Electrical & Mechanical Services Department
Hong Kong

Agreement No. CE51/2000 Implementation Study for a District Cooling Scheme at South East Kowloon Development

Executive Summary

Ove Arup & Partners Hong Kong Ltd
Consulting Engineers

Electrical & Mechanical Services Department Hong Kong
Energy Efficiency Office

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1. INTRODUCTION

In January 1997, the Energy Efficiency and Conservation Sub-Committee (EE&CSC) of the Energy Advisory Committee expressed the view that air-conditioning in commercial premises had become a basic requirement and supported the accord of high priority to consultancy studies which would support policy decision-making and address specific implementation problems relating to air-conditioning and energy efficiency matters.

In line with the above deliberation, the Electrical & Mechanical Services Department (EMSD) commissioned, in October 1998, a Preliminary Phase Consultancy Study on the Wider Use of Water-cooled Air-Conditioning Systems (WACS) in Hong Kong. This study was completed in April 1999 and concluded that there were economic and environmental benefits for adopting such air-conditioning systems. The study also highlighted the potential for WACS concepts to be incorporated into district-wide cooling systems including the potential of implementing a District Cooling System (DCS) in the future South East Kowloon Development (SEKD). The findings and recommendations of the study were endorsed by EE&CSC in October 1999.

To examine the feasibility of implementing a District Cooling System, Ove Arup & Partners HK Ltd (the Consultant) was appointed by EMSD to carry out an implementation study for a DCS to be located at SEKD area. SEKD is a major new development in the former Kai Tak International Airport and adjoining areas. It is planned to occupy a site area of some 460 hectares that will be developed in phases over a period of approximately 15 years as shown in Figure 1 at the time of conducting the implementation study (mid 2002).

This Executive Summary serves to summarise the principal findings and recommendations of this Implementation Study.

2. DCS DESIGN

2.1 Energy Model and Cooling Load Demand

One of the initial tasks of the study was to determine the cooling demands for the various elements of the development. To cater for different operating profiles and user characteristics, the buildings in SEKD were classified into twelve categories and an energy model was prepared to assess demand under various scenarios. The financial analysis is mainly based on estimated cooling demands of non-domestic potential customers, such as Government Institution or Community (GIC) buildings, shopping centres, underground railway stations, the proposed tourism node and the international stadium etc. However, the financial and viability implications of extending the DCS service to potential domestic customers was also assessed.

Upon full development of SEKD according to the plan prevailing at the time of the implementation study, the total gross floor area (GFA) of the non-domestic buildings which require air conditioning supply is estimated to be about 1,135,000 m² and the peak total cooling load demand is estimated to be about 196 megawatts.

The cooling load demand of the non-domestic buildings estimated in accordance with the development programme of SEKD prevailing at the time of the study is summarized in Table 2.1:

Table 2.1 Non-domestic Cooling Demand for SEKD

		Cumulative Cooling Demand* [MW]
Phase 1	2005	11
Phase 2	2006-2009	36
Phase 3	2010-2014	132
Phase 4	2015-2018	196

* Cooling demand including diversity factor

If the DCS service is to be extended to domestic premises, the additional GFA involved would be about 3,390,000m² by year 2018 with the following projected distribution:

- High Density Housing (GFA = 1,300,000m²)
- Medium Density Housing (GFA = 1,650,000m²)
- Low Density Housing (GFA = 440,000m²)

The above additional GFA will increase the total cooling demand from 196 megawatts to about 300 megawatts.

2.2 DCS Design

Two chiller plants are proposed for the DCS system located at Site 1N5 and Site 5B to serve the SEKD area and allow for the phased expansion of the system.

Design cooling capacities of the two chiller plants at Site 1N5 and Site 5B are estimated to be 158MW and 74MW respectively to serve non-domestic premises. These cooling capacities have factored in losses in the system and the requirements of standby chillers to cater for regular maintenance and other contingency situation such as the breakdown of individual chillers.

The two chiller plants will produce and supply chilled water at a constant temperature to premises using the DCS service. Variations in cooling load demand is accommodated by varying the flow rate of chilled water. To maintain a stable supply of chilled water at a constant temperature to customers, the underground chilled water distribution pipework will be insulated. Insulation will help confine heat gain along the pipes to less than 0.5% of the total cooling demand and limit the fluctuation of the temperature of the chilled water supply to less than 0.5°C.

A review of the various heat rejecting methods, including seawater cooling, cooling towers, air cooled chillers as well as the use of treated effluents revealed that seawater cooling would be the most energy efficient method which would also be acceptable from the planning, visual impact and environmental perspectives. Therefore, it is adopted as the preferred cooling mechanism.

Seawater is used for cooling and dissipation of exhausted heat for the two chiller plants. It will be distributed to the chiller plants using a dedicated pipe network served by a seawater pumphouse. The location of the pumphouse has been identified at the eastern end of the future waterfront. Several pump sets will be installed in the pumphouse and back-up pumping facilities will also be provided.

Alternative options have been considered to optimise the operation of DCS. Options such as thermal storage[1] and trigeneration[2] were reviewed but were not found to be cost-effective based on existing fuel costs and electricity tariffs and have not been further pursued.

[1] Thermal storage is to store the cooling to a media such as water, ice or phase-change material during periods of low cooling demand, which is later retrieved to meet air-conditioning cooling loads.
[2] Trigeneration is the simultaneous production of electricity, heating and cooling.

The proposed DCS design is expected to give a significant saving in energy in comparison with the traditional standalone air conditioning systems. It can reduce overall energy consumption by 19% and 35% respectively when compared with the standalone air conditioning systems operating on cooling towers and air-cooled chillers. The DCS will also reduce the overall requirement for plant rooms in individual buildings.

2.3 Phasing of DCS Construction

It is assumed that the proposed chiller plant at Site 1N5 and the seawater pumphouse should be commissioned in 2005 to serve the initial phase of SEKD development while the proposed chiller plant at Site 5B should be commissioned in 2014 to match the anticipated cooling demand growth. Figures 2 and 3 show the initial and final layout of the proposed DCS at SEKD respectively.

The phasing of the DCS facilities will depend on the programme and progress of SEKD and will need to be adjusted in the light of any subsequent changes to the prevailing development programmes for the proposed tourism node and cruise terminal, the Shatin to Central Rail Link, and the proposed international stadium.

2.4 Land Requirements

The proposed sites for the chiller plants have been selected having regard to various factors including the locations of the seawater intake and discharge, phasing of SEKD, cooling load distribution and chilled water distribution network, land zoning and land value.

The land requirements and the associated issues are as follows:

- <u>Chiller Plant at Site 1N5</u>

  The DCS chiller plant at Site 1N5 will occupy an area of 3,200m² and will be surrounded by a road tunnel, a CLP Substation, and the Kai Tak Nullah. The site was originally zoned for "G/IC" and intended to be used as highway depot.

- <u>Chiller Plant at Site 5B</u>

  The DCS chiller plant at Site 5B will occupy an area of about 4,400m² and is proposed to be underground. The site was originally zoned for open space but now rezoned for "Undetermined".

