Carbonomics

Behind-the-meter power solutions for data centers: gas turbines, fuel cells and reciprocating engines

We analyze the behind-the-meter (BTM) technologies for powering data centers, comparing economics, time to market and key supply chain constraints for gas turbines, fuel cells and reciprocating engines --introducing a global forecast for volumes and the addressable market by technology. With power availability emerging as a key constraint on AI infrastructure deployment and the time-to-grid connections in the US and Europe expected to rise over the next five years, **we raise our outlook for BTM power generation from 40GW to 67GW by 2030** vs. our previous estimates. Reflecting this more constructive outlook, we now forecast fuel cells supplying **c.12GW of US data center capacity a**We analyze the behind-the-meter (BTM) technologies for powering data centers, comparing economics, time to market and key supply chain constraints for gas turbines, fuel cells and reciprocating engines --introducing a global forecast for volumes and the addressable market by technology. With power availability emerging as a key constraint on AI infrastructure deployment and the time-to-grid connections in the US and Europe expected to rise over the next five years, **we raise our outlook for BTM power generation from 40GW to 67GW by 2030** vs. our . Reflecting this more constructive outlook, we now forecast fuel cells supplying **c.12GW of US data center capacity and c.18GW globally by 2030**, equivalent to a cumulative equipment opportunity of **c.$35bn and c.$55bn**, respectively. BTM gas-power generation could serve **c.28% of US and c.25% of global data center power demand by 2030**, representing a significant increase vs. our prior expectations and reinforcing our view that all of these technologies will be required to deliver the data center growth we expect.

While **CCGTs and RICEs screen best on economics and LCOE**, we believe technology selection is increasingly driven by execution-related considerations such as speed-to-power, reliability and permitting certainty. On this broader lens, **fuel cells score strongest on execution-related criteria, including time-to-power, availability and site efficiency; OCGT emerge as the most balanced conventional alternative; CCGTs remain attractive where longer build times and larger site requirements are manageable; and RICEs continue to offer compelling economics and deployment flexibility, albeit with trade-offs in operational resilience and environmental performance.**

Stock exposure: Among the Buy-rated names across our coverage, we view Ceres Power, Weichai Power and Delta Electronics as the stocks most leveraged to fuel cell adoption in data centers, while GE Vernova, Siemens Energy, Mitsubishi Heavy Industries and INNIO appear best positioned to benefit from rising demand for conventional gas-powered BTM generation.

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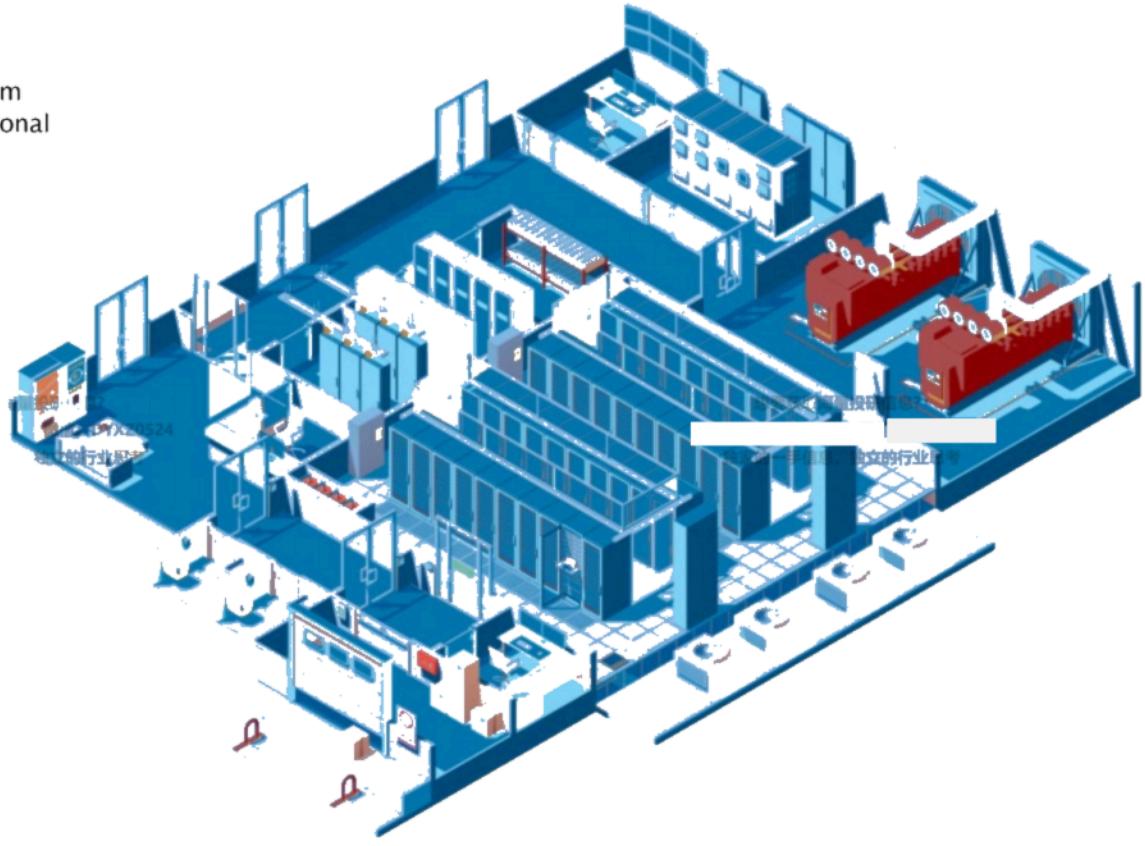
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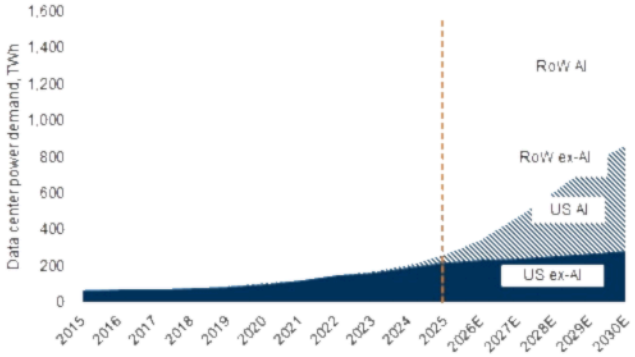
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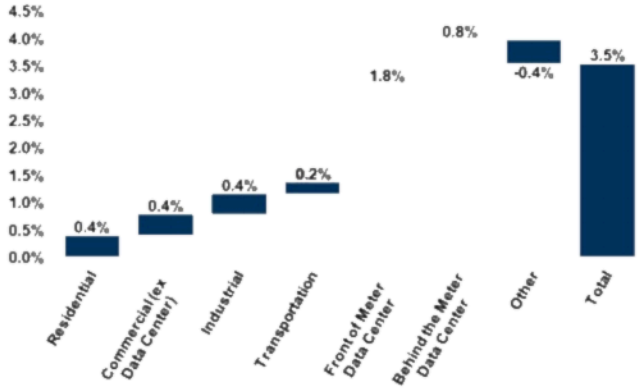
Thesis in 12 charts

Exhibit 1: We now see 170% global data center power demand growth in 2030 vs. 2025 levels, more than 60% of which comes from the US
Data center (AI + non-AI) power demand in US and rest of world, TWh



Source: Masanet et al. (2020), EIA, EMBER, IEA, Cisco, Goldman Sachs Global Investment Research

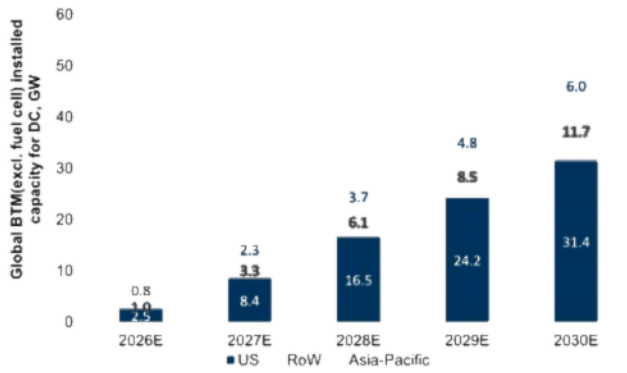
Exhibit 2: Our total power demand CAGR forecast increases to 3.5% through 2030, driven by both BTM and FTM data center demand



Numbers do not sum to total due to rounding.

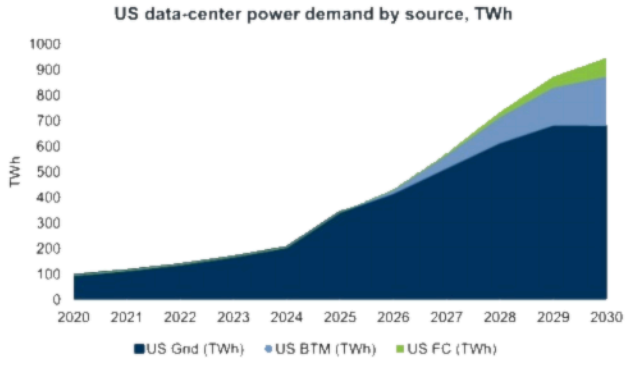
Source: Goldman Sachs Global Investment Research

Exhibit 3: Our US Utilities team has increased its estimate for BTM capacity (excl. fuel cells) available to serve data center load to c.31GW by 2030 from 20GW previously
Global BTM (excl. fuel cell) installed capacity for DC, GW



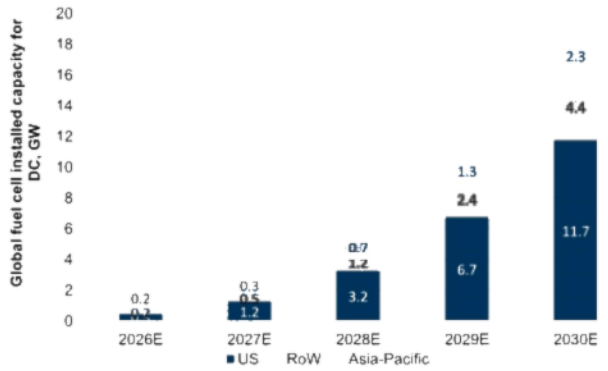
Source: Goldman Sachs Global Investment Research

Exhibit 4: We now see fuel cells supplying c.8% of US data center demand by 2030 and c.7% globally, on top of the c.20% / c.18% delivered by gas-BTM.
US DC power demand, TWh



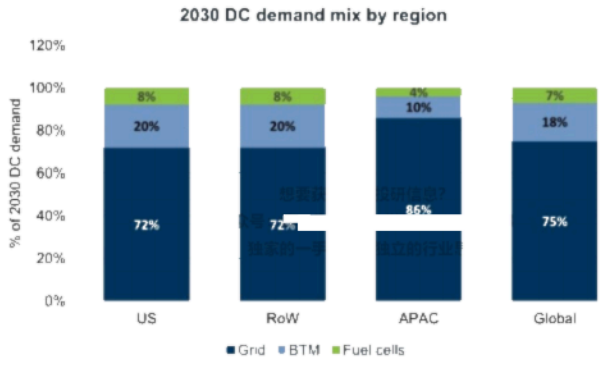
Source: Masanet et al. (2020), EIA, EMBER, IEA, Cisco, Goldman Sachs Global Investment Research

Exhibit 5: In installed terms, this corresponds to c.12GW of fuel cell capacity in the US and c.18GW globally by 2030, from a de-minimis base today
Global fuel cell installed capacity for DC, GW



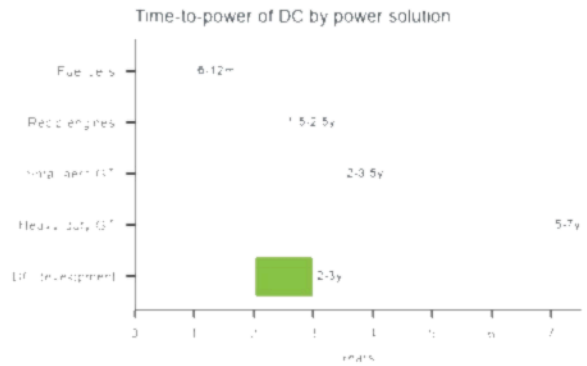
Source: Goldman Sachs Global Investment Research

Exhibit 6: Taken together, gas-turbines, RICE and fuel cells account for c.28% of US and c.25% of global data center demand by 2030E
2030E DC demand mix, %



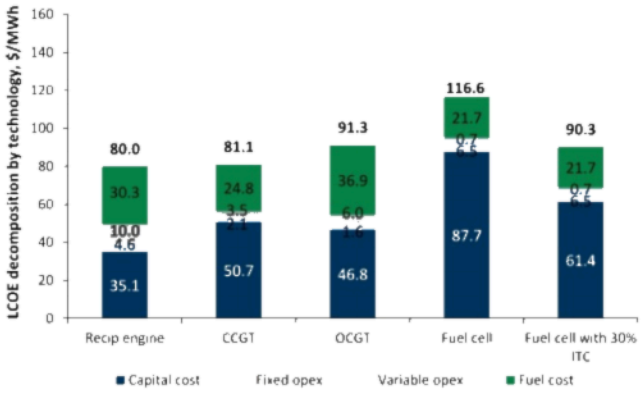
Source: Goldman Sachs Global Investment Research

Exhibit 7: As conventional power backlogs grow, speed-to-power becomes increasingly important for data centers
Time to power by power solution



Source: Data compiled by Goldman Sachs Global Investment Research

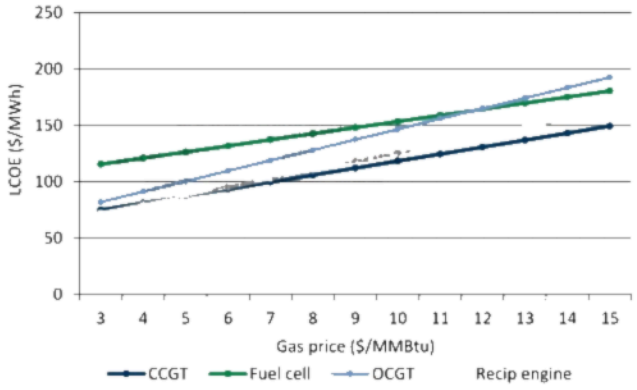
Exhibit 8: Fuel cell is the most expensive power solution based on LCOE - roughly 45% higher than CCGT and RICE and c.30% higher than OCGT, mainly driven by high capex
LCOE by technology, $/MWh



Natural gas price of 4$/mmbtu

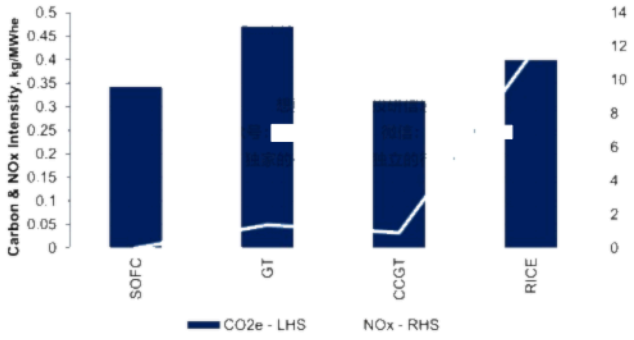
Source: Goldman Sachs Global Investment Research

Exhibit 9: Fuel cells approach OCGT economics at normalized European gas prices (12$/mmbtu), supporting competitiveness in a higher-for-longer gas price environment
LCOE sensitivity to Natural Gas price (US, $/MMBtu)



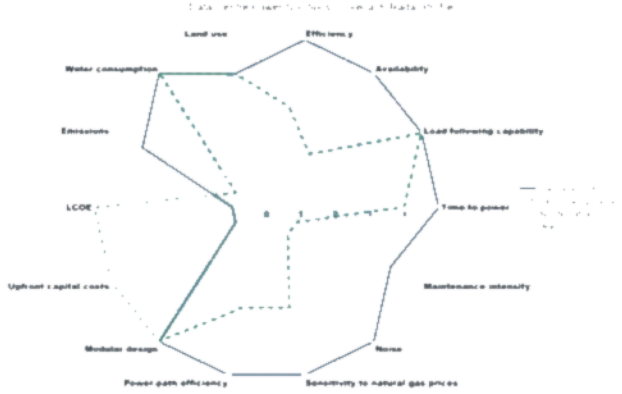
Source: Goldman Sachs Global Investment Research

Exhibit 10: CCGTs and SOFCs deliver the lowest emissions intensity, while reciprocating engines have materially higher NOx emissions. With environmental permitting and local opposition becoming more prominent constraints for US data center development, emissions performance is increasingly influencing technology selection
Carbon & NOx intensity, kg/MWhe



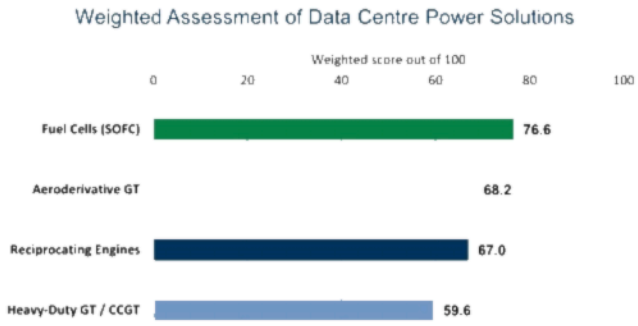
Source: InnoEnergy

Exhibit 11: Our weighted assessment suggests execution-related considerations such as deployment speed, availability and environmental performance are becoming as important as economics for hyperscale operators
Data center on-site power solutions scorecard: radar map



Source: Goldman Sachs Global Investment Research

Exhibit 12: Fuel cells offer the strongest overall combination of deployment speed, reliability and site efficiency for data centers, in our view
Weighted assessment of data center power solutions



Source: Goldman Sachs Global Investment Research

Comparison of behind-the-meter power solutions

There are several technologies that offer behind-the-meter characteristics, including on-site generation, energy storage, microgrids, and combined heat and power systems. Specifically for the needs of data centers, there are three main factors influencing the decision on the appropriate solutions: (1) the levelized cost of electricity; (2) power consistency and flexibility; and (3) power density and cleanliness.

