Emission Control for Data Centers

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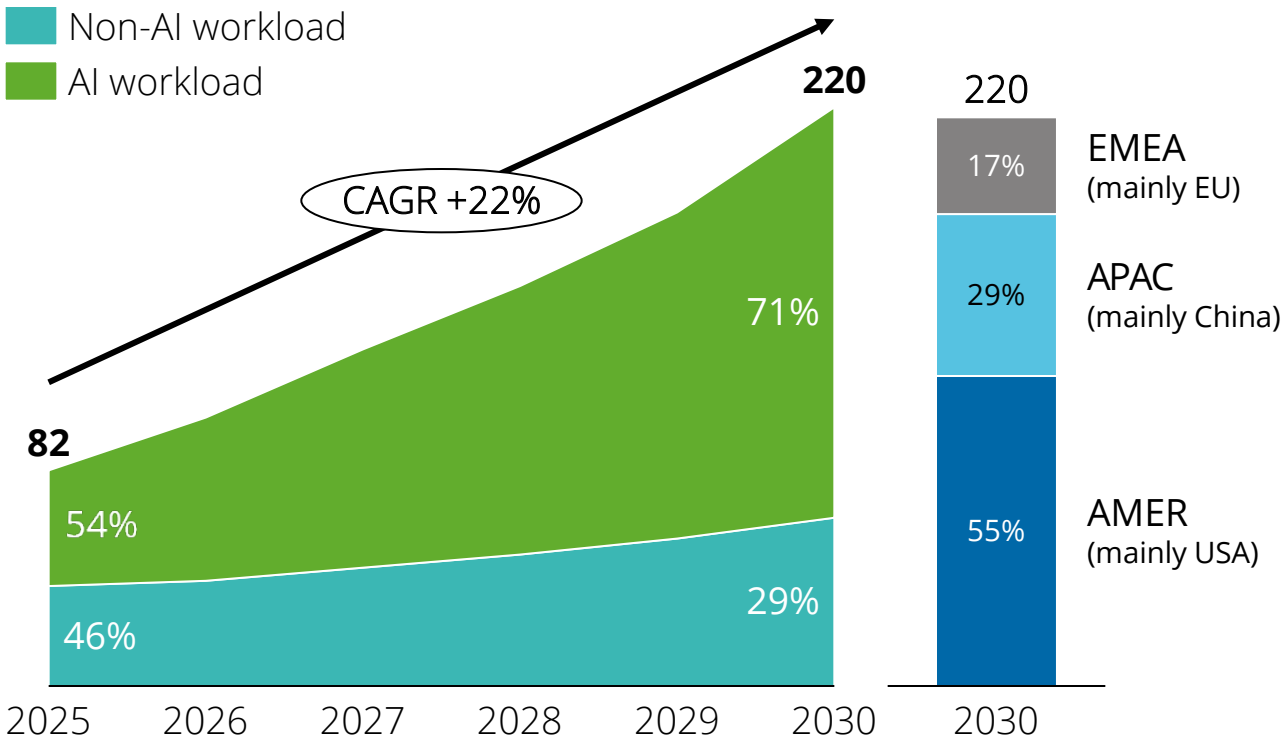
Data Center Boom or Bubble

Large scale capacity expansion since 2023 with USA being the key driver

Data Center capacity: AI vs. non-AI demand

Cumulated gigawatts[1]



1) Source: McKinsey data center report April 2025
CAGR = Compound Annual Growth Rate
EMEA = Europe, the Middle East, and Africa
APAC = Asia-Pacific

Linked to AI growth by 2.7x in next 5 years estimated for data center capacity.

Even non-AI workload increases by 11% per year.

Main expansion happens in the USA, where data center sites become larger and larger.

