Ceres Power Holdings

FY16 review

A fuel cell in every home and business

Alternative energy

During FY16, Ceres Power has made substantial progress towards achieving its aim of developing a next-generation fuel cell technology that will be cost-competitive with conventional power generation techniques. Recent enhancements to the technology have extended the range of applications where it may be deployed, resulting in the announcement of a succession of partnerships with blue-chips Cummins, Honda and Nissan.

Year end	Revenue (£m)	EBITDA (£m)	PBT* (£m)	EPS (p)	DPS (p)	P/E (x)
06/15	0.3	(9.7)	(10.5)	(1.2)	0.0	N/A
06/16	1.1	(10.5)	(11.6)	(1.2)	0.0	N/A
06/17e	2.2	(10.3)	(11.3)	(1.0)	0.0	N/A
06/18e	3.0	(9.5)	(10.5)	(0.9)	0.0	N/A

Note: *PBT and EPS are normalised, excluding amortisation of acquired intangibles, exceptional items and share-based payments.

Technology advances underpin engagement

Adoption of fuel cells generally remains limited because although the basic technology is proven, it is not yet cost competitive. Ceres' patented Steel Cell technology is an innovative solution to this cost problem. It uses non-exotic materials that can be processed in volumes using conventional manufacturing equipment and techniques, thus bringing down costs and enabling widespread adoption. Recent enhancements to the technology give it the electrical efficiencies, start-up times and robustness required to be viable for deployment in commercial premises, data centres and electric vehicle range extenders as well as residential applications. In addition, Ceres' high-speed print line has achieved a tenfold reduction in processing times, a key step in realising low-cost, high-volume production capability.

Customer engagement intensified during FY16

Ceres' business model is to focus on developing highly efficient, robust and cost-effective fuel cell stacks that will be deployed by brand leaders in their own power generation systems. Over the last year, Ceres has announced significant customer agreements with British Gas, Cummins, Honda and Nissan. We raise our FY17 revenue estimate and reduce losses to reflect increasing levels of customer engagement and introduce FY18 estimates. Cash consumption during FY16 totalled £11.3m, leaving £6.9m at end June 2016. In September Ceres raised £19.4m (net), through a placing at 8.75p/share, to take it through to the onset of commercial launches, which management targets for end calendar 2018.

Valuation: Long-term value from royalties

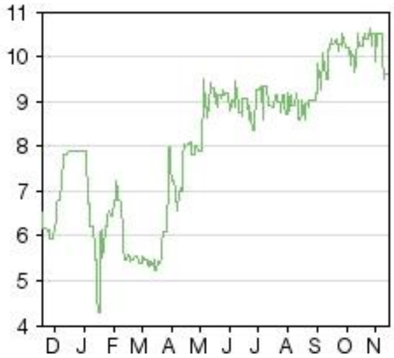
The long-term value for Ceres lies in potential royalty streams created when energy generation systems incorporating Steel Cell technology are commercialised. Management estimates that the entry into new markets achieved during FY16 means that the total value of potential royalty revenues has trebled from c £400m to c £1,200m.

15 November 2016

Price	**9.63p**
Market cap	**£97m**

Net cash (£m) at end June 2016 (including short-term investments but excluding £19.4m raised from placing)	6.9
Shares in issue	1,006.5m
Free float	43.6%
Code	CWR
Primary exchange	AIM
Secondary exchange	N/A

Share price performance



%	1m	3m	12m
Abs	(8.3)	11.9	51.0
Rel (local)	(5.0)	14.6	38.2
52-week high/low		10.6p	4.3p

Business description

Ceres Power is a developer of low-cost, next-generation fuel cell technology for use in decentralised energy products that reduce operating costs, lower CO_2 emissions, increase efficiency and improve energy security.

Next events

AGM	8 December 2016

Analysts

Anne Margaret Crow +44 (0)20 3077 5700

Roger Johnston +44 (0)20 3077 5722

industrials@edisongroup.com

Edison profile page

Ceres Power Holdings is a research client of Edison Investment Research Limited

Investment summary: Making fuel cells affordable

Company description: Low-cost, robust fuel cell technology

Ceres' patented Steel Cell technology for fuel cells operates on mains natural gas, is robust and offers high energy conversion efficiency. Importantly it is manufactured using standard processes and conventional materials such as ferritic steel, which means it can be mass produced at an affordable price for domestic and business use. Following the adoption of a new business model in 2013, Ceres now focuses on the fuel cells and stacks that selected partners integrate into their power generation systems, enabling it to access multiple geographies under the aegis of well-recognised brands. Ceres is currently working with industry partners to develop Steel Cell based power generation systems for a wide range of applications, including residential properties, data centres and other sites requiring back-up power, commercial premises and automotive range extenders. Ceres continues to improve electrical conversion efficiency, power density, stack lifetime and manufacturing techniques so that systems incorporating the Steel Cell technology will become cost-competitive with conventional technology without recourse to subsidies.

Financials: Placing supports next phase of commercialisation

Our financial model assumes a ramp-up in revenues as existing customers mature from initial technology evaluations to joint development programmes and additional customers engage in technology evaluations. Management's goal is to secure five global engineering companies as customers in joint development agreements by the end of 2017, with the intention of being in two commercial launch programmes by the end of 2018. The goal is for established customers to pay an upfront licence fee and royalties once their products incorporating the Steel Cell technology are commercialised. We exclude any potential licence and royalty fees from our financial model, giving substantial upside to our estimates. The net £19.4m proceeds from the September placing will put Ceres in a strong financial position to progress these commercial opportunities. It will help to fund the further development of the 1kW and multi-kW modular platforms and maintain its leadership position in solid oxide fuel cells (SOFCs) by continuously improving the performance and maturity of its Steel Cell technology. The funding also supports the advancement of the manufacturing readiness levels to enable future scale up with appropriate manufacturing partners.