Levelized cost of electricity is the average cost of the electricity aggregating the upfront investments needed and the unit costs to generate electricity over its useful life. Power consistency and flexibility measures how reliable and agile a grid is, respectively responding to the requirements of high up time for reliability and fast start-up time to handle surges in demand. Power density refers to the capacity of the power source relative to the area it occupies, while power cleanliness is the level of pollution it generates. These are relevant for dense urban centers where space is constrained and environmental regulations are stringent.

Based on the criteria, the viable BTM solutions for data centers range from onsite generation through gas turbines, fuel cells, reciprocating engines, diesel engines, solar, SMR and geothermal plants to energy storage system using batteries (BESS). Onsite generation will likely be used to handle longer-term electricity demand as grid infrastructure builds, while BESS responds to the short-term need for back up and load balancing.

- **Gas turbines** are internal combustion engines that convert fuel, such as natural gas or hydrogen, into mechanical energy. This process involves compressing air, mixing it with fuel and igniting the mixture in a continuous combustion process. The resulting high-pressure gases then spin turbine blades to generate power. **Combined-cycle gas turbines (CCGT) require significant water** for their steam cycle and cooling systems, while simple-cycle gas turbines require little to no operational water as they do not produce steam other than for temperature and NO_x management.
- **Diesel engines** are internal combustion engines that ignite fuel by compressing air to a high temperature, rather than using spark plugs like gasoline engines. They are widely used for electricity generation, particularly for backup power in remote locations, and for mobile power supply. They have relatively small power output and consume a large amount of diesel in the long run which makes them ideal for back up power.
- **Reciprocating gas engines** are internal combustion engines that convert natural gas, biogas or hydrogen into electricity using pistons connected to a crankshaft. They offer fast start-up, strong partial-load efficiency and modular deployment, making them suitable for flexible or base-load power. However, multiple units require more space and maintenance and produce CO_2, particulate emissions and noise. They use even less water for operations than single cycle gas turbines as they run at a much lower temperature than turbines.
- **Solar power** generation harnesses energy from the sun and converts it into electricity. It generates intermittent electricity, depending on the weather, making it more suitable for supporting the base load. It could also be paired with BESS for

more consistent power supply.

- **BESS** is a technology-based solution that utilizes rechargeable batteries to store electrical energy for later use. The systems gather energy from diverse sources, including renewable and conventional power, and discharge it to supply power during peak demand, outages or for grid stabilization.
- **Small modular reactors (SMRs) and geothermal** plants harness nuclear and geothermal power to generate electricity. They are reliable and relatively cheap over the long run. However, owing to their long investment cycle, the majority of the investments from data centers are unlikely to result in their realization before 2030.
- **Fuel cells (SOFC)** generate electricity electrochemically rather than through combustion. They convert fuels such as natural gas, biogas, hydrogen or ammonia directly into electricity using a ceramic electrolyte, achieving higher electrical efficiency than conventional gas turbines while producing very low NOx, SOx, particulate and noise emissions. SOFCs require little to no operational water for power generation, as water produced during the electrochemical process can be recycled within the system.

Exhibit 13: On-site power generation solutions comparison

Onsite Power Types	Fuel Cell (SOFC)	Gas Turbine	Reciprocating Gas Engine	Diesel Engine	Solar	BESS
Fuel	H_2, Natural Gas, Biogas	H_2, Natural Gas, Biogas	H_2, Natural Gas, Biogas	Diesel	None	None
Efficiency	60%	60%	40-50%	40%	100%	100%
Start-up Time	<1 hr	<0.5 hr	<2 min	<0.5 hr	0	0
Emissions	CO_2, No noise	NOx, CO, CO_2, Noise	CO_2, PM10, Noise	NOx, SOx, CO, CO_2, Noise	None	None
Land Intensity m2/MW	15-45	45-50(SC) / 350-400(CCGT)	50-60	25-50	20000	120-250
Capacity / Size	Up to 80 MW per plant; 200–300 kW per server	30–600 MW per turbine	2–20 MW per unit	150 kW–2 MW	5 MW per 0.1 km^2	20 kW–10 MW
Reliability	High; low downtime	High; low downtime	High; modular; unlimited stops/starts	High; costly to run for long	No downtime; intermittent generation	No downtime; needs recharging
Use Case	Base load	Base load	Fast deployment; flexible load; bridging/base load	Flexible load; backup/base load	Supporting base load	Backup power
Water Usage	4 L/Mwh	140L/MWh simple cycle; 10,000L.MWh for CCGT	1L/Mwh	Minimal	None	None
Main OEMs	Bloom Energy; Ceres Power; Wechai; Delta Electronics; FuelCell Technologies;	GE Vernova; Siemens Energy; Mitsubishi Power	Wartsila; Caterpillar; INNIO Jenbacher; Rolls-Royce mtu; Cummins; MAN Energy Solutions; Wechai Power	Caterpillar; Cummins; Rolls-Royce mtu; Kohler; Generac; Weichai Power	LONGi; JinkoSolar; Trina Solar; Canadian Solar; First Solar	Sungrow; Tesla; CATL; BYD; Fluence
Current backlog / lead time	12-24 months	4-7 years for CCGT, 18-36 months for Single Cycles	12-24 months	6-18 months	3-9 months for modules	6-12 months

Source: Company data, Goldman Sachs Global Investment Research

Benchmarking summary

Data center power requirements extend beyond generation cost alone, with deployment speed, availability, upfront capital intensity and environmental factors representing critical considerations for hyperscalers operating 24/7. Based on the time -sensitivities and their intrinsic performance, we introduce a BTM solution scorecard (Exhibit 14) grading aeroderivative turbine, CCGT, gas engine and fuel cells on a range of factors. The weighted assessment of behind-the-meter power solutions for hyperscale data centers highlights that technology selection is increasingly driven by execution considerations rather than generation economics alone. With **time-to-power (20%)**, **availability (15%)**, **LCOE (15%)** and **upfront capital costs (10%)** representing over 60% of the total weighting, solutions capable of delivering reliable power quickly are increasingly advantaged in today's supply-constrained market.

Fuel cells emerge as the highest-ranked solution under our framework, primarily reflecting their leading position on deployment speed, availability, efficiency and site requirements. Fuel cells achieve maximum scores for time-to-power, availability, load following, power-path efficiency and water consumption while also performing strongly on emissions, maintenance intensity and noise. Against these advantages, the technology remains disadvantaged on both upfront capital costs and LCOE, highlighting the trade-off between execution certainty and generation economics.

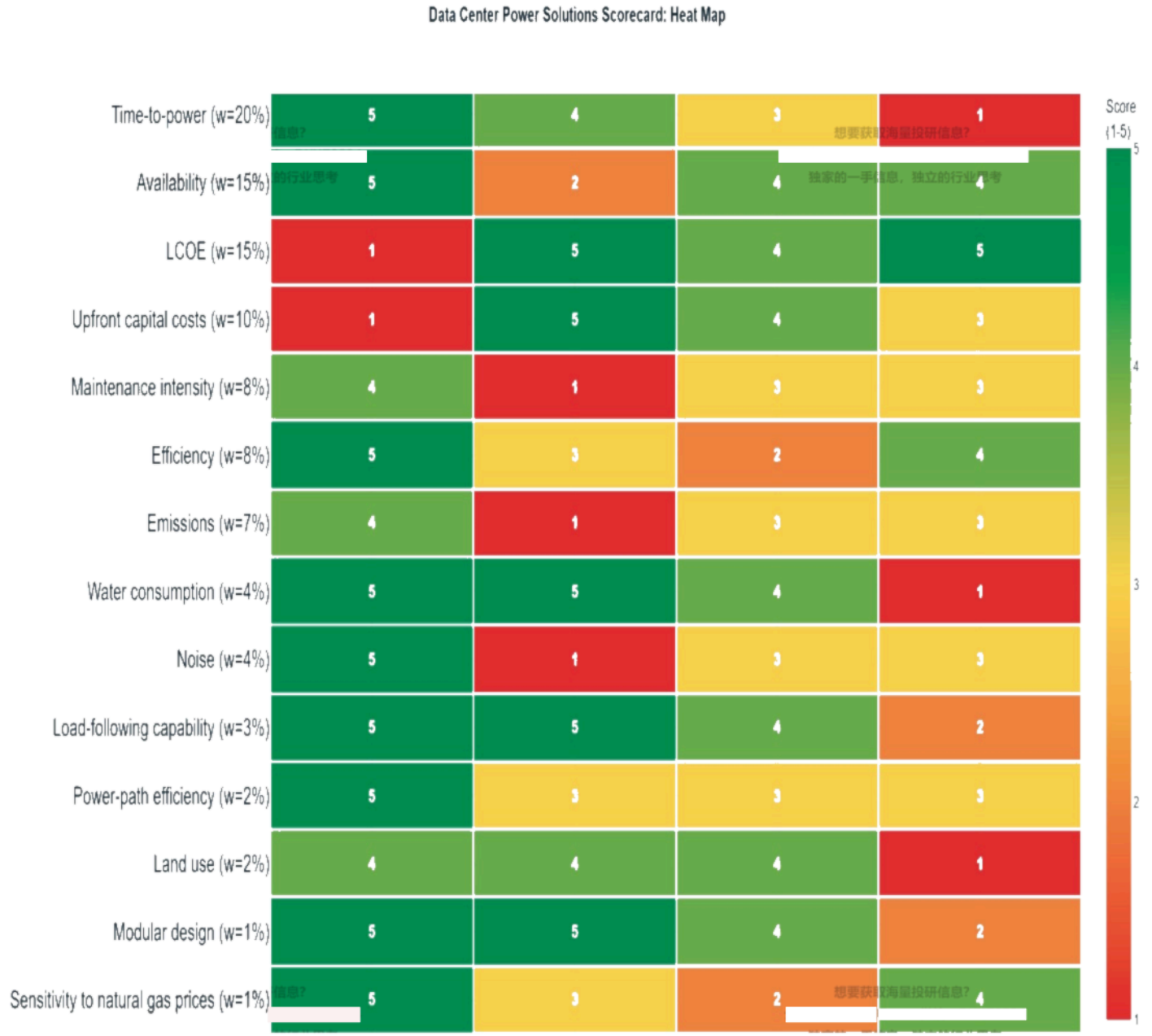
Single-cycle gas turbines provide the most balanced conventional-generation profile. While they do not lead any individual category, they score consistently well across availability, capital costs, LCOE and load-following capability. Critically, they avoid many of the land, water and modularity disadvantages associated with larger heavy-duty gas turbine installations, resulting in the second-highest weighted outcome in our assessment. However, currently elevated lead times remain a significant hurdle to deployment of gas turbines for data centers.

Reciprocating engines screen attractively from a cost and flexibility perspective, benefiting from high scores in upfront capital costs, LCOE, load following and deployment speed. However, these strengths are offset by weaker performance across maintenance intensity, emissions, noise and availability, factors that become increasingly important as data center operators prioritize operational resilience.

Heavy-duty gas turbines and CCGTs remain the strongest long-term economic generation solution, scoring highly on efficiency, availability and LCOE. However, their weaker performance on time-to-power, modularity, land use and water consumption lowers their attractiveness for developers seeking rapid deployment of new capacity. The technology remains best suited to large-scale applications where build timelines and site constraints are less critical considerations.

As data center developers increasingly compete for timely access to power, our assessment in this report suggests fuel cells offer the strongest overall combination of deployment speed, reliability and site efficiency. Aeroderivative gas turbines represent the most balanced conventional-generation alternative, while heavy-duty gas turbines and CCGTs remain attractive for large, power-intensive campuses where long-term generation costs are the primary consideration. Reciprocating engines continue to offer compelling economics and deployment flexibility, but with trade-offs in operational resilience and environmental performance.

Exhibit 14: As data center developers increasingly compete for timely access to power, our assessment...
Data center on-site power solutions scorecard: heat map



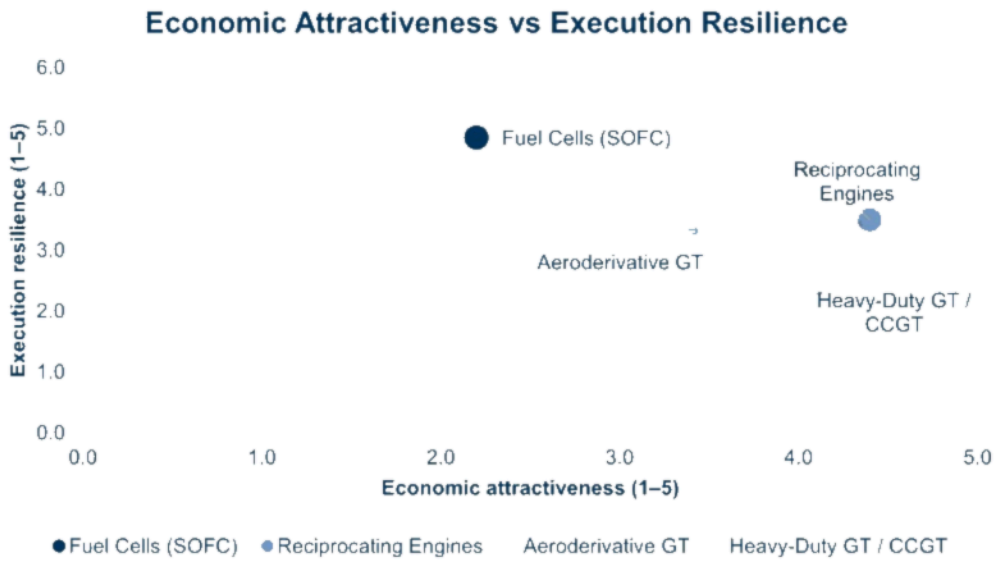
Source: Goldman Sachs Global Investment Research

Exhibit 15: ...is increasingly driven by execution considerations rather than generation economics alone
Data center on-site power solutions scorecard: radar map



