<u>CONSULTATION DOCUMENT</u>
PRICE REGULATION FOR DISTRICT COOLING SERVICES

ENERGY MARKET AUTHORITY

1 NOVEMBER 2002

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1. INTRODUCTION

1.1. Objective

The objective of this Consultation Document is to invite interested parties to comment on the proposals of the Energy Market Authority (EMA) as to the regulation of the price to users of the chilled water service from the pilot District Cooling Service (DCS) *for commercial buildings in the Marina South District*.

1.2. Background

A pilot district cooling system is to be constructed to supply chilled water (coolant) to new commercial buildings in the Marina South District.

The Energy Market Authority (EMA) is responsible for regulating the price of the pilot DCS service (the "DCS price") to be charged by the DCS operator to commercial buildings. The Government of Singapore is keen that all commercial users participate in the pilot scheme, and use of the service will be mandatory for all commercial buildings within the area (known as the DC zone) under the Government's land sale conditions.

As commercial consumers will have no choice over whether they will use the service or not (i.e., the DCS is a "must-use" service), equity considerations have led to a cap being placed on the maximum price for the DCS service, equal to the average cost to consumers of chilled water produced by a conventional, in-house, air-conditioning system (CCS). To this end, the average cost of chilled water produced by a CCS is to be used as a benchmark for price regulation purposes.

The rest of this Consultation Document is structured as follows:

- Section 2: description of the proposed price methodology
- Section 3: description of the methodology proposed to calculate each element of the price control formula
- Section 4: discussion of the methodology and assumptions for the calculation of the rate of return
- Section 5: discussion on the duration of the regulatory period
- Appendix A: description of cost of capital theory
- Appendix B: brief description of the characteristics of a district cooling system and a conventional, in-house, air-conditioning system

All interested parties are invited to comment on the issues and proposals discussed in this Consultation Document (the 'comment boxes' indicate where the EMA is inviting comments on specific, key issues). Comments should be sent to the EMA by **no later than 15 November 2002.**

All comments should be submitted in writing and in both hard and soft copy (Microsoft word format). Respondents are required to include their personal/company particulars, as well as their contact details (address, telephone number, fax number and e-mail address), in their submissions. Comments should be addressed to**:**

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2. EMA'S PROPOSED PRICE METHODOLOGY

The objective of the price methodology proposed by the EMA is to ensure that the DCS price to be paid by commercial buildings in the DC zone is not more than the average total cost of a conventional in-house air-conditioning system (CCS).

The EMA's methodology can be divided into two components:

- A price control formula; and
- A methodology for benchmarking the costs of CCS.

We discuss each of these components in turn.

2.1. Price Control Formula

The objective of the price control formula (PCF) is to ensure that

- If the costs of the DCS (including a return on assets) are lower than the "benchmark" cost of CCS, the DCS price is not more than the DCS costs plus a performance incentive;
- But, if the costs of the DCS (including a return on assets) are higher than the "benchmark" cost of CCS, the DCS price is not more than the "benchmark" cost of CCS.

The rest of this section describes the general structure of the formula. Section 3 describes the EMA proposed methodology for the calculation of the main elements of the PCF.

<u>Formula</u>

Permitted revenue in any year t,

$$M_t = \left[(1 + CPI_t / 100) FC_{B,t-1} * Q_{cap,t} / Q_{l,t}\right] + \left[(1 + EI_t / 100) C_{BE,t-1}\right] + \left[(1 + WI_t / 100) C_{BW,t-1}\right] + \left[(1 + OI_t / 100) VC_{BO,t-1}\right] + K_t - S_t$$

Where:

M_t means the maximum average revenue per kW_rh in relevant year t

KW_rh means kilowatt-hour (refrigeration)

KW_r means kilowatt (refrigeration)

CPI_t means the percentage change in the Consumer Price Index between that published with respect to January in relevant year t and that published with respect to January in relevant year t-1.

$FC_{B,t-1}$ benchmark cost (fixed cost component) of chilled water production by conventional in-house air -conditioning system in relevant year t-l, which has a value equal to an amount in $/kW$_r$, which is derived from the following formula:

$FC_{B,t-1} = (1+CPI_{t-1}/100)\ FC_{B,t-2}$

$Q_{cap,t}$ means the sum of declared capacity (kW$_r$) of all the consumers in the DC zone in relevant year t, calculated using agreed estimation procedures.

$Q_{l,t}$ means the total cooling load (kW$_r$h) of all the consumers in the DC zone in relevant year t, calculated using agreed estimation procedures.

EI_t means the percentage change in the electricity price (energy and grid charges at 22kV) in year t with respect to the price of electricity (energy and grid charges at *22kV)* in year t-l.

WI_t means the percentage change in the price of water supplied to commercial buildings in year t with respect to the price of water supplied to commercial buildings in year t-l.