Valuation: Long-term value from royalties

Ceres has yet to generate meaningful commercial revenues, so its value resides in the potential royalty streams generated once distributed power systems incorporating Steel Cell technology are eventually commercialised. Our analysis has been expanded from our initiation note, which only covered the residential market, to include the data-centre and back-up power segment, commercial segment and vehicle range extenders. This increases the size of Ceres' royalty opportunity, based on management's estimates of potential market penetration, from £400m to £1,195m.

Sensitivities: Dependent on partners

There is still development required to take the 1kW platform for residential applications from prototype to commercial readiness and to develop the 5kW modular platform at stack and system level for higher power applications. The strategy of working with partners to develop complete systems means that Ceres is reliant on those partners taking product to market. Adoption of fuel-cell technology is being driven by legislation to reduce airborne pollutants and subsidies. We note that the Steel Cell technology is intended to give a cost-effective alternative to conventional modes of power generation without recourse to subsidies.

Company description: Affordable fuel cell technology

Ceres Power was established in 2001 to acquire fuel cell intellectual property rights developed over the preceding decade by Imperial College, London. It was admitted to AIM in 2004.

The original research programme was aimed at determining whether it was possible to create a fuel cell from low-cost materials. From this IP, Ceres has developed its patented Steel Cell technology for producing third-generation SOFCs. The Steel Cell technology is more efficient, significantly lower cost and more robust than other SOFC technology and competing fuel cell technologies. Recent efficiency enhancements mean that the technology is potentially applicable not only to the residential sector, as previously, but also to the commercial sector, data centres and electric vehicle range extenders. Management is engaging with major OEMs that will potentially integrate the Steel Cell technology into their own products. These include British Gas (in conjunction with OEMs), Cummins Power Generation in the US, Honda, Korea-based KD Navien, and Nissan.

Ceres is headquartered in Horsham, England, with an office in Kyoto, Japan. It employs over 100 people. The Horsham facility houses production and test equipment capable of manufacturing fuel cells and stacks in the volumes required to support customer evaluations and development programmes. Ceres may partner with third parties to provide the higher volumes required as customers transition to the commercial phase.

Fuel cell market: Part of the distributed energy future

Market drivers

Power generation is shifting from a centralised to a distributed model in which fuel cell-based generation systems play a key role. There are several drivers behind this: efficiency, energy security and economics.

Energy conversion efficiency – distributed systems are a more efficient way of converting the energy in natural gas to electricity:

- SOFCs are inherently more efficient at converting natural gas to electricity than even advanced natural gas-combined cycle (NGCC) plants (Exhibit 1).
- In centralised power generation systems such as NGCC plants, around 8% of the initial energy content in the gas is dissipated as the electricity is distributed over the grid to household or business premises.
- If the SOFC is integrated into a combined heat and power system (CHP), the heat energy produced as a by-product of the energy conversion process is used to heat up water for washing or central heating, so the total amount of energy converted to useful power is 80-95%.

Security of energy supply – distributed systems reduce dependence on the electricity grid. This is important both in developed countries such as the UK and the US where the infrastructure is ageing and in developing economies where demand is growing faster than supply, causing prolonged blackouts. In South Korea, safeguarding the energy security of individual neighbourhoods is important because the government is concerned about the belligerent intentions of its northern neighbour. The Korean government is heavily subsidising fuel cell deployment to reach its target of obtaining 11% of the nation’s primary energy supply from “new” (which includes fuel cells) and renewable sources by 2035, while at the same time creating an indigenous fuel cell industry worth US$98bn and employing 175,000 people by 2040.

Reducing investment required in power generation infrastructure – substantial programmes of investment are required globally to meet increasing energy demands or replace ageing infrastructure. It is less expensive and risky for utilities to invest in distributed power generation systems than large centralised units because the smaller distributed systems may be deployed incrementally in line with rising demand, rather than building a large power station in anticipation of a forecast increase in demand and then running this inefficiently while demand rises to meet capacity. A study carried out by the Department of Energy's Pacific Northwest National Laboratory published in December 2014 noted that total electricity generation capacity in the US would need to increase by 68GW between 2013 and 2022. This capacity gap is exacerbated by the retirement of coal-fired generation facilities taking out 59-77GW of capacity by 2022. The study concluded that distributed generation based on SOFC technology could play a role in meeting this demand cost-effectively and more quickly than constructing advanced natural gas-combined cycle plants and with less risk to the investor, as capacity may be added as required. The cost effectiveness depends on being able to construct SOFCs with an extended stack life and in high volumes, which is what Ceres' Steel Cell technology is designed to do.

Exhibit 1: Comparison of costs and benefits of central grid production with distributed generation

	HHV efficiency	CO_2 emissions (g/kWh)	NOx emissions (mg/kWh)	SOx emissions (mg/kWh)	Capital cost ($/kW)	Levelised cost of electricity (c/kWh)	Fuel cost ($/mmbtu)	Additional benefit of distributed generation (c/kWh)
1,000MW vintage coal	32%	1,080	3,400	29,000	-	3.8	2.34	-
1,300MW pulverised coal with carbon capture and storage	28%	112	327	109	4,600	13.9	2.34	-
400MW advanced natural gas combined cycle	53%	341	22	3	1,000	6.5	4.5	-
270kW natural gas solid oxide fuel cell	56%	289	<33	0	672	8.2 5.2	8.69* 4.5**	6.18

Source: Pacific Northwest National Laboratory, December 2014. Note: *Gas at retail prices. **Gas at wholesale prices.

Market statistics

Annual sales of fuel cells for stationary power generation applications, the segment in which Ceres is primarily based, rose from 147.8MW in 2014 to an estimated 203.2MW in 2015 (source: e4tech: The Fuel Cell Industry Review 2015). However, the amount of power generated from fuel cells remains small in comparison with total generation capacity. In 2015 total electricity capacity in the US was 1,040.8GW, of which fuel cells contributed only 0.1GW (source: Annual Energy Outlook 2016, US Energy Administration). Uptake continues to be held back by the relatively high cost of fuel cell technology. This currently restricts adoption to situations where either the availability of subsidies or the financial cost of being without power, as in the situation for data centres, changes the economics in favour of fuel cell deployment. Reducing the cost of fuel cells through adopting Ceres' potentially lower-cost technology would accelerate deployment. We review the drivers within each of the segments in which Ceres is involved in the section on customer engagement.

