HYDROGEN REFUELLING INFRASTRUCTURE
FEBRUARY 2017

- Introduction
- Energy storage Infrastructure
- Clean Fuel Infrastructure
COMPANY INTRODUCTION
FEBRUARY 2017

ITM Power | History

• First AIM listed fuel cell & hydrogen company
• 2004 IPO | £10m | ITM.L
• 2006 Secondary | £30m
• 2012 -16 Expansion | £23m
• Two facilities in Sheffield | 70 staff
• Manufacturing business model

£18.27m projects under contract | £2.79m in negotiation | £21.06m total
ACHIEVEMENTS IN CALENDAR YEAR 2016

HYDROGEN ENERGY SYSTEMS

ORDERS OF £15.68m OVER THE LAST 12 MONTHS

Deal pipeline of £21m up 60% year-on-year

Losses decreased by 20% year-on-year

Head count unchanged

Achieved long run cost target €1m/MW

1st UK power-to-gas contract with national grid

Sold 5.25 MW of large scale electrolysers

1st opened three new refuelling stations in UK

Fuel contracts with

Toyota
Hyundai
CNG Group
Arval
Anglo American

1st Shell refuelling station on Shell forecourt

1st in USA

ITM Power
Energy Storage | Clean Fuel
Renewable Energy is Transforming the Energy Landscape

- World power generation reached 6,000GW in 2015
- Wind reached 432GW and solar reached 227GW of global installations in 2015 (~13%)
- Both need energy storage to sustain the growth rate

Source: GWEC
Source: Greentech media
UK WIND CURTAILMENT

- Evidence of grid balancing problems from Germany and Denmark
- Problems start at 20% capacity | UK hit this threshold at the end of 2013
- Wind curtailment is rising faster than wind capacity

UK wind curtailment (GWhr)

UK grid balancing market (£m)

Source: British Wind Energy Ass.
Source: REF
WHY HYDROGEN FUEL?

The Perfect Fuel

- Made from renewable power and water
- Energy storage for renewable power
- Zero carbon footprint

**WHY HYDROGEN FUEL?**

**ENERGY STORAGE | CLEAN FUEL**
ENERGY STORAGE TECHNOLOGIES

Power-to-gas is over 75% efficient | long term | low energy cost

Source: ITM Power plc
Lithium Ion System (6,300 sqft)
- Project did cost c.$53.5m
- 8MW with 4hr duration | 32MWh
- $6.7m/MW | $1.67m/MWh

Power-to-Gas System (3,530 sqft)
- Project would have cost c.$21.6m
- 8MW with 4hr duration | 32MWh
- $2.7m/MW | $0.67m/MWh

- 8MW with 12hr duration | 96MWh
- $2.7m/MW | $0.22m/MWh

Tehachapi Energy Storage Project

The Tehachapi Energy Storage Project features 604,832 lithium-ion battery cells, housed in 10,872 modules of 56 cells each, stacked in 604 racks arranged in rows.
RAPID RESPONSE ELECTROLYSER

Efficiently convert surplus renewable electricity into chemical energy (hydrogen gas)
MARKET OFFERING

Rapid Response | High Pressure | High Efficiency | MW scale

• Rapid response: less than 1s; for primary grid balancing
• High pressure: up to 80bar; for direct injection
• High efficiency: 77% measured by Thuga Group; 86% measured by RWE (with heat recovery)
• MW scale: 1MW modules available today
• Compliant: EU and USA
• Operations: 3yrs in the field
ITM REFERENCE PLANT

German Utility | Performance Evaluation

- Thüga group:
  - First PEM electrolyser in Power to Gas
  - Prequalified for secondary balancing market
  - Successfully tested for primary balancing market
  - 77% electrical system efficiency

- RWE / Westnetz
  - Second generation system
  - Utilises waste heat
  - 87% efficiency with heat recovery

ITM Power’s HGas System brings together rapid response and self-pressuring PEM electrolysis into a fully integrated package which injects hydrogen into the gas distribution network at the Mainova Aktiengesellschaft site, Frankfurt. Utilising pre-existing compliant gas mixing and grid injection infrastructure. The plant has undergone an extensive acceptance, compliance and commissioning phase before going live in December 2013. The scale was the result of a competitive tender; based on price and performance, and was commissioned ahead of schedule.

Source: ITM Power GmbH
CLEAN FUEL
WHAT IS AN FCEV REFUELLING STATION?

