Zakito District Cooling
Naturally Cool ™
A highly reliable and cost effective sustainable source

1 Introduction

Ecopower International (Curacao), Curacause Wegenbouw Maatschappij (CWM, Curacao par of Janssen de Jong Group, The Netherlands), Deerns (Netherlands), Civil Engineering Caribbean (Curacao) DEVCCO (Sweden), Makai Ocean Engineering (Hawaii) and Emmitt Green (Netherlands) have set-up a cooperation to jointly develop the Zakito District Cooling system (documentary https://youtu.be/roYfUXg4bLU).

Figure 1: Visualisation of the Zakito District Cooling pump/cooling station

Together this joint venture has an extensive track record and experience in the development of large scale District Cooling, Energy, Infrastructure and deep seawater pipeline projects Globally (incl. with all the seawater district cooling (SWDC) projects on Curacao). Developing District Cooling in large cities like Copenhagen, Stockholm Toronto, Along with specific projects like, Cornell University, Bora Bora, Abu Dhabi Airport or the NATO Headquarters in Brussels, Curacao Airport, or Energy projects in the Caribbean like the Wind Diesel system on Bonaire, conventional power and desalination plants on Curacao, onshore and near shore civil activities for projects like The New Hospital for Curacao, Mega Pier II, Kooyman mega store, Fisherman's Wharf Mari Pampoen, Sewage infrastructure for Punda, Tera Kora Wind Farm Klein Curacao Pier, the Curacao Airport; the technical installations for several resorts and hospitals, and deep seawater pipelines like in Hawaii, Bora Bora and India.

We believe that a development process with a combination of local and global partners is the most effective way forward. We will therefore work with local companies and expertise where each party contributes its core expertise, unique experience and/or knowhow, thus adding value to the development, financing, engineering, realization and/or operational process.

ZakitoDC intends to connect the Dreams resort, WTC Curaçao (incl. Clarion hotels), Piscadera Residence, Sentro Mediko Otrabanda, Corendon Beach Resort, ADC, the Curaçao Medical Center, Sint Elisabeth District and the Renaissance hotel, providing them with a sustainable, reliable and cheaper means for cooling of their buildings. The goal of this project is to connect all the suitable basically centralized cooled buildings between Renaissance and Dreams and in the future possibly clients like Marriott, the Sambil Mall ("the Zakito Area") (figure 2).

More than 90% of the capacity has already been committed to the project. The project is in the final phase. Permitting activities are being finalized, final cooling contracts with the clients are being negotiated, procurement detailed design is finished and procurement is ongoing. Several financial institutions have expressed a firm commitment to contribute the debt financing for the investment needed. The consortium will provide the equity needed for the project.

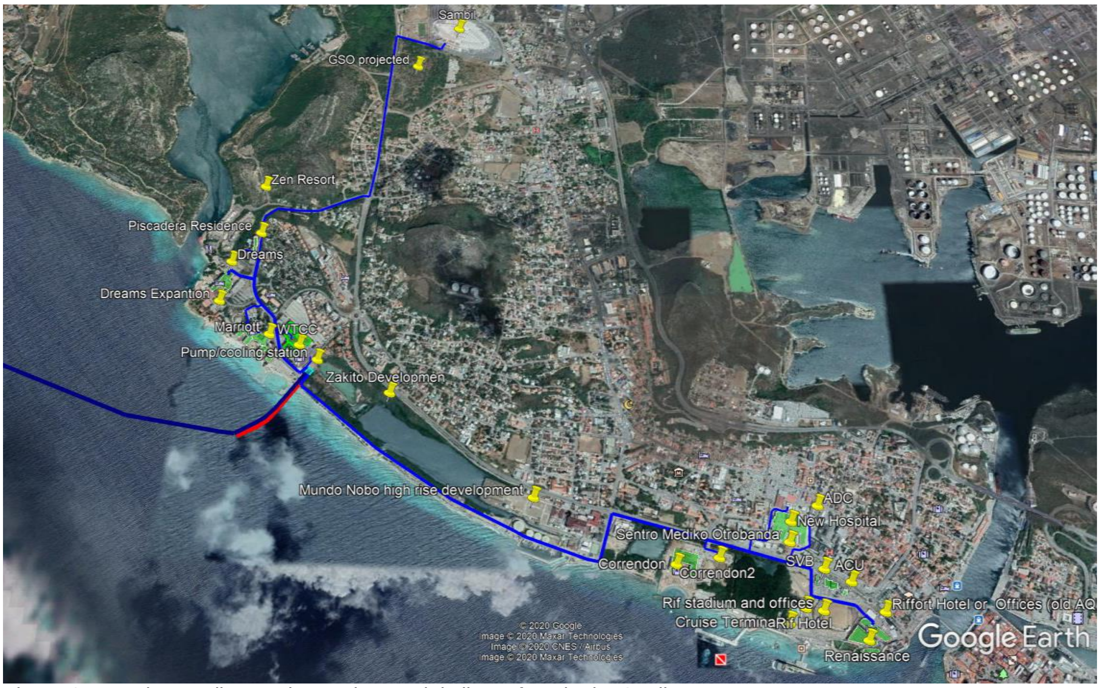


Figure 2 Location cooling station and potential clients for District Cooling.