Strengthening customer engagement

Business model

Ceres' strategy is to form partnerships with industry leaders that will develop and sell complete product, with Ceres licensing the core fuel cell technology. This enables Ceres to access multiple geographies under the aegis of well-recognised brands, potentially accelerating product adoption. When partnering with companies with an established presence in a sector, eg Honda, Ceres would supply cells or stacks, which the partner would then integrate into their systems. When partnering with new market entrants, eg KD Navien, Ceres will supply complete power generation systems based on Steel Cell technology to help its partner evaluate the technology. However, the intention in the longer term is for these partners to use the prototype system designed by Ceres as a blueprint for developing their own variants, which they, not Ceres, will manufacture. Management aims to have five global engineering companies as customers in joint development agreements by the end of 2017 in order to achieve traction in multiple markets in the major regions across the world, with the intention of being in two commercial launch programmes by the end of 2018. The relationships with Honda, Nissan and Cummins show that it is well on the path to achieving this.

The enhancements to the Steel Cell technology that have been made over the last year (discussed on page 7) have enabled Ceres to broaden the range of applications for which the technology is suitable. Initially the technology was targeted only at the relatively low power residential CHP sector, where energy utilisation levels were boosted by capturing the heat released during electricity generation. Advances in electrical efficiency have enabled Ceres to attract partners with which it is developing Steel Cell based power generation systems for residential power only, commercial and data-centre deployments. These technical advances also improve the competitiveness of the technology compared with conventional power generation, accelerating deployment. Reductions in start-up time, combined with the ability to maintain efficiency through an increased number of power cycles, have enabled Ceres to attract partners in the automotive and back-up genset markets. We review drivers and Ceres' position within each of these segments in turn.

Residential: Micro-CHP improves economics for householders

Japan – JDA with Honda

Japan is the most advanced country with regards to residential CHP initiatives as it is heavily dependent on imported gas to meet its energy requirements. Since 2009 the government has supported the ENE-FARM programme, which encourages the adoption of CHP fuel cells for domestic installation through the provision of subsidies. An estimated 40-50k units were shipped for the programme during 2015, the largest annual deployment to date. The majority of these were proton exchange membrane (PEM) fuel cells from Panasonic and Toshiba, the remainder SOFC from Aisin Toyota. The government goal is for 1.4m residential ENE-FARM units to be operating by 2020, 5.3m by 2030, around one tenth of all Japanese households, which is a big step up from current levels. Subsidies under the programme were extended into 2016, but at lower levels than previously. We understand that Ceres is addressing this segment through its JDA with Honda. Following a year-long evaluation of the Steel Cell technology, which concentrated on performance, robustness and ability to handle repeated power cycles, in October 2014 Ceres signed a JDA with Honda to jointly develop a fuel cell stack using the Steel Cell technology suitable for deployment in 1-5kW systems. The results from the first phase met performance targets, leading to the signature of a follow-on JDA agreement in January 2016. Ceres has developed a prototype CHP system that is smaller than any currently deployed in Japan and the only one able to meet the space constraints of a typical urban dwelling in the country. The system is also suitable for deployment in other situations where space is at a premium.

Europe – programme with British Gas

The European Commission is engaged in a smaller scale microCHP project: ene.field. This project, which ends in late 2017, targets the deployment of 1,000 proton exchange membrane fuel cell (PEMFC) and SOFC micro-CHP units. European boiler manufacturers have teamed up with suppliers of fuel cell technologies to develop systems for the project. For example German boiler giant Viessmann acquired Hexis for its SOFC technology and is partnering with Panasonic for PEMFC technology. Bosch is using SOFC technology from Aisin Seiki and BDR Thermea with Toshiba. During calendar Q416, Ceres will deliver 10 prototype home power systems to British Gas for deployment in homes and at British Gas sites. These will be used in the final phase of the EU ene.field fuel cell residential programme. The trial will confirm that the new systems, which run with existing heating, reduce the energy consumption and carbon emissions of a typical home by up to one-third and help quantify the potential cost savings. The trial will also prove that Ceres' Steel Cell technology is ready for commercial deployment and demonstrate that the technology can be integrated into cost-effective solutions for the European market, thus encouraging OEMs to develop domestic power systems tailored for the UK/European market that incorporate Ceres' fuel cells and stacks. These OEMs will be able to adapt Ceres' prototype design, thus accelerating their time to market. Since these Steel Cell-based systems will be able to run on bio-gas as well as natural gas, their deployment will give British Gas a route to a decarbonised, distributed power generation solution. The availability of this solution should help the UK government achieve the dual goal of reducing carbon emissions and replacing old, centralised power generation systems without incurring the significant expenditure and risk associated with nuclear options.

Korea – engagement with KD Navien

As in Japan, the government in South Korea is actively promoting the adoption of fuel cell technology in order to reduce dependence on imported fuel. Deployment to date has primarily been for utility-scale projects using systems from Doosan or POSCO (which license fuel cell technology from US-based FuelCell Energy). However, there are 140 1kW residential units at the Hydrogen Town demonstration site in Ulsan, which shows interest in fuel cells for this application. KD Navien, Korea's largest boiler maker, intends to address both the domestic and the international micro-CHP sector in partnership with Ceres Power. Ceres shipped a fuel cell power system to KD Navien, which successfully demonstrated superior performance for cycling and robustness compared to similar SOFC technologies. Ceres and KD Navien continue to discuss the next phase of the development programme.

Expanding residential market into non-CHP systems

Advances to the Steel Cell technology announced in December 2015, which are incorporated in the V3 Steel Cell, delivered Ceres' stated target of over 50% net electrical efficiency. This enables the creation of fuel cell power systems for residential use that are more efficient than the best centralised generating plant when operated in power only mode (as well as achieving overall efficiency of up to 90% when operated in CHP mode).

