DEMCOPEM 2MW

FCH JU Project

Grant Agreement 621256

Project Introduction and background

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Background

- From October 2011 an 1-MW PEM Power Plant (without heat integration) – built by NFCT and MTSA – is operational near Antwerpen
- Since then a series of potential improvements has been identified that would:
  - enhance system efficiency, system reliability and system uptime
  - create opportunities in the market for large size (2 - 6 MW) CHP PEM fuel cell generators for improving the overall efficiency of existing chlorine production plants

Background

- Response to the FCH JU call - Field demonstration of large scale stationary power and CHP fuel cell systems (SP1-JTI-FCH.2013.3.5)

→ Proposed solution from DEMCOPEM-2MW: demonstrate the feasibility, reliability, and availability of PEM fuel cells in a large scale stationary application of at least 2 MWe in China.

Facts and Figures

- Project start: 1st Jan 2015
- Project duration: 48 months
- Total budget: 10,5 M€
- Total FCH JU funding: 5,5 M€
- Consortium: 5 partners from 3 different EU countries

Project Objectives

The main objective of the four years DEMCOPEM-2MW project is to design, build and operate a 2 MW power generator, with:

- Full integration of heat and power with an existing chlorine production plant
- High net conversion efficiency, *i.e.* > 50% electric energy on system level and > 85% for combined heat and power
- over 2 years (16,000 hrs) for fuel cell stacks lifetime without any need for repair or maintenance of the membranes.
- Fully automated way of operation and remote control
- < €2,500 / kWe
- Demonstration of power and heat generation for over 2 years
- on-stream availability of > 95% for over 16,000 hours (in line with the AIP 2013)

Consortium

The partners in DEMCOPEM-2MW have a combined expertise that covers all aspects of the demonstration project:

- The company responsible for the overall PEM Power Plant concept of the Delfzijl PEM 70 kW pilot power plant and the Solvay 1 MW PEM power plant (Nedstack Fuel Cell Technology)
- The company responsible for the construction of both PEM Power Plants (MTSA)
- The producer of the membrane electrode assemblies (JMFC)
- Support in the process monitoring is provided by research institute (Polimi) that is experienced in modelling, data analysis and process simulations
- The company focused on technology licensing and business model (ANIC)

State of the Art

The balance-of-plant of the 70 kW Delfzijl unit:

- uses about 10 kW, that is 15 % of the fuel cell output.
- The fuel cell stack is operated at 55 % efficiency (of the LHV of hydrogen)
- Due to the balance-of-plant the net efficiency of the total system is reduced to 45 %.
- In smaller systems relative losses due to auxiliaries are generally larger than in a large system, as the smaller components are generally less efficient.
- Net efficiencies of larger PEMFC systems quoted in literature are in the range of 40-45 %.

Vision

In DEMCOPEM-2MW the overall system efficiency will be increased by:

- Determine the optimal set point of the fuel cell system, in terms of stack current, hydrogen and air flow and humidification.
- Optimising the system air manifold stack to reduce the pressure drop in cathode loop (less than 100 mbar). Then power consumption of an efficient radial blower will be less than 2 % of the power production of 2 MW.
- Reducing losses of hydrogen recirculation. The flow of excess hydrogen fed back to the inlet of the fuel cells should be minimized to 25 %.
- Reducing the power consumption of the air humidification, which is in the 1 MW unit 50 - 60 kW.
- Designing the power converter with dissipation losses of less than 2 %.
- Decreasing relative energy losses (due to the larger scale installation)

Expected Impact

- Full integration of heat and power with an existing chlorine production plant
- High net conversion: > 50% electric energy on system level and > 85% for combined heat and power;
- over 2 years (16,000 hrs) lifetime for fuel cell stacks without any need for repair.
- Full use of the water produced by the fuel cells
- Fully automated way of operation and remote control

