APEC Expert Group on Energy Efficiency and Conservation (EGEEC)

AI Energy Efficiency

Vice-Chairman, EGEEC
EGEEC Meeting · 2026

AGENDA

Challenges & Opportunities

As Energy CONSUMER

AI workloads in data centers consume a large and rapidly growing amount of energy.

4X	AI electricity demand multiplier by 2030
80 - 90%	AI energy from continuous inference (not training)
20%	of DC projects face grid connection delays

VS

AI Efficiency ENABLER

AI applied to buildings, industry, transport, and power grids reduces energy waste across the whole economy.

175 GW	extra grid capacity unlocked by AI (IEA)
5 - 40%	building energy savings via AI Building Management System (BMS)
300 TWh	potential savings in building management by 2035

EGEEC's mandate: to lead the balance between these two realities

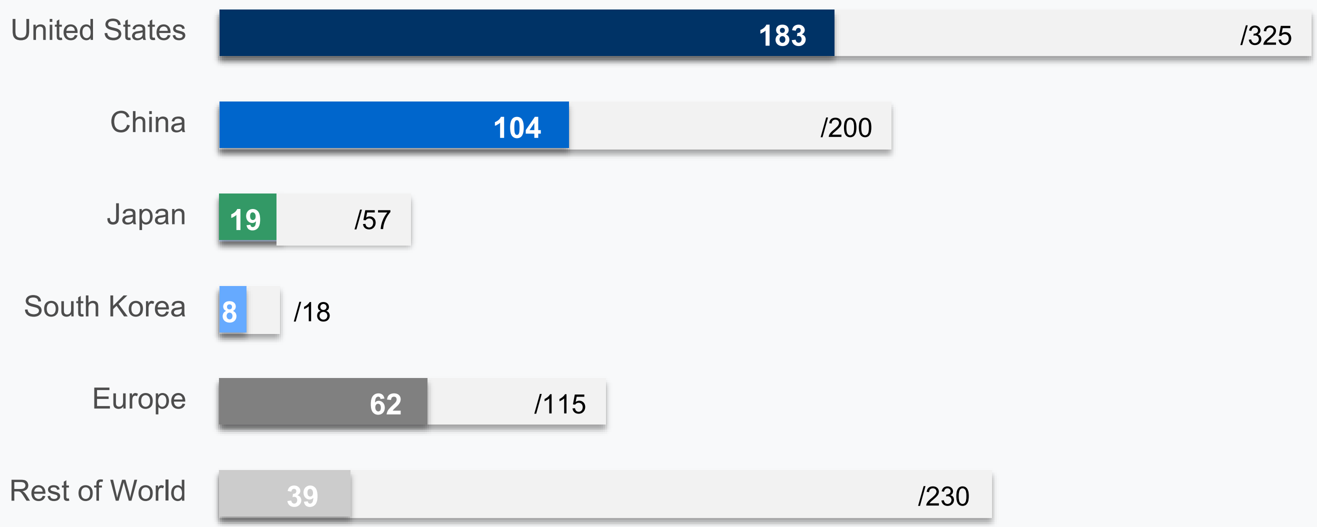
Source: IEA Energy and AI 2025 | ACEEE Smart Building Systems 2025 | WEF Transport AI 2026

Part 2
Demand Reality

Scale, APEC footprint & structural nature of AI energy demand

Global Data Centre Demand

Regional DC Electricity Demand (TWh)



■ Current Number / 2030 projected

945TWh **Total global DC demand by 2030**

= Japan's current entire electricity consumption

4× **AI electricity demand multiplier by 2030**

18% growth in US DC demand 2018–2023

2035 **700–1,700 TWh range**

Uncertainty reflects AI adoption speed

⚠ **Paradox :** Efficiency gains in AI hardware are outpaced by exponential growth in deployment scale

Why AI Demand Is Structural

Inference Dominates

- 80-90% of AI energy is consumed in inference

GPU Power Density

- 80-90% of peak power drawn even at 30–50%
- AI chips require 50–150 MW per facility
- Each AI query uses ~10× the energy of a normal search

Grid Bottleneck

- 20% of data center projects face grid connection delays.
- 7–10 year EU grid queues
- 10 GW pipeline jams in Tokyo metro area.

