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#### **ITM Power | History**

- First AIM listed fuel cell & hydrogen company
- 2004 IPO | £10m | ITM.L
- 2006 Secondary | £30m
- 2012 -14 Expansion | £17m
- Two facilities in Sheffield | 70 staff
- Manufacturing business model



## RAPID RESPONSE ELECTROLYSER

Scalable| Rapid Response | Self pressurising



## RAPID RESPONSE HYDROGEN ENERGY SYSTEMS



## ENERGY STORAGE | CLEAN FUEL

Energy Storage Sale: Clean Fuel Bid: The Thuega Group | Germany California Energy Commission



COMMERCIAL DEAL FLOW HYDROGEN ENERGY SYSTEMS



## ELECTROLYSER PLATFORM

#### Rapid response on-site electrolysis

- Modular design
- Input water clean-up
- Power conversion
- Pressurised electrolysis
- Thermal regulation system
- Hydrogen purification
- PLC control and data comms
- Remote operation
- CE Marked
- Assistance with site approvals



## A MODULAR OFFERING HYDROGEN ENERGY SYSTEMS





#### STACK PLATFORM RAPID RESPONSE DURABILITY GAS MIXING PLANT





## CORE TECHNOLOGY

#### **PEM Stack Platform | BoP Integration**

- Modular
- Rapid response
- Self pressurising





# STACKS PLATFORM HYDROGEN ENERGY SYSTEMS



## **RAPID RESPONSE**

#### **Rigorous testing**

- PEM enables rapid modulation
- Integrated power conversion electronics
- BoP & control system



## STACK PLATFORM HYDROGEN ENERGY SYSTEMS



## **RAPID RESPONSE**

#### **Rigorous testing**

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## STACK PLATFORM HYDROGEN ENERGY SYSTEMS



## EXTENSIVE DURABILITY TESTING

#### Small & large scale testing

- Continuous & intermittent operation
- Measurement of degradation mechanisms
- Electrochemical & mechanical factors
- Development of predictive tools
- Over 200 test stations





## DURABILITY HYDROGEN ENERGY SYSTEMS



## GAS MIXING & INJECTION PLANT

#### Pressure regulation, mixing & measuring

- Measurement & regulation of hydrogen & natural gas flows
- Controlled mixing of gasses
- Ensuring gas quality requirements
- Feed in to the local distribution network





# DIRECT HYDROGEN INJECTION HYDROGEN ENERGY SYSTEMS



## PROJECT CHALLENGES

#### REALITY CHECK TEAM REQUIREMENTS TIMEFRAME RISK





## **REALITY CHECK**

### **Pioneering is tough**

- ITM believe in P2G & its benefits
- Significant learning gained
- Detailed specification
- A clear compliance pathway
- Realistic timing
- Avoid interesting!



# THE CHALLENGE HYDROGEN ENERGY SYSTEMS



# TEAM REQUIREMENTS

### **Pioneering is tough**

- Understanding of electrolyser requirements
- Understanding of plant integration & planning
- Understanding of compliance & permitting
- Use existing experience where possible
- Open & direct communication



## THE CHALLENGE HYDROGEN ENERGY SYSTEMS



## TIMEFRAME RISK

#### **General observations**

- Too long to get into contract
- Specification changes
- Time pressure for project delivery
- Clarity on acceptance criteria



# THE CHALLENGE HYDROGEN ENERGY SYSTEMS



### LESSONS LEARNT

THÜGA ENERGY STORAGE PROJECT

SCHEDULE COMPLIANCE PERMIT





# THE SCHEDULE

#### A challenging time frame

- Discussions April 2011
- Competitive tender process
- Order March 2013
- On site in September 2013
- CE marked by December 2013
- TUV permit by December 2013
- Hydrogen injection planned for 2013



## THE SCHEDULE HYDROGEN ENERGY SYSTEMS



# THE SCHEDULE

#### A challenging time frame

- Discussions April 2011
- Competitive tender process
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- On site in September 2013
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## THE SCHEDULE HYDROGEN ENERGY SYSTEMS



## COMPLIANCE

#### **CE Directives**

- Approval of pressure vessels
- Witnessed pressure tests
- Acceptance of ATEX safety case
- Electro Magnetic Compliance
- Machinery Directive documents & technical file
- 5 boxes!
- Difficult translation of technical documents



## COMPLIANCE HYDROGEN ENERGY SYSTEMS



## PERMIT TO OPERATE

#### **TUV Hessen**

- Germany requires more than a CE mark
- 3 on-site audits
- Verify plant matches documentation
- Assess integration into wider system
- Permit to operate received
- Significant learning partnerships established





## PERMIT HYDROGEN ENERGY SYSTEMS



### GAS MIXING PLANT

#### Ensuring compliance with the gas grid

- Hydrogen is injected directly onto the gas distribution network
- Hydrogen concentration must not exceed 2%
- Highly variable natural gas flow rate must be considered
- Dew point of hydrogen/natural gas mix must not exceed 200mg/m<sup>3</sup>
- Compliance: DVGW-ABG260 | TUV
- ITM have a partnership with NRM



# DIRECT HYDROGEN INJECTION HYDROGEN ENERGY SYSTEMS



## SUCCESSFUL ACCEPTANCE TESTING

#### Detailed assessment of each system parameter



### DYNAMIC OPERATION HYDROGEN ENERGY SYSTEMS





## P2G PLANT & VISITOR CENTRE HYDROGEN ENERGY SYSTEMS



## **ENERGY STORAGE IN 2014**

#### Mandates & tenders outside Germany

- California Mandate: 1.3GW by 2020; 200MW by end 2014
- Puerto Rico Mandate: 600MW linked to wind and solar
- Hawaii Energy Policy: 200MW
- Ontario IESO: 35MW RFP









# MANDATED ENERGY STORAGE HYDROGEN ENERGY SYSTEMS



### P2G PROJECTS

### **Adoption in Germany**

Strategieplattform Power to Gas

- Numerous projects throughout Germany
- Existing deployments being closely analysed
- P2G important to "Energiewende"



POWER-TO-GAS IN GERMANY HYDROGEN ENERGY SYSTEMS



## **P2G PROJECTIONS**

#### **Deutsche Bank Note**

- Rapid growth in renewable energy
- New energy storage requirements
- P2G offers a technically viable route forwards
- Call for 1,000MW of P2G electrical capacity by 2022





Germany's "Energiewende" driving power-to-gas From an idea to market launch

## POWER-TO-GAS IN GERMANY HYDROGEN ENERGY SYSTEMS



#### Summary

- Renewable power needs energy storage
- Projects must carefully define requirements
- If possible, construct a team with relevant experience
- Agree the final acceptance criteria
- Recognise the scale of compliance challenge
- Provide a realistic project timeline
- Avoid changes to the specification
- Ensure clear & open communication



## VISITOR CENTRE ANIMATION HYDROGEN ENERGY SYSTEMS





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