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Implementation of District Cooling System in Hong Kong: Challenges and Experiences

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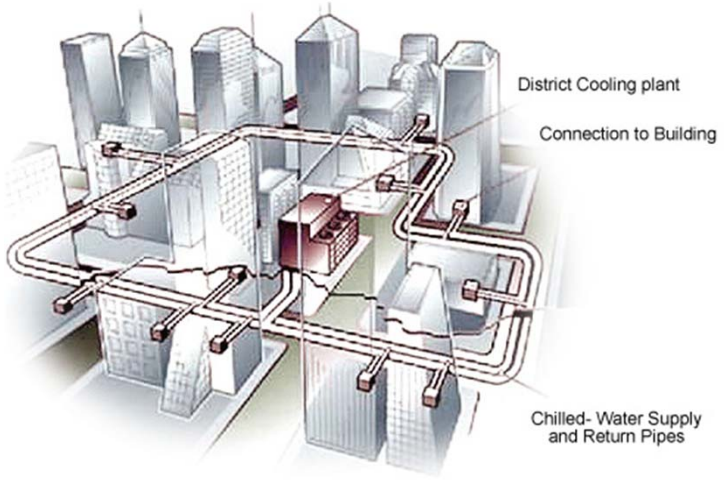
Brief Description of DCS at KTD

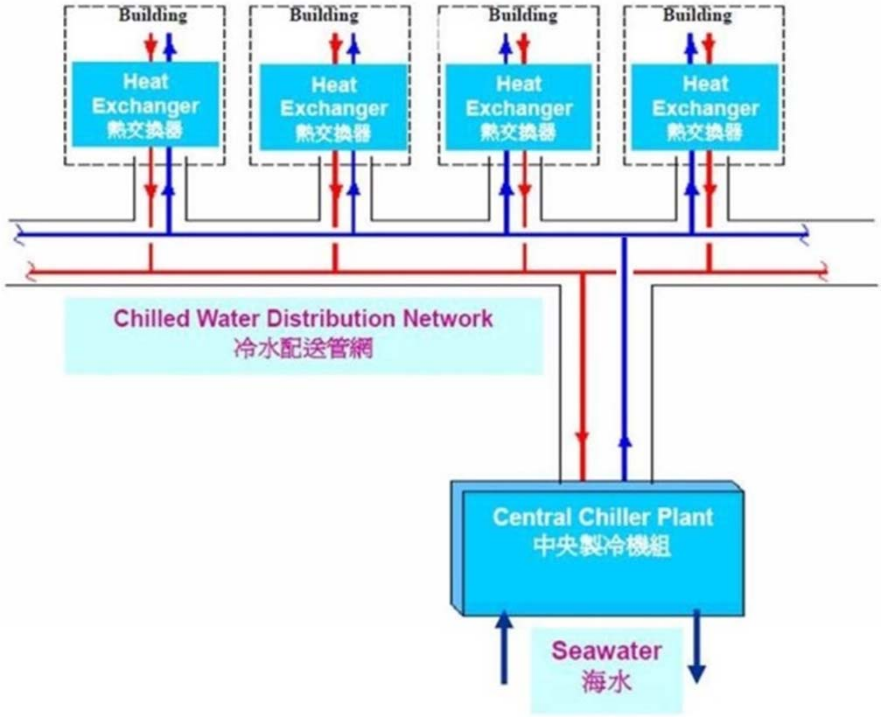
Kai Tak Development (KTD)

- Total area of over 320 hectares
- Comprises various types of buildings including hospitals, hotels, schools, commercial buildings, sport facilities, residential buildings, government buildings, etc.
- About 1.73 million square metres of public and private non-domestic air-conditioned floor areas

