For discussion
On 22 July 2003

Legislative Council
Panel on Environmental Affairs

Territory-wide Implementation Study for Water-cooled Air Conditioning Systems in Hong Kong

INTRODUCTION

This paper briefs Members on the findings and recommendations of the "Territory-wide Implementation Study for Water-cooled Air Conditioning Systems in Hong Kong" (hereunder referred as "this Study"), and invites Members' views on the strategies to promote Water-cooled Air Conditioning Systems (WACS) in Hong Kong.

BACKGROUND

2. At the meetings of this Panel held on 10 February 2000 and 2 March 2000, Members were informed that the Administration supported the findings and recommendations of the "Preliminary Phase Consultancy Study on Wider Use of Water-cooled Air Conditioning Systems in Hong Kong". Subsequently, with the support of this Panel, we obtained the funding approval of the Finance Committee for conducting this Study and two other studies on pilot implementation of WACS in a New Development Area (NDA)[1] and an Existing Developed Area (EDA)[2].

3. The Electrical and Mechanical Services Department (EMSD) commissioned this Study in October 2000 to formulate plans, programmes and control requirements for the phased implementation of WACS in the whole territory and examine in detail the relevant environmental, health, regulatory, institutional, financial, technical and land administration issues. The Study covers three WACS schemes, namely, the Centralised Piped Supply System for Cooling Towers (CPSSCT or Cooling Tower Scheme),

[1] This refers to the Implementation Study for a District Cooling Scheme at South East Kowloon Development, the findings of which were reported to this Panel at the meeting held on 20 December 2002.

[2] This refers to the Implementation Study for Water-cooled Air-Conditioning Systems at Wan Chai and Causeway Bay which is expected to be completed by end 2003

the more energy-efficient District Cooling Scheme (DCS) and Centralised Piped Supply System for Condenser Cooling (CPSSCC or Central Seawater Scheme)[3].

CURRENT APPLICATION OF WACS IN HONG KONG

4. WACS is not a new technology. Utilizing seawater for condenser cooling in air-conditioning system has already been adopted by some individual buildings along the seafront. Pursuant to the current Waterworks Regulations, except with the permission in writing of the Water Authority, no person shall use water from waterworks for air-conditioning use. Evaporative type cooling towers (i.e. those to be used under the Cooling Tower Scheme) are only permitted to use for industrial or essential purposes and seldom permitted for comfort air-conditioning in commercial buildings. In June 2000, the "Pilot Scheme for Wider Use of Fresh Water in Evaporative Cooling Towers for Energy-efficient Air Conditioning Systems" was launched for two years in six designated areas. The Scheme allows the use of fresh water evaporative cooling towers in all new and existing non-domestic buildings within the designated areas. The scheme was extended in May 2002 to last until 31 May 2004. The number of designated areas was also expanded to 45 in December 2002.

5. So far, there has only been one CPSSCC system in Hong Kong which was constructed by the Airport Authority for the Hong Kong International Airport and buildings nearby. There has been no DCS type WACS implemented in Hong Kong.

KEY FINDINGS OF THE STUDY

6. The key findings are as follows:-

(a) The projected air conditioning loads for non-domestic premises in the whole territory were estimated to be 13,348,500 kW by 2020[3];

(b) By switching from an Air-cooled Air Conditioning System

[3] According to the Hong Kong Energy Statistics Annual Report and the Energy Modelling of the study, there was 8,090,000 kW non-domestic air conditioning load in Year 2000. The Consultants estimated that for a mean annual growth of 2.5% in air conditioning load, the non-domestic air conditioning load in Year 2020 will become 13,348,500 kW.