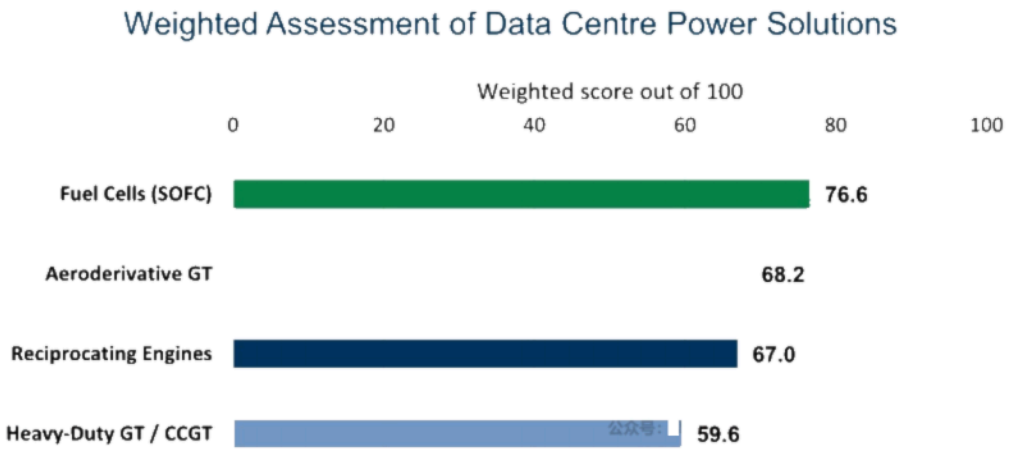
Source: Goldman Sachs Global Investment Research

Exhibit 16: Aeroderivative GTs represent the most balanced conventional-generation, heavy duty CCGTs have the best long-term economics while engines offer compelling economics and flexibility
Economic attractiveness vs. execution resilience



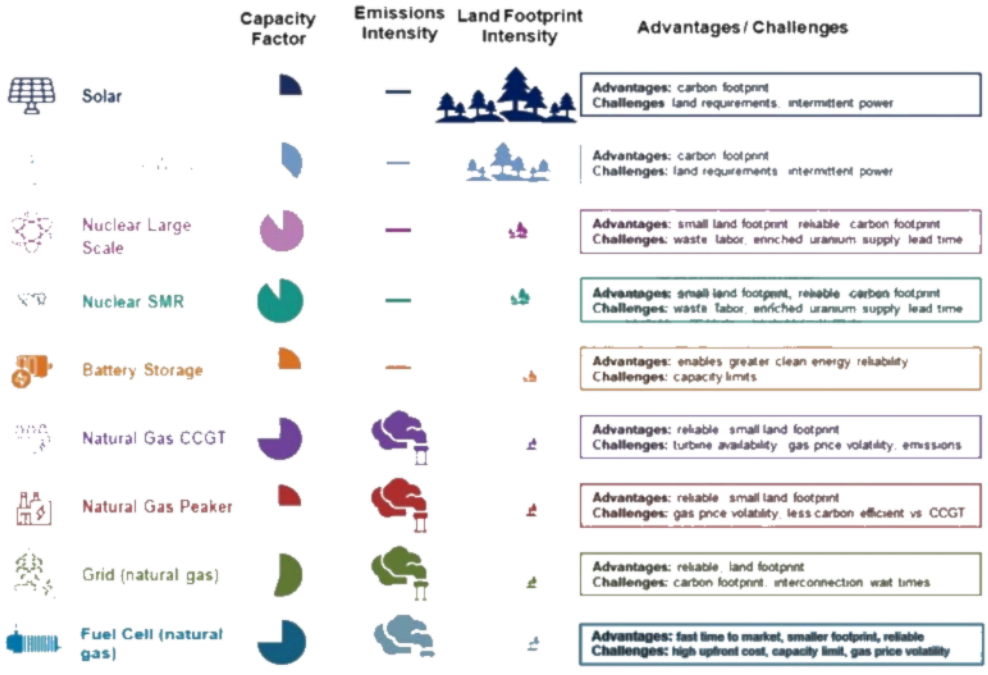
Source: Goldman Sachs Global Investment Research

Exhibit 17: Fuel cells offer the strongest overall combination of deployment speed, reliability and site efficiency, in our view
Weighted assessment of data center power solutions



Source: Goldman Sachs Global Investment Research

Exhibit 18: Compared to other energy sources, fuel cells have the advantage of being fast to market, reliable and having a limited footprint



Source: Goldman Sachs Global Investment Research

In this section, we present a comprehensive comparison analysis of fuel cells vs gas turbines vs reciprocating engines specifically in data center applications. To assess their suitability, we compared them across **five key areas: (1) time to market; (2) levelized cost of electricity (LCOE); (3) noise from electricity generation; (4) emissions and (5) load versatility.**

1) Time to market: Fuel cells offer the fastest path to power for data centers as conventional generation lead times remain above historical norms

Under normal market conditions, deployment timelines for distributed and utility-scale power projects were generally predictable, with reciprocating engines typically requiring around 12-18 months and large gas turbine projects approximately 2-3 years from order to commissioning. Over the past three years, however, unprecedented demand from data centers and AI-related power projects has materially altered this dynamic.

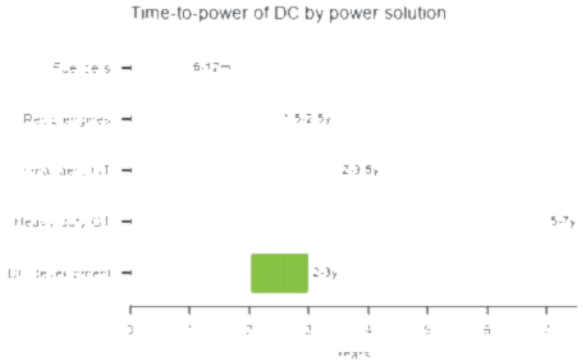
Global demand for gas turbines has surged, resulting in record order backlogs across all major OEMs, including GE Vernova, Siemens Energy and Mitsubishi Heavy Industries. To facilitate this unprecedented surge in power demand and hence turbine needs, all three companies have announced plans to scale up their production capabilities. However, the capacity increase seems unlikely to materially change the tight market conditions. GE Vernova guides to have by the end of the year >125GW under contract and sold all of 2030 and >50% of the 2031 production slots. Siemens Energy has built up a backlog approaching 69GW with 27GW of reservations, and plans to raise total capacity to 30GW per year in 2030, which gives an implied lead-time of 3-4 years from now. Mitsubishi Heavy Industries is negotiating projects to be shipped in the 2030s.

Data center developers now represent a significant share of new orders, stretching delivery schedules well beyond historical norms. The impact has been most pronounced

for **heavy-duty gas turbines, where lead times have expanded from roughly 2-3 years in a normal market to approximately 5-7 years today. Reciprocating engines have also experienced increased demand and longer delivery schedules, although the increase has been substantially more modest, with lead times generally increasing to 1.5-2.5 year range.**

Fuel cells currently offer the shortest and most predictable route to new power capacity. SOFC manufacturers indicate deployment timelines of approximately 6-12 months for modular fuel cell projects, materially below those currently seen across the gas generation market. For data center developers, where speed-to-power is increasingly a critical determinant of project economics and revenue generation, we think the ability to secure power capacity within months rather than years represents a significant competitive advantage. As a result, the widening gap between fuel cell deployment timelines and those of conventional gas generation has become an increasingly important consideration in data center power planning.

Exhibit 19: While conventional gas options experience heavy backlog, fuel cells offer a faster-to-market alternative
Time-to-power by power solution



Source: Data compiled by Goldman Sachs Global Investment Research

Exhibit 20: Nat-gas fueled turbine and engine makers have experienced a surge in demand and are planning capacity expansions.
Nat Gas turbine and engine demand and expansion plan

		Date	Demand trends	Capacity expansion
Turbines	GE Vernova	2Q-FY26	By year end will have **>125GW under contract** and **sold all of 2030 and >50% of its 2031 production slots**	Committed **$300mn investments** in the Gas Power business. **Mid-2028 capacity target of 24GW** and **30GW by 2030**
	Siemens Energy	2Q-FY26	Still sees a **c.10% gap between supply and demand in 2030** after all the capacity expansions are done	**Invested >€2bn in FY26** to build up production capacity. Plans to **raise total capacity to 30GW by 2030.**
	Mitsubishi Heavy	FY25	**Gas turbine demand in 2025 reached c.100 GW** (up from 55GW in 2024) and they are negotiating projects **to be shipped in the 2030s**	Production capacity will **increase by a further 50%** after the initial 30% increase, **2x compared to the FY2024 level.**
Engines	Wartsila	2Q-FY26	Wartsila have **sold out their 2028 capacity** and are **now negotiating orders for 2029 and 2030**	**35% increase in Technical Capacity** by 1Q28, **further 30% increase by 2029** vs 2025 baseline (which operated at 75%)
	Innio	FY25	**>15 GW** of combined equipment order backlog and slot reservations which is **>4x the power delivered over the last 12m**	Plans to **3x its total production capacity by 2030**, moving from 3.5 GW/year in 2025 to **c.10 GW/year**
	Caterpillar	FY25	The **backlog for large reciprocating engines has grown by >3.5x** since the company announced capacity expansion plans in 2024	Expects to **c.3x its large engines capacity by 2030** (vs. 2024) and **2.5x its gas turbine capacity** over the same period
	Cummins	2Q-FY26	Cummins are **taking orders out to 2028**	$450M investment **adding 20GW**, for a **total of 55GW** HHP capacity **by 2030**
	Rolls Royce	2Q-FY26	Datacenters are now **80%+ of power generation sales**, with Roll-Royce backup power systems supporting **>25% of U.S. data centers**	The Mankato investment will increase production capacity for **backup power systems by >2x by end of 2026**
	HD Hyundai Heavy	2Q-FY26	Order backlog stood at c.$8bn at the end of June, or **c.3x the division's revenue last year**	Plans to increase its total HiMSEN gas engine production capacity **from the current 3 GW per year to 7.2 GW by 2030**
	Rehlko	2Q-FY26	Multi-year engine framework agreement **with INNIO**, securing **supply of c.1.25 GW of gas engine capacity over the next 3 years**	Will expand capacity by **>400% through the decade**
	Generac	2Q-FY26	Signed a **long-term agreement to supply backup generators for Amazon data centers**, delivering a total **c.$2.4 billion in 2027-2028**	Expanding capacity from $1.25bn at the end of 2026 to $3.75bn, or **3x over one year**

Source: Company data, data compiled by Goldman Sachs Global Investment Research

2) Levelized cost of electricity

In this section we calculate LCOE of a 500MW data center using on-site gas assets across four technology options: reciprocating engines, OCGT, CCGT and fuel cells. **Based on our analysis, reciprocating engines have the lowest LCOE at $80/MWh, comparable to CCGT at $81/MWh. Fuel cells have the highest LCOE of $117/MWh, however with US 30% ITC the LCOE decreases to $90/MWh. Overall, our results show that fuel cells have a higher LCOE than gas turbines and reciprocating engines - roughly 45% higher than CCGT and c.30% higher than OCGT (at natural gas price of 4$/mmbtu).** The cost gap is mainly driven by the high cost of fuel cell systems and limited deployment scale.

Data centers usually need more power infrastructure than their headline IT capacity because electricity is not only used by servers, but also by cooling, pumps, power conversion and other support systems, and operators also keep a reliability buffer to avoid downtime. In our LCOE case, this results in clear overbuild across all technologies: fuel cells are lowest at about +9% (c.725MW installed vs. 665MW required), reciprocating engines are around +22% (c.810MW), OCGTs around +26% (c.840MW) and CCGTs the highest at about +47% (c.979MW). This extra installed capacity is an important cost driver in the model because more equipment is paid for than is used continuously.

Installed capital costs vary materially across reciprocating engines, gas turbines and fuel cells, reflecting differences in technology maturity, manufacturing scale and system complexity. For our base case assumptions, we use installed costs of $1,800/kW for reciprocating engines, $2,400/kW for OCGT, $2,600/kW for CCGT and $4,750/kW for fuel cells.

Reciprocating engines represent the lowest-cost dispatchable power technology in our analysis. Units typically range from 2.5MW to 35MW, with all-in capital costs of roughly $1,700-2,000/kW. We benchmarked our assumptions against pricing disclosed by leading engine manufacturers, including Wärtsilä, and adopt a base case assumption of $1,800/kW reflecting the benefits of a modular design, established supply chains and comparatively limited balance-of-plant requirements. While reciprocating engines often appear attractive on upfront economics, they require a large number of units to support 200-500MW campuses, increasing maintenance complexity, outage exposure, operating labour requirements and site footprint. For hyperscale operators, system reliability and operational simplicity are often prioritized over minimizing upfront capital expenditure.

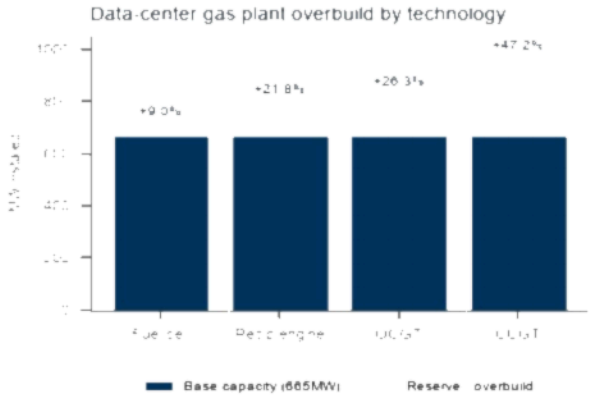
Gas turbines are more capital intensive and have experienced significant cost inflation in recent years as a result of strong equipment demand and rising construction costs. We assume installed costs of $2,400/kW for OCGT projects and $2,600/kW for CCGT plants. These assumptions are broadly consistent with recent industry observations that combined-cycle projects have increased from roughly $1,300/kW in 2023 to $2,000-2,200/kW in 2025, with projects scheduled for delivery beyond 2030 approaching $2,500/kW. Increasing demand for gas-fired generation has supported margin expansion among major turbine suppliers, including GE Vernova, Siemens Energy and Mitsubishi Heavy Industries, while engineering, procurement and construction costs have also risen materially. According to GE Vernova, the turbine itself accounts for only around one-third of the total capital cost of a gas-fired power plant, with the remainder attributable to balance-of-plant equipment, engineering, construction, cooling systems and grid interconnection. CCGT plants are inherently more capital intensive than OCGT

facilities owing to the additional heat recovery steam generator and steam turbine required to convert exhaust heat into incremental power output. As a result, recent turbine cost inflation has contributed to a narrowing of the capital cost gap between gas turbines and alternative technologies such as fuel cells. Additionally, gas turbines require complex maintenance.

Fuel cells remain the most capital-intensive technology considered in our analysis. Industry estimates suggest installed costs can range from approximately $2,700-5,000/kW, depending on technology, scale and available incentives. We assume an installed cost of $4,750/kW, towards the upper end of the range, reflecting current manufacturing scale limitations and supply chain constraints. Importantly, the fuel cell system itself typically accounts for around 80% of total project capital costs. With the 30% investment tax credit from the Inflation Reduction Act, the fuel cell system price can be brought down to $2,700/kW.

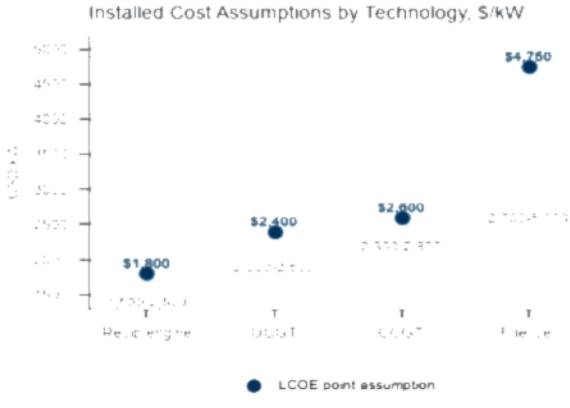
While fuel cells and CCGTs are more capital intensive, they have the highest electricity efficiency across 4 solutions (fuel cells: 57-63%, CCGT: 55-60%, RICE: 45-48%, OCGT: 35-42%). Higher electrical efficiencies reduce fuel consumption per unit of power generated, resulting in lower operating cost exposure. As a result, on our estimates fuel costs account for only c.20% of LCOE for fuel cells and c.30% for CCGTs versus c.38% for reciprocating engines and c.40% for OCGT. Fuel costs remain the largest component of operating expenses across all technologies.