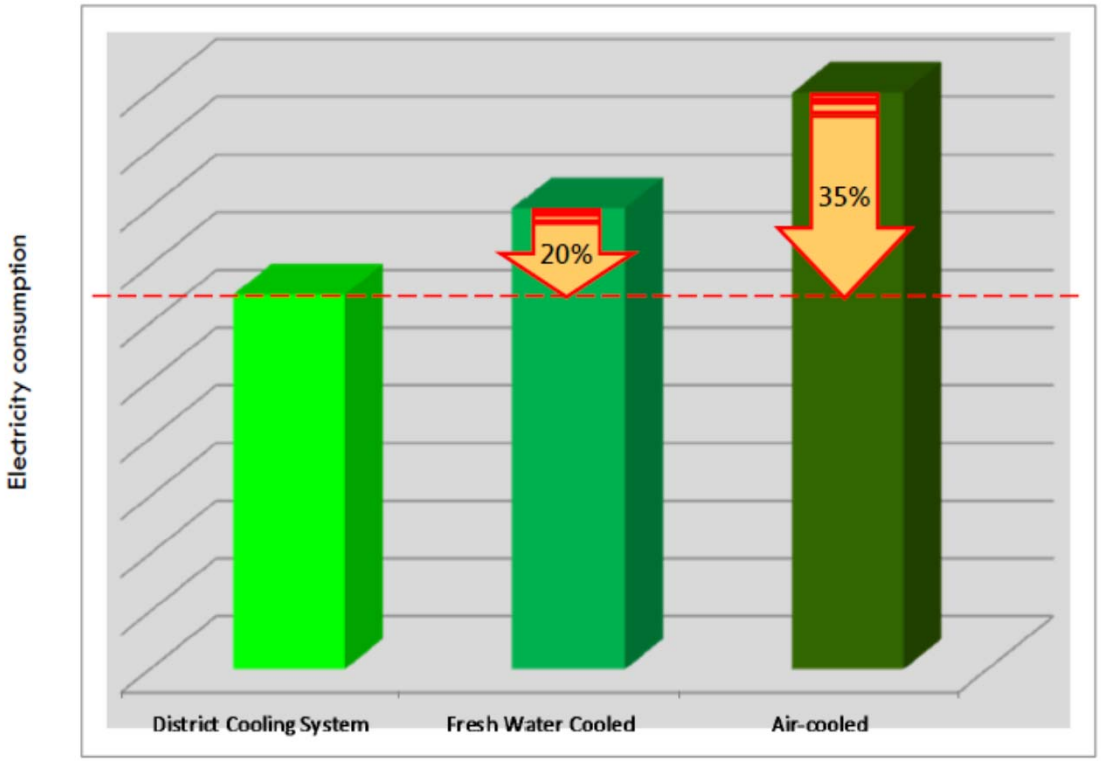
District Cooling System

- To supply chilled water to more than one building through a distribution network