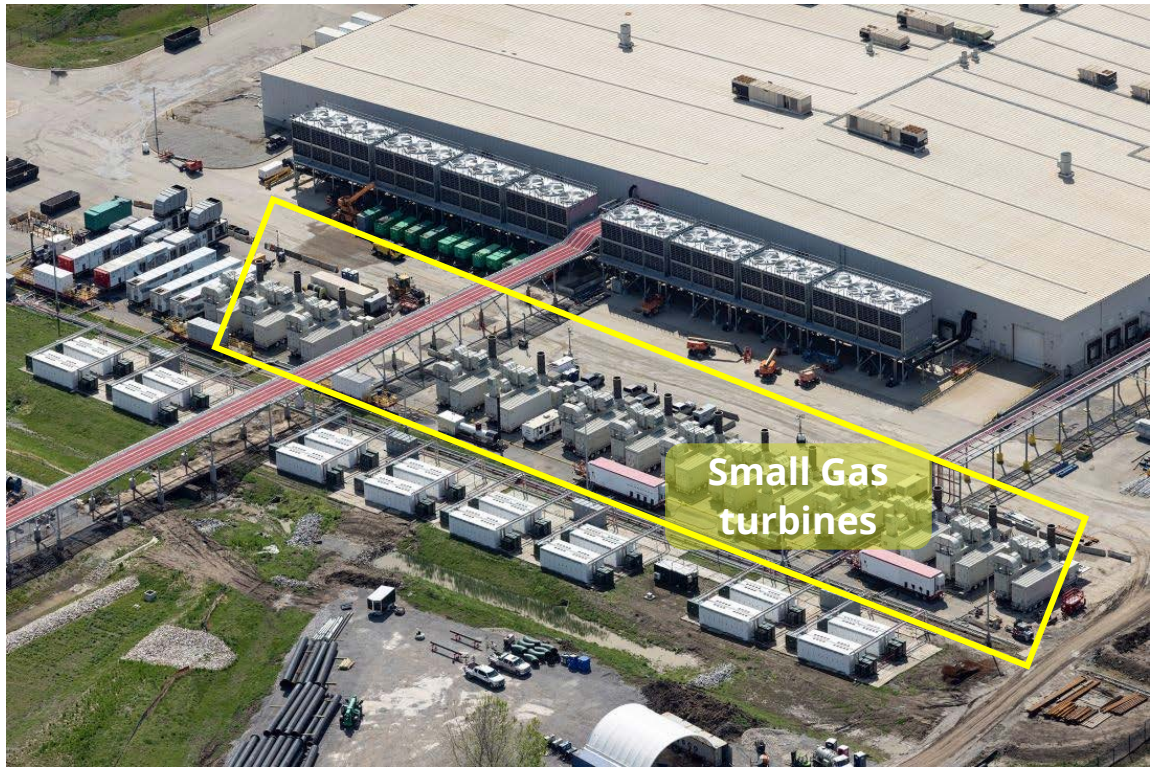
Growth estimated to continue until 2030. Main driver for growth beyond are commercially viable use cases of AI and computing power density.

AI = Artificial intelligence

The Size of AI's Appetite

Grid constraints are increasing interest in on-site gas turbines and fuel cells

xAI data centers



35 gas turbines have a generating capacity of 422 MW
(small modular 16MW turbines from Solar Turbines, a CAT subsidiary.)

Microsoft's trials with SOFC Fuel cells

~ 325-400 kW per Energy Server → ~1.3MW-1.6MW

UNIT: MW/ACRE	INDUSTRIAL GT	FUEL CELL - SOFC
Land use	20 - 30	30 - 100

AI's Emissions Paradox

Critical to ensuring uptime, permitting, and community acceptance

Black smoke created by diesel backup engines without catalyst/filter

Today, tight NOx and CO requirements in USA. Limited legislation in Europe and China

Regular testing of engine performance creates black smokes (testing required for data centers)

SCR and DPF technologies dramatically reduce NOx, soot, and visible smoke. SCR convert NOx into nitrogen and water vapor. DPF capture and removes particulate matter before it reaches the atmosphere.

