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1.1 District Cooling Technology

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Outline of presentation

Description of District Cooling System (DCS)

Brief history

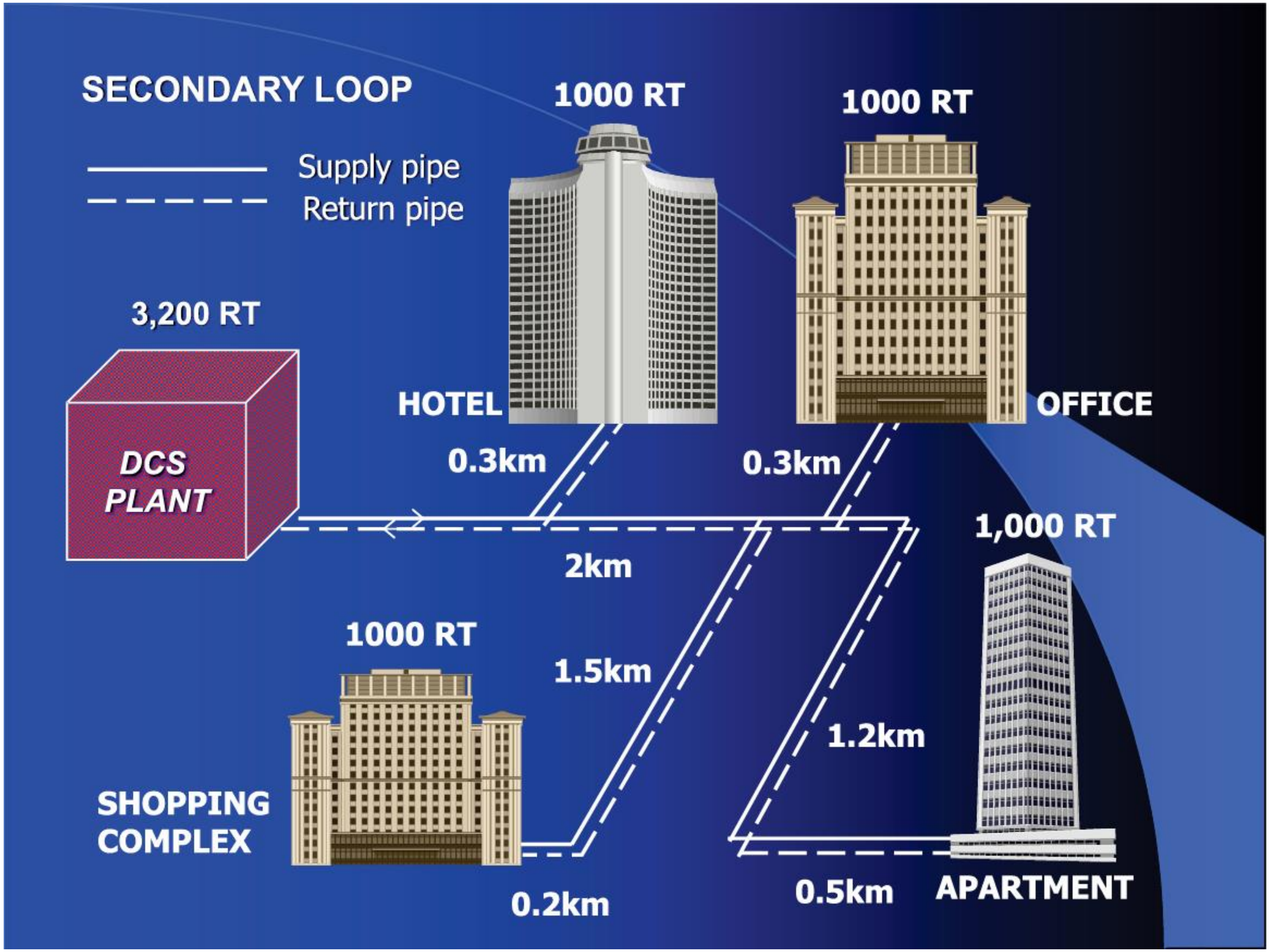
How DCS works

- Concept
- Lake water cooling in Toronto (Illustration)
- Components

Deep Lake Water Cooling

- Characteristics
- Countries using the scheme
- Sample establishment

What is district cooling (DC)?



