ITM Power Plc

United Kingdom / Alternative Energy
London
Bloomberg: ITM LN
ISIN: GB00B0130H42

Initiation of coverage

RATING	**BUY**
PRICE TARGET	**GBp 43.00**
Return Potential	99.5%
Risk Rating	High

RIDING THE GREEN HYDROGEN WAVE

Green hydrogen is rightly the new magic word in the debate on how to decarbonise energy production & consumption, and the British company ITM Power ("ITM") is a pioneer in hydrogen energy systems. ITM is a leading supplier of hydrogen production plants, so-called electrolysers, including complete hydrogen refuelling stations, and looks set to be a prime beneficiary of rising demand for green (i.e. low carbon) hydrogen. Hydrogen is an excellent all-round fuel and suitable for all three energy applications: power, heat, and mobility. Furthermore, it is needed as feedstock in the chemicals and refining industries. ITM is focusing on the most promising markets: mobility (hydrogen refuelling stations for fuel cell electric vehicles (FCEVs)), power-to-gas applications to store cheap solar & wind power in the form of hydrogen, and renewable chemistry. In the mobility area, Toyota has already recognised the advantages of FCEVs and was the first manufacturer to offer a standard FC car (Toyota Mirai). In the heat area, the British town of Leeds (ca. 780k inhabitants) has started a process to switch completely to hydrogen-based heat. Shell has ordered a 10 MW electrolysis plant from ITM to use green hydrogen as feedstock in a refinery. We forecast a massive scaling up of global green hydrogen production & consumption in coming years. ITM Power's high order backlog and rising tender opportunity pipeline suggest strong sales growth in coming years, which should pave the way to break-even EBIT in FY 2022. We initiate coverage with a Buy rating and a GBp 43 price target.

High order backlog and pipeline suggest strong growth In February 2019, ITM had GBP 23.2m of projects under contract and GBP 12.5m in the final stages of negotiation, making a total order backlog of GBP 35.7m. The tender opportunity pipeline amounted to GBP 240m as of January 2019.

Sufficient financial means to grow At the end of H1/19, ITM had GBP 15.6m in cash to finance rising working capital requirements and CAPEX for a larger production site. The company is prepared for the next growth step.

FINANCIAL HISTORY & PROJECTIONS

	2017	2018	2019E	2020E	2021E	2022E
Total income (GBP m)	9.23	14.10	16.56	23.44	36.65	56.79
Revenue (GBP m)	2.42	3.28	6.56	15.44	28.65	50.79
Y-o-y growth	n.a.	35.9%	99.8%	135.3%	85.6%	77.3%
EBIT (GBP m)	-3.55	-6.49	-7.77	-5.41	-1.31	3.27
EBIT margin	n.a.	-197.8%	-118.4%	-35.1%	-4.6%	6.4%
Net income (GBP m)	-3.78	-6.12	-7.29	-5.07	-1.37	2.76
EPS (diluted) (GBp)	-1.7	-2.1	-2.2	-1.6	-0.4	0.9
FCF (GBP m)	-5.85	-9.57	-7.19	-11.39	-3.98	-1.74
Net gearing	-11.9%	-57.3%	-46.7%	-7.9%	9.8%	15.8%
Liquid assets (GBP m)	1.56	20.40	13.22	1.83	1.85	1.11

RISKS

The main risks are financing, Brexit, unfavourable regulation, technological innovation, and increasing competition.

COMPANY PROFILE

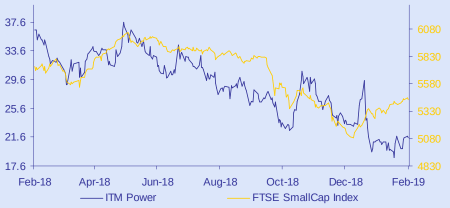
ITM Power designs and manufactures integrated hydrogen energy systems for energy storage, clean fuel production, and renewable chemistry. The group's product offering is based on PEM technology and is scalable to 100 MW. ITM is headquartered in Sheffield, UK, and has ca. 140 employees.

MARKET DATA

MARKET DATA	As of 2/19/2019
Closing Price	GBp 21.6
Shares outstanding	324.01m
Market Capitalisation	GBP 69.82m
52-week Range	19 / 38
Avg. Volume (12 Months)	425,652

Multiples	**2018**	**2019E**	**2020E**
P/E	n.a.	n.a.	n.a.
EV/Sales	15.1	7.5	3.2
EV/EBIT	n.a.	n.a.	n.a.
Div. Yield	0.0%	0.0%	0.0%

STOCK OVERVIEW



COMPANY DATA

COMPANY DATA	As of 31 Oct 2018
Liquid Assets	GBP 15.60m
Current Assets	GBP 36.52m
Intangible Assets	GBP 0.49m
Total Assets	GBP 41.22m
Current Liabilities	GBP 10.92m
Shareholders' Equity	GBP 30.30m

SHAREHOLDERS

SHAREHOLDERS	
JCB Research	12.6%
Allianz SE	11.0%
Hargreaves Peter	8.8%
Other	30.3%
Free Float	37.3%

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INVESTMENT CASE

TECHNOLOGICAL LEADERSHIP

Since its founding in 2001, ITM Power has accumulated vast knowhow and field experience in hydrogen-based energy systems and has protected its IP with a double-digit number of patents. This creates a significant entry barrier for new competitors and makes it difficult for existing competitors to threaten ITM's market position. ITM has special knowhow in the area of polymer membrane materials and production of membrane electrode assemblies (MEA). The company applies high precision engineering in both the manufacture of electrolysis cell components and their assembly, and the complex assembly of cells into useable stacks. The fact that ITM will construct the largest Proton Exchange Membrane (PEM) electrolyser worldwide (10 MW) for Shell is a clear sign of ITM's competitive edge.

ITM's electrolysers produce green hydrogen and are able to respond rapidly to fluctuating power supply and demand, thus meeting the requirement for grid balancing. They can be ramped-up and down in less than one second and are able to operate for a short time (typically 10 min) at much higher capacity than nominal load (160%). ITM's PEM electrolysers are thus capable of supplying frequency reserve and are suitable for a wider range of grid services. They are a natural complement to fluctuating wind and solar power as they can absorb excess power supply, and store energy until it is needed.

THE NEXT GROWTH STEP WILL LEAD TO A STANDARDISED AND INDUSTRIALISED PRODUCTION PROCESS

ITM is currently developing a new larger production site in Sheffield. It will have five times as much manufacturing space as ITM's current facility, and it will increase production capacity from 100 - 300 MW with the opportunity to increase it to 1 GW in the medium term. Furthermore, an upgraded power supply (7 MW) will allow for testing of larger systems. The factory will be used for product assembly, external product testing, and stack production, plus it will also include a technology centre, and sales, marketing & corporate area. ITM has designed the new factory layout to optimise product flow-through and the manufacturing process (new automated technical processes, semi-automated stack component preparation). The introduction of standardised and industrialised production processes will enable ITM to realise larger products, speed-up production, and reduce cost per MW. The new state-of-the-art production site should thus significantly increase ITM's competitiveness.

MARKET FOR GREEN HYDROGEN AT THE BEGINNING OF A LONG GROWTH PHASE

Current global hydrogen production amounts to ca. 55m t p.a., but water electrolysis only has a market share of ca. 5%. If the power needed for electrolysis comes from renewable energy, hydrogen will be an almost zero-carbon fuel. As hydrogen is applicable for power, heat, and mobility, we believe that green hydrogen will play a significant role in decarbonising the economy and forecast a massive scaling up of global green hydrogen production & consumption in coming years. A rising share of volatile wind and solar power gives hydrogen a vital role as storage for (excess) power supply and sector coupling. The first power-to-gas applications have already started commercial operation. In the mobility area, Toyota has recognised the advantages of hydrogen-driven Fuel Cell Electric Vehicles (FCEV) and was the first to offer a standard FC car (Toyota Mirai), and Hyundai is eager to follow. In the heat area, the British town Leeds (ca. 780k inhabitants) has started a process to switch completely to hydrogen-based heat. Hydrogen is an important feedstock in the refining and chemical industry and water electrolysis can substitute fossil fuel-based hydrogen production. Shell is building a 10 MW electrolysis plant in a refinery to use green hydrogen as feedstock. According to the Hydrogen Council, hydrogen production could rise tenfold by 2050 (CAGR: 7%).

SWOT ANALYSIS

STRENGTHS

- **Technological leadership** Since its establishment in 2001, ITM Power has accumulated vast knowhow and field experience in hydrogen-based energy systems and has protected its IP with a double-digit number of patents. This creates a significant entry barrier for new competitors and makes it difficult for existing competitors to threaten ITM's market position. The fact that ITM will construct the largest Proton Exchange Membrane (PEM) electrolyser worldwide for Shell is a clear sign of ITM's competitive edge.

- **ITM's PEM technology suitable for grid balancing** ITM's electrolysers are able to respond rapidly to fluctuating power supply and demand, and thus meet the requirement for grid balancing. They can be ramped up and down in less than one second and are able to operate for a short time (typically 10 min) at much higher capacity than nominal load (160%). ITM's PEM electrolysers are thus capable of supplying frequency reserve and are suitable for a wider range of grid services. They are a natural complement to fluctuating wind and solar power as they can absorb excess power supply, and store energy until it is needed.

- **Strong track record of equity raises** Access to the capital market and long-term investors backing ITM in many equity financing rounds have been crucial for the company's development. The ability to raise funds has thus been a major strength of ITM. In FY 2018, the company raised GBP 29.4m.

WEAKNESSES

- **Still loss-making** ITM Power has been loss-making for many years. This is however not a company-specific problem, but a phenomenon of an infant market waiting for take-off. As we believe that this take-off is imminent, we expect ITM to be at the beginning of a phase of strong growth which will lead to break-even within a few years.

- **Balance sheet not strong enough for many large projects** Large projects can take more than a year and require high working capital. Given the rather small balance sheet of the company, the number of large projects that can be executed in parallel with the current financial means is limited. The strategic agreement with Sumitomo, however, has the potential to increase ITM's financial flexibility.

- **Cost overruns in "first-of-a-kind" projects** "First-of-a-kind" projects have a higher execution risk and can lead to higher than anticipated costs, as reported in the H1/19 results. With increasing experience, the number of such projects and thus the risk of cost overruns should however fall.

OPPORTUNITIES

- **Strong market growth for green hydrogen** Mounting pressure to decarbonise the economy in all three energy areas power, heat, and mobility is causing strongly increasing demand for green hydrogen. Furthermore, green hydrogen can play a vital role in integrating large quantities of volatile solar and wind power into the grid without compromising its stability. In addition, industry demand for green hydrogen offers enormous growth potential. Green hydrogen can substitute fossil fuel based hydrogen as a feedstock in the refining and chemicals industry.

- **Improving hydrogen regulation** A lot of countries and regions have introduced legislation to decarbonise the economy in general and to support green hydrogen. The first movers in hydrogen regulation are Japan, Germany, the UK, California, and South Korea. We expect further improvements in hydrogen regulation and more countries/regions to follow the first movers.

- **Standardisation and industrialisation of production** ITM is developing a larger production site with a much higher capacity and upgraded power connection. On this site, ITM will establish standardised and industrialised production processes. This will enable ITM to realise larger products, speed up production, and reduce cost per MW. The new state-of-the-art production site should thus increase ITM's competitiveness.

THREATS

- **Battery Electric Vehicle (BEV) versus Fuel Cell Electric Vehicle (FCEV)** Currently, most car manufacturers are investing significantly in BEV development as power is currently more readily available than hydrogen, and BEVs promise quicker returns than FCEVs. However, continuous improvements in hydrogen infrastructure and the sustainable advantages of FCEVs (quicker refuelling and longer range) look set to increase FCEV market share in the medium term. Recently, Hyundai followed Toyota on the FCEV pathway and announced investments of ca. €6bn in fuel cell-based mobility.

- **Brexit** With Great Britain leaving the EU, trade relations between the two will probably worsen and in the worst case, tariffs could be established. This could harm ITM's market position in the EU. Furthermore, EU funding will no longer be available for ITM Power Plc. Via its EU subsidiary, ITM Power GmbH, application for the same funds is, however, still possible.

- **Financing** ITM is still loss-making and will face high working capital requirements for large projects. The company's growth trajectory may be jeopardised unless further external financing is available.

VALUATION

Our valuation of ITM Power is based on a discounted cash flow (DCF) model that discounts future free cash flows back to present value. Our DCF model yields a fair shareholder value of GBp 43 per share.

In order to determine ITM's cost of equity, we use our proprietary multi-factor risk model, which takes into account company-specific risk factors, such as management strength, balance sheet, financial risk, competitive position, and company size. We assume a cost of equity of 12.3%. Our calculation is based on a risk-free rate of 0.75% and a market risk premium of 5.0%.

For the cost of debt we assume an interest rate of 8.0%. With a terminal effective tax rate of 20%, the financing costs after tax are 6.4%. Our targeted capital structure assumes an equity / debt ratio of 75% / 25%. The WACC (Weighted Average Costs of Capital) thus amounts to 10.8%.

In our DCF model we distinguish three planning periods:

- We have carried out a detailed estimate for the planning period FY 2019E - FY 2021E (three years). We forecast the profit and loss account as well as the balance sheet and the cash flow statement in detail.
- For the planning period FY 2022E - FY 2033E (12 years), parameters relevant to the valuation (profit and loss account, CAPEX, working capital, amongst others) are estimated.
- For the terminal period we assume a constant growth in sales, a constant EBIT margin and a constant tax rate.

Detailed estimates for the fiscal years 2019E - 2021E are outlined in the chapter “Financial History and Outlook”. For the period FY 2022E - FY 2033E we assume:

- a sales growth rate declining from 77.5% to 3%;
- an EBIT margin increasing from 6.4% to 12.0%;
- an effective tax rate of 20%.

For the terminal period we assume a sales growth rate of 3%, an EBIT margin of 12.0% and a tax rate of 20%.

At the end of FY 2018, ITM had a cash position of GBP20.4m and no financial debt. This results in a net cash position of GBP20.4m.

Figure 1: Valuation model

DCF valuation model All figures in GBP '000	2019E	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Net sales	**6,560**	**15,438**	**28,650**	**50,791**	**78,726**	**106,281**	**130,339**	**156,644**
NOPLAT	**-7,766**	**-5,412**	**-1,311**	**3,094**	**5,925**	**7,972**	**9,883**	**12,040**
+ depreciation & amortisation	1,915	2,103	2,503	2,313	2,080	2,929	4,342	5,920
Net operating cash flow	-5,852	-3,309	1,192	5,406	8,005	10,901	14,225	17,959
- total investments (CAPEX + WC - grants)	-1,813	-8,418	-5,116	-6,813	-9,092	-10,559	-12,241	-13,502
Capital expenditures	-8,562	-10,107	-6,887	-5,739	-8,316	-10,444	-11,849	-13,087
Working capital	749	-3,310	-3,229	-5,073	-3,776	-2,114	-1,392	-415
Grants received	6,000	5,000	5,000	4,000	3,000	2,000	1,000	0
Free cash flows (FCF)	-7,665	-11,727	-3,924	-1,406	-1,087	343	1,984	4,458
PV of FCF's	**-7,493**	**-10,343**	**-3,123**	**-1,010**	**-705**	**200**	**1,047**	**2,122**

All figures in thousands	
PV of FCFs in explicit period (2019E-2033E)	17,640
PV of FCFs in terminal period	100,021
Enterprise value (EV)	117,661
+ Net cash / - net debt	20,403
+ Investments / minority interests	0
Shareholder value	138,064
Diluted number of shares	324,009
Fair value per share in GBp	42.6

WACC	10.8%
Cost of equity	12.3%
Pre-tax cost of debt	8.0%
Tax rate	20.0%
After-tax cost of debt	6.4%
Share of equity capital	75.0%
Share of debt capital	25.0%
Price target in GBp	43.0

		Terminal growth rate					
WACC	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
6.8%	90.2	99.3	110.6	124.8	143.2	168.3	204.1
7.8%	69.3	75.1	82.0	90.2	100.4	113.3	130.0
8.8%	54.8	58.6	63.1	68.3	74.5	82.0	91.2
9.8%	44.1	46.8	49.8	53.3	57.3	62.1	67.7
10.8%	36.1	38.0	40.2	42.6	45.4	48.5	52.2
11.8%	30.0	31.4	32.9	34.7	36.6	38.8	41.3
12.8%	25.1	26.2	27.4	28.6	30.0	31.6	33.4
13.8%	21.3	22.1	23.0	23.9	25.0	26.1	27.4

* for layout purposes the model shows numbers only to 2026, but runs until 2033

Source: First Berlin Equity Research

The DCF model yields a fair value of GBP 138.1m. Based on a diluted number of 324,009,401 shares, this results in a fair value of GBp 43 per share.

