

ENERGY TRANSITION · GRID · AI · NEGATIVE EMISSIONS

The Enabling Layer: *Unlocking Negative Emissions* through Grid Digitalization and AI

Grid digitalization, AI, and the enabling infrastructure behind negative emissions

Grid Investment Super Cycle – EU

	KEY POINTS	INVESTOR TAKEAWAYS
Scale	Annual European investment in electricity networks is +£100bn To meet climate targets, annual investment needs to at least double by 2030 This implies a step-change in capital formation through the decade	Multi-year investment cycle across T&D with clear visibility and downside protection in regulated returns
Demand drivers	Rapid renewables buildout, electrification of transport and heat High-load industrial decarbonisation: DAC and green hydrogen Data centres and AI loads increase the need for real-time visibility and automation	Pull for grid intelligence, asset performance and flexibility trading Majority of pressure sits on low-voltage networks supporting intermittent electricity
Bottlenecks	Planning and permitting often take six to ten years Interconnection queues exceed c.1,000 GW of wind and solar projects. OEM constraints and long lead times for transformers and HV cables	Value accrues to platforms that can execute at scale and manage supply-chain risk
Regulatory unlocks	Europe identifies material cross-border capacity gaps this decade. The UK has a national upgrade programme and rising allowed spend.	Clearer line of sight to project selection and cost recovery improves bankability and reduces timing risk
Where to play	Equipment makers for transformers, switchgear, cables and towers Grid-enhancing tech: dynamic line ratings and advanced conductors Storage-as-transmission, flexible capacity, grid planning and operations software	Mix of regulated yield, contracted growth and technology upside Focus on platforms with delivery capacity and service differentiation

The EU Electricity Grid at a Glance

18m km

length of cables and infrastructure

250m

connected households and businesses

c.40%

EU grid over 40 years old

€100bn/yr

grid investment requirement

+2.5k

total DSOs across the EU

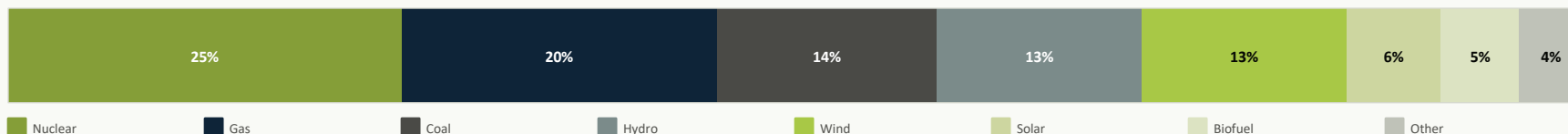
23%

electricity share of final EU energy demand

70%

renewable capacity by 2030

EU electricity generation by source



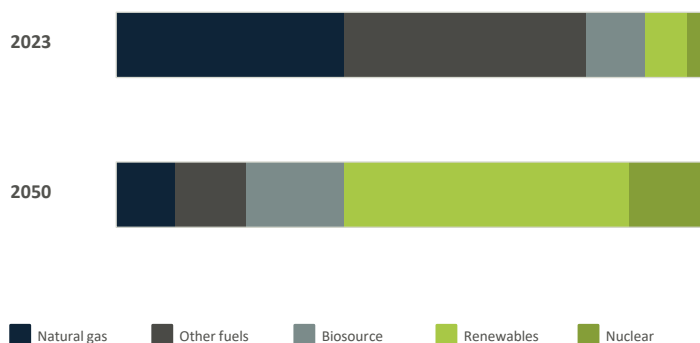
Implications for investors

- Renewables, EVs and heat pumps move the constraint to distribution: by 2030, most new demand and capacity connects close to the grid edge
- Annual investment has to cover deferred maintenance and future-proofing - renewal and digital upgrades are now unavoidable
- A fragmented DSO landscape creates a premium for software, planning and automation layers that can standardise operations across jurisdictions.

Electrification Requires Clean Generation + Supply-Chain Investment

Fossil fuels are projected to decline from c.80% to c.20% of the global energy supply mix by 2050; renewables carry the majority of the required capex.