- <u>Seawater Pumphouse near the Waterfront</u>

  The seawater pumphouse will occupy an area of 3,200 m². It will be located on the waterfront away from drainage/sewage outfalls where the seawater is of good quality. The site was originally zoned for open space but now rezoned for "Comprehensive Development Area" (CDA). The pumphouse is proposed to be mainly underground.

- <u>Seawater Pipes and DCS Distribution Network</u>

  The seawater pipes and distribution network will mostly be laid under Government land and roads.

Through careful selection of sites and integration into the layout of SEKD, the presence of the DCS components will only have very minimal impact on the neighbourhood land use and land value. The opportunity cost of the underground space used for installing DCS pipes will also be minimal. If DCS is not implemented, the underground pipe space may be occupied by other public utilities subject to the payment of nominal licence fees.

3. COST MODEL AND FINANCIAL ANALYSIS

The commercial viability of the SEKD DCS was assessed using a purpose-built cost model. The model was also used to conduct sensitivity tests for variations in assumptions and for different scenarios.

The main inputs to the model are: the design parameters for the DCS; unit costs of supplying chilled water; projections of annual cooling demand and peak cooling load; and information on the alternative cooling technologies available to potential DCS customers.

Outputs from the model include the estimated market-based DCS tariff, and the financial appraisal results in terms of its net present value, internal rate of return, and payback period.

The commercial viability of the DCS is assessed solely in terms of the provision of cooling services by the DCS operator. (The cost and revenue figures discussed in this report are discounted unless otherwise mentioned.)

3.1 Base Case

A base case scenario has been developed to provide a benchmark for comparison of alternative assumptions and assessment parameters. Assumptions adopted for the base case are as follows:

- potential DCS customers have the choice of using the DCS or using traditional self-generated water-cooling tower air-conditioning systems (the cost of chilled water production for the latter is estimated to be 59.3 cents/kWh which is set to be the DCS tariff for financial analysis);

- the DCS only serves non-domestic premises;

- the DCS operator is charged $1,000/m^2 (GFA) for the land occupied by the DCS chiller plants and the seawater pumphouse. This land cost is estimated having regard to the industrial land values of Kowloon Bay and Kwun Tong after allowing for the location difference. The pipe network licence fee is $10.5 per 10mm diameter per meter per annum which is the current standard rate applicable for pipeline licences for private developments as quoted in the Revenue Assessment Manual (RAM) of the Lands Department.

- there are no delay in the planned development of the SEKD area;

- the cost of capital for the DCS operator of 8.85%;

- the DCS service uptake is equal to the forecast maximum uptake in each year;

- a 30–year Contract period; and

- at the end of the Contract, Government will take over the ownership of the whole system by paying the DCS operator the residual value of the assets.

The undiscounted base costs and revenues used in the financial analysis for the base case are summarised in Table 3.1 and 3.2 respectively. Figure 3.1 shows the discounted cash flow for the project and the cumulative net revenues (discounted rate of 8.85% p.a.).

Table 3.1 Undiscounted DCS Costs

		Cost (HK$M)
1) Capital Costs	Site 1N5 (construction cost of plant, chillers and pumps)	356
	Site 5B (construction cost of plant, chillers and pumps)	190
	Seawater pumphouse (construction cost of pumphouse, pumps and seawater pipes)	274
	Chilled water distribution pipework	222
	Customer substations	92
	Land cost for DCS chiller plants + pumphouse	19
2) Operating Costs *	Pipe network licence fee **	624
	Non-energy operation and maintenance cost (including land rate)	258
	Energy cost (Electricity)	2,079
Total		4,114

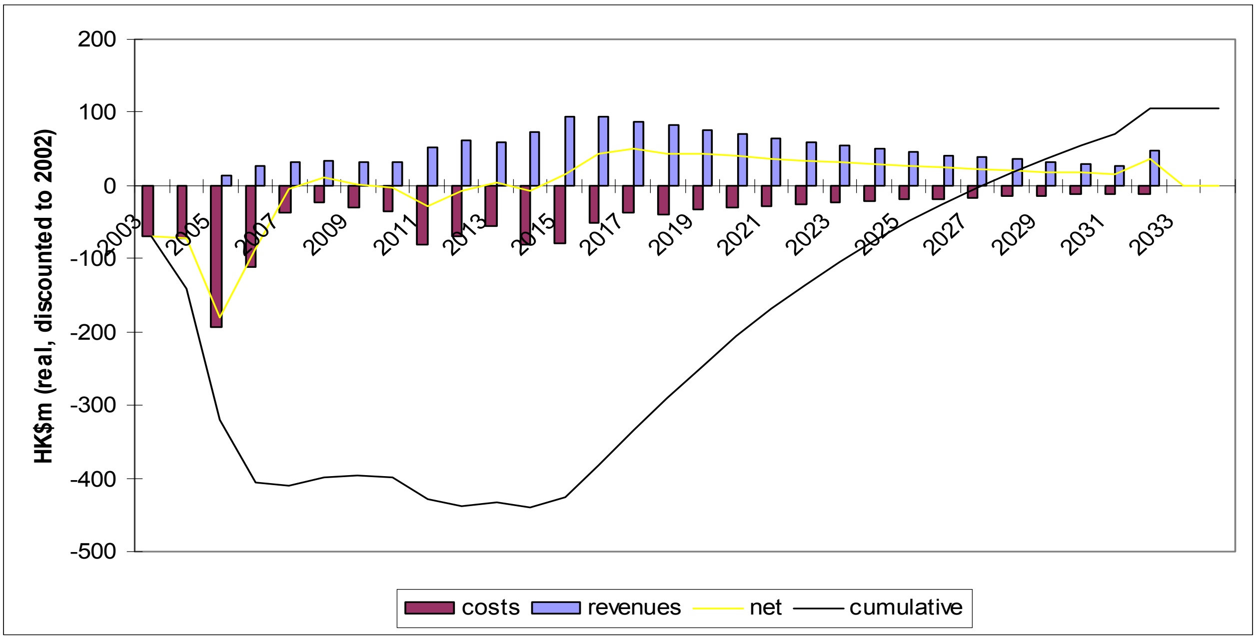
* This cost refers to the total costs for the whole Contract period (30 years)
** This fee may be waived or considerably reduced if it is decided to categorise DCS as either a ‘utility’ or ‘water supply’ in the calculation of the licence fee for the DCS pipe network (Section 4.5.3 refers).

Table 3.2 Undiscounted Annual Revenues

	Revenue (HK$M)
2005	29
2006	49
2007	49
2008	55
2009	58
2010	105
2011	105
2012	125
2013	143
2014	203
2015	255
2016	290
2017	290
2018	313
2019	313
2020	313
2021	313
2022	313
2023	313
2024	313
2025	313
2026	313
2027	313
2028	313
2029	313
2030	313
2031	313
2032	313
2033	313
2034	634*

* The revenue includes payment from the Government for the assets at the end of the Contract.