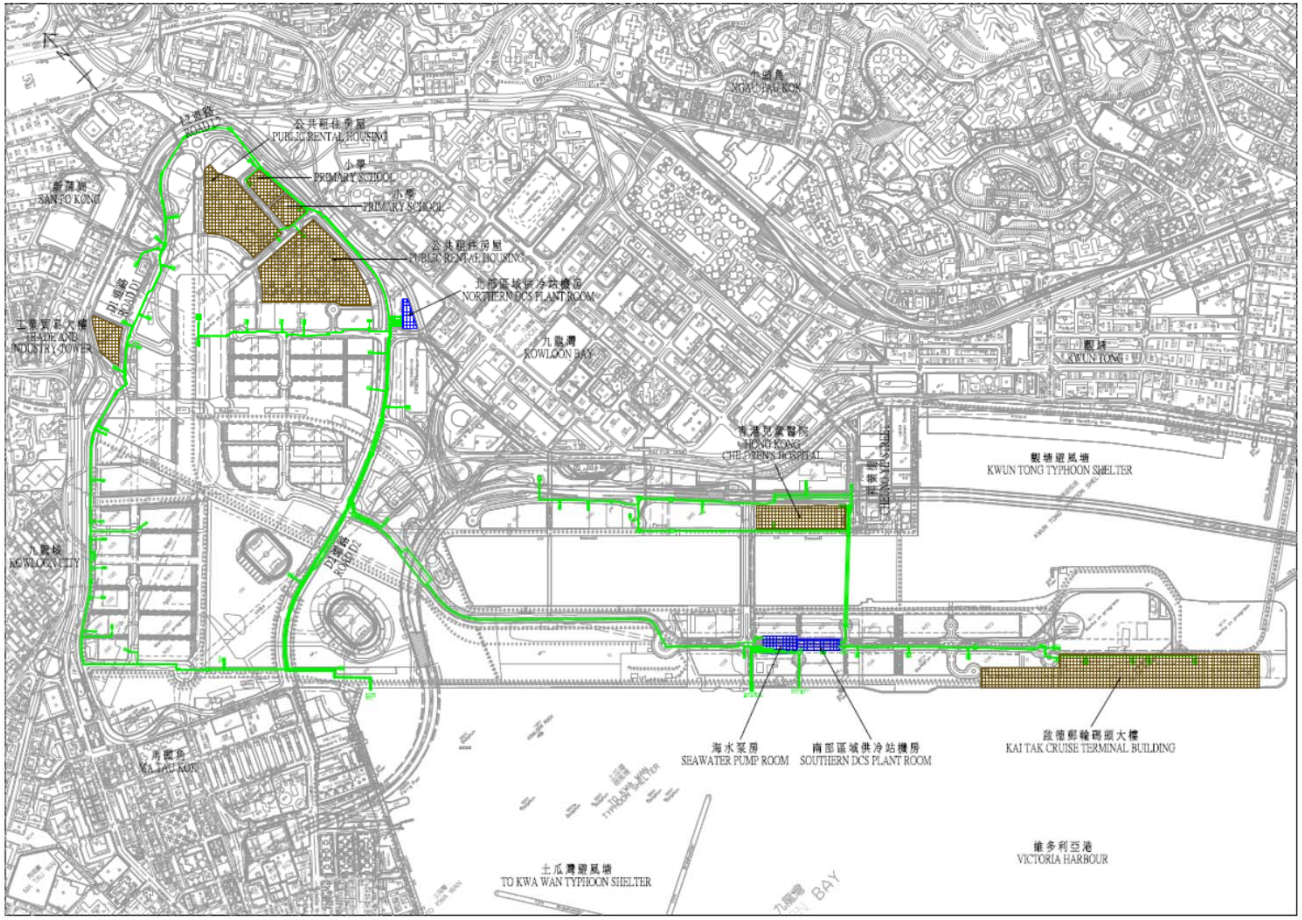


Benefits of DCS



- Energy saving as compared with traditional A/C systems
- Annual saving in electricity consumption up to 85 million kilowatt-hour (kWh)

DCS at Kai Tai Development



Design Data of DCS at KTD

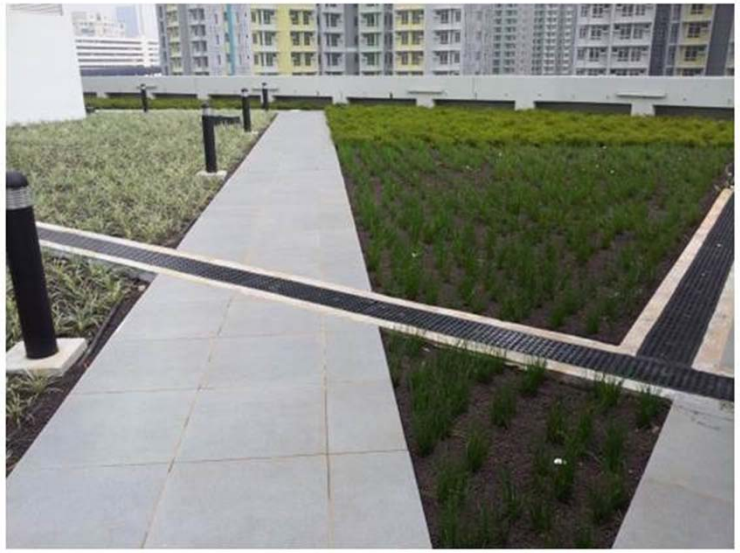
- Cooling capacity about 284 megawatt of refrigeration (MWr)
- North Plant – 162 MWr
- South Plant – 122 MWr
- A total of 26 nos. chillers, range from 1.4 MWr to 17.5 MWr
- Total underground water pipes: 39 kilometers

Benefits of DCS

- Reduction in upfront capital cost for installing chiller plants at consumer buildings, which account for 5 – 10% of the total building cost

Benefits of DCS

- More flexible building design for consumer buildings

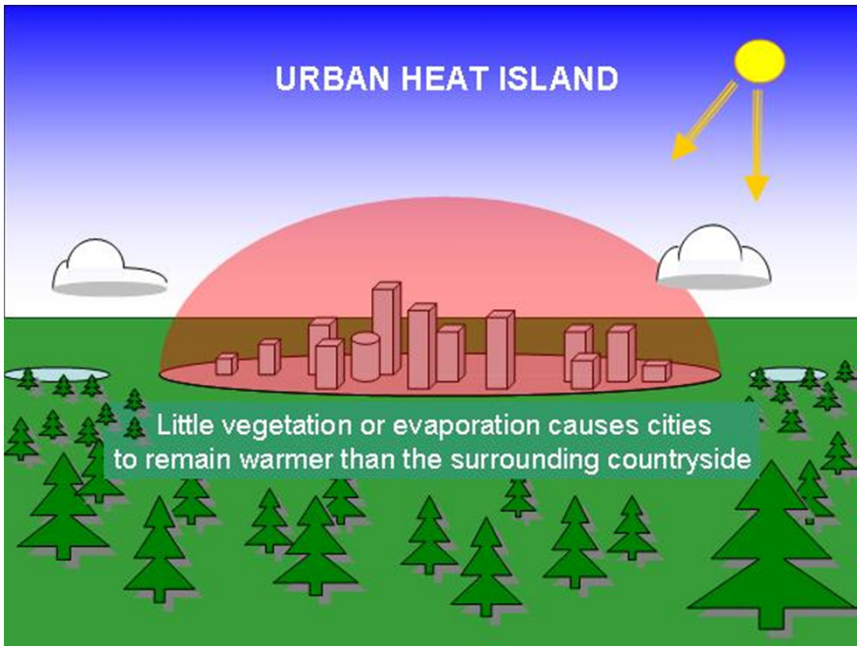


Benefits of DCS

- More adaptable to varying cooling demand
  - e.g. Increase cooling capacity without extensive modification works of the consumer buildings