Energy supply mix: 2023 vs 2050



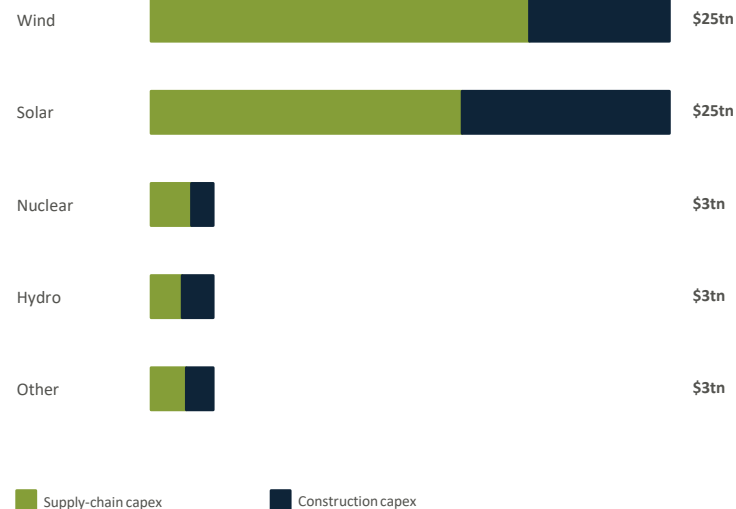
80% fossil / NG in 2023 **20%** fossil / NG in 2050

Renewables move from a small share of supply to the core capacity buildout

Capex required to 2050

\$59tn

not including transmission and storage



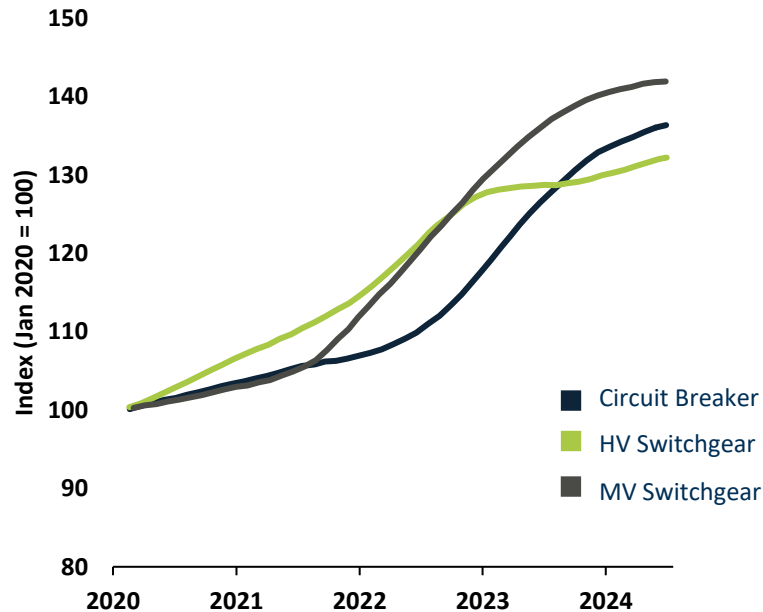
Two-thirds of renewable investment is concentrated in the supply chain - equipment, components, and buildout capacity

Grid Upgrades and Expansion Are Critical

Transformer demand is set to rise materially through 2030, while T&D equipment prices remain elevated after the 2020-2024 reset.