Data centres: Programme with Cummins

Banks, telecommunications network operators, hospitals, educational and penal establishments and wastewater treatment sites are increasingly deploying fuel cells as primary or back-up power. For these applications the economic cost of not having power, estimated by the Lawrence Berkeley National Laboratory in 2009 at $14.4-173.1/kWh for medium and large commercial and industrial facilities in the US, is more significant than the comparative cost of electricity from fuel cells. The comparative cost is currently higher than that from conventional sources, but will potentially be less if Ceres is successful in taking its technology through to mass adoption. Alternative back-up systems depend on batteries, which are expensive and discharge over time, or diesel generators, which emit pollutants and are noisy, making them unsuitable for use in an urban environment. Currently Bloom Energy and Doosan are the dominant providers of high-power systems for data centres. Advances in electrical conversion efficiency mean that Ceres is now able to address these sectors. In August 2016 it announced that it was working with Cummins Inc. on a programme for the US Department of Energy (DOE) to develop a demonstration 5kW SOFC system with a target 60% electrical efficiency. It has already demonstrated 56% efficiency in initial tests of a multi-kW system. Management estimates that, if successful, the Steel Cell-based system would enable data centre operators to cut overall costs by over 20% and carbon footprint by <49%. This programme represents Ceres' first engagement in the US.

Motive: Programme with Nissan

The key driver for the adoption of fuel cells in vehicles is the introduction of regulations reducing carbon emissions and particulate emissions from vehicles. Car manufacturers are introducing a variety of electric vehicles: fuel cell vehicles, plug-in hybrids (battery-powered electric motor plus internal combustion engine) and battery-powered vehicles. Battery-powered vehicles are more suitable for smaller cars and shorter trips because of the limited driving range (currently 100-200km for a medium-sized vehicle), while fuel cell electric vehicles offer comparable range (around 600km) to internal combustion engine vehicles and are the lowest carbon solution for medium and larger cars and longer trips. A battery-powered vehicle currently requires six to 12 hours connected to the grid for a recharge with standard charging equipment. Even rapid charging equipment takes half an hour to charge a vehicle so a public electrical charging point would need to be several times larger than a conventional petrol station to be able to refuel the same number of vehicles per day. By contrast, a fuel cell-powered vehicle can be refuelled in a similar time to a petrol vehicle.

Four things are needed for fuel cell-powered vehicles to be widely adopted:

- Vehicles need to be available commercially. This has happened. For example, both the Hyundai Tucson and the Toyota Mirai are available from dealers in California.
- Hydrogen refuelling stations needs to become widely available (for adoption of PEM fuel cell-powered vehicles). Infrastructure roll-out has commenced but is not extensive. For example ITM Power does not expect to reach 11 refuelling stations in the UK until the end of 2018, and roll-out of vehicles in California is restricted to drivers within easy reach of refuelling stations.
- The cost of fuel cell electric vehicles needs to reduce. According to Green Car Reports, the Toyota Mirai is priced at $57,500 in the US (before any subsidy).
- Fuel cell technology must not be rendered obsolete by advances in battery technology that enable manufacture of battery-powered vehicles with adequate range at a price sufficiently low for volume adoption. The production of suitable batteries still appears to be several years away. Management notes that if a significant number of new cars were to be battery powered electric vehicles, the existing electricity grid would not be able to deliver the power required. Paradoxically, homes and businesses may then need to deploy fuel cells running off mains-delivered natural gas to provide the additional electricity required.

While Ballard Power Systems, Plug Power, Hyster-Yale (which acquired Nuvera in December 2014), Intelligent Energy and Horizon Fuel Cell Technologies are involved in the sector, the first three only work with heavy vehicles where high power density is not so important. Intelligent Energy has mothballed its liquid cooled technology for larger vehicles and is concentrating on air-cooled technology suitable for primary power of motor scooters and range extenders of larger vehicles. Horizon focuses on range extenders for lightweight electric vehicles.

In March 2016 Ceres Power announced it was leading a UK government-backed consortium, including Nissan, to trial its Steel Cells with a view to extending the range of electric light commercial vehicles. Nissan is opting for SOFC rather than the PEM technology adopted by other automotive companies, as SOFC already works with natural gas rather than pure hydrogen, so should be more readily adapted for use with bio-ethanol. Bio-ethanol fuels such as those sourced from sugarcane and corn are widely available in countries in North and South America and Asia, supporting adoption of fuel cell vehicles in these regions without needing a hydrogen distribution infrastructure, as well as delivering a carbon-neutral solution. Ceres' Steel Cell architecture is one of a small handful of SOFC technologies robust enough to withstand the thousands of power cycles demanded by an automotive application and able to start from cold and reach full power in less than 15 minutes.

Commercial applications: Agreement with unnamed global OEM

As a result of the advances in system efficiency, which position the technology for deployment in higher power applications, in February 2016 Ceres announced that it had signed an evaluation agreement with a new potential customer who is a leading global OEM. Ceres has commissioned a complete Steel Cell system for a period of rigorous testing at the customer's site. Under the terms of an additional memorandum of understanding, if this testing proves successful, the two parties intend to enter into joint development of a multi kilowatt system later in calendar 2016. In addition, the system being developed under the DOE programme with Cummins will be modular and scalable for multiple distributed power applications up to 100kW. This should make it suitable for deployment in numerous commercial and industrial applications.

Technology developments

Efficiency enhancements open up new sectors

The V3 Steel Cell technology platform, announced in December 2015, improved efficiency and power density to the point at which Ceres was able to address a broader range of applications, as discussed above, as well as significantly improving the economic case for the CHP residential market. V4, released in calendar Q316, was primarily intended to focus on reduced manufacturing costs (discussed below), but this iteration of the technology also exhibits improved power density, and can start from cold and reach full power in less than 15 minutes, which management believes is a world first for solid oxide fuel cells. This iteration exhibits increased lifetime, having been cycled through thousands of warm-ups and cool-downs. The reduced start-up times and longer lifetime have enabled Ceres to further expand its addressable market, as discussed.