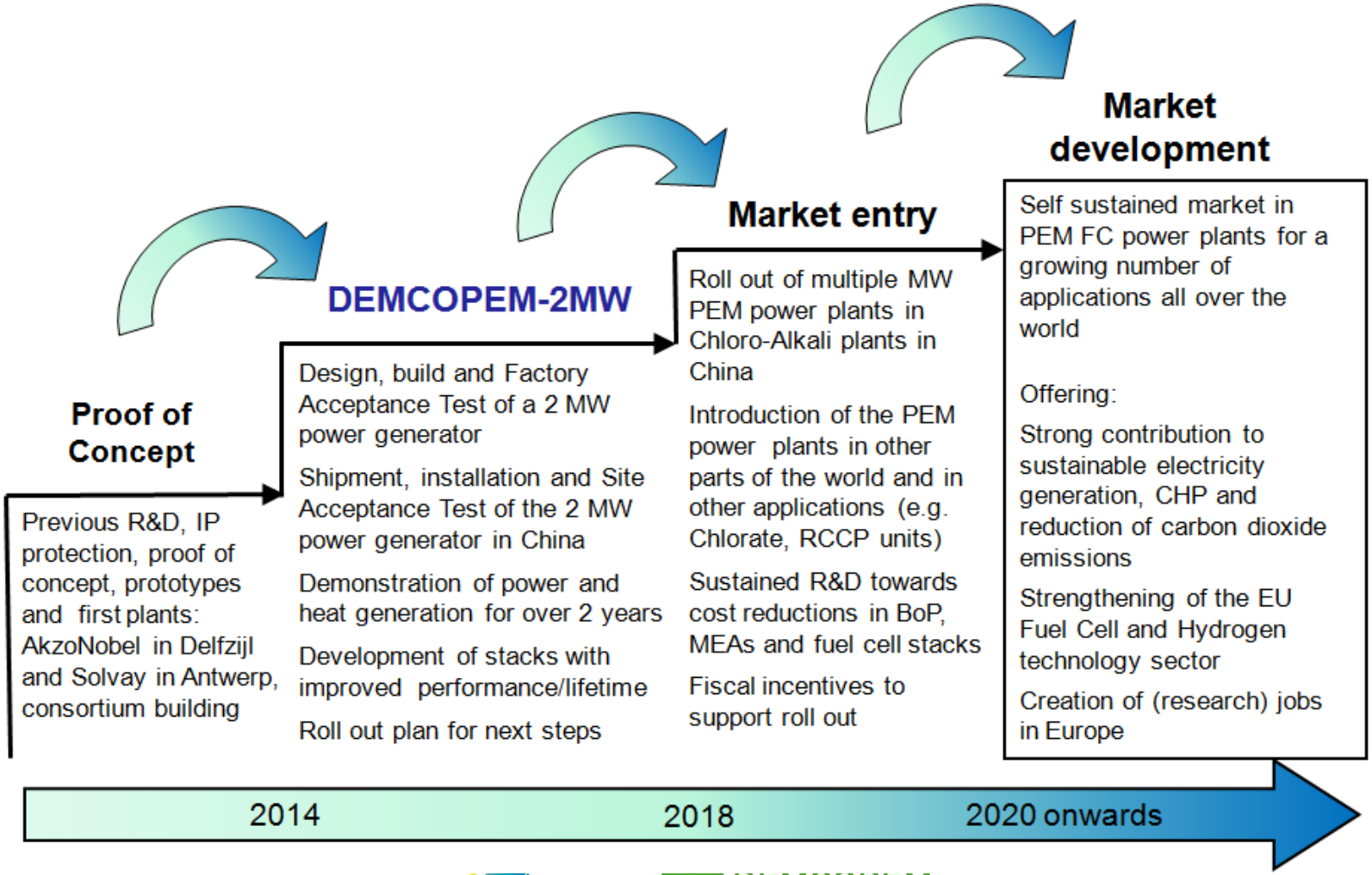
Expected Impact

...last but not least

- Compliance with the cost and efficiency targets of the MAIP 2008-2013.