T&D equipment price trend

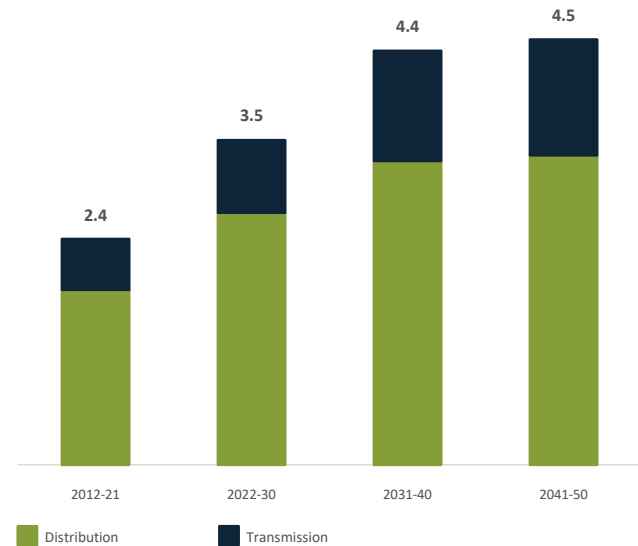
Index, Jan 2020 = 100



Equipment inflation creates a premium for execution certainty, procurement access, and asset-light grid-enhancing software.

Transformer capacity additions / replacements

TW/year, average annual capacity



Distribution networks represent c.70% of forecast spend, with emerging markets driving the next wave of transformer capacity.

European Network Operators Are Revising Capex Upward

- Average TSO/DSO capex in Europe is projected to increase 30%+ per year over the next decade compared to 2024
- This trend is expected to drive a sustained Electricity Transmission & Distribution (ET&D) Supercycle

Capex Spent - Large European Network Companies

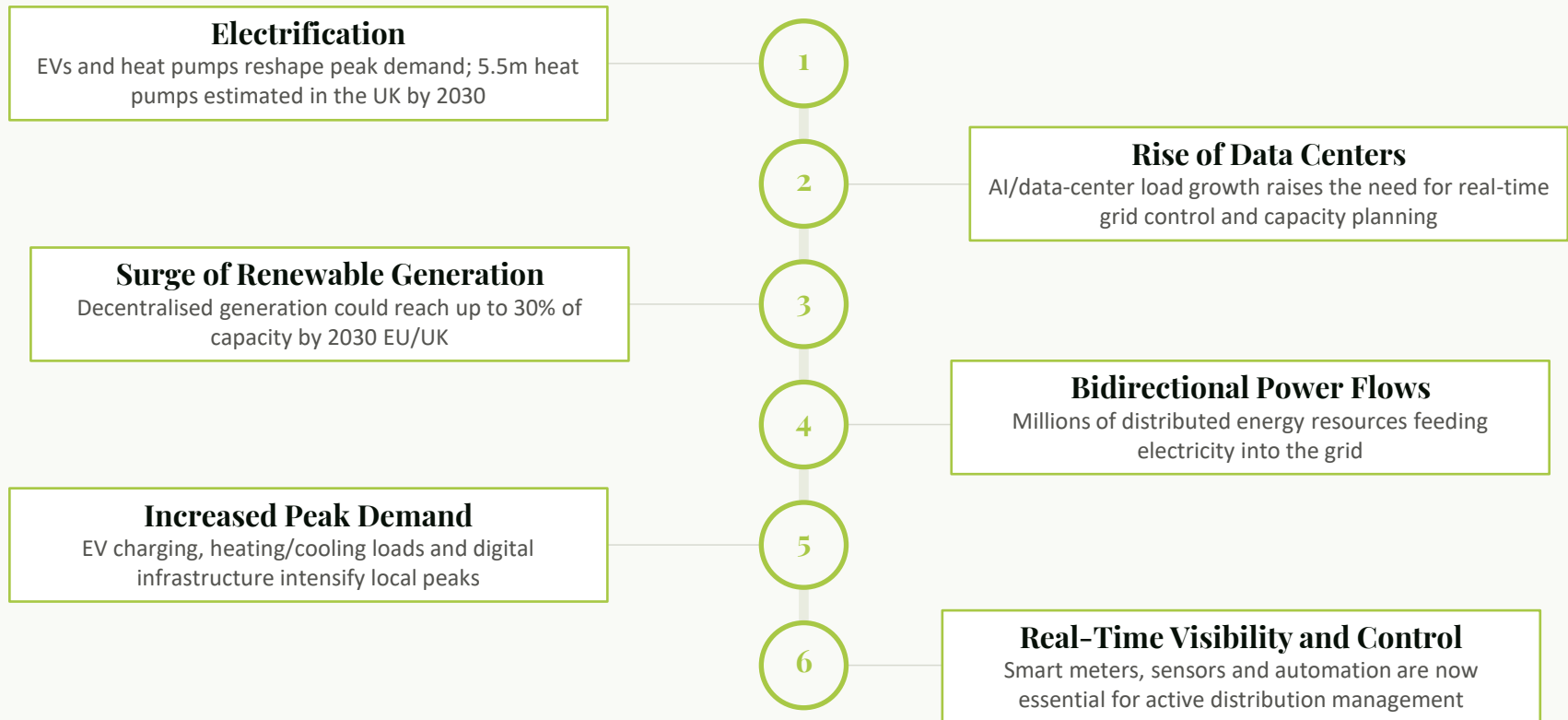
Company	Capex Earnings Release 2022	Capex Earnings Release 2024	% 2024/2022
RTE (France)	€ 1.8 bn	€ 2.6 bn	44.4%
Terna (Italy)	€ 2.9 bn	€ 3.5 bn	20.7%
National Grid (UK)	€ 4.8 bn	€ 6.0 bn	25.0%
TenneT (NL/DE)	€ 10.0 bn	€ 12.0 bn	20.0%
Elia (BE/DE)	€ 2.2 bn	€ 2.8 bn	27.3%
Red Eléctrica (Spain)	€ 0.70 bn	€ 0.8 bn	14.3%
Enel (IT/ES)	€ 6.0 bn	€ 7.0 bn	16.7%
Amprion (Germany)	€ 3.2 bn	€ 3.8 bn	18.8%
Svenska (Sweden)	c.€ 0.80 bn	c.€ 0.9 bn	12.5%
SSE Transmission (UK)	£ 1.6 bn	£ 1.8 bn	12.5%
E.ON (Germany)	€ 6.5 bn	€ 7.5 bn	15.4%
Enedis (France)	€ 4.5 bn	€ 5.5 bn	22.2%
Energinet (Denmark)	c.€ 1.7 bn	c. € 2.0 bn	17.6%
Vattenfall (Sweden)	€ 2.5 bn	€ 3.0 bn	20.0%
TOTAL	€ 49.2 bn	€ 59.2 bn	20.3%