District cooling is the production and distribution of chilled water from a central source to facilitate air conditioning. This is done by producing chilled water at a central plant and then piping the water to customers through an underground insulated pipes network.*

Source: Image: http://www.kenwisesb.com/wp-content/uploads/2014/03/1.jpg
* Tabreed. https://www.tabreed.ae/district-cooling/. Accessed: 24 October 2017

When did DC start ?

Brief history

14th century

- Concept of heating system started in Europe

1960s

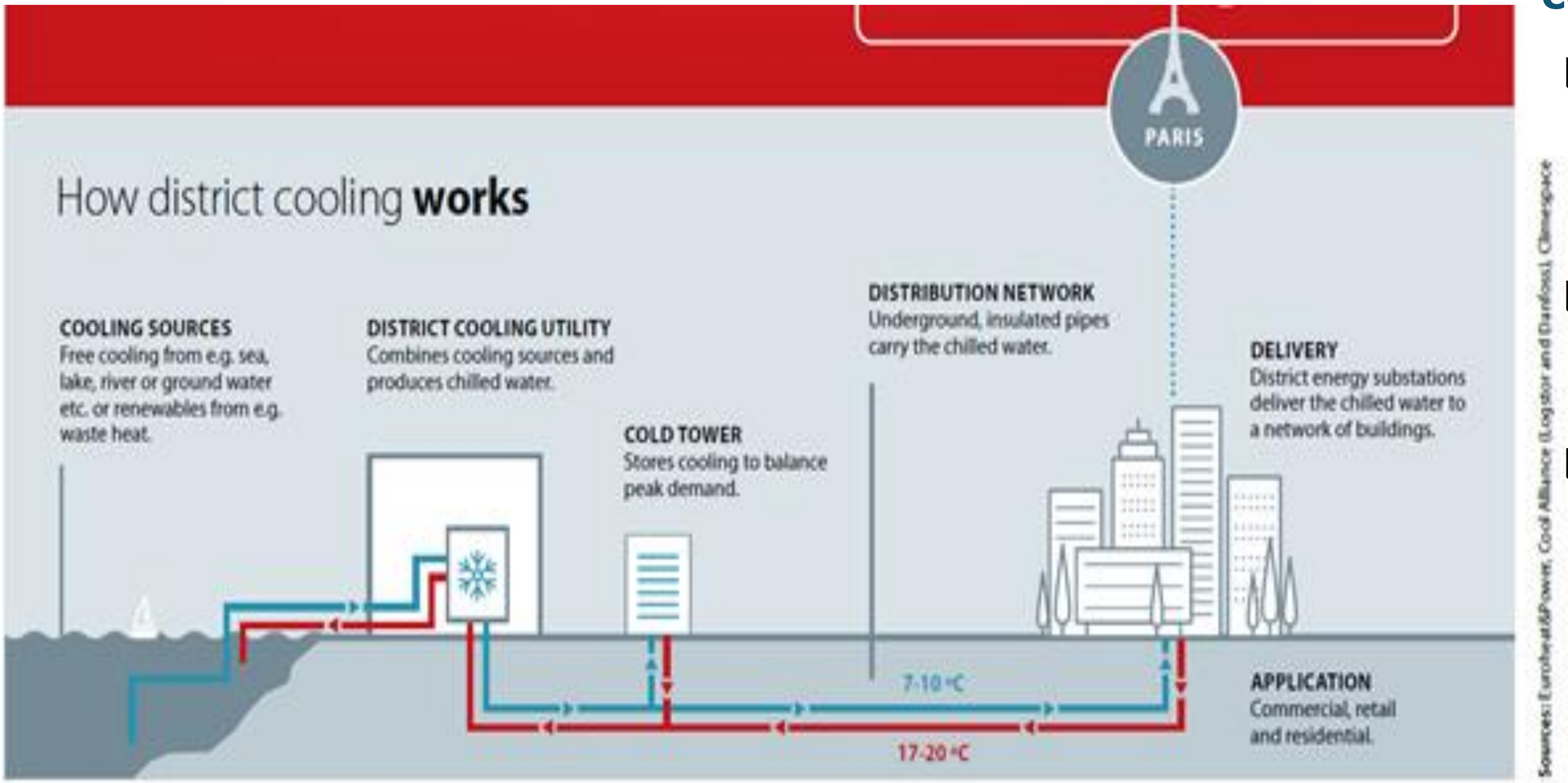
- Started as central chilled water plants in the Middle East

