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ESMAP
Energy Sector Management Assistance Program

Seawater Air-Conditioning (SWAC): Opportunities for Implementation

October 17, 2024 I 8:30-10:00 AM EST

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Seawater Air-Conditioning (SWAC)

uses inexhaustible cold deep seawater to replace conventional, energy intensive cooling.

SWAC can address surging cooling demands in a cost-effective and sustainable way for island states

SWAC systems **operate around the** including Tahiti's largest hospital complex

SWAC can **save more than 85% of electricity** compared to conventional systems

Customers include **resorts, airports, office/municipal buildings and industrial zones**

In addition to cooling, the ocean water is used for **aquaculture, agriculture and desalination**

SWAC **substantially lowers CO2 emissions** to help meet climate targets

SWAC brings **investment, jobs, and reduced fossil fuel imports**

World Bank has completed a project to identify SWAC potential in the Caribbean

SWAC Design

- Technology off-the-shelf and well-understood
- One moving part (seawater pump)
- System redundancy for greater reliability

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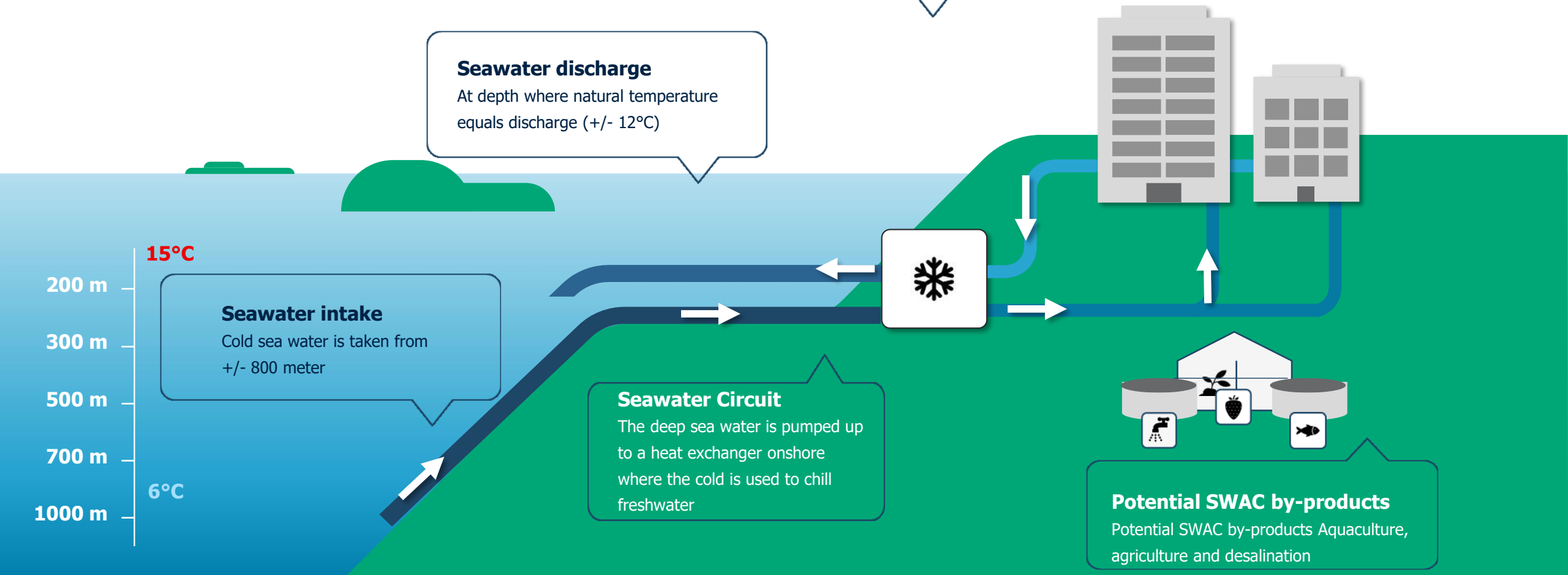
Cooling station
Titanium heat exchangers are used to chill a freshwater circuit using the cold available from the deep seawater

Freshwater Circuit
HVAC systems of buildings connected to the chilled freshwater to provide cooling

Seawater discharge
At depth where natural temperature equals discharge (+/- 12°C)



Seawater intake
Cold sea water is taken from +/- 800 meter

Seawater Circuit
The deep sea water is pumped up to a heat exchanger onshore where the cold is used to chill freshwater

Potential SWAC by-products
Potential SWAC by-products Aquaculture, agriculture and desalination

Operational and planned sea water cooling systems demonstrate reliability

Beyond cost savings, multiple benefits from a SWAC system

Green Branding
Establishes resorts as premier green and sustainable tourist destination

Drives New Investment
Catalyzes investment from private and public sector to Jamaica

Creates Jobs
Leads to jobs across various stages and components of construction

Climate Resilience and Mitigation
SWAC will helps adapt to a changing climate and reduces CO2 emissions significantly

Reduces Fossil Fuel Imports
Reduces substantia BBL of oil imports / year

Reduces Electricity Usage
90% reduction in power needs shaves approx 4 MW off peak demand and reduces nearly 18k MWhs per year

SWAC can be the cornerstone of a multi-use facility

A Hawaii facility with deep ocean pipelines has more than 40 companies using the ocean water

The cold, clean, nutrient and pathogen-free deep seawater has multiple uses:

District Cooling: low-cost cooling for multiple residential, commercial and municipal customers

Enhanced Industrial Productivity: Low-cost cooling and heat sink increases efficiency of industrial processes

Aquaculture: The cold, deep seater is very advantageous for many forms of aquaculture

Agriculture: The low-cost, always available cooling can enhance greenhouse-based agricultural production

Premium seaweed and water: Deep ocean water combines purity with naturally occurring electrolytes for premium seaweed and water

Marine research: Deep water and pipelines offer many opportunities for world class oceanographic research

Potential Options for SWAC Ownership / Governance Structures

1) Ownership by Hosts

- Hotels jointly own and run the SWAC facility
- SWAC facility provided on EPC, turn-key basis by credible construction firm with performance guarantee
- Regular maintenance managed by hotels and provided by global SWAC experts

2) Public Ownership

- Government takes full/ partial ownership stake in the SWAC facility as a global public good
- Responsible for operations (likely outsourced)
- Gets revenues from hotels for provision of cooling to repay CapEx