COMPANY PROFILE

ITM Power designs and manufactures integrated hydrogen energy systems for energy storage, clean fuel production, and renewable chemistry. The company's electrolysers are based on the Proton Exchange Membrane (PEM) technology and produce hydrogen from power and water. The group's product offering is based on a standardised 2 MW module, and the current design is scalable to 100 MW. Thanks to its rapid response ability, ITM's products meet the requirement for grid balancing. The technology is designed to meet specific requirements regarding pressure, flow rate, and purity. Furthermore, the company builds, owns and operates complete hydrogen fuel stations for both cars and larger transport vehicles such as buses and lorries. ITM was founded in 2001 and floated on the Alternative Investment Market (AIM) of the London Stock Exchange in 2004. Financial reporting is based on the IFRS standard, and ITM's current financial year (2019) ends on 30 April. The company is headquartered in Sheffield, UK, has subsidiaries in Germany, the US, and Australia, and ca. 140 employees.

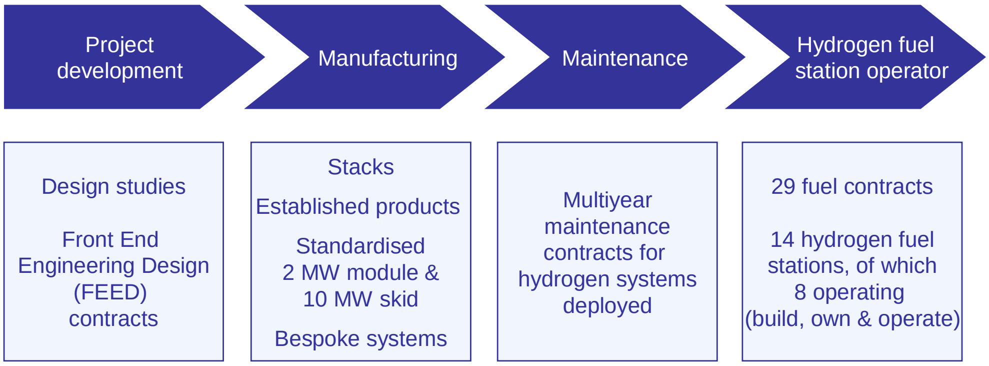
Company strategy

ITM is focused on the sale of large scale hydrogen solutions. Existing product designs are used to form a suite of standard products, as well as offering larger scale bespoke solutions (>2 MW up to 100 MW). The building of modular systems allows ITM to access tenders with a product capacity that suits potential customers. The company is expanding into new markets to drive sales. Based on its position as a hydrogen refueller, ITM plans to increase hydrogen sales as fuel cell vehicle adoption accelerates. The Board's key objective is reaching break-even.

Value chain

ITM covers a large part of the hydrogen value chain (see figure 2). It offers design studies, FEED contracts, and consultancy to develop hydrogen projects. In the manufacturing area, ITM is a system integrator for electrolysers and hydrogen fuel stations, and a stack producer. For hydrogen systems deployed to customers, the company offers multiyear maintenance contracts. Furthermore, as an owner and operator of hydrogen fuel stations, ITM sells hydrogen to its fuel clients.

Figure 2: ITM's coverage of the hydrogen value chain



Source: First Berlin Equity Research, ITM Power Plc

Production Sites

ITM Power has two main sites in Sheffield, the Manufacturing & Testing Facility and the Research & Development Facility. The manufacturing site has a production capacity of 100 MW and covers an area of 10,000 square feet. It has fully flexible rooms with single cable connection enabling rapid changes in format and functionality. The facility includes:

- High pressure refuelling station
- Mobile refuelling station
- Power-to-Gas testing
- 1MW commissioning substation
- External commissioning bays

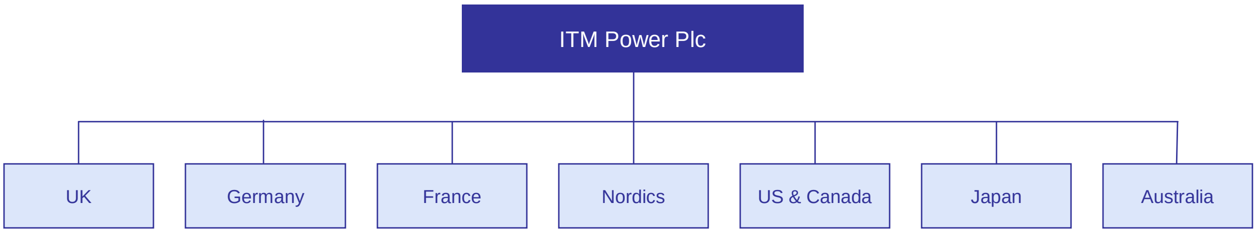
The Development Facility comprises custom laboratory facilities and accommodates specialist equipment for ongoing durability and optimisation of ITM's core materials and processes.

ITM is currently developing a new larger production site in Sheffield which covers an area of 30,000 m^2 and offers floor space of 11,610 m^2. The site has a 7 MW power supply allowing testing of larger systems. It will be used for product assembly, external product testing, and stack production, and will also contain a technology centre, and sales, marketing & corporate area. The new factory will increase manufacturing space fivefold, and production capacity from 100 MW to 300 MW, with the option to further increase it to 1,000 MW in the medium term. The layout of the new factory optimises product flow-through, and a new manufacturing process includes new automated technical processes, such as semi-automated stack component preparation.

Salesforce

ITM places agents in key territories to position the company as a developer and supplier of electrolyser products. Currently, the company is active in seven territories (see figure 3).

Figure 3: Salesforce



Source: First Berlin Equity Research, ITM Power Plc

Clients

ITM's clients often come from the utilities, automotive, oil & gas, and chemicals sectors. Among them are reputable multinationals such as Shell, BOC Linde, RWE, Engie, Toyota, Honda, Hyundai, Anglo American, and large national utilities such as National Grid, Northern Gas Networks, Cadent, Gasunie, and Thüga.

Suppliers

ITM's main suppliers are Linde (compressors, storage, dispenser), Siemens (control systems), and ABB (power suppy).

Income generation

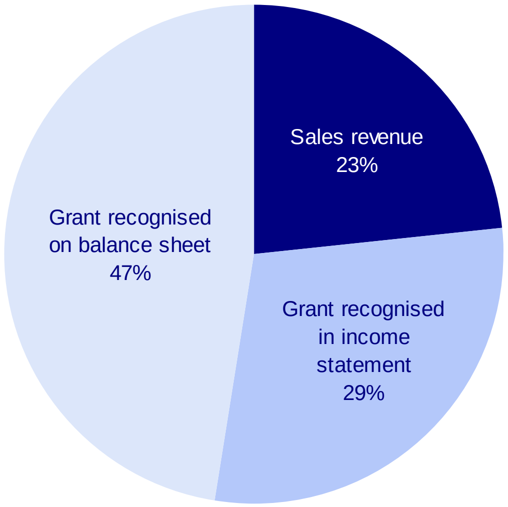
Income is generated via product & service sales and grant funding. Five main revenue streams, which are accounted for in the income statement, can be identified:

1. The sale of systems comprising both electrolysers and full systems such as hydrogen fuel stations.
2. Revenues from design and consultancy. These often precede sales of bespoke systems. Examples are design studies or Front End Engineering Design (FEED) contracts that define solutions for customised systems.
3. Maintenance revenues are generated from maintenance contracts. These revenues are recurrent and will increase with continuing system deployments.
4. Fuel sales revenue come from hydrogen fuel stations which are owned and operated by ITM.
5. Grant funding for innovation and scale up. ITM receives grants from grant bodies such as UK ministries or the EU for the technical advancement of the electrolyser product. In the income statement, grants are a separate line item.

ITM generates further income from grants recognised on the balance sheet. This income comprises grant income against assets.

Total project income (FY 2018: GBP 14.1m) is split into sales revenues (FY 2018: GBP 3.3m, 23% of total project income) grants recognised in the income statement (FY 2018: GBP 4.1m, 29% of total project income), and grants recognised on the balance sheet (FY 2018: GBP 6.7m, 47% of total project income, see figure 4).

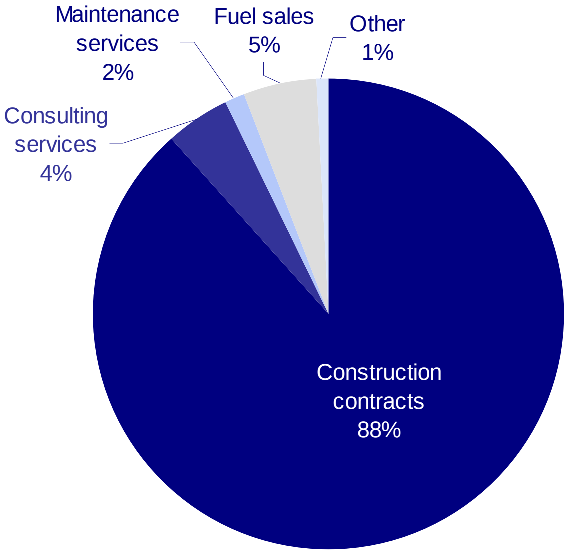
Figure 4: Total project income (sales and grants receivable) in 2018



Source: First Berlin Equity Research, ITM Power Plc

The sales revenue split (see figure 5 overleaf) shows that the overwhelming revenue share (88% of total revenues) in 2018 stems from construction contracts. Fuel sales amounted to 5% of total revenues, sales from consulting services 4%, and maintenance services sales 2% of total revenues.

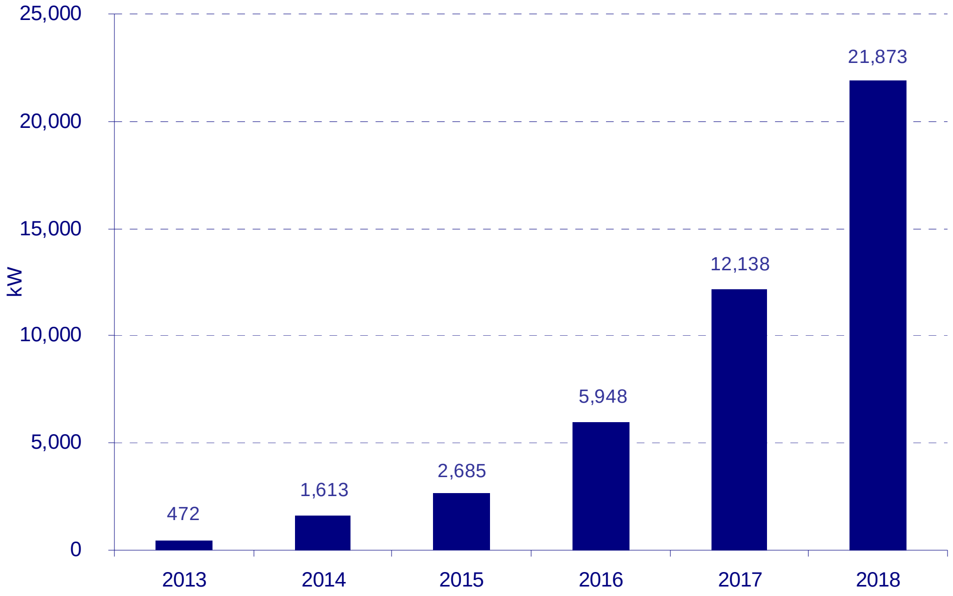
Figure 5: Revenue split, income statement, 2018



Source: First Berlin Equity Research, ITM Power Plc

Maintenance services sales were still low in FY 2018 at only GBP 48k. However, we forecast them to grow strongly as they are recurrent, and new plants are usually sold together with a maintenance contract. Electrolyser system capacity, which ITM has under contract, has increased significantly in recent years and reached almost 22 MW in 2018 (FY 2017: 12 MW, see figure 6).

Figure 6: Electrolyser system capacity under contract in kW



Source: First Berlin Equity Research, ITM Power Plc

Fuel sales jumped to GBP 161k based on 16 t sold in FY 2018. In FY 2017, ITM sold ca. 2 t hydrogen (+700% y/y). The number of fuel contacts increased to 20 from 14 in FY 2017. Fuel sales stem from the eight operating fuel stations ITM owns and operates, which, except for one in the US, are situated in the UK (see figure 7). By the end of Q1 2020, seven further British fuel stations are slated to have opened, increasing the hydrogen refuelling station (HRS) portfolio to 15. The portfolio has a hydrogen production capacity of 3,400 kg per day or 1,241 t per year. Assuming (an unrealistic) 100% capacity utilisation and a hydrogen price of 10 GBP/kg for cars and 6 GBP/kg for busses, the portfolio's maximum annual sales would be GBP 10.4m. In the medium-term, the British mobility programmes, in which ITM has positioned itself as a key partner for refuelling through electrolysis, will drive refuelling station sales.

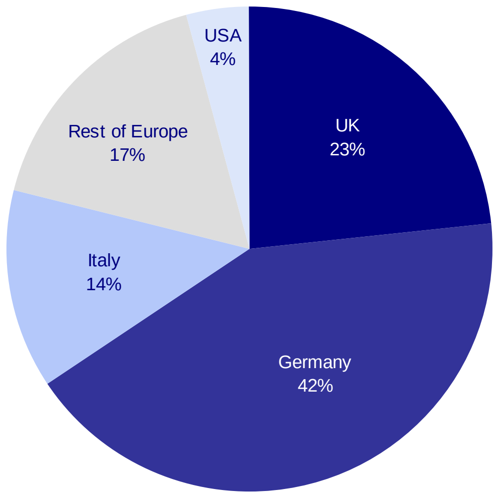
Figure 7: ITM's portfolio of hydrogen refuelling stations

No.	Hydrogen Refuelling Station (HRS)	Status	Opening	Electrolyser (kg/day)	Dispenser (kg/day)	Maximum sales in GBP (p.a.)
1	Riverside, USA	open	2015	100	200	365,000
2	Rotherham	open	2015	100	570	365,000
3	Teddington	open	2016	200	570	730,000
4	Rainham	open	2016	100	570	365,000
5	Cobham	open	2017	100	570	365,000
6	Beaconsfield	open	2017	100	570	365,000
7	Swindon	open	2018	100	570	365,000
8	Kirkwall	open	2018	400	200	1,460,000
9	Gatwick	under construction	Q2/2019	100	570	365,000
10	Birmingham Bus	under construction	Q3/2019	1,400	1,100	3,066,000
11	Birmingham Public		Q2/2019		570	
12	Derby	under construction	Q2/2019	100	570	365,000
13	Central London	funded	Q1/2020	200	570	730,000
14	W London	funded	Q1/2020	200	570	730,000
15	South England	funded	Q1/2020	200	570	730,000
Sum				**3,400**	**8,340**	**10,366,000**

Source: First Berlin Equity Research, ITM Power Plc

The geographical sales split shows that Europe (including UK) is ITM's key market. In FY 2018, Germany was ITM's most important national market (42% of total sales, or GBP 1.4m), followed by the UK (23%, GBP 0.8m). Italy's share was 14%, and the Rest of Europe's 17%. In the US, ITM generated 4% of total sales (see figure 8 overleaf).

Figure 8: Geographical sales split in 2018



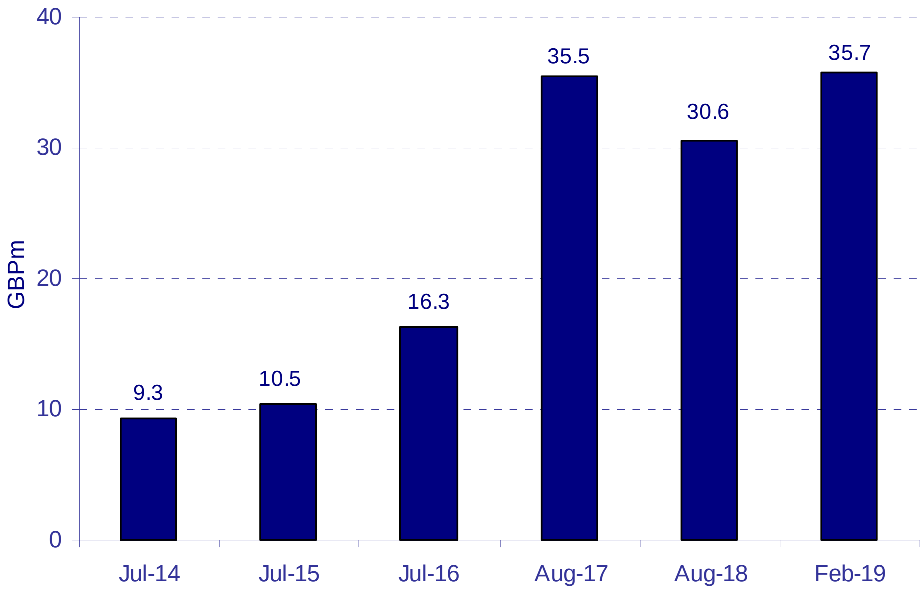
Source: First Berlin Equity Research, ITM Power Plc

Order entry, backlog, and pipeline

The tender opportunity pipeline contains projects tendered in the last 12 months that are expected to be executed within the next three years. In August 2018, the tender opportunity pipeline amounted to GBP 250m (September 2017: GBP 200m, +25%). In January 2019, the tender opportunity pipeline was slightly lower at GBP 240m, representing 36 commercial tender responses. Average project size increased y/y from GBP 3.5m to GBP 6m.