2 District Cooling

District cooling is suitable for developments with large air conditioning demands. District cooling is produced centrally and is often based on natural cooling from bottom water of lakes, ground waters, rivers, the sea or conversion of waste heat/bio energy to cooling through absorption technology.

It could also include conventional chillers, heat pumps and storage. The cold water is usually distributed to the customers via a closed-loop, ground-laid distribution system. In each building the distributed cold water passes through an energy transfer station (ETS). This ETS is the interface between the distribution system and the customers' conventional internal system providing the building with air conditioning, which remains the same. The centrally produced district cooling can reach up to 10 time's higher energy-efficiency than local electricity-driven equipment.

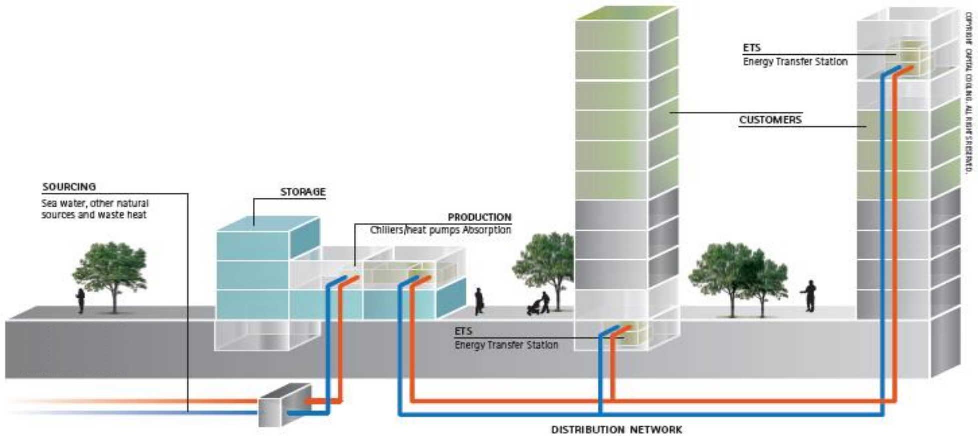


Figure 3 Schematic description of district cooling

The main factors that influence the economic viability are:

- Size and concentration of the air conditioning load
- Utilization of air conditioning during days and nights

- Size of the distribution system
- Local cost of electrical power and water
- Availability of natural cooling source to maximize the energy efficiency of the system

The initial assessment of these factors for the Caribbean region in general for District Cooling look promising because of the availability of cold deep seawater and in some cases waist heat.

The system can decrease the total electric energy consumption and related CO_2 emissions for cooling up to 90%, thus reducing total energy cost considerably. When properly designed and constructed the seawater district cooling system has no negative impact on the environment. Furthermore, the use of freon is reduced with 100%. As such the system contributes to a sustainable environment in a cost-effective manner.

3 Zakito District Cooling

For many businesses up to approximately 70% of their total energy consumption is for cooling. With the high electricity tariffs and the proximity to the ocean, Seawater District Cooling (SWDC) seems a logical option for the Zakito area. The benefit of this is the possibility to offer very cost effective and price stable cooling to the potential customers while creating a push for the development of area.
System specifications:

1. The total capacity of the system is ca 3,500 Ton A/C (ca 11MWth which represents ca 4MWe.)
2. Deep seawater intake pipeline of ca. 6km length and 850m depth (ca. 6 ºC water which can be used for direct cooling).
3. Pumps/Cooling station (figure 1): The cooling station is the heart of the system. Here all the equipment is localized, including the deep seawater- and distribution pumps, and the control and monitoring system.
4. Distribution system: length ca. 8.0km, with heat exchangers, pumps, control and measurement equipment at each client. The cold temperature of the DC system (the deep seawater), ca 7.2ºC (45ºF), is transferred via titanium heat exchangers to the fresh water that runs through the internal air conditioning system in the hotels and companies.

Some general facts of the project are:

- It will reduce energy consumption for cooling by 95% resulting in:
  - Reduction of oil imports and thus foreign currency expenditure,
  - SWDC will also save (if compared to average electricity tariffs) in cross subsidies by the other consumers to customers with the export tariff.
  - Reduction of GHG emissions.
  - SWDC will provide up to 70% of the total energy compared to conventional energy supply (electricity now used by the chillers).
- Furthermore SWAC opens the Deep Seawater Industry possibilities for research, development and exploitation of aquaculture, agriculture and other spinoff activities.