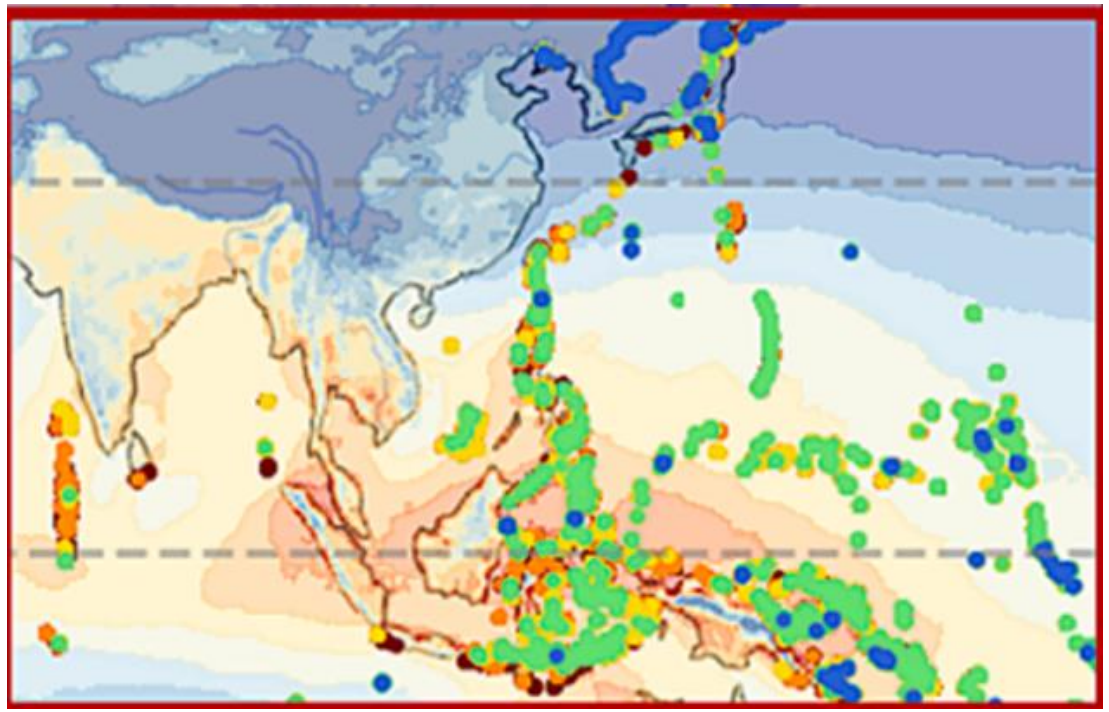
3) SWAC SPV

- Company establishes special purpose vehicle (SPV) to finance, own and operate SWAC facility
- Possible government stake via PPP
- SWAC installed via EPC contract with guarantee on performance
- Sells cooling to hotels via Cooling Sales Agreement

Projections of SWAC Global Potential

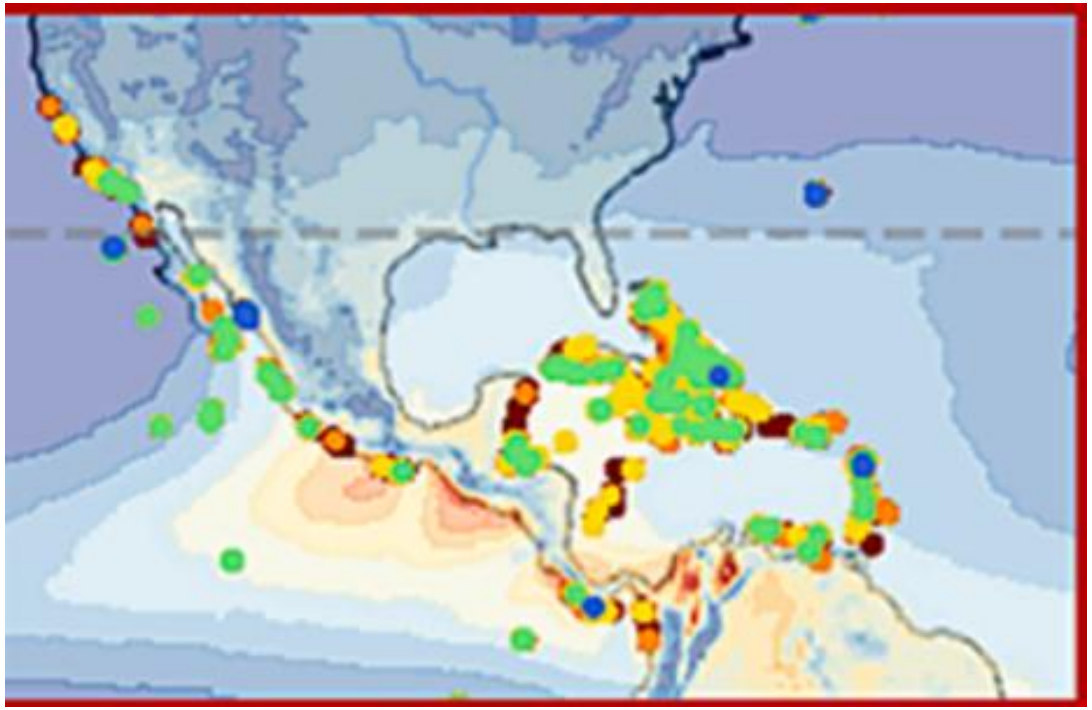
East Asia

(each dot represent site with accessible cold water)



Caribbean, Mexico

(each dot represent site with accessible cold water)

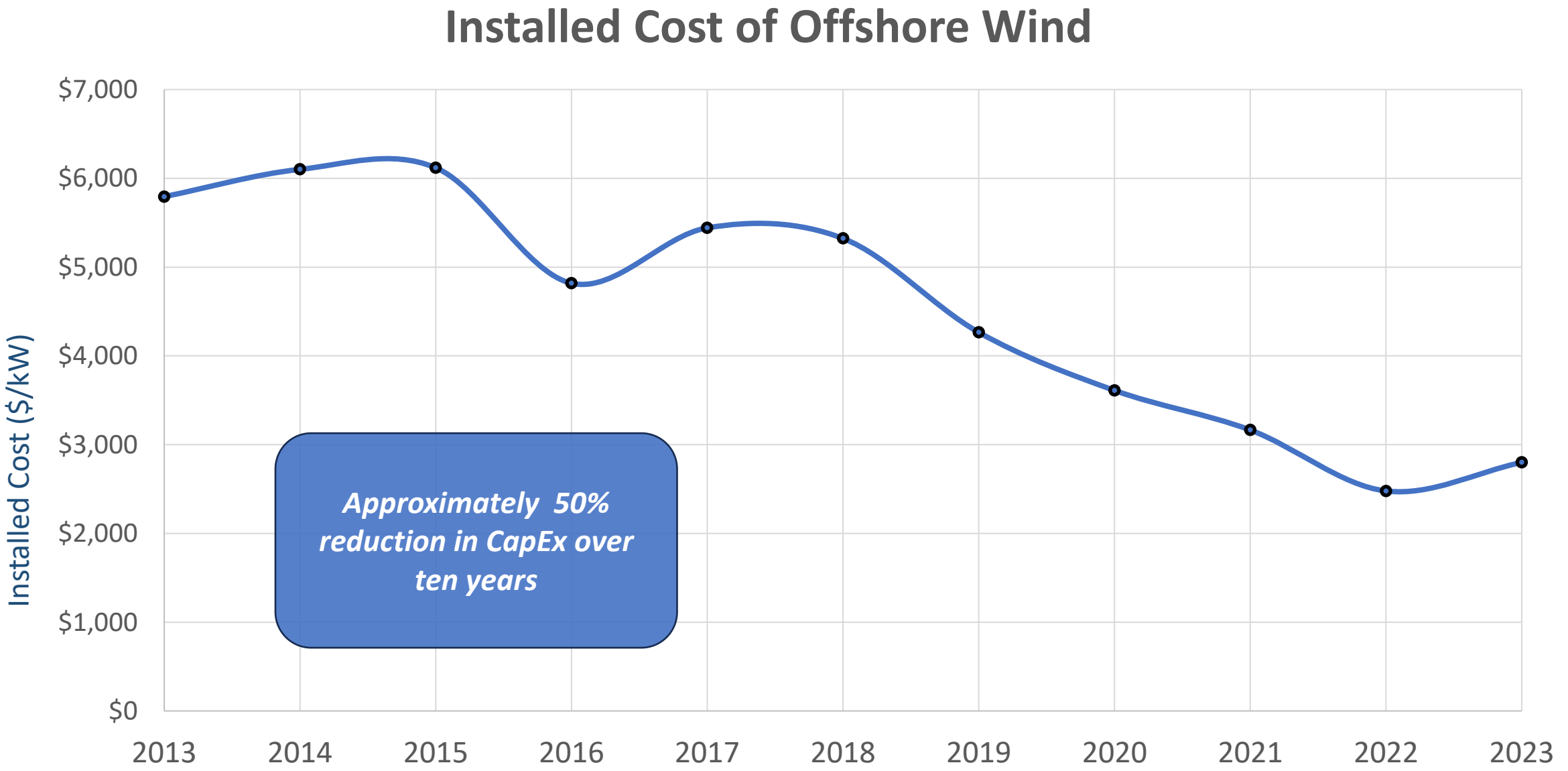


Number of facilities with access to 5 C water

Distance to 5 C	N America	Eastern Asia	Europe	Total
0 - 2.5 km	418	13,319	5,627	19,364
2.5 - 5 km	2,354	17,926	2,976	23,256
5 - 7.5 km	9,830	40,951	2,914	53,695
7.5 - 10 km	11,160	33,499	1,498	46,157
Total	23,762	105,695	13,015	**142,472**