NOX = Nitrogen Oxides; CO = Carbon Monoxide; ESG: Environmental, Social Governance

The AI power crisis - Need to reduce Time to Power

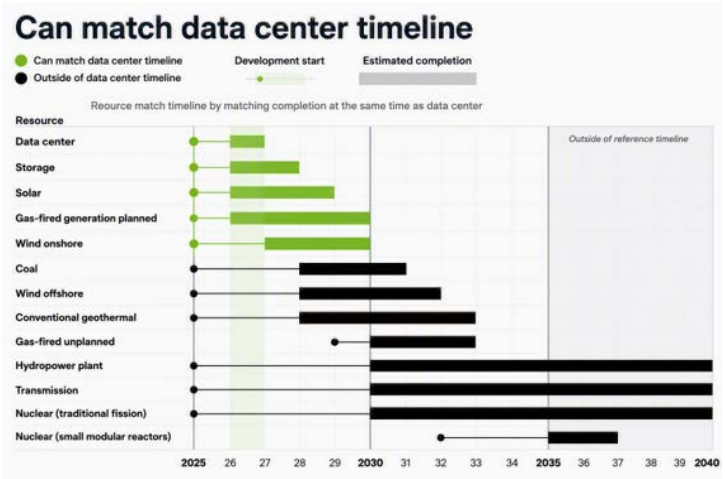
Microsoft's Satya Nadella says power, not chips, is now the largest limitation to AI growth

POWER DEMAND GROWTH

Data Centers now consume >6% of electricity in the USA

AI is redrawing the electricity map of North America

COMPARISON OF RAMP-UP TIME REQUIRED



Only few energy resources align with Data centers timeline of 1-2 years

Transmission line takes avg. 5-10 years for permitting and construction

Preference for quick on-site power generation1 (e.g. gas turbine, engines)

ESG VS. UPTIME

Google aws Tencent 腾讯 Microsoft Alibaba Group

Hyper scalers set carbon neutrality targets for their data centers

Backup power systems need to ensure uptime during failures; cannot all be renewable (~99.995% uptime)

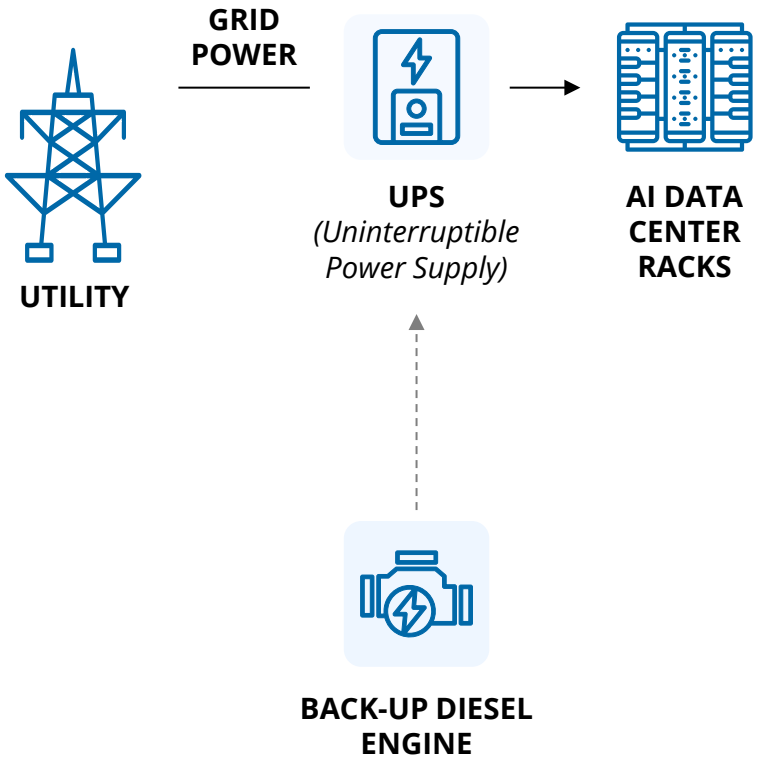
Legislators in the USA require up to 99% NOx conversion