3.1 Seawater air-conditioning potential customers

Some of the opportunities of the seawater air-conditioning system for potential customers are:

- Long-term reduction in cooling cost (Electricity, Maintenance and Capital costs).
- Possibility get Stable and Predictable cooling costs for a long term (15-25 years) as SWDC costs are mostly subject to the normal consumer price index (CPI) and not sensitive to oil price volatility (30-130 USD/bbl).
- No investment, all relevant connections will be accounted for if feasible.
- It reduces noise, increasing the comfort of the clients of the customers.
- It is a healthier and environmentally safer system, eliminating risks of legionella, lowering the Islands CO2 output and reducing the use of harmful refrigerants and other chemicals.
- It increasing their asset value of the properties and enhances their opportunity for corporate branding, by improving the ratings of for example for LEED certified companies.
- Expansion plans could be covered.
- SWDC is a Reliable (hurricane and tsunami proof) and Renewable alternative.

3.2 Activities and Planning

Due to the Covid-crisis construction is planned to start in 2022, subject to financial closure. The construction is expected to take ca. 24 months.

4 Reference projects

The cooling of buildings by using District Cooling is one of the most reliable and stable systems, when compared to the conventional air conditioning systems and is being used in various ways al around the world. Like in Finland where Google uses seawater based District Cooling to cool their Datacenter 24 hours a day or at Cornell University in Ithaca New York, where the entire campus has been cooled by lake water District Cooling for the last 10 years, a system 5 times larger as the one planed for Curacao.

Cities like Stockholm, Helsinki, Copenhagen, Amsterdam, Paris, Vienna, Toronto and Hong Kong are also using this district cooling mostly based on the use of seawater to cool their buildings. Even the Island of Bora Bora (French Polynesia) has installed a Seawater based cooling system for their tourist industry.

In Europe about 40% of commercial and institutional buildings, have some kind of cooling, In the US and Japan it’s no less than 80%. In the Caribbean this number is similar.

Also the construction of pipelines in the deep ocean (>500m) is not new and has also been around for many decades for example in the oil and gas industry. At NELHA Hawaii, Deep Seawater pipelines have been installed since 1974, so they have more than 25 years of experience with this system and all those years that system has supplied the cold water used to achieve a flourishing Deep Seawater Industry. Other locations where similar deep seawater pipelines are used are Japan, Korea, Taiwan and India.

5 Spin-off activities of SWAC, Deep seawater Industry

Because of the climate change, more of the larger countries will have to deal with more dry areas and longer periods of drought.” “The next world crisis will be the food crisis.”

Besides for cooling, another way of using the cold seawater is for activities in a Deep Seawater Industry (DSI) such as Agriculture and Aquaculture. After the water has been used for the cooling of buildings, it will still have a temperature of approximately 12 degrees Celsius, which is still cold enough for agricultural or aqua cultural use.

There are multiple DSI facilities, many located in Japan, Korea, Taiwan and India, which use deep sea water pipelines (pipes that go as deep as around 1,000 meters below the sea surface). These facilities utilize the seawater for refrigeration or for example for high value water desalination or aquaculture.

For example - the Natural Energy Laboratory of Hawaii Authority (NELHA, State agency that operates a unique innovative ocean science and technology park on the island of Kailua-Kona) in Hawaii, USA. NELHA provides office and laboratory facilities, infrastructure and leasable open land with access to deep seawater for use by tenant research, education, and commercial projects. It currently hosts over 40 tenants that operate in a wide range of fields including aqua and agriculture, cosmetics, water desalination, bio fuels and others. There is also an experimental Ocean Thermal Energy (OTEC) plant located on the promises.

The NELHA project has proved how the modular (tenant alike) type of strategy for managing technologies that are being integrated in the park can be beneficial. Within the 30 years of its existence, it has been steadily growing around its core elements - the experimental OTEC plant and the deep seawater pipelines.

The DSI organization could be structured in various ways. For example it could operate as a large facility with separated R&D, commercial and pre-commercial zones, each evolving independently. However, the NELHA project has proved how the modular (tenant alike) type of strategy for managing technologies that are being integrated in the park can be beneficial. Within the 30 years of its existence, it has been steadily growing around its core elements - the experimental OTEC plant and the deep seawater pipelines. The steadily increasing number of tenants then discovered the benefits of the infrastructure and possibilities of synergies.

