AFC Energy

# Project POWER-UP

Dr Suzannah Hexter

Fuel Cell and Hydrogen Technical Conference 2017

www.afcenergy.com

# Contents



01

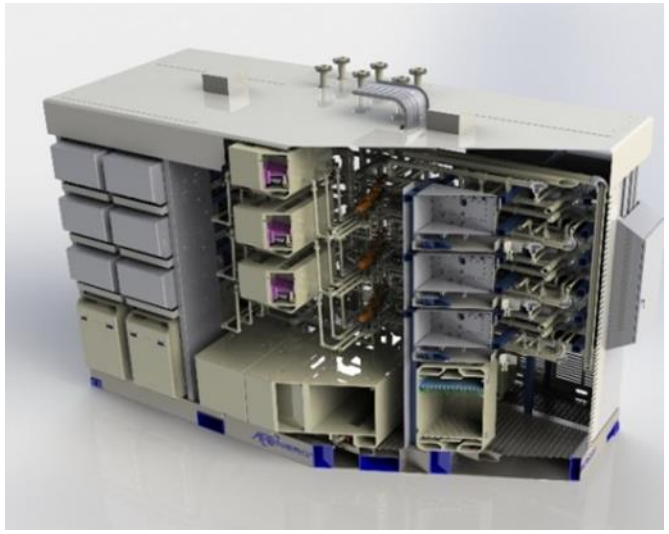
# Overview of AFC Energy

# Overview of AFC Energy

- AFC Energy is **the world's leading developer of industrial scale alkaline fuel cells**
- Formed in 2006, publicly listed on AIM since 2007
- Global strategic partnerships with leading electro-chemical and engineering companies
- AFC Energy is edging increasingly closer to delivery of a commercial-scale fuel cell system capable of deployment across a range of markets.
- Key technical objectives not only short-term operational success, but also longevity, safety and stability of power supply across the life of the project

# Technology Overview

- Simple
- 98 patents covering key technology
- Basic modular design
- Standard industrial materials
- Low-cost scale-up to automated manufacturing
- Designed for reuse or recycling
- Ease of Operations and Maintenance

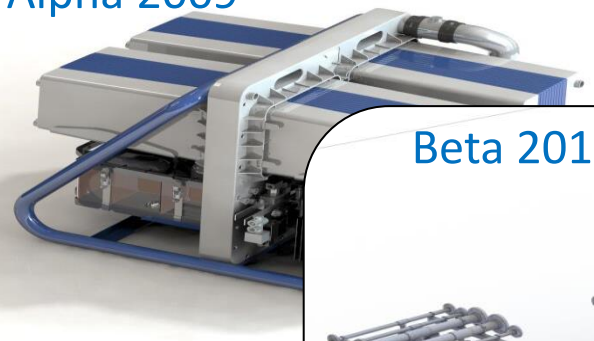


AFC KORE module, both as a 3D model and in assembly

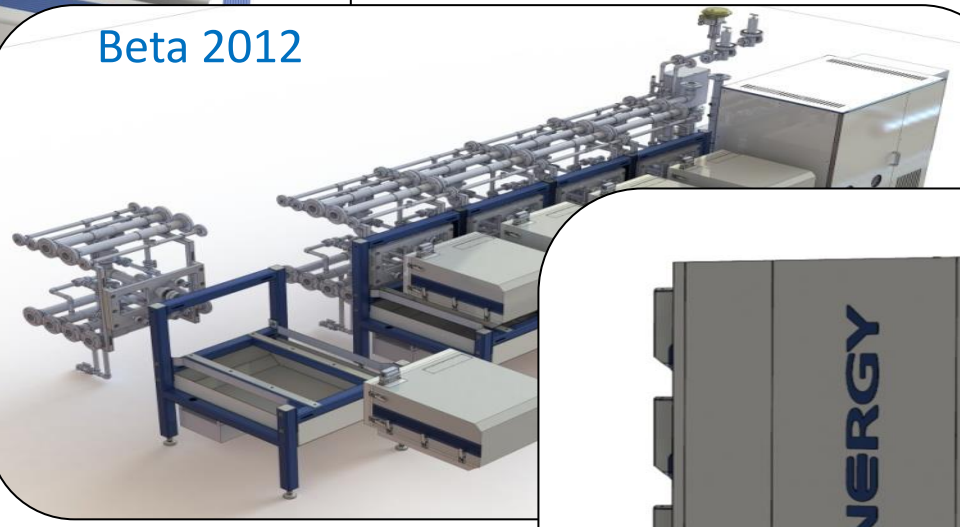
# Technology – Development timeline

Stepped development towards realisation of KORE – standardised design basis - supports further scaling

