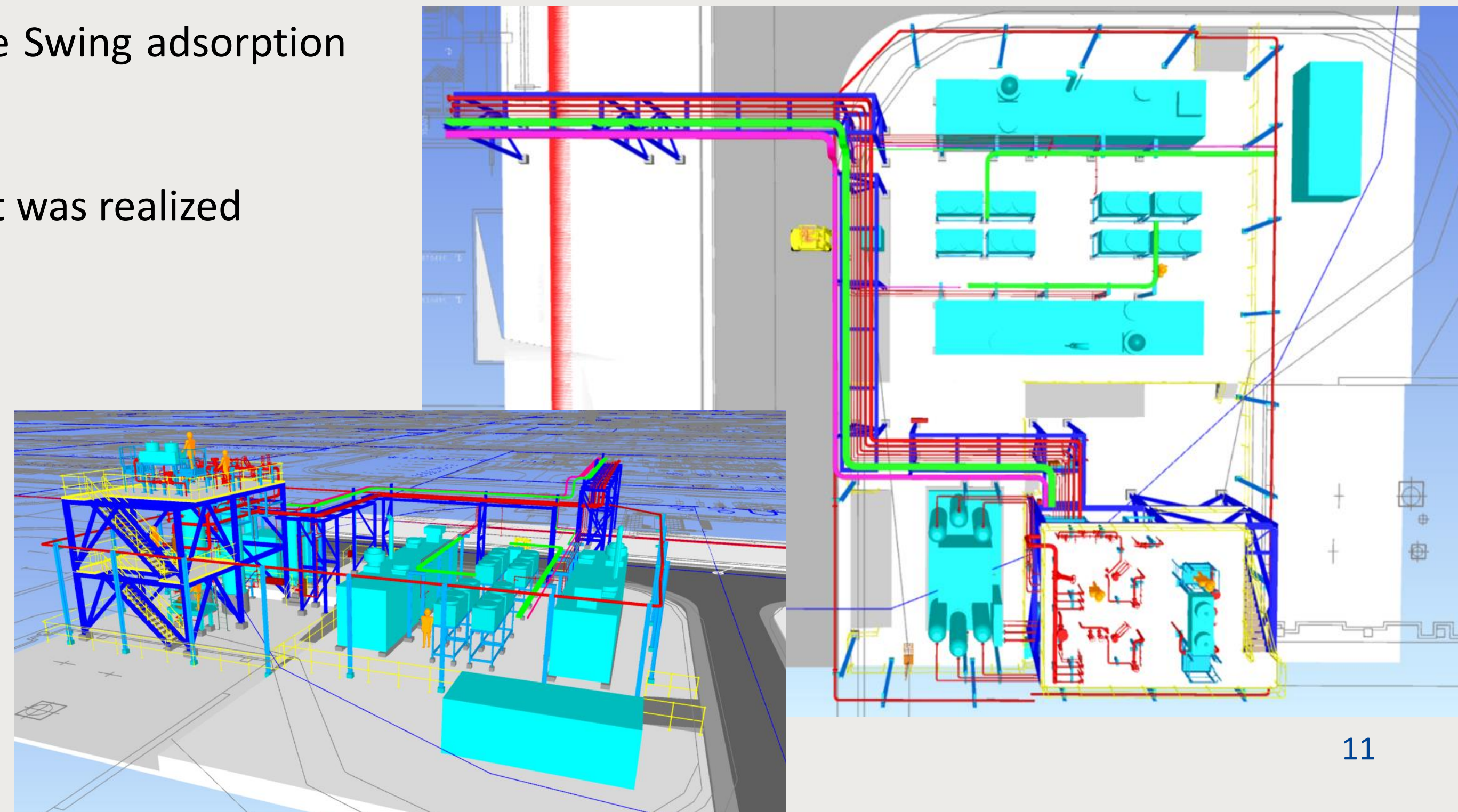
50%

75%

1 MW Fuel cell, implemented in a refinery

- Purification system was designed and built (Pressure Swing adsorption system)
- Detail engineering was performed and the site layout was realized
- 4 work contracts were ordered:
 - Civil work
 - Steel structure
 - Pipelines
 - Electricity & Instrumentation