1) Source IEA
2) Independent of the grid, in close proximity to the data center
ESG: Environmental, Social Governance

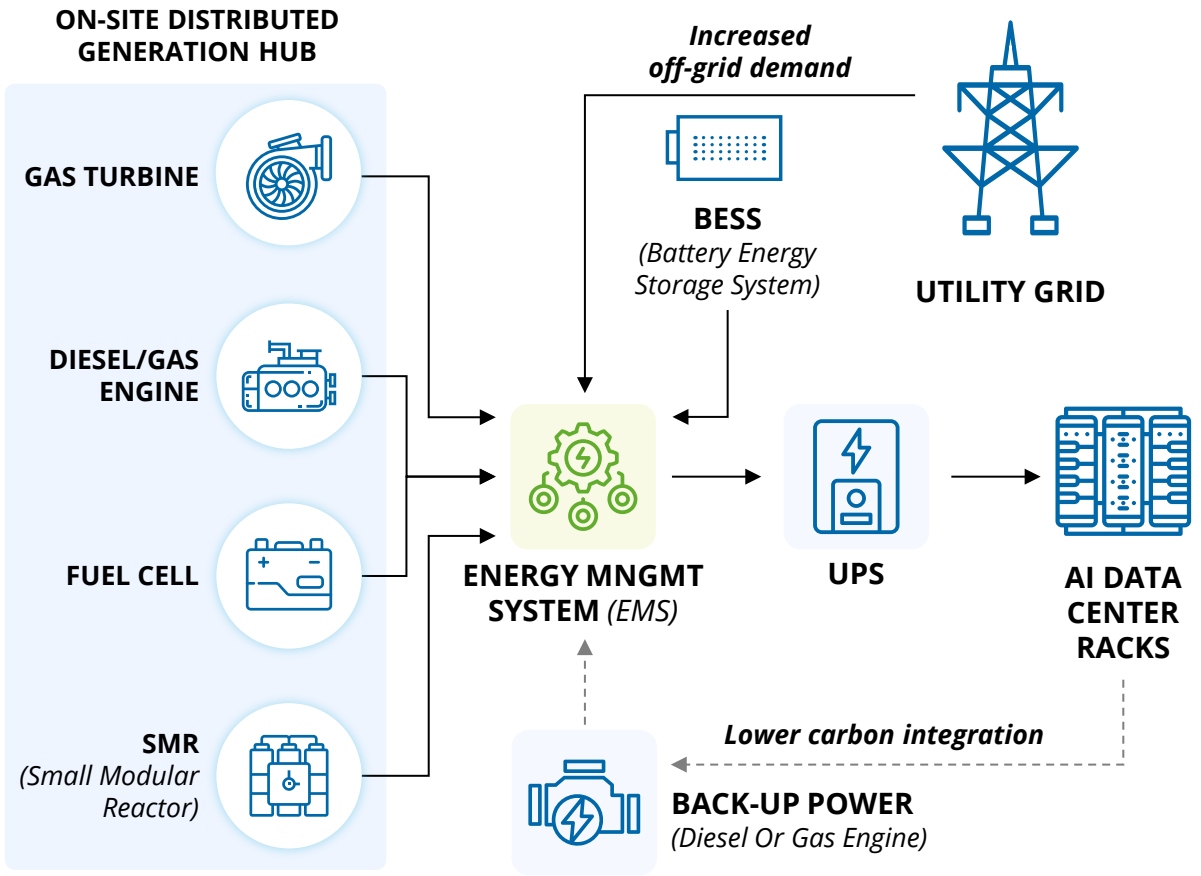
Behind-the-meter (BTM) power addresses grid constraints

Generation on the customer side of the utility meter supplies the data center, with or without a grid connection

Traditional grid-dependent model



Behind-the-meter (BTM) on-site generation



Gas engines and turbines are established on-site options. Fuel cells are emerging; SMRs remain prospective.
Sources: Umicore / Arthur D. Little; Enverus (11 Aug 2026); Data Center Knowledge (4 Jun 2026).