Alpha 2009

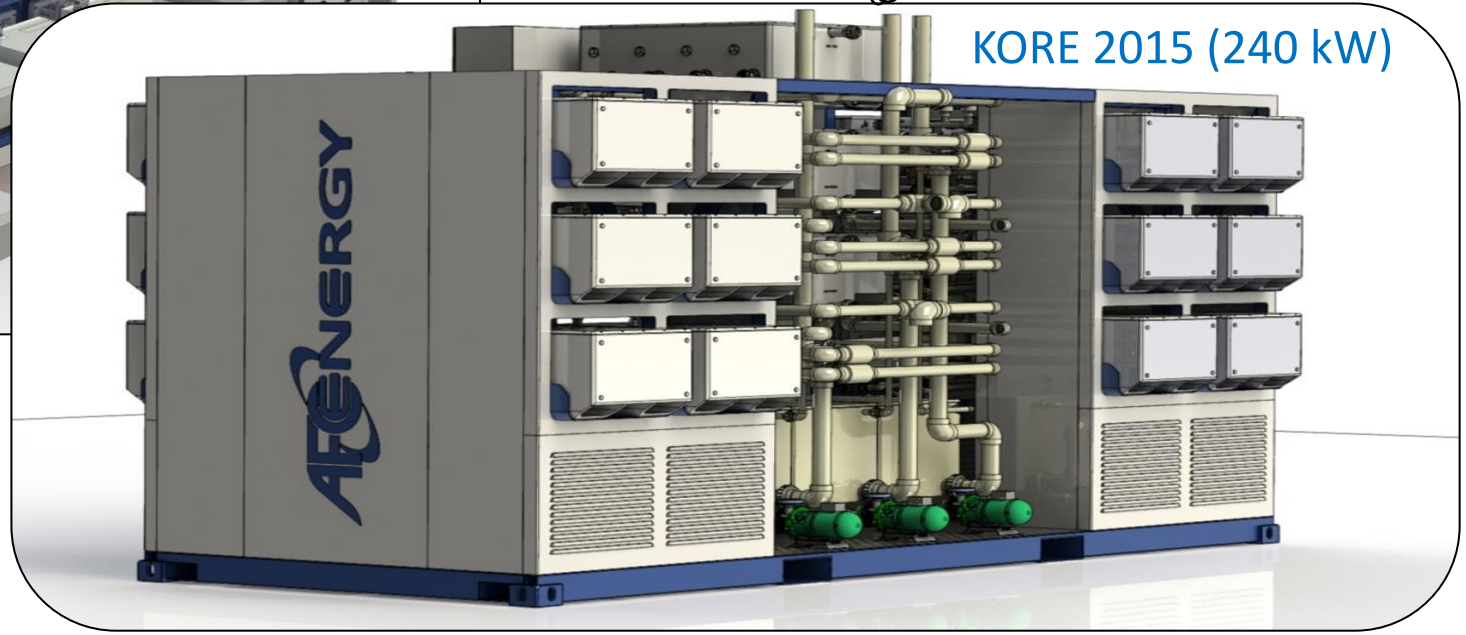


Beta 2012



Next step to complete detail design for 1MW facility

KORE 2015 (240 kW)



02

# Project POWER-UP

# Project POWER-UP, Stade - Germany

POWER-UP is one of the EU Fuel Cell and Hydrogen Joint Undertaking's stationary fuel cell demonstration projects. This FCH JU co-funded project has a budget of €11.5 million and a scheduled duration of 51 months, starting in April 2013 and concluding in June 2017.