Exhibit 21: Fuel cell systems can deliver up to 99.999% uptime which leads to the least overbuilt capacity, while CCGT needs the most.
Power capacity overbuild needed for gas plant serving a 500MW IT capacity data center



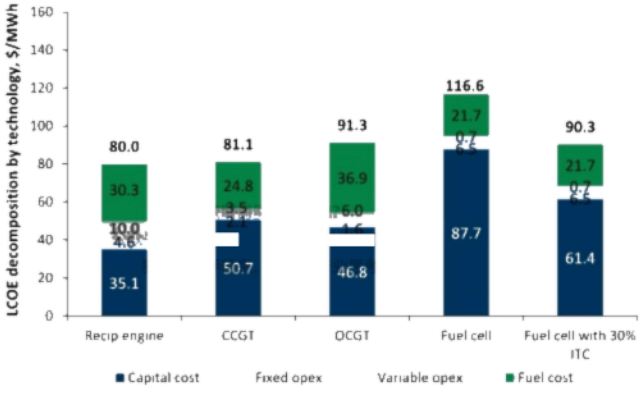
Source: Goldman Sachs Global Investment Research, GE Vernova, Siemens Energy, Bloom Energy, Wartsila, BNEF

Exhibit 22: Recip engine has the cheapest installed cost, followed closely by OCGT and CCGT, while fuel cell needs significant upfront investment
Installed cost assumptions, $/kw



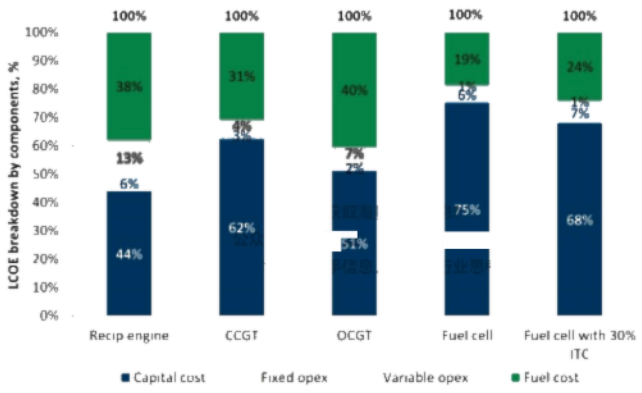
Source: Goldman Sachs Global Investment Research, Bloom Energy, GE Vernova, Siemens Energy, Wartsila

Exhibit 23: Fuel cell is the most expensive on a LCOE scale - roughly 45% higher than CCGT and RICE and c.30% higher than OCGT (at natural gas price of 4$/mmbtu)
LCOE by technology, $/MWh



Source: Goldman Sachs Global Investment Research

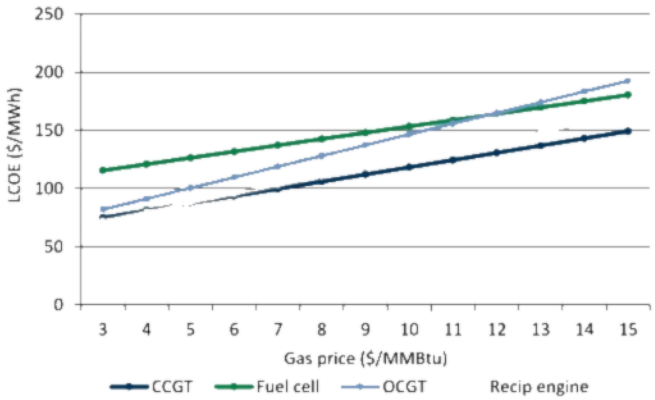
Exhibit 24: RICE and OCGT are the most sensitive to fuel cost, while fuel cell is the most capital-intensive
LCOE breakdown by technology, %



Source: Goldman Sachs Global Investment Research

Our LCOE sensitivity work indicates that fuel cells have the lowest fuel-cost exposure among behind-the-meter power solutions, driven by their highest electrical efficiency. While OCGT and reciprocating engines show the steepest gas pass-through (c.$0.09/MWh and c.$0.07/MWh per +$1/MMBtu, respectively), fuel cells are least sensitive at c.$0.05/MWh (vs. CCGT at c.$0.06/MWh). As a result, fuel-cell LCOE converges toward single-cycle gas turbine economics at around $12/MMBtu gas, which is close to our normalized TTF reference (GSe TTF 2027 at c.$11/MMBtu), supporting the case for fuel cells as a structurally resilient option in higher-for-longer gas-price environments.

Exhibit 25: OCGT has the highest fuel sensitivities, while fuel cell the lowest
LCOE sensitivity to Natural Gas price (US, $/MMBtu)



Source: Goldman Sachs Global Investment Research

3) Noise from electricity generation: Fuel cells offer near-silent operation vs. high-noise gas turbines and vibrating engines

In terms of noise, gas turbines operate within a range of 90dB to 120dB, at a high frequency similar to that of a jet engine. There can also be significant burst sounds at startup, and vibration is likely to follow as it operates. For data center applications, reciprocating gas engines are generally noisier than gas turbines, particularly at close range, because they generate significant mechanical noise (pistons, valves, crankshafts)

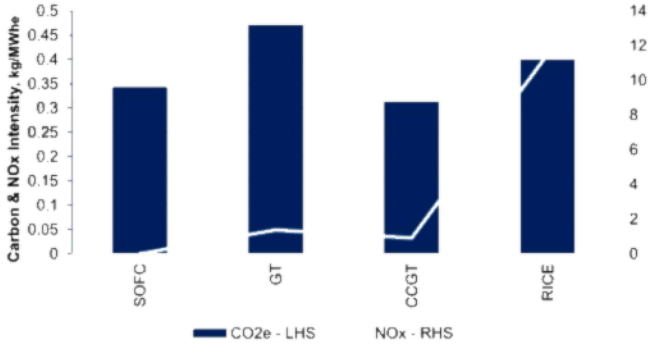
in addition to exhaust noise and produce more vibration. These could be challenging factors when considering setting up onsite power close to business or residential areas. RICE operates at a louder level than turbines due to their shared mechanical characteristics. **Fuel cells, on the other hand, are nearly completely silent**, free of any moving components, making them more neighborhood friendly and aligning well with urban noise-control standards and ESG priorities. **For data centers, this translates into a major advantage: fuel cells can be sited directly adjacent to buildings or even indoors, while gas turbines require dedicated acoustic treatment and separation zones.**

4) Emissions: Fuel cells deliver cleaner power with lower emissions

Another important consideration for onsite power is air pollution. Compared to fuel cells, gas turbines and reciprocating engines rely on a dirtier combustion process to harness methane's chemical energy. This creates a high-temperature environment where nitrogen in the air is oxidized. In the case of incomplete combustion, turbines could produce carbon monoxide. This is an important distinction between gas turbine and fuel cells: the operating temperature of SOFCs, around 600 Celsius, is too low to produce NO_x, nor is there combustion to create CO, which is especially harmful in an urban setting where data centers are located. Gas engines should have a higher level of emissions than gas turbines, as they produce a higher level of NO_x and CO. In terms of carbon intensity, it is lower than gas turbine, but higher than Fuel cells and CCGT. The two have similar levels of carbon intensity, with SOFC and turbine in a combined-cycle setting boasting greater than 60% fuel efficiency.

Emissions performance is becoming an increasingly important consideration for data center developers as air-quality permitting and community acceptance emerge as key project risks. **Several US data center developments have faced regulatory scrutiny or local opposition related to NOx emissions from diesel generators and gas-fired power systems. Against this backdrop, the low emissions profile of SOFCs and high-efficiency CCGTs could represent a meaningful advantage in environmentally sensitive locations where permitting timelines and public acceptance are becoming increasingly important determinants of project execution.**

Exhibit 26: CCGT and SOFC are the least carbon intensive due to their efficiency, while RICE emits significant NOx
Carbon & NOx intensity, kg/MWhe



Source: InnoEnergy

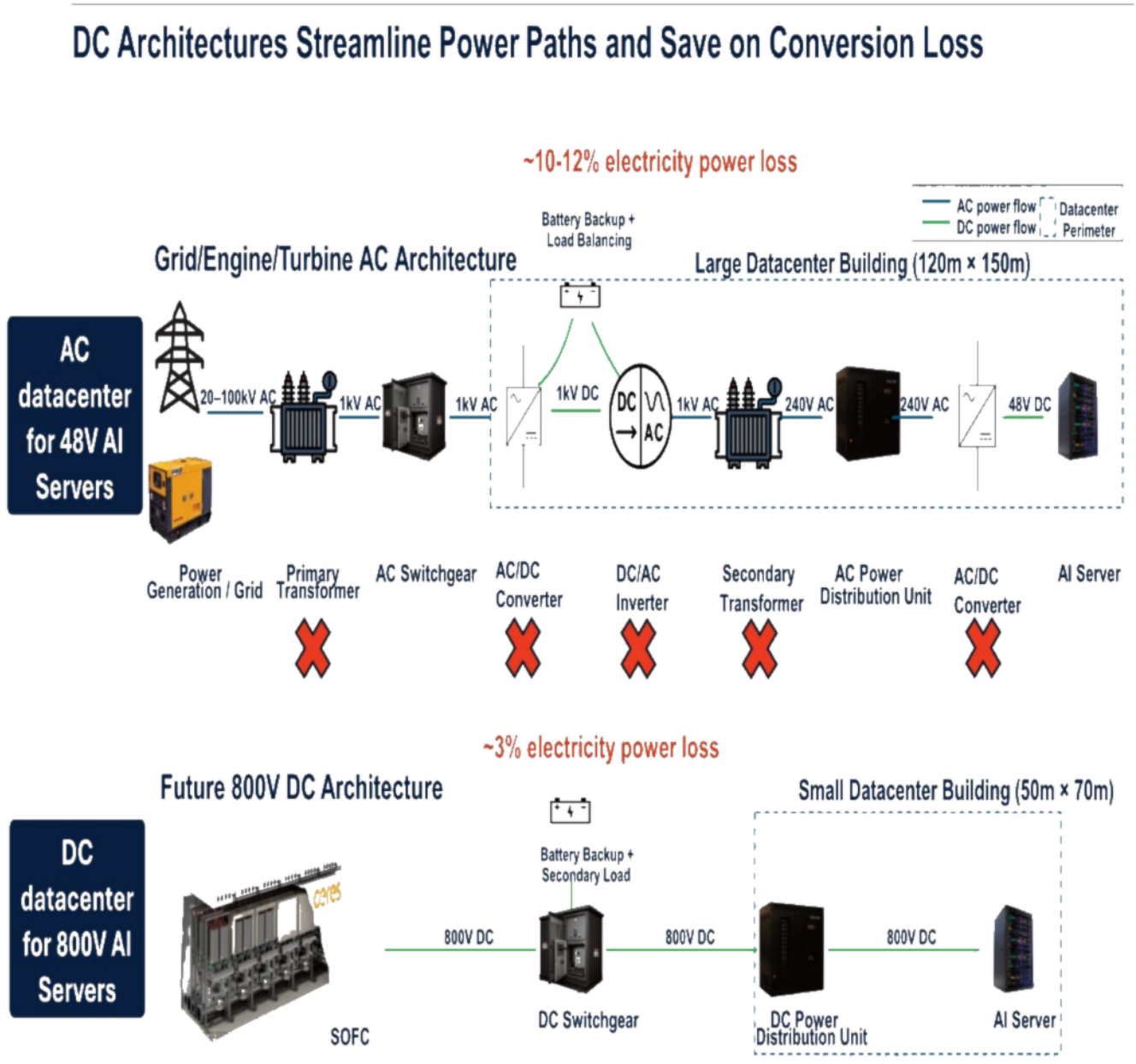
5) Load versatility and data center HVDC power trend

Fuel cells are excellent at producing more or less power in the face of changing load demand. They do not possess the mechanical combustion parts that restrict them to operation within a certain range. For instance, a gas turbine generator should operate above 40%-50% of its total capacity as operating at a lower load leads to higher NO_x emissions. Fuel cells can be operated within a wider range because of their modular design, responding to the needs for electricity more rapidly.

Nvidia is pushing for a new 800V high-voltage direct-current (HVDC) design for electricity transmission from grid to data center stacks. This reflects the limitations of the current 48V/54V AC (alternating current) infrastructure that requires large transformers, AC/DC converters & inverters and thicker copper cables, which are both space consuming and uneconomical. Fuel cells produce DC (direct current) electricity which bypasses these limitations and can be easily connected to an 800V HVDC system, while engines, turbines and grid only offer AC connections. The existing AC architecture results in a loss from conversion at around 10-12%, and these electrical infrastructures have surged in pricing at the start of the data center build out. The DC architecture streamlines the power paths of the data centers, saving on infrastructure capex and electrical conversion losses. These advantages further underpin the competitive position of fuel cells for data center power demand.



Exhibit 27: DC architectures streamline power paths and save on conversion loss
48V AC vs. 800V DC data center architecture



Source: Bloom Energy, Energy Star

BTM solutions could address up to 25% of data center power demand

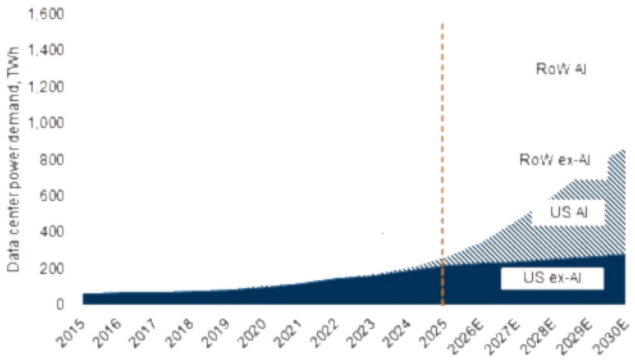
Updating our data center power demand assumptions raises our BTM and fuel cell opportunity estimates

Our US Technology and GS SUSTAIN teams recently raised their global data center capacity and power demand forecasts, reflecting continued strength in AI infrastructure investment, accelerating hyperscaler and neocloud capacity additions, and increasingly tight supply-demand dynamics across the sector. The revised forecasts imply **217GW of global data center capacity by 2030, up from 101GW in 2025 and versus 168GW in their prior forecast**, while US data center demand is expected to reach **108GW by 2030**. On the back of greater data center capacity, our global team sees 170% global data center power demand growth in 2030 vs. 2025 levels (117% previously). This rapid growth strains grid systems and reserve margins, which struggle to keep pace, while data centers compete with other industries for limited electricity supplies amid environmental compliance pressures, especially in regions where power supply is tight (Europe, India, Japan). Data centers pose unique challenges to electricity grids compared to other types of energy users. They represent large, localized loads which typically operate continuously and can ramp up their operations faster than most large energy users.

Given the near-term constraints on accessing grid power with regulatory uncertainty and lengthy interconnection queues, we see increasing focus on behind-the-meter solutions in the near term to provide data center customers with better time to power, which we view as their top priority. Reflecting this more constructive outlook, our US Utilities team increased their estimate for **BTM capacity (excl. fuel cells) available to serve data center load to c.31GW by 2030 from 20GW previously**, corresponding to **c.22GW of delivered power versus 14GW previously**, with BTM solutions (excl. fuel cells) expected to supply around **20% of total data center demand by 2030**. We expect natural gas to remain the primary BTM technology in the near term given superior time-to-market characteristics, but the larger addressable market reinforces our positive view on fuel cells as an increasingly relevant solution for mission-critical and distributed data center power applications. As a result, **we are updating our global estimates for both total BTM (incl. fuel cells) generation demand and the portion that could ultimately be served by fuel cells.**

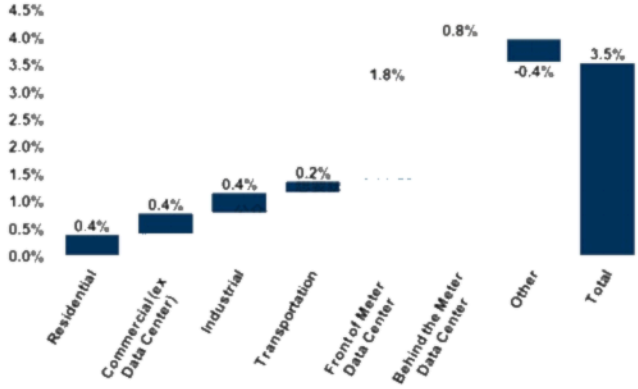
Exhibit 28: We now see 170% global data center power demand growth in 2030 vs. 2025 levels, more than 60% of which comes from the US

Data center (AI + non-AI) power demand in US and rest of world, TWh



Source: Masanet et al. (2020), EIA, EMBER, IEA, Cisco, Goldman Sachs Global Investment Research

Exhibit 29: Our total power demand CAGR increases to 3.5% through 2030, driven by both BTM and FTM data center demand



Numbers do not sum to total due to rounding.

