CHP – A Key Enabling Technology for Ensuring Data Centre Development is Efficient, Cost-Effective and Resilient

Introduction

Project Overview

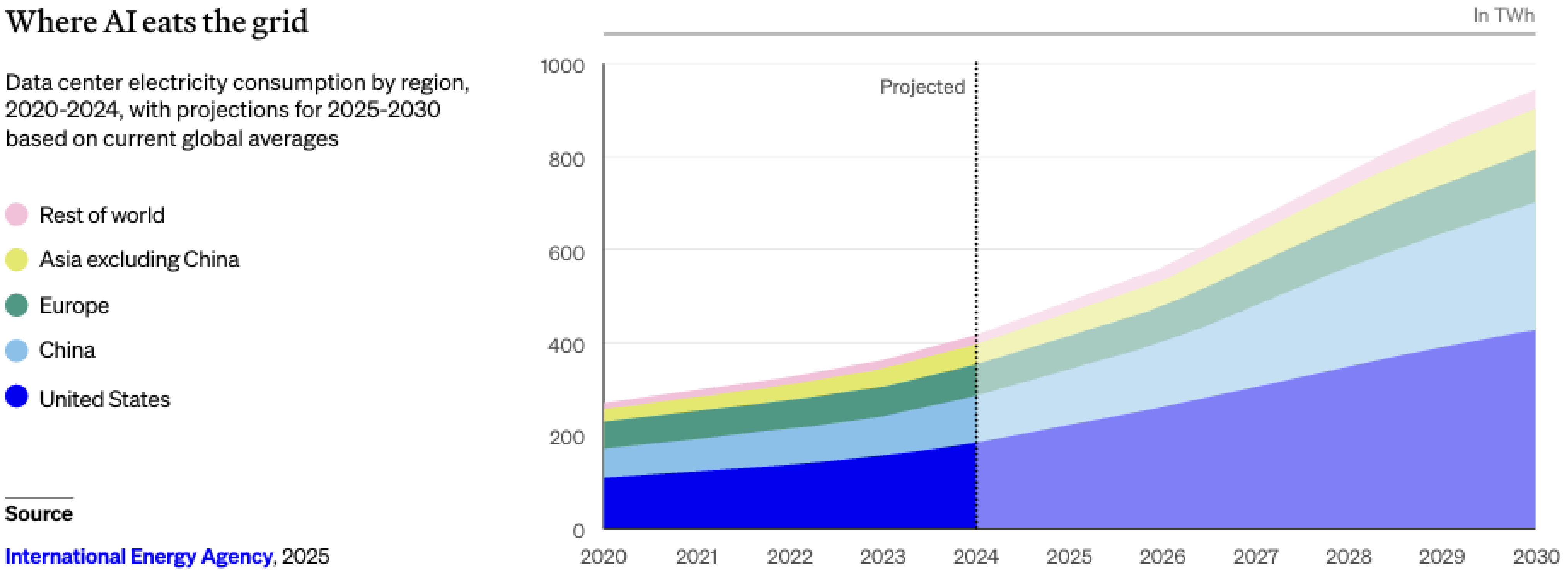
- Growing DC loads + AI cooling intensity require efficient, resilient power solutions
- Grid delays (24–48 months) increase the need for on-site generation
- CHP provides combined power + cooling with high efficiency
- Reduces grid dependence and accelerates time-to-power
- Supports water-efficient cooling via absorption chillers
- Data centre waste heat reuse
- Proven globally from 100 kW to multi-MW deployments

Objective

Shows how CHP enables efficient, cost-effective, and resilient data centre development