OI_t means the percentage change in the price of services (other than electricity and water) in year t with respect to the price of services (other than electricity and water) in year t-1.

$C_{BE,t-1}$ means electricity cost component of benchmark cost of chilled water production by conventional in-house air-conditioning system in year t-l; which has a value equal to an amount in $/kW$_r$h, which is derived from the following formula:

$C_{BE,t-1} = (1+EI_{t-1}/100)C_{BE,t-2}$

$C_{BW,t-1}$ means water cost component of benchmark cost of chilled water production by conventional in-house air-conditioning system in year t-1, which has a value equal to an amount in $/kW$_r$ h, which is derived from the following formula:

$C_{BW,t-1} = (1 + WI_{t-1}/100)C_{BW,t-2}$

$VC_{BO,t-1}$ means other variable costs (other than the costs of electricity and water) component, if applicable, of benchmark cost of chilled water production by conventional in-house air-conditioning system in year t-l, which has a value equal to an amount in $/kW$_r$h, which is derived from the following formula:

$VC_{BO,\ t-1} = (1 + OI_{t-1}/100)VC_{\ BO,\ t-2}$

K_t means the correction factor (per kW_rh) for under-recovery (+ve value) or aver-recovery (-ve value) in year t, to be applied to the average revenue per kW_rh, which is derived from the following formula:

$K_t = [(M_{t-1} * Q_{1,t-1} - R_{\ t-1}) / Q_{1,t}] \times (1 + I_t/100)$

Where

R_{t-1} means the revenue from provision of district cooling services in DC zone in year t-l.

I_t means the interest rate in relevant year t which is equal to, where R_{t-1} has a value greater than an amount equal to the product of M_{t-1} and $Q_{1,t-1}$ plus a margin expressed in percent of the product of M_{t-1} and $Q_{1,t-1}$ to be determined by the EMA, the average of the daily Singapore Inter-Bank Offer Rate during relevant year t-l plus a number to be determined by the EMA or, where R_{t-1} has a value less than or equal to an amount equal to the product of $M_{t-1}$and Q_{1t-1} plus a margin expressed as a percentage of the product of M_{t-1} and $Q_{1,t-1}$to be determined by the EMA, the average of the daily Singapore Inter-Bank Offer Rate during relevant year t-l.

S_t = Sharing of economic efficiency contribution by DCS in year t.

= FS_t if $FS_{t} > 0$

= 0 if $FS_t \leq 0$

FS_t =

$$\left\{ \left[\left(FC_{B,t-1} * Q_{cap,t-1} \right) + \left(C_{BE,t-1} + C_{BW,t-1} + VC_{BO,t-1} \right) * Q_{1,t-1} \right] - \left(\sum FC_{D,t-1} + \sum VC_{D,t-1} \right) - L_{t-2} \right\} * \phi / Q_{1,t} \}$$

where

$\Sigma FC_{D,t-1}$ Means total fixed operating costs of the DCS operator (*according to audited accounts*) for the purpose of providing district cooling services in the DC zone in relevant year t-l including a return based on the investment made by the operator for the provision of district cooling services in the DC zone.

$\Sigma VC_{D,t-1}$ Means total variable cost of operating the DCS (*according to audited account*) for the purpose of providing services in the DC zone in relevant year t-l.

φ = sharing ratio for economic efficiency contribution by DCS between consumers and DCS operator

L_{t-2} Means net cumulative losses at end of year t-2, if applicable, which is derived from the following formula:

$= 0 \quad \text{if } FL_{t-2} \leq 0$

$= FL_{t-2} \quad \text{if } FL_{t-2} > 0$

$FL_{t-2} = L_{t-3} + (\Sigma FC_{D,t-2} + \Sigma VC_{D,t-2}) - (M_{t-2} * Q_{I,t-2})$

2.2. Methodology for Benchmarking the Costs of CCS

In order to calculate the initial CCS benchmark costs, the EMA proposes using cost information from ten commercial buildings currently using CCS in Singapore. The EMA recognises that the sample buildings should be representative of those buildings to be built in the DC zone. However, most of the land parcels in the DC area have not yet been sold. Therefore, at this stage, there are some uncertainties on the detailed characteristics of the commercial buildings to be built in the area.

The EMA notes that the costs of the CCS installed in existing commercial buildings may not fully correspond to the costs of a new CCS today, because of deterioration and changes in the efficiency of the equipment. However, the EMA believes that given the difficulties of developing stable, transparent and credible measures of CCS efficiency and deterioration rates, the use of actual data from a sample of buildings seems to be the most transparent, readily measurable, and objective approach to calculating the CCS benchmark costs.