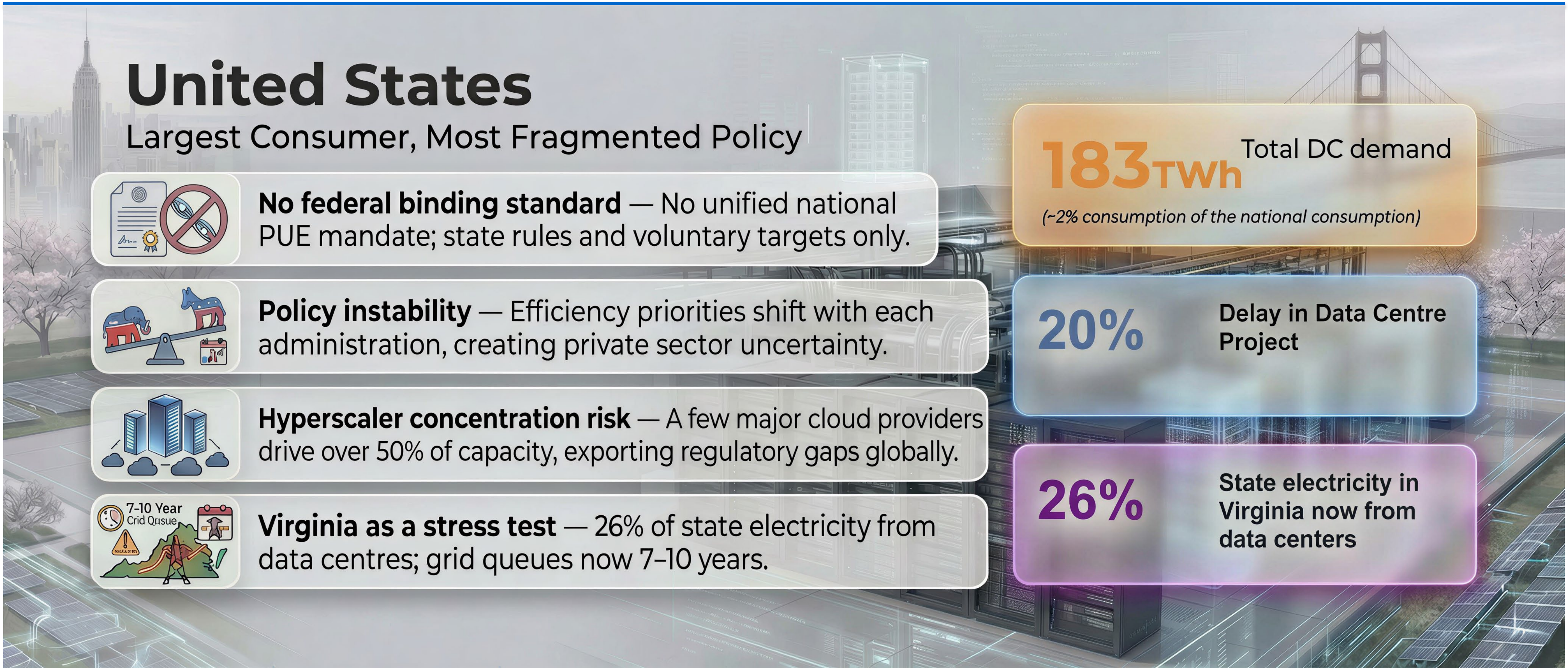
APEC Concentration

- >70% of global DC capacity in APEC economies.
- US + China alone represent the dominant share
- Japan, Korea, Singapore, Australia rapidly growing.

"The decisions made in the next 18 months will determine whether AI becomes a climate accelerant or a climate solution."

Source: IEA Energy and AI 2025 | ETH Zurich Systems Group 2025 | Stanford AI Index 2025