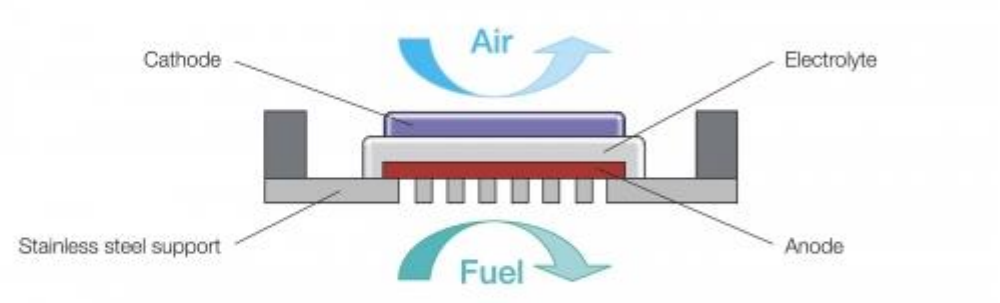
Manufacturing advances reduce costs

During FY16, significant progress was made on production scale-up projects intended to provide demonstration and validation of a production process suitable for high-volume fuel cell manufacture at market cost points. The key innovation is based on changing the way in which the thin ceramic layers forming the electrolyte layer inside individual cells are laid down. Originally this was done by spraying. In February 2016 Ceres commissioned its high-speed print line, which is used to deposit the thin ceramic layers. The new print line reduced print cycle time from 30 seconds to three, substantially improving throughput. The technique also gives a better-quality deposition layer.

V4 of the Steel Cell incorporates these and other manufacturing enhancements, removing over 20% of the processing steps and improving material utilisation. Combining these manufacturing gains with the greater power density achieved in this release gives better cost-effectiveness, thus improving the competitiveness of the technology and potentially accelerating adoption. Ceres currently has the capacity to manufacture 30,000 Steel Cells each year. In the longer term, Ceres is likely to partner with third parties that will manufacture fuel cells in volume using Ceres' proprietary process.

Technology: Innovative solid oxide fuel cell technology

Exhibit 2: Ceres' Steel Cell structure



Source: Ceres Power

Fuel cells bring about a controlled reaction between hydrogen and oxygen to form water, electrical energy and heat energy. Since hydrogen and oxygen do not spontaneously react, the electro-chemical reaction is effected either by bringing them together in the presence of an expensive catalyst such as platinum or heating the gases to a high temperature. PEMFCs are the most widely deployed at present because this is a mature technology that operates at relatively low temperatures. The drawback is that the technology relies on platinum, pushing up costs. SOFC, which is Ceres' technology, is gaining in popularity because it offers potentially higher levels of electrical efficiency and does not require a costly platinum catalyst (see Exhibit 3). However, SOFCs depend on high temperatures to get the reaction going. The higher the temperature, the more exotic and more expensive the fuel cell materials become. The evolution of SOFC cells, which is discussed later, can be viewed as a quest to find electrolyte materials and structures that operate at lower temperatures, enabling the entire fuel cell to be made from less expensive materials.

The other drawback with PEM systems is that they typically run off pure hydrogen gas, which is not readily available. This significantly limits deployment to regions where there is an established infrastructure for distributing hydrogen. As discussed, it currently restricts roll-out of fuel cell-powered vehicles to parts of the western and eastern seaboards of the US and a few areas in Europe, Japan and Korea. PEM systems can be adapted to run off natural gas, which is readily available through national grid networks, but only by adding a complex external reformer to the fuel cell system that adds significant cost to the completed product. SOFC systems typically run off natural gas, using a simpler, less expensive type of external reformer.

Crucially for applications in the domestic or commercial environment, SOFC exhaust streams are sufficiently hot to heat water for washing purposes or for space heating in a CHP system. This raises the overall energy conversion of the system from over 40% to between 80% and 95%. The additional efficiency offered by using the heat generated improves the total cost-effectiveness compared with conventional techniques for power generation.

Exhibit 3: Comparison of fuel cell types

Fuel cell type	000s of units shipped*	MW shipped*	Platinum catalyst	Operating temperature	Electrical efficiency	Applications	Companies
Proton exchange membrane fuel cell (PEMFC)	63.8	179.6	✓	80°C	40-60% hydrogen fuel, c 35% natural gas	Transport, portable, stationary residential and commercial/industrial	Ballard, Doosan, EPS, Heliocentris, Hydrogenics, Intelligent Energy, Hyster-Yale, ITM Power, Plug Power
Solid oxide fuel cell (SOFC)	5.4	63.1		550-1,000°C	45-60%	Stationary utilities, commercial/industrial and residential, auxiliary power units, portable military	Aisin Seiki, Bloom, Ceres Power, Dominovas Energy, FuelCell Energy, GE, Hexis, SOLIDPower (also see Exhibit 4)
Direct methanol fuel cell (DMFC)	2.2	0.2	✓	50-120°C	<40%	Portable consumer/military, auxiliary power units	SFC Energy
Alkaline fuel cell (AFC)	0.0	0.2		90-100°C	60-70%	Stationary industrial	AFC Energy
Phosphoric acid fuel cell (PAFC)	0.1**	24.0	✓	100-250°C	36-42%	Stationary utilities, commercial/industrial, auxiliary power units	Doosan
Molten carbonate fuel cell (MCFC)	0.1**	75.6		600-700°C	50-60%	Stationary utilities, commercial/industrial	FuelCell Energy

Source: E4tech, Fuel Cells 2000, LG Fuel Cell Systems, Edison Investment Research. Note: *2015 estimates; **PAFC and MCFC systems are very high-output power, so small numbers of units shipped equate to high generation capacities.

Evolution of the Steel Cell SOFC

We noted earlier that the evolution of SOFCs represents a quest to find electrolyte materials and structures that operate at lower temperatures, enabling the entire fuel cell to be made out of less expensive materials. The first generation, developed in the 1980s and 1990s, uses a thick layer of yttrium-stabilised zirconia as the electrolyte (see Exhibit 2), which also serves as the support for the entire cell. The electrolyte needs to be heated up to almost 1,000°C to become sufficiently conductive, so the rest of the components must be made from expensive and exotic ceramic materials to withstand the high temperature. As they are made entirely from ceramic materials, the fuel cell stacks are delicate and liable to crack when exposed to thermal stress when turned on and off. Second-generation cells have much thinner electrolyte layers. This allows the cell to operate at lower temperatures (650-850°C), so that the interconnect can be made from high-quality steel rather than exotic ceramics, substantially reducing cost. However, there are still issues with robustness because the anode (see Exhibit 2) has to be made thicker to give mechanical support to the cell and is prone to cracking.