Figure 3.1 Base case cash flows (discounted)



It can be seen that the DCS is a project of long pay-back period with significant up-front capital costs, and low revenues in the initial years which would increase over time. Under base case assumptions and as illustrated in Figure 3.1, it will take approximately 25 years to achieve a positive return and has a net present value (NPV) of around $107M for the 30-year operating period (PVs of total revenue and cost are $1,447M and $1,340M respectively. The total cost is composed of $655M of capital costs, $216M of fixed operating costs, $16M of variable operating costs and $453M of energy costs). Sensitivity analysis has been conducted as outlined in the following section.

3.2 Sensitivity Analysis

3.2.1 Customer Uptake

If uptake falls, the NPV of the DCS project will reduce. Table 3.3 shows the decline of NPV under various uptake rate assumptions.

Table 3.3 Sensitivity of NPV (HK$M) as a Function of Customer Uptake

Uptake GIC *						0%
		107	-26	-166	-300	-435
		40	-93	-232	-367	-500
		-26	-160	-296	-434	-566
		-92	-227	-362	-497	-633
	0%	-158	-292	-429	-564	-690

* The GIC demand includes premises that are under and not under government control.

3.2.2 DCS Contract Length and Payment for Residual Value of Assets at Contract End

A reduction of the Contract period will reduce the commercial viability of the project. The NPV of the project will be reduced to -$15M with a 20-year Contract period. If no residual value is paid for taking over the assets at the end of the contract, the NPV of the project would be reduced to -$135M;

3.2.3 Alternative Cooling Systems

In the event that the fresh water cooling tower option (the base case of 59.3 cents/kWh) is not permitted in SEKD, the potential DCS users will probably need to rely on the traditional air-cooled air conditioning system. This is less efficient than the water cooling tower system and the cost of producing chilled water will be increased to around 63.6 cents/kWh. As the DCS operator is likely to be able to charge higher tariffs under such situation (around 63.6 cents/kWh which is the unit cost for typical air-cooled air conditioning system), the NPV of the project will increase to $211M.

3.2.4 Land Costs and Pipe Network Licence Fees

If these are waived, the NPV of the project will increase to $298M.

3.2.5 Risk of Delay

The maximum potential demand for DCS services is expected to rise over the period from 2005 to 2018 in line with the phased development of SEKD planned at the time of the Study. Any delay in this development process would therefore impact on the level and timing of the revenue of the DCS service, and reduce the NPV of the project. To investigate the potential impact on the NPV of delays in developing SEKD, the following four scenarios were examined:

- Scenario 1 — all development post-2010 delayed by 1 year;
- Scenario 2 — all development post-2010 delayed by 2 years;
- Scenario 3 — scenario 1 plus additional 1-year delay post-2014; and
- Scenario 4 — scenario 2 plus additional 2-year delay post-2014.

Table 3.4 shows the impacts of these delays on the NPV of the project relative to the base case. It can be seen that the delay in SEKD development will have a significant impact on the DCS operator.

Table 3.4 Impact of Development Delays (relative to base case)

	Reduction in NPV (HK$M)
Scenario 1	54
Scenario 2	108
Scenario 3	86
Scenario 4	153

3.2.6 Domestic Premises

If the DCS service is intended to cover domestic premises, the impacts on the project viability will depend on whether the operator is required to construct sufficient distribution capacity to serve all domestic premises, or is free to choose whether or not to serve domestic premises or only some sectors of all the domestic premises. In the former case, much of the cost of serving domestic premises is 'sunk' and is not related to the actual demand. Hence the operator will be exposed to significantly greater demand risk. For example, the NPV of the project, even assuming 100% customer uptake (including all GIC, private non-domestic & domestic), will only be $49M in this case. However, if the uptake rate is only 85%, the value will fall to -$103M (compared with $107M and -$15M without covering domestic premises). The conclusion is therefore that it would greatly affect the commercial viability of the project if the DCS operator is required to serve all domestic premises. However, if the operator is given the free choice to serve only certain sectors of all the domestic premises, it may still be profitable if the operator can take advantage of the different daily cooling demand profiles of non-domestic and domestic premises.

3.2.7 Impact of GIC Premise Uptake

The GIC premises include both those under government direct control and those not under government direct control. Assessment of various scenarios of uptake of the DCS service by the GIC premises is shown in Table 3.5.

Table 3.5 Sensitivity of NPV (HK$M) as a Function of GIC Premise Uptakes

GIC Premise Uptake Scenario				Project NPV (with land costs) (HK$M)
		Non-GIC (Private Non-domestic)		
100% (20%)	100% (33%)	100% (47%)	298	107
100%	100%	50%	145	-47
100%	70%	50%	64	-127
0%	70%	50%	-160	-352

Note: Value in bracket indicates the estimated percentage of total non-domestic cooling demand load (in 2018) based on OZP in July 2002

4. INSTITUTIONAL ARRANGEMENTS AND CONTRACT STRATEGY

One of the primary objectives of the Study is to assess whether the DCS can be implemented without causing undue burden to either service users or the government. Essentially this requires the DCS to be competitive with other forms of cooling as well as ensuring a suitable framework for the DCS to operate and develop. Accordingly, the study has focused on:

- whether it would be possible to implement a market-based solution (where the DCS tariff would be set, in part, by competition between the DCS and other forms of cooling methods);
- how to encourage potential DCS service providers to bid for the DCS project in SEKD, without placing unnecessary burdens on either service users or the government; and
- whether legislation would be required for the implementation of a DCS in SEKD and the framework of the contractual arrangement to be used.

4.1 A Market Solution

A market-based solution is desirable because it provides choices for consumers (rather than compelling consumers to use the DCS), encourages competition and maximises efficiency. The market-based solution is potentially feasible because, for non-domestic customers, the cost of traditional self-generated cooling may exceed the cost of purchasing the same amount of cooling from a DCS operator. A DCS will benefit from economies of scale and allow a private-sector DCS operator to earn a return on its investment. The estimated cooling demand composition for SEKD is summarised in Table 4.1 and it shows that a considerable fraction of non-domestic cooling demand in SEKD is expected to come from GIC premises. This will help reduce demand uncertainty as a DCS operator will not need to reach out a large number of potential customers just to secure the basic demand and can approach the Government to negotiate the arrangement for the GIC premises as a whole. Although a market-based solution is potentially feasible, it may still be necessary to provide protection for customers if switching back to traditional cooling would involve significant switching costs.

Table 4.1 Estimated Cooling Demand Composition for SEKD

	Cooling Demand [MWh]									
			-							Hotel, Marina Club
2005	460	0	0	2,099	19,489	0	4,143	793	0	0
2006	460	0	0	2,099	47,187	0	8,287	793	3,860	0
2007	10,023	0	0	2,099	48,911	0	8,287	1,043	9,208	0
2008	16,144	0	0	2,099	48,911	0	9,127	1,445	17,829	0
2009	16,144	0	0	2,099	48,911	0	9,127	1,445	17,829	0
2010	16,144	0	0	2,099	49,293	0	9,127	1,445	28,449	0
2011	16,144	75,789	2,367	2,099	52,560	0	9,127	1,445	28,449	0
2012	21,931	75,789	2,367	8,695	66,331	0	17,166	2,121	48,453	0
2013	21,931	75,789	2,367	8,695	77,184	0	22,398	2,121	48,453	0
2014	23,191	75,789	2,367	8,695	77,184	0	25,015	2,660	126,126	0
2015	23,191	75,789	2,367	47,934	81,037	32,105	27,631	2,807	166,667	15,512
2016	23,191	75,789	2,367	47,934	81,037	32,105	27,631	3,193	209,479	15,512
2017	23,191	75,789	2,367	47,934	81,465	32,105	28,471	3,193	220,568	15,512
2018	23,191	75,789	2,367	47,934	81,465	32,105	28,471	3,335	234,750	15,512

Note * 1. Demand based on development programme at the time of the study.
2. 2 new SCL stations are assumed in SEKD.