Source: K. Sanjivy et al, Exploring global accessibility of deep ocean water for sea water air conditioning (SWAC) process; Sustainable Energy Technologies and Assessments (61) 2024

Lessons on Cost Trends from Similar Technologies



Source: Statista 2024

SWAC Technical and Financial Assessment in Dominican Republic | Jamaica | Grenada

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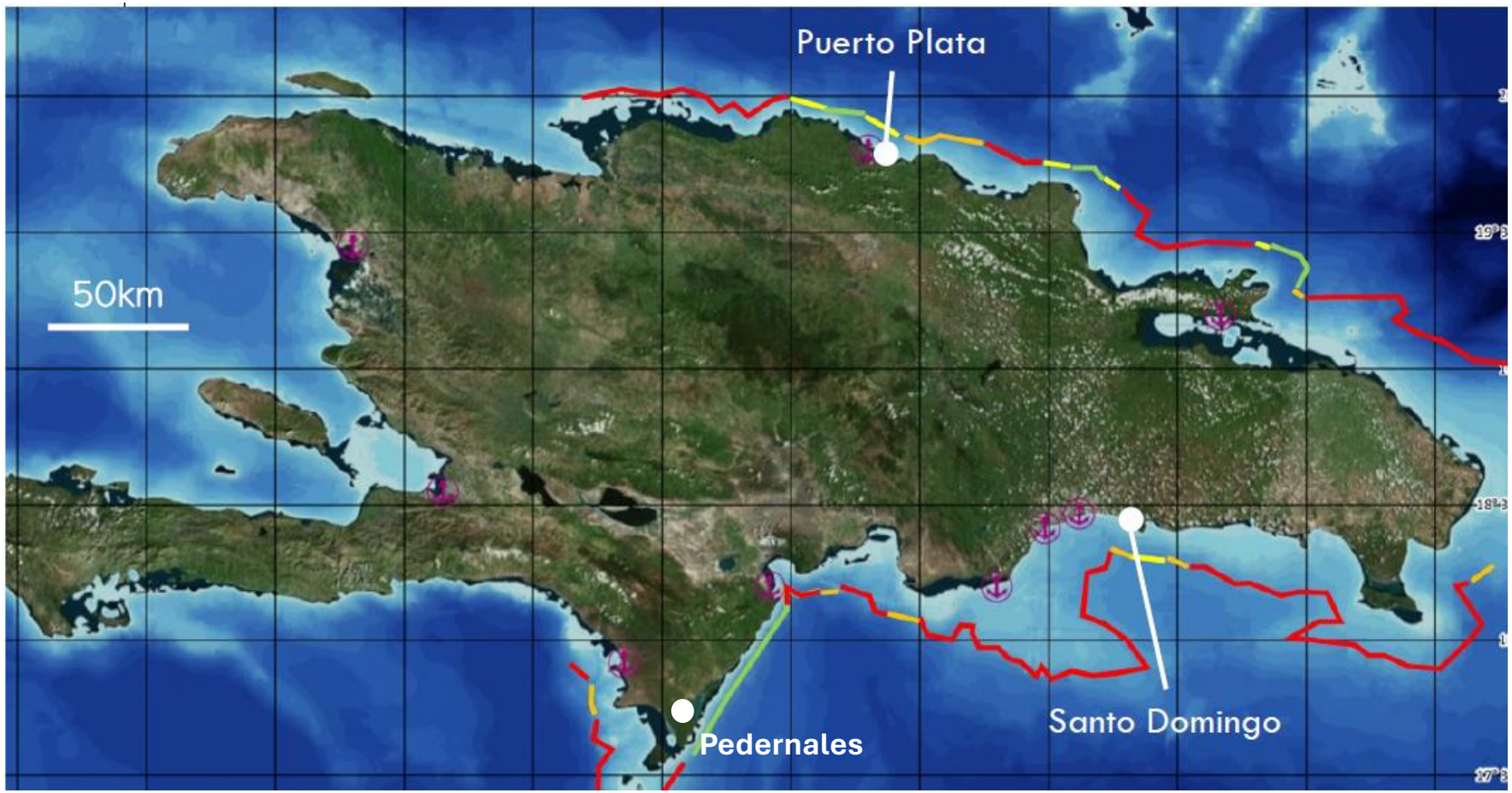
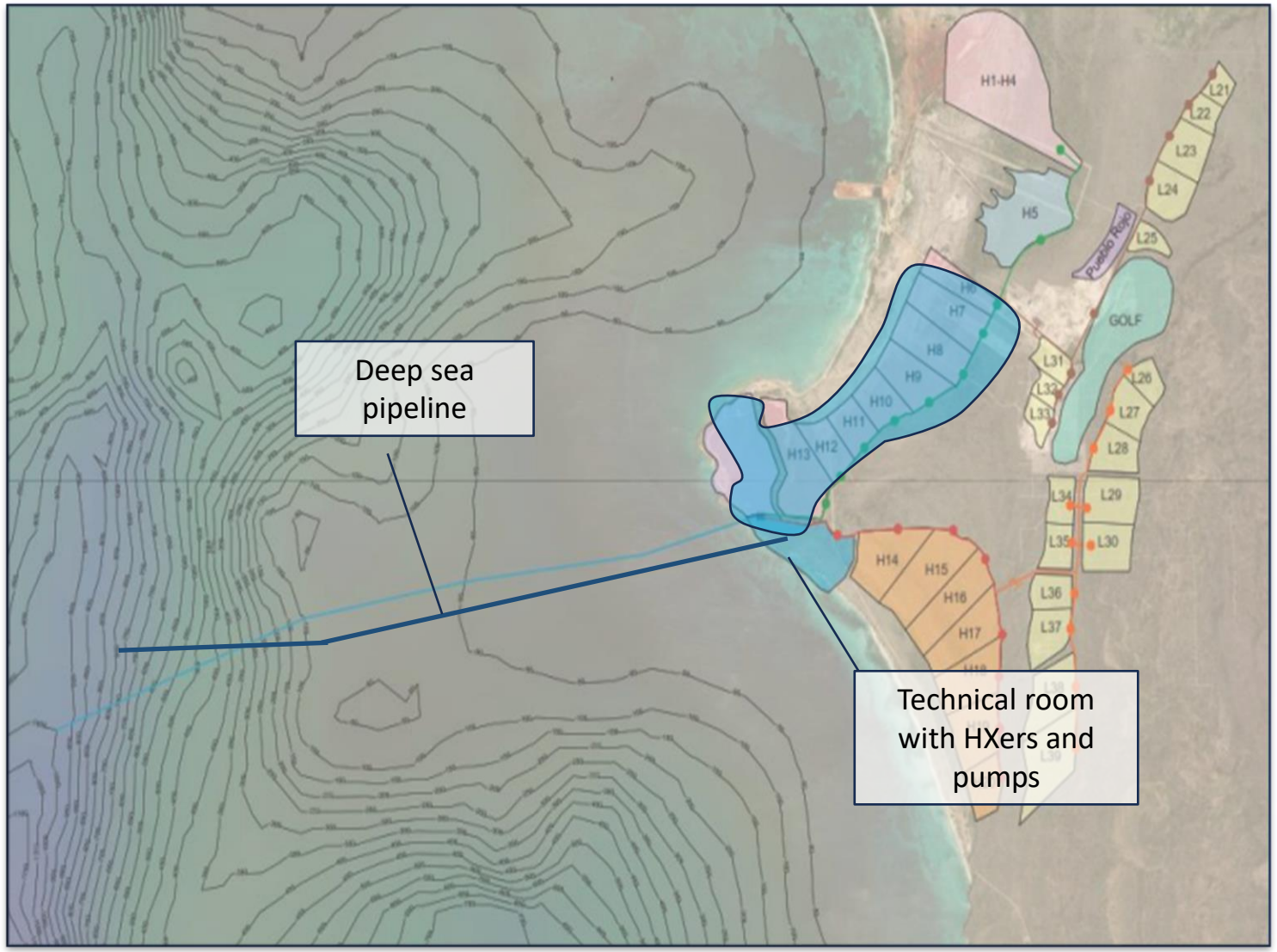
Preferred locations for SWAC facilities in Dominican Republic