Objectives for the project include:

1. Converting industrial grade hydrogen into electricity at competitive prices
2. Scale-up manufacture of fuel cell components to meet ISO standards
3. Demonstrate and validate the automated manufacturing processes to assemble fuel cell components into stacks
4. Verify installation and commissioning times (costs) for the system are reduced, by the development of the modular, containerised Balance of Plant
5. Effective recycling/reconditioning of fuel cell components

# Project POWER-UP Consortium

| Partner No. | Partner Name | Contribution | Logo | Country |
|---|---|---|---|---|
| Project Coordinator | AFC Energy plc | Technology and plant owner | | UK |
| 2 | Air Products plc | Site provision & infrastructure support, hydrogen supply | | UK |
| 3 | Zentrum fur Brennstoffzellentechnik ZBT Gmbh | CE Marking, Independent data validation | | Germany |
| 4 | GB Innomech Limited | Manufacturing automation | | UK |
| 5 | Paul Scherrer | Life cycle and cost analysis | | Switzerland |
| 6 | FAST in cooperation with European Hydrogen Association | Project dissemination | | Italy |

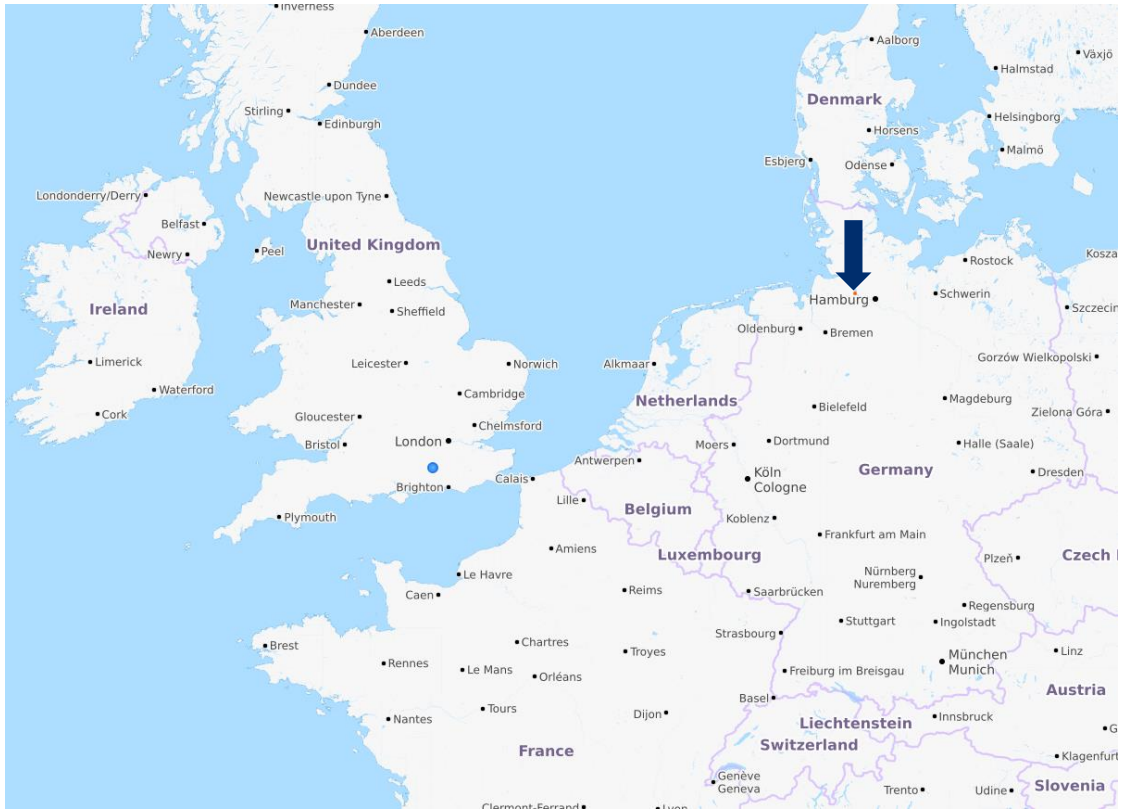
# Other key participants

| Company | Role |
|---|---|
| Foster Wheeler Energy Ltd | Gap analysis |
| Artelia GmbH | Civil & structural design, permitting. EPCM until April 2015 |
| PlantIng GmbH | Plant design, engineering & construction, EPCM from May 2015, O&M support |
| Stadtwerke Stade ( SWS) | Power off taker & MV Grid Connection |
| Siemens AG | Design, supply, commissioning and BDEW certification of power inverters |
| Georg Fischer (GF Piping Systems) | Fabrication of piping assemblies for the KORE module |
| Richard Ditting GmbH & Co. KG | Civil works sub-contractor |
| Rudolstaedter Systembau (RSB) | Building shell sub-contractor |
| Zwingmann GmbH | Piping sub-contractor |
| Hanseatische MessTechnik (HMT) GmbH & Co. KG | Electrical, C&I sub-contractor |