Benefits of DCS

- Mitigation of heat island effect

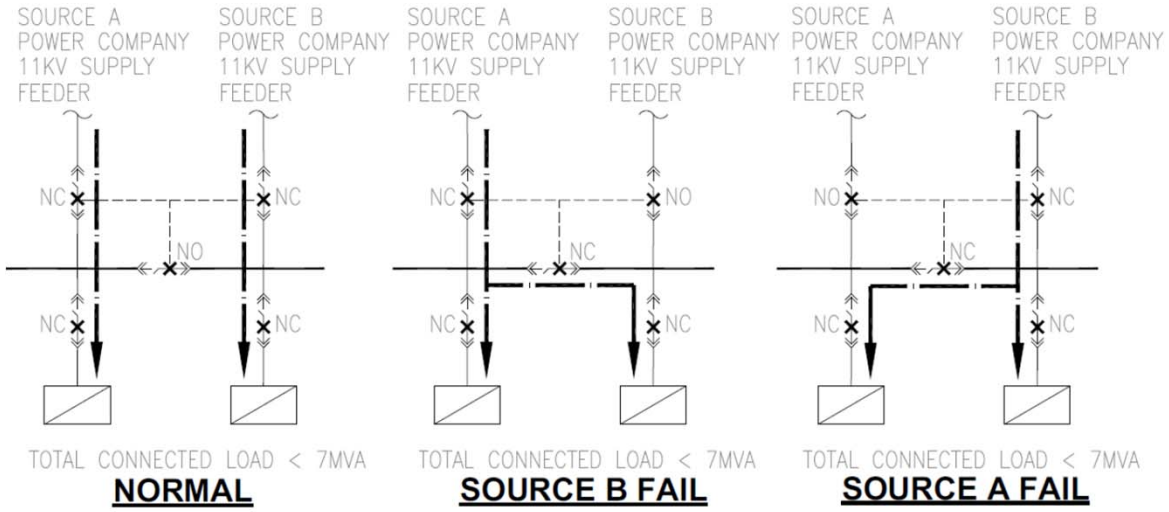


Implementation of DCS at KTD

- The whole DCS project will be implemented in 3 phases
- Phase I & II completed in 2013 and 2014 respectively and is serving Kai Tak Cruise Terminal and Ching Long Shopping Centre
- Phase III commenced in 2013 for completion by 2022

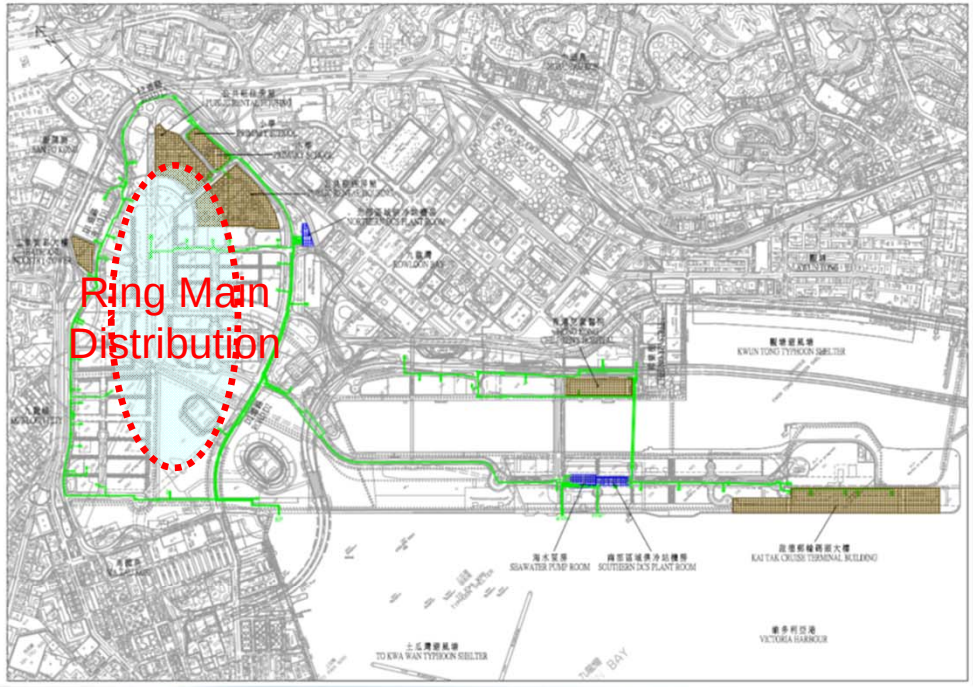
Reliable District Cooling Services

- Electricity Supply
  - Each supply feeder is only 50% loaded
  - Supply feeders come from 2 supply sources