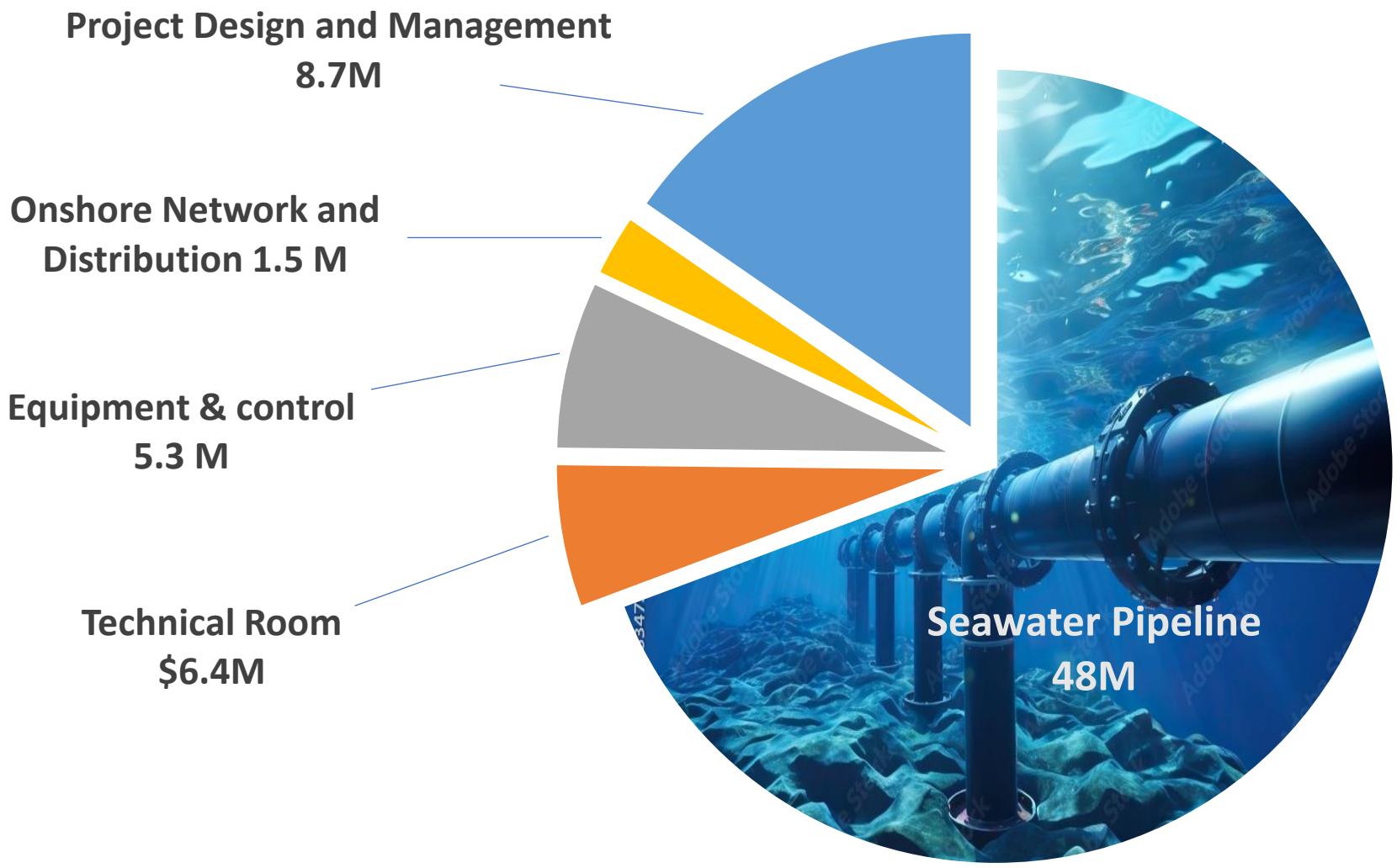
- Pedernales offers a more strategic location to deploy SWAC. It has excellent bathymetry for easy access to cold, deep seawater and substantial cooling demand.

System Specifications Summary



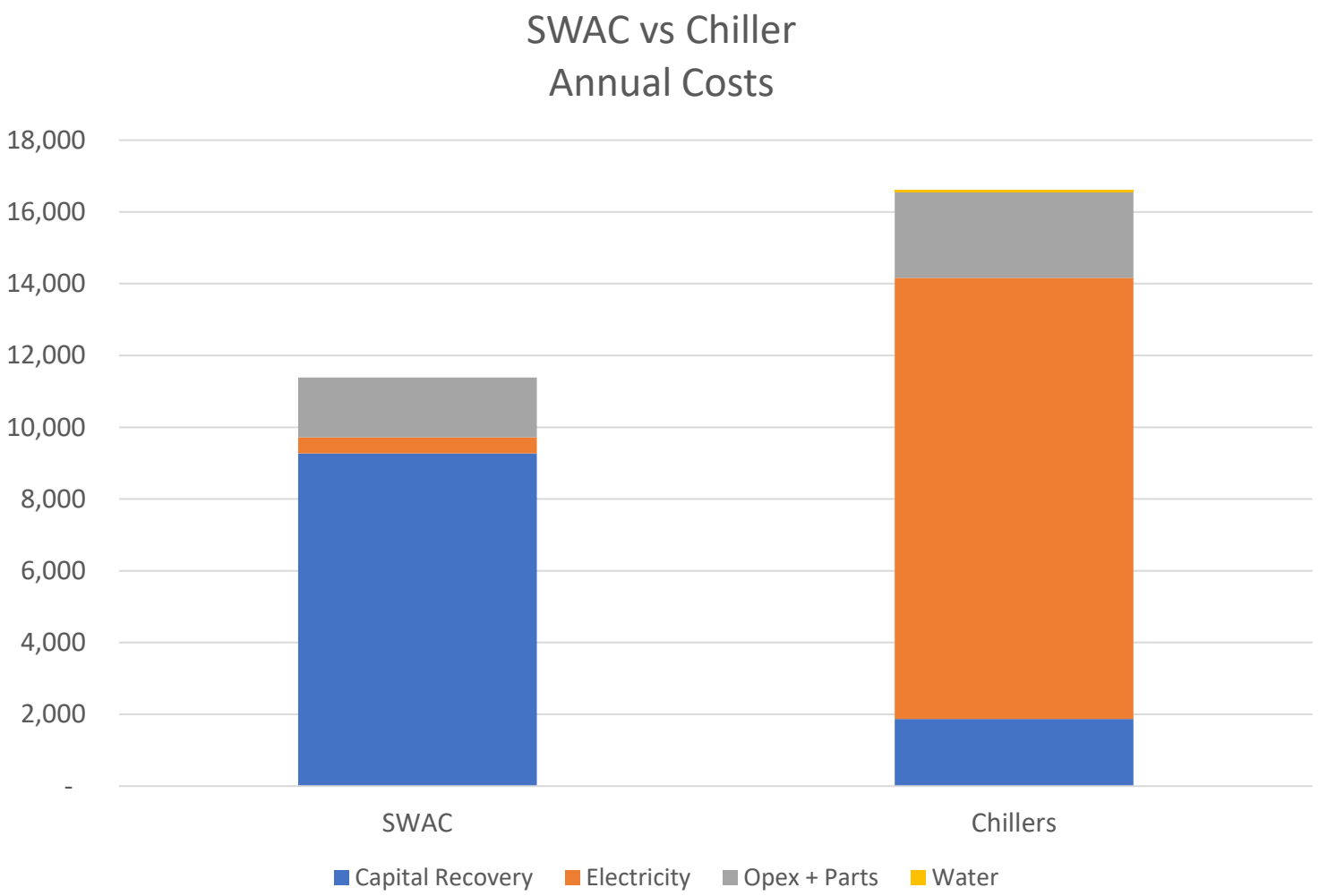
Cooling Power	**7,100 ton**
Operating temperature	**7°C – 12 °C**
Pipeline length	**7,850 m**
Seawater intake depth	**958 m**
Seawater flow rate, m3/hr	**4,340 m3/hr**
Pipeline outer diameter	**1400 mm**