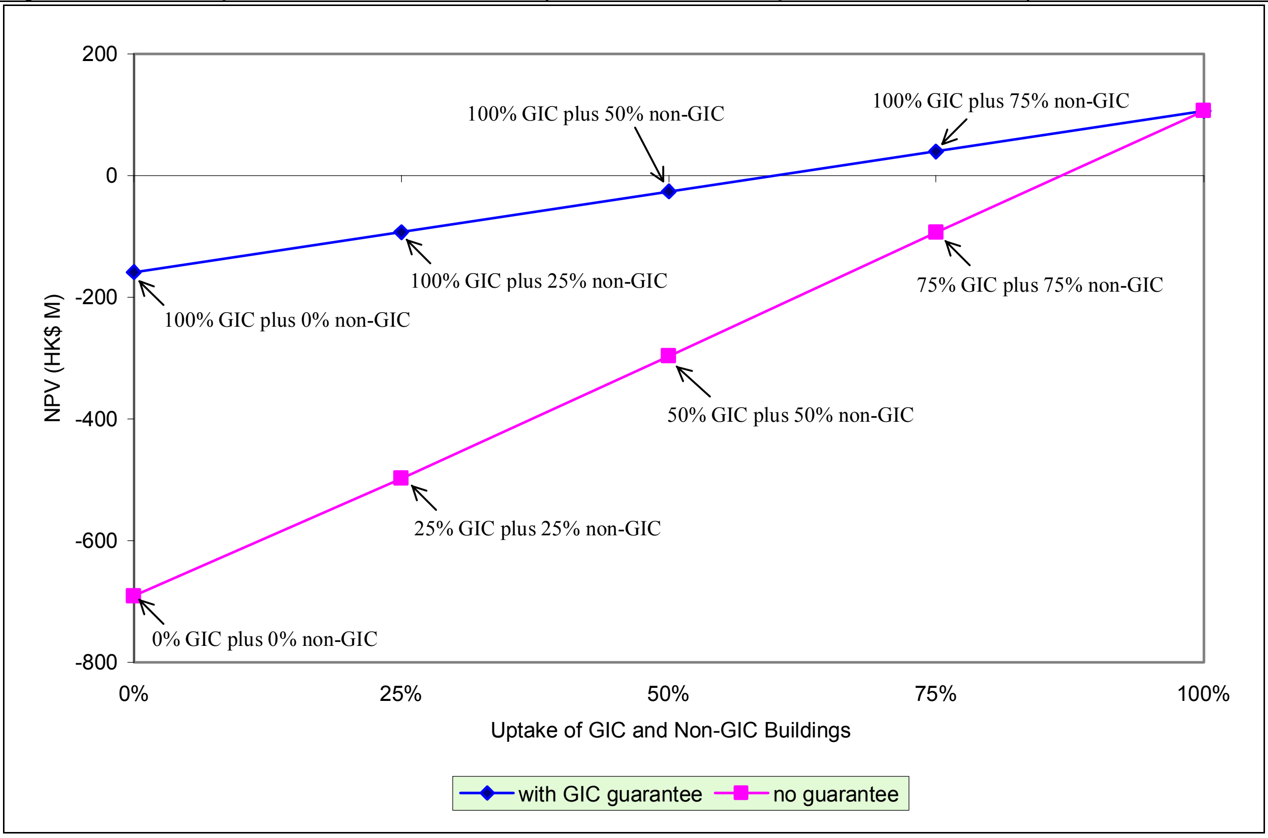
4.2 Enhancement Measures

4.2.1 Demand Guarantees

Customer uptake is a very significant risk for the DCS operator, under a market-based solution. This risk could be significantly reduced if the DCS bidders can be assured that GIC premises will use the DCS service at the time of tender (subject to acceptable pricing offered by the DCS operator).

Figure 4.1 shows the impact of GIC demand on the project NPV. With 100% GIC uptake and 75% non-GIC[3] uptake, the NPV of the project would be around $40M, whereas if the GIC update rate is only 75%, the NPV would be around -$93M.

Figure 4.1: Impact of GIC Guarantee on NPV (with Land Cost and Pipe Network Licence Fee)



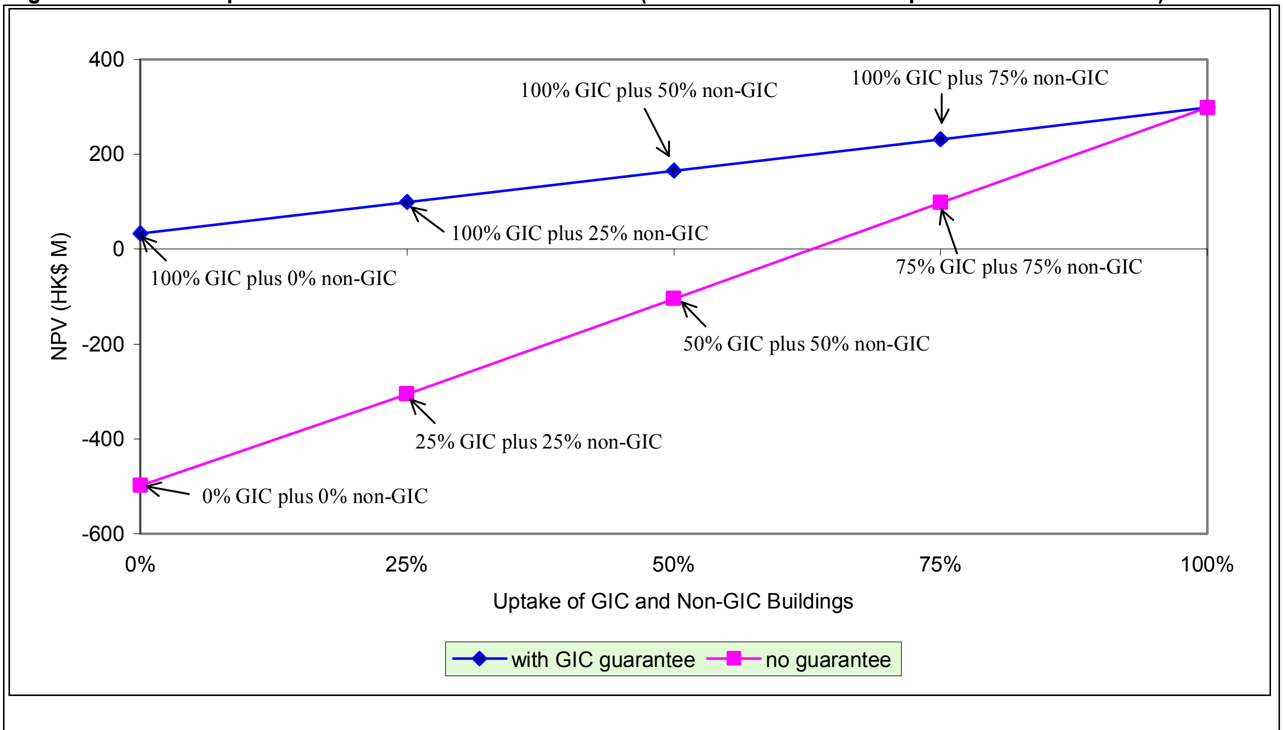
Note: On the top blue line (GIC guarantee) the uptake percentages are those which are non-GIC. The bottom red line (no guarantee) is the uptake of all potential customers (GIC and non-GIC) because no demand is guaranteed.