Exhibit 4: SOFC evolution

	First generation	Second generation	Third generation
	Electrolyte-supported cells	Anode-supported cells	Metal-supported cells
Operating temperature	900-1,000°C	650-850°C	550°C
Maturity of technology	✓✓✓	✓✓	✓
Fuel cell stack cost		✓✓	✓✓✓
System cost		✓	✓✓✓
Robustness	✓	✓	✓✓✓
Companies	Bloom, Fraunhofer (Vaillant), Siemens, Staxera, Westinghouse	Acumentrics, Delphi, Hexis (Viessmann), Kyocera/Aisin Seiki (Bosch, JX Nippon, Toyota), LG, Solid Power (Danfoss), Sumitomo, Versa (FuelCell Energy)	Ceres Power Steel Cell technology, GE, Redox Power Systems

Source: Ceres Power, Edison Investment Research. Note: ✓ = OK; ✓✓ = good; ✓✓✓ = excellent.

Ceres Power addresses the problems of cost, robustness and performance by using a thin layer of cerium oxide doped with gadolinium as the electrolyte. This material is conductive at 550°C, so it can be used in conjunction with ferritic stainless steel. This is a relatively inexpensive and readily available metal that is commonly used for car exhausts. As it is widely used in the automotive industry, it can be turned into different shapes using conventional manufacturing techniques. A sandwich of thin layers of ceramic metal mixture (anode), ceria (electrolyte) and conducting ceramic (cathode) is deposited on a thin steel plate to make a single cell (see Exhibit 2). The steel acts as a support, so the anode can be made thin enough to reduce cracking. The manufacturing process is inherently simpler, less expensive and suitable for high-volume production since it uses printing techniques developed for high-volume production of photovoltaic cells. The technology is protected by 47 patent families, which cover core technology areas including anode and electrolyte materials and structure, Steel Cell design, certain manufacturing techniques such as the use of lasers to perforate the steel interconnect with thousands of tiny holes to admit the reactant gases, and stack and system design and operation.

Market consolidation and new entrants

The fuel cell market is dynamic, with global majors taking strategic positions in the sector. Ceramic Fuel Cells went into voluntary liquidation in March 2015 and the assets, some employees and licence for the IP acquired by SOLIDPower (formerly SOFC Power) in August 2015. In June 2015 Ballard acquired Protonex. In July 2015 Plug Power acquired the outstanding stake in its HyPulsion joint venture that it did not already own. During 2015 German boiler manufacturer Veissman acquired the remaining 50% stake in Hexis that it did not already own. New entrants are being attracted to the market. In July 2015 Swiss Hydrogen was spun out of the Swatch Group. Electro Power Systems floated on Euronext in April 2015, raising over €14m.

Sensitivities: Affordability is key to market adoption

Technology risk: Ceres has demonstrated that its Steel Cell technology is sufficiently efficient to be viable in power-only residential and commercial deployment. There is still development required to take the 1kW platform for residential applications from prototype to commercial readiness and develop the 5kW modular platform at stack and system level for higher power applications.

Government subsidies: At present most fuel cell activity, whether in Asia, North America or Europe, is supported by government subsidies. These are intended to encourage customer adoption and research in technology and manufacturing techniques to create volume production at competitive prices without the need for further subsidy. The subsidies will not remain in place indefinitely and may be removed if economic conditions weaken, so standalone economic viability must be proven. Management notes that Ceres' Steel Cell technology should not require subsidies when manufactured in volume.

Legislation: Adoption of fuel cell technology in Europe, North America and China is being driven by legislation to reduce greenhouse gases and other airborne pollutants. Abandonment of these policies, which seems unlikely, would have an adverse effect on adoption. We note that this legislation presents a threat to manufacturers of diesel-fuelled power generation systems, hence the interest in the Steel Cell technology from major companies operating in this sector.

Reliance on channel partners: The strategy of working with partners to develop complete systems means that Ceres is dependent on those partners taking product to market.

Valuation

Ceres has yet to generate commercial revenues, so its value resides in the potential royalty streams generated once distributed power systems incorporating Steel Cell technology are eventually commercialised. In Exhibit 5 we present our scenario analysis, which explores potential royalty revenues and profit generated in each of the key markets as commercial partners take significant share in their respective markets. This analysis is similar in approach to that adopted in previous notes, but refers to a larger set of market segments as technology advances over the last year have broadened the potential application areas.

Exhibit 5: Scenario analysis showing potential profits attributable to key markets

Global residential market					
Total number of domestic boilers and gas water heaters sold annually excluding China and Iran: 17.4m units (source: BSRIA)					
Average selling price per unit: $3,555. Royalty rate: 4.0%.					
Market share for products with Steel Cell technology	2%	5%	10%	15%	20%
Royalty revenues	£40.0m	£100.0m	£200.0m	£300.0m	£400.0m
Annual profit after tax	£15.4m	£39.2m	£78.5m	£119.2m	£157.0m
Global data centre/back-up market					
Total annual market size: 140GW (source: Navigant Research)					
Average selling price per kW: $2,000 (source: management). Royalty rate: 4.4%.					
Market share for products with Steel Cell technology	0.3%	0.5%	1.0%	1.5%	2.0%
Royalty revenues	£30.0m	£50.0m	£100.0m	£150.0m	£200.0m
Annual profit after tax	£10.8m	£18.8m	£39.2m	£59.2m	£79.9m
Global commercial market					
Total annual market size: 20GW (source: BSRIA)					
Average selling price per kW: $2,000. Royalty rate: 6.1%.					
Market share for products with Steel Cell technology	2%	7.5%	10%	15%	20%
Royalty revenues	£39.5m	£148.1m	£197.4m	£296.1m	£394.8m
Annual profit after tax	£15.1m	£58.4m	£77.5m	£117.6m	£157.2m
Global range extender market					
Total annual market size: 7.9GW (new trucks only, not retrofit) (source: Heavy Duty Manufacturers Association)					
Average selling price per kW: $2,000. Royalty rate: 7.9%.					
Market share for products with Steel Cell technology	2.5%	5%	10%	15%	20%
Royalty revenues	£25.0m	£50.0m	£100.0m	£150.0m	£200.0m
Annual profit after tax	£8.6m	£19.9m	£39.8m	£59.2m	£79.9m

Source: Edison Investment Research, BSRIA, Heavy Duty Manufacturers Association, management, Navigant Research. Note: $1.2/£.