Capital Expenditures - SWAC Facility at Pedernales



$ 70M
Total CapEx

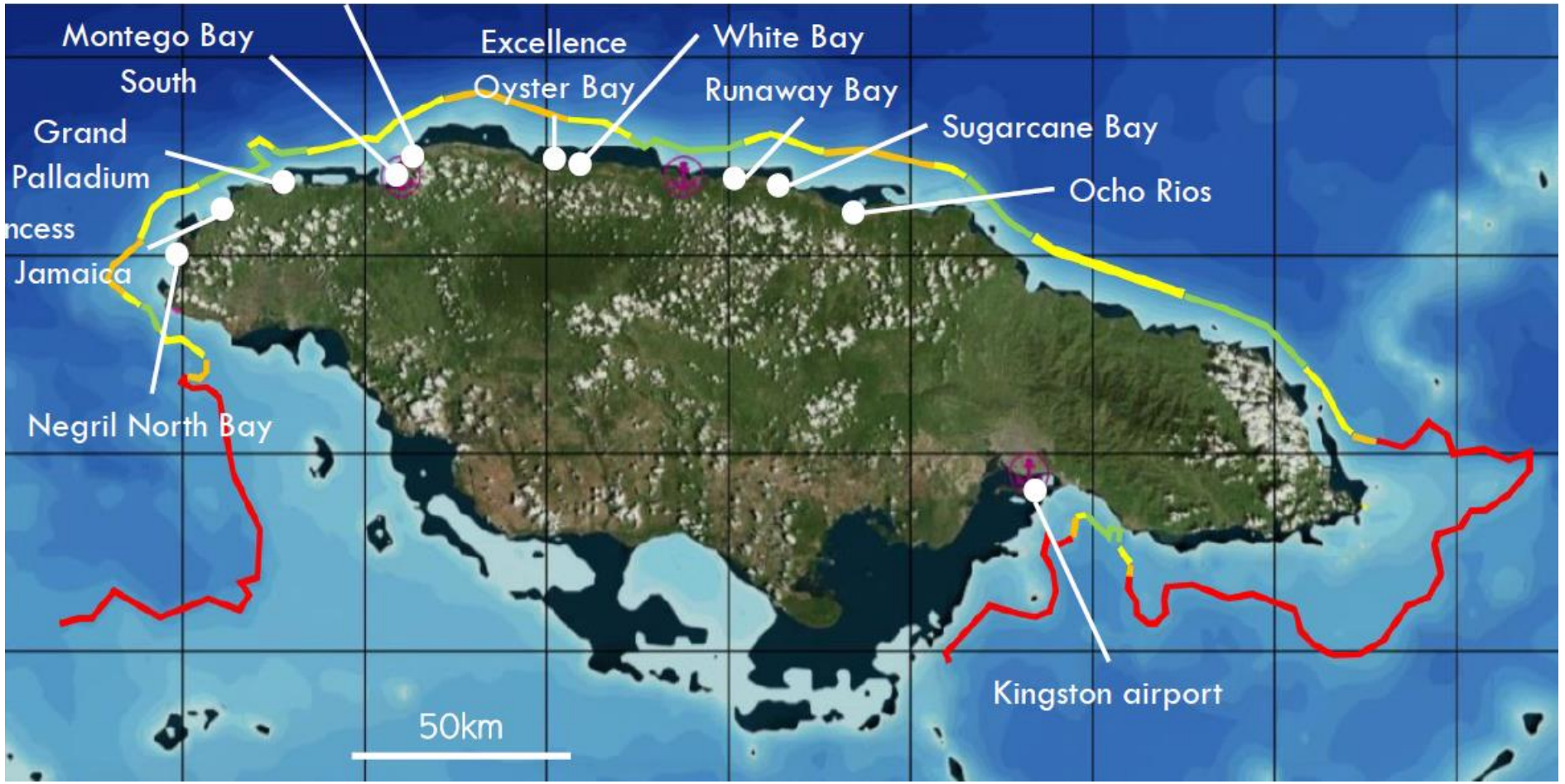
Projected SWAC all-in cost 30% less than mechanical chillers



Lifetime cost savings of $64 mn

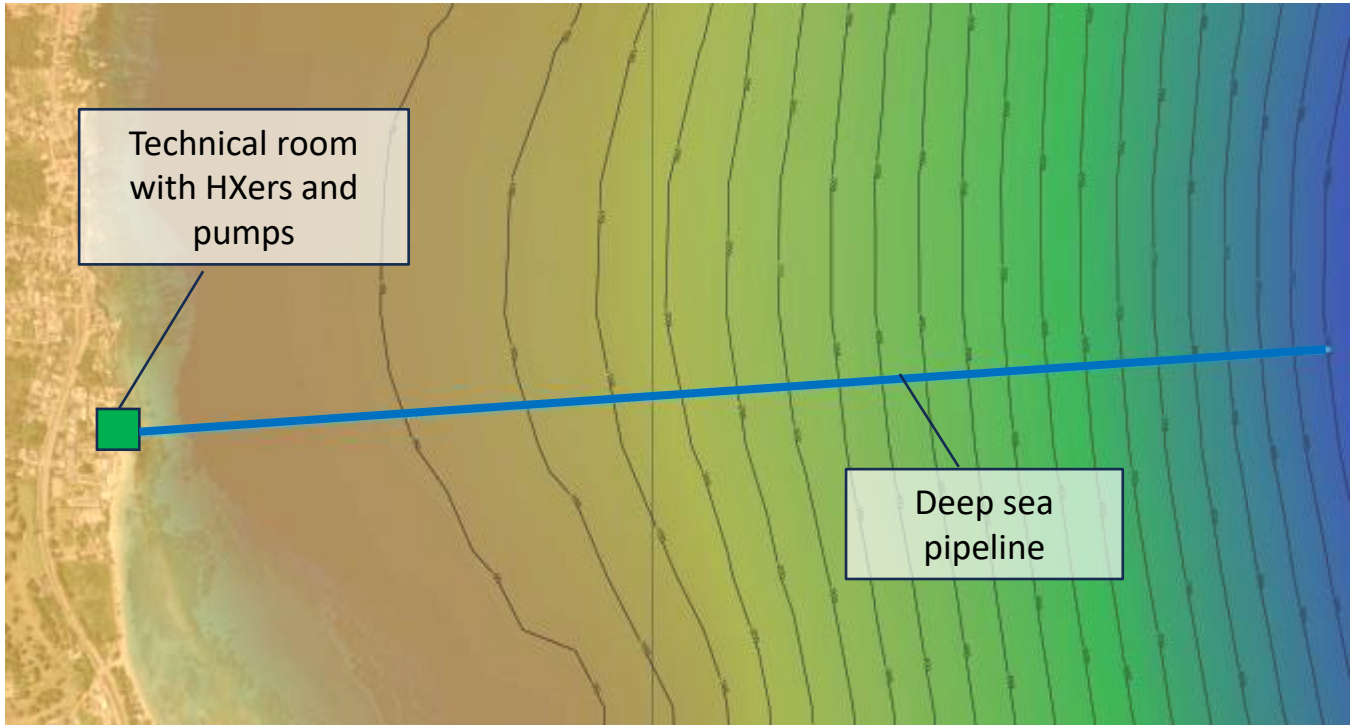
Cost of capital	10%
Concessional funds	Assume nothing but likely available
Price of electricity	US$ 0.16/ kWh
Price of water	US$ 0.15 / m3
Lifetime	15 years – expected longer lifetime brings greater savings
Capacity Factor	57% (5,000 hrs)
Pipeline inspection	Every three years
Replacement pumps	Every six years