	Volume & cost		
Market application	2010 baseline	2015 mid-term	2020 long-term
Stationary Power Generation & CHP **Industrial/commercial, H_2 based**	1 MW / 4,500 €/kW	>5 MW / 3,000 €/kW Assuming supported deployment from 2013+	>50 MW / 1,500 €/kW Anticipating commercial introduction beyond 2018
DEMCOPEM-2MW		2 MW / < €2,500 / kW and potential for 20 more similar sized PEM power plants	Commercial introduction in 2017 and stepwise cost reductions to reach < €1,500/kW in 2020

DEMCOPEM-2MW Roadmap



Impact: technology demonstration in China

Why do we demonstrate in China?

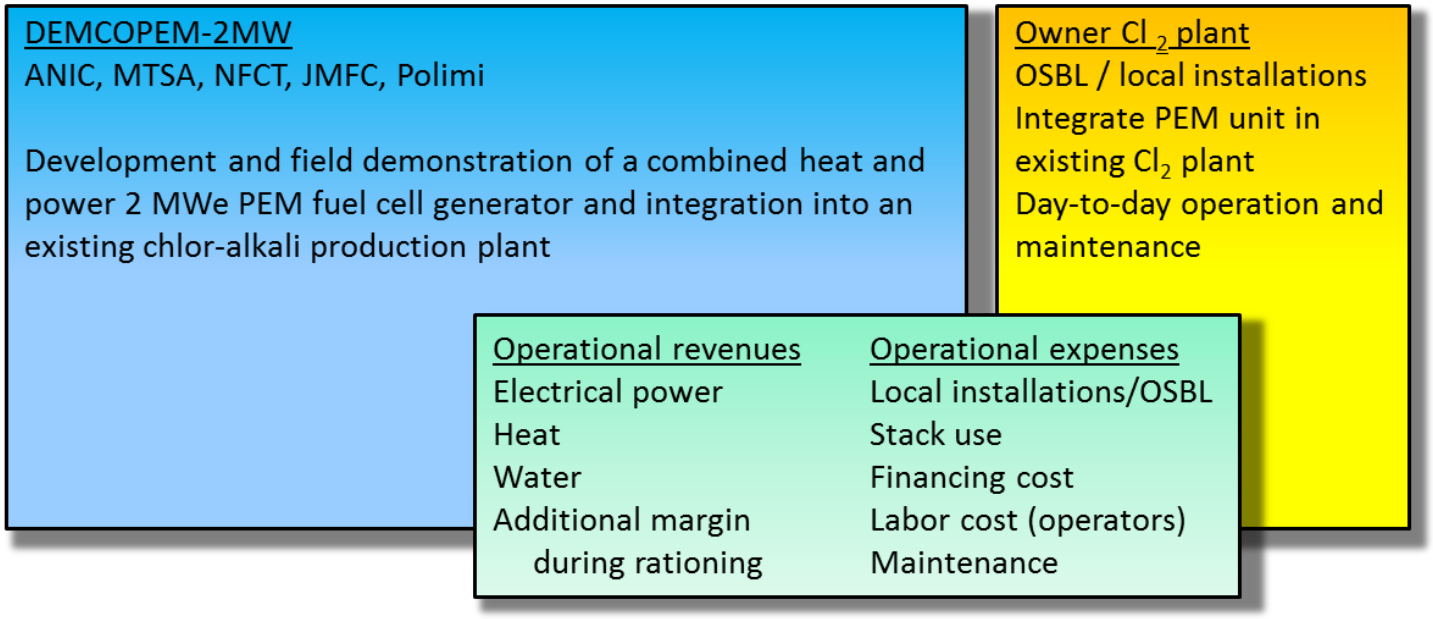
Most favorable conditions for the business case due to:

- High electricity prices (up to 2 times higher than in Europe and rising) in most areas in China
- Availability of waste hydrogen by many of the ca. 180 chlor-alkali plants in China
- Common shortage of electricity supply in China in certain periods of the year

Project Structure

Project Structure and approach:

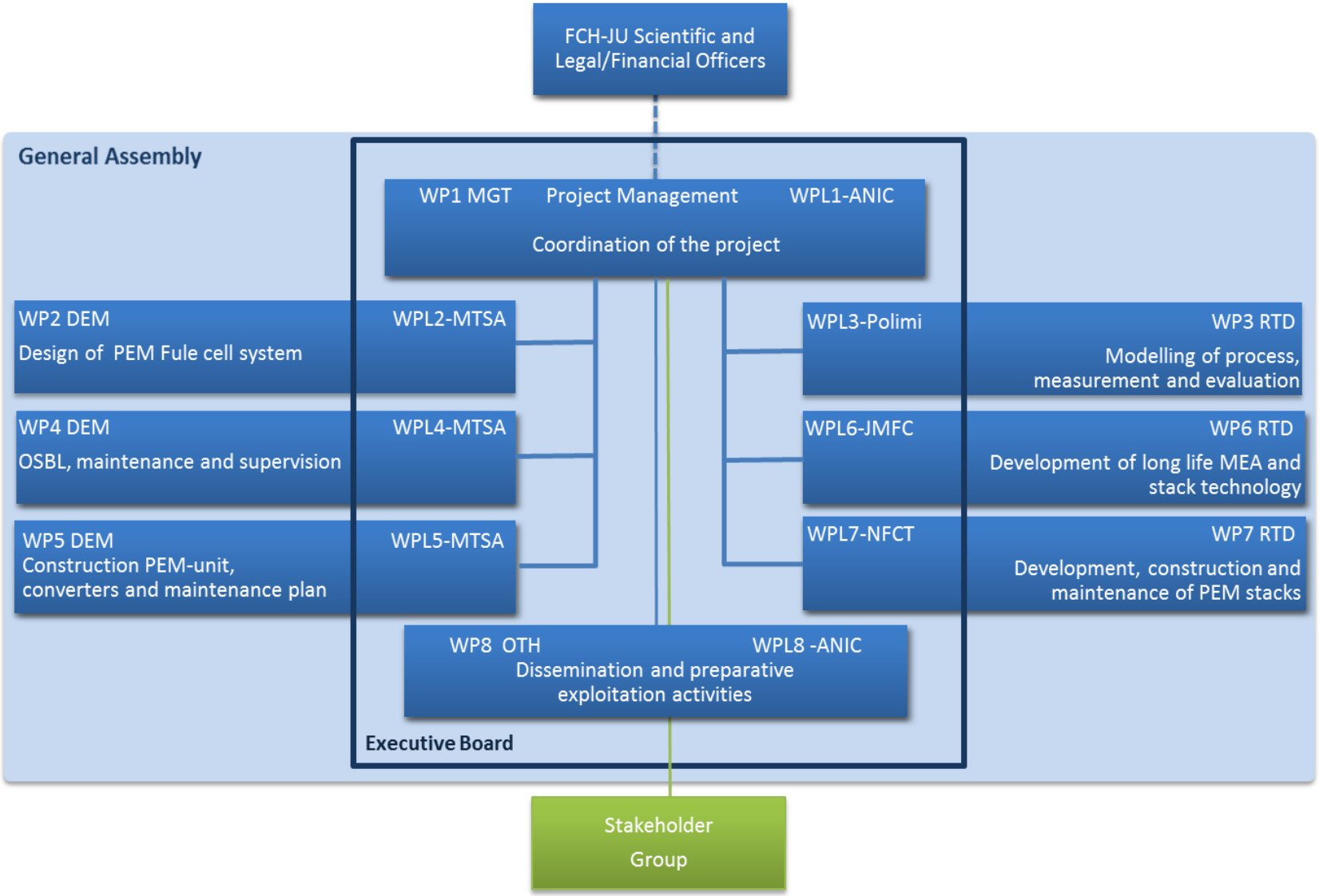
- Blue box: DEMCOPEM-2MW project proposed for cofunding by FCH-JU;
- Yellow box: Local activities 100% funded by the owner of the chlorine plant;
- Green box: Operational revenues and expenses related to the demonstration.