In August 2018, order entry amounted to GBP 23m, up 5% y/y. Projects under contract or in the final stages of negotiation with management being absolutely certain that a contract will be signed, amounted to GBP 30.6m in August 2018, down from GBP 35.5m in August 2017. In February 2019, this figure increased to GBP 35.7m (see figure 9).

Figure 9: Projects under contract or in final stages of negotiation



Source: First Berlin Equity Research, ITM Power Plc

A sector split of the projects under contract or in the final stage of negotiation (order backlog) from February shows that the order backlog of the industrial sector amounts to GBP 14.6m due mainly to the large Shell order (10 MW). The order backlog of the fuel sector is GBP 13.1m due mainly to fuel station construction contracts. The power-to-gas sector's order backlog is GBP 2.2m (see figure 10).

Figure 10: Sector split of projects under contract or in final stage of negotiation

Sector	Negotiation / Contract in GBPm
Industrial	14.6
Fuel	13.1
Power-to-gas	2.2
Maintenance	0.4
Other	5.4
Sum	**35.7**

Source: First Berlin Equity Research, ITM Power Plc

The geographical mix of the order backlog shows that the company's global footprint is broadening. The UK is the top market followed by Germany. Between them, the two countries accounted for almost ¾ of the total backlog. The remainder comes from France, Japan, Australia, North America, and Benelux.

COMPETITIVE POSITION

Given ITM's vast knowhow and field experience in hydrogen-based energy systems and its protected IP (double-digit number of patents), we believe that the company's competitive position is very strong. Alkaline electrolysis (AEL) is certainly a strong rival to Proton Exchange Membrane (PEM) technology. But the latter is a natural complement to fluctuating wind and solar power due to its rapid response capability, and is thus suitable for a wider range of grid services.

PEM electrolysis knowhow is still concentrated among a low number of players. On the one hand, hydrogen energy system providers, which are usually vertically integrated, execute many manufacturing steps themselves. On the other hand, there are only a few suppliers of key components such as membranes or membrane electrode assemblies (MEA).

We view companies that focus on hydrogen production plants and are listed on the stock exchange as ITM's main competitors (i.e. Hydrogenics, McPhy Energy, and NEL). These hydrogen pure plays have a strong technological base, access to growth financing via the stock market, are more agile than large groups, and have a clear focus on their core products and markets. We will describe them in more detail below. Global players such as Siemens and Thyssenkrupp (via its joint venture Thyssenkrupp Uhde Chlorine Engineers (TKUCE)) are also significant competitors, as they are financially strong and have vast technological experience. Non-listed smaller players such as H-TEC Systems or Sunfire often find it difficult to attract enough capital to finance growth.

Figure 11: Electrolyser suppliers

No.	Company	Technology*	Country	Owner	Established	Employees	Products
1	H-TEC SYSTEMS GmbH	PEMEL	Germany	GP JOULE GmbH	1997	n.a.	Electrolysers, stacks
2	HydrogenPro AS	AEL	Norway	R. Espeseth et al.	2013	n.a.	Distributor of THE electrolysers
3	Hydrogenics Corp.	PEMEL/AEL	Canada	publicly listed	1995	>160	Electrolysers, fuel stations, fuel cells
4	ITM Power Plc	PEMEL	UK	publicly listed	2001	140	Electrolysers, fuel stations
5	McPhy Energy S.A.	AEL/PEMEL	France	publicly listed	2008	80	Electrolysers, fuel stations, storage
6	NEL ASA	PEMEL/AEL	Norway	publicly listed	1927	>200	Electrolysers, fuel stations, storage
7	Siemens AG	PEMEL	Germany	publicly listed	1847	380,000	Electrolysers
8	Sunfire GmbH	SOEL	Germany	n.a.	2010	n.a.	Electrolysers, fuel cells
9	TKUCE GmbH	AEL, CAEL	Germany	ThyssenKrupp/De Nora	2015	n.a.	Electrolysers

* AEL: Alkaline Electrolysis, CAEL: Chlorine-Alkaline Electrolysis, PEMEL: Proton Exchange Membrane Electrolysis, SOEL: Solid Oxide Elextrolysis

Source: First Berlin Equity Research

The Canadian **Hydrogenics Corporation** offers industrial hydrogen generators (both alkaline and PEM), energy storage & fuelling solutions, and fuel cell power systems. Hydrogenics is headquartered in Mississauga, Canada with manufacturing facilities located in Germany, Belgium, and the United States, and has more than 160 employees. In 2017, revenues amounted to $48.1m, and the operating result was $-8.7m. The OnSite Generation segment, which includes the design, development, manufacture and sale of hydrogen generation products, reported $25.0m in sales. In January 2019, the French multinational Air Liquide acquired 18.6% of Hydrogenics for €18m. Both companies have also entered into a technology and commercial agreement to jointly develop PEM electrolysis technologies.

The French company **McPhy Energy** designs, manufactures, and integrates hydrogen equipment. It has three centres of development, engineering and production in Europe (France, Italy, Germany), and offices in Singapore, UAE, and the US. The company has roughly 80 staff. McPhy offers both alkaline and PEM electrolysers, hydrogen refuelling stations, and hydrogen storages systems. In 2018, McPhy's revenues declined 21% to €8m. In 2017, the operating result amounted to €-6.5m. In June 2018, the French utility EDF invested €16m for a 21.5% stake in McPhy.

Nel ASA is a Norwegian hydrogen company delivering electrolysers (both alkaline and PEM), hydrogen fuelling technology, and hydrogen energy solutions. The company started commercial sales of electrolysers in the 1970s and has installed more than 3,500 units. Nel has production facilities in Norway and the US, and more than 200 employees. In 2017, sales amounted to NOK 286.4m (ca. €31m), and the operating result was NOK -117.2m (ca. €-12.5m).

For a peer group comparison, we also include the main listed fuel cell producers (Plug Power, Ballard Power Systems, Fuel Cell Energy, and Ceres Power). The comparison is based on analysts' consensus estimates for 2018 - 2020 (source: Bloomberg). Figure 12 shows that the industry will not be profitable until 2020. A comparison of earnings multiples is thus not meaningful.

Figure 12: Peergroup

Peergroup - Key Figures

Company	LC	Price in LC	MC in LC m	EV in LC m	exchange rate	Price in €	MC in €m	EV in €m
Hydrogenics	USD	7.87	149.4	138.6	0.8816	6.94	131.7	122.2
McPhy Energy	EUR	4.79	69.9	57.1	1.0000	4.79	69.9	57.1
NEL	NOK	4.98	5,973.1	5,494.4	0.1029	0.51	614.6	565.4
Plug Power	USD	1.69	394.4	614.9	0.8816	1.49	347.7	542.1
Ballard Power Systems	USD	3.60	834.5	817.5	0.8816	3.17	735.7	720.7
Fuel Cell Energy	USD	0.75	83.9	237.5	0.8816	0.66	74.0	209.4
Ceres Power	GBp	144.50	219.9	213.5	1.1519	1.66	253.3	245.9

Peergroup - Key Figures

Company	Sales in €m			EBITDA in €m			EBIT in €m			EPS in €		
	18e	19e	20e	18e	19e	20e	18e	19e	20e	18e	19e	20e
Hydrogenics	29.1	45.0	69.5	-7.8	-2.4	4.6	-8.6	-7.4	2.7	-0.74	-0.29	0.13
McPhy Energy	8.0	10.9	15.0	-7.0	-6.7	-6.1	-8.3	-8.4	-9.0	-0.55	-0.54	-0.51
NEL	51.8	65.8	88.6	-9.7	-2.6	4.8	-15.0	-5.0	-1.8	-0.01	0.00	0.00
Plug Power	157.7	201.7	248.4	-18.3	1.9	29.0	-57.7	-23.5	-2.6	-0.26	-0.19	-0.03
Ballard Power Systems	80.4	91.1	124.9	-11.1	-5.0	9.3	-16.9	-11.7	0.3	-0.10	-0.06	0.00
Fuel Cell Energy	77.7	80.5	120.3	-30.0	-24.9	-17.3	-38.9	-28.3	-24.1	-0.65	-0.55	-0.40
Ceres Power	7.5	15.8	17.8	-12.3	-7.6	-6.8	-13.6	-9.3	-8.4	-0.11	-0.06	-0.05

Source: First Berlin Equity Research, Bloomberg

FINANCIAL HISTORY AND OUTLOOK

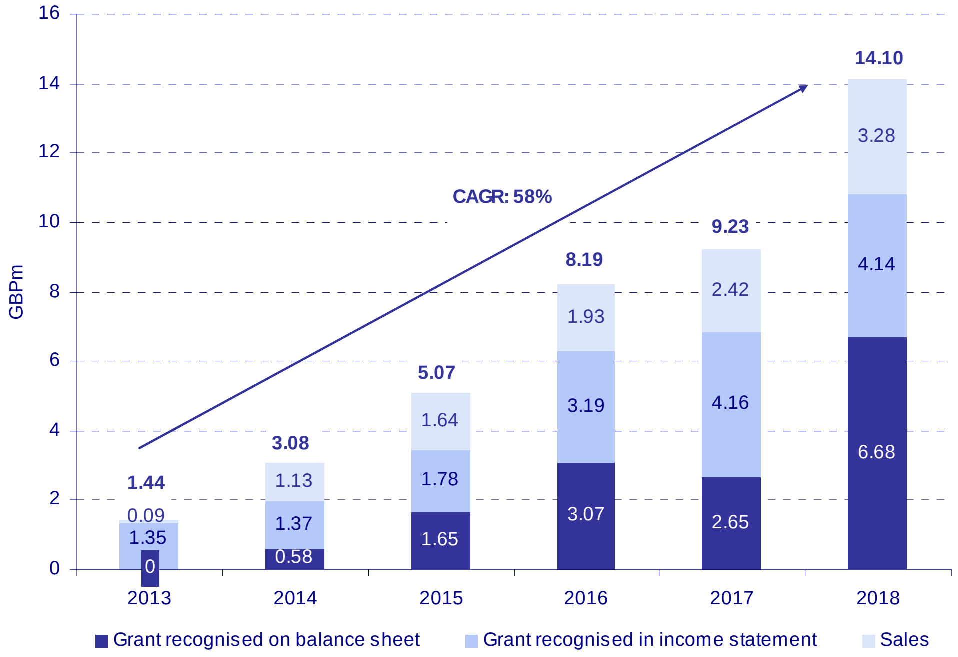
FINANCIAL HISTORY

In FY 2018, which ended on 30 April 2018, ITM's total project income amounted to GBP 14.1m. Total project income has three constituents:

- Sales;
- Grants recognised in the income statement in a separate line item, e.g. for studies;
- Grants recognised on the balance sheet, mainly for building hydrogen refuelling stations.

Total project income rose almost tenfold from 2013 - 2018 at a CAGR of 58% (see figure 13). In FY 2018, total project income rose 53%, driven by grants recognised on the balance sheet (GBP 6.7m, +152% y/y) and revenues (GBP 3.3m, +36% y/y).

Figure 13: Total income development FY/13-FY/18 in GBPm



Source: First Berlin Equity Research, ITM Power Plc

Revenues can be split into construction, consulting, maintenance, fuel, and other revenues (see figure 14). The main source is revenue from construction contracts, which amounted to GBP 2.9m (+39% y/y) or 88% of FY/18 revenues. The second most important revenue source was hydrogen fuel sales (GBP 161k), which were almost 15 times higher than in the previous year due to higher hydrogen volume sold (16t versus 2t).

Figure 14: Revenue split

Revenue split (GBPm)	2016A	2017A	2018A
Construction contracts	1.70	2.09	2.90
Consulting services	0.07	0.24	0.14
Maintenance services	0.05	0.06	0.05
Fuel sales	n.a.	0.01	0.16
Other	0.11	0.02	0.03
Sum	**1.93**	**2.42**	**3.28**

Source: First Berlin Equity Research, ITM Power Plc

FY 2018 gross profit was negative at GBP -0.2m due to first-of-a-kind plant production and the associated non-recurring engineering costs. Operating loss widened to GBP -6.5m (FY 2017: GBP -3.6m). The reasons are inefficiencies associated with testing large plant at ITM's existing facilities and higher cost of recruitment as the company prepares for the next growth step. The net result was GBP -6.1m (FY 2017: GBP -3.8m). The loss per share increased to 2.1 pence from 1.7 pence in FY 2017. This increase was less than the increase in net loss as the average number of diluted shares rose to 287,331,287 from 222,513,007 in FY 2017 (see figure 15).

Figure 15: Income statement – selected items

in GBP m	2017A	2018A
Sales	2.42	3.28
Growth	*25.1%*	*35.9%*
Gross profit	0.66	-0.16
Margin	*27.2%*	*-4.7%*
EBITDA	-2.35	-4.78
Margin	*-97.1%*	*-145.7%*
EBIT	-3.55	-6.49
Margin	*-147.0%*	*-197.8%*
EBT	-3.55	-6.48
Margin	*-147.0%*	*-197.3%*
Net result	-3.78	-6.12
Margin	*-156.5%*	*-186.3%*
EPS (diluted, in GBp)	-1.70	-2.13

Source: First Berlin Equity Research, ITM Power Plc

Balance Sheet

In FY 2018, a large capital increase resulted in gross proceeds of GBP 29.4m. Despite the net loss of GBP 6.1m, equity rose from GBP 13.1m in FY 2017 to GBP 35.6m. The equity ratio climbed to 80% from 66%. The cash position increased from GBP 1.6m to GBP 20.4m. Given that ITM had no financial debt, the net cash position was also GBP 20.4m (see figure 16).

Figure 16: Selected balance sheet items

in GBPm	2017A	2018A
Intangible goods & Goodwill	0.38	0.36
Property, plant & equipment	4.52	4.45
Financial assets	0.00	0.00
Non-current assets, total	**4.90**	**4.81**
Inventories	0.76	0.66
Receivables	12.53	18.50
Cash and cash equivalents	1.56	20.40
Current assets, total	**14.85**	**39.56**
Equity	13.07	35.59
Equity ratio	*66.2%*	*80.2%*
Financial debt (long-term)	0.00	0.00
Financial debt (short-term)	0.00	0.00
Net debt	-1.56	-20.40
Net Gearing	*-11.9%*	*-57.3%*
Payables	6.67	7.93
Balance sheet total	**19.75**	**44.37**

Source: First Berlin Equity Research, ITM Power Plc

Plant, property and equipment were stable at GBP 4.5m and mainly reflect the hydrogen fuel station assets. ITM owns and operates eight hydrogen fuel stations; a further four are under construction, and three more are funded. At the end of Q1 2020, we expect ITM to have 15 stations in operation.

Trade and other receivables increased from GBP 12.5m at the end of FY 2017 to GBP 18.5m (+48% y/y). Inventories were relatively stable and amounted to GBP 0.7m at the end of FY 2018. Trade and other payables rose 19% to GBP 9.7m. Working capital thus amounted to GBP 11.2m versus GBP 6.6m at the end of FY 2017 (+70% y/y). Larger construction projects resulted in higher working capital requirements.

The balance sheet total more than doubled from GBP 19.8m at the end of FY/17 to GBP 44.4m. The capital increase significantly strengthened the balance sheet and provided sufficient financial means to execute ITM's growth strategy.

Cash Flow Statement

Operating cash flow in FY 2018 was GBP -8.0m (see figure 17) due mainly to the net loss and higher working capital requirements. CAPEX of GBP 8.7m, mainly for hydrogen fuel stations, was largely offset by grants received for building fuel stations (GBP 7.1m). Free cash flow thus amounted to GBP -9.6m (FY 2017: GBP -5.9m). Cash outflow from investing was GBP 1.6m (FY 2017: GBP 0.8m). Financing cash flow in FY 2018 amounted to GBP 28.4m due mainly to the mentioned capital raise. As a result, net cash flow was GBP 18.9m (FY 2017: GBP -0.3m).