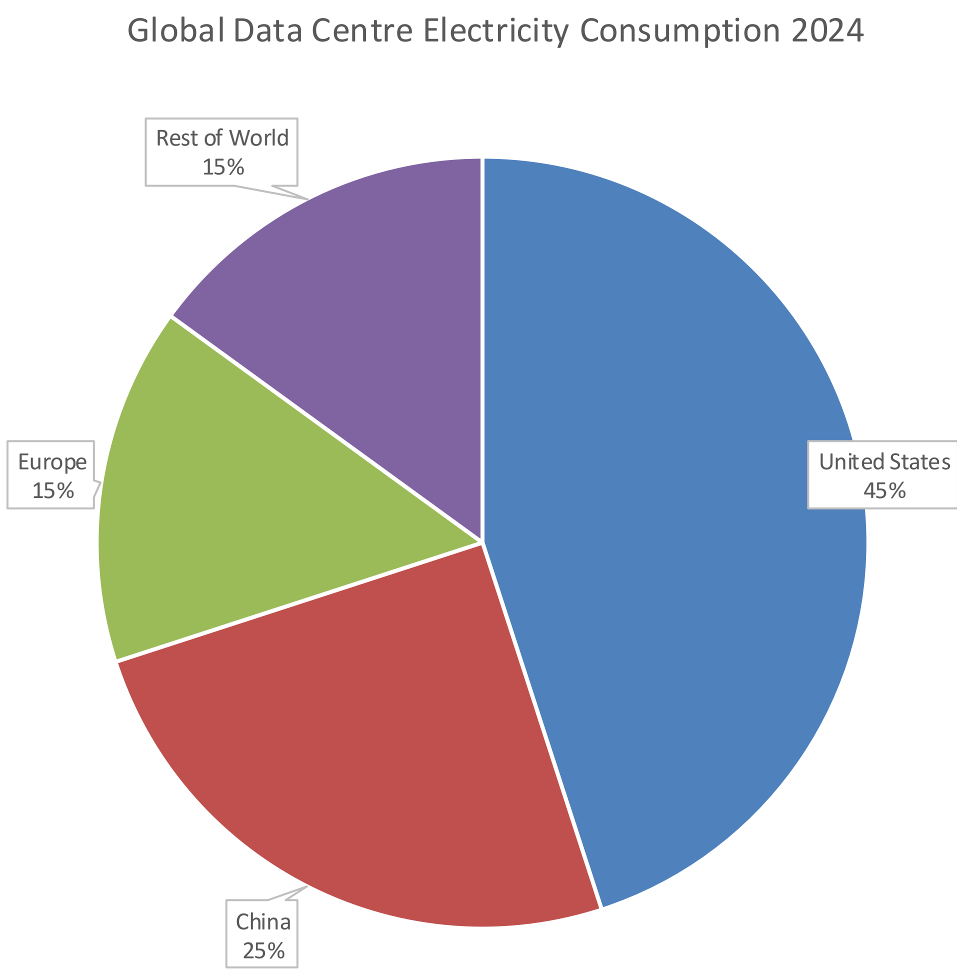
The Data-Centre Energy Challenge

- Global data centre energy demand projected to reach 800–1,000 TWh by 2030
- AI clusters driving 10–30 times higher cooling density
- Grid connection delays commonly 24–48 months
- Need for local, efficient, resilient power solutions



AI Data Centre Growth & Challenges

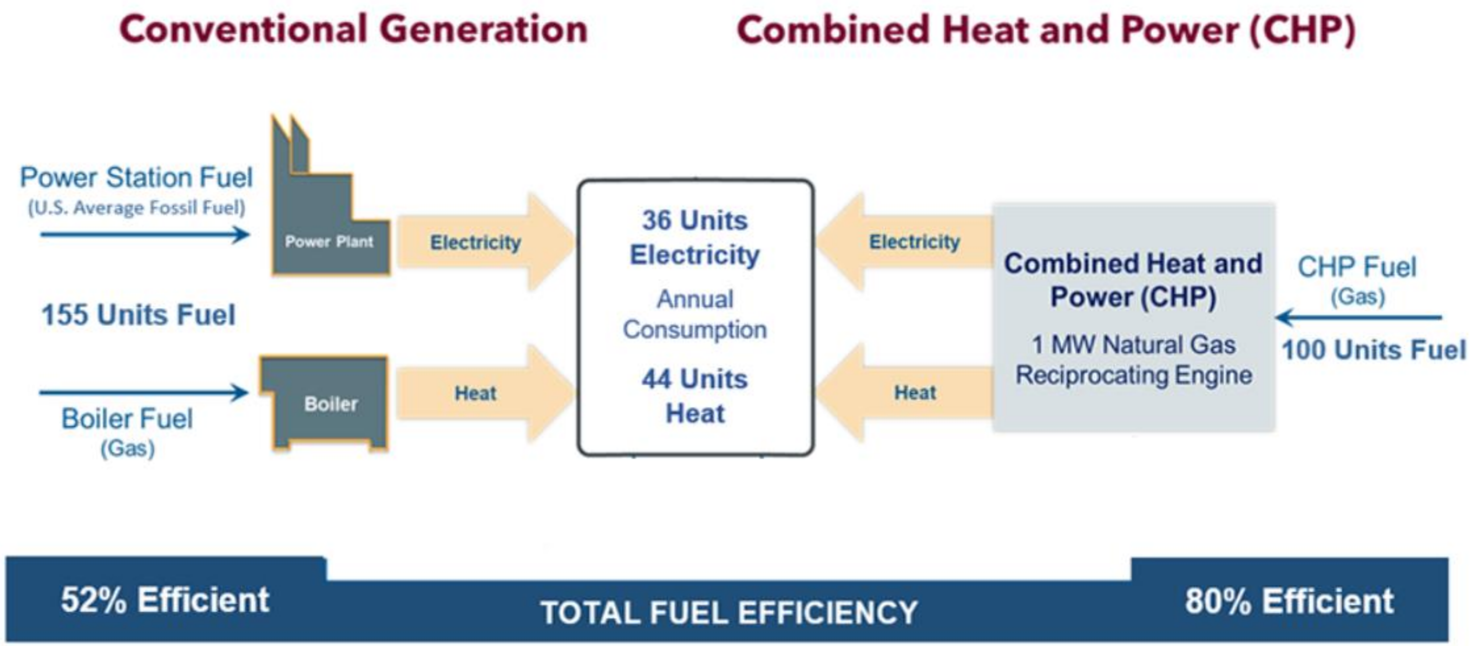
- Massive GPU clusters → extreme electricity + cooling needs.
- Ramping = MW-scale changes in seconds.
- Cooling now ≈ 40–60% of facility load for AI-scale DCs.
- Grid connection delays (3–10 years in some regions).
- Shift toward hybrid on-site generation.