Capex Projection - EU/UK

Period year	Cumulative Amount	Yearly Projections	% Yearly projection / 2024
2024-2040	c.€ 100 bn	€ 5.8 bn	123.1%
2025-2034	c.€ 23 bn	€ 2.3 bn	(34.3%)
24/25-28/29	c.£ 60 bn	€ 14.3 bn	100.0%
Until 2034	c.€ 200 bn	€ 11 bn	(8.3%)
2025-2028	c.€ 26.8 bn	€ 6.75 bn	141.1%
2020-2030	c.€9 bn	€ 0.9 bn	12.5%
2025-2027	c.€26 bn	€ 8.7 bn	24.3%
2025-2029	c.€ 36.4 bn	€ 7.3 bn	92.1%
2025-2028	c.€ 6 bn	€ 1.5 bn	66.7%
2026-2031	c.£ 22 bn	€ 4.4 bn	144.4%
2024-2028	c.€ 42 bn	€ 8.4 bn	12.0%
2022-2032	c.€ 50 bn	€ 4.5 bn	(18.2%)
2024-2027	c.€ 36 bn	€ 1.21 bn	(39.5%)
2025-2029	c.€ 15 bn	c.€ 3.0 bn	0.0%
TOTAL	c.€ 663.5 bn	€ 77.76 bn	31.4%

