Caribbean Green Data Centre Initiative

Harnessing Waste Heat, Solar Energy and Seawater for Sustainable Power
Concept Proposal by OPEXA Limited

Executive Summary

The Caribbean faces high electricity costs, grid instability and climate vulnerability. Data centres, which are essential for digital growth, consume large amounts of energy and emit significant waste heat. This proposal outlines a hybrid energy system that combines:

- Recovery of server waste heat
- Concentrated solar thermal energy
- Deep seawater cooling
- Thermophotovoltaic (TPV) electricity generation

The aim is to transform data centres into clean energy contributors, reducing operational costs and supporting regional energy independence.

Why the Caribbean?

- Electricity costs range from **$0.30 to $0.40 per kWh**, compared with **$0.10 to $0.15 per kWh** in mainland United States
    - *Sources:*
        - CARILEC Tariff Survey (Dec 2022): carilec.org
        - World Population Review (2025): worldpopulationreview.com
- The region benefits from year-round sunlight, cold deep seawater (4 to 6°C) and consistent trade winds
- Servers typically discard **40 to 60 percent** of input energy as heat, which is currently wasted
    - *Source:* Uptime Institute, 2023: uptimeinstitute.com

This hybrid system captures and amplifies waste heat using solar concentrators. The heat is converted into electricity via TPV cells, with seawater cooling used to maximise efficiency.

How the System Works

Process Overview:

1. **Waste Heat Capture** – Liquid cooling loops extract heat (approximately 50 to 60°C) from server racks
2. **Solar Concentration** – Heliostats or parabolic dishes focus sunlight onto a high-temperature emitter

3. **Infrared Emission** – The emitter reaches around 1100°C, producing radiation tuned for TPV conversion
4. **TPV Conversion** – Infrared radiation is converted into electricity with 20 to 40 percent efficiency
5. **Seawater Cooling** – Cold seawater condenses excess heat, improving performance
6. **Energy Storage** – Batteries smooth the output and surplus power is used to offset demand or exported to the grid

Commercial Viability

- A **10 MW data centre** could generate **1.5 MW** from the hybrid system
- Annual savings estimated at **$3.9 million** at $0.30 per kWh
- Payback period of **3 to 5 years** for new builds with incentives

Additional Benefits:

- Reduces reliance on diesel generators and unstable grids
- Enables night-time operation using molten salt thermal storage
- Supports climate pledges and UN Sustainable Development Goals
- Scalable to other coastal regions including Mediterranean islands and Pacific nations

Challenges and Mitigation Strategies

Challenge	Mitigation Strategy
High Initial Cost	Phased rollout, green bonds, climate grants and public-private partnerships
Technical Complexity	Collaboration with TPV innovators such as MIT and Antora Energy
Hurricane Risk	Modular and hardened infrastructure, submerged seawater pipes
Intermittent Sunlight	Thermal storage using molten salts for extended operation
Marine Environmental Impact	Closed-loop cooling and IUCN-compliant intake systems

Call to Action

To advance this initiative, the following steps are proposed:

1. Identify a suitable pilot site with ocean access
2. Commission a feasibility study supported by multilateral development banks such as the IDB
3. Introduce incentives including tax holidays and duty waivers for renewable technologies
4. Develop local expertise in TPV and solar thermal systems through targeted training programmes

Conclusion

This initiative offers a reimagining of data centres as integrated clean energy hubs. By drawing on the Caribbean's natural assets, it outlines a potential pathway toward sustainable development, energy resilience, and climate leadership. Presented as a concept proposal, it is intended to encourage dialogue and invite collaborative exploration of climate-smart infrastructure and regional innovation.

Appendix: ROI Snapshot

- Capital cost: $20 to $30 million
- Annual savings: $3.9 million
- Payback period: 5 to 7 years (conservative) or 3 to 5 years with incentives

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