The EMA has set the following five criteria for the selection of buildings to be used to calculate the benchmark values:

(1) Type and composition of buildings

The following building type and composition (prepared in consultation with URA) should be observed –

- Office buildings – 50%.
- Mixed developments (offices, retail and other functions) – 40%.
- Hotels – 10%.

(2) Size of buildings

The buildings selected should have a Gross Floor Area (GFA) not significantly less than 40,000 sqm.

(3) Type of central air-conditioning plant

The buildings selected should have a typical conventional in-house air-conditioning system as used by commercial buildings in Singapore. This is characterised as having –

- One central plant supplying the majority of areas in the building.
- A central plant producing chilled water using water-cooled chillers.

(4) Stability of building operations

The building should reflect normal operation of a central air-conditioning plant. This is characterised as having –

- Close to full load occupancy.
- Stabilised building operations.

(5) Age of the central air-conditioning plant

The central air-conditioning plant in the buildings selected should be as new as possible.

Comment is invited on:

- The general structure of the price control formula
- The methodology for benchmarking the costs of CCS

3. CALCULATION OF THE MAIN ELEMENTS OF THE FORMULA

This section explains how the EMA proposes calculating each of the main elements of the price control formula described in Section 2.1. The EMA proposed methodology for the calculation of the regulated rate of return for the DCS operator is discussed in Section 4.

3.1. Benchmark CCS Fixed Costs

In the proposed formula the benchmark fixed cost *of CCS* in a relevant year t ($FC_{B,t}$) is calculated as the total fixed costs per unit of peak cooling load, using data from a sample of commercial buildings currently using CCS. [1]

The fixed costs of a CCS can be classified into annual fixed costs and investment costs. Annual fixed costs are all those fixed costs incurred on an *ongoing (or annual) basis* (e.g. maintenance, rents). Investment costs are *one-off costs* (as opposed to annual costs), such as the purchase of plant and equipment.

One-off investment costs have to be annualised to be able to calculate annual charges. The EMA proposes to annualise those costs through a depreciation charge and a return on assets. Each of these elements is discussed in turn.

3.1.1. Depreciation

A depreciation charge allocates the gross value of an asset to each year over the life of that asset. There are several methods of calculating the depreciation charge (e.g. straight-line, front-loading, and back-loading). In most regimes, the profile is a simple straight-line – i.e. the value of the asset is charged equally to every year of its life. The EMA endorses the straight-line depreciation approach in this case, as it is simple, transparent and objective.

3.1.2. Return on CCS Benchmark Assets

The benchmark costs should also reflect the costs of financing CCS investments. In order to do this, the benchmark fixed cost component should include the return on CCS assets. To calculate the rate of return for CCS, the EMA proposes using the methodology proposed to calculate the regulated rate of return for DCS described in Section 4 using the appropriate parameters for CCS.

[1] The EMA will approve the buildings to be used in the benchmarking using the criteria set out in Section 2.2.

3.1.3. CCS Fixed Costs in the Formula

The EMA proposes that the CCS fixed cost component is kept constant in real terms throughout the regulatory period. Therefore, the benchmark fixed cost component per unit of capacity will only be adjusted by inflation, as follows:

$$(1 + CPI_t / 100) FC_{B,t-1} * Q_{cap,t} / Q_{1,t}$$

Where:

$Q_{cap,t}$ = the sum of declared capacity (kW_r) of all the consumers in the DC zone in year t

$Q_{1,t}$ = total cooling load ($kW_r h$) of all the consumers in the DC zone in relevant year t

Given that the fixed cost component for investment costs will be the sum of (1) depreciation charge and (2) the return *on* assets, and that the return on assets decreases as the net book value of the assets decreases, it is necessary to develop a methodology to calculate a constant fixed cost component.

The EMA proposes using a combination of straight-line depreciation with a return on assets measured at some point in the life of the assets, such that the net present value (NPV) of (constant) annual payments over the life of the asset (discounted by the regulated rate of return) is equal to the initial value of the assets. The table below illustrates this approach with a simplified example.

Consider, for illustration, an asset with an initial value of S$ 50 and a life of 10 years, and a rate of return of 10%. At half of the asset life (5 years), the annualised investment fixed cost (depreciation plus return on assets) is S$ 8. This figure can be used as the constant benchmark fixed cost per unit of capacity, as it ensures that the net present value (NPV) of the annual payments over the life of the asset (discounted at the rate of return) is approximately equal to the initial value of the asset.