Late 1989

- USA first introduced district cooling system, through Denver's Colorado Automatic Refrigerator Company with the original intention of just distributing clean, cold air to buildings through underground pipes.

How does it work? (1)

The concept of district cooling



Source: Danfoss. (2016). How District Cooling Works. © Copyright Danfoss | Pravda.dk.

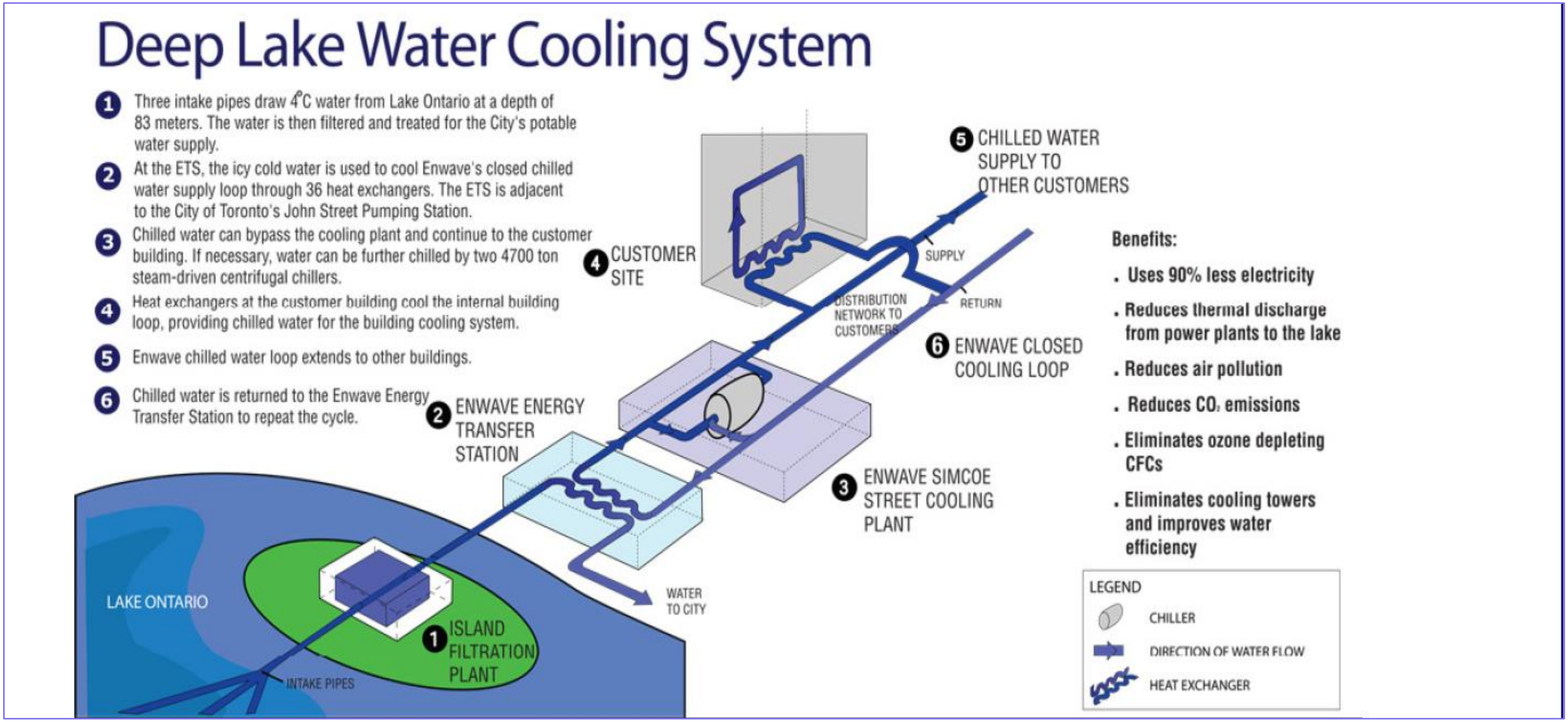
Three main components

- ❑ Cooling source and generating plant
- ❑ Cooling distribution system,
- ❑ Substation or Energy transfer station with heat exchanger

The concept of DCS is similar to that of heating—chilled water is distributed in much the same way as steam or hot water—but this time to satisfy cooling needs

How does it work (2)

Deep lake water cooling system in Toronto



Source: https://www1.nyc.gov/assets/globalpartners/downloads/pdf/Toronto_DLWC.pdf

The water is transported back to the source and repeats the cycle

How does it work (3)

Cooling Source and Generating Plant

- where the chilled water is typically generated and usually equipped with compressor chillers, heat-driven absorption chillers, or passive heat exchangers or with a combination of these technologies.

Compressor chillers—works similarly like a heat pump; driven by electricity, turbines or reciprocating engines and use different types of heat sinks*

Absorption chillers – works similarly like a compressor chiller but, the compressor is replaced by an arrangement of generator, pump, absorber and absorbent. To drive the cycle, uses hot sources such as steam, hot water, or gas and the heat sinks used are similar to compressor chillers.

Free cooling—direct use of a heat sink in a district cooling system, without a chiller. The advantage of free cooling is that it offers cooling on a renewable basis.

****A device or substance for absorbing excessive or unwanted heat. The most common heat sinks for district cooling system are air, wastewater, river water, lake water, seawater, groundwater, and treated sewage water***

How does it work (4)

Cooling Distribution System

- District cooling distribution systems are similar to district heating systems, the chilled water is distributed to buildings where it loses its cold content, thus cooling down the building temperature; the warmed up water is then returned to the central production facility

Energy Transfer Station with Heat Exchanger

- The interface between the district cooling system and the building cooling system is commonly referred to as the Energy Transfer Station (North America) or Substation (other countries); mainly consisting of a heat exchanger* unit with measurement (meters and transmitters) and control (pump, valves)

a device used to transfer heat between a solid object and a fluid, or between two or more fluids