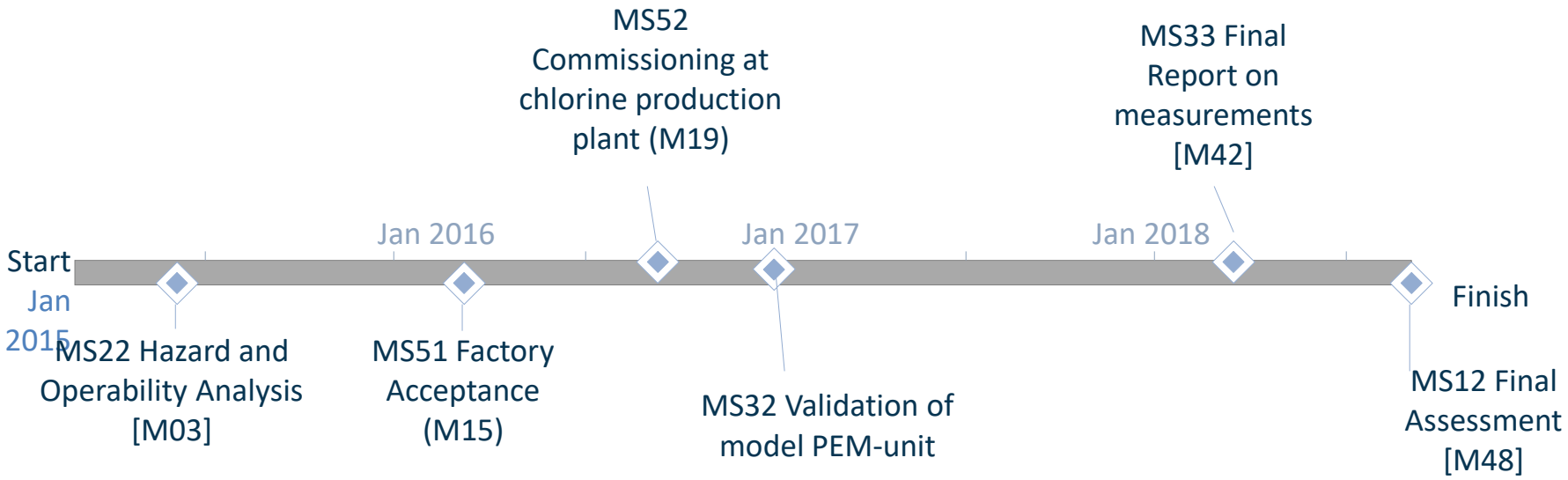
After successful field demonstration

- Sales of DEMCOPEM-2MW plant to owner Cl_2 plant
- Roll-out of CHP PEM power plants in China by ANIC, MTSA, NFCT and Chinese partners
- Roll-put of CHP PEM power plants worldwide

Work Package structure



Timing


Start
Jan 2015
Jan 2016
Jan 2017
Jan 2018
Finish
MS22 Hazard and Operability Analysis [M03]
MS51 Factory Acceptance (M15)
MS52 Commissioning at chlorine production plant (M19)
MS32 Validation of model PEM-unit
MS33 Final Report on measurements [M42]
MS12 Final Assessment [M48]