United States



China

Source: IEA Energy and AI 2025 | MIIT Green DC Program

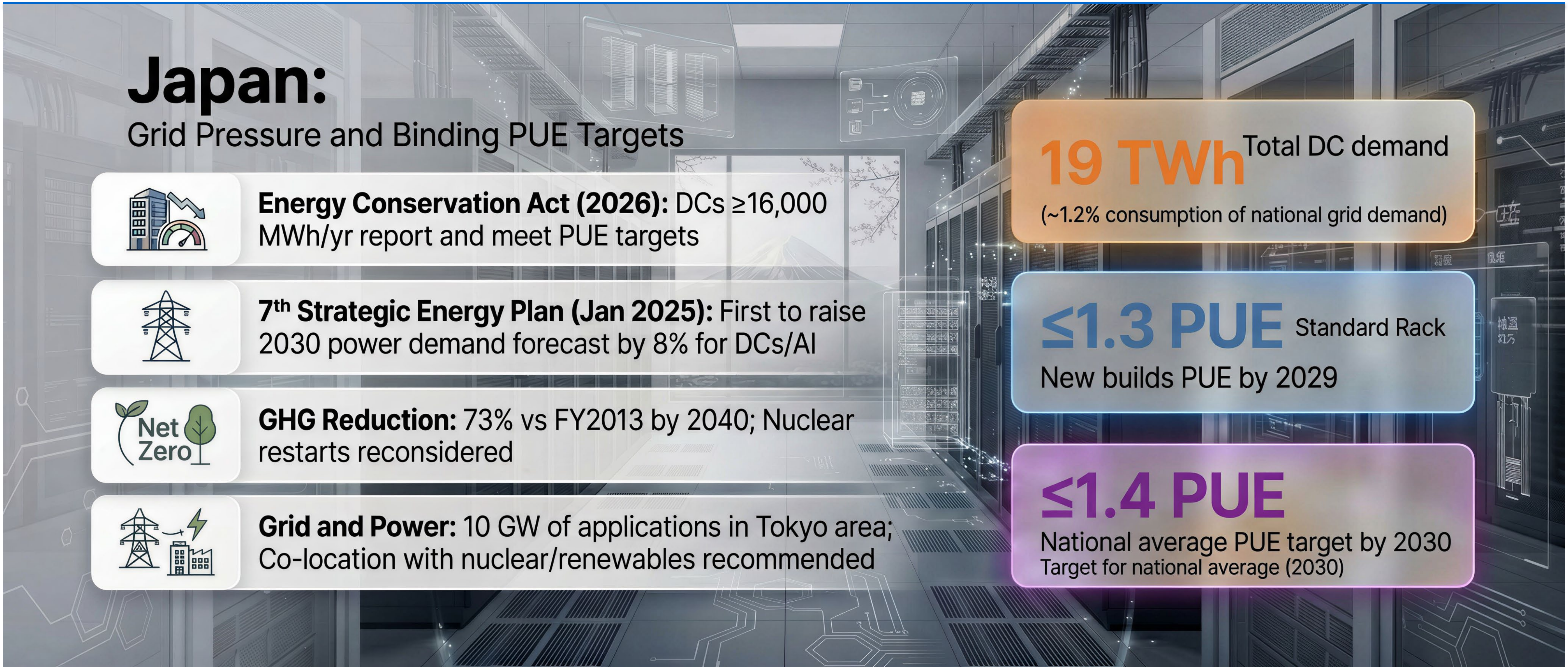
China

15th Five-Year Plan (2026–2030)

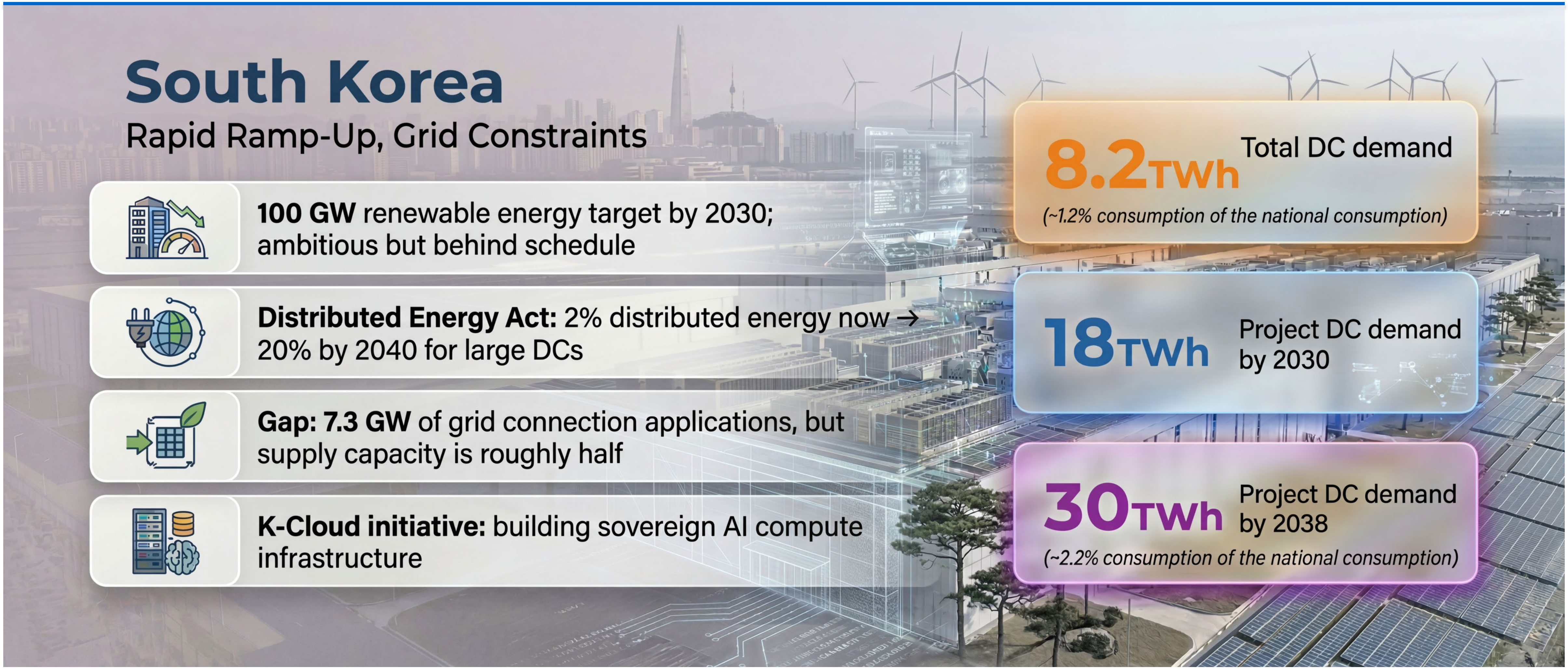
100 Zero-Carbon Parks	New target for zero-carbon data center industrial parks by 2030
Hyper-Scale AI Clusters	Dedicated AI computing clusters with enhanced cooling and renewable power
¥4 Trillion Grid Investment	State Grid investing ¥4 trillion (+40%) in grid modernisation for data center demand
Carbon Dual-Control Shift	Moving from energy intensity to carbon intensity targets for data centers
Green Procurement Ramp	30% green electricity procurement (2025) → 80% (2030) for data centers