[3] Non-GIC are those buildings that are private and non-domestic type.

4.2.2 Waiver of Land Costs

The sensitivity analysis in Section 3.2 and assumptions regarding the demand discussed above highlight the risks to the project. The attraction of the DCS project may be increased if the project is allowed a waiver of some or all land costs and the pipe network licence fees. The impact of different GIC uptake rates on the project NPV assuming the waiver of land costs and the pipe network licence fees is shown in Figure 4.2. A complete waiver of land costs and licence fees with good uptake rates can boost the NPV of the project to $298M. It should be noted that the land costs used in the base case financial assessment have assumed that the DCS operator would acquire the title of the lands. They may not apply if the DCS operator is allowed to operate on the lands through other land disposal arrangement. Similarly, the licence fee assumptions used in the base case may not apply if the DCS is considered as a "utility" as discussed in Section 4.5.

Figure 4.2 Impact of GIC Demand Guarantee on NPV (without Land Cost and Pipe Network Licence Fee)



Note: On the top blue line (GIC guarantee) the uptake percentages are those which are non-GIC. The bottom red line (no guarantee) is the uptake of all potential customers (GIC and non-GIC) because no demand is guaranteed.

4.3 Domestic Cooling

The financial analysis has shown that the marginal return of serving domestic premises is low and may be negative. A DCS operator may therefore not be willing to serve domestic premises if given the choice. However, given the different demand profile and timing of peak load for domestic premises, the DCS operator may still be interested in serving certain sectors of domestic premises. Low-density housing will normally demand a higher quality of air conditioning services and occupiers of these buildings may be prepared to pay higher costs for a better quality of air conditioning supply and the convenience offered by the DCS. For high-density housing, the operating costs of traditional cooling are similar to the estimated DCS tariff, while the capital cost of installing DCS equipment is higher. In the event that in-building DCS installations were constructed by developers at the time of building construction, it may be viable for the DCS operator to serve high density housing. Furthermore, it may also be viable for the DCS operator to serve some domestic premises if it is possible to make use of the unused chilled-water distribution capacity.

4.4 Institutional and Legal Framework

4.4.1 Contract Strategy

A review of the current legal framework has concluded that new legislation is not required to implement the project. Essential elements of implementing the DCS project in SEKD can be dealt with under a contract, subject to existing laws, regulations, and the Government's administrative procedures. These elements include provision of land for the DCS chiller plants and pipeline network, design and construction, operation and maintenance, finance, initial tariff and pricing mechanism, off-take agreement, and incentives for attracting private sector participation.

It is assumed that the Government will not wish to allow or create a monopoly whereby parties are compelled to use the DCS services. So long as a monopoly is not created, the SEKD DCS may be procured and regulated by way of a contract.

If DCS services are to be introduced in other parts of Hong Kong subsequently, other circumstances not applicable to SEKD may warrant territory-wide legislation to regulate DCS generally. Therefore, the contract regulating the SEKD DCS would need to cater for the possibility (i.e. risk) of the subsequent legislation governing DCS affecting the rights and obligations of the parties to that contract.

The "build-operate-transfer" (BOT) or similar model type of contract is recommended for SEKD DCS in which the private sector undertakes the construction, funding and operation before transferring the facility to Government at the end of the contract period. This procurement method has been used successfully in Hong Kong on a number of infrastructure projects and accords with Government's policy of encouraging private sector involvement in the delivery of public services to enhance efficiency and quality. Typical projects in Hong Kong include the Tai Lam Tunnel and Route 3 (Country Park Section), Western Harbour Crossing and Dedicated LPG Filling Stations.

Alternative approaches include Government to procure, design and construct the DCS with "operation" either contracted out to the private sector or operated as a Government entity. Under these approaches, the Government will need to finance the project and assume all design, construction and capital investment risks.

In comparison with the other procurement approaches, the BOT procurement model can effectively transfer risk from the Government to the private sector whilst minimising public spending on the project. Efficiencies can be maximised by competitive tendering of the project to potential bidders which will encourage the private sector to apply expertise and innovation to secure efficient and economic services. At the same time, the services offered to customers may be safeguarded with contractual requirements written into the BOT contract.

4.5 Land Disposal

The DCS is proposed as part of the SEKD, which is a "Greenfield" development. There is no private land involved, and thus no resumption of land will be required. However, there remain three issues to consider in relation to the provision of land: planning approval, disposal of land for the DCS chiller plant, and use of land under public roads for the seawater pipes and distribution network of pipelines connecting the DCS chiller plants to users. In considering these three items, it is necessary to bear in mind the timing for the construction of the DCS scheme, Government's internal disposal procedure and the associated costs for the land disposal.

The consultant considers each of these issues and the pros and cons of of various alternative solutions. The recommendations are summarised as follows:

4.5.1 Planning Permission

On the basis that the chiller plant at Site 1N5 comprises a Public Utility Installation it would fall under Column 1 of the Notes to OZP S/K19/3 and would hence not require planning permission. The chiller plant at site 5B and the pumphouse near the waterfront under the current zoning would, however, require planning permission. Planning permission is usually sought before disposal of land and the application process including preparation of the submission could take six months.

4.5.2 Land for DCS Chiller Plants

The land disposal approaches considered by the consultant are: (1) selling the site by auction, (2) granting land use rights by private treaty grant, (3) selling the land by tender containing conditions and (4) allocating the land to a Government department or bureau who then grants the land use rights by way of a licence. The first three approaches would take a long time and involve complicated land sale procedures.

A sale by auction has the following disadvantages: (a) the permitted land use would be restricted to use in connection with the DCS. Therefore, the auction would not attract general public interest, which is what a land auction is normally designed for; (b) the best bidder at the land auction may not be the best bidder for the Project, and vice versa.

A sale by private treaty grant has the following disadvantages: (a) lengthy period for disposal. Policy approval would be required for a land disposal at low or nil land premium. For a straightforward case, this would typically take some 18 months. But the DCS is not a straightforward project, being the first of its kind in Hong Kong; (b) normally with this type of disposal for commercial use there is a need to identify the specific purchasing party, which has to demonstrate that it is the only party capable of undertaking the commercial use in question. This will not be the case with the DCS operator as there would be a number of parties capable of undertaking the Project; (c) the premium would not be fixed in advance or at the time of the award of the Project. Therefore, unless policy approval was obtained for charging a nominal premium, the premium would need to be valued and negotiated at the time of the grant. This may deter bidders or cause them to put a price on this risk in their bids.