Preferred locations for SWAC facilities in Jamaica



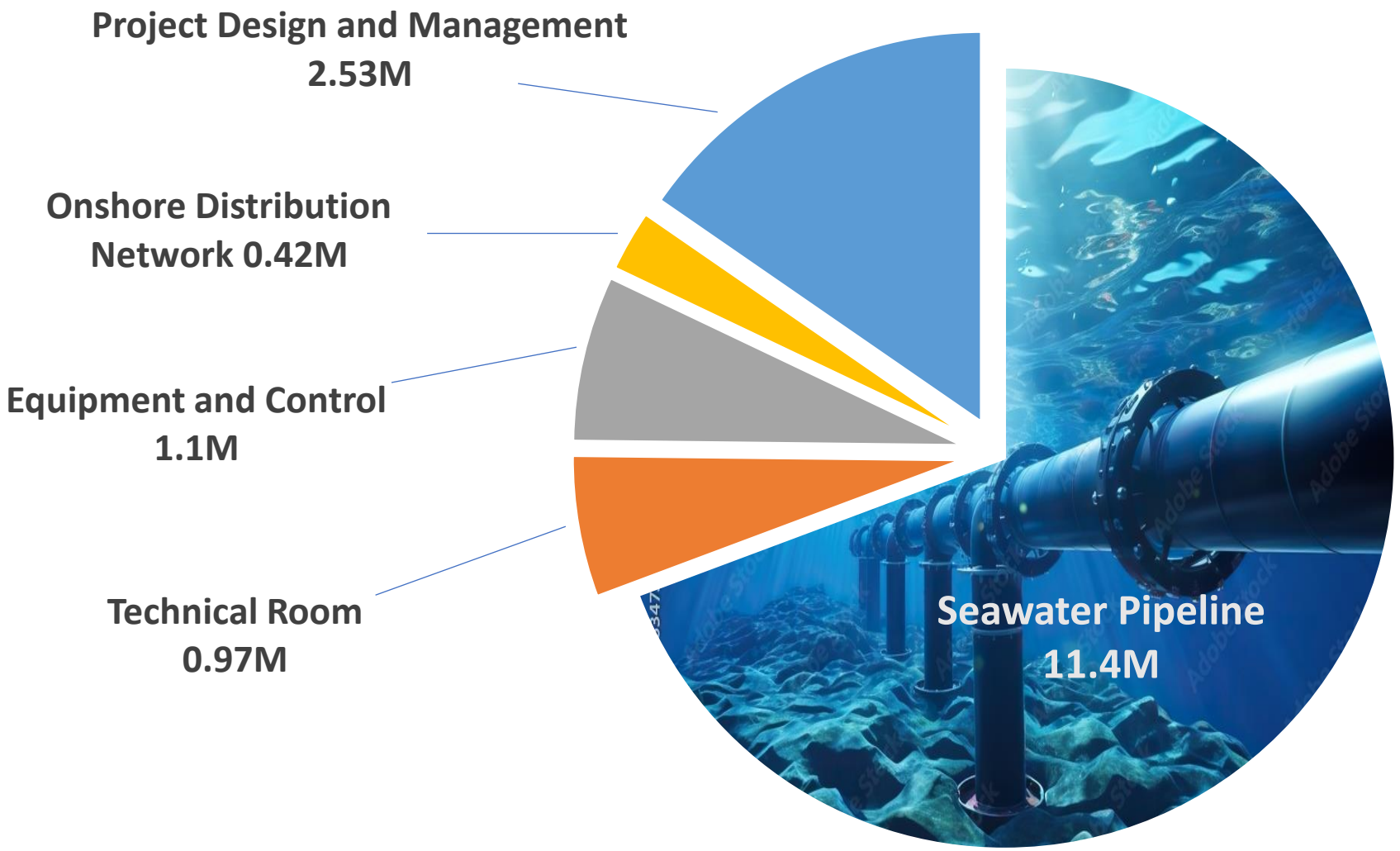
- Runaway Bay was selected as the strategic location for SWAC based on its bathymetry and substantial cooling demand from hotels and resorts.

System Specifications Summary



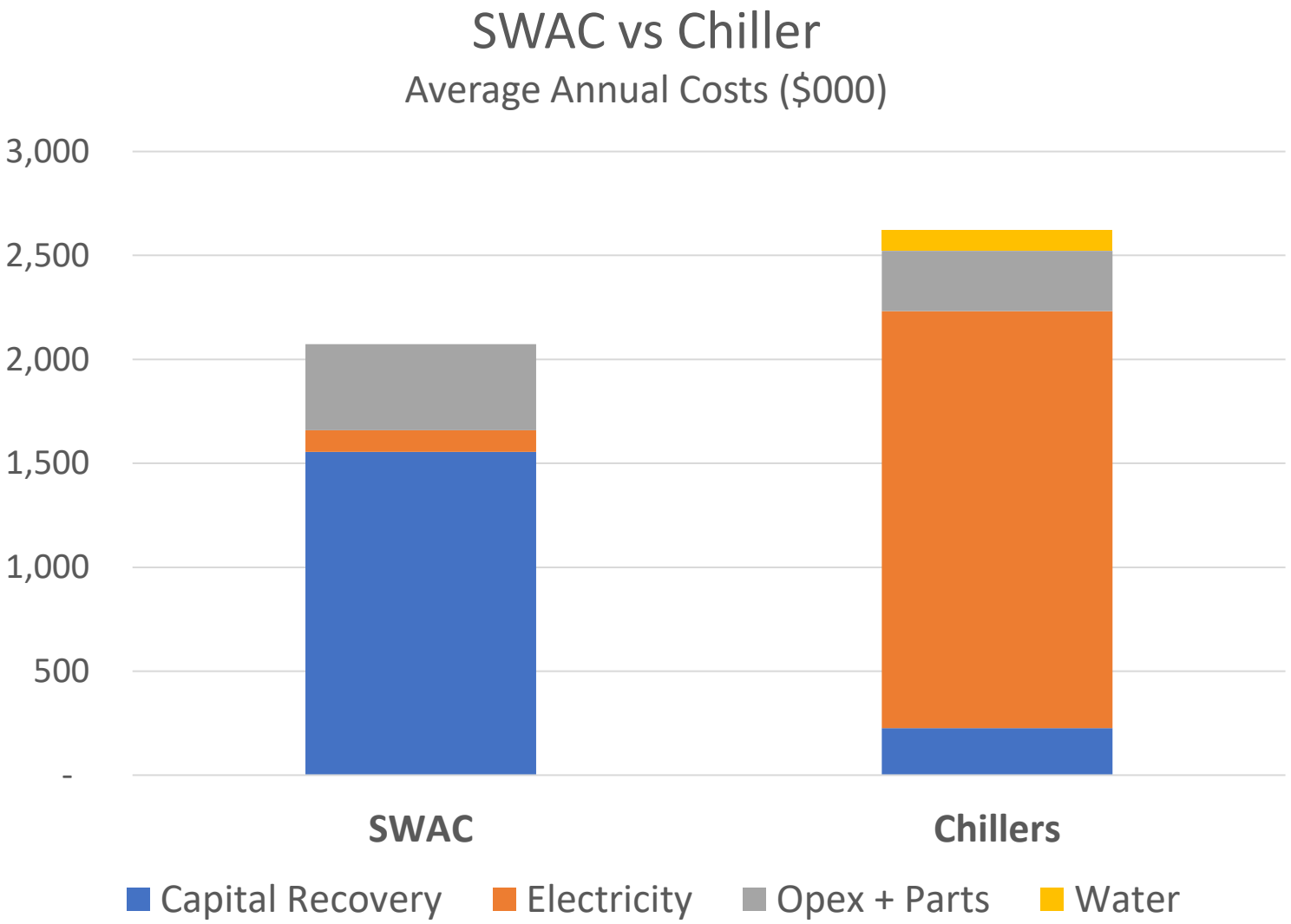
Cooling Power	**854 Ton**
Operating temperature	**7°C – 12 °C**
Pipeline length	**4,418 m**
Seawater intake depth	**958 m**
Seawater flow rate, m3/hr	**521 m3/hr**
Pipeline outer diameter	**560 mm**

