Optimizing Computational Infrastructure for Data Center Deployment in Cyprus
Integrated Modeling of Grid–Scale Data Centers and Investment Returns Outlook

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Abstract

This outlook presents a comprehensive feasibility assessment of data center computational infrastructure for Cyprus, based on integrated techno–economic modeling of multiple configurations (5–100 MW IT capacity). The analysis evaluates grid integration, cooling systems, computational efficiency, and financial viability against Cyprus' renewable energy transition and digital economy objectives. Our latest modeling reveals:

- **Medium–sized facility (20 MW)** achieves 2.1 year payback with €M35.9 net present value over 10 years
- **Extra Large–sized facility (100 MW)** achieves 1.8 year payback with €M142.5 net present value over 10 years
- **Grid feasibility confirmed** for all configurations $\leq$ 100 MW IT load (max 8.79% of national grid capacity)
- **Water efficiency** with 0.35 million m^3/year for 20 MW facility through optimized cooling
- **Coastal seawater cooling** provides 10–15% efficiency advantage over inland air–cooled alternatives
- **1.8–4.5 year payback horizon** across feasible configurations under realistic market assumptions

Computational Model Overview

The feasibility analysis integrates:

- **Infrastructure layer:** Cyprus electricity grid capacity mapping (both conventional and renewable), fiber optic connectivity (98% coverage), and undersea cable capacity (6 international landing stations; 2.0 Tbps bandwidth)
- **Computational sizing:** Four facility configurations (Small 5 MW, Medium 20 MW, Large 50 MW, Extra–Large 100 MW IT load)
- **Cooling and efficiency:** Power Usage Effectiveness modeling (data center energy efficiency metric that compares total facility energy use to the energy used directly by IT equipment), chiller power calculations, seawater *vs* air–cooling trade–offs
- **Economic framework:** Capital expenditure, multi–component operating costs (electricity, staffing, maintenance, cooling water), revenue modeling, and financial metrics (NPV, payback, IRR)
- **Sensitivity and break–even analysis:** Six key variables tested across realistic ranges to identify critical thresholds.

Key Results

Computational Capacity

The modeling confirms that Cyprus' grid infrastructure can accommodate data center facilities without reinforcement up to approximately 100 MW IT load:

Data Center Feasibility

Configuration	IT Load (MW)	Total Power (MW)	Grid Impact (%)	Feasible
Small	5	6.5	0.44%	✓ Yes
Medium	20	26.0	1.76%	✓ Yes
Large	50	65.0	4.40%	✓ Yes
Extra–Large	100	130.0	8.79%	✓ Yes

All analyzed configurations remain well within the 20% of grid capacity (295 MW facility equivalent) feasibility threshold constraint, indicating high scalability potential.

Energy Consumption and Efficiency

Annual energy use scales linearly with IT load and assumes a modern efficient facility, including cooling, power distribution, and auxiliary systems. This corresponds to continuous 24/7 operation and defines both the electricity demand and associated cooling water requirements for each sizing option:

Data Center Feasibility

Configuration	Annual Energy (GWh/year)	PUE	Water Usage (Mm^3/year)	Water Cost (€M/year)
Small (5 MW)	56.9	1.25	0.09	0.09
Medium (20 MW)	227.8	1.25	0.35	0.35
Large (50 MW)	569.4	1.25	0.87	0.87
Extra–Large (100 MW)	1,138.8	1.25	1.74	1.74

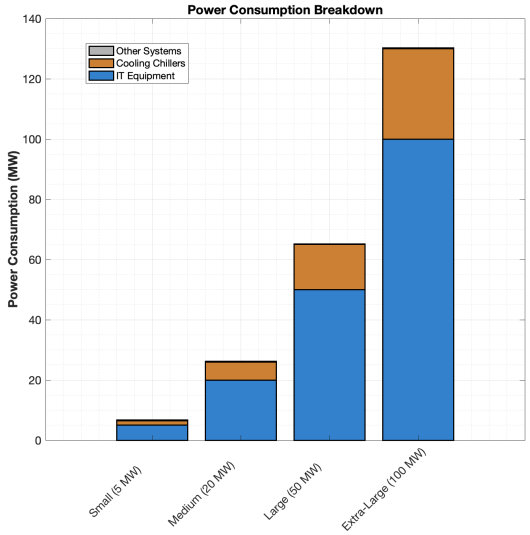
Location Analysis

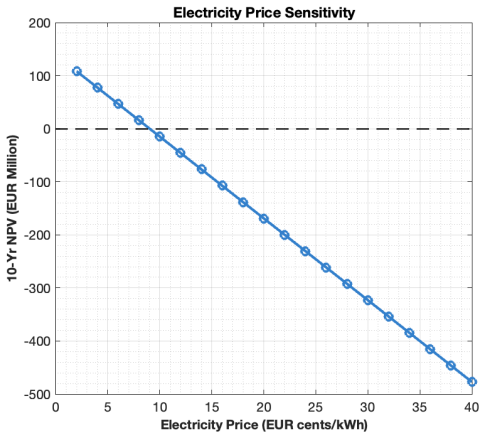
Coastal sites with direct seawater access can reduce cooling energy use by roughly 10–15%, improving effective Power Usage Effectiveness (PUE) by 5–10% relative to inland, air-cooled locations and strengthening both efficiency and environmental performance. The location analysis scoring model combines grid connection distance, fiber distance, and qualitative cooling advantages into a single composite index.