WPs focus

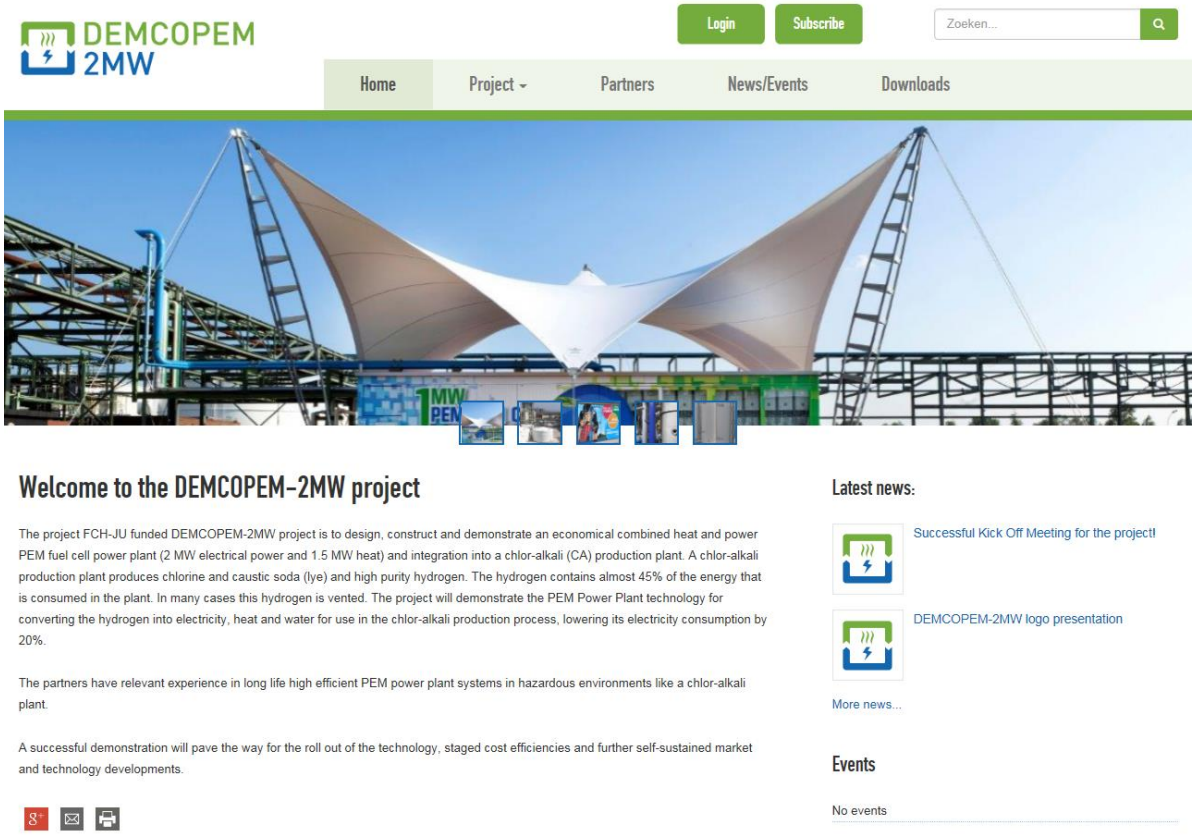
- WP2: Design of the PEM fuel cell system
  - Establish the flows and design the piping and instrumentation of the integrated system
  - Decide which of the two options DC-DC and DC-AC for the power converter is preferred
  - Perform the Hazard and Operability Analysis (Hazop) of the integrated system.
- WP3: Modelling of process, measurements and evaluation
  - Develop and validate a thermodynamic model to predict PEMFC unit performances
  - Optimize the efficiency of the system and minimize costs of components with the model
  - Evaluate data and advice on optimal economical and technical integration of a PEM fuel cell generator into an existing chlorine production plant.
- WP4: Outside Battery Limits, maintenance and supervision
  - Propose technical solutions for full integration of electrical and thermal power.
  - Design and engineer all connections between chlorine production unit and PEM-generator
  - Supervise the operation of the PEM-generator at the chlorine production plant

WPs focus and Main deliverables

- WP5: Construction of PEM-unit incl. stacks
  - Prepare for construction and order components
  - Qualify MEAs, build and test stacks and measuring tools
  - Manufacture and test the PEM-generator and the power converter
- WP6: Development of volume manufacturing processes for MEAs and stacks technology
  - Develop a capable volume manufacturing process for high quality MEAs
  - Set-up a strategy for MEAs to be used in stacks of existing chlorine production plants
  - Develop protocols for advanced stack voltage monitoring
- WP7: Development, construction and maintenance of PEM stacks
  - Qualify the improved MEAs and build a second set of 24 stacks
  - Keep the PEM-generator running by stack performance monitoring and rapid replacement of faulty stacks

WPs focus and Main deliverables

- WP8: Dissemination and preparative exploitation activities
  - Elaborate a dissemination and exploitation plan and initiate follow up activities
  - Organise a workshop for relevant stakeholders



End of presentation

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