Capital Expenditures - SWAC Facility at Runaway Bay



$ 16.4 M
Total CapEx

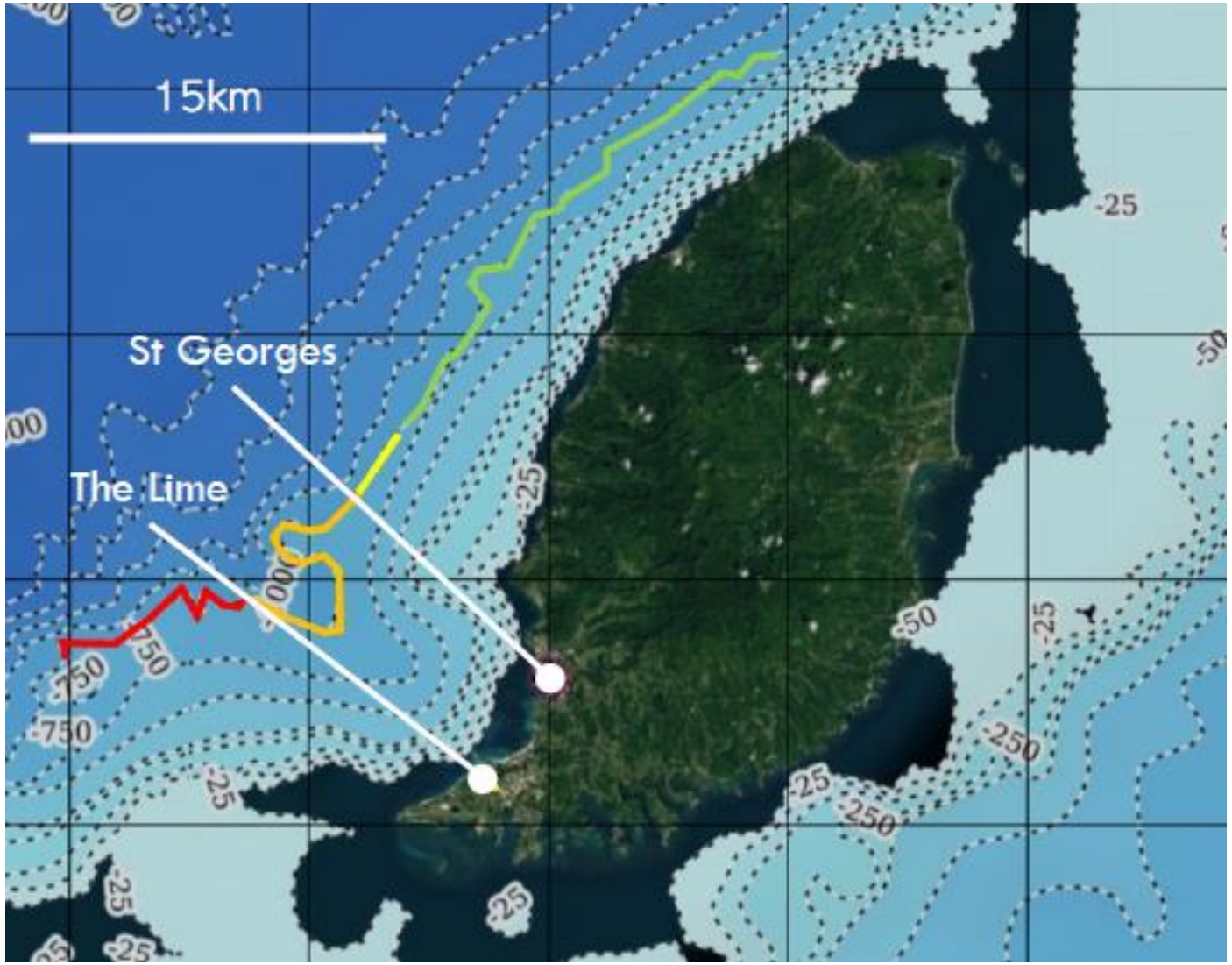
Projected SWAC all-in cost 25% less than mechanical chillers



Lifetime cost savings of $13.2 mn

Cost of capital	10%
Concessional funds	Assume nothing but likely available
Price of electricity	US$ 0.38/ kWh
Price of water	US$ 2.13 / m3
Lifetime	15 years – expected longer lifetime brings greater savings
Capacity Factor	57% (5,000 hrs)
Pipeline inspection	Every three years
Replacement pumps	Every six years