(AACS) to the DCS, Central Seawater Scheme, or Cooling Tower Scheme, it is possible to achieve annual air conditioning end-use energy savings of up to 35%, 28% and 20% respectively;

(c) The territory is divided into 50 zones. Broad evaluations about the adequacy of water supply infrastructure, financial viability of adopting WACS, environmental impacts, and energy conservation benefits were conducted to formulate the master plans, implementation priorities, and programme, the details of which are at **Annexes B to E;**

(d) Having compared the financial viabilities, energy efficiency and infrastructure constraints of the three types of WACS schemes, it was found that:-

(i) The Cooling Tower Scheme requires the least initial infrastructure and equipment costs. It could co-exist with either the DCS or the Central Seawater Scheme in the same zone;

(ii) Financial viabilities of the DCS and Central Seawater Scheme are more sensitive to pipeline wayleave charges[4] for their huge and extensive dedicated supply and discharge pipeline infrastructure; and

(iii) It is not practical to allow the DCS and the Central Seawater Scheme to co-exist in the same zone because both systems are capital intensive and there is limited underground space for laying two sets of extensive pipelines. With higher energy efficiency and cost effectiveness, the DCS is preferable to the Central Seawater Scheme in general and the latter should only be considered under exceptional circumstances;

[4] The Government levies annual fees on owners of subterranean pipes based on the length and diameter of the pipe. The fees levied for granting of an easement or a licence for laying such pipes are assessed in accordance with guidelines adopted by the Lands Department.

Cooling Tower Scheme

(e) Studies on the demand for water supply and sewerage arising from the Scheme revealed the following:-

(i) Additional fresh water demand generated by the Scheme could largely be met by the existing fresh water supply infrastructure by making use of the capacity reserved for the anticipated fresh water demand growth due to the planned future developments in the short to medium term. In the long run, the water supply system should be upgraded to meet the demand arising from the gradual intake of the planned developments;

(ii) In most situations, all wastewater from cooling towers could be used for toilet flushing and zero additional discharge could be achieved; and

(iii) Use of fresh water, rather than seawater, by cooling towers is preferable due to the high corrosive effect of seawater and insufficient capacity of existing seawater supply infrastructure;

(f) Strategic Environmental Assessment (SEA) reviewed that proper control of the concentration of residual chemicals in the wastewater from the cooling towers is necessary to prevent undermining the effectiveness of standard sewage treatment processes;

(g) The Health Risk and Control assessment concluded that the requirements stipulated in the existing "Code of Practice for Prevention of Legionnaires' Disease" and the application procedures/guidance document for the "Pilot Scheme for Wider Use of Fresh Water in Evaporative Cooling Towers for Energy-efficient Air Conditioning Systems" issued by EMSD should be supplemented by a standing surveillance programme to prevent the breeding of Legionnaire bacteria;

District Cooling Scheme and Central Seawater Scheme

(h) To avoid overloading existing seawater supply and sewerage infrastructure, the DCS and the Central Seawater Scheme adopting the once-through seawater cooling system[5] will require dedicated supply and discharge pipelines, which can be provided by competent private contractors. The Administration should, however, be responsible for vetting and approving the programme, zoning and land requirements;

(i) The implementation of either the DCS or the Central Seawater Scheme should not cause any insurmountable traffic problems. However, since the relevant contractors/operators will need to lay large water pipes under major roads with heavy traffic, they should conduct detailed traffic impact assessment and implement proper mitigation measures, such as time constraints imposing on pipelaying work, decked open trench excavation method and trenchless excavation method, etc to minimize the disruption to the traffic and pedestrians; and

(j) SEA reviewed that:-

(i) It is not suitable to locate the intakes and outfalls of a DCS and a Central Seawater Scheme adopting the once-through seawater cooling system in sensitive marine areas such as Deep Bay, Tolo Harbour and near fish culture zones;

(ii) Proper control of the concentration of residual chemicals in the wastewater from DCS or the Central Seawater Scheme adopting once-through seawater cooling system is necessary ; and

(iii) There would be no significant air quality and noise problems during implementation.

[5] The once-through seawater cooling system means an open loop system with seawater passing through the condenser and returning the warm seawater back to the sea.

