Dr. Chris Dudfield

Chief Technology Officer
Intelligent Energy

Sponsors

Cymru Wales
GLOBALEVRI ACCELERATING ELECTRIC VEHICLE ADOPTION
IHS Markit
JM Johnson Matthey Inspiring science, enhancing life
trueform

Intelligent Energy

7th September 2017

Creating the blueprint for advanced fuel cell manufacturing

Dr Chris Dudfield
Chief Technology Officer

The objective

To raise the manufacturing readiness level for fuel cells by introducing enhanced design for assembly, automated processes for assembly, inspection and test, coupled with materials acceptance standards in order to meet 2020 targets.

About Intelligent Energy

Intelligent Energy delivers clean energy solutions for the UAV, automotive and stationary power markets. We embed our fuel cell stack technology into products in co-operation with key industry partners to create solutions which extend their capabilities. We are a global business operating out of our UK base, with additional operations currently in the US, Japan, India, China and France.

Intelligent Energy Holdings plc is listed on the London Stock Exchange (LSE: IEH.L).

Our technology strengths

Our strategy is to bring to market our Air Cooled (AC) technologies. The technology roadmap continues to focus on driving performance improvements and cost reduction, to support the commercial objectives of the business.

- Intelligent Energy's AC systems are field proven in demanding applications:
  - modular nature allows for precise scaling sub 1W to 20kW to meet customer power & form factor needs
  - providing clean DC power in a lightweight and robust package
  - simplified fuel cell system design for a cost effective power solution
  - systems can be applied across a wide range applications

Products

Focusing on air cooled fuel cell technology scaling from sub 1W to 20kW

AC64
fuel cell stack

AC64
Lightweight
fuel cell stack

Fuel Cell Modules
(FCM 800 series)
Self-contained fuel cell
power utilising AC64
technology

Gen4 fuel cell system
Utilising AC64
technology

Fuel cell power for UAVs
Fuel cell units for UAVs
utilising AC technology

Air Cooled (AC) stack technology platform

Stack Features:

- Operation on dry hydrogen and ambient air
- Robust metal cell construction
- Ideal for hybridisation with battery and or super-capacitors
- Proven durability and reliability for application environments
- Multiple configuration options providing modular and scalable solutions
- Range of stack options to fit different application requirements
- Low thermal and acoustic signature
- Series and parallel connections possible

- NEW Lightweight Air Cooled Stack

World-class facilities

Access to state of the art, research, development and production facilities.

- 2 semi automated stack production lines

- 600 square metres of fully hydrogen-enabled test space
- 90 test stations covering sub 1W-100kW+ power range systems
- 8 environmental chambers, including 2 walk in
- Close partnerships with 3rd party test houses
- Acoustic chamber facility
- Centre of excellence for leading edge fuel research and development based at the NASA building, Merritt Island, Florida

Our AC stack manufacturing expertise & capability

- Automation of critical activities
  - Gasket seal application & activation
  - Cell QC test
  - Stack Assembly
- Full materials traceability, unique cell and stack ID
- Cell assembly yield >99%
- Flexibility to handle multiple cell material combinations

Challenges for fuel cell manufacturing

- Current PEM fuel cell stack manufacturing is focused on existing volume demands
- Components selected based on bespoke quality requirements
- To meet the needs of modern auto-industry in EU, development of the manufacturing approach of all components for automated assembly is required:
  - Component incoming format and presentation techniques
  - Materials handling (multiple thin film) and fixing
  - Materials utilisation and yield
  - QC inspection
  - Digital manufacture
  - End-of Line testing
- Cost reduction and scalability to meet 2020 targets

DIGIMAN project – addressing the challenge

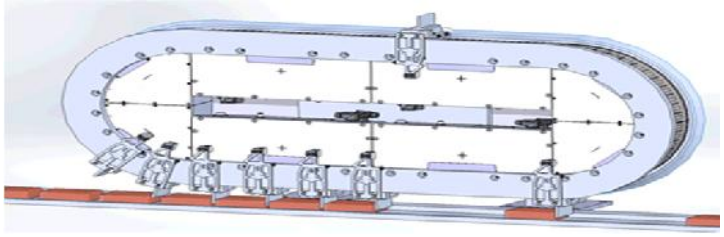
- DIGIMAN = DIGItal MANufacturing and Proof-of-Process for Automotive Fuel Cells
- FCH-01.1-2016 topic: Manufacturing technologies for PEMFC stack components and stacks
- Start Date: January 2017
- Duration: 36 months
- EU Contribution: €3.5M fully funded