Why CHP Matters Now

- CHP provides **power + cooling** with high efficiency
- Reduces dependency on congested grid nodes
- Offers **bridge capacity** while waiting for grid reinforcements
- Strong fit for AI-driven thermal loads

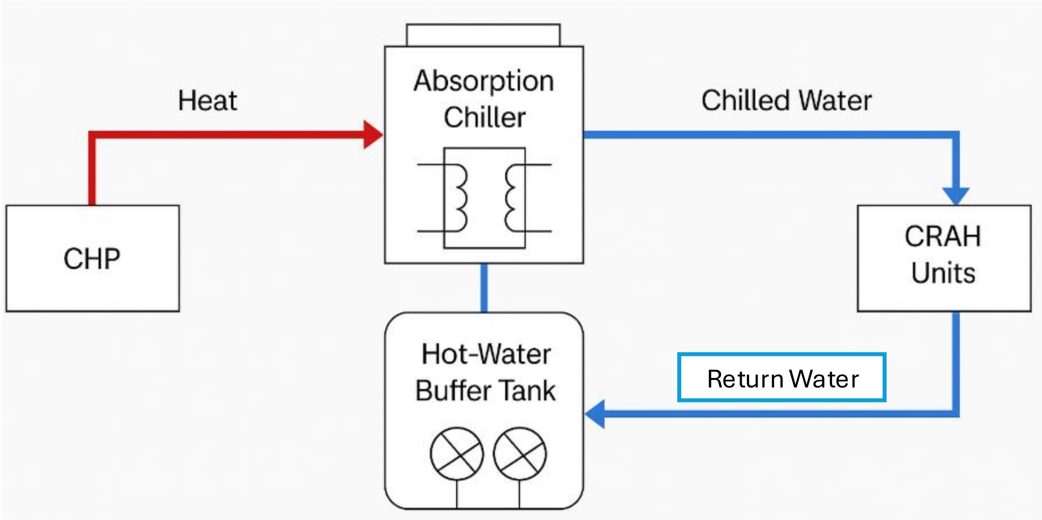
Conventional Generation vs. CHP: Overall Efficiency



Source: US Environmental Protection Agency

CHP for AI-Driven Cooling Loads

- AI/GPU racks create rapid thermal spikes (idle → full load in seconds).
- Absorption chillers use engine waste heat, providing stable cooling output with slower ramp-up, smoothing GPU peaks.
- Thermal storage (hot-water/chilled-water tanks) absorbs sudden load changes and prevents chiller short-cycling.
- Reduced mechanical compressor use lowers peak water usage effectiveness (WUE) and avoids electrical hot-day cooling penalties.