RECOMMENDATIONS OF THE STUDY

7. In light of the above findings, the following implementation strategies were recommended:-

(a) Cooling Tower Scheme

(i) The Scheme should be accorded with priority for territory-wide implementation, given that it does not require substantial investment in infrastructure and long planning lead-time before actual implementation;

(ii) The Scheme should first be implemented in those zones with adequate fresh water supply capacities;

(iii) The environmental and health risk control measures outlined in paragraphs 6(f) and 6(g) above should be stipulated as the conditions for permission to use fresh water by cooling towers; and

(iv) A standing surveillance programme to ensure proper implementation of the required control measures by the owners or operators of the cooling towers should be set up by the approving authority;

(b) District Cooling Scheme

(i) Suitable zones should be selected for detailed studies and pilot implementation; and

(ii) The rights to implement and operate a DCS in a designated area can be granted through either a contractual agreement or a statutory licensing agreement[6]. The environmental and regulatory control measures described in paragraph 6(j) above

[6] The Contract Approach can only govern the rights and obligations of the Government and the DCS operator. The Statutory Licensing Approach is necessary if the rights and obligations of third parties are affected. For example, this approach is necessary if the designated DCS would encroach on private land/premises; if mandatory connection to the DCS is required; or if other parties are required to carry out investigation and take necessary measures to protect the distribution network before executing any works in the vicinity.

should be stipulated as the contract conditions or licensing conditions;

(c) The Central Seawater Scheme, being less energy efficient than the DCS and mutually exclusive with the latter in the same district, should be considered when DCS is not practicable;

(d) A Regulator Office should be set up to oversee the above key implementation issues of Cooling Tower Scheme and District Cooling Scheme.

ENVIRONMENTAL BENEFITS OF WIDER-ADOPTION OF WACS

8. The consultant has estimated[7] that wider-adoption of WACS schemes in the territory can help reduce electricity consumption by air-conditioning systems by 1,360 millions kWh or about $1.2 billion saving[8] per year. Moreover, the energy conserved can also be translated into reduction in greenhouse gas emission by 950,000 tonnes annually.

WAY FORWARD

9. EMSD will upload the Executive Summary of the Study onto its website for public access and comment. In the light of the feedback received and having regard to the response rate to the Pilot Scheme for Wider Use of Fresh Water in Evaporative Cooling Towers for Energy-efficient Air Conditioning Systems, the Government will review the pace of expanding the Scheme to allow the wider use of fresh water for evaporative cooling towers in Hong Kong. We will also consider how to involve the private sector in implementing the DCS in areas recommended by the consultant.

[7] The estimation assumes 90% penetration of DCS in 10 newly developed DCS zones, 35% penetration of DCS plus 15% penetration of Cooling Tower Scheme in 5 existing DCS zones and 50% penetration of Cooling Tower Scheme in the remaining zones with adequate fresh water supply capacity. For newly developed zones, most building owners are assumed to be rational and are expected to use the most cost effective air-conditioning systems that become available. For existing zones, due to the higher switching cost, the penetration rates are assumed to be lower.

[8] Assuming $0.9 per kWh.

ADVICE SOUGHT

10. Members are invited to comment on the findings and recommendations of the Study and offer views on the implementation strategies of the WACS schemes.

Environment, Transport and Works Bureau
Electrical and Mechanical Services Department
July 2003

BASIC FEATURES OF DISTRICT COOLING SCHEME, CENTRAL SEAWATER SCHEME, AND COOLING TOWER SCHEME

The basic features of the three WACS schemes, namely the District Cooling Scheme, the Central Seawater Scheme, and the Cooling Tower Scheme, are summarized below :-

- The District Cooling Scheme **generates chilled water centrally** and supplies chilled water to the connected building groups for air-conditioning through a closed loop of distribution pipeline network. This Scheme is suitable for large developments, where a large central chiller plant is normally located in close proximity to user buildings. It may employ seawater cooled once through condenser, or fresh water or sea water cooling towers for heat ejection.

- The Central Seawater Scheme supplies sea water from a central pumphouse through an open loop of distribution pipeline network to individual buildings' air-conditioning systems, which generate their own chilled water and employ **once through sea water condensers** for heat ejection. Due to the need to consume a large volume of seawater, this Scheme is most suitable for buildings near the sea front.

- The Cooling Tower Scheme, unlike the two Schemes above, does not have centralized components and requires no pipeline network. Individual buildings are installed with their own **evaporative cooling towers** for heat ejection by their own chiller plants. Cooling towers may use seawater or fresh water. Water may be recycled for a number of times before being discharged into the sewerage system. As the Cooling Tower Scheme does not require a new distribution network, the investment in infrastructure would be minimal.