Emergency backup power solutions

SCR, cDPF

Diesel backup engines

cDPF + SCR

Sample case: 3,500 kW genset

50 pieces with a 10.5-inch round cross-section

cDPF + SCR with one 6-inch layer

Tier 4F (Stage V) emissions standards met

Pressure drop is a key design factor

System requirements

Engine Size	Fuel	Max Temp. (°C)	Inlet NOx	NOx Reduction	Exhaust Flow (CFS)	dP (inches H_2O)
3500kW	Diesel	495	886.3 ppmvd @ 12% O_2	91.53%	423.50	2.0

Prime power solutions

SCR + ASC

Prime-power natural gas engines

Selection depends on fuel type and temperature

Stationary products: SCR + hybrid SCR/oxidation

[3×3] to [4×5] element cross-section

540 mm SCR + 250 mm dual-function SCR/oxidation catalyst

HDD products: SCR + ASC for high temperature and VOC conversion

40–100 elements with a 10.5-inch round cross-section

SCR with one ≤6-inch layer + ASC layer

Tier 4F (Stage V) emissions standards met

System requirements

Engine Size	Fuel	Max Temp. (^{o}C)	Inlet NOx	Inlet CO	Inlet VOC	NOx Reduction	CO Oxidation	VOC Oxidation	Exhaust Flow (CFS)	dP (inches H_2O)
4045 kW	NG	413.9	165.1 ppmvd @ 12% O_1	326.2 ppmvd @ 12% O_2	99.2 ppmvd @ 12% O_2	97.90%	93.00%	60.00%	398.29	2.0
1400 kW	NG	524	138.0 ppmvd @ 12% O_2	397.4 ppmvd @ 12% O_2	163.6 ppmvd @ 12% O_2	95.00%	93.00%	60.00%	191.41	2.0