Figure 17: Cash flow statement overview

in GBPm	2017A	2018A
Operating cash flow	-5.05	-8.01
CAPEX	-3.44	-8.70
Grants received against purchases of PP&E	2.65	7.13
Free cash flow	-5.85	-9.57
Cash flow investing	-0.79	-1.57
Cash flow financing	5.47	28.39
Net cash flow	-0.33	18.85

Source: First Berlin Equity Research, ITM Power Plc

H1/19 Figures

Total income in H1/19 amounted to GBP 5.0m (H1/18: GBP 4.4m, +12% y/y). Revenue fell 32% y/y to GBP 1.2m, but grant income climbed 31% y/y to GBP 2.5m, and grants receivable for capital projects rose 72% to GBP 1.3m (see figure 18).

Figure 18: Total income split in H1/19

Total income (GBPm)	H1/2018	H1/2019	delta
Revenue	1.74	1.19	-32%
Grant income (P&L)	1.92	2.51	31%
Grants receivable for capital projects	0.76	1.27	67%
Total income	**4.42**	**4.97**	12%

Source: First Berlin Equity Research, ITM Power Plc

H1/19 revenues fell mainly due to lower construction revenues. Fuel sales jumped by 150% to GBP 158k (see figure 19) based on the increasing number of fuel contracts (29 versus 20 at the end of FY/18).

Figure 19: Revenue split in H1/19

Revenue source (GBPm)	H1/2018	H1/2019	delta
Construction contracts	1.52	0.95	-38%
Consulting services	0.10	0.02	-84%
Maintenance services	0.03	0.03	6%
Fuel sales	0.06	0.16	150%
Other	0.02	0.03	24%
Sum	**1.74**	**1.19**	**-32%**

Source: First Berlin Equity Research, ITM Power Plc

The loss from operations widened to GBP 5.3m (H1/18: GBP 2.9m) due to increasing overhead as the company prepares for the next growth step and invested heavily in staff and capacity, and due to cost overruns on four first-of-a-kind projects.

Due to the net loss of GBP 5.2m equity declined to GBP 30.3m. Compared to the figure at the end of FY 2018, the equity ratio was down 6 PP at 74%. The cash position was at a satisfactory GBP 15.6m (FY/18: GBP 20.4m).

Operating cash outflow was GBP 4.0m. CAPEX of GBP 0.8m resulted in a free cash flow of GBP -4.8m. As financing cash flow was negligible, net cash outflow amounted to GBP 4.8m.

FINANCIAL FORECASTS

Before we show our financial forecasts, we note that changes to the IFRS standard, which came into force on 1 January 2019, will result in postponed revenue recognition and hence lower sales. A comparison of 2018 revenues based on existing rules and the new IFRS 15 reveals that sales are ca. GBP 1m lower (see figure 20).

Figure 20: Comparison of sales according to existing and new IFRS 15 rules

Revenue source (GBPm)	2018 existing rules	2018 IFRS 15
Construction contracts	2.90	1.93
Consulting services	0.14	0.11
Maintenance services	0.05	0.04
Fuel sales	0.16	0.16
Other	0.03	0.03
Sum	**3.28**	**2.27**

Source: First Berlin Equity Research, ITM Power Plc

Under IFRS 15, revenue recognition is based on stage of completion only in cases where performance obligations are satisfied over time. While there are no changes regarding bespoke contracts, revenue from standard products will be recognised only when the contractual obligation has been fulfilled and ownership of the goods has been transferred.

Income statement

Whereas in recent years, grants dominated total income, revenue will soon be the most important total income source. As ITM is changing from a research company into a commercial hydrogen energy solution provider, revenues will rise rapidly while grants will stagnate. Given strongly increasing demand for green hydrogen, sales will rise significantly (FY 2019E: GBP 6.6m, +100%, FY 2020E: GBP 15.4m, +135% y/y). We expect total project income to climb 17% to GBP 16.6m in FY 2019E, and 42% to GBP 23.4m in FY 2020E (see figure 21).

Figure 21: Total income development FY18A-FY21E

Total income (GBPm)	2018A	2019E	2020E	2021E
Revenue	3.28	6.56	15.44	28.65
Grant income (P&L)	4.14	4.00	3.00	3.00
Grants receivable for capital projects	6.68	6.00	5.00	5.00
Total income	**14.10**	**16.56**	**23.44**	**36.65**
Growth y/y	53%	17%	42%	56%

Source: First Berlin Equity Research

The revenue split shows that construction contracts are the most important sales growth driver by some distance (see figure 22).

Figure 22: Revenue development FY18A-FY22E

Revenue split (GBPm)	2018A	2019E	2020E	2021E
Construction contracts	2.90	6.00	14.25	27.00
Fuel sales	0.14	0.35	0.91	1.23
Maintenance services	0.05	0.08	0.13	0.27
Consulting services	0.16	0.08	0.10	0.10
Other	0.03	0.05	0.05	0.05
Sum	**3.28**	**6.56**	**15.44**	**28.65**

Source: First Berlin Equity Research

We forecast a strong increase in electrolyser capacity sold in coming years (see figure 23). In FY19E we assume 6 MW, in FY20E 15MW, and in FY21E 30 MW. Average project size in tenders increased to GBP 6m versus GBP 3.5m in the previous year's period. We expect the market trend towards larger electrolysis systems to continue resulting in a lower price per MW. ITM's construction revenues should amount to GBP 6.0m in FY19E, GBP 14.3m in FY20E, and GBP 27.0m in FY21E.

Figure 23: Forecast of revenue from construction, FY19E-FY21E

Revenue from construction (GBPm)	2019E	2020E	2021E
Installed capacity in MW	6.0	15.0	30.0
Price per MW in GBPm	1.00	0.95	0.90
Revenue from construction in GBPm	6.00	14.25	27.00

Source: First Berlin Equity Research

The second revenue driver will be fuel sales. As more ITM fuel stations open and more fuel contracts are signed, we forecast rapid sales growth, especially as the first bus refuelling station looks set to start operation this year. For cars, we assume a hydrogen volume of 35 t sold in FY19E, 55 t in FY20E, and 75 t in FY21E. Furthermore, we model a constant hydrogen price for cars of GBP 10 per kg. For buses, we assume a hydrogen volume of 60 t sold in FY20E, and 80 t in FY21E, and model a constant hydrogen price for buses of GBP 6 per kg. This results in hydrogen fuel sales of GBP 0.35m in FY19E, GBP 0.91m in FY20E, and GBP 1.23m in FY21E (see figure 24).

Figure 24: Forecast of hydrogen fuel sales, FY19E-FY21E

Fuel revenue (GBPm)	2019E	2020E	2021E
Hydrogen in t (cars)	35.0	55.0	75.0
Hydrogen price per kg in GBP (cars)	10.00	10.00	10.00
Hydrogen in t (buses)	0.0	60.0	80.0
Hydrogen price per per kg in GBP (buses)	6.00	6.00	6.00
Revenue from construction in GBPm	**0.35**	**0.91**	**1.23**

Source: First Berlin Equity Research

We forecast a low FY19 gross profit of just GBP 0.4m due to cost overruns in first-of-a-kind projects (gross margin: 6%). Rising overhead due to investments in people, resources, and capacity should result in an operating loss of GBP 7.8m in FY19E. We expect a net result of GBP -7.3m and EPS of -2.2 pence.

In FY20E, we forecast the first substantial gross profit of GBP 3.1m due to standardisation and fewer first-of-a-kind projects. The gross profit margin rises to 20%. The operating loss should narrow to GBP -5.4m. In FY21E, ITM almost reaches operating break-even (GBP -1.3m) due mainly to a rising gross profit (GBP 6.6m). The FY21E net result should amount to GBP -1.4m, which corresponds to EPS of -0.4 pence (see figure 25). We project the first net profit in FY22E. Based on GBP 50.8m in revenues and GBP 12.7m in gross profit, EBIT should reach GBP 3.3m and net profit GBP 2.8m.

Figure 25: Forecast of sales and earnings, FY19E-FY21E

in GBP m	2018A	2019E	2020E	2021E
Sales	3.28	6.56	15.44	28.65
Growth	*35.9%*	*99.8%*	*135.4%*	*85.6%*
Gross profit	-0.16	0.39	3.09	6.59
Margin	*-4.7%*	*6.0%*	*20.0%*	*23.0%*
EBITDA	-4.78	-5.85	-3.31	1.19
Margin	*-145.7%*	*-89.2%*	*-21.4%*	*4.2%*
EBIT	-6.49	-7.77	-5.41	-1.31
Margin	*-197.8%*	*-118.4%*	*-35.1%*	*-4.6%*
EBT	-6.48	-7.75	-5.40	-1.46
Margin	*-197.3%*	*-118.2%*	*-35.0%*	*-5.1%*
Net result	-6.12	-7.29	-5.07	-1.37
Margin	*-186.3%*	*-111.1%*	*-32.9%*	*-4.8%*
EPS (diluted, in GBp)	-2.1	-2.2	-1.6	-0.4

Source: First Berlin Equity Research

Balance sheet

According to our model, financing strong growth (working capital, CAPEX, increasing overhead) in coming years will require further liquid funds in FY21E. We have thus added GBP 4m in short-term debt. The equity share looks set to remain at a high level of 57% in FY21E, and net debt of just GBP 2.2m does not undermine the solidity of the balance sheet (see figure 26 overleaf).

Figure 26: Forecast of selected balance sheet items, FY19E-FY21E

in GBPm	2018A	2019E	2020E	2021E
Intangible goods & goodwill	0.36	0.53	0.71	0.82
Property, plant & equipment	4.45	4.93	7.76	7.03
Financial assets	0.00	0.00	0.00	0.00
Non-current assets, total	**4.81**	**5.46**	**8.46**	**7.85**
Inventories	0.66	0.84	1.35	1.81
Receivables	18.50	19.77	23.27	26.69
Cash and cash equivalents	20.40	13.22	1.83	1.85
Current assets, total	**39.56**	**33.83**	**26.45**	**30.35**
Equity	35.59	28.30	23.23	21.86
Equity ratio	*80.2%*	*72.0%*	*66.5%*	*57.2%*
Financial debt (long-term)	0.00	0.00	0.00	0.00
Financial debt (short-term)	0.00	0.00	0.00	4.00
Net debt	-20.40	-13.22	-1.83	2.15
Net Gearing	*-57.3%*	*-46.7%*	*-7.9%*	*9.9%*
Payables	7.93	10.14	10.83	11.48
Balance sheet total	**44.37**	**39.29**	**34.91**	**38.19**

Source: First Berlin Equity Research, ITM Power Plc

Cash flow statement

In FY19E, we expect operating cash flow of GBP -4.6m due mainly to the net loss of GBP 7.3m. CAPEX remains at a high level of GBP 8.6m due to the construction of hydrogen stations. Grants received against purchases of PP&E of GBP 6.0m lead to free cash flow and net cash flow of GBP -7.2m (see figure 27).

In FY20E, operating cash outflow should reach GBP 6.3m due mainly to the net loss and higher working capital requirements. CAPEX increases to GBP 10.1m due to the building of the new factory (FBe: GBP 4m). We expect grants received at GBP 5.0m resulting in free cash flow and net cash flow of GBP -11.4m.

In FY21E, we expect a significant improvement in operating and free cash flow. We model cash inflow from debt of GBP 4.0m to finance the negative free cash flow.

Figure 27: Forecast of the cash flow statement, selected items, FY19E-FY21E

in GBPm	2018A	2019E	2020E	2021E
Operating cash flow	-8.01	-4.62	-6.28	-2.09
CAPEX	-8.70	-8.56	-10.11	-6.89
Grants received against purchases of PP&E	7.13	6.00	5.00	5.00
Free cash flow	-9.57	-7.19	-11.39	-3.98
Cash flow investing	-1.57	-2.56	-5.11	-1.89
Cash flow financing	28.39	0.00	0.00	4.00
Net cash flow	18.85	-7.19	-11.39	0.02

Source: First Berlin Equity Research

NEWSFLOW

ITM Power reports half-yearly. The H1 report is usually published at the end of January and the annual report at the end of July.

On 16 Jan 2019, ITM reported its first success in Australia with the sale of four 250kW electrolyser systems totalling 1MW to three different customers.

On 17 December 2018, ITM announced it is expanding its presence in Germany and will occupy new premises north of Frankfurt am Main to support growing operations. The new office will provide a base, for the first time, for technical staff engaged in supporting the Group's projects in Germany including the 10 MW green hydrogen refinery project with Shell.

In November 2018, the HyDeploy partners were awarded GBP 14.9m by Ofgem to fund two hydrogen field trials on public gas networks supplying a total of 1,500 homes. The hydrogen for these trials will be produced by an ITM Power electrolyser.

In September 2018, ITM received funding from Innovate UK for a feasibility study to deploy a 100 MW Power-to-Gas (P2G) energy storage project, which aims at the production of green hydrogen at industrial scale, including pipeline transmission, salt cavern storage, and gas grid injection. The feasibility study will explore system design and costs, and assess the business case for deployment.

On 26 September, ITM opened its seventh hydrogen refuelling station on the motorway M4 at Swindon, UK. The station uses electricity via a renewable energy contract to generate hydrogen on-site with no need for deliveries. It is the first of two stations in the UK to be deployed as part of the pan European H2ME2 project, which is funded by the European Fuel Cell and Hydrogen Joint Undertaking (FCH JU) and the Office of Low Emission Vehicles (OLEV).

In July 2018, ITM entered into a Strategic Partnership Agreement with Sumitomo Corporation for the development of multi-megawatt projects in Japan. ITM Power will supply multi-megawatt electrolyser systems to Sumitomo for integration into wider projects on an exclusive basis in Japan and on a non-exclusive basis in other territories. The Japanese Sumitomo Group is a large global conglomerate with more than 70,000 employees.

In March 2018, ITM was awarded a grant from the British Columbia Government Ministries of Energy, Mines and Petroleum Resources and Jobs, Trade and Technology to undertake a Power-to-Gas (P2G) feasibility study. In the initial phase of the project, ITM Power will undertake a techno-economic feasibility study for the large scale centralised production of renewable hydrogen in the province of British Columbia. The project has the potential to be one of the largest of its kind globally, with total hydrogen electrolysis capacity of up to 300 MW under consideration.

HYDROGEN & ELECTROLYSIS – AN INTRODUCTION

Hydrogen is a colourless, odourless, non-toxic, non-self-ignite gas. In pure form, it occurs in molecular form as H_2. Given that hydrogen is ca. 14 times lighter than air it has buoyancy force and volatilises outdoors. It has a very high permeability and is able to diffuse through porous materials or even metals. Storage requires special materials such as austenitic steal or coatings to prevent diffusion loss. Hydrogen is most common in the chemically bound forms water (H_2O) or methane (CH_4).

EXCELLENT FUEL WITH HIGH ENERGY DENSITY

Its chemical features make hydrogen an excellent fuel, but require a careful handling and compliance with safety regulations. It is inflammable even at low concentrations (≥4% by volume), needs very low ignition energy, and is thus classified as an extremely inflammable gas. Hydrogen has a very high gravimetric energy density. The higher heating value (HHV) is 142 MJ/kg or 39.4 kWh/kg and the lower heating (LHV) value is 120 MJ/kg or 33.3 kWh/kg. If the process using hydrogen can recover and use the exhaust gas heat the HHV can be reached, otherwise the LHV is relevant (see figure 28).
Hydrogen's lower heating value is almost three times higher than diesel (43 MJ/kg), gasoline (ca. 41 MJ/kg), or liquid gases such as LPG (Liquefied Petroleum Gas) or LNG (Liquefied Natural Gas). The use of hydrogen in a fuel cell does not generate any local CO_2 or other emissions except for water vapour. In a combustion, hydrogen also creates nitrogen oxides (NO_x). However, the amounts are so small compared to those of fossil fuels that hydrogen is still heralded as a clean fuel.

Despite its high gravimetric energy density, hydrogen's volumetric energy density is very low (0.01 MJ/l) due to its low density (0.09 kg/Nm^3). For practical handling, its storage density therefore has to be increased significantly either by compression or by liquefaction. In the mobility area, storage pressures of 350 bar (buses) or 700 bar (cars) have been established. The compressed gaseous hydrogen (CGH_2) reaches a volumetric energy density of 2.9 MJ/l at 350 bar and 4.8 MJ/l at 700 bar. This is still significantly lower than gasoline's (31 MJ/l) and diesel's (36 MJ/l) volumetric energy density. Furthermore, the compression consumes energy amounting to ca. 9-12% of the hydrogen.