Source: Goldman Sachs Global Investment Research

Exhibit 30: We include the below project announcements in our bottom-up approach to sizing the fuel cell opportunity in US by 2030

Fuel cell announcements and MW of cumulative capacity through 2030

Company - Project	MW of fuel cell capacity
Oracle - Project Jupiter	2,450
AEP - Ohio	100
AEP - Wyoming DC	900
Nebius	328
Equinix	100
CoreWeave - Illinois	14
FitEnergy	380
Texas Colocation operator	75

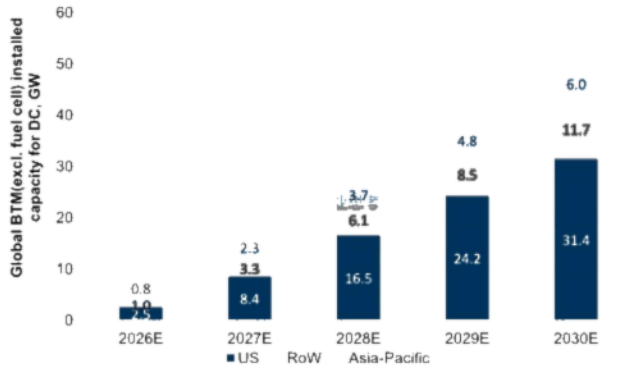
Source: Company data, Goldman Sachs Global Investment Research

On fuel cells specifically, we model a distinct pool of on-site power separate from gas turbines and reciprocating engines, reflecting their differentiated value proposition: dispatchable, low-emission, permit-light, higher electrical efficiency than reciprocating engines and eligible for the §48E ITC through 2035 with no phase-out. **We now see fuel cells supplying c.8% of US data center demand by 2030 and c.7% globally, on top of the c.20% / c.18% delivered by gas-BTM**. In installed terms, this corresponds to **c.12GW of fuel-cell capacity in the US and c.18GW globally by 2030**, from a de-minimis base today, translating into a cumulative equipment TAM of c.$35bn in the US and c.$55bn globally through 2030, with a recurring service and stack-replacement stream on top. Taken together, **gas-BTM plus fuel cells account for c.28% of US and c.25% of global data center demand by 2030** versus effectively 0% in 2025 — a step-change in the addressable market that we view as structurally supportive of the fuel cell investment case.

This represents a meaningful upgrade versus our prior work, where we had estimated c.7-19GW of fuel-cell capacity required to serve data centers by 2030. Our updated numbers — c.12GW US and c.18GW global — sit at the upper end of that prior range, giving us higher conviction in both the level and the composition of the addressable

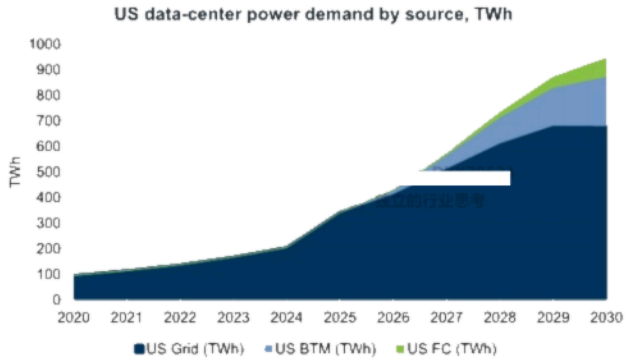
market.

Exhibit 31: Our US Utilities team increased their estimate for BTM capacity (excl. fuel cells) available to serve data center load to c.31GW by 2030 from 20GW previously
Global BTM (excl. fuel cell) installed capacity for DC, GW



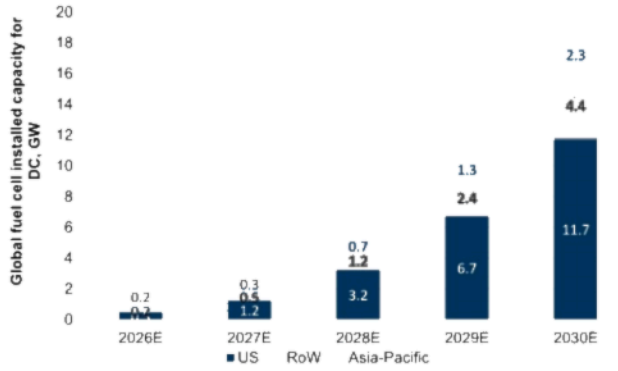
Source: Goldman Sachs Global Investment Research

Exhibit 32: We now see fuel cells supplying c.8% of US data center demand by 2030 and c.7% globally, on top of the c.20% / c.18% delivered by gas-BTM.
US DC power demand, TWh



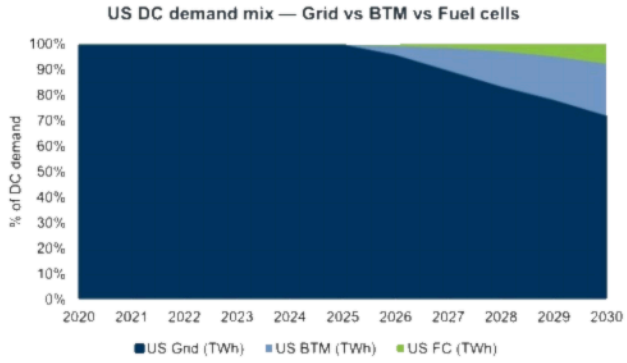
Source: Masanet et al. (2020), EIA, EMBER, IEA, Cisco, Goldman Sachs Global Investment Research

Exhibit 33: In installed terms, this corresponds to c.12GW of fuel-cell capacity in the US and c.18GW globally by 2030, from a de-minimis base today
Global fuel cell installed capacity for DC, GW



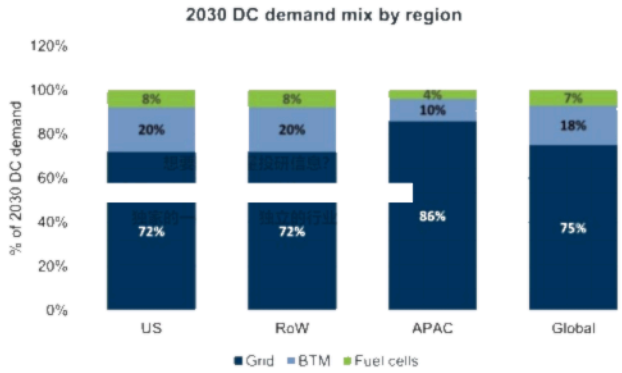
Source: Goldman Sachs Global Investment Research

Exhibit 34: Taken together, gas-BTM plus fuel cells account for c.28% of US...
US DC demand mix, %



Source: Goldman Sachs Global Investment Research

Exhibit 35: ...and c.25% of global data center demand by 2030 vs. effectively 0% in 2025 — a step-change in the addressable market that we view as structurally supportive of the fuel cell investment case
2030 DC demand mix, %



Source: Goldman Sachs Global Investment Research

Construction of new high-voltage transmission lines has continued to slow
Connecting data centers to the grid is a complex and often lengthy process reflecting several critical factors. The surge in demand for data centers has overwhelmed existing grid infrastructure and planning processes.

The primary reasons for delays:

- **Insufficient transmission and generation capacity:** The fundamental issue is a lack of adequate transmission infrastructure and generation capacity to meet the continuous, high-utilization power demands of data centers. Data centers require round-the-clock power comparable to small cities. **Building new transmission lines and generation facilities involves years of permitting, land acquisition, supply chain management and construction, typically (5-10 years).** In the US, the pace of new high-voltage transmission line construction has significantly declined, from an average of 1,700 miles annually in 2010-14 to just 350 miles per year from 2020 to 2023, with only 55-125 new miles added in 2023-24.
- **Outdated planning tools and processes:** Utility planning tools and processes were not designed to handle the current scale of growth, particularly the influx of numerous large load requests from data centers. Evaluation procedures are often ad hoc, causing long backlogs and delays.
- **Conservative utility planning assumptions:** Utilities often use very conservative assumptions (e.g. requiring generation or transmission to be available even under extreme scenarios), which make many otherwise viable projects appear too risky and delay approvals. This leads to slow grid interconnection timelines and limited ability to support new data center capacity.

Exhibit 36: The pace of new high-voltage transmission line construction in the US has significantly declined, from an average of 1,700 miles pa between 2010 and 2014 to just 350 miles pa from 2020 to 2023

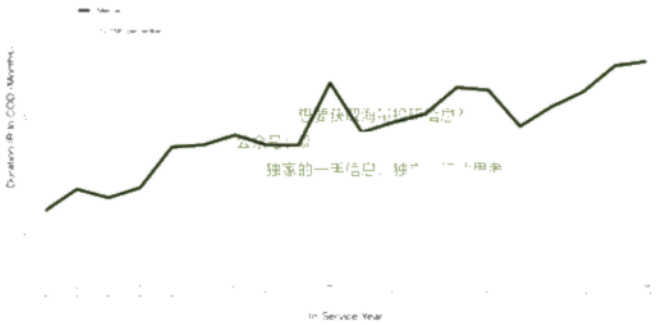
US transmission lines built, miles



Source: Grid Strategies

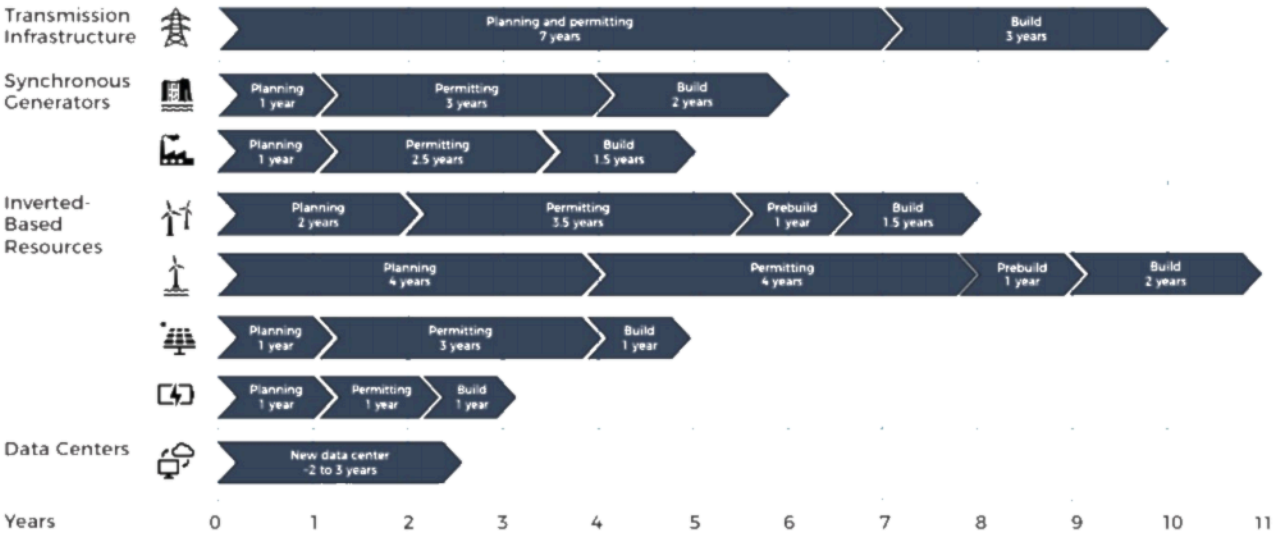
Exhibit 37: The median duration from interconnection request (IR) to commercial operations date (COD) continues to rise, approaching 5 years for projects completed in 2023-24

Median duration from Interconnection request to commercial operations in the US



Source: Lawrence Berkeley National Lab

Exhibit 38: Illustrative time to market for various grid projects



Source: GridLab

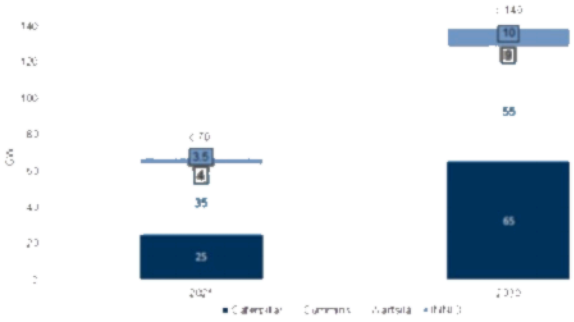
Conventional Gas Options: technological readiness led to >5-year backlogs and waiting time

Historically, gas turbines and reciprocating engines have been widely adopted by data centers due to their technological readiness and proven mass application.

Gas Turbines vs. Engines

Gas turbine and engine manufacturers largely benefited from the capex wave. Makers of reciprocating engines have increased their production capacities in large part to cater to increased power demand. Cummins is investing $450m to add 20GW of manufacturing capacity, targeting 55GW of high-horsepower (HHP) output by 2030. Caterpillar is aiming for an annual engine capacity of 65GW by 2030, representing a threefold increase from its 2024 baseline. INNIO plans to ramp up from 3.5GW to 7GW by 2028 and c.10GW by 2030/2031. Wartsila is planning a 120% capacity expansion by 2029 compared to the operational 2025 level, which will introduce c.6.8GW of additional capacity.

Exhibit 39: Gas engine makers are investing to expand production capacity by 2030
Engine manufacturing capacity plans of selected players



Source: Company data, data compiled by Goldman Sachs Global Investment Research,

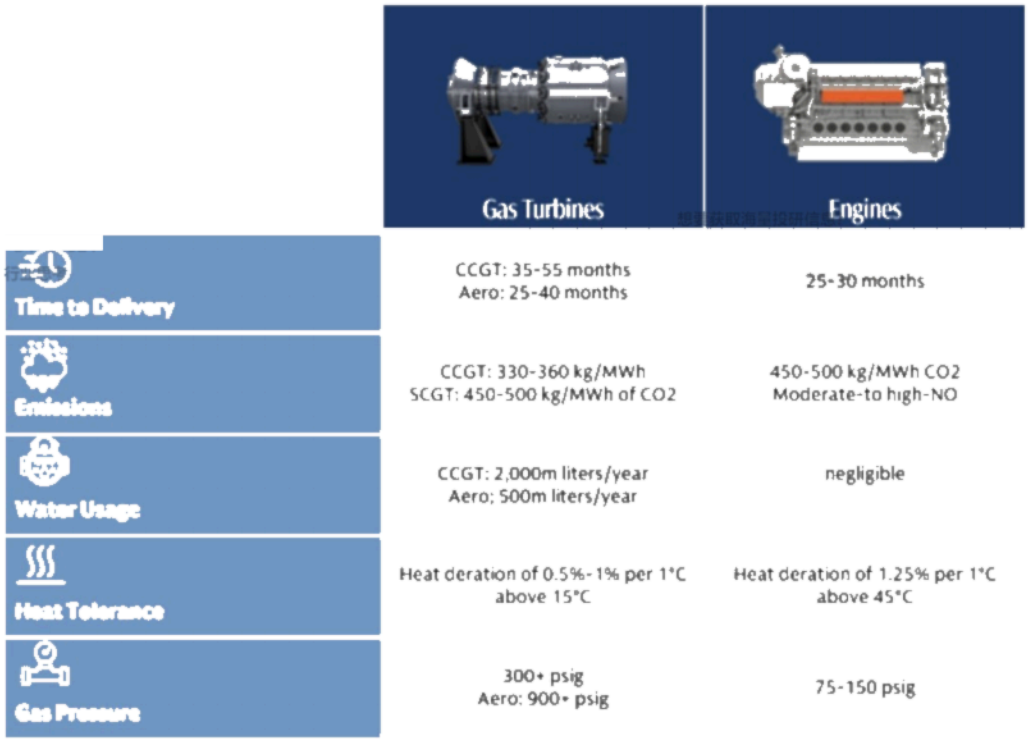
The aforementioned companies are not fully gas-focused distributed energy players and have other exposures. Based on projected exposure to distributed energy solutions (reflecting company projected growth rates; GS analyst estimates for INNIO and Wartsila), c.30GW of selected players' manufacturing capacity targeted for 2030 will be allocated to power generation. This compares with a gas turbine market that we see approaching capacity of 100GW by 2030E.