Figure 4: Areal view of NELHA and the nearby airport: Pearl culture, Algae/seaweed production, Agriculture (greenhouses, aquaponics/hydroponics; Aquaculture (shrimps, fish), Water bottling, Pharmaceutical: minerals and proteins production; Research & Development Campus (Deep seawater biology, Global warming etc.)

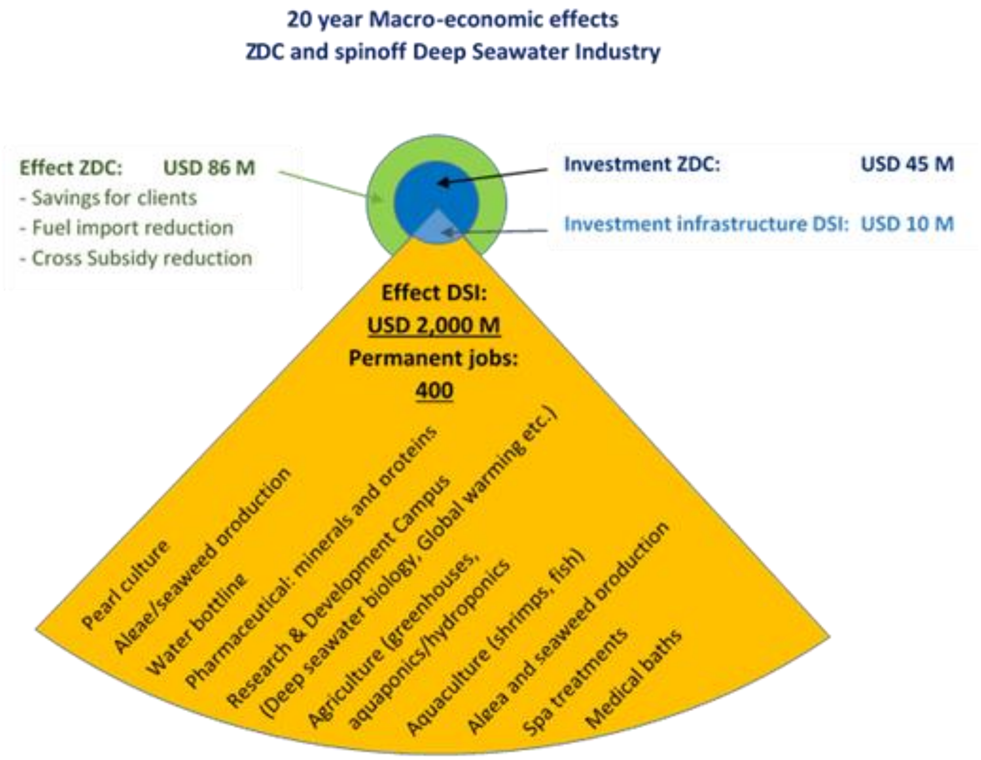
The total economic output of NELHA to the Hawaii economy is ca. $100 million dollars, which generated $5 million dollars in state tax revenue annually. NELHA tenants employ hundreds of people and their expenditures contributed to hundreds of other jobs in the Hawaii economy. It is estimated that NELHA generated ca. 600 jobs in Hawaii in. NELHA also has in-house Hawaii’s biggest exporter (bottled water to Japan, Koyo USA Corp.), grossing ca.140MUSD annually.

The effluent water of the Zakito system can be the input for the Deep Seawater Industry. Activities which are envisioned to be developed there are Agriculture (greenhouses which can produce a large part of vegetables needed for Curacao), Aquaculture (shrimp farming, lobster storage etc.), Micro Algae farms for the pharmaceutical industry, deep seawater desalination and R&D facilities like Ocean Thermal Energy conversion (OTEC). The Zakito system will pump an equivalent of ca. 100-150% of the water NELHA is currently selling annually.

On initiative of Zakito District Cooling the Curacao Deep Seawater Industry Platform has been established, consisting of public and private organizations (incl. Universities). Its goal is to analyze and determine the possibilities and value of deep seawater for Curacao and work out an implementation strategy for the subsequent deep seawater industry.

With an investment of ca USD 50M, Zakito District Cooling could create ca.100 construction jobs and would have a macroeconomic impact of ca USD 4M annually.

With the Zakito District Cooling project it will be possible to not only provide reliable hurricane and tsunami proof, sustainable and cost-effective cooling for many clients, but also develop a deep seawater industry which can generate export earnings and in time provide all the vegetables and seafood, creating a green and more self-sufficient Island. An industry that can potentially create an direct and indirect economic output of USD100M annually and 400-600 new medium to high level permanent jobs (R&D, education, commercial and industrial, etc.).



The Zakito District Cooling system and the subsequent potential for a Deep Seawater Industry can thus be seen as an insurance for our future energy and food supply, now and for generations to come.

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