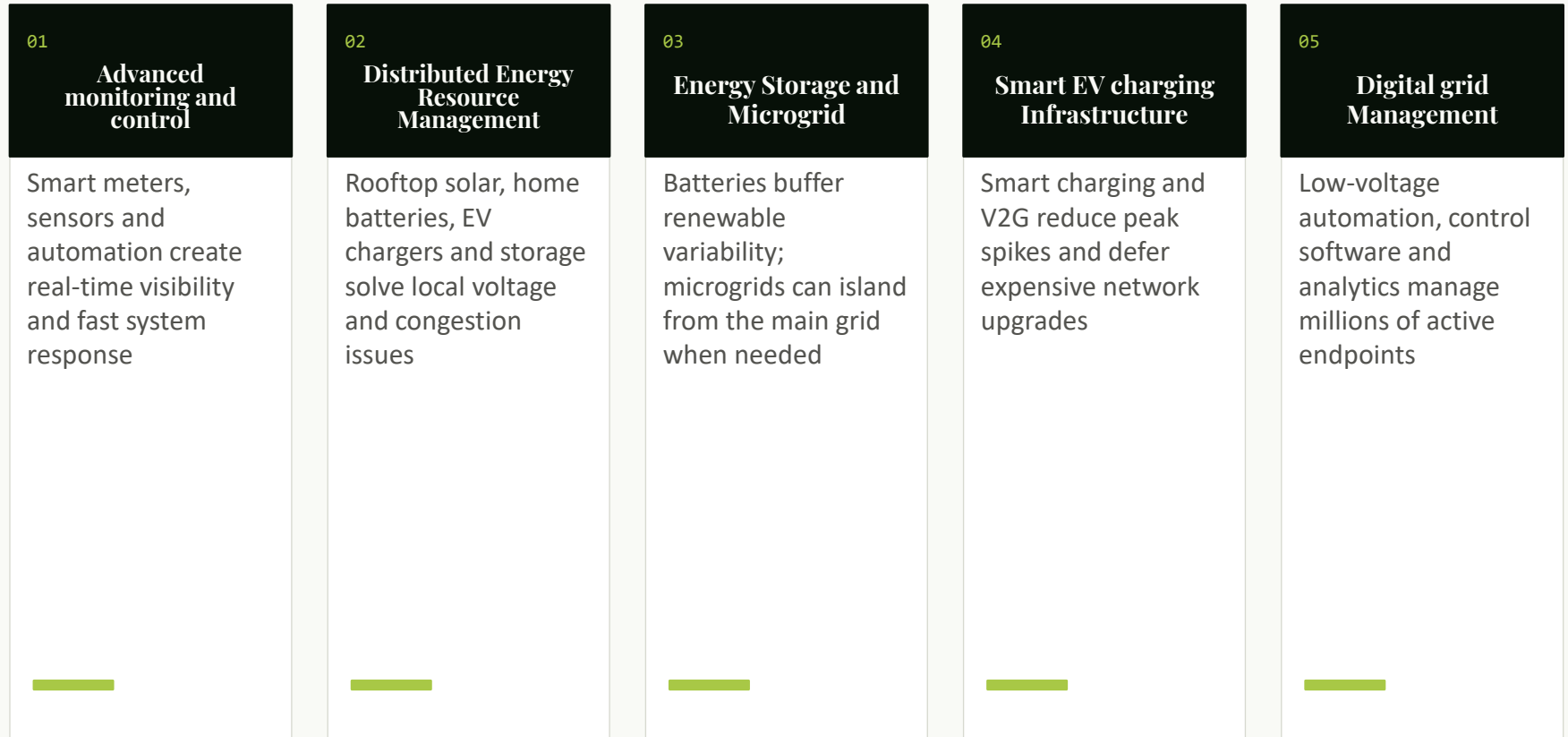
Grid Under Pressure: Distribution Innovation Is Unavoidable

Electrification, renewables and digital infrastructure are increasing peak loads and bidirectional power flows - exposing the limits of aging networks.