03

# Project POWER UP: The Site

# POWER-UP Site Location




# POWER-UP Site Preparation


Pile driving machinery and piled foundations field executed in April and May 2015

# POWER-UP Site Preparation

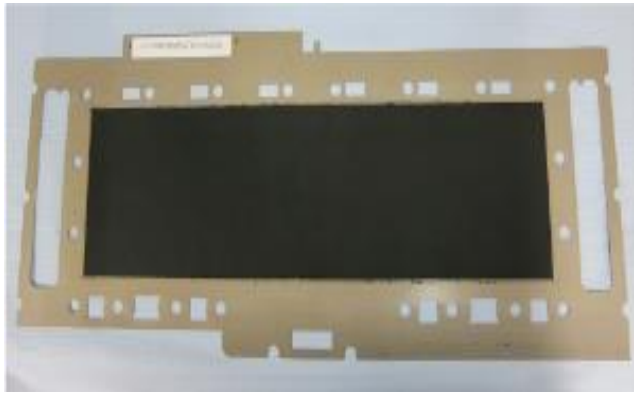
# POWER-UP Site Preparation


Site ready to accept KORE, July 2015

04

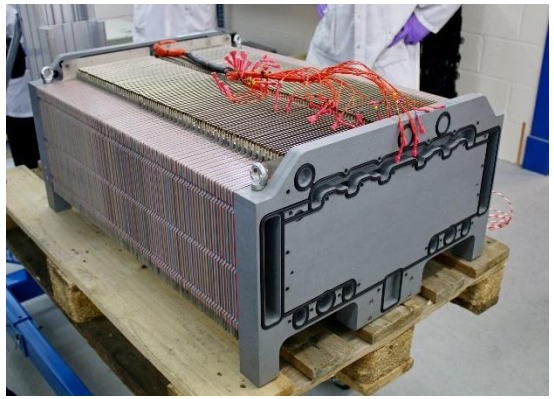
# Project POWER UP: The Fuel Cell Stack

# Overview of Components and Assembly



**Electrodes (x4848)**

Electrodes: produce the power