Source: IEA Energy and AI 2025 | MIIT Green DC Program

Japan


Japan:
Grid Pressure and Binding PUE Targets
Energy Conservation Act (2026): DCs ≥16,000 MWh/yr report and meet PUE targets
7th Strategic Energy Plan (Jan 2025): First to raise 2030 power demand forecast by 8% for DCs/AI
Net Zero
GHG Reduction: 73% vs FY2013 by 2040; Nuclear restarts reconsidered
Grid and Power: 10 GW of applications in Tokyo area; Co-location with nuclear/renewables recommended
19 TWh
Total DC demand
(~1.2% consumption of national grid demand)
≤1.3 PUE
Standard Rack
New builds PUE by 2029
≤1.4 PUE
National average PUE target by 2030
Target for national average (2030)

South Korea

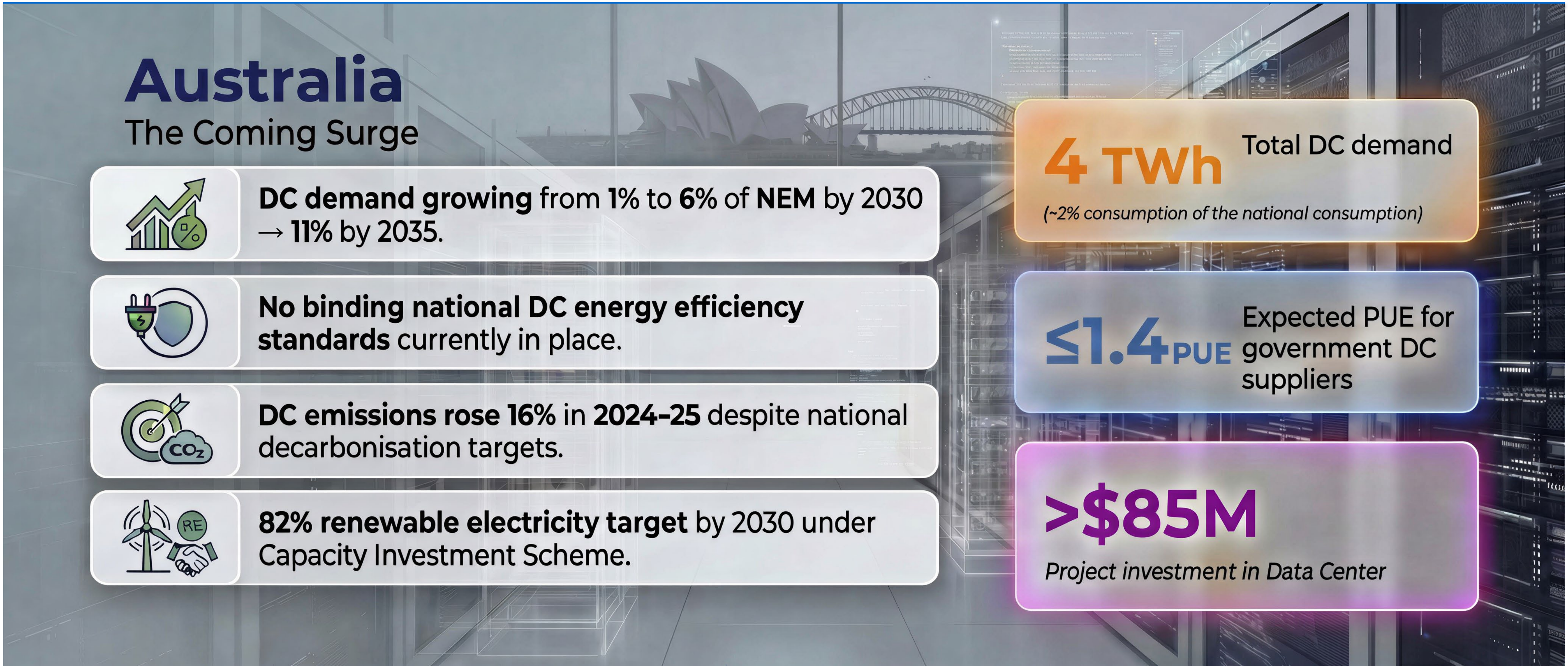


Source: IEA Energy and AI 2025 | Korea Energy Agency

Singapore

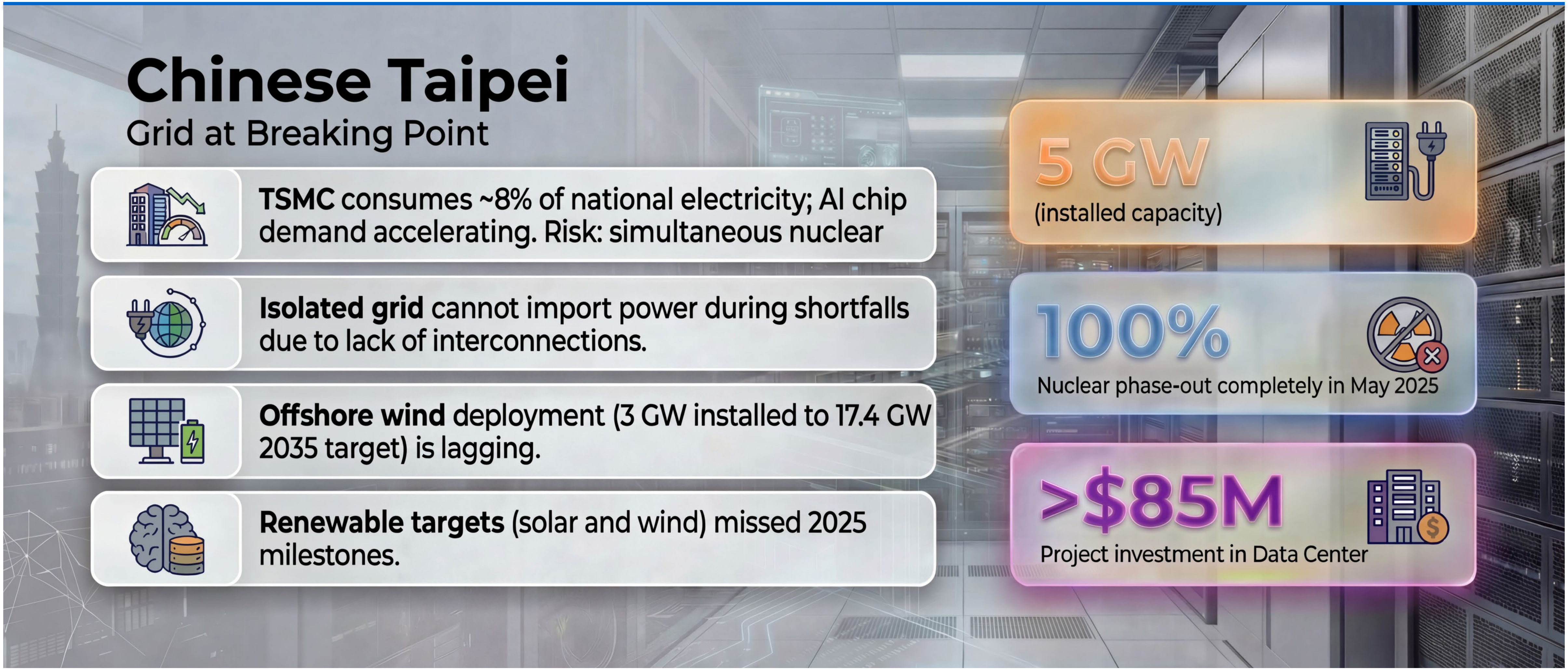
Source: IEA Energy and AI 2025 | IMDA Green DC Standards