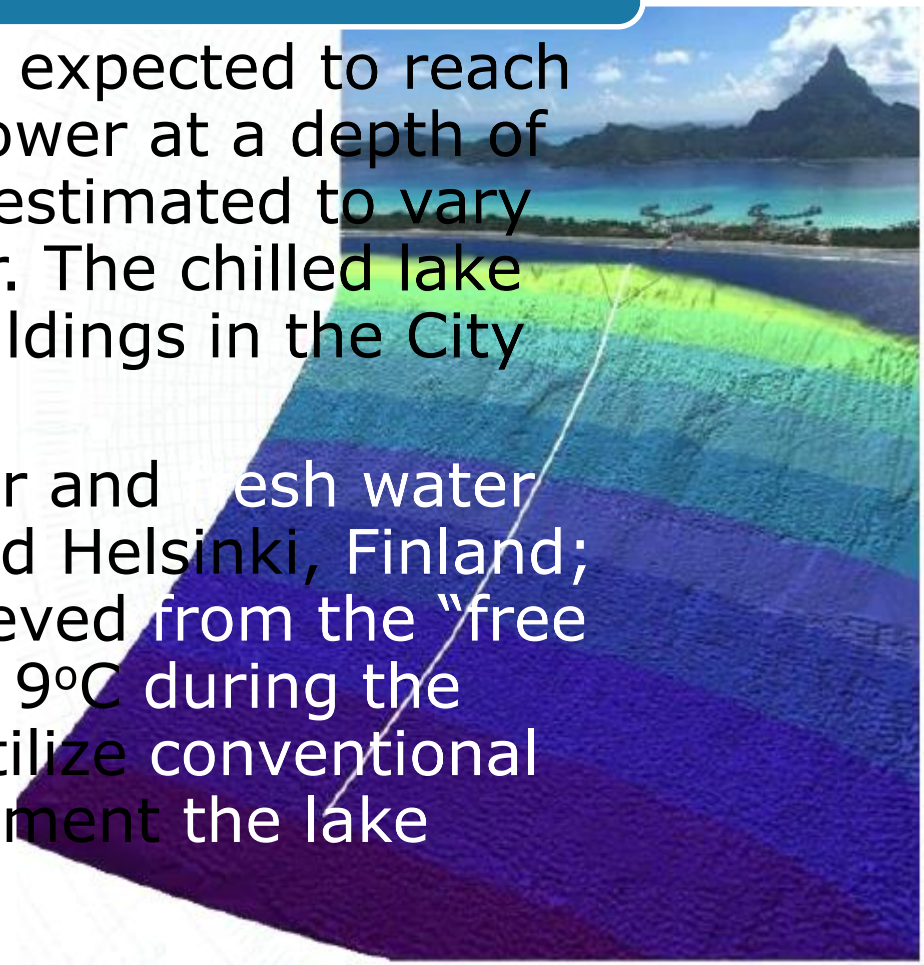
Deep Lake Water Cooling (1)

Characteristics

- any large physical body that could naturally act as a source of cold temperature fluid or heat sink; can be found in oceans, lakes, rivers or aquifers.
- maybe employed directly in building cooling systems, or indirectly by providing cooling energy through a heat exchanger to a circulating network of chilled water;
- local climatic conditions and physical geometry of the water body allow the water temperature to decrease to a relatively low temperature level, the water may be withdrawn and the cooling energy extracted and used. The water would then be returned to its source.

This source of cooling energy could displace many kWh of electricity consumed in the operation of electric vapor compression chiller systems as well as minimize the amount of refrigerants employed for air conditioning system

Countries which use this scheme



- "Great Lakes" in North America, expected to reach a water temperature of 4^{o}C or lower at a depth of 80 meters. This temperature is estimated to vary by 1^{o}C over the course of a year. The chilled lake water are utilized for cooling buildings in the City of Toronto, Ontario, Canada.
- Lake water (both from salt water and fresh water lakes) in Stockholm, Sweden and Helsinki, Finland; chilled water temperatures achieved from the "free cooling" source varies from 7 to 9^{o}C during the cooling season. Most systems utilize conventional chillers or heat pumps to supplement the lake water cooling

Source :Makai.com

Deep Lake Water Cooling (3)

Specific establishments

- Kona, Hawaii 30-50 tons (1986)
- Cornell University, Ithaca, NY, 20 000 tons (1999)
- Toronto, Canada, 58 000 tons (2001)
- Bora Bora, French Polynesia, 450 tons (2006)

- Excelsior Hotel in Hong Kong
- Hong Kong and Shang-hai Banking Corp (HSBC)
- Honolulu, Hawaii, 17 000 (under development)
- Curacao, Caribbean; 3 000 tons (under development)

Source: https://energyandsustainability.fs.cornell.edu/util/cooling/production/lsc/default.cfm

Deep Lake Water Cooling (4)

Benefits

- Long term savings on operations: reduction on maintenance and electrical costs by 85-90%
- Future costs are independent of price volatility;
- Short economic payback period, then ROI;
- Predictable, stable renewable energy and thus reduced fuel consumption and CO_2 emissions

Thank you for your kind attention

http://aperc.ieej.or.jp/

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