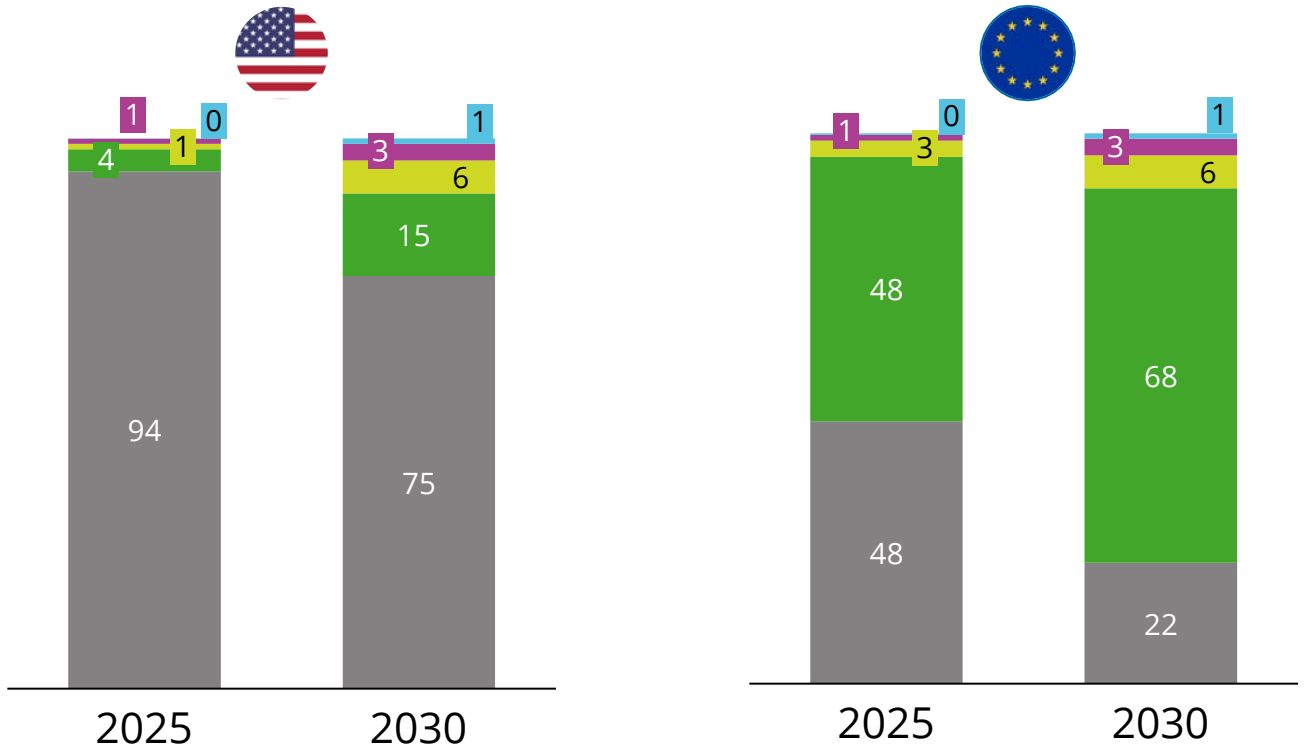
Design critical parameter

Emergency backup technology mix

Mission-critical uptime requires redundant capacity, with (bio)diesel engines still dominant

Emergency backup technology mix (model assumptions)

[% shares of installed power generation capacity]



Source: Bloomberg, EUDCA, Arthur D. Little Analysis

Comments

01 Diesel remains the backbone of emergency backup

Diesel / HVO gensets remain ~90%+ of backup capacity through 2030, driven by reliability and rapid start-up

02 Europe shifts faster toward HVO

HVO / biodiesel rises to 68% in Europe by 2030 vs. 15% in the US, displacing fossil diesel

03 Alternatives grow, but remain niche throughout 2030

BESS reaches ~6%; hydrogen fuel cells remain marginal in back-up tech

04 Engine-based backup remains catalyst-relevant

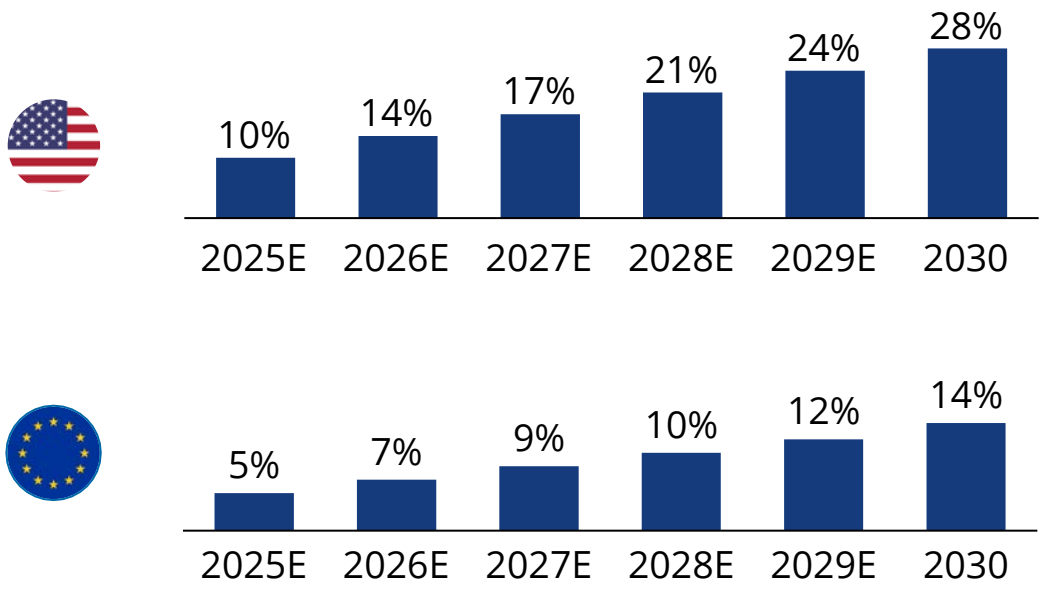
HVO / biodiesel still requires exhaust aftertreatment, while BESS and fuel cells do not