Our EU Utilities team notes that the overlap between the engine and gas turbine markets is only partial, and that not all peaking plants can be served by engines. For example, it would not make economic sense for peaking plants based on large gas turbines to be replaced by a large number of engines from a capex perspective. Nevertheless, there are applications for both in a power market that is becoming increasingly intermittent as renewables generation increases or fossil fuels and nuclear capacity are phased out.

For data centers, the picture is somewhat more mixed. In the team's view, the key advantages of engines are negligible water usage, lower gas pressure requirements for operation and faster time to market. For gas turbines, the advantages include scale and emissions. In an environment where gas turbine backlogs have been filled, the appeal of engines has increased for a market that needs to build compute today. Furthermore, avoiding the need for water or gas connection approvals can help lessen permitting

constraints, even if the overall solution is more expensive.

Exhibit 40: Gas turbines vs. engines
Infographic



Source: Data compiled by Goldman Sachs Global Investment Research

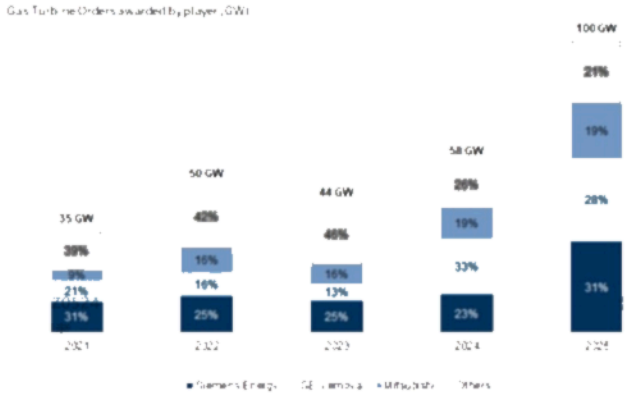
Gas Turbine makers: growth for all...

Over the past year and a half, there has been a significant step-up in gas turbine orders for the three main players in the industry. Since 1Q25, all three players have grown their order backlog by over 50% in GW terms (see Exhibit 41), with Siemens Energy's backlog growing the most, by 107% from 29GW to 60GW at its latest results. Reservation Agreements have also become far more significant in recent quarters and are now regularly accompanied by substantial customer down payments to ensure the slots are secured. Siemens Energy has stated that of the 87GW of commitments, 24GW are data center related.

...which has led to an increase of backlog and lead time for new equipment

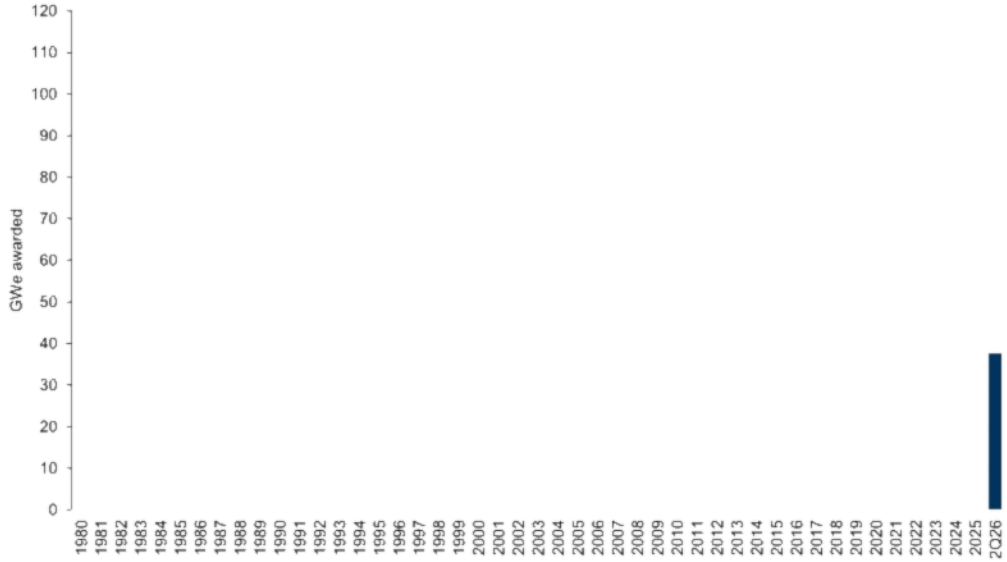
In addition to a step-up in both volume and margins, the duration of revenues has increased as rising demand has filled more years of future supply. This provides greater visibility, creating a business unit with higher growth and a longer duration revenue profile.

Exhibit 41: 2025 marked a significant step-up in demand
Gas turbine orders awarded by player (GW)



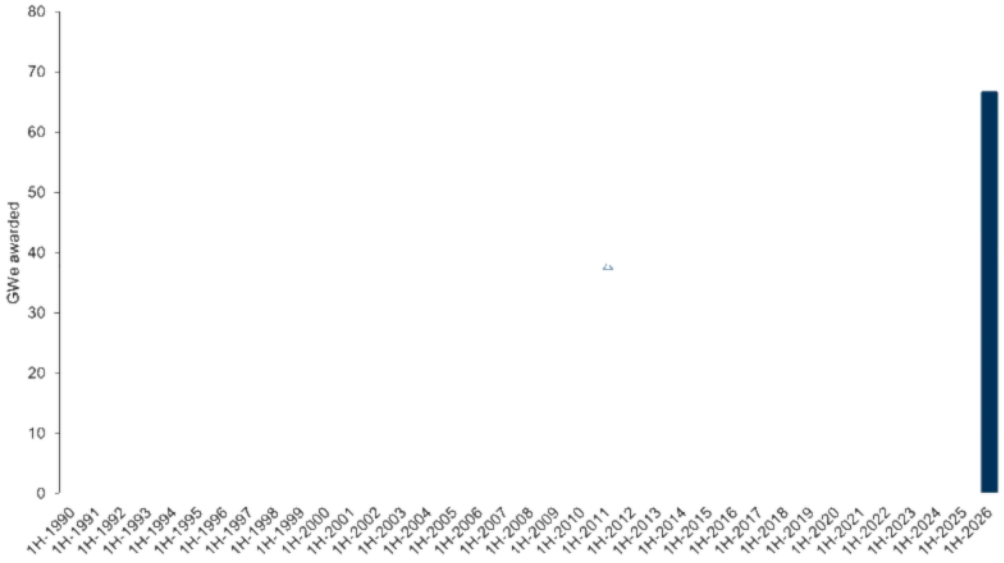
Source: McCoy Data, data compiled by Goldman Sachs Global Investment Research

Exhibit 42: 2Q26 reported orders came in at 38GW (vs. 100GW in full year 2025)...
Gas turbine capacity awarded globally (in GWe)



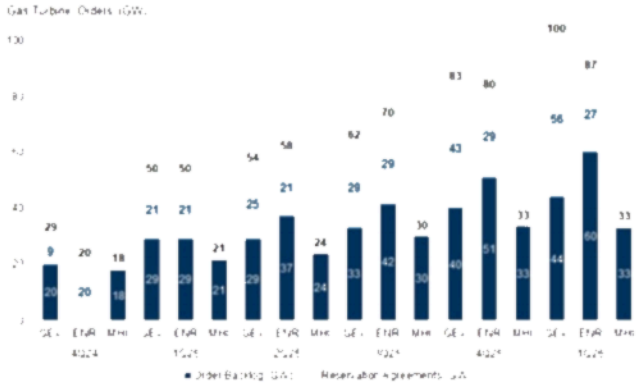
Source: McCoy Power reports

Exhibit 43: ...accounting for 67GW booked YTD, implying a stronger 1H vs. history
Gas turbine capacity awarded globally (in GWe)



Source: McCoy Power reports

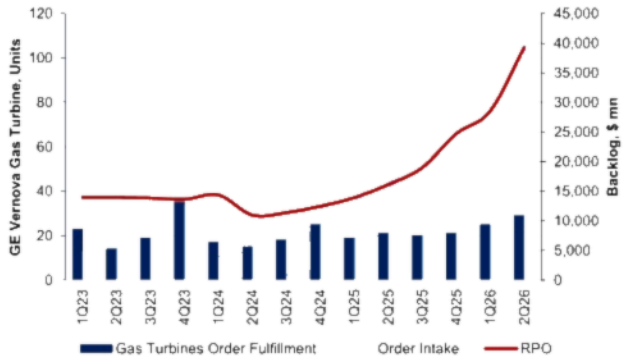
Exhibit 44: Siemens Energy has seen 87GW of commitments over the last six quarters
Gas turbine order split for three major players (GW)



MW per unit assumption of 0.45 for MHI. Company announcements calendarized.

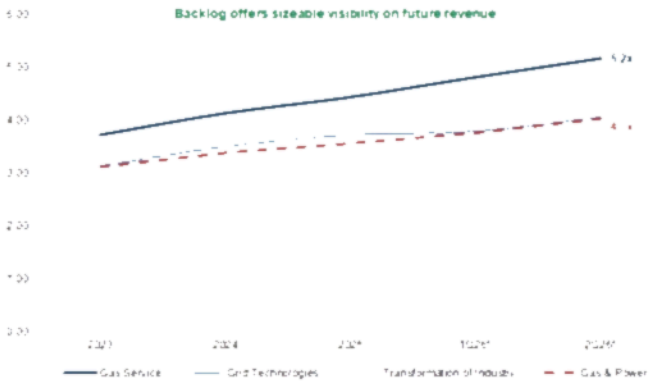
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 45: GE Vernova reported an end of 2Q26 backlog of 116GW, giving an implied lead time of 4-5 years from now



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 46: Siemens Energy's order books have been filled for a number of years
Gas & Power sales backlog ratio



*Trailing 4 quarters

Source: Company data, Goldman Sachs Global Investment Research

Sizing the market opportunity for data center fuel cell adoption: Ceres well positioned to benefit

We believe the market opportunity for fuel-cells for DC is sufficiently large enough to support multiple SOFC suppliers. With power availability increasingly becoming the key bottleneck, we believe demand is likely to exceed industry capacity for several years, creating room for multiple manufacturing platforms to scale. We believe fuel cells are moving from pilot applications to primary onsite power infrastructure for AI data centers, driven by speed-to-power, reliability, citing flexibility and permitting advantages.

We see our thesis validated by recent comments from Bloom Energy (not covered), the market leader in the global SOFC market and a major supplier of fuel-cell solutions for data centers. On its 2Q earnings call, Bloom management noted that AI data center demand is increasingly constrained by power availability, and fast-to-deploy onsite power is becoming strategically valuable. Bloom stated that all major US hyperscalers and more than a dozen neoclouds, AI labs and co-location providers have used its power solutions, while management highlighted expectations for 40-30GW of new AI data center capacity to come online in 2027. Bloom management framed the customer decision not around traditional LCOE, but around "total cost of power to token revenue", noting that one month of earlier power availability for a 1GW data center could represent $1-2bn of revenue for the customer. To meet this demand, Bloom has a 2GW SOFC production line expected to come online by the end of this year.

On the industry level, Bloom Energy's recent order announcements in the US highlight that DC fuel cell usage is clearly progressed from technology validation to gigawatt-scale adoption:

- Equinix (>100MW): The company is deploying SOFCs across 19 US data centers to supplement grid power and enhance resiliency; serves primarily as a proof-of-reliability and reference case, not a volume driver.
- AEP (up to 1GW; 100MW firm): Bloom Energy's agreement with **American Electric Power (AEP)** provides a **framework for up to 1 GW** of solid-oxide fuel-cell capacity to support AI-driven data-center developments, with an **initial 100MW order already placed**. Under the structure, AEP is an infrastructure partner, co-locating Bloom's fuel cells at or near data center sites to deliver **immediate, dispatchable onsite power** while longer-dated grid and transmission upgrades are pursued.
- Oracle (up to 2.8GW; ~1.2GW contracted): Under Bloom Energy's hyperscale agreement with Oracle, Oracle plans to deploy **up to 2.8GW** of Bloom's solid-oxide fuel-cell capacity to power AI and cloud data centers, with **1.2GW already firmly contracted and under deployment**. The fuel cells are intended to operate as **primary onsite power**, helping Oracle sidestep grid-interconnection delays and materially accelerate time-to-power for large AI campuses.

Demand backdrop should support additional entrants and Ceres' licencees

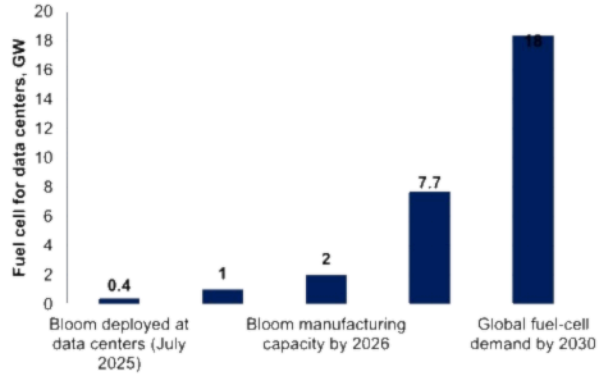
Scaling global SOFC deployment up to our forecasted ~18GW of installed fuel cell capacity by 2030 implies a sustained ramp-up in annual installations over the remainder of the decade. On a cumulative basis, this translates into required installations of ~3.8GW per annum globally, with the US accounting for ~2.6GW p.a., reflecting its

outsized share of hyperscale data center growth.

Importantly, data center demand is not the sole end market for SOFC capacity. **Baseline demand from commercial buildings, industrial facilities and CHP applications**—while structurally smaller than hyperscale data center demand—will continue to absorb part of the overall manufacturing output. This incremental, non-data center pull further tightens effective supply available to hyperscalers.

Against this backdrop, if we simplistically assume a full ramp up and 85% utilization, Bloom's 2GW expansion of manufacturing capacity would enable cumulative deliveries of ~7.7GW of SOFC capacity by 2030 — well short of our forecast for **~18GW of global installed SOFC capacity by 2030**. We believe that achieving our forecast, would require **multiple manufacturers to scale simultaneously**, in particular Ceres Power licensees like **Doosan Fuel Cell, Delta Electronics, Weichai and new partners**.

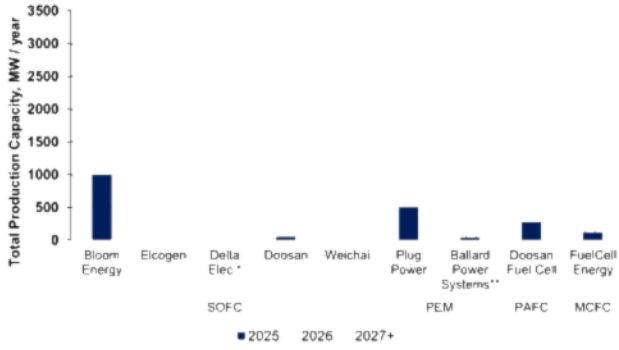
Exhibit 47: Our 2030 demand forecast suggests the market could support multiple entrants
Illustrative



Cumulative possible deployed volume by Bloom Energy does not take into account possible expansion up to 5 GW; we assume 85% utilization as a realistic rate for manufacturing capacity when strong demand

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 48: There is a significant near-term build-up of capacity for fuel cell production
Total production capacity per year, MW



*GSe of Delta Electronics production capacity at 200MW per year; **PEM Ballard's Giga-factory is pending FID in late 2026

Source: Company data, Goldman Sachs Global Investment Research

Ceres Power is a leading European solid oxide technology developer and innovator, developing technological solutions for applications in fuel cells and hydrogen
In our latest Ceres note, we showed that the company is differentiated from other European clean technology innovators by its asset-light business model, which is centered around core stack and system manufacturing partnerships for fuel cells and electrolyzers, as opposed to direct manufacturing, which also limits its exposure to manufacturing supply chain bottlenecks and competition.