POTENTIAL ZONES, PHASING AND RANKING LIST FOR COOLING TOWER SCHEME

	Condition of Fresh Water Supplies Capacity	Adequate	Marginally Adequate	Currently Inadequate	Remark
Zone ID	Zone District Recommended Relaxation Timeframe	Now	2005-2008	Subject to WSD's Programme	Concurrent DCS Potential Zone
A8	North Point	✓			
A11	Tsim Sha Tsui (Central)	✓			
A12	Tsim Sha Tsui (South)	✓			✓
A13	Tsim Sha Tsui (East)	✓			
A14	Hung Hom (KCRC Station)	✓			
A15	Aberdeen	✓			
A16	Yau Ma Tei	✓			
A17	Mongkok	✓			
A18	Prince Edward	✓			
A20	Tuen Mun	✓			
B2	South East Kowloon Redevelopment	✓			✓
B4	Telegraph Bay	✓			
B5	North Lantau Foreshore New Reclamation	✓			✓
B6	Penny's Bay New Reclamation	✓			✓
C2	Tuen Mun Area 38 New Reclamation	✓			✓
C4	Tai Po	✓			
C5	Yuen Long	✓			
D1	Hung Shui Kiu NDA	✓			
D2	Kwu Tung North NDA	✓			
E1	Wong Chuk Hang	✓			
E3	To Kwa Wan	✓			
E4	Cheung Sha Wan	✓			
E6	Kwun Tong	✓			
E9	Fanling	✓			
E10	Yuen Long	✓			
E12	Kowloon Bay	✓			
E13	Kwai Chung	✓			
A5	Wan Chai (North)	✓			✓
A4	Wan Chai (South)		✓		
A1	Western District		✓		
A2	Central District (Central)		✓		✓
A3	Central District (West)		✓		✓
A6	Causeway Bay (South)		✓		
A7	Causeway Bay (North)		✓		✓
A9	Taikoo Shing		✓		
A10	West Kowloon (Kowloon Station)		✓		
B1	Central & Wan Chai New Reclamation		✓		✓
B3	West Kowloon (Art & Performance Venue)		✓		✓
B7	Tung Chung New Reclamation		✓		✓
B8	Tseung Kwan O Area 137		✓		✓
C1	Pak Shek Kok		✓		
C3	Chek Lap Kok Airport (North-east Corner)		✓		✓
C6	Tseung Kwan O New Reclamation		✓		✓
E2	Chai Wan		✓		
E7	Sha Tin Shek Mun		✓		
F1	Other Parts		✓		
A19	Sha Tin			✓	
E5	San Po Kong			✓	
E8	Fo Tan			✓	
E11	Tsuen Wan			✓	

