Sea Water Air Conditioning for Coastal Data & Urban Loads

Florida OTEC plantships moored in the Gulf Stream export power to the grid and pipe post-turbine cold water ashore to a SWAC district loop — cooling downtown Miami carrier hotels, edge data centers, and high-rises at a fraction of mechanical-chiller energy.

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CONCEPTUAL ENGINEERING BRIEF

Figures, performance estimates, and projections are illustrative and forward-looking; they describe a proposed system architecture and do not represent built, measured, or independently verified results.

ABSTRACT

Sea Water Air Conditioning (SWAC) uses naturally cold deep seawater as the chilled-water source for a district cooling network, displacing the electrically intensive vapour-compression chillers that dominate building energy in hot, humid coastal cities. In the TROIB Southeast Florida zone, utility OTEC plantships are moored 3–5 mi offshore in the Gulf Stream; they export firm power to the FPL grid through a high-voltage subsea cable, and their *post-turbine* cold water (already drawn from depth and warmed only to ≈7–10 °C) is piped to a mainland SWAC district loop serving downtown Miami carrier hotels, edge data centers, and high-rise HVAC. Because SWAC replaces compressor work with pumping work, cooling energy intensity falls from ≈0.6–0.9 kW/ton for conventional chillers to ≈0.1–0.2 kW/ton. This brief presents the loop heat-exchange basis, the tons-of-refrigeration accounting, and the district load-growth trajectory to a Year-10 offset of ≈250 MW of urban cooling alongside 600 MW of direct-to-grid power.

1 Plantship and Grid Architecture

The Florida zone uses purpose-moored OTEC plantships rather than re-used rigs. Stationed 3–5 mi offshore over the Florida Straits, each plantship sits in the Gulf Stream where warm surface water is reliably ≈25 °C and a cold-water pipe reaches ≈4 °C deep water. Two products leave the plantship: **electricity**, exported through a high-voltage subsea cable to a Florida Power & Light (FPL) shore station, and **cold water**, whose remaining thermal capacity is harvested ashore for district cooling rather than discharged.

This dual-use is the efficiency multiplier of the Florida zone. The cold seawater has already been pumped from depth — the dominant OTEC parasitic — so using its residual chill for air conditioning is nearly free incremental value. After passing the OTEC condenser the water has warmed only to roughly 7–10 °C, still far colder than any chilled-water loop a mechanical plant would produce.

2 The SWAC District Loop

Cold seawater is never circulated through customer buildings directly — corrosion and biofouling forbid it. Instead, a shoreside **titanium plate heat exchanger** transfers cold from the seawater stream to a closed freshwater district loop. That district loop distributes chilled water through insulated mains to building cooling stations, where a second heat exchanger serves the in-building HVAC. The seawater, now warmed, is returned to a benign mixing depth offshore.

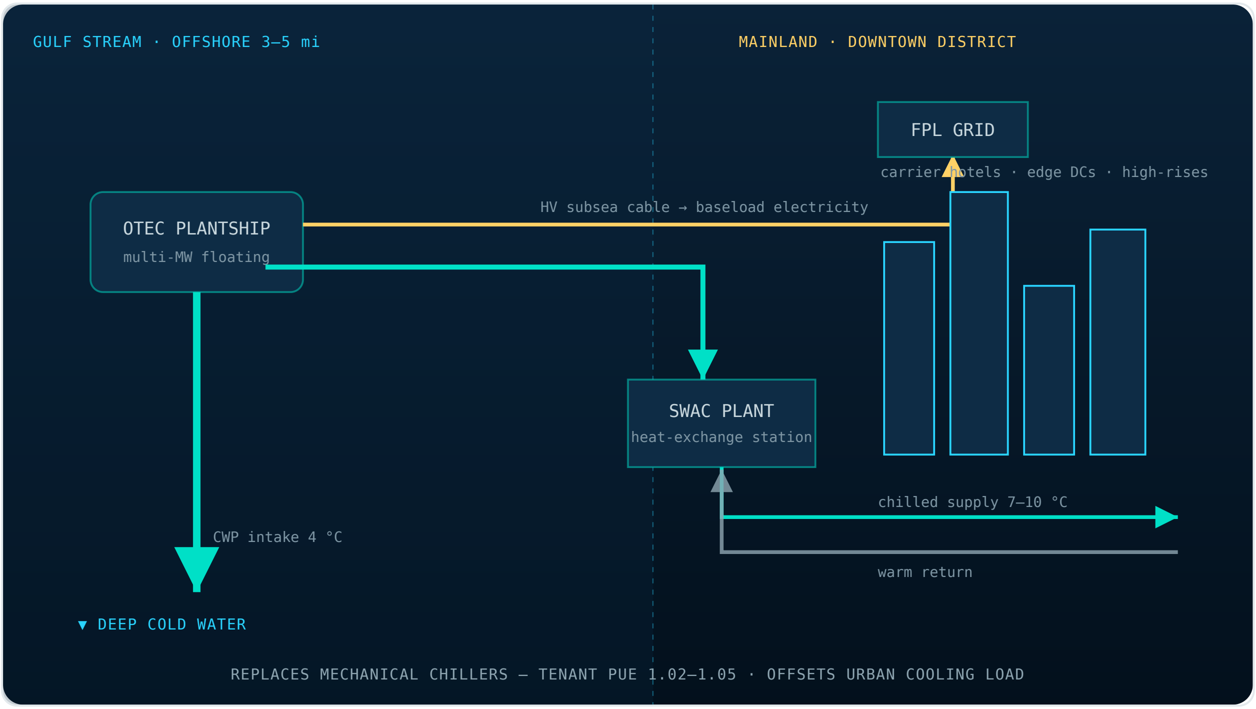

FIG 1 — Florida SWAC district-cooling loop. An offshore OTEC plantship exports power via HV subsea cable and sends post-turbine cold water (≈7–10 °C) ashore. A titanium plate heat exchanger couples the seawater to a closed freshwater district loop that cools downtown Miami carrier hotels, edge data centers, and high-rises, replacing mechanical chillers.