A sale by tender containing conditions could address the problem of the best bid for the land not being the best bid for the Project which may appear in a sale by auction. However, a tender on such basis is likely to take more than 18 months, which could adversely affect the implementation timetable.

Our recommended approach is the fourth option, i.e. for Government to allocate the land to a Government bureau or department who then grants a licence to the DCS operator. However, the Government bureau or department needs to be authorised by the Chief Executive to grant the licence under the Land (Miscellaneous Provisions) Ordinance.

Under this approach, many of the complications (including delays) associated with the sale of the land are avoided because Government remains the owner of the land. Government could terminate a licence much easier than terminating a lease. This is important, because the DCS operator’s rights in respect of the Project should be subject to rights of Government to step-in and take over the Project in the event of certain defaults by the DCS operator. In addition, the use of a licensing approach can avoid land title complications arising from the transferral of the DCS assets to Government after the contract expires.

4.5.3 Land for Seawater Pipes and DCS Distribution Network

The Government's roads under which the distribution network will be laid are unleased Government land. With appropriate policy directives the DCS operator may be granted a licence or licences to use that land for the purpose of the DCS pipe network. The Land (Miscellaneous Provisions) Regulations, Cap. 28A enacted under the Land (Miscellaneous Provisions) Ordinance, Cap. 28 set out fees payable for licences to use unleased Government land. The fees are calculated by reference to a schedule in the Regulations that refers to various categories of land use. Different fees are payable for different categories of land use.

Two possible categories of land use in the Regulations may be applicable to the DCS pipe network: (1) land use by a "Utility" and (2) land use for "Water Supply". If the DCS pipe network is accepted to be either "Utility" or "Water Supply", nominal fees or fee exemptions set out in the Regulations for the relevant categories will apply. The consultant concludes that only by applying a very liberal interpretation of the Regulation could the DCS pipe network be said to fall into the "Utility" category. However, the DCS pipe network could comfortably fit within the "Water Supply" category.

An alternative approach would be to amend the Regulations so as to set out a separate fee for DCS pipes commensurate with those for "Utility". However, a problem with this approach is that the process would be time consuming.

Another approach would be for the Lands Department to issue a block licence to the DCS operator and deal with all the issues relevant to the land for the pipeline network in the block licence. This type of arrangement is the more common approach used for licences required by utility companies. It is currently used (for example) for Towngas's pipeline network. Under this approach, a single block licence would apply to the whole DCS pipe network.

The fee for any licence or licences or block licence, if granted for the DCS project, will be set in accordance with the Land (Miscellaneous Provisions) Ordinance, Cap 28. However, licences are rarely issued under Cap 28 nowadays.

If none of the above approaches are adopted, an appropriate land tenure document may need to be issued and the fees specified in the Land (Miscellaneous Provisions) Regulations, Cap. 28A for "intake pipes" would probably apply. The fees would be substantial because of the extensive pipeline network necessary for the DCS scheme as given in Table 3.1.

5. PRELIMINARY ENVIRONMENTAL REVIEW

5.1 Air Quality

The air quality impact assessment identified that implementing proper dust suppression measures, in particular, those relevant measures set out in the *Air Pollution Control (Construction Dust) Regulation*, would minimise air quality impacts during the construction phase of the project. Adverse dust impacts are not therefore expected during the construction of the DCS. To avoid additional air pollution in the vicinity of the plant, it is recommended that the necessary power requirement for the DCS should be obtained from the electricity supply network. With the DCS in full operation, the energy saving upon completion of SEKD would be equivalent to an annual reduction of CO_2 emission by about 38,400 to 53,300 tonnes.

5.2 Noise

Comparing the DCS to conventional air-cooled design, noise impacts from the DCS would be significantly reduced. The chillers would be located within an underground chiller plant and the pumphouse would also be located below ground, it will help reduce noise emission.

5.3 Water Quality

No adverse impact on water quality is anticipated for the operation of the DCS. The near-field and far-field modelling results showed that temperature rise due to the discharge of sea water used for heat exchange would be less than 2°C and would meet the relevant Water Quality Objective. Using the near-field model, seawall discharge and short outfall discharge options were examined. For the seawall discharge option, the distance required to separate the discharge points from the intake point would range between 607m and 956m. For the short outfall discharge option, the required separation distance between the discharge and intake points would be reduced to a range from 382m to 420m.

Alternatively, the discharge of sea water used for heat exchange into the public drainage channel adjacent to site 1N5 was also considered. Apart from the potential environmental impacts caused by mixing the warmer sea water with the original flow in the drainage channel, Drainage Services Department also has reservations from the drainage capacity, risk of flooding and maintenance perspectives.

The far-field modelling results showed that the release of residual chlorine and biocide due to the discharge of sea water used for heat exchange would have minimal impacts on the identified water quality sensitive receivers. With suitable control of the discharge concentrations of chemicals, the implementation of DCS at SEKD would not cause adverse water quality impacts to the receiving water environment.

6. OPERATIONAL RISK ASSESSMENT

The DCS , like other utilities, will be subject to equipment failure risks, resulting in service disruptions.

6.1 Failure Analysis

The engineering systems forming the DCS at each phase of its development have been analysed to examine the failure risks. Because the system is configured with parallel 'trains' of equipment at every stage, the probability of a single failure causing the whole system to shut down is small. Apart from a complete failure of electricity supplies, the main concern in this respect is debris blocking the seawater intake pipes. The operator should be aware that clearance of debris from the intakes is important to the system.

A variety of possible failures can, in principle, lead to the DCS cooling supply being less than the overall demand. The significance varies with the phasing – although the total capacity should always be greater than the projected load, the margin will change over time, – and with the time of year, as there is more reserve capacity outside the summer peak.

6.2 Risk Summary

The operational risk assessment provides estimates for 'corporate risk' – loss of all capacity and shortfall related to peak demand – and for 'consumer risk' – loss of all supply and shortfall in meeting cooling demands. The risks are considered to be appropriate to a system engineered with a conventional level of reserve capacity. Options are open, while developing the design in greater detail, to improve reliability and to optimise performance and reliability parameters with respect to whole life costing. Reliability figures are available as guidance for the DCS operator to develop the appropriate design. For individual consumers, the reliability of the DCS should generally be greater than his own system.

7. IMPLEMENTATION FRAMEWORK

The Implementation Study has established the conditions under which a DCS in SEKD can become a viable business. The Study also concludes that implementation of the SEKD DCS does not require new legislation. It is considered that an efficient approach to procure this district cooling service is through letting and administering a BOT contract within the existing government institutional structure. This role can be taken up by an implementation team comprising relevant works departments, with guidance from the concerned policy bureaux and support from a number of other enabling departments. The DCS is primarily to serve non-domestic buildings but the contract can be framed to incorporate domestic premises if required. The implementation plan to be executed by the DCS implementation team will involve the following major tasks:

7.1 Policy Approval

It is necessary to seek policy approval to implement a DCS in SEKD, as a new project as well as a new service. Major issues include: BOT approach, scope of DCS, nature of contract, land disposal method, tariff mechanism and bidding strategy. Consultations with relevant Legislative Council panels and government advisory committees are recommended before the policy approval is given.