Figure 28: Hydrogen conversion factors

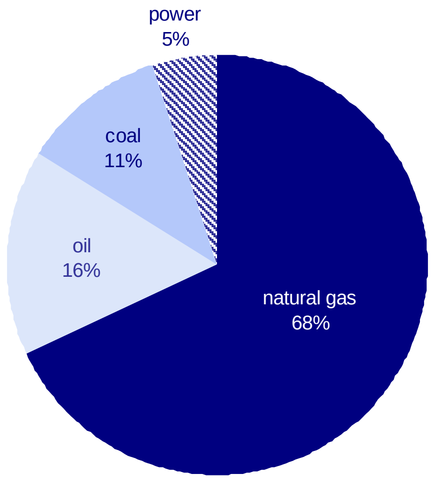
Hydrogen conversion factors			
Volume equivalent	1 kg	=	11.1 Nm^3
Reciprocal value	1 Nm^3	=	0.09 kg
Higher heating value	1 kg	=	39.4 kWh
Reciprocal value	1 kWh	=	25 g
Lower heating value	1 kg	=	33.3 kWh
Reciprocal value	1 kWh	=	30 g
Higher heating value	1 kg	=	142 MJ
Reciprocal value	1 MJ	=	7.0 g
Lower heating value	1 kg	=	120 MJ
Reciprocal value	1 MJ	=	8.3 g
Higher heating value	1 Nm^3	=	3.55 kWh
Reciprocal value	1 kWh	=	0.28 Nm^3
Lower heating value	1 Nm^3	=	3.00 kWh
Reciprocal value	1 kWh	=	0.33 Nm^3

Source: First Berlin Equity Research

HYDROGEN PRODUCTION TECHNOLOGIES AND COSTS

Reforming of hydrocarbons is the most common hydrogen production technology with a share of ca. 95%. The reforming is a chemical process that transforms hydrocarbons and alcohols into hydrogen. It uses fossil fuels such as natural gas, oil, or coal as inputs (see figure 29). Byproducts are carbon monoxide (CO), carbon dioxide (CO_2), and steam.

Figure 29: Share of hydrogen production inputs



Source: First Berlin Equity Research, Shell (2017), p.11

Another way to produce hydrogen is water electrolysis, which uses power and water (H_2O) as inputs, and separates hydrogen (H_2) from oxygen (O_2) in an electrochemical process. Water electrolysis does not emit greenhouse gases. If renewable power is used as an input for the electrolysis hydrogen will become an almost zero-carbon fuel, and the electrolysis a clean and sustainable fuel producer. Water electrolysis using renewable power is thus the only way to produce clean and CO_2 poor hydrogen. Currently, the market share of water electrolysis is just 5%, since this production method is usually more expensive than reforming of hydrocarbons.

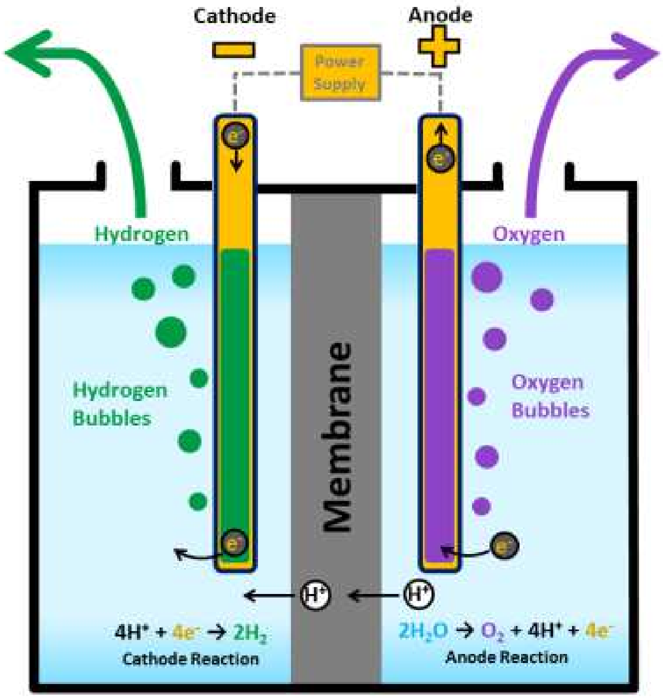
There are three different water electrolysis technologies:

- Alkaline electrolysis (ALK-EL)
- Proton Exchange Membrane electrolysis (PEM-EL), which is also called Polymer Electrolyte Membrane-EL
- Solid Oxide electrolysis (SO-EL)

The ALK-EL and the PEM-EL are low temperature technologies (50-90°C) and commercially available, whereas the SO-EL is a high temperature technology (500-1,000°C) and still in the R&D phase.

The heart of a PEM electrolysis system is the stack where the catalytic separation process takes place. The stack is an assembly of electrolysis cells and consists of a direct current source, and two electrodes (anode & cathode), which are coated with noble metals (platinum, ruthenium, or iridium) and are separated by an electrolyte (ion conductor). Passing an electric current, i.e. a stream of negatively charged electrons, through water starts the electrolysis process. The water, which contains positively charged hydrogen ions (H^+) and negatively charged hydroxyl ions (OH^-), reacts and hydrogen ions are neutralised and converted into molecules of hydrogen gas (H_2) at the cathode. Meanwhile, at the anode, the applied current strips electrons from hydroxyl ions and converts them into molecules of oxygen gas (O_2) and neutral water molecules. The PEM-EL uses a thin (150-220 µm thick) proton-conducting polymer membrane which prevents the mixing of hydrogen and oxygen, but admits the transport of H^+ ions (see figure 30).

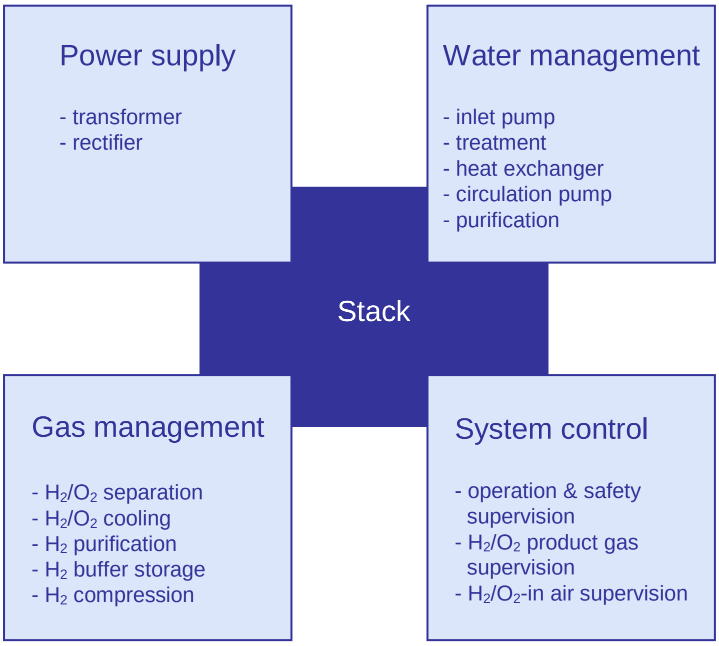
Figure 30: How PEM electrolysis works



Source: First Berlin Equity Research, Hydrail Feasibility Study Report 2018

Further system components (balance of plant) are the power supply, the gas management, the water management, and the system control (see figure 31).

Figure 31: Electrolysis system



Source: First Berlin Equity Research, ZSW, Tractebel (2017), p.46

The efficiency of electrolysis is determined by the quantity of power necessary to produce a certain hydrogen volume. Water electrolysers usually have efficiencies between 70% and 80%, depending on technology and load. PEM efficiency is expected to increase to approximately 86% before 2030 and theoretical efficiency for PEM electrolysers is predicted at up to 94%. Producing 1 kg of hydrogen (which has a higher heating value of ca. 39.4 kWh/kg) requires ca. 49-56 kWh of power, depending on efficiency.

Compared to the ALK electrolysis, the PEM-EL has some advantages (see figure 32):

- PEM-EL has excellent flexibility and reactivity characteristics. Flexibility: It is able to operate at different input power levels (zero – max. power). Reactivity: The time required to respond to power constraints and reach sub- / supnominal current densities is very short. It can thus be ramped-up and down in less than one second, and it is able to operate for a short time (typically 10 min) at much higher capacity than nominal load (160%). PEM electrolysers are therefore capable of supplying frequency reserve and suitable for a wider range of grid services.
- PEM is better suited for operation under pressure due to smaller cell surfaces and simpler mechanical integration. Letting the pressure build up inside the stack is more energy efficient than mechanical compression and can significantly simplify the downstream process by avoiding an additional compression system. Higher pressure operation induces mechanical stress on the membranes which has an impact on system efficiency and stack replacement rate.
- PEM has a higher compactness than ALK due a higher current density of >2 A/cm^2 versus 0.5 A/cm^2 for ALK.

Figure 32: Comparison of PEM and ALK electrolysis

1 MW electrolyser	PEM	ALK
Power consumption (kWh/kg H_2 at nominal power)	58	51
Necessary minimum power (in % of nom. power)	5%	15%
Peak power (for 10 min)	160%	100%
Output pressure (bar) *	30	atmospheric
Water consumption (l/kg)	15	15
System lifetime (years)	20	20
Stack lifetime (hours)	40,000	80,000
System degradation (%/1000 h)	0.25%	0.11%
Availability	98%	98%
Start-up time	1 s - 5 min	1 - 10 min
Ramp-up per second	100%	0.2-20%
Ramp-down per second	100%	0.2-20%
Shut-down time	seconds	1-10 min

* Higher output pressure leads to lower downstream cost to pressurise the hydrogen for end use.

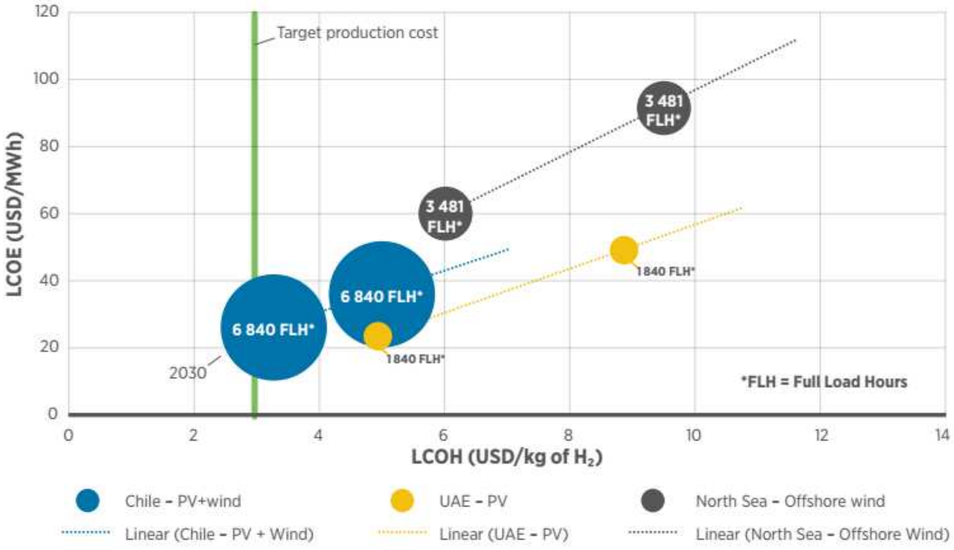
Source: First Berlin Equity Research, FCH JU (2018), p.49 f. Tractebel (2017), p.46.

In the reference scenario of the study “Die zukünftigen Kosten strombasierter synthetischer Brennstoffe” (Future costs of power-based synthetic fuels) the think tanks Agora Verkehrswende and Agora Energiewende assume capital expenditure for low temperature electrolysis (both PEM and ALK) to decline from the current level ca. 1,000 €/kW to 625 €/kW by 2030.

The economic attractiveness of water electrolysis critically depends on the power price which accounts for up to 80% of the hydrogen price. Figure 33 shows the levelised cost of hydrogen (LCOH) for electrolysers that are directly connected to a variable renewable power plant. The bubble size indicates the amount of annual full load hours (FLH) per year. The ratio of full load hours to hours per year (= 8,760 h) is called load factor. Lower load factors (i.e. smaller bubble size) increase the LCOH as the amortisation costs of the electrolyser need to be allocated to a lesser volume of hydrogen produced. The black bubbles show the LCOH for offshore wind in the North Sea assuming 3,481 FLH. If the levelised cost of electricity is at 60 $/MWh the LCOH will amount to 6 $/kg. In November 2016, Vattenfall won the tender for the construction of the 600 MW Kriegers Flak offshore wind project in Danish waters with a bid of 49.9 €/MWh (~ 56 $/MWh at an EUR/USD exchange rate of 1.13).

The example of Chile (large blue bubbles) shows that combining wind and PV resulting in much higher full load hours of 6,840 would bring down LCOH further. LCOE of almost 40 $/MWh would result in LCOH of ca. 5 $/kg. Roughly the same hydrogen cost could be achieved in the United Arab Emirates UAE (small yellow bubbles) assuming 1,840 full load hours for a PV plant with LCOE of ca. 22 $/MWh. Recent tender results reveal that the above mentioned cases use realistic LCOE (e.g. Dubai PV: 29 $/MWh, Arizona, USA, PV: 25 $/MWh, Morocco, wind: 30 $/MWh). Low green hydrogen prices are already possible today at sunny or windy sites.

Figure 33: Cost of hydrogen as a function of the cost of electricity



Source: First Berlin Equity Research, IRENA 2018, p. 29

A study by the German "Nationale Organisation Wasserstoff- und Brennstoffzellen-technologie" (National Organisation for Hydrogen and Fuel Cell Technology, NOW) sees hydrogen cost at almost €10/kg assuming 3,000 full-load hours for the electrolyser and electricity costs of 15.4 €Ct/kWh. This level reflects electricity prices for industry in Germany.

HYDROGEN REFUELLING STATIONS

For consumers, hydrogen refuelling stations have much in common with traditional gasoline refuelling stations. Hydrogen stations also have fuel pumps and refuelling time is similar to conventional refuelling stations (3-5 min). The typical hydrogen station design is shown in figure 34 overleaf. At the beginning, hydrogen is pumped from a hydrogen source (be it an electrolyser or a hydrogen transport vehicle) into low pressure storage. Via compressors, which reduce the hydrogen volume per kg by ca. 94%, it is transferred to a high pressure storage. During the fuelling process, the hydrogen undergoes minimal expansion which warms it up. The cooling system cools the hydrogen to ca. -40 degrees Celsius to prevent too much heating. The fuelling process is monitored electronically to ensure safety.

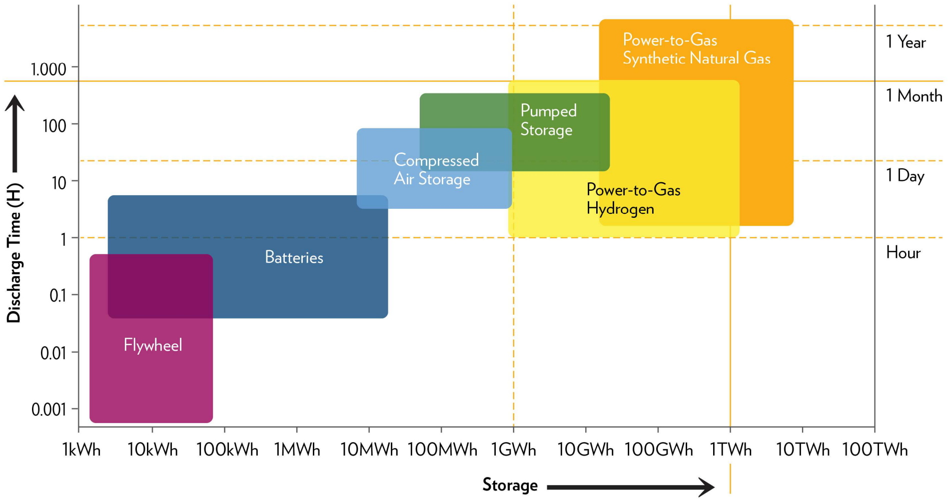
Figure 34: Hydrogen refuelling station design

Source: First Berlin Equity Research, Shell (2017)

HYDROGEN STORAGE

Hydrogen is exceptionally well suited to store large quantities of energy for long durations (see figure 35). On a large scale, hydrogen can be stored in underground salt caverns in pure or methanised form. At costs of ca. 50 to 150 $/MWh, hydrogen storage is significantly cheaper than other storage technologies for electricity. Only pumped hydro storage is more competitive, but its remaining untapped potential is subject to local geographic limitations.