3 Energy: Compressors vs Pumps

A conventional building chiller runs a vapour-compression cycle: a compressor lifts heat from chilled water up to a hot outdoor condenser. That compressor is the energy cost, conventionally expressed in kilowatts of electricity per **ton of refrigeration** (1 ton = 3.517 kW of cooling). Efficient water-cooled chillers run ≈0.6 kW/ton; older or air-cooled units reach 0.9 kW/ton or worse.

SWAC has *no compressor*. The cold already exists in the deep sea; the only electrical cost is pumping seawater and circulating the district loop — on the order of **0.1–0.2 kW/ton**. The energy reduction is therefore roughly 4–8×, as summarized in Table 1.

TABLE 1 — Illustrative cooling energy intensity: conventional chillers vs SWAC.

System	Mechanism	Energy intensity	Relative
Air-cooled chiller	Vapour compression	~0.9 kW/ton	1.0×
Water-cooled chiller	Vapour compression	~0.6 kW/ton	0.67×
TROIB SWAC loop	Pumping only	~0.1–0.2 kW/ton	0.11–0.22×

3.517 kW
1 TON OF REFRIGERATION

~0.15 kW/ton
SWAC PUMPING INTENSITY

250 MW
URBAN COOLING OFFSET · YR 10

600 MW
DIRECT-TO-GRID POWER · YR 10

4 Loop Heat-Exchange Sizing

The cooling capacity a SWAC loop can deliver is fixed by the seawater flow it can move and the temperature rise allowed across the shoreside exchanger:

$$Q = \dot{m} \cdot c_p \cdot \Delta T \quad (1)$$

where Q is cooling power (kW), $\dot{m}$ the seawater mass-flow rate (kg/s), $c_p \approx 3.99$ kJ/kg·K, and ΔT the seawater temperature rise across the heat exchanger. Converting the result to tons of refrigeration uses Q[tons] = Q[kW] / 3.517.

4.1 Worked example — district main

Suppose the shoreside exchanger draws seawater at $\dot{m}$ = 3,000 kg/s and the seawater is allowed to warm by ΔT = 10 K (from ≈8 °C to 18 °C):

$$Q = 3{,}000 \times 3.99 \times 10 \approx 119{,}700 \text{ kW} \approx \mathbf{120\ MW_{th}} \quad (2)$$

$$Q = 119{,}700 / 3.517 \approx \mathbf{34{,}000\ tons} \text{ of refrigeration} \quad (3)$$

A single district main on the order of 3 m^3/s of cold seawater therefore delivers roughly 120 MW of cooling — enough to serve a substantial cluster of downtown towers and data halls. The avoided compressor energy at ≈0.6 kW/ton would be near 20 MW_e, which instead remains available as grid export.

5 District Load Growth

The Florida district cooling offset and direct-to-grid power scale together as plantship capacity and the shoreside distribution network expand. Table 2 gives the illustrative trajectory.

TABLE 2 — Illustrative Florida-zone load growth.

Milestone	Urban cooling offset	Direct-to-grid power	Primary loads served
Year 3	~40 MW	~120 MW	Anchor carrier hotels, pilot district
Year 6	~130 MW	~350 MW	Downtown core, edge data centers
Year 10	~250 MW	~600 MW	Full district + high-rise HVAC

By replacing roughly 250 MW of compressor-based cooling with pumping-only SWAC, the zone removes both the electrical demand and the urban waste-heat rejection of those chillers from a dense, heat-stressed coastal core — while the 600 MW of firm OTEC power feeds the FPL grid as zero-emission baseload.

6 Nomenclature

SWAC	Sea Water Air Conditioning
Q	Cooling (heat-exchange) power (kW)
$\dot{m}$	Seawater mass-flow rate (kg/s)
c_p	Specific heat of seawater (≈3.99 kJ/kg·K)

ΔT	Seawater temperature rise across exchanger (K)
ton	Ton of refrigeration = 3.517 kW of cooling
kW/ton	Electrical energy intensity of cooling
HV	High-voltage (subsea export cable)
FPL	Florida Power & Light (grid offtaker)

7 Selected References (illustrative)

[1] International District Energy Association. *District Cooling Best Practice Guide.* Illustrative bibliographic entry.

[2] Makai Ocean Engineering. *Sea Water Air Conditioning: System Design and Pipeline Engineering.* Conceptual reference, illustrative.

[3] ASHRAE. *Handbook — HVAC Systems and Equipment: District Cooling.* Illustrative bibliographic entry.

[4] U.S. Department of Energy. *Deep-Water Source Cooling for Coastal Urban Districts.* Conceptual reference, illustrative.

[5] TROIB Project. *Engineering Brief TROIB-EB-01: Closed-Cycle Ammonia OTEC.* Companion document.