Project consortium

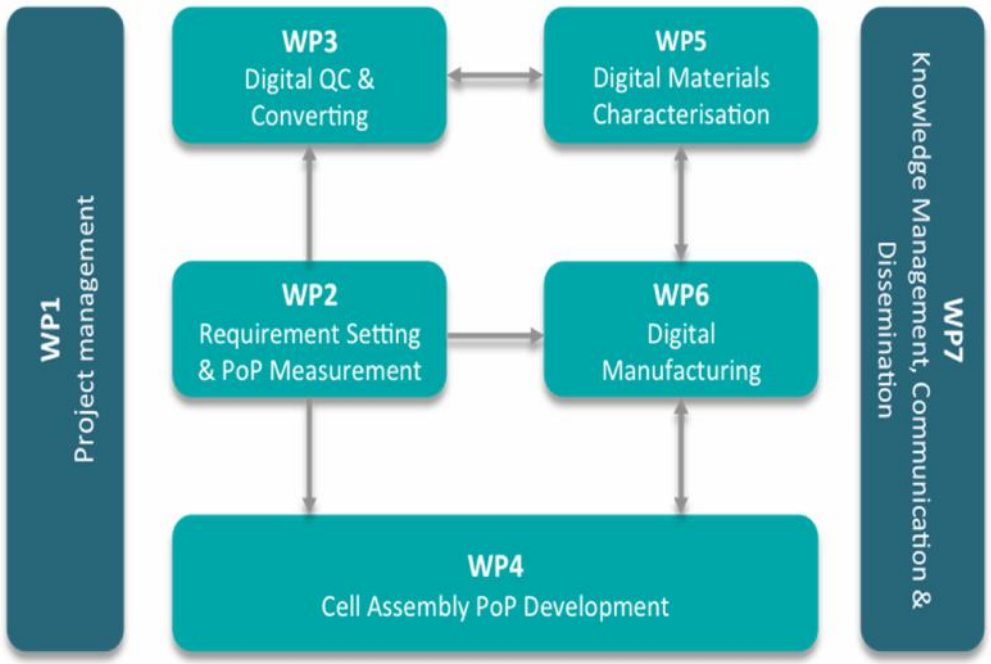
- CEA Tech – LITEN, France
  - Project Coordinator & Materials Characterisation WP leader
- Intelligent Energy Ltd, United Kingdom
  - Technical Coordinator & Digital Manufacturing WP leader
- Toyota Motor Corporation – Europe, Belgium
  - Requirement Setting & Proof of Process Measurement WP leader
- Freudenberg Performance Materials, Germany
  - GDL Digital QC & Converting WP leader
- Warwick Manufacturing Group, United Kingdom
  - Automated Cell Assembly PoP Development WP leader
- Pretexo, France
  - Knowledge Management, Communication & Dissemination WP leader

Objectives of DIGIMAN programme

- Delivering automated manufacturing maturity to fuel cell stack and components
- Establishing an integrated European supply chain for key fuel cell components
- Embedding quality in automotive stack production process to a ‘blueprint’ reference design, for full automation within an automotive value chain via PoP (Proof-of-Process) demonstrator testing and simulation tools



Project structure and work scope



In summary, Digiman aims to:

- Create a robust platform for PEM fuel cell stack production for zero emission vehicles
- Establish best practice requirements for automotive fuel cell stack production
- Demonstrate operational and supply chain cost reduction – EU centric
- Integrate digital manufacturing techniques with advanced automated production technology to check the quality of production
- Enable build-to-print machine configurations with ready to scale production capacity
- Implement capability to meet requirement of more than 50,000 fuel cell stacks per annum by 2020

Disclaimer

This presentation was prepared on behalf of Intelligent Energy Holdings plc (the "Company") in August 2017 for information and discussion purposes. No reliance may be placed for any purposes whatsoever on the information contained in this presentation or on its completeness. The Company is not under any obligation to update or keep current the information contained in this presentation. No representation or warranty, express or implied, is given by or on behalf of the Company or its respective subsidiary undertakings, affiliates, respective agents or advisers or any of such persons' affiliates, directors, officers or employees or any other person as to the fairness, accuracy or completeness of the information, or of the opinions, contained in this presentation and no liability is accepted for any such information or opinions.

NEITHER THIS PRESENTATION NOR ITS INCLUSION ON THE COMPANY WEBSITE CONSTITUTES OR FORMS PART OF ANY OFFER, INVITATION, PROMOTION OR RECOMMENDATION TO PURCHASE OR TO SUBSCRIBE FOR, OR ANY OFFER OR INDUCEMENT OR INVITATION OR COMMITMENT TO PURCHASE OR SUBSCRIBE FOR (OR ANY SOLICITATION OF ANY OFFER TO PURCHASE OR SUBSCRIBE FOR), ANY SHARES IN THE COMPANY OR ANY SECURITIES IN ANY OTHER ENTITY.

Without limitation to the foregoing (and subject to certain limited exceptions) this presentation is not for use in the United States and may not be transmitted, published or otherwise distributed in the United States. The Company's securities have not been and will not be registered under the US Securities Act of 1933 or under any applicable securities laws of any state or other jurisdiction of the United States. Certain statements (or information) included in this document constitute, or may constitute, forward-looking statements and / or financial projections which can be identified by the use of terms such as "may", "will", "should", "expect", "anticipate", "project", "estimate", "intend", "continue," "target" or "believe" (or the negatives thereof) or other variations thereon or comparable terminology. Due to various risks and uncertainties, actual events or results or actual performance of the Company may differ materially from those reflected or contemplated in such forward-looking statements and no reliance should be placed on such forward-looking statements. No statement in this presentation is intended to be nor may be construed as a profit estimate or profit forecast.


LCV
cenex