Although it is likely that Ceres will adopt a business model in which some of the potential royalties related to single customer engagement are paid upfront as a one-off licence fee, with the payment offset against lower royalty rates, for simplicity our analysis assumes royalty revenues but no upfront licence fees. We apply a higher royalty rate for those segments where legislation relating to emissions from power generators or vehicles and the cost of power outages is likely to justify a premium compared to the residential sector. Management notes that up to 10% may be achievable in these sectors compared with 4-5% in the residential sector, but this analysis takes a more prudent view. Since the back-up power segment, which includes data centre back-up power, is so large, we model a much smaller penetration rate in this segment. We note that our calculation for range extenders only includes trucks, although the technology is also potentially applicable to other vehicles. For the earnings calculation we apply cost of sales as 7.5% of licence revenue, 20% tax and model a base level of operating costs at FY17e levels (£14.0m) split equally between the four segments.

Management believes that 20% market penetration in the residential, commercial and truck range extender markets is achievable, and 2% in the much larger back-up power market. This gives a total royalty opportunity of c £1,200m compared with c £400m a year ago. We note that even a less ambitious level of penetration represents a material opportunity. Since it is not possible at this stage to determine the rate of roll-out in the four segments, we are not calculating an indicative valuation from this analysis.

Financials: Progressing to commercialisation

Ceres follows a phased programme of engagement with potential customers. This begins with an evaluation of the technology, during which time Ceres receives a fee from the third party for the supply of fuel cell modules or systems and associated engineering support. Once successful, this progresses to a joint development programme, under which Ceres receives higher levels of payment for sharing its IP with the partner. When the partner launches a product incorporating the technology Ceres will receive an upfront licence fee plus follow-on royalty payments based on the volumes sold. While not all the partnerships can be expected to go through commercialisation, success with a relatively small number of companies would give Ceres a significant market share.

Earnings

During FY16 revenues (excluding “other operating income”, which primarily relates to grants) almost quadrupled year-on-year from £0.3m to £1.1m, slightly ahead of our £1.0m estimate. Revenues benefited from the release of £0.6m deferred revenue in respect of contract work completed for British Gas as Ceres demonstrated the prototype residential system to British Gas during H216. The remaining £0.5m revenues were from customers in Asia. Other operating income was at similar levels to FY15 (£0.6m). Operating costs increased by 12% (£1.6m) to £14.0m, reflecting the increased number of employees engaged in R&D and initiatives to improve the company’s test and manufacturing capability. This rise was in line with budget. Reported operating losses increased by £1.0m to £12.7m, which is less than our £13.2m estimate. As the tax credit increased by £0.6m to £2.2m, reported losses after tax were only £0.4m wider than FY15 at £10.5m.

Exhibit 6: Revisions to estimates

	FY16			FY17e			FY18e
	Old	Actual	% change	Old	New	% change	New
Revenues (£m)	1.0	1.1	+10	2.0	2.2*	+10	3.0**
EBITDA (£m)	(11.2)	(10.5)	-6.3	(10.8)	(10.3)	-4.6	(9.5)
PBT (£m)	(12.4)	(11.6)	-6.5	(12.0)	(11.3)	-5.8	(10.5)
EPS (p)	(1.4)	(1.2)	-14	(1.1)	(1.0)	-9.1	(0.9)

Source: Edison Investment Research. Note: *Excluding £0.8m “other income”. **Excluding £1.0m “other income”.

Our model assumes that engagement with existing partners will intensify further during FY17 and that discussions with potential partners will mature into evaluations and development programmes, resulting in a strong ramp-up in revenues through the forecast period. Management continues to aim for the target initially stated at the AGM in December 2015 of securing five global engineering companies as customers in joint development agreements by the end of 2017, with the intention of being in two commercial launch programmes by the end of 2018. Noting the announcements of programmes with blue-chips British Gas, Cummins, Honda (which has signed a JDA), Nissan and an unnamed global OEM in power generation (which has signed an MoU advising of the intention to proceed to a JDA if the ongoing test programme is successful), we raise our FY17 revenue estimate and reduce losses. We estimate that annual revenues from technology evaluations could be £100-200k per partner, scaling up to £500-1,000k for a joint development agreement. At this early stage, we exclude any potential licence and royalty fees from our financial model, giving scope for substantial upside. We estimate that a single licence fee could be worth tens of millions of pounds.

Cash flow and balance sheet

FY16 cash consumption totalled £11.3m (compared to £9.1m in FY15, excluding funds raised from the issue of shares). This included £1.3m invested in the new print line and additional test equipment. It does not include any R&D expenditure as Ceres’ policy is to expense this in the year in which the expenditure occurs. Net cash (including short-term investments) reduced from £18.2m at end June 2015 to £6.9m at end June 2016. Management expects the September 2016 placing, which raised £19.4m (net), to provide funding through to the onset of commercial launches, which management targets for end calendar 2018. It is possible that additional funding may be required at this point to support the launch programmes.

Management notes that FY16 represents the peak of cash consumption. Our estimates show narrowing losses, and a higher R&D related tax credit in FY17 to result in decreasing levels of cash consumption during FY17 and FY18 (£10.8m and £9.0m, respectively) despite slightly higher levels of investment in test and manufacturing during FY17 and FY18 than in FY16. This leaves Ceres with £6.6m estimated net cash at the end of FY18.