Currently Ceres Power has three key licensees in the fuel cell segment with Delta Electronics, Doosan Fuel Cell and Weichai Power.

- **Delta Electronics** (covered by Chao Wang, GS Taiwan tech analyst), the third largest company in Taiwan by market cap**. Through its US arm, Delta Americas, Delta Electronics has an established presence in the US data center market**. Delta has a long-term collaboration agreement with Ceres to develop SOFC and solid oxide electrolysis cell (SOEC) systems for hydrogen energy applications. Delta acquired land and factory facilities last year in Taiwan for approximately £170mn for the

large-scale manufacturing of hydrogen energy solutions based on Ceres' solid oxide technology. Delta has indicated a **clear commitment to initial pilot production based on Ceres' technology by the end of 2026**.

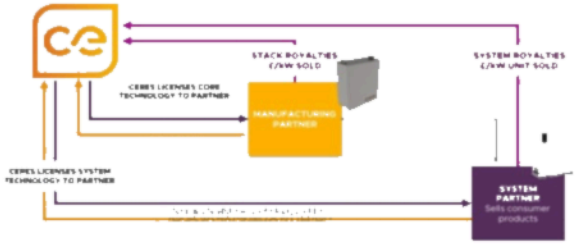
- **Doosan Fuel Cell (not covered) is an active participant in the fuel cell market and is targeting data centers as a key application for its stationary fuel cell systems, leveraging its Ceres-licensed SOFC technology**. Doosan is the first of Ceres's strategic licensing partners to commence mass production of Ceres' metal-supported SOFC systems with its dedicated facility in South Korea, which has annual output capacity of 50 MW. **We believe Doosan could expand its SOFC manufacturing capacity if demand materializes**. Doosan Fuel Cell is primarily targeting stationary distributed power applications, including data centers, to address the spike in power demand caused by AI processing.
- **Weichai Power** (covered by Nick Zheng, GS HK Industrials analyst), a global original equipment manufacturer and power systems developer. Weichai Power management sees **an estimated TAM of at least 10GW+ by the end of this decade and has 700MW+ capacity currently planned.** Weichai's management has mentioned that the **construction cycle for new capacity is short, at approximately six months**. They also indicated that the **company should begin generating SOFC sales in 2026 (partially from data center customers).**

Sizing the fuel cell AI data center opportunity

As discussed above, we estimate that c.18% of total power generation supply could ultimately be provided through fuel cells, which would **correspond up to c.18GW of required fuel cell capacity to supply electricity by 2030**. Depending on Ceres Power's market share, which we assume conservatively could be 7.5%-15%, we estimate that its licensees (existing ones - Delta Electronics, Doosan Fuel Cell, Weichai Power - and new potential partners) could collectively reach fuel cell manufacturing capacity of 1.5-2.7GW by 2030. Adopting a conservative approach, we assume that the **company's licensees would collectively reach around 1.5GW of fuel cell manufacturing capacity by 2030, implying 8% market share** and representing a scenario we view as realistic. In Exhibit 50, we present Ceres' licensees potential manufacturing capacity where we apply a conservative set of assumptions: Weichai reaching 700MW (while the company highlighted c.1GW by 2030), Delta at 350MW, Doosan expanding to 250MW and Denso (pure SOEC) at 200MW. Importantly, these figures do not factor in any new partnerships that Ceres is now actively pursuing, particularly with a focus on the US. Thus, we believe **our base case estimate of 1.3GW of fuel cell and 0.2GW H2 manufacturing capacity by 2030 is achievable, with upside risk to these numbers.**

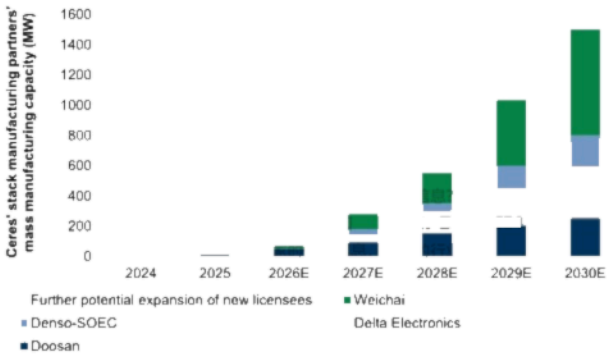
This licensee growth should support the ramp-up of mass manufacturing and royalty revenues to c.£99mn in our base case and £178mn in an upside scenario by 2030 assuming c.8%-15% market share globally. We do not expect royalties to be a meaningful contributor over the next c.3 years given the typical lag from partner signing to scaled manufacturing output; consistent with the company's messaging, we expect licensing-related fees to remain the primary revenue driver in the near term, with royalties becoming more material as partner deployments scale into the latter part of the decade.

Exhibit 49: Ceres Power is a leading European solid oxide technology company adopting an asset-light, licensing business model



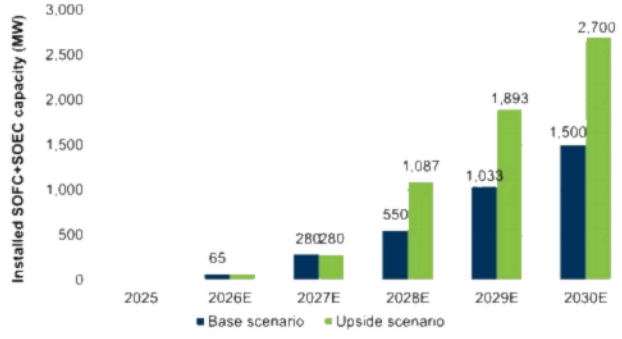
Source: Company data

Exhibit 50: Our base case sees Ceres-related SOFC manufacturing capacity of 1.3GW by 2030
Ceres' stack manufacturing partners; manufacturing capacity (MW)



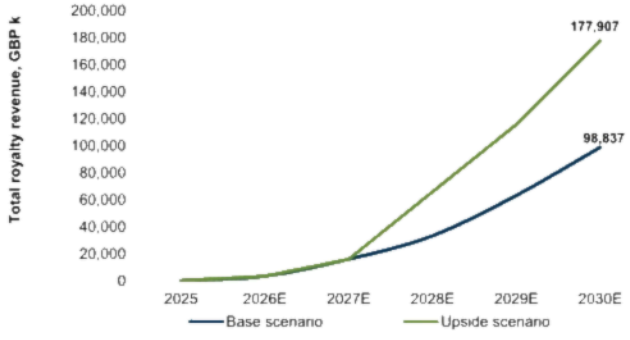
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 51: In order to address some uncertainty regarding how the fuel cell industry and its competitive landscape is likely to evolve, we have assessed two scenarios - base and upside
Installed SOFC+SOEC manufacturing capacity, MW



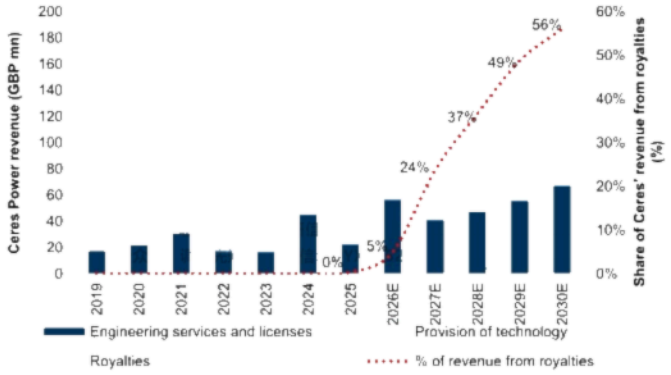
Source: Goldman Sachs Global Investment Research

Exhibit 52: Each scenario models distinct trajectories for installed authorized fuel cell capacity by Ceres Power licensees and royalty revenue generation depending on the overall pace of fuel cell adoption for data centers and Ceres Power's market share within this market
Ceres royalty revenue, £ k



Source: Goldman Sachs Global Investment Research

Exhibit 53: We believe royalties could contribute more than half of the total revenue by the end of the decade
Ceres Power revenue by type (£ mn, base case scenario)



Source: Company data, Goldman Sachs Global Investment Research

Are fuel cells manufactured outside the US eligible for the 30% ITC?
Based on the latest Section 48E rules introduced under the OBBBA, fuel cell projects that begin construction after December 31, 2025 are eligible for a 30% Investment Tax Credit (ITC) regardless of fuel source, and eligibility is not contingent on meeting domestic-content requirements. As a result, fuel cell systems incorporating stacks or components manufactured outside the US can still qualify for the full 30% ITC, provided the project complies with the applicable Section 48E rules, including restrictions relating to prohibited foreign entities (PFEs).

Importantly, unlike other clean energy technologies, fuel cell projects are not eligible for domestic content bonus credits under the OBBBA, but neither are they required to satisfy domestic content thresholds to receive the 30% ITC. This suggests that fuel cell systems supplied by international manufacturers, including those using components produced in countries such as South Korea or Taiwan, may remain eligible for the base 30% ITC when deployed in the US, subject to compliance with the new foreign entity restrictions. However, projects receiving material assistance from prohibited foreign entities, with the legislation specifically referencing entities connected to China, Russia, Iran and North Korea, may not qualify for tax credits.

Stock exposure

Fuel cell exposed names:

Ceres Power (CWR.L, Buy, CL, covered by Michele Della Vigna):
Leading fuel cell player with licensees positioned to benefit from next wave of data center growth

- **Fuel cell technology is needed to meet growing data center demand as AI grows.** GS expects ~175% growth in data center power demand through the rest of the decade, straining existing grids and driving the need for reliable, on-site, green power. Fuel cells, particularly solid oxide fuel cells (SOFCs) offer a compelling solution thanks to their efficiency, reliability and quick deployment.
- **We think Ceres is an underappreciated player despite its well-positioned licensees...** Bloom has a leading position in the global SOFC market and provides proof points with real-world deployments, showing the advantage of fuel cell technology over combustion-based solutions and a partnership with Oracle. All of this reads across well to Ceres which has a low capital intensity licensee model with licensees who are well positioned for the next wave of growth.
- **...with revenues and margins set to expand as those licensees grow.** This licensee growth should support the ramp up of mass manufacturing and royalty revenues to £99mn on a base case to £178mn in an upside scenario by 2030E assuming c.8-15% market share globally. As royalties start to ramp up, we expect half of total revenue to come from them by the end of the decade which is margin accretive given the high drop through, which should result in Ceres going from loss making at an EBIT level to c.50% EBIT margins by 2030E on our base case.

Catalysts: Deal announcements are typically catalysts for fuel cell players (for example Bloom and Brookfield's recent deal). We believe Ceres is well positioned to announce a new licensing partnership by the end of this year.

Valuation: Our 12-m PT of 930p is based on a blend of 2030E EV/EBITDA (discounting back to end-2026E) and discounted cash flow (DCF), reflecting the company's revenue growth momentum in the near term and its profitability prospects longer term.

Key downside risks include: Slower execution of Asian contracts, higher-than-expected operating costs and capex, delays in partners' manufacturing ramp-ups, cancellation of existing partnerships, changes to manufacturing expansion and SOEC development plans, and a lack of new licensing agreements.

Weichai Power (2338.HK, Buy, covered by Nick Zheng):
Weichai Power is **China's largest manufacturer of internal combustion engines**, with ~20% volume share in China's multi-cylinder engine market, with key verticals across commercial vehicle (mainly heavy-duty trucks), construction machinery, agricultural equipment, marine and power generation. We believe the investment narrative for Weichai has now shifted from heavy-duty trucks to AI data center power generation as the company has managed to build a comprehensive technology/product portfolio

across large engines for diesel gensets (as back-up power for AIDC), gas gensets (onsite primary/standby power) and fuel cells (an emerging onsite generation solution). AIDC power generation, currently 12% of Weichai's total 2025 NP, is poised to grow ~10x by 2028E and we see its earnings contribution more than quadrupling to 50%+ of the total, driving 80%+ of its incremental EPS growth through 2028E.

We see Ceres licensee Weichai (which holds a 17.8% stake in Ceres Power) as one of the best implementations of the SOFC theme in Asia, forecasting that the company looks set to take 5% of the global market by 2030. We note Weichai's latest comments suggest stronger-than-expected demand from customers in the wake of its Ceres partnership, with the company upgrading guidance for SOFC capacity to 30MW+ in 2026, ~200MW in 2027 and 700+MW of capacity by 2030. Weichai is demonstrating a high level of operational readiness. Weichai's management has mentioned that the **construction cycle for new capacity is short, at approximately six months**. They also indicated that the **company should begin generating SOFC sales in 2026 (partially from data center customers).** Every GW of SOFC shipped implies incremental net profit of Rmb3.5-4bn at Weichai (vs. Weichai's total net profit of Rmb10.9bn/Rmb14.9bn in 2025/26E), we estimate. **The opportunity adds to Weichai's attractive exposure as a provider of a range of power solutions for AI data centers, including diesel and gas generator sets, in our view.**

Valuation: We adopt a SoTP-based valuation methodology as we believe SoTP better captures the different stages of growth the company's various power generation products are in. Our primary valuation is anchored to the H-share.

- We value **Weichai's legacy business** using lower-than-mid-cycle P/E (at 10x) on average 2026E-27E EPS and KION's attributable market cap value to Weichai.
- For Weichai's AIDC power generation business portfolio: **1) Diesel large engines (back-up power):** We apply a 20x 2028E P/E, discounted back to mid-2027E using a CoE of 9%; **2) RICE (prime power):** We apply a 25x 2030E P/E, discounted back to mid-2027E using a CoE of 9%. **3) SOFC (prime power):** We apply a 25x 2030E P/E, discounted back to mid-2027E using a CoE of 9%.

With this, we derive our H-share 12-m price target of HK$55.0/share (A-share Rmb48).

Key downside risks include: 1) Slower-than-expected macro activity, particularly in road freight, infrastructure and property; 2) weaker-than-expected global economic growth; 3) powertrain shift to higher electrification penetration and lower LNG penetration; 4) weaker-than-expected HDT engine market share performance; and 5) slower-than-expected development in power generation business.

Delta Electronics (2308.TW, Buy, covered by Chao Wang):
Delta Electronics, the third largest company in Taiwan by market cap, is **involved in the provision of power equipment to AI data centers** (such as power supply unit, power conditioning equipment and uninterruptible power supply (UPS) equipment). **Through its US arm, Delta Americas, Delta Electronics has an established presence in the US data center market**, supplying uninterruptible power supplies (UPS), power supply unit, precision cooling, and modular data center infrastructure. Delta has a long-term collaboration agreement with Ceres, including technology transfer and licensing, to develop SOFC and solid oxide electrolysis cell (SOEC) systems for hydrogen energy

applications. These SOFC systems are considered ideal for mission-critical facilities such as data centers owing to their reliability and high efficiency in electricity generation. Delta is specifically developing MW-scale SOFC systems for AI data centers using Ceres's technology which aims to provide electricity to UPS units. Delta's expertise in mass manufacturing, power electronics, and data centers for customers such as Microsoft positions it well to leverage Ceres's technology, in our analyst's view. Delta Electronics has advanced at pace toward establishing large-scale manufacturing in Taiwan, **targeting AI-enabled data centers**, commercial buildings, industrial facilities, and microgrid applications. Last year, Delta acquired land and factory facilities in Taiwan for approximately £170mn, expected by the company to be partly focused on the large-scale manufacturing of hydrogen energy solutions based on Ceres' solid oxide technology. Delta has indicated a **clear commitment to initial pilot production based on Ceres' technology by the end of 2026**, followed by mass production in 2027-28.

Valuation: Delta 12-m PT of NT$4,120 is based on a 26.5x P/E multiple (+1.6x STDV higher than Delta's past 15-year average valuation).

Key downside risks include: (1) Slower-than-expected AI server power consumption growth momentum; (2) Potential market share loss risk in AI server DC-DC power system or the potential design change on AI server DC-DC system; and (3) Slower-than-expected of future products deployment, including power rack, SST and SOFC.

