Green Hydrogen: An Electrolyser Manufacturers Perspective

27th May 2021

Dr Graham Cooley - CEO
Key Achievements in the period:

- Record Backlog: £124m (October 2020: £118m)
- Increasing Tender pipeline of £434.7m (Oct 2020: £324.9m)
- £172m fundraise in Oct 2020 | £30m investment by Snam
- Opened Bessemer Park | world’s largest electrolyser factory
- Sale to Linde of 24MW | world’s largest PEM electrolyser
- 100MW Humber FEED study in process
- 100MW Refhyne II announced by Shell
- Strategic partnership with Scottish Power
- Strong momentum with Linde in key strategic markets

A strong platform for rapid future growth
Rapidly Accelerating Market Dynamics:
- Renewable energy costs are falling alongside volume deployment
- Energy storage and grid balancing will be increasingly important
- Green hydrogen market is being driven by net zero targets

Transformative EU Green Hydrogen Package:
- Target spend of €150bn by 2030 (€100bn over 10yrs for Green H₂ CFDs)
- Electrolyser capacity target of 6GW by 2024 | 40GW by 2030
- Germany (5GW), Holland (4GW) Portugal (2GW), France (6GW), Spain (4GW)
- Italy (5GW), Chile (25GW), UK (5GW) full strategy Q2 2021

Why ITM Power:
- Global technology leadership and manufacturing scale
- Strong global partners: Shell, Linde, Snam, Ørsted and SPR (Iberdrola)

“The blending of hydrogen into gas networks has already begun. Without a doubt, we need hydrogen-ready backbones. We are making it happen.”
Marco Alverà, CEO, SNAM | 9th July 2020 | EU Hydrogen Strategy Launch
ITM Power product evolution:

- The pace of PEM development is fast
- Core technology (stack) improvements over 20 years
- Maximum capacity ‘building blocks’ & system designs
- Development of manufacturing processes & facilities
- 10kW to 10MW in <10 years (3 orders of magnitude)
Superior offering for the XL market:

- Acceleration of 5MW stack module underway
- Market leading electrolyser performance
- Responding to the market demand for large scale
- Standardisation and modularity at scale
- Pre-engineer into 20MW packages for rapid deployment
- Exposure to larger projects faster | Minimise on site works
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100MW design | Part of the Gigastack FEED study

Best in class | available 2 years earlier
Sale to Linde of World’s Largest PEM Electrolyser:

- A 24MW industrial turn key plant
- Linde Engineering designed the BoP
- First ILE industrial scale project
- Demonstrates Linde’s commitment to the technology
- Important new German reference plant
- World leading deployment
Refhyne II | Expansion of the Wessling Project:

- Shell to produce synthetic kerosene in Rhineland Refinery
- Shell’s vision of an eRefinery
- "Shell Energy and Chemicals Parc Rhineland"

**Partnership for new 100MW:**

- ITM Power, ITM Linde Electrolysis GmbH (ILE) and Linde
- Grant support applied for
- Construction of this plant could start in 2022
Double Capacity | Half Lead Times:

- Enhance 1GW capacity of Bessemer Park through automation
- Eliminates bottleneck of testing with 5MW power supply
- Use blueprint to set up new factory to increase capacity
- New factory in strategic location to optimise cost, quality, supply
- Increase minimum stock | Reduce lead times | Project wins
- Market supply capacity to show ability to respond

Double capacity (1 to 2GW/year) | Halve lead time (14 to <8 months)
## MANUFACTURING ACCELERATION
### HYDROGEN ENERGY SYSTEMS

**ITM Power Bessemer Park | 1GW pa Capacity Electrolyser Factory**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Atlas Way</th>
<th>Bessemer</th>
<th>Change</th>
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<tr>
<td>Production capacity</td>
<td>100MW</td>
<td>1GW+</td>
<td>10x</td>
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<tr>
<td>Effective capacity</td>
<td>&lt;30MW</td>
<td>1GW+</td>
<td>30x</td>
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<td>Test Zone</td>
<td>0.5MW (outside)</td>
<td>5MW ATEX (inside)</td>
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<tr>
<td>Automation</td>
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<td>Semi Automated</td>
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<tr>
<td>Control room</td>
<td>24hr UK</td>
<td>24hr Worldwide Systems</td>
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<tr>
<td>IT</td>
<td>Connectivity</td>
<td>100Mbps</td>
<td>1Gbps</td>
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<tr>
<td>Office + lab space</td>
<td>80 staff</td>
<td>320 staff</td>
<td>4x</td>
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<tr>
<td>Marketing suite</td>
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<td>Conferences</td>
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ITM Electrolyser Cost Reduction

- Target **50% electrolyser cost reduction** within 5 years
- Biggest gains available in PEM stack & power conversion
- Based on product **standardisation & modularisation**
- Product control enables improvement in all areas
- Leveraging buying power of partners (Linde)
- Currently tracking **ahead of target**

**Enablers for cost reduction:**

- Manufacturing volume | Semi-automation | Procurement
- Application of technology improvements
- Provision of larger systems

<€1,000/kW today @ MW scale | <€800/kW @ 10MW | <€500/kW by mid 2020’s
Green Hydrogen Cost:

- Assumptions for 2025 deliveries
- Orders placed in 2023
- Capex $500/kW ($0.5m/MW)
- LCOE $50/MWh (5c/kWh)
- 50% Load Factor
- Direct coupling to renewables

Green Hydrogen Cost Dominated by LCOE, Electrolyser Capex and Load Factor
"If electrolyser manufacturing can scale up, and costs continue to fall, then our calculations suggest renewable hydrogen could be produced for $0.8 to $1.60/kg in most parts of the world before 2050. This is equivalent to gas priced at $6-$12/MMBtu, making green hydrogen competitive with current natural gas prices and cheaper than producing hydrogen from natural gas or coal with CCS.‘‘ BNEF

Green Hydrogen Cost:

- $0.8 to $1.60/kg before 2050
- Equivalent to gas at $6-$12/MMBtu
- Lower cost than NG
- Lower cost than CCS (Blue H₂)
- Broad agreement from BNEF, Platts, Hydrogen Council and Hydrogen Europe

Green Hydrogen should be prioritised in the cost down journey because its Net Zero
Hydrogen in the 10 point plan:

- Point 1: 40GW of offshore wind by 2030
- Point 2: 5GW Hydrogen by 2030 | £240m
- Point 5: Low carbon buses
- Point 6: Sustainable shipping and aviation fuel
- Point 8: CCS | Blue hydrogen | £1bn

UK hydrogen strategy to be announced Q1 2021
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