Exhibit 7: Financial summary

£000	2014	2015	2016	2017e	2018e
Year end 30 June	IFRS	IFRS	IFRS	IFRS	IFRS
PROFIT & LOSS					
Revenue	1,224	324	1,113	2,200	3,000
EBITDA	(6,663)	(9,716)	(10,504)	(10,302)	(9,495)
Operating Profit (pre amort. of acq intangibles & SBP)	(7,732)	(10,642)	(11,682)	(11,302)	(10,495)
Amortisation of acquired intangibles	0	0	0	0	0
Share-based payments	(856)	(1,080)	(1,012)	(712)	(512)
Exceptionals	0	0	0	0	0
Operating Profit	(8,588)	(11,722)	(12,694)	(12,014)	(11,007)
Net Interest	73	110	77	50	30
Profit Before Tax (norm)	(7,659)	(10,532)	(11,605)	(11,252)	(10,465)
Profit Before Tax (FRS 3)	(8,515)	(11,612)	(12,617)	(11,964)	(10,977)
Tax	1,122	1,571	2,157	2,000	1,500
Profit After Tax (norm)	(6,537)	(8,961)	(9,448)	(9,252)	(8,965)
Profit After Tax (FRS 3)	(7,393)	(10,041)	(10,460)	(9,964)	(9,477)
Average Number of Shares Outstanding (m)	536.8	753.2	774.0	949.5	1,007.0
EPS - normalised (p)	(1.22)	(1.19)	(1.22)	(0.97)	(0.89)
EPS - normalised fully diluted (p)	(1.22)	(1.08)	(1.11)	(0.90)	(0.83)
EPS - FRS 3 (p)	(1.38)	(1.33)	(1.35)	(1.05)	(0.94)
Dividend per share (p)	0.00	0.00	0.00	0.00	0.00
EBITDA Margin (%)	N/A	N/A	N/A	N/A	N/A
Operating Margin (before GW and except.) (%)	N/A	N/A	N/A	N/A	N/A
BALANCE SHEET					
Fixed Assets	1,715	2,080	2,309	2,809	3,309
Intangible Assets	0	0	0	0	0
Tangible Assets	1,715	2,080	2,309	2,809	3,309
Current Assets	10,084	20,685	10,081	19,783	10,897
Stocks	0	0	0	0	0
Debtors	2,385	2,501	3,134	4,165	4,269
Cash, cash equivalents and short-term investments	7,699	18,184	6,947	15,618	6,628
Current Liabilities	(1,385)	(2,013)	(2,206)	(2,260)	(2,839)
Creditors including tax, social security and provisions	(1,385)	(2,013)	(2,206)	(2,260)	(2,839)
Short term borrowings	0	0	0	0	0
Long Term Liabilities	(2,341)	(2,071)	(897)	(897)	(897)
Long term borrowings	0	0	0	0	0
Other long term liabilities	(2,341)	(2,071)	(897)	(897)	(897)
Net Assets	8,073	18,681	9,287	19,435	10,470
CASH FLOW					
Operating Cash Flow	(8,252)	(9,182)	(11,773)	(11,279)	(9,020)
Net Interest	75	110	77	50	30
Tax	1,000	1,218	1,679	2,000	1,500
Capital expenditure	(520)	(1,243)	(1,302)	(1,500)	(1,500)
Capitalised product development	0	0	0	0	0
Acquisitions/disposals	0	0	0	0	0
Financing	(41)	19,569	54	19,400	0
Dividends	0	0	0	0	0
Net Cash Flow	(7,738)	10,472	(11,265)	8,671	(8,990)
Opening net debt/(cash)	(15,437)	(7,699)	(18,184)	(6,947)	(15,618)
HP finance leases initiated	0	0	0	0	0
Other	0	13	28	0	0
Closing net debt/(cash)	(7,699)	(18,184)	(6,947)	(15,618)	(6,628)

Source: Edison Investment Research, Ceres Power company accounts

EDISON

Contact details	Revenue by geography
Viking House Foundry Lane Horsham RH13 5PX UK +44 (0)1403 273463 www.cerespower.com	N/A

Management team

Chairman: Alan Aubrey	Chief Executive Officer: Phil Caldwell
Alan Aubrey is CEO of IP Group, non-executive chairman of AIM-listed Proactis and non-executive director of Oxford Nanopore. From 2008 to 2014, he was a non-executive director of the Department for Business, Innovation & Skills. Previously he was a partner at KPMG, where he specialised in providing advice to fast-growing technology businesses. He became chairman in December 2012.	Phil Caldwell was previously corporate development director at Intelligent Energy, where he secured OEM partners and executed licence deals and joint ventures. Before this he was responsible for business development for the Electrochemical Technology Business in ICI. He joined Ceres as CEO in September 2013.
Chief Financial Officer: Richard Preston	**Chief Technology Officer: Mark Selby**
Richard Preston joined Ceres in 2008 as financial controller and was appointed to the board in February 2013. Previously he held a number of senior roles in business transformation and project finance at Cable & Wireless.	Mark Selby joined Ceres in 2006 and was appointed to the board in 2014. He is responsible for leading all aspects of the strategy and delivery of the Steel Cell technology development. Before joining Ceres he was part of the Control & Electronics department at Ricardo UK.

Principal shareholders	(%)
IP Group	25.6
Richard Griffiths	18.0
Henderson Group	12.3
Lansdown Partners	9.8

Companies named in this report

AFC Energy (AFC:LN); Ballard Power Systems (BLDP:US); Dominovas Energy Corporation (DNRG:US); Doosan Corp (000150:KS); Electro Power Systems (EPS:FP); FuelCell Energy (FCEL:US); Heliocentris (H2FA:GR); Hydrogenics (HYGS:US); Hyster-Yale Materials Handling Inc. (HY:US); Intelligent Energy Holdings (IEH.L); ITM Power (ITM.L); POSCO (005490:KS); Plug Power (PLUG:US); SFC Energy (F3C:GR)