Figure 35: Storage technology overview (power and time)



Source: First Berlin Equity Research, ITM Power Plc

REGULATORY ENVIRONMENT SUPPORTS HYDROGEN

At the COP21 meeting in Paris in 2015, 195 countries signed a legally binding agreement to keep global warming below two, ideally 1.5 degrees Celsius above pre-industrial levels (**Paris Agreement**). To reach this target cumulative carbon dioxide emissions have to be limited to less than 900 Gt by 2100. According to the International Energy Agency (IEA), CO_2 emissions have to decrease by 60% to ca. 13 Gt by 2050, which can only be achieved by a radical transformation of the global energy production and consumption patters. Hydrogen is an almost zero-carbon fuel, if produced by water electrolysis with green power, and can play a very important role in this transformation.

In the **EU**, hydrogen is directly or indirectly supported by the EU Alternative Fuels Infrastructure Directive, the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), and the decision to reduce the CO_2 emissions of the car fleets by 2030.

The **EU Alternative Fuels Infrastructure Directive** (2014/94) provides a framework for establishing a charging/fuelling infrastructure for hydrogen, power, and other alternative fuels. It requires member states to set up a national strategy for alternative fuel infrastructures.

The **Fuel Cells and Hydrogen Joint Undertaking** is a public private partnership supporting research, technological development and demonstration activities in fuel cell and hydrogen energy technologies in Europe. The FCH JU was established by an EU Council Regulation on 30 May 2008 and has three members, the European Commission, fuel cell and hydrogen industries represented by Hydrogen Europe and the research community represented by Hydrogen Europe Research. It aims to accelerate the development and deployment of fuel cell and hydrogen technologies to achieve a carbon-clean energy system. On 6 May 2014, the Council of the European Union formally agreed to continue the Fuel Cells and Hydrogen Joint Technology Initiative under the EU Horizon 2020 Framework Program. The first phase (2014-20) has a total budget of €1.33bn. The second phase ("FCH 2 JU") will reinforce this commitment. The projects under FCH 2 JU will improve performance and reduce the cost of products as well as demonstrate the large scale readiness of the technology to enter the market in the fields of transport (cars, buses and refuelling infrastructure) and energy (hydrogen production and distribution, energy storage and stationary power generation). The FCH 2 JU is set up for a period lasting until 31 December 2024 and will focus on accelerating the commercialisation of fuel cell and hydrogen technologies.

In December 2018, the EU tightened its **CO_2 emission standards** for cars and vans, and decided to reduce the CO_2 emissions of the car fleets by 15% by 2025 and by 37.5% by 2030, based on the target value for 2021 of 95 g/km as average value per car. As these emission targets are not achievable with combustion motors the regulation will spur the market for electric vehicles, both BEV and FCEV. The dimension of the change becomes visible when we look at the current car fleet CO_2 emission levels. In 2017, according to a study of PA Consulting, the average CO_2 emission value of VW, Europe's largest car producer, was 122 g/km (Daimler: 127 g/km, BMW 122 g/km).

The **UK H_2Mobility** Project is a partnership of UK national and local governments, and fuel cell, industrial gases, energy, and car industry companies to support the introduction of hydrogen as a transport fuel by developing and implementing a strategy that will help to decarbonise road transport. The partnership has drawn up a roadmap detailing how the UK can build a hydrogen refuelling infrastructure to support the introduction of Fuel Cell Electric Vehicles. Initially, the focus will be to build an infrastructure serving metropolitan areas and the major routes which link them, progressing to nationwide coverage by 2030. In 2017, the United Kingdom had 15 hydrogen stations in operation, and at least five more in the planning stages. The UK H_2Mobility consortium has provided estimates for hydrogen infrastructure to match fuel cell vehicle goals through 2030. An initial set of 65 stations is estimated to be able to support the development of an early market of 10,000 fuel cell vehicles. Subsequent station construction depends on the demand for hydrogen. The group projects that approximately 1,100 stations, with a public investment of GBP 400m, would sufficiently cover a fuel cell vehicle growth to a total of 1.6m FCEVs by 2030.

In July 2018, the UK government announced its **“Road to Zero” strategy** which aims at all new cars and vans to be effectively zero emission by 2040 – and for every car and van to be zero emission by 2050. The strategy includes funding of GBP 1.5bn for ultra-low-emission vehicles. At the ‘Zero Emission Vehicle Summit’ in Birmingham on 11 September 2018, Prime Minister Theresa May announced more than GBP 100m of funding for innovators in ultra-low-emission vehicles and hydrogen technology.

In **Germany**, the **mobility and fuel strategy** (Mobilitäts- und Kraftstoff-Strategie, MKS) supports alternative fuels such as hydrogen. The **second National Innovation Program Hydrogen and Fuel Cell Technology (NIP II)** of the Federal Ministry for Transport for the period 2016-2019 has a funding volume of almost €250m for innovation and research activities in the area of hydrogen and fuel-cell technology and for market activation. The program funds

- fuel cell technologies for transport (cars, buses, commercial vehicles)
- hydrogen production from renewable energies
- integration of hydrogen into the fuel portfolio.

The **NOW** GmbH, a federal programme management association, implements the funding programmes of the Federal Ministry for Transport and Digital Infrastructure (BMVI) on hydrogen, fuel cell technology, electric mobility with batteries, and charging infrastructure. NOW coordinates and controls commercialisation programmes for products and applications in the field. Germany’s goal for hydrogen refuelling stations is 400 by 2023.

In the US, **California** has adopted the **Zero Emission Vehicle (ZEV) program**, a state regulation that requires car manufacturers to sell electric cars and trucks. The exact number of vehicles is linked to the automaker’s overall sales within the state. Nine other states have joined the program. To push the development of a hydrogen refuelling station infrastructure, the California Energy Commission offers grants of up to 85% of the initial capital expense plus another $300,000 for operation and maintenance for several years. Companies apply for the grants, and own and operate the stations. The California legislature has authorised funding of up to $20m per year until the first 100 hydrogen stations are built. The state’s Low Carbon Fuel Standard program provides additional fiscal incentive for fuel providers to sell hydrogen, based on the fuel’s low carbon intensity. California, along with other zero-emission vehicle (ZEV)-adopting states, also offers fuel cell vehicle purchase rebates, which further supports the market. In January 2018, the Californian Governor increased the hydrogen station network development target to 200 stations by 2025. Besides, a target for 5 million ZEVs by 2030 was set.

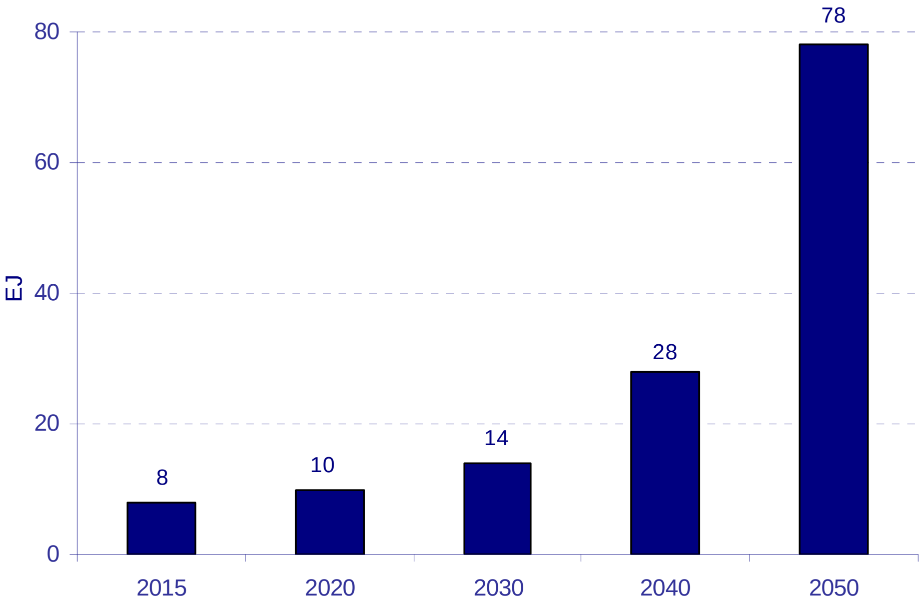
Japan has the most ambitious plans for a transition of the power and transport sectors to hydrogen by 2050 with concrete interim targets for 2030. In 2017, the Ministry of Economics, Trade and Industry (METI) determined a basic hydrogen strategy for realising a hydrogen-based society. In the mobility sector, the country aims to increase the number of FCEVs to 40,000 by 2020, 200,000 by 2025 and 800,000 by 2030. The number of fuel cell buses should reach 100 in 2020 and ca. 1,200 in 2030. Furthermore, Japan aims to increase the number of FC forklifts to 500 by 2020 and 10,000 by 2030. To support this growth, the number of hydrogen refuelling stations is to rise to 160 by 2020, 320 by 2025, and 900 by 2050. In August 2017, Japan had 90 stations. The Japanese government financially backs the hydrogen infrastructure build-out with support for stations, on the price of hydrogen, and at vehicle purchase. Hydrogen refuelling stations are funded to up to two-thirds of initial capital expense.

THE HYDROGEN MARKET

According to Zion Market Research, the global hydrogen market was valued at ca. $129bn in 2017 and is expected to generate revenue of around $183bn by the end of 2023, growing at a CAGR of ca. 6% between 2017 and 2023. The water electrolysis market is much smaller. According to the “IndWEDe” study for the German Ministry for Transport in 2018, global market volume is estimated to amount to ca. €100-150m. A study on early business cases for green hydrogen by Tractebel shows that water electrolysis is bankable today and sees an economically viable potential of 2,800 MW in Europe by 2025, with access to low-cost electricity (<5€Ct/kWh) being a key factor of profitability. Assuming a price of €1m per MW electrolysis capacity, the market potential is €2.8bn.

In 2015, according to the Hydrogen Council, global hydrogen demand was ca. 8 EJ (exajoule). As 1 EJ is provided by almost 7m tons of gaseous hydrogen, 8 EJ is roughly equivalent to the previously mentioned 55m tons of hydrogen. The Hydrogen Council expects hydrogen demand to grow ca. tenfold from 2015 to 2050, which corresponds to a CAGR of almost 7% (see figure 36). The main growth drivers are power-to-gas applications, transportation, building heat and power, and industrial feedstock. Hydrogen could account for almost one fifth of total final energy consumption by 2050, save 6 Gt of CO_2 emissions and eliminate local emissions such as SO_x & NO_x, and particulates linked to smog.

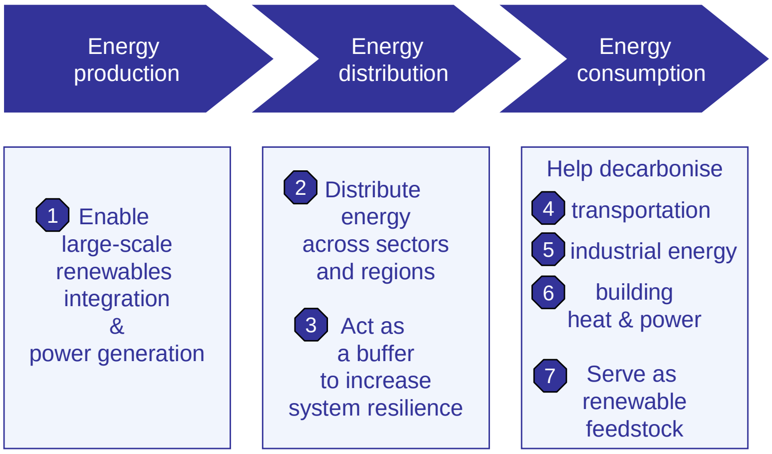
Figure 36: Hydrogen Council scenario: global hydrogen demand 2015-2050, in EJ



Source: First Berlin Equity Research, Hydrogen Council 2017

To stay within the carbon budget, the world needs to reduce energy-related CO_2 emissions by 60% by 2050. To achieve such deep decarbonisation, renewable power generation needs to increase from 23% to 68% and end-use applications (transportation, industry, buildings) switch to low-carbon energy carriers such as green hydrogen. Hydrogen can play seven roles in this radical transformation of the global energy system (see figure 37 overleaf).

Figure 37: Hydrogen's seven roles in a decarbonised economy



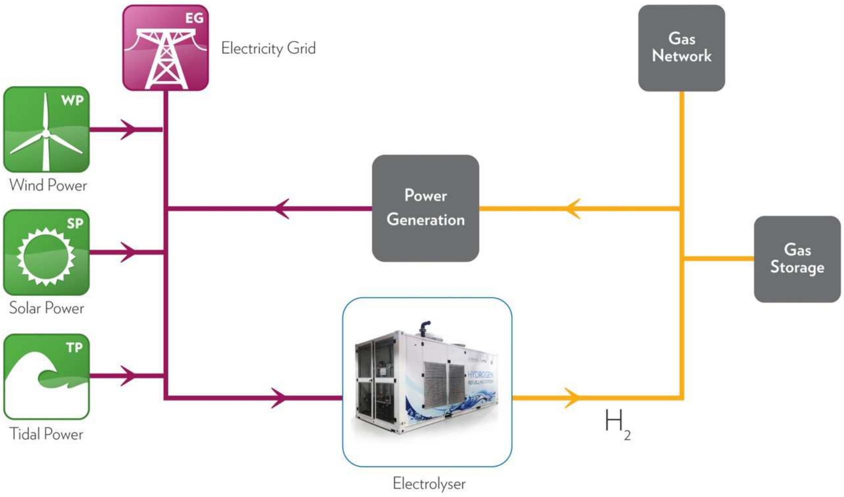
Source: First Berlin Equity Research, Hydrogen Council 2017

In this study, we focus on hydrogen's role in renewables integration & generation (1), transportation (4), building heat & power (6), and as renewable feedstock (7). We do not discuss energy distribution (2 & 3), as it does not directly generate hydrogen demand, or industrial energy (5), as we believe that the other areas are easier to decarbonise.

HYDROGEN CAN ENABLE LARGE-SCALE RENEWABLES INTEGRATION & POWER GENERATION

As the energy system relies increasingly heavily on renewables, hydrogen could play a growing role in the storage of renewable electricity (power-to-gas, PtG) and the production of green power (see figure 38). Hydrogen allows efficient storage and transportation of renewable electricity over long periods of time and is therefore a key enabler of the transition to 100% renewable energy. By 2030, 250-300 TWh of surplus renewable power could be stored in the form of hydrogen for use in other segments. Furthermore, hydrogen could generate ca. 1,500 TWh of clean power.

Figure 38: Power-to-gas



Source: First Berlin Equity Research, ITM Power Plc

In Germany, according to the research institute Fraunhofer ISE, the share of renewable power increased to 40% of net power production in 2018. As Germany plans to increase its share of renewable power to 65% by 2030 and 80% by 2050, the increasing use of fluctuating power sources such as wind and solar makes storage more and more necessary to balance the grid. In 2018, Germany faced 134 hours of negative power prices (2017: 146 h). According to the Bundesnetzagentur (Federal Grid Agency), the curtailment of renewable power reached its highest value to date at 5,518 GWh in 2017 (2016: 3,743 GWh, 2015: 4,722 GWh). Total redispatch costs also reached a new high at €1.4bn (2016: €0.9bn, 2015: €1.1bn). These figures make clear how large the market potential for hydrogen produced with cheap renewable power by water electrolysis already is in Germany alone. As the share of renewable and thus fluctuating power will rise further, we will probably see many more hours where pricing on the wholesale market is very low (when it is very windy and sunny) or very high (hardly any wind and no sun). This will increase the financial attractiveness of rapid response electrolysers.

According to the consultancy E-Bridge, ca. 20 MW of electrolysis capacity is installed in Germany. It estimates that within the next 15 years, more than 2,000 MW will be necessary to transport additional green power. The “IndWEDe” study, in its base case scenario S3, even expects 1 GW electrolysis capacity by 2022 in Germany. By 2030, according to this scenario, installed capacity could reach 44 GW. Average annual installation could amount to 3.4 GW. Even in the most conservative scenario, cumulative installation capacity will reach 7 GW by 2030 with an average annual installation of 0.5 GW.

First electrolysis projects have begun commercial operation, e.g. the world’s largest PEM electrolyser to date, the German “Energiepark Mainz” with a peak capacity of 6 MW. It was built by a consortium comprising Linde, Siemens, the RheinMain University of Applied Sciences, and the local utility Mainzer Stadtwerke to convert surplus wind energy to hydrogen for injection into the public natural gas grid, and started test operation in 2015. Following the end of the research phase, the plant began commercial operation in 2018.