Buffer Tank
20bar 15m³ tank

BOC | Linde Compression
Ionic Compressor and gas storage,
600kg/day

ITM Power Electrolyser
80kg/day expandable to
500kg/day in 20ft container

Dispenser
350 and 700 bar refuelling point

Payment Unit
Card reader, touchscreen and
printer for cash register receipt

FCEV REFUELLING STATION
VEHICLES | ROLL OUT
HYDROGEN REFUELLING BUSES

Tailored to suit customer requirements

- Sized for multi MW large schemes
- Rapid response for grid balancing
- Larger stack platform enables smaller footprint
- Skid mounted options for use indoors
- Multiple modules can be operated together

BUS HRS CONFIGURATIONS

ENERGY STORAGE | CLEAN FUEL
REGULATIONS, CODES & STANDARDS

A leading role in shaping hydrogen deployment

- Secretary of BCGA Technical Steering Sub Committee 9
- Secretary and UK Expert to ISO Technical Committee 197 WG24 on HRS
- UK Expert to ISO working groups...
- ...for electrolysers, dispensers & H2 quality
- Chair of BSI PVE/3/8

COMPLIANCE
HYDROGEN ENERGY SYSTEMS
Four FCH JU projects that define UK hydrogen fuel

- Build | Own | Operate model
- 3 operational HRS by December 2016
- Siting collaboration with Shell
- Dispenser collaboration with BOC Linde

**ITM POWER HRS SITES**

**HyFive**
3 HRS in London (M25)
UK Gov Co-Funded

**H2ME**
2 Forecourt HRS
UK Gov Co-Funded

**H2ME2**
3 HRS on major routes (M4 and M1)

**BIG HIT**
Hydrogen Territory
Scottish Gov Co-Funded

**ITM POWER**
Energy Storage | Clean Fuel
FCH JU Project number: 621219

- NPL Teddington London  Opened May 2016
- CEME Rainham London  Opened Oct 2016
- Cobham M25 Shell forecourt  Opening Feb 2017
H2ME | UK

FCH JU Project number: 671438

• Beaconsfield M40 Shell Forecourt Opening Q2 2017
• Gatwick M23 Shell Forecourt Opening Q2 2017
• Forecourt integration with dispenser under the main canopy
H2ME2 | UK

FCH JU Project number: 700350

- H2ME2 1  Swindon  Q4 2017
- H2ME2 2  Birmingham Q4 2017
- H2ME2 3  TBC  Q2 2018
BIG HIT | ORKNEY

FCH JU Project number: 700092

Eday: Curtailed wind and tidal turbines
• 0.5 MW of electrolysis | 500kg storage
• Heating of school

Shapinsay: Curtailed wind
• 1MW of electrolysis
• Heating of school

Orkney Mainland:
• 75 kW FC: heat and power to marina
• H2 refuelling station | 10x Symbio FC vans
• Transport: 5x 250 kg tube trailers

POWER-TO-GAS | ORKNEY
ENERGY STORAGE | CLEAN FUEL
CLEAN FUEL FOR TRANSPORT
ITM POWER | FUEL CONTRACTS

UK stations | £10/kg | dispensing 1tonne/day by the end of 2018
FUEL CELL CAR ROLLOUT

ENERGY STORAGE | CLEAN FUEL
WHAT IS A FUEL CELL VEHICLE?

An EV drive train that’s refuelled rather than recharged

- Refuel in 3 mins
- Range 300 miles
- Managed energy export
HYDROGEN BUSES

An EV drive train that’s refuelled rather than recharged

- Refuel of 40kg in 6 mins
- Range 200 miles
- Managed energy export

Sadiq Khan said there will be no more pure diesel double-decker buses will be added to the capital’s fleet from 2018 (Source: Greater London Authority)
GREEN HYDROGEN

Strategy alternatives to ensure low carbon footprint

- Direct coupling: AMP | EMEC | CEME
- Grid balancing: NPL
- Renewable contracts: Forecourts

We're powered by Good Energy
100% renewable electricity

GREEN HYDROGEN
ENERGY STORAGE | CLEAN FUEL
CLEAN FUEL - BUSINESS AS USUAL

Enables rapid adoption of clean emission transportation
• Meets multiple policy goals - clean air and GHG targets

ITM Power Rapid Response Systems
• On-site production – no need for fuel deliveries
• High purity – made from water – “Fuel cell friendly”
• Utilises surplus renewable energy supply for carbon free fuel
• Attracts grid-balancing, demand-side response tariffs
• Addresses grid capacity constraints for Solar PV/ Wind
• Compliant, modular, low footprint - forecourt integration

Fuel cell electric vehicles
• Rapid fill (cars 3-5 minute, buses ~6 minutes)
• Long range - extended duty cycle (cars ~350 miles)
• 65% efficient, Full-power on-demand
• Variety vehicles – cars/ vans/ buses/ bin lorries

“THE ROAD TO SUSTAINABILITY”
HYDROGEN ENERGY SYSTEMS
HYDROGEN REFUELLING INFRASTRUCTURE
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