Reliable District Cooling Services

- Chilled Water Pipe Network
  - Dual-feed supply by means of ring circuit arrangement



Reliable District Cooling Services

- Chilled Water Pipe Network
  - 3-pipe system arrangement

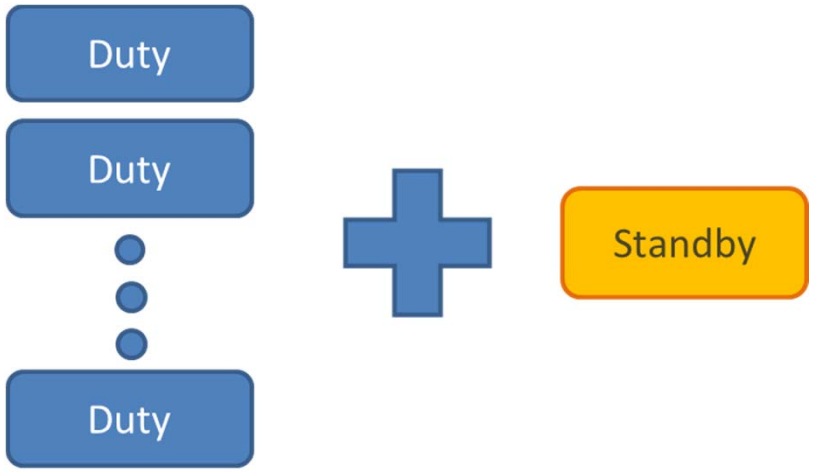
Reliable District Cooling Services

- Chilled water pipes with leakage detection cable
  - Thermal Insulation :
    - Polyurethane (PU)
  - External Jacket :
    - High Density Polyethylene (HDPE)

Reliable District Cooling Services

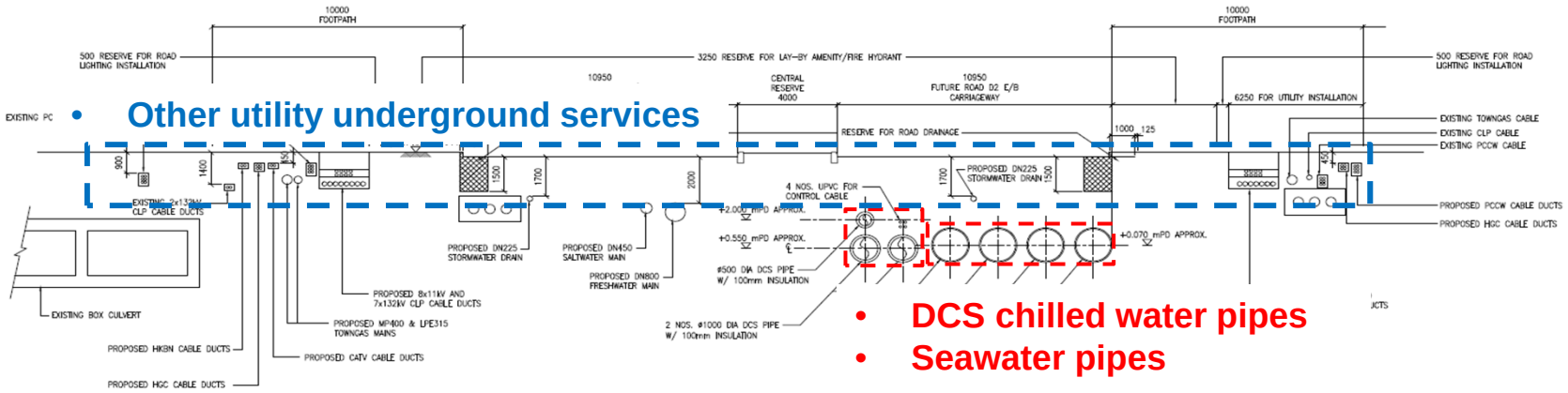
- Central Chiller Plant
  - "N+1" Arrangement :

    There are always at least one spare chiller and chilled water pump as standby equipment



Challenges in Water Pipe Laying Works

- DCS pipes are normally laid at the bottom of carriageway or footpath which increase the construction difficulties