HYDROGEN FOR TRANSPORTATION

Transportation is the sector with the highest hydrogen potential (22 EJ or more than 150m t hydrogen by 2050). Fuel cell cars are a driver for green hydrogen as hydrogen prices of up to 10 €/kg are possible. Pricing at this level matches current fossil fuel prices/km for cars at fuel stations. Assuming a hydrogen price of 10 €/kg and average hydrogen consumption of 0.8 kg / 100 km for a FC car results in costs of €8 / 100 km. In 2018, the average fossil fuel price in Germany was ca. €1.40 / l. Assuming average fossil fuel consumption of 6 l / 100 km results in €8.40 / 100 km. Hydrogen pricing can thus be much higher in the mobility sector than in the industry sector, where 2-5 €/kg are usual. However, as long as FCEV fleets are small, operators have to cope with low utilisation levels of their hydrogen refuelling stations.

Fuel cell electric vehicles (FCEVs) are commercially available today, e.g. forklifts, medium-sized cars, and buses. More than 15,000 fuel cell forklifts (manufactured by companies such as Plug Power and Toyota) are operational in global warehouses. The market potential is huge as there are more than 850,000 forklifts in operation in the US alone.

A total of 6,475 **hydrogen fuel cell cars** were sold globally between 2013, when they first became commercially available, and year-end 2017. Toyota secured the lion’s share of sales (76%), followed by Honda (13%), and Hyundai (11%). At least 11 car manufacturers including Toyota, Hyundai, Honda, Kia, Mercedes-Benz, BMW, and General Motors are planning to roll out fuel cell cars by 2021. California is currently the largest FCEV market. On 1 December 2018, FCEV deployment amounted to 5,658, up from 3,234 reported at the same stage of 2017. According to projections by the California Air Resources Board, the state will have 23,600 FCEVs by 2021 and 47,200 by 2024.

We concede that FCEVs currently only have a tiny share of the electric vehicle market, which, according to a study by Allied Market Research, was valued at $119bn in 2017, and is projected to reach $567bn by 2025, growing at a CAGR of more than 22% from 2018 to 2025. In Europe, according to a study of the Joint Research Centre (JRC) of the EU Commission, 290,000 electric cars were registered at the end of 2017, of which 155,000 plug-in hybrids (PHEV) and 135,000 BEVs. We view battery electric vehicles (BEV) as an enabler of FCEVs as both use an electric motor instead of a combustion motor. Given that hydrogen tanks have a much higher energy density than batteries (ca. 6 MJ/kg, long-term: 9 MJ/kg versus ca. 0.3 MJ/kg, long-term: 1.1 MJ/kg for batteries), FCEVs have a much higher range or lower vehicle weight compared with BEVs. Furthermore, refuelling just takes a few minutes compared with hours for BEVs. Currently, the higher price of FCEVs compared with BEVs, and insufficient hydrogen fuelling infrastructure disadvantage FCEVs, but this looks set to change in the coming decade. The International Council on Clean Transportation (ICCT) expects cost reductions for FCEVs of ca. 70% from 2015 to 2030, mainly through economies of scale. If these cost reductions are realised, FCEVs would have lower investment costs than BEVs in long-range segments. Environmentally, FCEVs using green hydrogen emit very little CO_2 and require less resources and energy to manufacture than BEVs.

The car industry has already shown first signs that it believes that FCEVs are an economically viable option. Toyota has been manufacturing a standard FC car, the “Mirai”, since 2015. In 2018, Hyundai, which currently offers the fuel cell SUV “Nexo”, announced its strategy to become world market leader in FCEVs and plans to invest ca. €6bn by 2030. The company plans to build its own fuel cell factory to expand fuel cell production to 130,000 per year by 2025. Hyundai wants to sell 500,000 FCEVs by 2030 and aims at a market share of 25%.

Fuel cell buses are also gaining significant traction due to concerns about pollution, in particular in Europe, Japan, South Korea, and China. Compared to battery-driven buses, fuel cells buses can cover longer distances and operate with fewer interruptions. For buses, the infrastructure hurdle is less relevant, as most rely on purpose-built refuelling stations. More than 450 FCEV buses from different OEMs (including ADL, Daimler, Foton, Solaris, Solbus, Van Hool, VDL, Yutong, and Wrightbus) are currently on the road in the US, Europe, Japan, and China today, and there are ambitious plans to deploy thousands over the next few years. South Korea plans to replace 26,000 compressed natural gas buses with fuel cell buses by 2030; Shanghai is planning to operate 3,000 fuel cell buses by 2020, and Toyota plans to ship 100 hydrogen buses by the beginning of the Olympic summer games in 2020 in Tokyo. The company equips each bus with two fuel cells of the type already used in its Mirai.

Fuel cell trucks with heavy payloads for long-haul freight would benefit from the long range of hydrogen. According to the Hydrogen Council, Total Cost of Ownership (TCO) breakeven for longhaul trucking could be achieved between 2025 and 2030. As these trucks typically drive along major highways, only a limited number of refuelling stations would be necessary for complete coverage resulting in lower infrastructure cost. In 2018, Ballard Power announced the deployment of 500 FC trucks in China. In August 2018, the American start-up Nikola Motor reported an order backlog of ca. 11,000 fuel cell trucks totalling ca. $11bn. At the IAA Commercial Vehicle show 2018 in Germany, Hyundai Motor Co. announced that it will build 1,000 commercial fuel cell trucks to be operated in Switzerland beginning in 2019.

Hydrogen-powered trains are an attractive alternative to diesel trains, which still have a large market share of 70% of the global fleet of 200,000 locomotives. In Europe and the US, about 55,000 diesel locomotives are in operation. Besides avoiding carbon emissions, hydrogen trains reduce noise and eliminate local emissions such as particulates. The required infrastructure is limited and can be immediately utilised. Hydrogen-powered trains are already being introduced for light-rail vehicles and regional railways – such as the trams produced by the China South Rail Corporation/Sifang, which are being deployed in several Chinese cities. According to the Hydrogen Council, 10% of the trains sold for non-electrified railways could be powered by hydrogen by 2030. By 2050, 20% of the trains running on non-electrified railways, or 10% of all trains could run on fuel cells.

A study by Ernst & Young shows that hydrogen trains are a viable economic alternative to diesel trains in Germany given the right legal framework. About 50% of the German rail network is not electrified, and overhead wire construction is expensive, unprofitable on low-traffic sections, and undesirable in scenic areas.

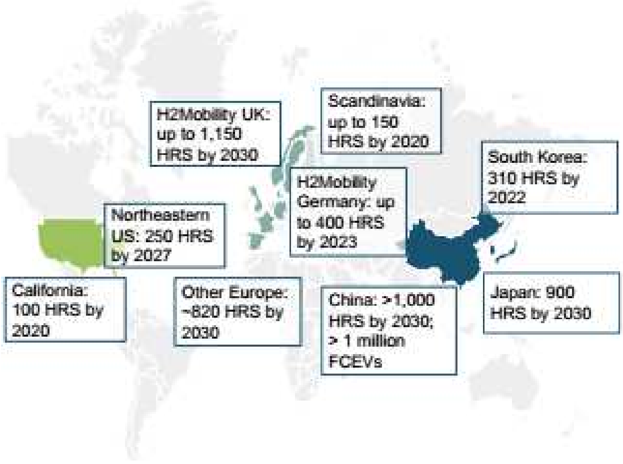
In 2018, Alstom's "Coradia iLint", the world's first zero-emission passenger train based on hydrogen technology, entered commercial service in Germany. Two trains operate on a nearly 100 km line between Cuxhaven and Buxtehude. One fuelling stop at a mobile refuelling station suffices for ca. 1,000 km. A stationary filling station is scheduled to go into operation in 2021, when Alstom will deliver a further 14 trains to the Landesnahverkehrs-gesellschaft Niedersachsen.

By 2050, according to the Hydrogen Council, hydrogen could power a global fleet of more than 400 million cars, 15 to 20 million trucks, and around 5 million buses, which would constitute on average 20 to 25% of their respective transportation segments. In automotive segments, the adoption of hydrogen vehicles could range from 20 to 25% for large cars and trucks to ca. 35% for vans.

Hydrogen refuelling station market

Deployment of FCEVs critically depends on the availability of an extensive hydrogen refuelling station network. Serving a fleet of 10 to 15 million FCEVs, for example, would require the equivalent of roughly 15,000 large refuelling stations with a daily capacity of 1,000 kg hydrogen each. A network of this size could sell more than 4 million t of hydrogen per year. Developing and building this refuelling infrastructure could cost roughly $20bn assuming average costs of ca. $1.3m per station. Hydrogen mobility front runners such as Germany, Japan, California, and the UK have adopted rollout plans (see figure 39) and begun the station rollout.

Figure 39: Hydrogen refuelling station rollout plans



Source: First Berlin Equity Research, Hydrogen Council (2017), p. 40

In Germany, car manufacturers, gas companies, and refuelling retailers (Air Liquide, Daimler, Linde, OMV, Shell, Total) have formed and funded a joint venture, the H2 Mobility initiative, which plans the establishment of a refuelling station infrastructure with a network of 1,000 hydrogen fuel stations by 2030. The joint venture builds and operates the hydrogen refuelling stations and receives government support. By the end of 2019, 100 stations should be operational. After this initial phase, the initiative aims to build another 300 stations to provide full coverage of the country, contingent on FCEV sales. According to H2 Mobility Deutschland's homepage https://h2.live, 60 refuelling stations were in operation and 34 in different stages of development at the end of 2018. The H2 Mobility refuelling station network reported a 176% increase in hydrogen demand from 25.1 t in 2017 to 69.2 t in 2018. As the H2 Mobility partners fixed the price for 1 kg hydrogen at €9.50 (1 l = €0.95), the market volume was €658,000.

Japan had 100 hydrogen refuelling stations at the end of 2017 and plans to increase the number of stations to 160 by 2020, and 320 by 2025. In the UK, 15 hydrogen refuelling stations were in operation in 2017, and the H_2Mobility initiative aims at up to 1,150 stations in operation by 2030. Similar initiatives exist in South Korea (H2Korea), and Scandinavia (Scandinavia Hydrogen Highway Partnership).

At the end of 2018, California had 39 Open-Retail hydrogen refuelling stations and 25 stations in different phases of development. The establishment of a hydrogen refuelling station infrastructure is supported by the California Fuel Cell Partnership, an industry/government collaboration aimed at expanding the market for fuel cell electric vehicles powered by hydrogen.

In the UK, the fuels market is ca. 700 TWh. Assuming a share of 1% for hydrogen results in 7 TWh. Given that electrolysers operate 3,650 h per year and have an efficiency of 70%, the necessary electrolyser capacity would be roughly 2.7 GW. Assuming electrolyser costs of 1,000 €/kW, the market size is ca. € 2.7bn.

According to the IndWEDe study, electrolysis capacity of 1 GW would be sufficient to fuel almost 700,000 cars. For electrolysers, the study assumes power consumption of 55 kWh/kg H_2, and operation time of 4,000 full-load hours per year resulting in 4,000,000 MWh of power consumption to produce 72,727 t of hydrogen. For car hydrogen consumption, the study assumes 0.8 kg/100 km and annual range of 13,500 km resulting in 108 kg H_2 per car per year, and 75,600 t for 700,000 cars.

HYDROGEN TO DECARBONISE BUILDING HEAT AND POWER

For building heat and power, hydrogen can use existing gas infrastructure. Low concentrations of green hydrogen can be blended into public natural gas grids with only minor infrastructure upgrades. Depending on the grid and local natural gas composition, hydrogen can make up 5 - 20% of the volume content of natural gas supply. It is also possible that entire cities will switch to pure hydrogen heating. Hydrogen could provide roughly 10% of the heat and power jointly required by the global household sector. These shares are higher for residential heat and power in regions with high winter heating demand such as the UK, Germany, the US, Canada, and South Korea, as such regions tend to have a natural gas infrastructure on which hydrogen can piggyback.

Blending hydrogen is actually an old, safe, and proven technology. From the mid-1800s to the 1950s in the US and the 1970s in the UK and Australia, manufactured gas, also called "town" gas, was used in what is today the natural gas grid. This gas was produced from coal or oil and contained 30% to 60% hydrogen. In Hawaii, Singapore, and some other areas with limited natural gas resources hydrogen blends are still common.

Hydrogen blending into the natural gas grid has the advantage of relatively simple implementation, but does not solve the decarbonisation of the non-hydrogen part. Alternatively, complete cities can switch to a 100% hydrogen supply. The “H21 Leeds City Gate” project in the UK plans to progressively convert all of Leeds’ households to 100% hydrogen between 2026 and 2029. Leeds is one of the largest cities in the UK and has ca. 780,000 inhabitants. The project will replace natural gas with hydrogen from four steam methane reformers with a capacity of 1 GW, or about 150,000 tons of hydrogen per year, equipped with 90% carbon capture. The produced hydrogen will be stored in salt caverns and fed into the existing gas grid through a hydrogen transmission system. The project is to be executed by Northern Gas Networks, a regional utility with 2.7m customers, and funded by the British government. The Leeds transition could provide a “blueprint” for a rollout in other countries and regions. However, the project still uses fossil fuel-based hydrogen production and requires carbon capture to prevent CO_2 emissions.

Given the UKs enormous wind resources (ca. 25% of the total European wind resources), we see potential for green hydrogen production by electrolysis of wind power. The UK gas grid throughput is roughly 900 TWh/p.a. Assuming a volume blending of 3% hydrogen, the hydrogen energy share would be 1% (1 Nm^3 = 1/3 kWh), or 9 TWh. Assuming 8,500 working hours per year, and 70% electrolyser efficiency, the necessary electrolyser capacity would be roughly 1,500 MW. Assuming cost of €1m per MW electrolysis capacity, the potential market size is €1.5bn.

HYDROGEN AS RENEWABLE FEEDSTOCK

Several industries use hydrogen as feedstock, especially the refining and chemicals industry. According to the Hydrogen Council, global industry demand amounts to ca. 8 EJ (ca. 55m t) hydrogen annually, of which 3.9 EJ (ca. 27m t) for ammonia production and 2.4 EJ (ca. 17m t) for refining.

In the chemicals industry, hydrogen is used in the production of fertiliser and methanol. In fertiliser production, hydrogen is combined with nitrogen to make ammonia (NH_3), and in methanol production, it is applied to convert methane and water to methanol (CH_4O). The demand for hydrogen is likely to grow in line with the overall demand for ammonia and methanol. Replacing only 5% (=1.35m t) of the hydrogen used to produce global ammonia volume with green hydrogen would require 1.35m t * 39.4 MWh/t = 53 TWh p.a. Installation of ca. 9.5 GW of electrolysis capacity if operated around 8,000 h per year at 70% efficiency would generate a hydrogen output of 53 TWh. Assuming cost of €1m per MW electrolysis capacity, the potential market size is ca. €9.5bn.

In the refining industry, hydrogen is used in technical processes such as desulphurisation, hydrotreating, and hydrocracking to produce gasoline, diesel, and kerosene. Due to stricter desulfurisation requirements around the world, hydrogen use is expected to increase until around 2030.

Shell and ITM Power plan to build a 10 MW PEM electrolyser in Shell’s Rhineland refinery in Germany. The so-called REFHYNE project is funded by the European Commission’s Fuel Cells and Hydrogen Joint Undertaking (FCH JU).

According to ENCON.Europe, the German refinery and chemicals industry consume ca. 85% of the total of 1.6m t hydrogen p.a. Ca. 40% is used by the refining and 45% by the chemicals industry (ammonia: 25%, methanol: 20%). Switching from fossil fuel-based hydrogen to green hydrogen from power-to-gas applications can reduce more than 90% of the greenhouse gases produced by fossil fuel-based hydrogen.

Current uses of hydrogen as industry feedstock could be sourced completely from water electrolysis resulting in deep decarbonisation. In total, industrial hydrogen feedstock demand could increase from 8 EJ to more than 10 EJ (ca. 70m t) in 2050.

PRODUCTS AND SERVICES

The special features of ITM's electrolysers are their rapid response (below one second), and the high pressure. They are modular and scalable, and comply with the EU CE standard.