⇒ Civil work is currently in progress

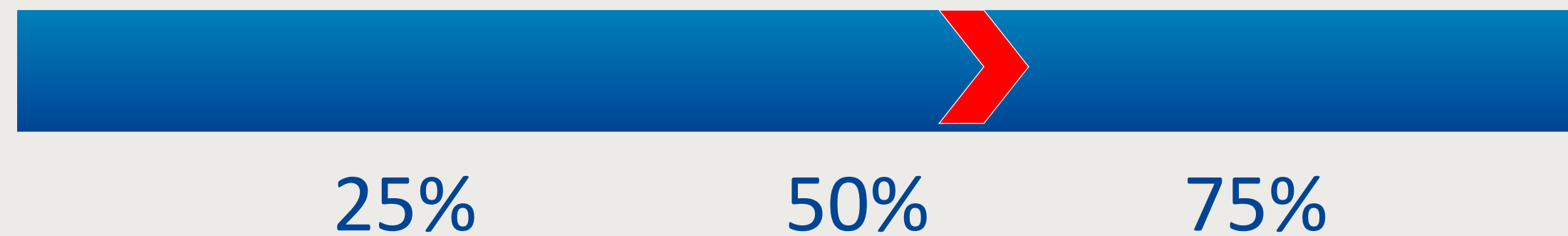


PROJECT PROGRESS – Business model for large stationary fuel cell



Achievement to-date

PPA* for other energy



Business model for large stationary fuel cell

* PPA: Power Purchase Agreement

- Promoting to French government and local authorities of hydrogen fuel cell technology for energy market
- PPA contract Signed with grid operator and validated it by French regulator (24th of July 2018) based on :
 - 15 years of operation
 - Tariff of electricity : 233,70 €/MWh
 - Hydrogen cost around 1 €/kg included

⇒ Adapted Business model for Continental Europe

⇒ Integrated cost projection



DELIBERATION N° 2018-172

Délibération de la Commission de régulation de l'énergie du 24 juillet 2018 portant décision sur le projet de contrat d'achat entre la société EDF (centre EDF Martinique) et la société Aquipac pour une installation de production d'électricité à partir d'une pile à combustible en Martinique

Participaient à la séance : Jean-François CARENCO, président, Christine CHAUVET, Catherine EDWIGE, Hélène GASSIN, Jean-Laurent LASTELLE et Jean-Pierre SOTURA, commissaires.



Risks and Challenges



Main challenge/bottlenecks encountered:

- Find appropriate site
- Integrated safety strategy to comply with CE certification of the fuel cell
- Adapted the integration to high standards of the refinery (sizing, quality of material, etc.)
- Design versatile purification system adapted to evolution of hydrogen flow composition
- Value electricity at an appropriate tariff for amortizing investment

Risks on the project:

- An efficiency lower than expected for purification system or a lower availability of hydrogen flow
- Operation and maintenance costs
- Identify assumptions promoting large scale stationary fuel cell for energy market



Communications Activities



- The project is certified as “territory of hydrogen” by French government (the only one in overseas territories).
- The project was presented to the French minister of energy and environment (Segolène Royal) on the 15th of March 2017.
- SARA presents the project to public during several events.
- The project was included in the presentation of Aquitaine region during “Journées hydrogène dans les territoires” at Cherbourg, 17th and 18th of June 2015.
- A website was edited : www.cleargen.eu



EXPLOITATION PLAN/EXPECTED IMPACT



Exploitation

- Monitoring the degradation of stacks performance
- The consortium will published the key parameters of operation of the fuel cell during and after the project
- The project CEOG : a hybrid power plant (Renewstable[®] power plant) using PV plant, electrolyzer and fuel cell to provide baseload production (HDF);
- ClearGen solution: deliver up to 1 MW clean shore power to ships (BPSE)

Impact

- Demonstrate more than 30,000 hours of operations for stack (target 40,000 h) which consolidate the business plan
- Demonstrate the viability of 15 years operation of the system (fuel cell and purification)
- Interest from grid operators about fuel cell and hydrogen technologies





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