Australia



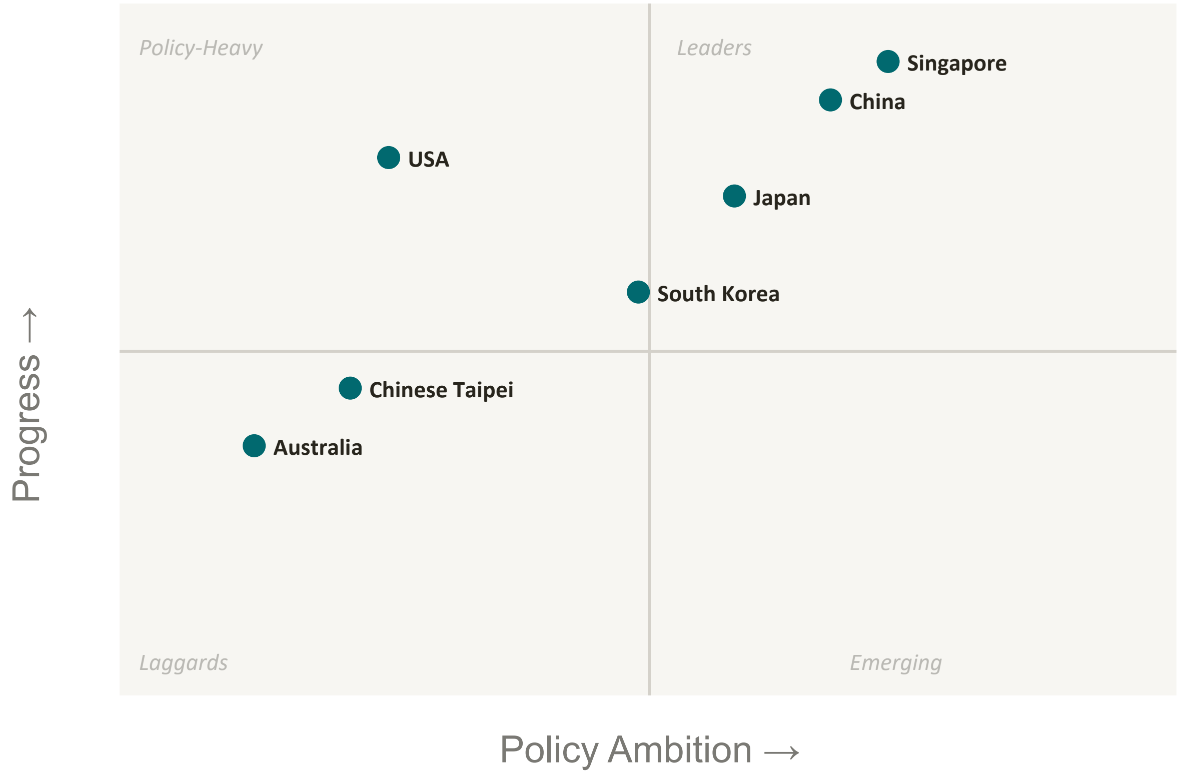
Source: IEA Energy and AI 2025 |

Chinese Taipei



Source: IEA Energy and AI 2025 |

APEC AI Energy Policy: Ambition vs Implementation Progress



Key Observations

1. Explosive demand outpacing grid capacity

Each faces grid connection delays.

2. Renewables behind schedule everywhere

Most of the renewable targets are not on track. Even Canada's clean grid faces capacity pressure. Chinese Taipei renewable gaps are acute.

3 . Few binding AI-specific energy standards

Only China and Singapore have mandatory PUE. Most economies rely on voluntary programs or lack DC-specific regulation entirely.

Source: IEA Energy and AI 2025 |

Part 3
Energy Efficiency

Technology clusters, deployed examples & real-world impact

Technology Clusters

AI for Energy Efficiency

A DEMAND SIDE				B SUPPLY SIDE			C AI INFRASTRUCTURE	
A1 Buildings	A2 Industry	A3 Transport	A4 Consumer	B1 Grid & Networks	B2 Generation & Storage	B3 Demand Response & Flexibility	C1 AI Hardware	C2 Software & Algorithms
BEMS · HVAC AI Digital Twins	Process Opt. Predictive Maint.	Route Opt. AV & EV Mgmt.	Smart Homes Demand Response	VRE Forecasting Fault Detection	Power Plant Opt. Battery Mgmt.	Load Shifting Virtual Power Plants	GPU/TPU/NPU Liquid Cooling	Model Compress. Green AI Methods

Following IEA, ACEEE & UNIDO classification | Two primary groupings: (A) Demand-Side · (B) Supply/Energy-Side · Cross-cutting: (C) AI Infrastructure Efficiency

Source: IEA Energy and AI 2025 | ACEEE Energy Efficiency 2025 | UNIDO AI in Industry 2025

Buildings & Industry — AI Energy Efficiency Technologies

A1 BUILDINGS

AI-driven Building Energy Management Systems (BEMS)

ML models optimise HVAC, lighting & plug loads in real time. Dollar Tree, Finnish malls, hospitals deployed.

5–40% energy savings vs conventional — DEPLOYED

Predictive HVAC Optimisation

AI forecasts occupancy & weather to pre-cool/heat. Deployed at scale in commercial real estate.

15–25% HVAC energy reduction — DEPLOYED

Digital Twins for Buildings

Full virtual replica of building systems. Enables scenario modelling & continuous AI commissioning.

20–30% operational energy reduction — DEVELOPING

Agentic AI Building Controls

AI agents manage all systems autonomously. Key IEA 2025 use case — still in pilot phase.

≤40% energy savings (IEA) — DEVELOPING

A2 INDUSTRY

AI Process Optimisation (Cement, Steel, Chemicals)

Closed-loop AI (ABB, Carbon Re, Imubit) writes setpoints directly to DCS. Payback < 12 months.

10–15% fuel & electricity reduction — DEPLOYED

Industrial Digital Twins

Full-plant virtual replica. IEA Task XVIII AI in Industrial Systems (2025–2026) leading global collaboration.

15–25% energy intensity reduction — DEVELOPING

AI Predictive Maintenance

ML fault prediction prevents motors & compressors running inefficiently. Widely deployed in manufacturing.

5–12% energy from avoided downtime & over-running — DEPLOYED

AI-optimised Heat & Cooled Supply Networks

AI-controlled district heating/cooling with demand forecasting. Pilot scale in Nordic countries.

10–20% district energy savings — DEVELOPING

Reinforcement Learning for Industrial Control

RL agents continuously learn plant-specific dynamics. Cement kilns, steel converters — growing deployments.