7.2 Land Procedures

The land requirements for the DCS chiller plants, pumphouse, pipe network, seawater intake and outfall have been identified. Following policy approval, statutory procedures including Section 16 application under Town Planning Ordinance for approval of the respective DCS installations, and gazetting of the intake and outfall under the Foreshore and Seabed (Reclamations) Ordinance should be commenced. Also, if the recommended land licensing approach is adopted, the allocation of all required sites can be processed right after the completion of necessary statutory procedures.

7.3 Interface with other Infrastructure Works

There will be extensive interfaces between the DCS chiller plants and pipe network and other infrastructure works in SEKD. At each interface, it is necessary for any potential conflict in the design, construction method and programme to be monitored and resolved at the appropriate time. As this is a developing situation for a new town like SEKD, there is a need for prompt on-going liaison between the DCS implementation team and relevant project proponents until a DCS operator is selected.

7.4 Tender Documentation

It is recommended that a 'Project Brief' type tender document to be used for the BOT contract for the DCS. The Brief will document fully the Instructions to Tenderers, Form of Tender, Conditions of Contract, Employer's Requirements and Performance Specifications. The Conditions of Contract may be based on similar BOT contracts used in Hong Kong, but updated and re-framed to suit the DCS project.

7.5 Selection of DCS Operator

The recommended bidding strategy is a conventional two-stage process consisting of pre-qualification to produce a shortlist of tenderers and then invitation of detail bids from qualified tenderers to identify the successful DCS operator. Open notification will be given to invite interested firms to submit an Expression of Interest (EOI) for pre-qualification. Assessment panels will have to be set up to vigorously examine the EOI and, at a later stage, the detail bids submitted by the tenderers.

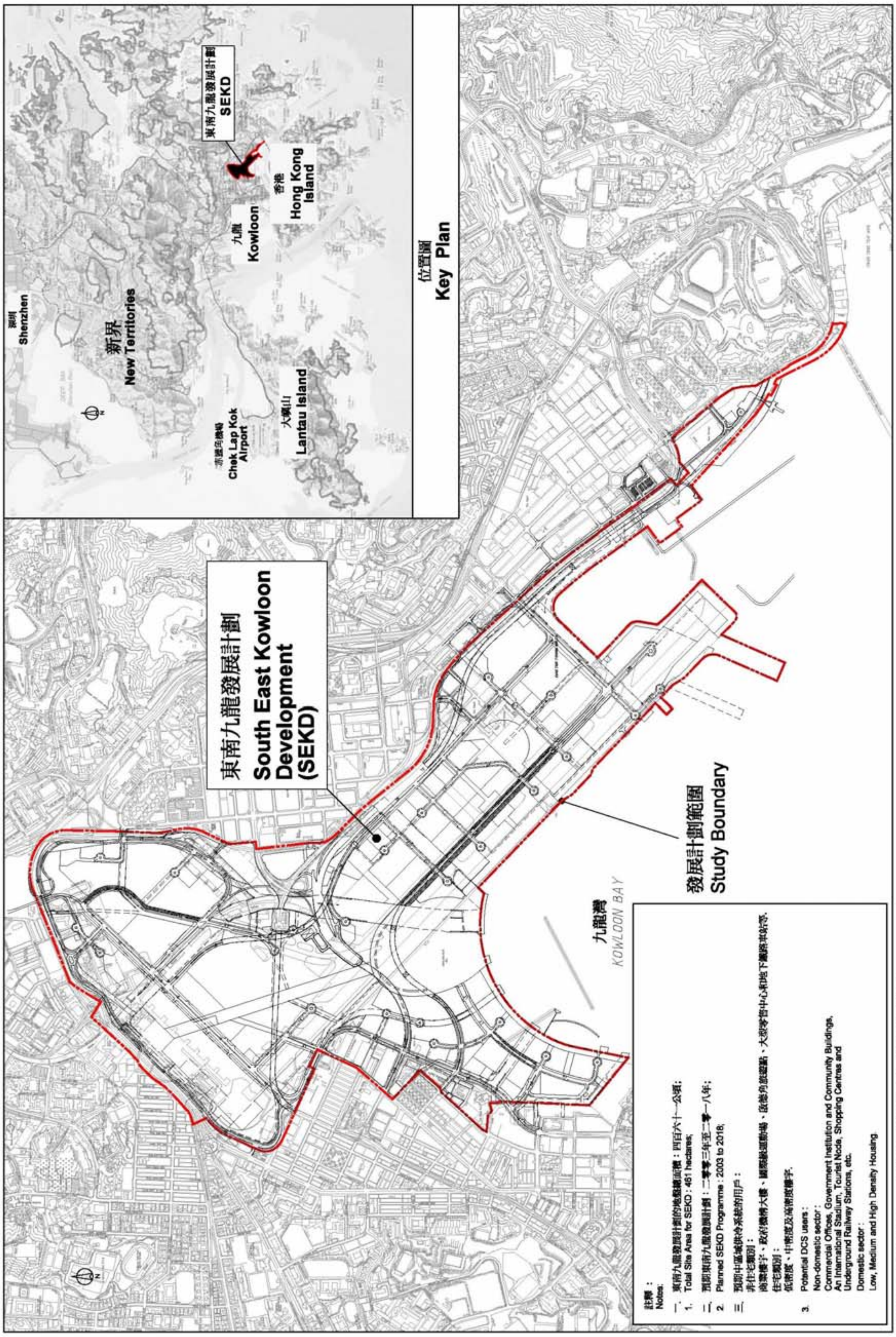
After the policy approval is obtained, the possible timeframes to achieve the target commissioning of the initial phase of DCS is as follows:

Expression of Interest	5 months
Tender & Selection of DCS Operator	8 months
Design and Construction	24 months

The target commissioning date is subject to change to suit the development programme of SEKD.