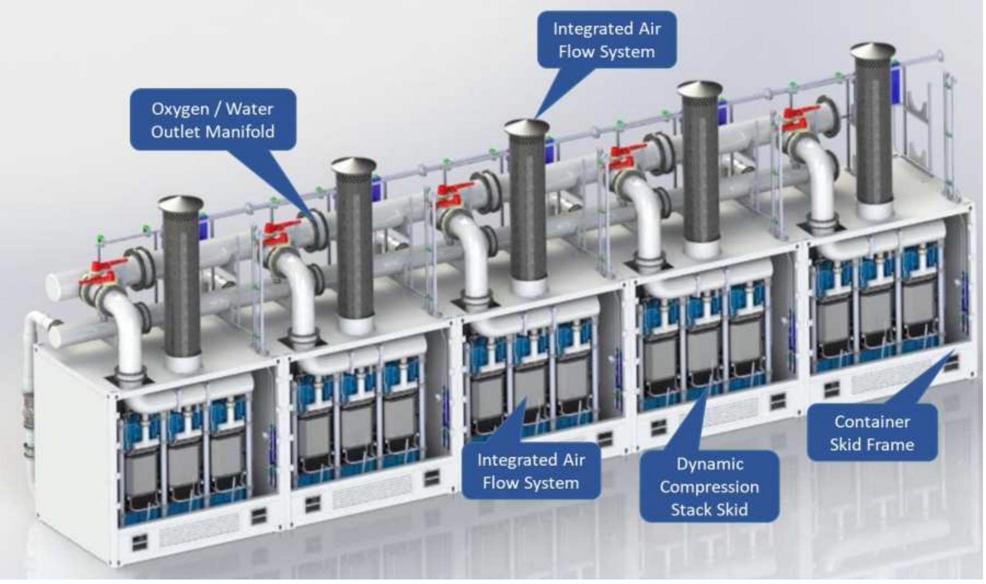
ITM's standardised 2 MW module contains three stacks with ca. 0.7 MW capacity each (see figure 40). The standardisation increases manufacturing and test efficiency and minimises design time and cost for each project. A modular system provides flexibility regarding total system capacity and offers scalability up to 100 MW with balance of plant.

Figure 40: Standardised 2 MW electrolyser module

Source: First Berlin Equity Research, ITM Power Plc

The standardised 10 MW stack skid contains five modules, an integrated air flow and oxygen and water outlets (see figure 41).

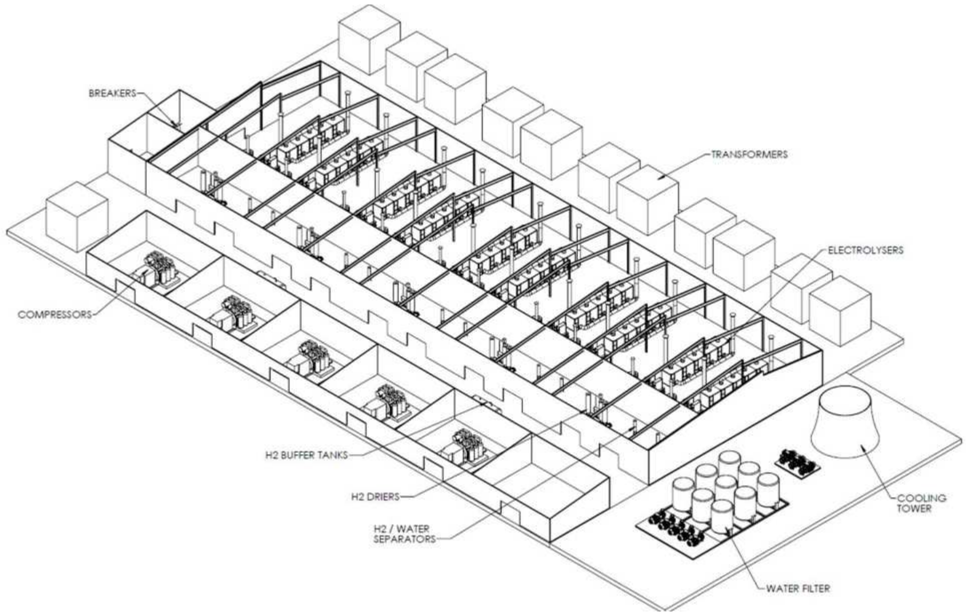
Figure 41: Standardised 10 MW stack skid



Source: First Berlin Equity Research, ITM Power Plc

Based on its 10 MW standard skids ITM has developed a 100 MW plant design suitable for industrial scale hydrogen production. Possible applications are power-to-gas, refineries, ammonia, or steel (see figure 42). In Sweden, SSAB, LKAB and Vattenfall have started to build a pilot steel plant using green hydrogen (HYBRIT project).

Figure 42: 100 MW plant design



Source: First Berlin Equity Research, ITM Power Plc

ITM produces its own stacks which provide the mechanical and electrical environment where water is split into hydrogen and oxygen. The company manufactures two stack types, a ca. 225 kW stack with a max. capacity of ca. 85 kg per day, and a ca. 670 kW stack with a max. capacity of ca. 270 kg per day. As a system integrator, ITM' combines its stacks with the necessary subsystems (power system, water system, gas system, control system), which are delivered by suppliers, to manufacture its electrolysers. All subsystems must be brought together as a compliant system to gain the CE mark required for commercial sales within the EU.

ITM's already established product platforms comprise HFuel and HGas:

- HFuel, ITM's hydrogen refuelling station, is a self-contained module suitable for refuelling hydrogen powered road vehicles and forklift trucks. It is based around a modular platform (standard freight containers) and can be expanded at any point after the initial installation enabling a staged roll-out of hydrogen fuel. HFuel generates hydrogen by electrolysis, compresses it, stores it, and dispenses the gas on demand at high pressure (normally 350 and 700 bar). ITM builds, owns and operates a portfolio of stationary hydrogen refuelling stations in the UK and the US, and sells hydrogen to customers which have signed hydrogen fuel contracts.
- HGas brings together rapid response and self-pressuring PEM electrolysis into a fully integrated package. It addresses MW scale applications, accommodates fluctuating power while generating hydrogen at pressures suitable for either direct injection into natural gas grids or via methanation processes without additional compression. The electrolyser can be switched on and off from 0 to 100% in less than one second and is self-pressurising up to 80 bar.

MANAGEMENT & BOARD

CEO

Graham Cooley joined ITM Power as CEO in 2009. He was previously Business Development Manager at National Power and spent 11 years in the power industry developing energy storage and generation technologies. Graham was CEO of Sensortec Ltd, founding CEO of Metalysis Ltd, a spin-out of Cambridge University, and founding CEO of Antenova Ltd.

CFO

Andy Allen qualified as a chartered accountant in Sheffield in 2007, and has an extensive background in auditing manufacturing SMEs in South Yorkshire. Andy joined ITM Power in 2011 as Financial Controller before becoming CFO in 2015.

CTO

Dr Simon Bourne joined ITM Power in 2002 and has been one of the leading technologists involved in the development of the company’s core technology. Simon is responsible for Development, Engineering and Production functions and was instrumental in the design and realisation of ITM’s electrolyser platform. Before joining ITM Power, Simon was Project Engineer with Sonatest Plc and a Researcher with the Ministry of Defence. Simon has a BSc Hons in Materials Science (UMIST) and a PhD (Cranfield).

Executive Director

Dr Rachel Smith has worked for ITM since its incorporation in 2002. Starting as a research scientist, Rachel has a solid background in materials and their use in electrochemical cells. She has worked on and managed various externally funded projects and now acts as the funding co-ordinator for ITM’s activities. Rachel also manages ITM’s patent and trademark portfolio.

Non-Executive Chairman

Professor Roger Putnam CBE, the former Chairman of Ford of Britain and President of the Society of Motor Manufacturers and Traders was a member of the Government’s Energy Review Partnership, which reported to the Chancellor on the country’s future energy strategy. Roger’s career in the automotive industry began at Lotus Plc. From 1982 to 2002 he held different positions at Jaguar Cars Ltd.

Non-Executive Director

Sir Roger Bone was President of Boeing UK from 2005 to 2014. He is the senior independent director of Foreign and Colonial Investment Trust plc, and Chairman of Over-C Ltd, a small high tech company in the telecoms sector. He was British Ambassador to Brazil from 1999 to 2004 and to Sweden from 1995 to 1999, and prior to that an Assistant Under-Secretary of State in the Foreign and Commonwealth Office.

Non-Executive Director

Lord Roger Freeman joined ITM Power Plc in October 2010 as a non-executive director. Lord Freeman is a member of the House of Lords and is currently a member of the Advisory Boards of Thales SA and PricewaterhouseCoopers (UK). Lord Freeman was the Conservative MP for Kettering from 1983 to 1997 and served as the Parliamentary Secretary for the Departments of Health and Armed Forces and as Minister of State for Public Transport and Defence Procurement. He concluded his political career as a Cabinet Minister in the government of John Major.

Non-Executive Director

Mr Bob Pendlebury has worked in senior management positions in both Ford Motor Company and JCB. Joining JCB in 1991, he became their Engineering and Research Director. He remains a consultant to JCB, Associate Engineering Director to the JCB Academy and a Visiting Professor to Loughborough University.

SHAREHOLDERS & STOCK INFORMATION

Stock Information	
ISIN	GB00B0130H42
WKN	A0B57L
Bloomberg ticker	ITM LN
No. of issued shares	324,009,401
Transparency Standard	Alternative Investment Market
Country	United Kingdom
Sector	Alternative Energy
Subsector	Renewable Energy Equipment

Source: AIM London, First Berlin Equity Research

Shareholder Structure	
JCB Research	12.6%
Allianz SE	11.0%
Hargreaves Peter	8.8%
Other	30.3%

Source: ITM Power Plc

INCOME STATEMENT

All figures in GBP '000	2017A	2018A	2019E	2020E	2021E
Total income	**9,230**	**14,100**	**16,558**	**23,438**	**36,650**
Revenues	**2,415**	**3,283**	**6,560**	**15,438**	**28,650**
Cost of goods sold	1,757	3,438	6,166	12,350	22,061
Gross profit	**658**	**-155**	**394**	**3,088**	**6,590**
S&M	1,528	1,455	1,510	1,400	1,500
G&A	2,202	3,086	3,700	3,500	3,700
R&D	2,023	1,792	2,150	2,200	2,200
Prototype production & engineering	2,615	4,144	4,800	4,400	3,500
Grant income	4,160	4,138	4,000	3,000	3,000
Operating income (EBIT)	**-3,550**	**-6,494**	**-7,766**	**-5,412**	**-1,311**
Net financial result	0	18	13	15	-146
Pre-tax income (EBT)	**-3,550**	**-6,476**	**-7,753**	**-5,397**	**-1,456**
Income taxes	230	-360	-465	-324	-87
Minority interests	0	0	0	0	0
Net income / loss	**-3,780**	**-6,116**	**-7,288**	**-5,073**	**-1,369**
Diluted EPS (in GBp)	**-1.7**	**-2.1**	**-2.2**	**-1.6**	**-0.4**
EBITDA	**-2,346**	**-4,782**	**-5,852**	**-3,309**	**1,192**
Ratios					
Gross margin	27.2%	-4.7%	6.0%	20.0%	23.0%
EBITDA margin on revenues	-97.1%	-145.7%	-89.2%	-21.4%	4.2%
EBIT margin on revenues	-147.0%	-197.8%	-118.4%	-35.1%	-4.6%
Net margin on revenues	-156.5%	-186.3%	-111.1%	-32.9%	-4.8%
Tax rate	-6.5%	5.6%	6.0%	6.0%	6.0%
Expenses as % of revenues					
S&M	63.3%	44.3%	23.0%	9.1%	5.2%
G&A	91.2%	94.0%	56.4%	22.7%	12.9%
R&D	83.8%	83.8%	83.8%	83.8%	83.8%
Prototype production & engineering	108.3%	126.2%	73.2%	28.5%	12.2%
Y-Y Growth					
Revenues	n.a.	35.9%	99.8%	135.3%	85.6%
Operating income	n.a.	n.m.	n.m.	n.m.	n.m.
Net income / loss	n.a.	n.m.	n.m.	n.m.	n.m.

BALANCE SHEET

All figures in GBP '000	2017A	2018A	2019E	2020E	2021E
Assets					
Current assets, total	**14,846**	**39,558**	**33,831**	**26,446**	**30,347**
Cash and cash equivalents	1,558	20,403	13,217	1,826	1,846
Short-term investments	0	0	0	0	0
Receivables	12,528	18,500	19,770	23,266	26,688
Inventories	760	655	845	1,354	1,813
Other current assets	0	0	0	0	0
Non-current assets, total	**4,899**	**4,809**	**5,456**	**8,462**	**7,846**
Property, plant & equipment	4,519	4,454	4,928	7,756	7,030
Goodwill & other intangibles	380	355	529	705	815
Other assets	0	0	0	0	0
Total assets	**19,745**	**44,367**	**39,287**	**34,907**	**38,193**
Shareholders' equity & debt					
Current liabilities, total	**6,675**	**8,776**	**10,985**	**11,677**	**16,332**
Short-term debt	0	0	0	0	4,000
Accounts payable	6,666	7,928	10,137	10,829	11,484
Current provisions	9	848	848	848	848
Other current liabilities	0	0	0	0	0
Long-term liabilities, total	**0**	**0**	**0**	**0**	**0**
Long-term debt	0	0	0	0	0
Deferred revenue	0	0	0	0	0
Other liabilities	0	0	0	0	0
Minority interests	**0**	**0**	**0**	**0**	**0**
Shareholders' equity	**13,070**	**35,591**	**28,303**	**23,230**	**21,861**
Share capital	12,531	16,200	16,200	16,200	16,200
Capital reserve	61,930	86,631	86,631	86,631	86,631
Other reserves	-2,169	-1,902	-1,902	-1,902	-1,902
Treasury stock	0	0	0	0	0
Loss carryforward / retained earnings	-59,222	-65,338	-72,626	-77,699	-79,068
Total consolidated equity and debt	**19,745**	**44,367**	**39,287**	**34,907**	**38,193**
Ratios					
Current ratio (x)	2.22	4.51	3.08	2.26	1.86
Quick ratio (x)	2.11	4.43	3.00	2.15	1.75
Net debt	-1,558	-20,403	-13,217	-1,826	2,154
Net gearing	-11.9%	-57.3%	-46.7%	-7.9%	9.9%
Book value per share (in GBP)	0.06	0.12	0.09	0.07	0.07
Return on equity (ROE)	-28.9%	-17.2%	-25.8%	-21.8%	-6.3%

CASH FLOW STATEMENT

All figures in GBP '000	2017A	2018A	2019E	2020E	2021E
EBIT	**-3,550**	**-6,494**	**-7,766**	**-5,412**	**-1,311**
Depreciation and amortisation	1,204	1,712	1,915	2,103	2,503
EBITDA	**-2,346**	**-4,782**	**-5,852**	**-3,309**	**1,193**
Changes in working capital	-3,076	-3,602	749	-3,312	-3,227
Other adjustments	374	379	478	339	-58
Operating cash flow	**-5,048**	**-8,005**	**-4,624**	**-6,282**	**-2,093**
Investments in PP&E	-3,293	-8,622	-8,300	-9,800	-6,601
Investments in intangibles	-151	-76	-262	-309	-287
Grants received against purchases of PP&E	2,646	7,130	6,000	5,000	5,000
Free cash flow	**-5,846**	**-9,573**	**-7,186**	**-11,390**	**-3,980**
Acquisitions & disposals, net	4	1	0	0	0
Investment cash flow	**-794**	**-1,567**	**-2,562**	**-5,109**	**-1,887**
Debt financing, net	0	0	0	0	4,000
Equity financing, net	5,732	29,358	0	0	0
Dividends paid	0	0	0	0	0
Other financing	-267	-970	0	0	0
Financing cash flow	**5,465**	**28,388**	**0**	**0**	**4,000**
FOREX & other effects	45	29	0	0	0
Net cash flows	**-332**	**18,845**	**-7,186**	**-11,390**	**20**
Cash, start of the year	1,890	1,558	20,403	13,217	1,826
Cash, end of the year	**1,558**	**20,403**	**13,217**	**1,826**	**1,846**
EBITDA/share (in GBp)	**-1.1**	**-1.7**	**-1.8**	**-1.0**	**0.4**

Y-Y Growth					
Operating cash flow	n.a.	n.m.	n.m.	n.m.	n.m.
Free cash flow	n.a.	n.m.	n.m.	n.m.	n.m.
EBITDA/share	n.a.	n.m.	n.m.	n.m.	n.m.

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FIRST BERLIN RECOMMENDATION & PRICE TARGET HISTORY

Report No.:	Date of publication	Previous day closing price	Recommendation	Price target
Initial Report	Today	21.55GBp	Buy	43.0GBp

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Category		1	2
Current market capitalisation (in €)		0 - 2 billion	> 2 billion
Strong Buy[1]	An expected favourable price trend of:	> 50%	> 30%
Buy	An expected favourable price trend of:	> 25%	> 15%
Add	An expected favourable price trend of:	0% to 25%	0% to 15%
Reduce	An expected negative price trend of:	0% to -15%	0% to -10%
Sell	An expected negative price trend of:	< -15%	< -10%

[1] The expected price trend is in combination with sizable confidence in the quality and forecast security of management.

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