ANNEX C

POTENTIAL ZONES AND RANKING LIST FOR DISTRICT COOLING SCHEME

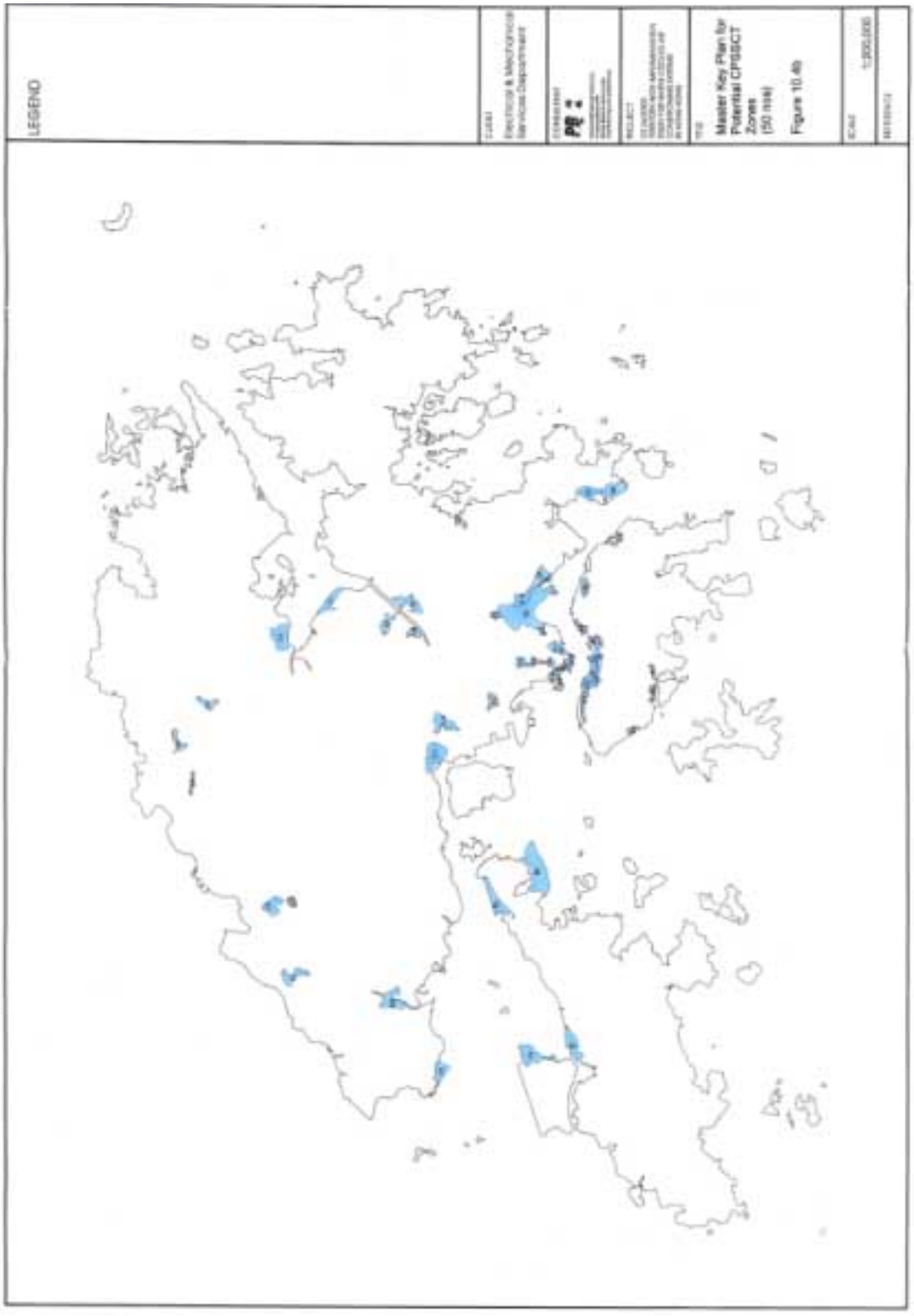
Zone ID	Location of DCS Zone	Ranking according to Financial Viability	Ranking according to Energy Saving	Overall Ranking
C3	North-east Corner Commercial Distrct of HK International Airport at CLK - New Development Area	1	2	1
B8	Tseung Kwan O Area 137 New Reclamation Area - New Development Area	2	6	2
A2	Central District (West) - Existing Developed Area	4	4	3
A4-5	Wan Chai District - Existing Developed Area	5	5	4
A3	Central District (Central) - Existing Developed Area	3	8	5
A11-A13	Tsim Sha Tsui District - Existing Developed Area	11	3	6
B6	Penny Bay - New Development Area	6	9	7
B2	South East Kowloon New Redevelopment - New Redevelopment Area	14	1	8
B1	Central & Wan Chai New Reclamation - New Development Area	7	11	9
A6-7	Causeway Bay District - New Development Area	10	10	10
C6	TKO New Reclamation Industrial Areas - New Development Area	8	13	11
B5	North Lantau New Reclamation - New Development Area	9	12	12
B7	Tung Chung New Reclamation - New Development Area	15	7	13
B3	West Kowloon New Reclamation Area - New Development Area	12	15	14
C2	Tuen Mun New Reclamation Area - New Development Area	13	14	15

Notes:

1. Overall ranking based on equal weighting on financial viability and energy saving benefit.
2. Phasing and implementation timeframe is subject to the development programme of new development.

ANNEX D

MASTER PLAN FOR COOLING TOWER SCHEME (50 ZONES)



ANNEX E

MASTER PLAN FOR DISTRICT COOLING SCHEME (15 ZONES)