≤30% in targeted process energy — DEVELOPING

Source: IEA Energy and AI 2025 | ACEEE Smart Buildings 2025 | UNIDO AI Heavy Industry 2025 | Imubit Cement AI 2026

Transport & Consumer Applications

A3 TRANSPORT

Application	Description	Impact	Status
AI Route Optimisation (Road, Rail, Maritime)	UPS ORION saves 10M gallons/yr. DHL multimodal cut costs 13%, emissions 58% per t-km.	**10–15%** fuel per tonne-km (DHL: 58% CO_2/tonne-km)	DEPLOYED
AI Traffic Management & Signal Optimisation	Real-time signal timing optimised via ML. Deployed in Singapore, Seoul, major US cities.	**10–15%** urban fuel consumption reduction	DEPLOYED
AI-managed EV Charging & Grid Integration	Smart charging coordinates EVs as grid assets. V2G and demand response programs active.	**15–20%** grid demand peak reduction	DEPLOYED
Autonomous Vehicle Energy Management	AI driving reduces braking losses, optimises speed profiles. IEA: potential = 120 million cars.	**~30%** energy per passenger-km vs. human-driven	DEVELOPING
AI-optimised Capacity & Modal Shift Planning	AI demand forecasting shifts freight to rail/sea from trucking. Airline cargo +8% load factor.	**8–12%** cargo load capacity improvement	DEPLOYED

A4 CONSUMER APPLIANCES & SMART HOMES

Application	Description	Impact	Status
AI Smart Home Energy Management (HEMS)	AI learns occupant schedules, optimises appliances. Google Nest, Amazon Echo ecosystems deployed.	**10–35%** household energy consumption	DEPLOYED
AI-enhanced Appliances (A/C, Refrigerators, Washing)	IEA 2025: current appliances are often half as efficient as best models. AI closes the gap rapidly.	**10–30%** vs non-AI equivalent appliance	DEPLOYED
AI Demand Response (Residential)	AI aggregates smart appliances as Virtual Power Plants. PG&E, OhmConnect deploy at scale.	**10–20%** peak demand shift per household	DEPLOYED
AI-powered MEPS Compliance Monitoring	AI monitors appliance real-world performance vs. MEPS. EU & AU piloting smart meter analytics.	**Policy** enabler	DEVELOPING
Edge AI for Ultra-low Power IoT Devices	NPU chips enable inference at <1W on device. Reduces round-trip data centre energy for IoT.	**70–90%** vs cloud compute per inference task	DEVELOPING

Source: WEF Transport AI 2026 | IEA Energy Efficiency 2025 | ACEEE Smart Homes 2025

AI for Energy Supply Systems — Overview

B1 Grid & Networks

175 GW
extra transmission capacity unlocked via AI

30–50%
reduction in grid fault outage duration

Key Technologies:

- Dynamic Line Rating (DLR)
- AI Fault Detection & Self-healing Grids
- VRE Forecasting & Curtailment Reduction
- Transmission Congestion Management

B2 Generation & Storage

22%/yr
growth in renewable energy for data centres

5–15%
power plant heat rate improvement via AI

Key Technologies:

- AI-optimised Power Plant Operations
- Battery State Estimation & Management
- AI for Nuclear Plant Monitoring
- Renewable Output Forecasting (solar/wind)

B3 Demand Response & Flexibility

VPPs
AI-aggregated Virtual Power Plants emerging

10–20%
peak demand reduction potential

Key Technologies:

- AI-managed Virtual Power Plants (VPPs)
- Smart Meter Analytics & Load Forecasting
- Data Centre Load Shifting (grid ally)
- Industrial Demand Response Automation

Source: IEA Energy and AI 2025 | Schneider Electric Grid Analysis 2026 | IEA World Energy Outlook 2025

Making AI Itself More Energy Efficient

100×	30×	40–60%	70–90%	25%
GPU efficiency gain 2008–2025 (perf/watt)	Google Ironwood TPU vs first-gen TPU	energy savings from model compression	energy reduction: edge vs cloud inference	savings from dynamic model selection

C1 AI HARDWARE EFFICIENCY

Purpose-built AI Chips (TPU/NPU) Google Ironwood TPU: 2× perf/watt vs prior gen. NPUs for edge inference at <1W.	DEPLOYED
Liquid Cooling for AI Accelerators Direct liquid cooling cuts PUE to <1.2. Standard in Tier-4 AI data centres now.	DEPLOYED
Advanced Packaging (3D stacking) HBM memory stacking cuts data movement energy. TSMC CoWoS, Intel Foveros.	DEPLOYED
Neuromorphic / Photonic Computing Intel Loihi 2, IBM NorthPole: 100× efficiency for specific tasks. Pre-commercial.	EMERGING
Optical Interconnects Silicon photonics replaces copper in data centres — dramatically lower energy/bit.	DEVELOPING

C2 GREEN AI — SOFTWARE & ALGORITHMS

Model Compression & Pruning 40–60% energy savings. Removes redundant neural connections. Widely adopted.	DEPLOYED
Quantisation (INT8, INT4) Edge inference 3–5× faster at 8-bit. Cuts energy without accuracy loss >5%.	DEPLOYED
Knowledge Distillation Train small 'student' model from large 'teacher'. ~70% size reduction, 90% accuracy retained.	DEPLOYED
Dynamic Model Selection Route queries to lightweight models when possible — up to 25% savings. Emerging.	DEVELOPING
Carbon-aware Workload Scheduling Training runs timed to match low-carbon grid periods. Google, Microsoft piloting.	DEVELOPING