Preferred locations for SWAC facilities in Grenada

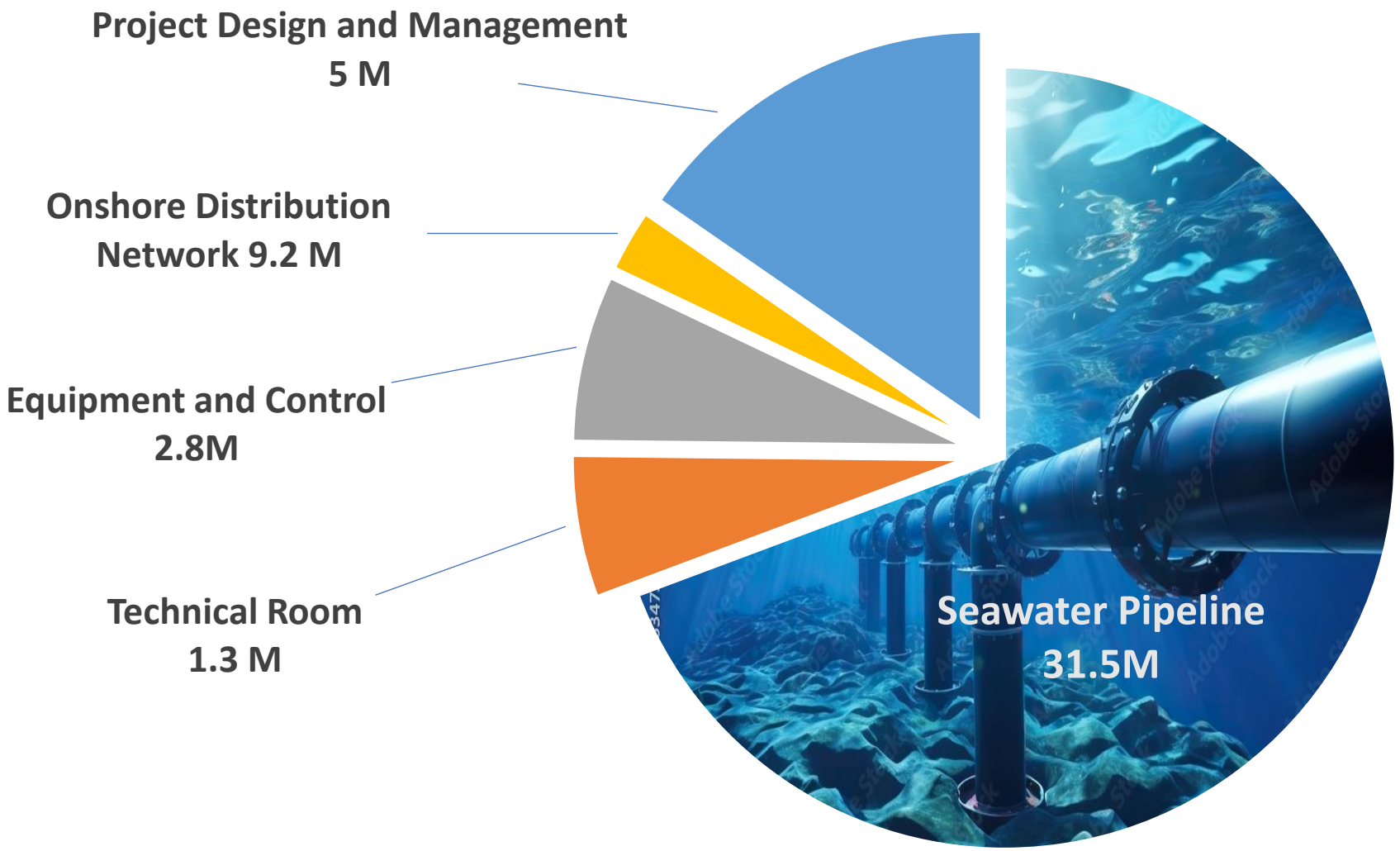


- The Lime location was selected as the preferred site for SWAC deployemnt based on favorable conditions – bathymetry and cooling demand.

System Specifications Summary

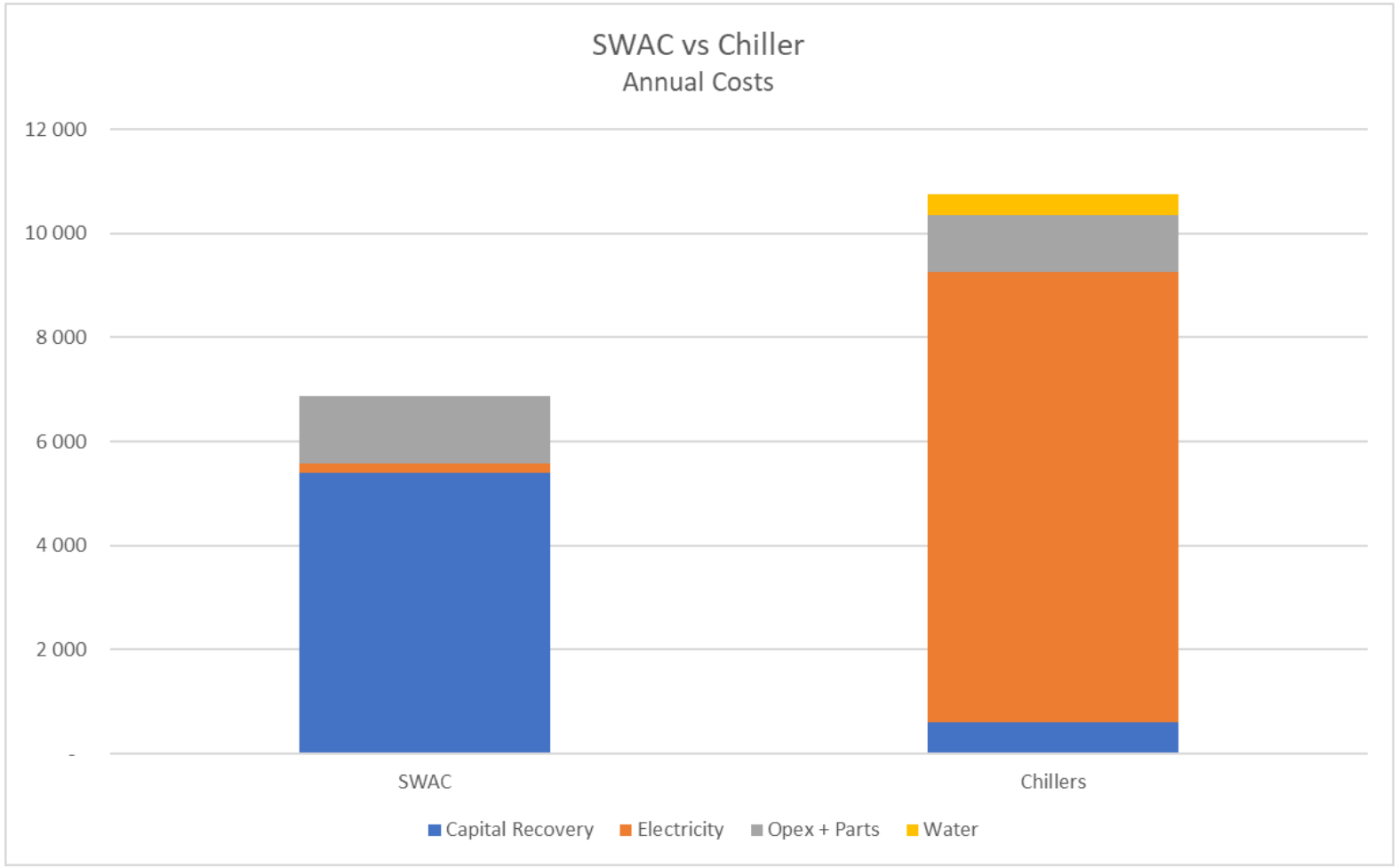
Cooling Power	**3,500 Ton**
Operating temperature	**7°C – 12 °C**
Pipeline length	**7,657 m**
Seawater intake depth	**916 m**
Seawater flow rate, m3/hr	**2067 m3/hr**
Pipeline outer diameter	**1,100 mm**

Capital Expenditures - SWAC Facility at the Lime



$ 49.8 M
Total CapEx

Projected SWAC all-in cost 40% less than mechanical chillers



Lifetime cost savings of $75 mn

Cost of capital	10%
Concessional funds	Assume nothing but likely available
Price of electricity	US$ 0.40/ kWh
Price of water	US$ 2.16 / m3
Lifetime	15 years – expected longer lifetime brings greater savings
Capacity Factor	57% (5,000 hrs)
Pipeline inspection	Every three years
Replacement pumps	Every six years

Summary of SWAC Results

Indicator	Dominican Republic	Grenada	Jamaica
Cooling Power	**7,100 ton**	**3,500 Ton**	**854 Ton**
Operating temperature	**7°C – 12 °C**	**7°C – 12 °C**	**7°C – 12 °C**
Pipeline length	**7,850 m**	**7,657 m**	**4,418 m**
Seawater intake depth	**958 m**	**916 m**	**958 m**
Seawater flow rate, m3/hr	**4,340 m3/hr**	**2067 m3/hr**	**521 m3/hr**
Pipeline outer diameter	**1400 mm**	**1,100 mm**	**560 mm**
Total CapEx (US$'M)	**70**	**50**	**16**

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Thank you for your attention

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