BTM (Behind-the-meter) adoption and technology mix

BTM adoption is accelerating. Gas-based generation remains central as the mix diversifies

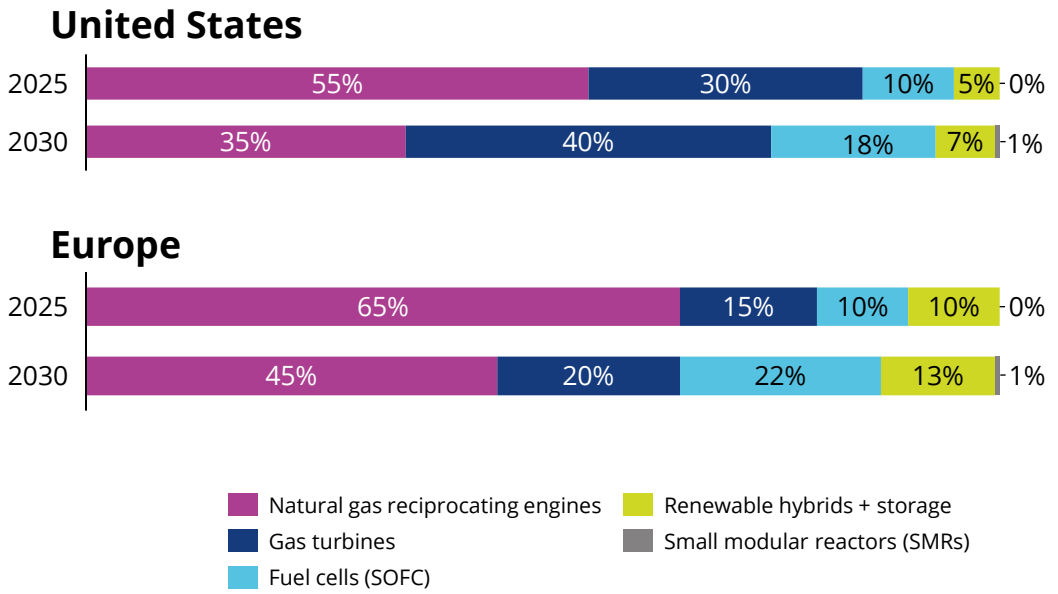
BTM Penetration

[% shares of total installed capacity], E: Estimate



BTM/onsite generation technology mix

[% shares of total BTM capacity]



Onsite generation is expanding rapidly, reaching ~28% of total data center capacity in the US and ~14% in Europe by 2030

Gas remains the core BTM technology through 2030, while the mix diversifies toward gas turbines and SOFC in the US and fuel cells and renewable hybrids in Europe

Source: EUDCA / Climate Neutral Data Centre Pact, Uptime Institute, Aggreko, Vertiv, EU Medium Combustion Plant Directive (EU 2015/2193), national & local emissions regulations (incl. Germany TA Luft, UK requirements), ADL analysis

Conclusions

1. Emission control technology for datacenters is mature and available.
2. Diesel/bio-diesel gensets will continue to be preferred technology for back-up power.
3. Diesel backup engine preferred emission control technology is similar to heavy-duty diesel (HDD) after-treatment systems. A standard layout combines a diesel particulate filter (DPF) with a downstream SCR catalyst.
4. Prime power gas engines preferred emission control technology is an SCR catalyst combined with an oxidation catalyst. For prime power, stationary emission control systems with lower pressure drop are preferred.
5. Emission control on datacenter can be applied as a tail-end retrofit solution.

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