**Stack (x24)**

Consists of 101 fuel cells, each with 2 electrodes – one anode and one cathode

**Cartridge (x24)**

Contains the stack, local control electronics and power take off

**Balance of Plant (x1)**

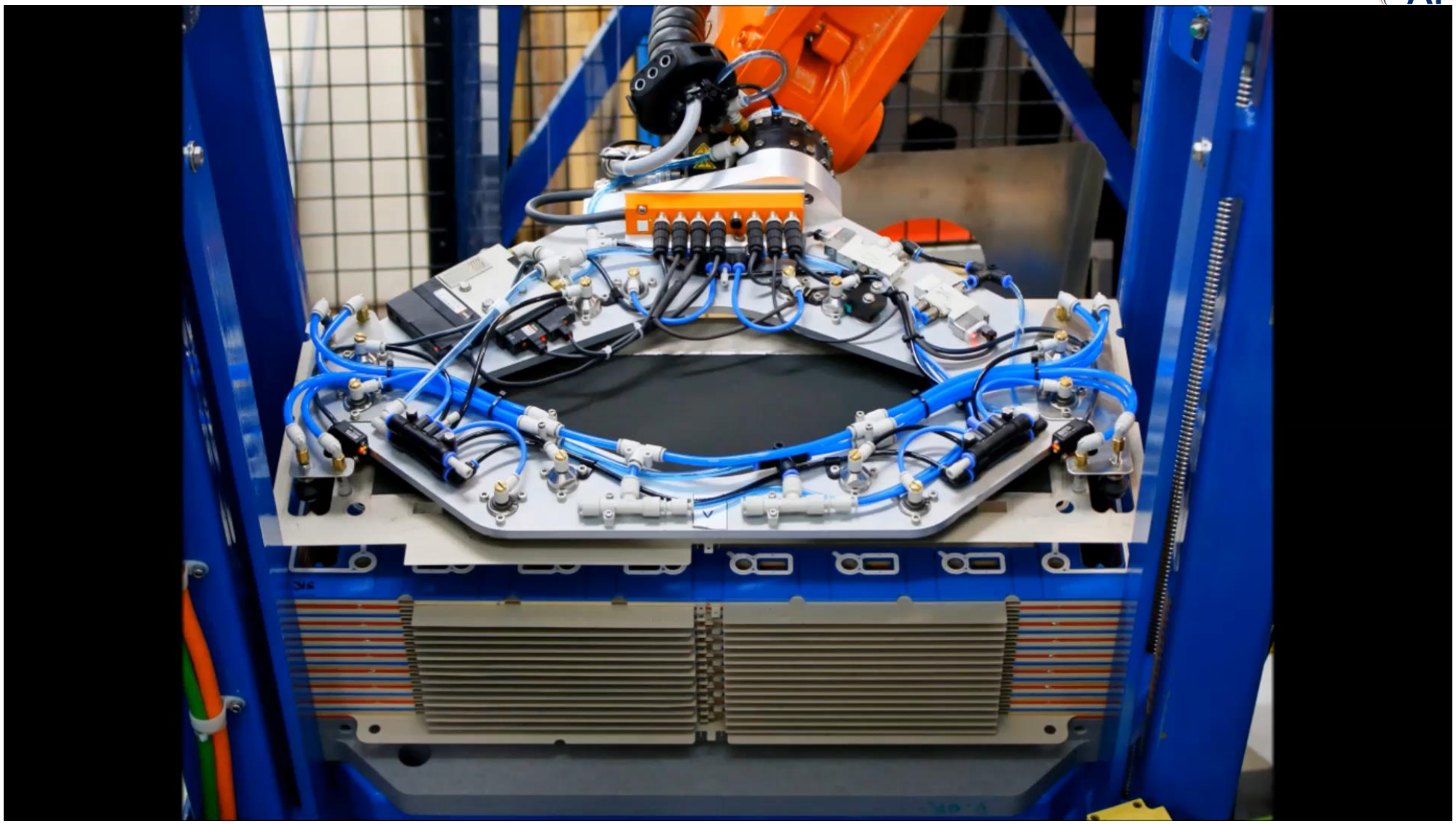
Balance of Plant: regulates fluid (potassium hydroxide electrolyte) and gas (hydrogen and oxygen) supply and management, superstructure, safety systems, C&E, integration into customer site