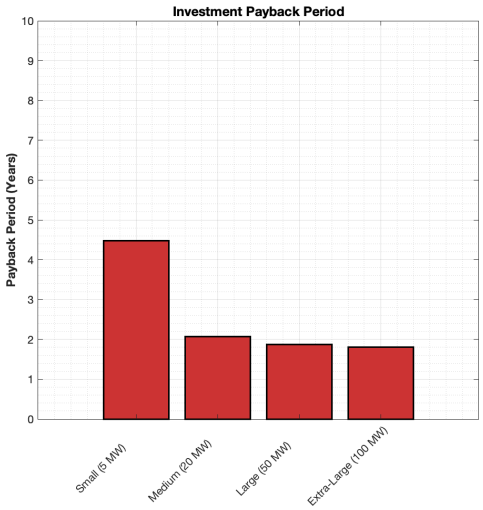
Grid, Fiber and Cooling Suitability by Location

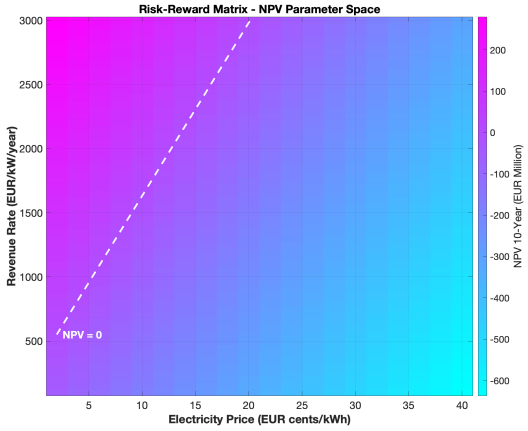
Location	Grid Distance (km)	Fiber Distance (km)	Cooling Advantage	Overall Score
Nicosia (Capital)	5	3	Limited	7.83
Larnaca (Port City)	15	2	High Seawater	8.93
Limassol (Port City)	40	5	High Seawater	6.77
Paphos (West Coast)	60	1	Excellent Seawater	7.16

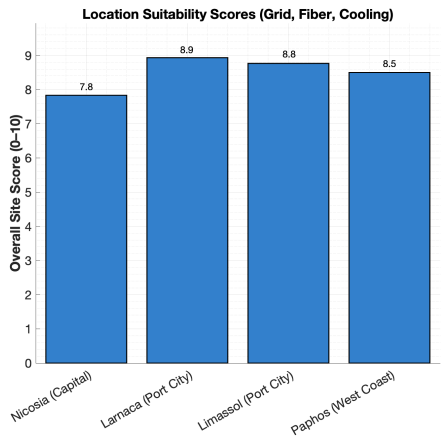
Detailed Results











Economic Implications

- Investment returns scale linearly with data center size
- IRR remains constant across medium to extra large configurations due to uniform cost structure
- Larger deployments generate proportionally higher absolute returns, reducing financing risk for institutional investors.

Investment Requirements and Returns

Metric	Unit	Small	Medium	Large	Extra–Large
CAPEX	€M	4.0	16.0	40.0	80.0
Annual Revenue	€M	7.1	28.5	71.3	142.5
Annual OPEX	€M	6.2	20.8	49.8	98.2
Annual Profit	€M	0.9	7.7	21.4	44.2
Payback Period	years	4.5	2.1	1.9	1.8
10–year NPV	€M	2.0	35.9	103.8	217.0
IRR	%	19	25	25	25

Policy Recommendations

Based on computational feasibility modeling, we recommend:

1. **Reduction of RES curtailments:** Data center demand can absorb surplus renewable generation, reducing curtailments while supporting competitive green electricity prices
2. **Geographic hub positioning:** Strategic location for low-latency access across Europe, the Middle East, and Africa, supporting regional AI and cloud services
3. **Fiber connectivity:** Six submarine cables and three landing stations provide strong redundancy and reliable international connectivity
4. **Competitive costs:** CAPEX of 800€/kW and annual OPEX of €M20.8 for a 20 MW facility remain attractive relative to Western Europe
5. **Stable framework:** EU regulation, government support, and a reliable operating environment reduce investment risk
6. **Launch 20 MW data center facility in 2027–2028** then expand to 50–100 MW+ regional hub configuration by 2030–2031 capturing premium workload pricing (AI and regional cloud services) and positioning Cyprus as Mediterranean computational gateway for Europe–Middle East–Africa markets.

Conclusion

Cyprus' computational infrastructure opportunity is technically feasible, economically viable, and strategically aligned with European digital economy objectives. The modeling confirms:

- **Capacity:** Grid infrastructure accommodates 50–100 MW+ data center facilities without major reinforcement; all tested configurations remain below 9% grid impact threshold
- **Efficiency:** Modern cooling systems (PUE 1.25–1.30) combined with Mediterranean seawater access achieve competitive efficiency metrics relative to Northern European hubs
- **Economics:** Facilities achieve 2–year payback, €M35.9–219.0 net present value over 10 years, and 25% internal rate of return under medium–to–extra large scenarios
- **Strategic value:** Geographic positioning of Cyprus as regional hub, renewable energy integration, and fiber connectivity create sustainable competitive advantage for emerging AI and cloud services markets.