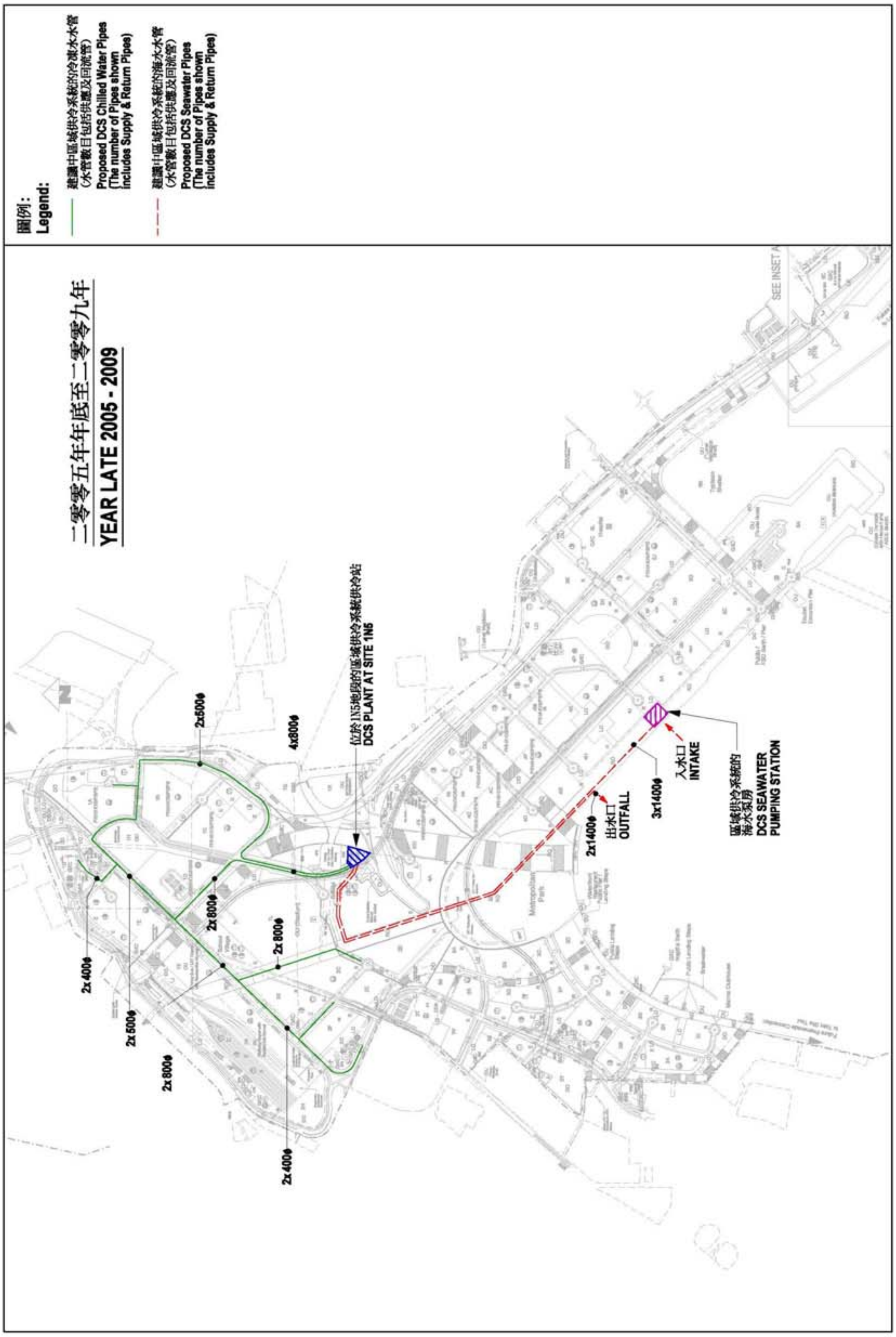
APPENDIX

Figures



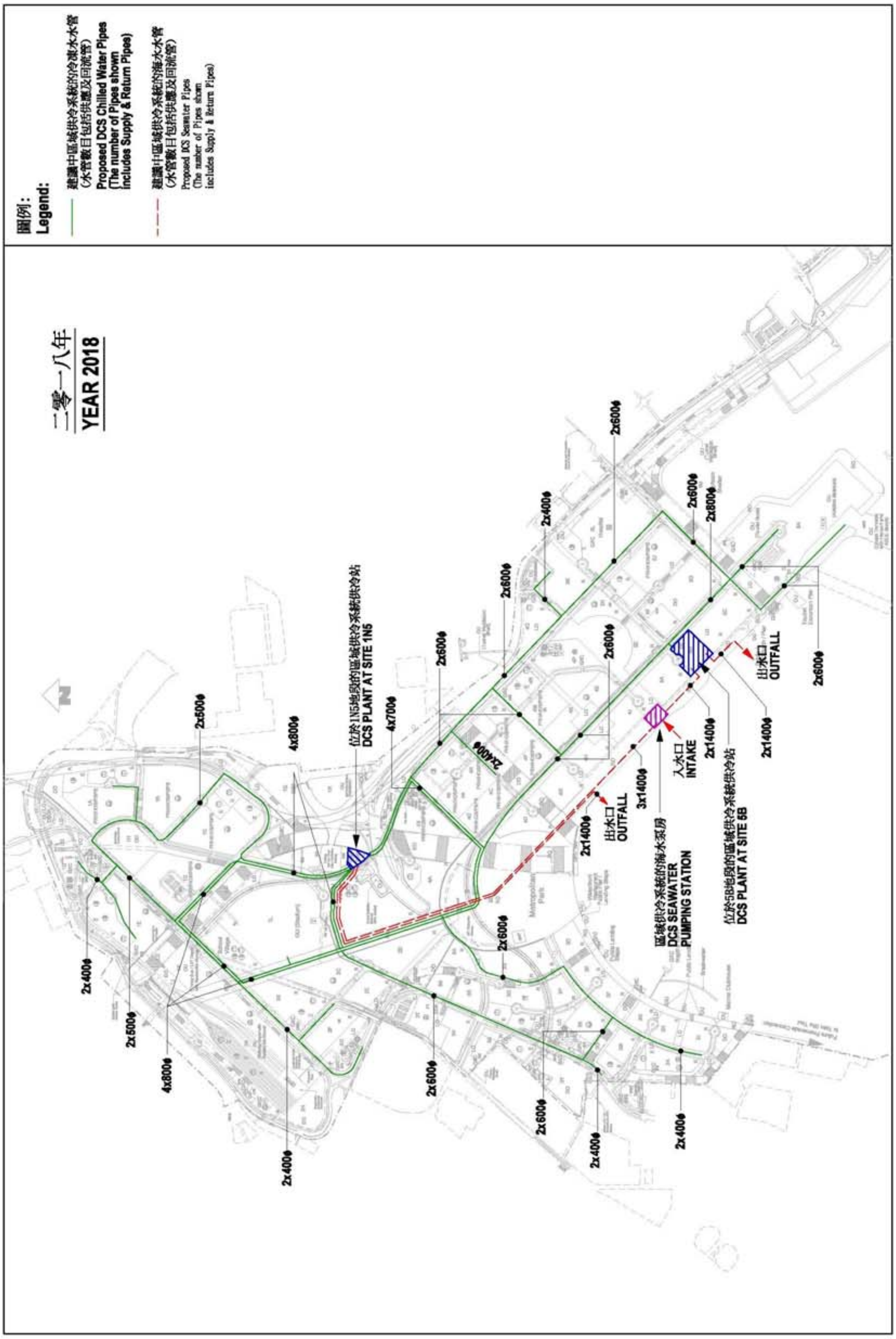
香港特別行政區－東南九龍發展計劃的位置圖
Location Plan of SEKD, Hong Kong SAR

圖一
Figure 1



圖二
Figure 2

東南九龍發展計劃中區域供冷系統的初期發展
Initial Phase of DCS at SEKD



圖三
Figure 3

東南九龍發展計劃中區域供冷系統的後期發展
Final Phase of DCS at SEKD