# Scale-up and Automation of Components and Assembly

**Automated extrusion of electrode layers**

**Automated electrode stacking**

# Scale-up and Automation of Components and Assembly



05

# Project POWER UP: The Balance of Plant

# Building the Balance of Plant – The KORE system

## Pre- assembly check of BOP ahead of shipment






# Delivery and Final Assembly of Balance of Plant to Site

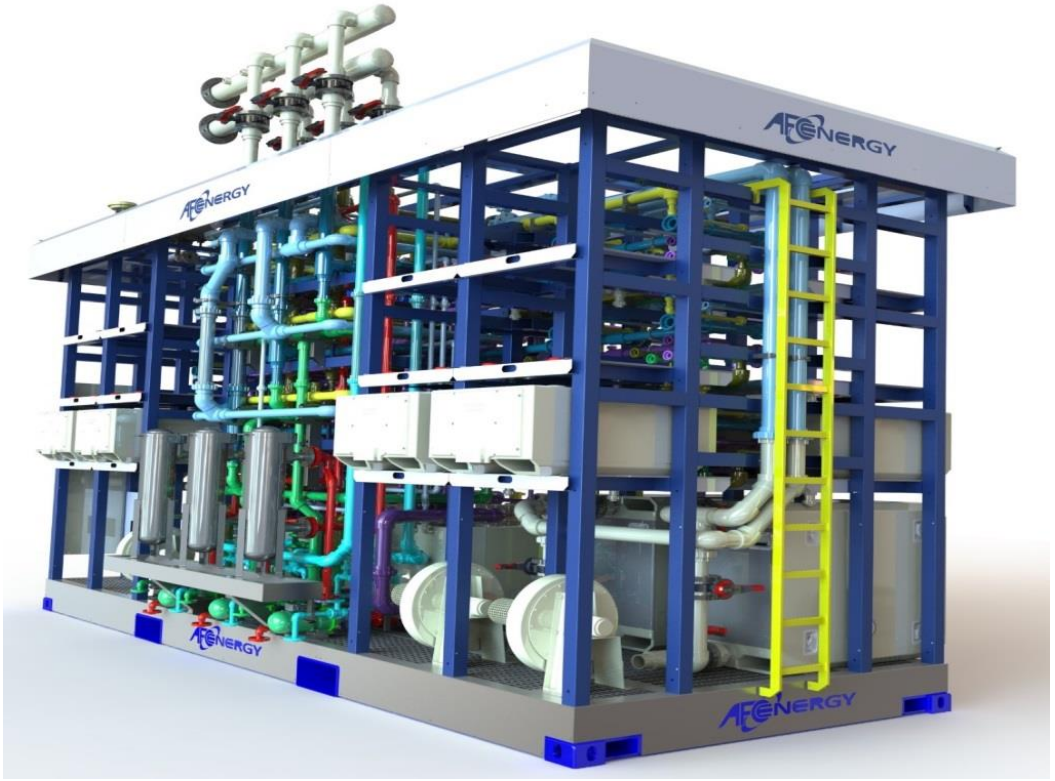




# Delivery and Final Assembly of Balance of Plant to Site

# Delivery and Final Assembly of Balance of Plant to Site

## 3D CAD model to installed facility





6th July 2015 – Balance of Plant delivered to site

30th July 2015 – First power delivered to the grid

# The Finished KORE System

# The Finished KORE System

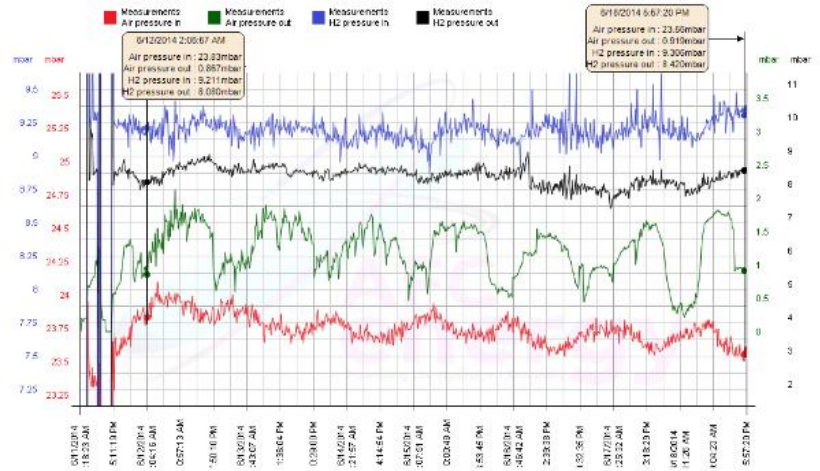
- Repeatable, stacked, modular design
- Cartridges / piping to fuel cell stacks mainly polypropylene allowing for ease of manufacture of modularised skids
- Most of the internal stack components can be recycled supporting lower cost OPEX
- Lightweight overall unit, skid mounted supply