Challenges in Water Pipe Laying Works

- If feasible, water pipes will be laid by open trench method at a level as shallow as possible
- The chance of seepage of underground water also increase the construction difficulties of DCS
- Installation of grout curtain and dewatering are required to control ground water flows

Challenges in Water Pipe Laying Works

- Due to site constraints/obstruction, open trench excavation method may not be feasible
- Trenchless excavation method is adopted to overcome such site constraints
- Precautionary measures are necessary to identify the underground conditions which includes :
  - Trial Pit
  - Underground Utilities Detection

Challenges in Water Pipe Laying Works

- About 1 km of DCS pipes are constructed by Heading Method or Hand Dug Tunnel

Heading Method

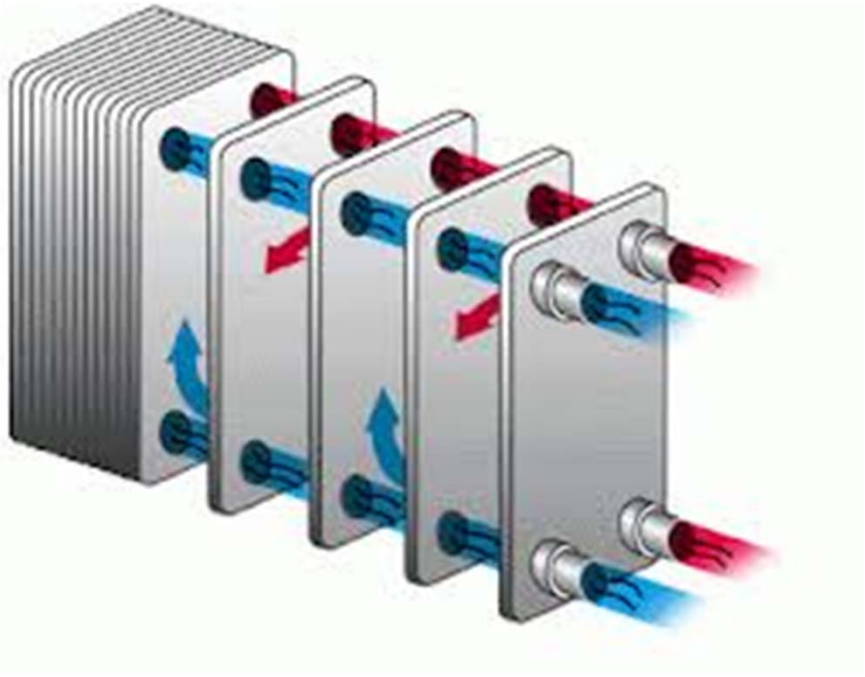
Hand Dug Tunnel

Challenges in Water Pipe Laying Works

- About 5 km of DCS pipes are constructed by Tunnel Boring Machine (TBM)

Diameter 2,800 mm TBM are involved, which is the largest one ever used in pipe jacking in Hong Kong

Challenges in Operation of DCS



At the primary chilled water side of the heat exchanger :

- Supply Temperature = 5℃
- Return Temperature = 13℃

At the secondary chilled water side of the heat exchanger :

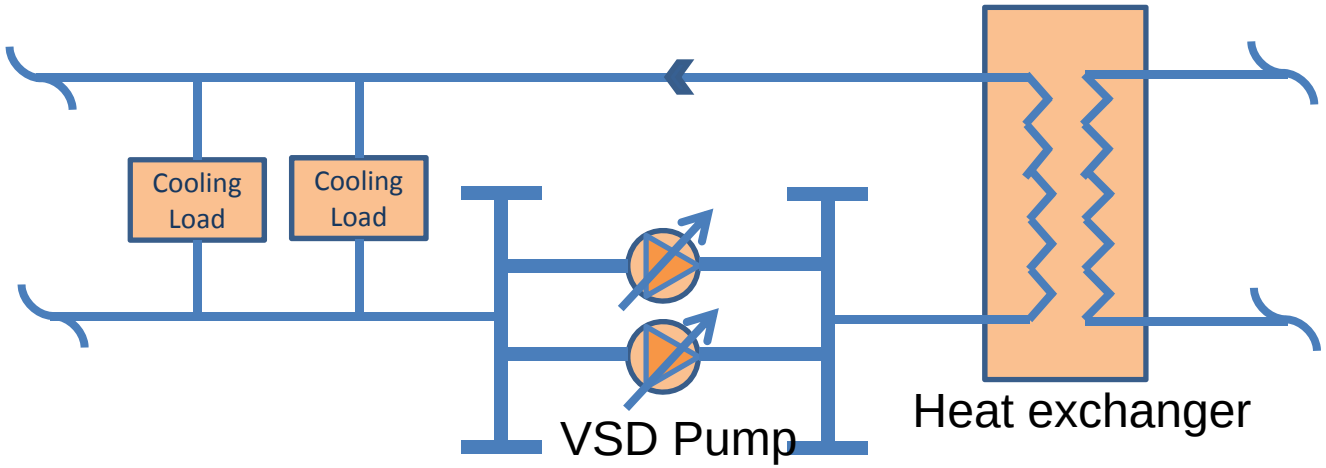
- Supply Temperature = 6℃
- Return Temperature = 14℃