Waste-Heat Reuse: Unlocking Extra Value from CHP/CCHP

- Data centres produce large, continuous, 30–60°C waste heat.
- CHP/CCHP raises this heat to usable levels (65–90°C) via heat pumps.
- Cities like Stockholm and Helsinki already pay operators for exported heat.
- Heat export can improve:
  - ERF/ERE metrics
  - Business case (revenue stream)
  - Planning approval
- Example:
  - In Helsinki, Telia and Helen are expanding their interface so the datacentre can provide heat for ~14,000 apartments now, with plans to double that—a tangible proof that DC heat is an urban resource

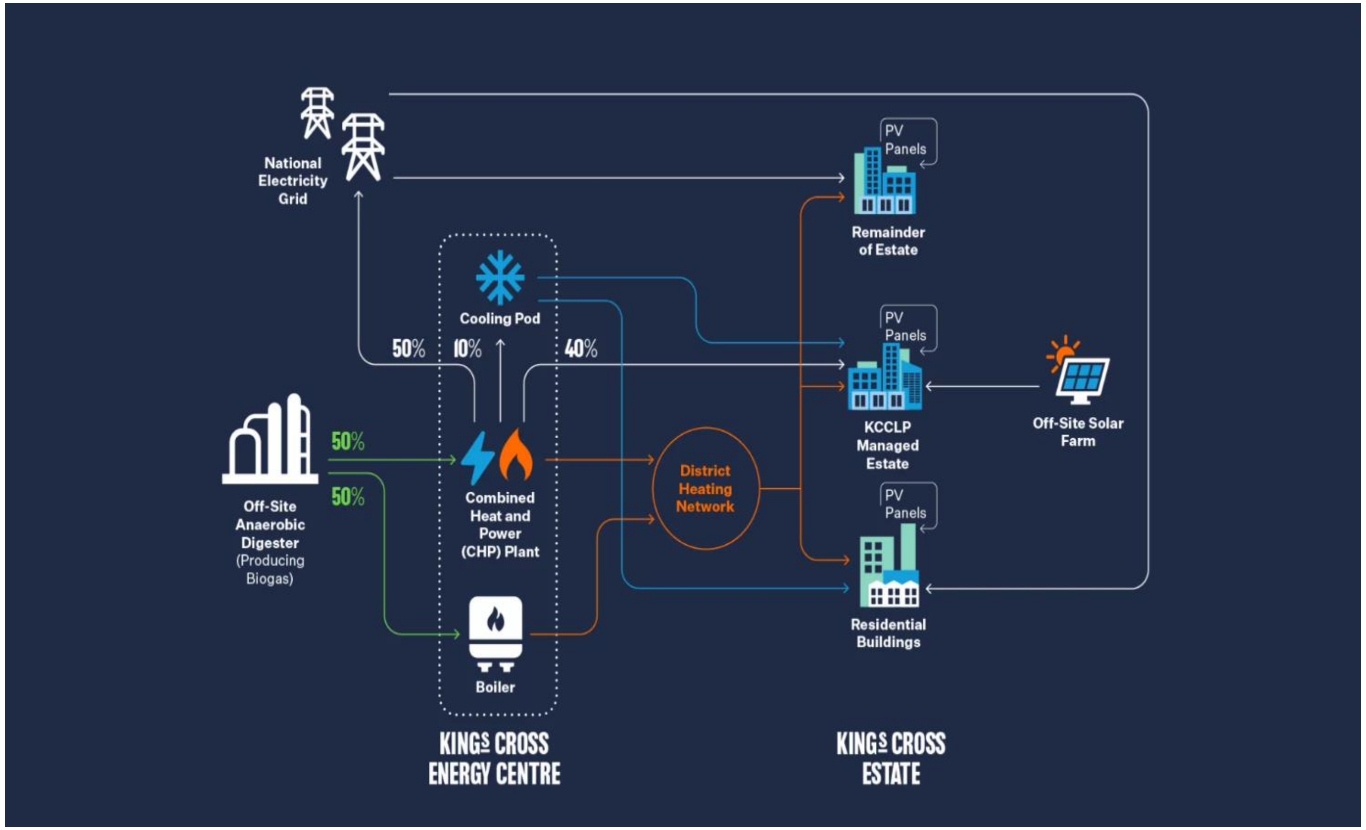


Figure: District Heating from CHP Plant
Source: KingsCross

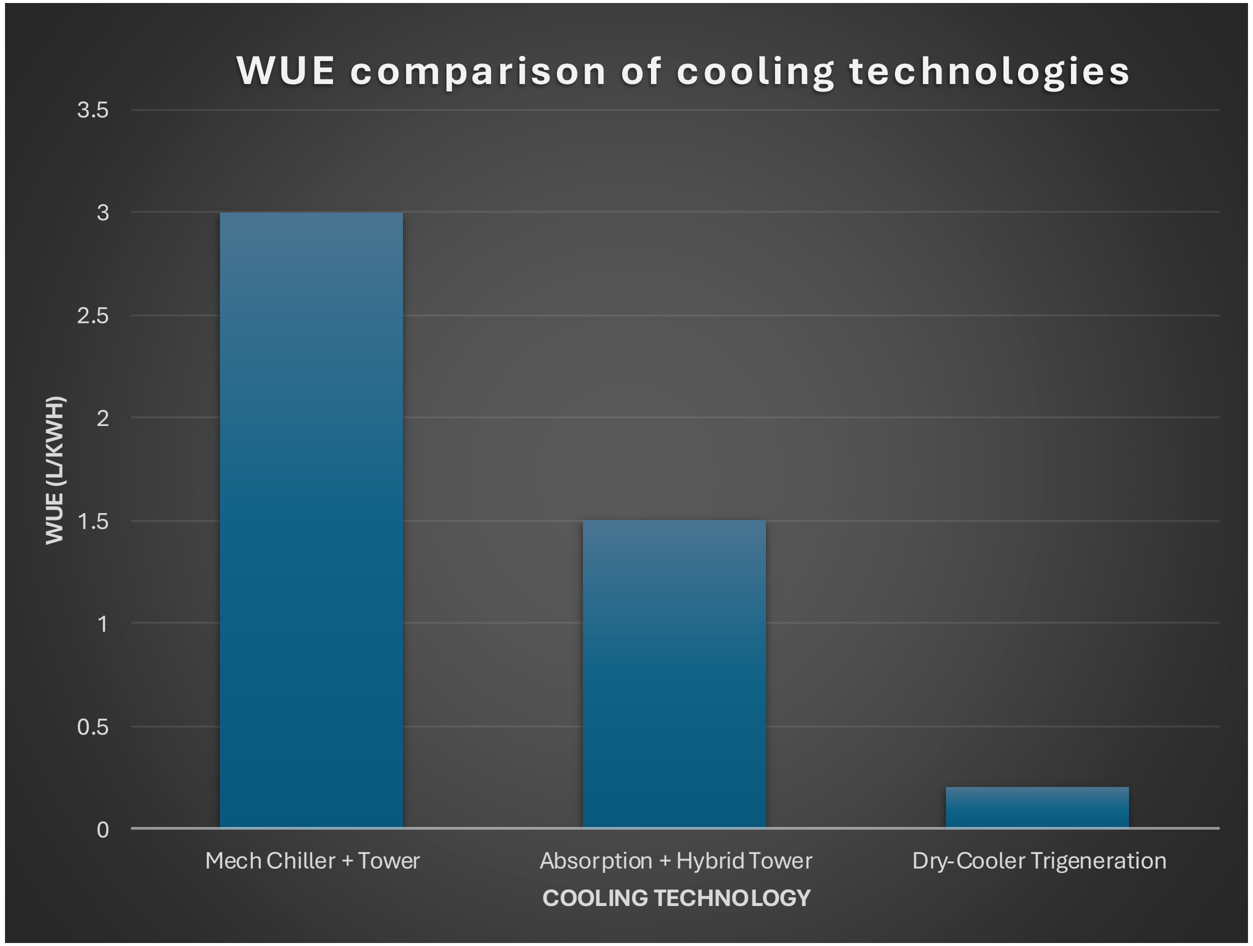
Trigeneration
Water-Use Perception Challenge

Cooling towers seen as "high water consumption"

Data centres already face WUE scrutiny

Misunderstood net water balance

Trigeneration often **reduces**, not increases, total water use



How CHP Enables Cost Efficiency

TOTAL SYSTEM EFFICIENCY: **70–85%**

LOWER COOLING ENERGY (ABSORPTION CYCLE)