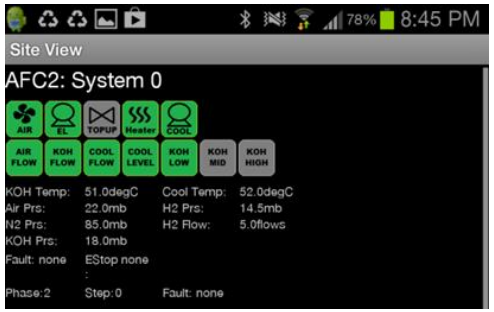
# Control, Electronics and Power

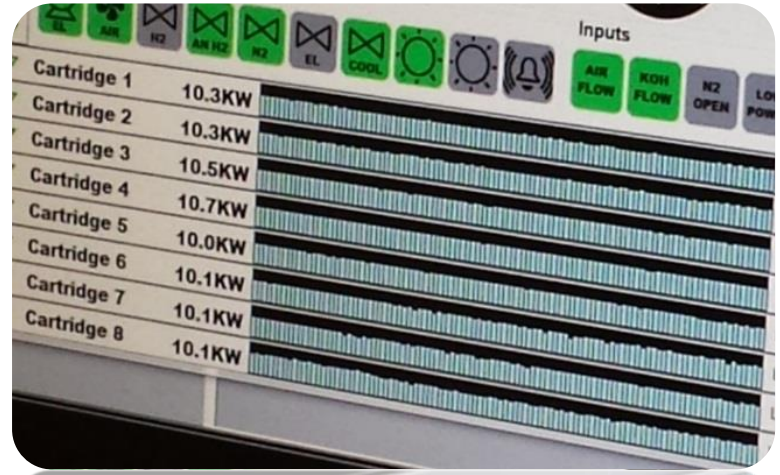

- Control System
- Cell Voltage Monitoring
- Software
- Site Integration
- Power Electronics

# Remote Monitoring

- Application for acquiring and managing data from AFC Systems
- Tool for accessing and viewing data from AFC Systems
- Notification of alarm conditions via email
- Versatile data plotting and exporting routines
- Mobile phone app





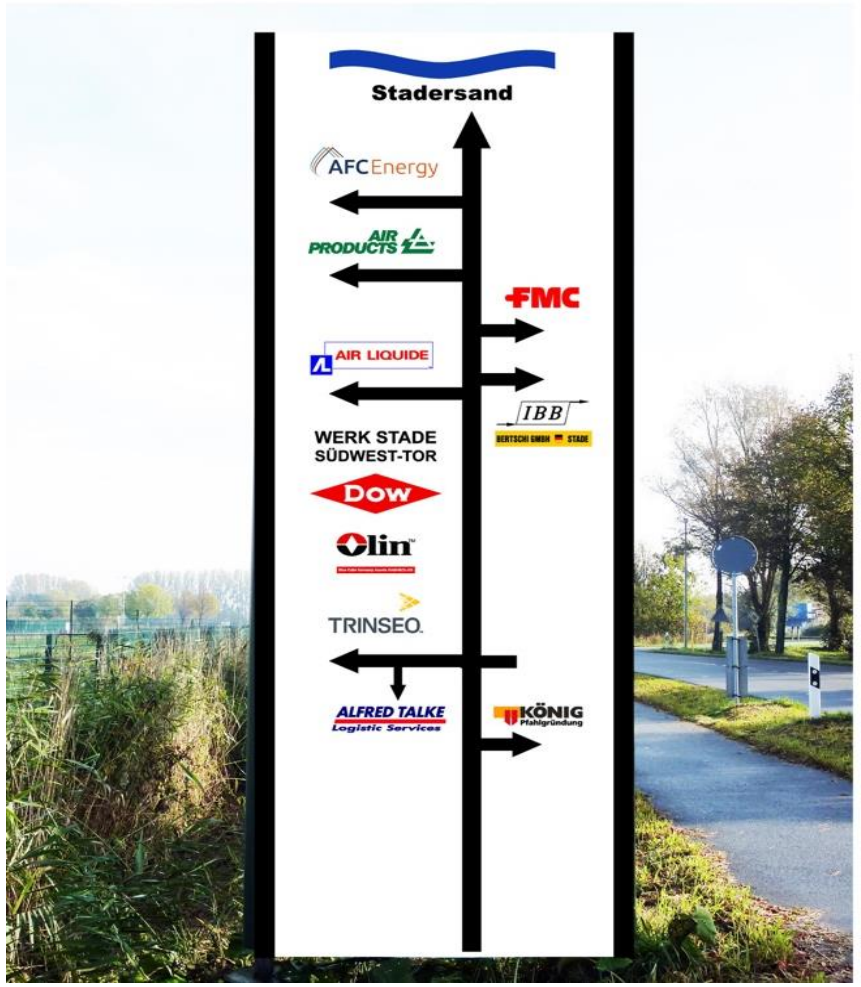
06

# Project POWER UP: Project Highlights

# Project POWER-UP – Operational Highlights

- Max power produced from KORE system = 204kW (240kW)
- Max power produced from 2 tiers = 158.4kW (160kW)
- Max power produced from 1 tier = 83.3kW (80kW)
- Max power produced from single cartridge = 10.9kW
- Max power from single cartridge on bench test = 11.7kW
- Automation of start up, operation and shutdown fully demonstrated
- > 1,000h operating time

(Design target values)



AFC Energy

Thank you for your kind attention.

www.afcenergy.com