Challenges in Operation of DCS

- Under low load condition, chilled water return temperature at the consumer side may fall below 14℃
- More pumping energy is consumed and the system efficiency is adversely affected

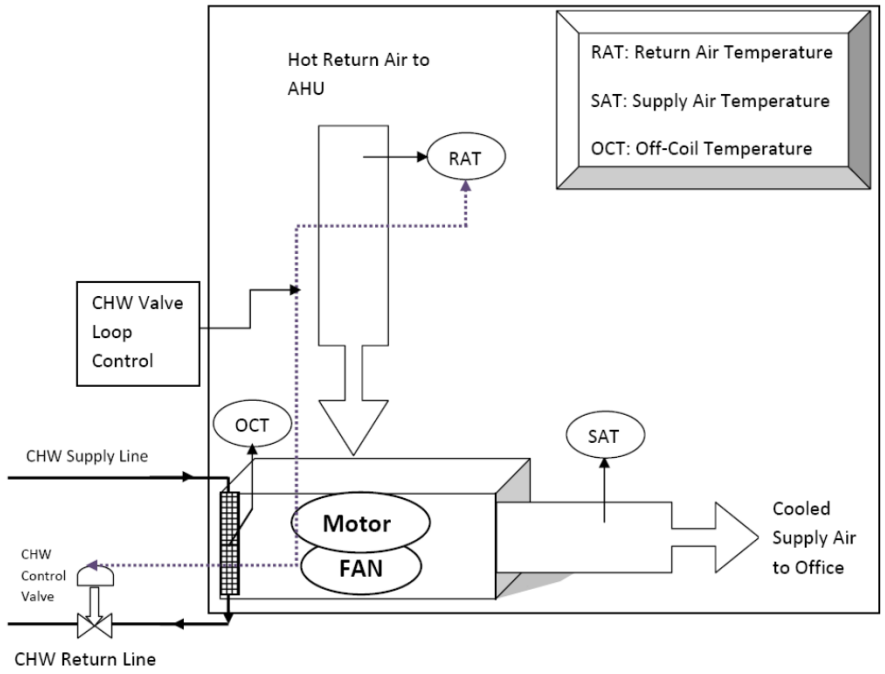
Challenges in Operation of DCS

- To enhance energy efficiency, the following design features at the consumer side are recommended
  - Variable Flow Chilled Water System



Challenges in Operation of DCS

- Temperature Oriented Control
  - Operation of the control valve should make reference to the Return Air Temperature



Challenges in Operation of DCS

- Interlocking Control Mechanism
  - When the status of the AHU/ FCU is off, the associated control valves should also be closed

Programmable Logic Controller (PLC)

District Cooling Services Bill

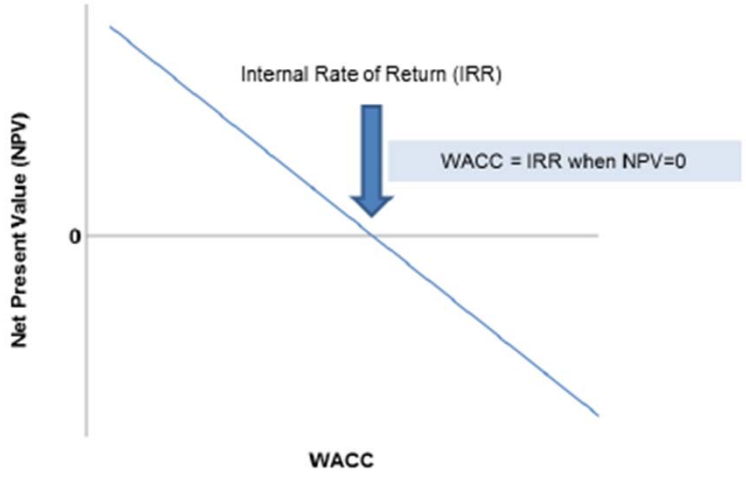
- The District Cooling Services Bill will be introduced to the Legislative Council in 2014-15 to set the tariff mechanism and tariff rates

District Cooling Services
Tariff Charging Principles

- Charging Principles of district cooling services:
  - Comparable to the cost of individual water-cooled air-conditioning systems (WACS) using cooling towers