Efficiency of AI hardware and algorithms is the critical swing factor — IEA High Efficiency Case = 20% lower data centre demand by 2035

Source: IEA Energy and AI 2025 | TPU Ironwood 2025 | Green AI Methods IJPREMS 2025 | CEUR Green AI 2026

Part 4
APEC EGEEC

Regional momentum, economy deep-dives & critical gaps

APEC: Strong Foundations — But Critical Gaps Remain

What APEC Already Has

- ✓ 45% energy intensity reduction goal by 2035 (vs. 2005 baseline)
- ✓ EGEEC mandate covering all end-use sectors including digital infrastructure
- ✓ 2025 APEC Energy Ministerial: 'AI-Driven Energy Innovation' as priority theme
- ✓ APERC 9th Edition Supply & Demand Outlook (2025) : economy-level baseline data
- ✓ Peer Review on Energy Efficiency (PREE) process : established framework
- ✓ APEC Workshop on AI for Future Energy (EWG_103_2025A) : May–July 2026
- ✓ 19 of 21 APEC economies signed UN Resolution on Safe, Secure & Trustworthy AI

⚠ The Stocktake Gaps

- ⚠ **Measurement:** No agreed APEC methodology for AI/DC energy intensity at economy level
- ⚠ **Disclosure:** Inconsistent reporting obligations across 21 economies — no common standard
- ⚠ **Targets:** No sector-specific AI energy efficiency sub-target within the 45% framework
- ⚠ **Cooperation:** Bilateral sharing exists, but no structured multilateral benchmarking
- ⚠ **Capacity:** Developing economies lack tools & data to assess their own AI energy footprint

Source: APEC PSU Policy Brief No. 67 Aug 2025 | APEC AI Initiative (ROK 2025) | APEC EGEEC 64th Meeting 2025

Where APEC Economies Stand on AI Energy Policy

Economy	Binding PUE	Data Centre Reporting	AI Energy Target	Renewable DC Target	National AI Policy
China	🟢	🟢	🟢	🟢	🟢
Singapore	🟢	🟢	⚪	🟢	🟢
Japan	🟢	🟢	⚪	⚪	🟢
USA	🔴	⚪	🔴	⚪	⚪
South Korea	⚪	⚪	⚪	⚪	🟢
Australia	🔴	🔴	🔴	⚪	🔴
India	🔴	🔴	🔴	⚪	🟢
Canada	🔴	⚪	🔴	🟢	🟢
Chinese Taipei	🔴	🔴	🔴	🔴	⚪
Mexico	🔴	🔴	🔴	🔴	🔴

🟢 Yes / Binding ⚪ Partial / Voluntary 🔴 No / Not yet

Source: IEA Energy and AI 2025 | MIIT Green DC Program | IMDA Green DC Standards | METI 7th Energy Plan 2025

Part 5

Call to Action

Four decisions for EGEEC to make today

EGEEC to ACTION

01 Establish AI Energy Efficiency Sub-Track

Formalise AI energy efficiency as a standing agenda item within EGEEC, with a designated rapporteur economy and annual reporting cycle.

→ **Decision: Agree in principle**

02 Develop a Measurement Framework

Commission a joint EGEEC–APERC technical paper on AI/data centre energy intensity metrics aligned with IEA methodology and covering all 9 technology clusters.

→ **Decision: Mandate & timeline**

03 Economy Self-Assessment (Stocktake Survey)

Circulate a structured survey to all 21 member economies covering DC capacity, existing policies, reporting obligations, and voluntary targets. Basis for 2027 progress review.

→ **Decision: Approve survey design**

04 Convene APEC Projects and Capacity Building Workshops

Propose a focused EGEEC workshop on AI Energy Efficiency alongside a future EWG meeting, with IEA and private sector co-presenters. Build on EWG_103_2025A.

→ **Decision: Host economy volunteer**

Source: APEC EGEEC Presentation Planning Document | APEC AI Initiative (ROK, 2025)

Part 6 Discussion

Data centre demand will double by 2030. The decisions made in the next 18 months on grid investment, renewable energy procurement, and AI efficiency standards will determine whether AI becomes a climate accelerant or a climate solution.

> ***"A unified APEC framework for AI energy efficiency is not optional — it is essential."***

EGEEC's ACTIONS:

1 Establish AI Energy Efficiency Sub-Track

2 Develop a Measurement Framework

3 Economy Self-Assessment Survey

4 Convene APEC Projects and Capacity Building Workshops

APEC Expert Group on Energy Efficiency and Conservation (EGEEC)

www.apec.org/egeec

Source: IEA Energy and AI 2025 | APEC EGEEC Working Group | APEC PSU Policy Brief No. 67