10–20% LOWER OPEX FOR HIGH-LOAD AI SITES

LOWER GRID-IMPORTED KWH REDUCES DEMAND CHARGES

Some Proven CHP Deployments Worldwide

- **Citi Missouri (US):** 1.2 MW microturbine CCHP
- **Citi London (UK):** Combined cooling & power system supporting office + IT loads
- **Chevron California:** Campus trigeneration
- **NEXTDC Australia:** 200–400 kW trigeneration
- **Keppel Singapore:** Large-scale absorption + hybrid towers
- **Johannesburg:** 3.5 MW trigeneration

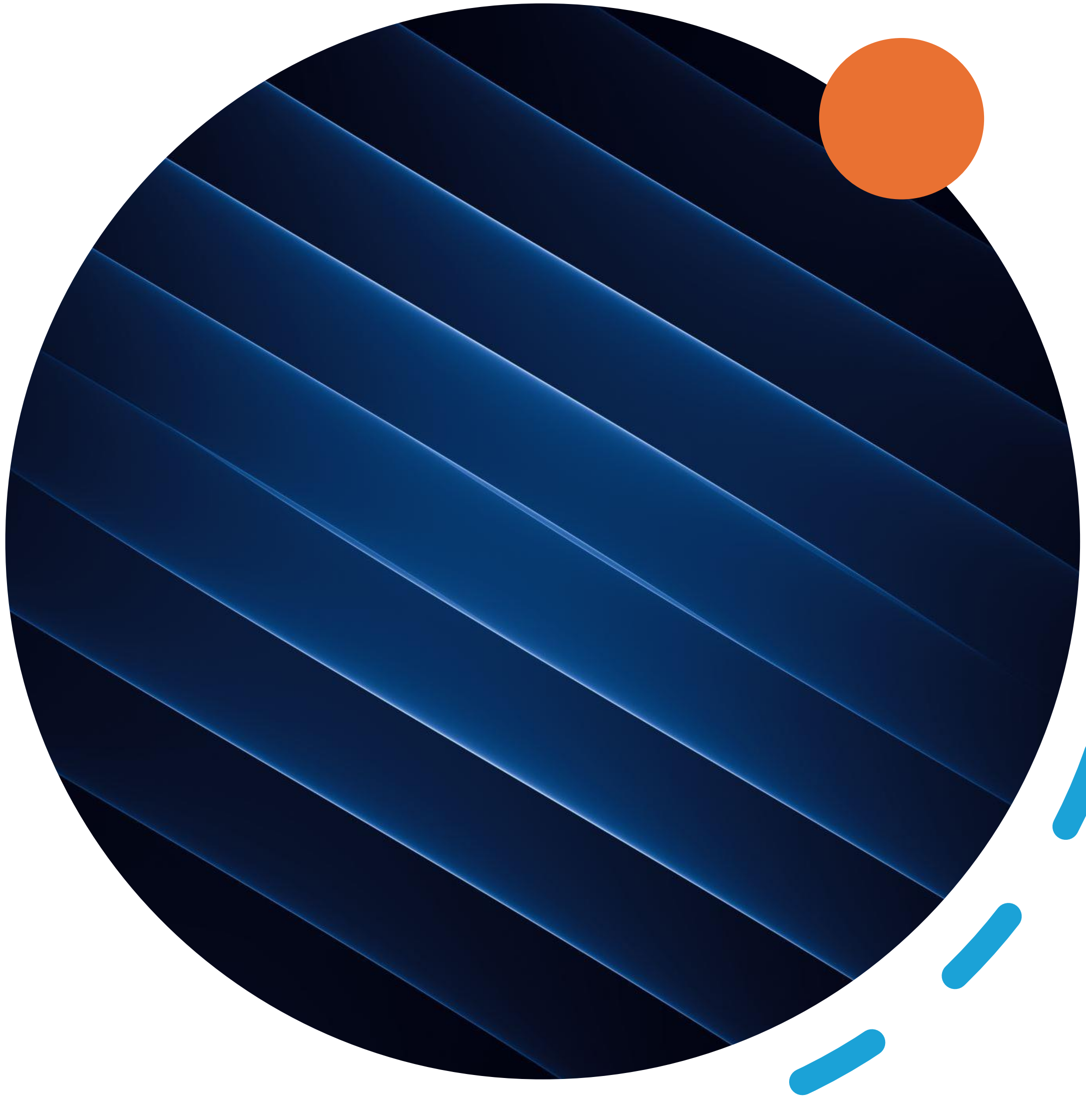
Economic Advantage: Payback Periods

US: **3–5 years** capex recovery

Europe: **5–7 years**

Faster payback when:

- Grid tariffs high
- Cooling load high
- Gas prices stable
- Avoided capex on chillers/towers



Global Context: US, Asia-Pacific, EU

- US = largest & fastest growing Data Centre market, driven by hyperscale + AI clusters and strong gas infrastructure (CHP-ready).
- APAC = highest cooling intensity, making CCHP attractive for high-heat, high-humidity environments (Singapore, Australia, Japan).
- Middle East & Africa = water-sensitive regions, increasing interest in hybrid/dry CHP cooling for resilience.
- EU = mature, efficiency-regulated market with strong decarbonisation frameworks and interest in heat-recovery integration.

CHP as a Bridging Power Solution

- Grid connection delays of 36–48 months are now common for hyperscale and AI expansions.
- CHP can be deployed in 12–18 months, enabling immediate capacity while waiting for grid upgrades.
- Reduces strain on congested substations, freeing up headroom for IT load.
- Ensures near-term power and cooling resilience so AI/ML clusters can go live without delay.
- Can later transition to standby generation or peak-shaving mode once the grid reinforcement arrives.

Space Constraints & Mitigation

Why Space Is a Challenge

- Urban/coastal hyperscale sites often have zero spare land
- Many sites use two-storey mechanical plant decks already full
- Colocation operators often have strict leasable whitespace ratios
- Absorption chillers and cooling towers cannot easily be retrofitted indoors

Mitigation Approaches

- Rooftop trigeneration (Dubai Jebel Ali)
- Modular skids with compression chillers + absorption chillers combined
- Vertical plantrooms
- Dry coolers to avoid water-use permitting challenges
- Underground buffer tanks (used in Singapore & Tokyo)

Component	Typical Footprint
Gas engine (2–10 MW)	60–120 m^2
Absorption chiller (1–2 MW thermal)	40–80 m^2
Cooling tower or hybrid cooler	60–150 m^2
Hot-water buffer tank	60–150 m^2
ORC module (optional)	20–50 m^2

Examples

- NEXTDC M2 (Melbourne) — compact micro-CCHP plant.
- Jebel Ali Industrial Campus (UAE) — rooftop CCHP.
- London Canary Wharf (UK) — CCP installed in constrained basement plantroom.

Data Centre Type Segmentation

CHP/CCHP suitability varies by data-centre class because each type has distinct thermal behaviour, ambient exposure, and redundancy expectations:

- **Enterprise (0.5–5 MW)**
  - I. Cooling profile: **Stable, low-density loads** with moderate thermal variation.
  - II. CCHP fit: **Excellent** — micro-CHP and rooftop units efficiently meet heating/cooling needs for HQ and campus sites.
- **Edge (50–500 kW)**
  - I. Cooling profile: **Small, remote sites** exposed to high ambient temperatures.
  - II. CCHP fit: **Very High** — micro-CCHP provides resilience where grid reliability is weak or unavailable.
- **Colocation (5–30 MW)**
  - I. Cooling profile: **Mixed tenant loads**, predictable but with load diversity.
  - II. CCHP fit: **Medium** — steady baseload cooling makes CCHP effective, though space constraints can limit adoption.
- **Hyperscale (30–500 MW and more)**
  - I. Cooling profile: **Largest thermal I/O**, often including **GPU racks and liquid cooling**.
  - II. CCHP fit: **High** — trigeneration significantly reduces peak cooling and grid draw for AI/ML-intensive campuses.

Recent press
Iberdrola has created a new joint venture, Echelon Iberdrola Digital Infra, alongside Echelon Data Centres, which will invest more than €2 billion in large-scale data centre developments across Spain. (source Enlit World)

Microsoft CEO Satya Nadella warned that the vast amount of energy consumed by artificial intelligence could turn people against the industry — and that AI and tech companies need to earn public trust to turn things around.

While downplaying the immediate impact of AI on power consumption, Nadella admitted that the rapid growth of data centers is "putting a lot of pressure" on the electric grid — and that the public will accept that pressure only if it "results in economic growth that is broad-spread in the economy."

Key Takeaways

- CHP delivers efficiency, cost savings, resilience
- Ideal match for AI-driven thermal profiles
- Solves grid-connection delays
- Reduces net cooling water usage
- Scales from 100 kW to multi-MW to GW

Thank You and Questions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