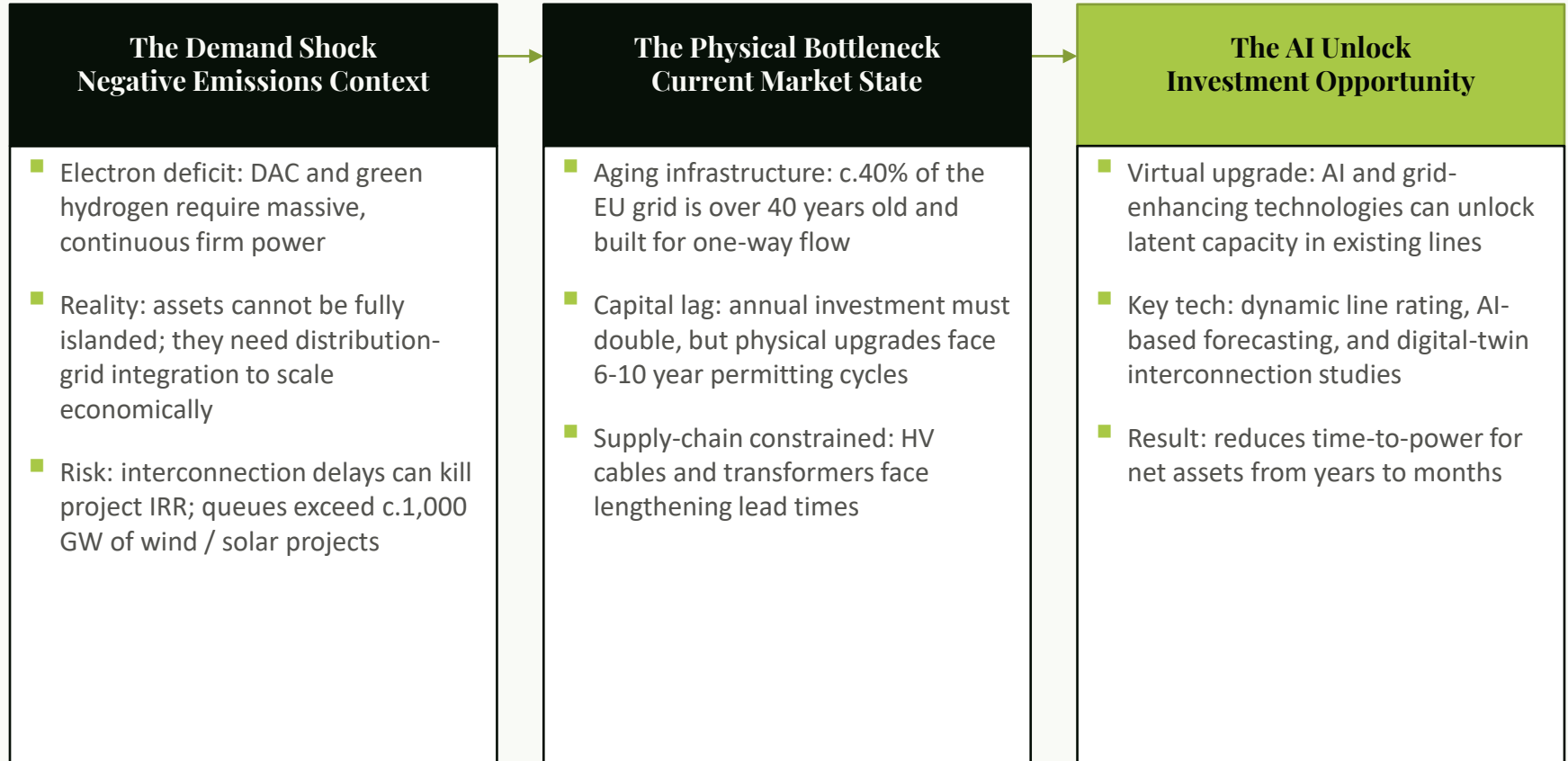
Grid Modernization: Strategic Enablers

Decentralized flexibility and digital intelligence unlock efficiency across complex, active networks.



De-Risking Negative Emissions via Grid Intelligence

Physical grid constraints are the primary bottleneck for scaling DAC; AI-driven optimization is the immediate unlock.



Investing in the 'Grid OS' software layer directly de-risks hard-tech infrastructure: it prepares the grid to absorb the load of the negative-emissions portfolio