Gas turbine exposed names:

GE Vernova (GEV, Buy, covered by Joe Ritchie):
GEV is the biggest US manufacturer of gas turbines, wind turbines and grid solutions. In 2Q26, GEV achieved record orders of $24.2bn. Notably, Electrification orders were +66% organically, with NA equipment orders +4x y/y driven by Prolec. Power orders were +134% y/y organically, and as a result, backlog + SRAs (slot reservation agreements) are now 116GW, and GEV raised its full year guide to 125GW (vs. 110GW prior and 100GW when the year started). **GEV is expanding its turbine capacity to 30GW in 2028,** while most of the slots for 2030 have been sold and >50% for 2031 will be on contract by end of year. We also note that some of this capacity expansion is related to Service as GEV has ~3 times the current fleet on contract and will need additional capacity in the years to service the higher installed base.

Valuation: Our 12-m PT for GEV is $1,268 to with a target multiple to 28.0x and our projected Q5-Q8 EBITDA.

Key downside risks include: Slower growth due to regulatory/geopolitical changes; project delays from supply chain disruptions; and execution risk.

Siemens Energy (ENR1n.DE, Buy, CL, covered by Ajay Patel):
Siemens Energy is a German energy technology company that operates across the entire energy value chain, providing equipment and services for conventional power generation, power grids, industrial decarbonization and renewable energy. Siemens Energy's Gas Service division is benefiting from the generational increase in power demand driven by AI data centers, reshoring, electrification, coal retirements and grid reliability needs, while simultaneously compounding a highly attractive long-term

service revenue stream. Gas Service combines accelerating OEM demand with a large and growing installed base, creating a powerful flywheel of recurring revenues, margin expansion and backlog-driven earnings visibility.

Gas Service a beneficiary of the power generation bottleneck. Since FY2021, Gas Service order intake has increased 123%, helping drive a broader expansion of the company's order book. Gas Service also became the largest source of orders in FY2025 and is expected to remain so in FY2026. With the largest market share at 31% of awarded turbine orders in 2025, the company's gas turbine backlog increased 107%, from 29GW to 60GW, in just over a year. Siemens Energy has accumulated 87GW of commitments, including 24GW related to data centers. As demand fills future production slots, backlog duration has extended materially, creating a business unit with higher growth, a longer-duration revenue profile and higher profitability.

The flywheel service annuity embedded within every new installation is an even more attractive feature. Of the €8bn of Service revenue delivered in FY 2025, about 60% comes from long-term service agreements and the rest from transnational sales. On the Service side, contracts build cumulatively; in year 1, there are 30GW of Service contracts, but by year 5 this will grow to 150GW. The new fleet additions over FY 2024 to FY 2030 come with more profitable service contracts and are expected to be primarily run as baseload. Siemens Energy has flagged that these have revenue potential of €0.4m/MW over the first 20 years of the asset life. In total, this implies that 180GW of additions across FY 2024 - FY 2030 should add €72bn of revenue potential over 20 years.

Valuation: Our 12-m price target is €212. Our SOTP-based valuation methodology is based on a peer group CY27E EV/EBITA multiple for Gas & Power of 21.5x. We value Siemens Gamesa using a DCF, in which we use a 7.4% post-tax WACC.

Key downside risks include: Inability to manage the quality issues emerging in specific onshore wind turbine models; increasing competition and price pressure; failure to deliver cost savings; a weaker economy; and FX and material headwinds.

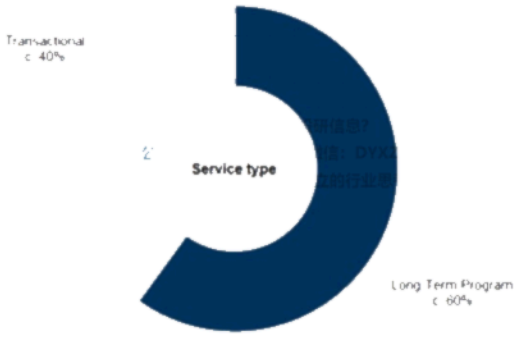
Exhibit 54: Order books have been filled for a number of years
Gas & Power sales backlog ratio



*Trailing 4 quarters

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 55: Long-term service agreements account for 60% of service revenue
Gas Service's Service mix; FY24



Source: Company data, data compiled by Goldman Sachs Global Investment Research

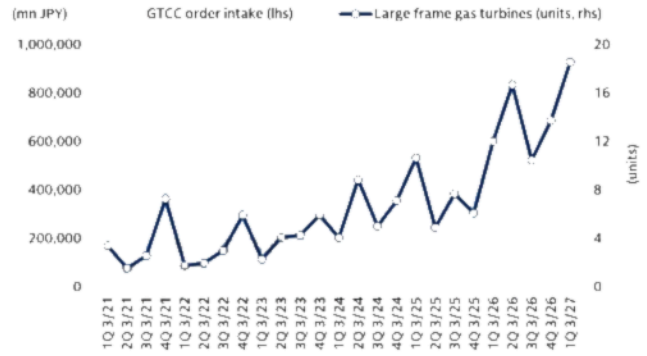
Mitsubishi Heavy Industries (7011.T, Buy, covered by Yuichiro Isayama):
We believe Mitsubishi Heavy Industries is one of the clearest beneficiaries of the global shortage of large high-efficiency gas turbines. We are confident about the continuation of benefits from tight global supply/demand dynamics in large-frame gas turbines for power generation, which remains MHI's core market. We expect FY3/27 large gas turbine order intake on both a unit and GW basis to potentially exceed FY3/26 levels of 35 units and 16GW. More importantly, the company is now entering a period where revenue recognition from previously booked projects with favorable order-time profitability will accelerate, supported by long-term order backlogs. We continue to prefer the gas turbine business because revenue recognition of projects secured during a period of strong pricing and favorable margins is progressing, creating a visible pathway for sustained earnings growth.

We also see a compelling margin expansion story driven by capacity investment and operating leverage. MHI plans to invest more than ¥100bn in gas turbine production facilities in Japan and the US and aims to roughly double large gas turbine production capacity by FY3/31 relative to FY3/25. Management had already outlined a strategy to increase production by 30% by FY3/29, followed by a further 50% increase thereafter, with the latest disclosures providing a more concrete timeline. Crucially, we believe MHI is maximizing prior cycle investments, increasing throughput while maintaining a lean cost base, and focusing capital on bottlenecks such as precision casting capacity for high-pressure turbine blades where demand visibility is strongest. As a result, we expect the Energy Systems segment to benefit from both higher volumes and improved profitability, with margins rising from 13.0% in FY3/26 to 16.5% in FY3/27, 17.5% in FY3/28, 19.0% in FY3/29 and 20.0% by FY3/30. We believe MHI is capturing the combined benefits of higher production, improved order-intake margins and growing high-margin aftermarket revenues, positioning the business to deliver structurally higher profit growth relative to the sector.

Valuation: Our 12-month price target of ¥6,200 is calculated using our FY3/30E estimates and a target EV/EBITDA multiple set at a 40% premium to the Japan Aerospace & Defense subsector average of 14X, deriving a theoretical value that we then discount back to the midpoint of FY3/27E and FY3/28E using a cost of capital of 9%.

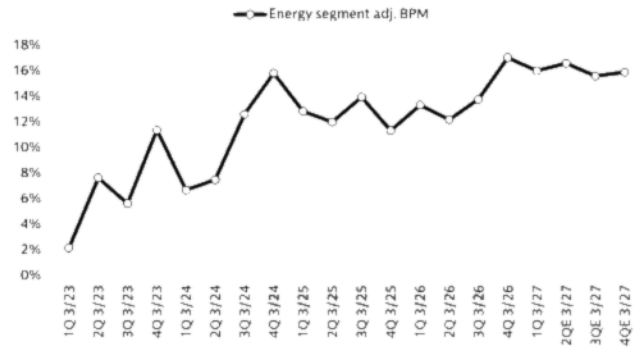
Key downside risks include: (1) a stronger yen versus our assumptions; (2) lower profitability in the energy business due to a concentration of low-margin projects or large one-time costs; and (3) a decline in overall returns due to setbacks in portfolio reforms.

Exhibit 56: MHI: Trends in large frame gas turbine order intake



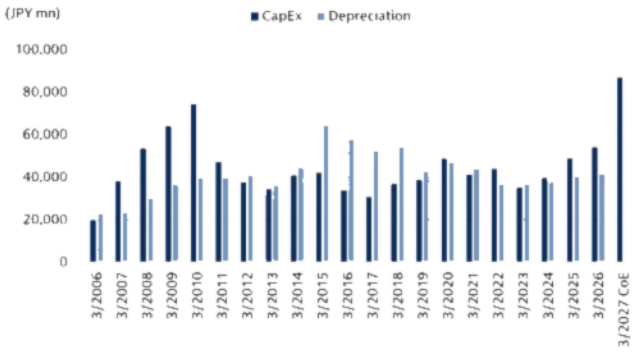
Source: Company data, data compiled by Goldman Sachs Global Investment Research

Exhibit 57: MHI: Energy Systems adjusted business profit margins



Source: Company data, Goldman Sachs Global Investment Research

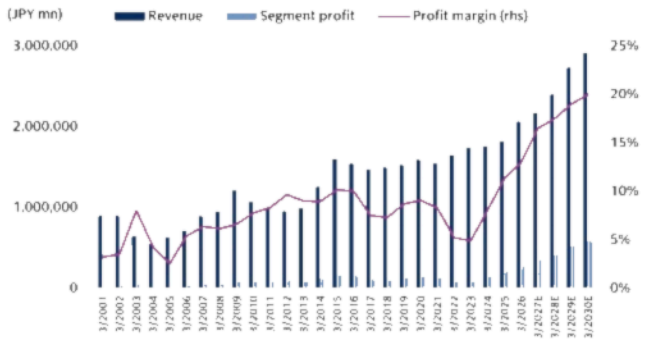
Exhibit 58: MHI: Capex and depreciation trend (GTCC-inclusive segment)



Historical figures reflect the segment classification in effect at the time. The GTCC business, previously reported under the Power Systems segment or the Energy & Environment segment, is now included in the Energy Systems segment.

Source: Company data, data compiled by Goldman Sachs Global Investment Research

Exhibit 59: MHI: Revenue, segment profit and profit margin trend (GTCC-inclusive segment)



Historical figures reflect the segment classification in effect at the time. The GTCC business, previously reported under the Power Systems segment or the Energy & Environment segment, is now included in the Energy Systems segment.

Source: Company data, Goldman Sachs Global Investment Research

Reciprocating engines exposed names:

<u>INNIO (INIO, Buy, covered by Joe Ritchie):</u>

- **We believe that INIO is a uniquely positioned <u>marginal supplier of prime gas power</u>.** Unlike diversified peers that serve marine, off-highway, or diesel end markets, INIO offers a fully gas-focused, distributed-energy solution that directly addresses the near-term grid constraints faced by data center developers. INIO's core product is a high-speed 5 MW gas engine power node that is differentiated for data center applications, offering the following advantages –
  - **(i) Speed to market:** INIO's engines do not require connection to the electrical grid, allowing for significantly faster deployment compared to traditional Combined Cycle Gas Turbines (CCGTs), which are already sold out of 2030 production slots;

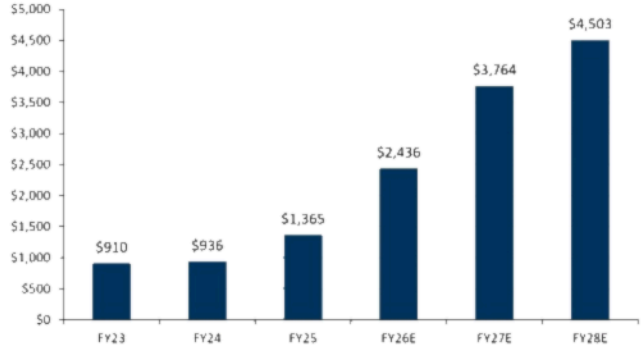
- **(ii) Fast start-to-first-load capabilities:** INIO's engines have low heat rates and fast start-to-first-load capabilities, starting up in ~45 seconds (vs 5-10 min for competing engines), making them well-suited for data centers; and
- **(iii) Modularity:** INIO's engines are designed for modularization and containerization. Containerized solutions are seeing increasing demand, helping to close the margin gap with standalone engines and providing scalable, plug-and-play power for developers.

- **Unprecedented demand and visibility**. INIO's backlog and orders are benefitting from the explosion in data center BTM demand, with data centers accounting for roughly 60% of the company's equipment order intake in 2025, up from just 24% in 2024. In 2Q26, INIO reported $2.29 bn in equipment orders (+316% yoy, data center orders were $1.464 bn, +398% yoy), which included a large 1.1 GW prime power order for a megascale data center priced at a blended rate of ~$750/kW. Currently, INIO's combined backlog and slot reservations stand at over 15 GW - more than four times its current manufacturing capacity - with production slots sold out through 2027.
- **Capacity ramp and long-term service tail.** With grid connection times extending from ~2 years historically to 7+ years today, hyperscalers are increasingly signing 15-year contracts for BTM solutions. To meet this surging BTM demand, INIO is executing a capacity expansion, scaling from 3.5 GW in 2025 to 7 GW by 2028, and targeting 10 GW by 2030/2031. This not only secures medium-term equipment revenue but also locks in a long-term services tail - as the data center installed base matures post-2030, we expect service intensity stepping up to $75k-$100k/MW/yr vs ~$31k/MW/yr currently.

Valuation: Our 12-month price target for INNIO of $40 is based on a target multiple of 25x Q5-Q8 EBITDA.

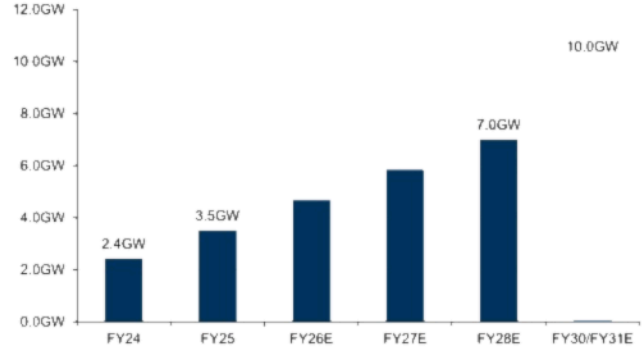
Key downside risks include: Slowdown in data center capex spending; increased competition; and capacity expansion/execution risk.

Exhibit 60: Backlog provides significant near-term visibility to our Equipment revenue estimates
Equipment revenue ($mn)



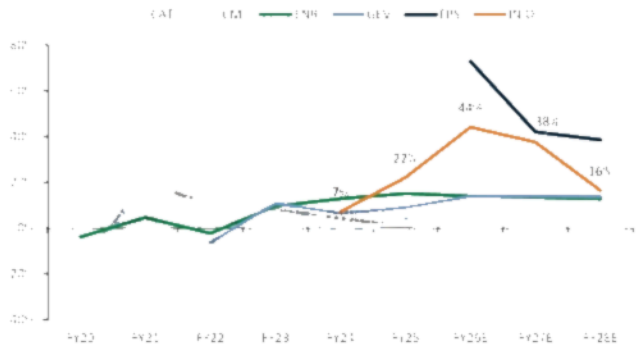
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 61: INIO expects to ramp from 3.5GW to 7.0GW by 2028 and ~10GW by 2030/2031
Projected capacity (GW)



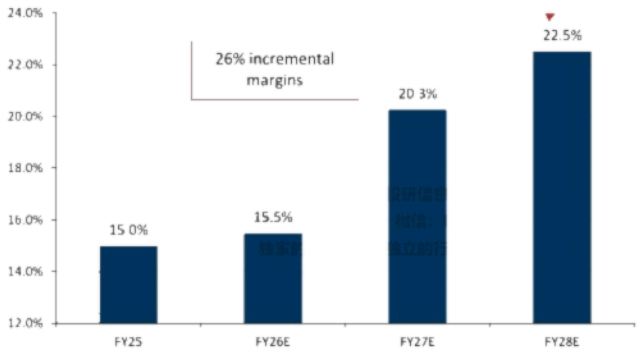
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 62: All-in, we expect this to translate to a 2025-2028E organic growth CAGR of 32% (vs. 19% for peers)
INIO organic growth vs peers



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 63: We are also forecasting Equipment margins to expand +750bps over this timeframe to 22.5%, implying 26% incremental margins
Equipment EBITDA margins (%)



Source: Company data, Goldman Sachs Global Investment Research