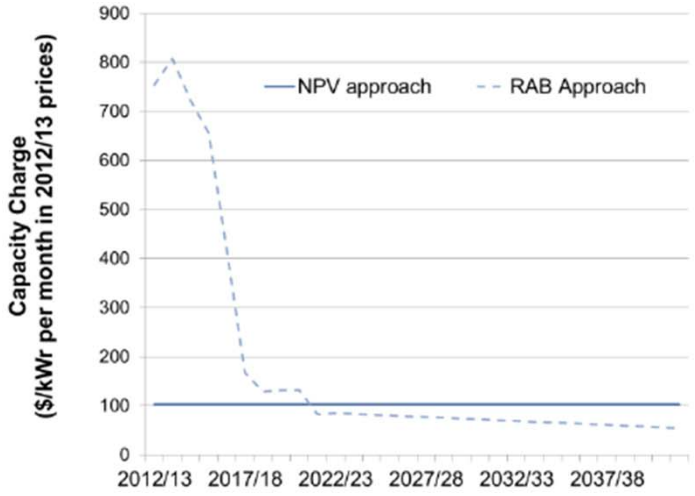
District Cooling Services
Tariff Charging Principles

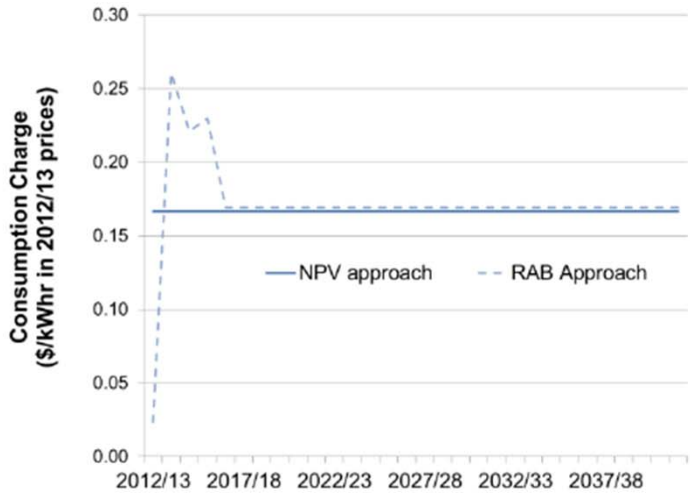
- Charging Principles of district cooling services:
  - Cost recovery in 30 years for capital and operating costs



District Cooling Services
Tariff Charging Principles

- Charging Principles of district cooling services:
  - Price stability



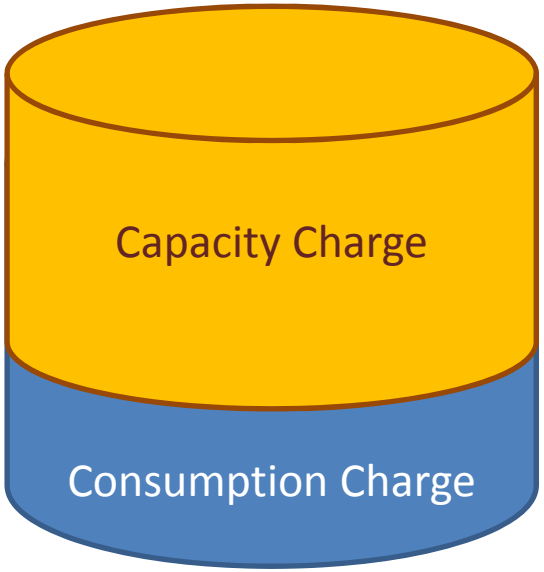


District Cooling Services
Tariff Charging Principles

- Charging Principles of district cooling services:
  - Simple charging mechanism with common charge rates for all consumers

District Cooling Services Tariff Charging Mechanism

- The proposed tariff of District Cooling Services comprise of two major components :
  - Capacity Charge
  - Consumption Charge



District Cooling Services Tariff Charging Mechanism

- Adjustment mechanism of the proposed tariff of District Cooling Services :
  - Capacity charge rate is proposed to be adjusted annually based on the Composite Consumer Price Index (CCPI)
  - Consumption charge rate is proposed to be adjusted annually to take into account of the change in electricity tariff rate

Conclusion

- DCS is a multi-disciplinary project involving civil engineering and E&M engineering
- Challenges in project management, design, construction, operation as well as legislation of tariff mechanism
- Implementation program is on schedule
- Scheduled to be completed in 2022 to achieve annual saving of 85 million kWh

Thank You


Joint Symposium 2014
25 November 2014 The Kowloon Shangri-La, Hong Kong
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