Table 3.1
Example on Annuitised Investment Costs

Assumptions	
Investment Costs	50
Life of Asset	10
Rate of Return (RoR)	10%

Year End	Net Asset Base	Depreciation	Return on Assets (ROR * Net Asset Base	Annual Investment Costs (Depreciation + Return on Asset)	Benchmark Cost
y/e	y/e	y/e	y/e	y/e	y/e
0	50.0				
1	45.0	5.0	5.0	10.0	8.0
2	40.0	5.0	4.5	9.5	8.0
3	35.0	5.0	4.0	9.0	8.0
4	30.0	5.0	3.5	8.5	8.0
5	25.0	5.0	3.0	8.0	8.0
6	20.0	5.0	2.5	7.5	8.0
7	15.0	5.0	2.0	7.0	8.0
8	10.0	5.0	1.5	6.5	8.0
9	5.0	5.0	1.0	6.0	8.0
10	0.0	5.0	0.5	5.5	8.0
			NPV	£50.00	£49.16

3.2. Electricity and Water Costs

In order to determine the benchmark electricity and water costs of a CCS, the EMA proposes measuring the consumption of electricity and water for the production of chilled water by the CCS installed in the sample buildings. This data, and information on water and electricity prices, would be used to calculate the benchmark electricity and water costs of CCS for the first year of the regulatory period. These components would then be updated every year using appropriate indices (see Section 3.6).

3.3. Other Costs

There may be other CCS costs that should be included in the formula. The EMA expects to obtain figures for these from the sample buildings. Using the data gathered from the buildings, the EMA will set benchmarks for these costs.

3.4. District Cooling Service Costs

The formula also considers the actual costs of the DCS operator for the calculation of S_t. These costs will be the firm's audited costs, and will be therefore based on clear and transparent industry accounting rules.

The DCS costs will include a return on assets, based on the investment made by the DCS operator and a regulated rate of return. The EMA's proposal for the calculation of the DCS operator's regulated rate of return is discussed in Section 4.

Comment is invited on:

- The proposed methodology to annualise the benchmark fixed investment costs
- The proposed approach to calculating a constant fixed cost component per unit of capacity

3.5. Sharing Ratio

Under the proposed PCF if the actual total costs of the DCS plus "net cumulative losses" are lower than total benchmark costs, the DCS operator is obliged to share some proportion of the difference with consumers. For the DCS operator, the incentives to improve efficiency (i.e. reduce costs) derive from the share of efficiency gains that the DCS operator expects to keep.

For the DCS operator, retention of 100 per cent of any cost savings would provide the strongest incentive. In this case the PCF would be set independently of the DCS operator's costs (i.e. the PCF does not rebalance in line with the DCS operator's actual costs), so the DCS operator would have every incentive to minimise its costs regardless of the limit placed on prices.

However, the EMA proposes requiring the DCS operator to pass a proportion of any efficiency gains or cost savings through to consumers, to ensure that the DCS price reflects such efficiency gains or cost savings. This reduces the share of cost savings kept by the DCS operator. To the extent that the sharing is expected (i.e. that the sharing ratio is set beforehand), it may alter the DCS operator's incentive to reduce costs. For example, if the DCS operator knows that only a small proportion of anticipated cost savings will be retained, such cost savings might not be pursued as vigorously as where retention of a large proportion has been established.[2]

Thus the EMA faces a trade-off in deciding how much of any cost saving to pass through to consumers. If too little is passed through, consumers will pay more than necessary to cover DCS production costs, and to secure continuing investment and other improvements in the business. If too much is passed through, the incentive for the DCS operator to make efficiency gains is reduced, and cost recovery and efficient investment may even be threatened.

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2 See Weisman, D.L. (1993), "Superior regulatory regimes in theory and practice" *Journal of Regulatory Economics*: 5, p355-366 and Mayer, C. and Vickers, J. (1996), "Profit-sharing regulation: an economic appraisal" *Fiscal Studies*, Vol 17, No 1, p1-18 for a discussion of the view that the (expected) sharing of efficiency gains weakens the prior incentive to reduce costs below the anticipated level.

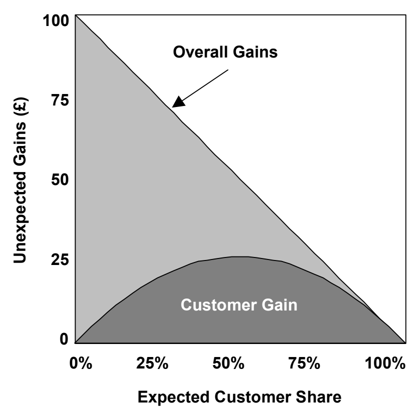
Where the balance should be drawn is a matter of judgement. There is little empirical evidence as to the level at which sharing significantly changes the incentives for a regulated company. We discuss this topic below.

3.5.1. Incentives and Sharing

While the precise relationship between incentives and efficiency gains is unknown, it is possible to investigate the relationship assuming different relationships between "unexpected gains" (the amount by which the DCS operator's costs are below the allowed revenue under the PCF) and incentives for efficiency. For the DCS operator, the incentives to improve efficiency (i.e. reduce costs) derive from the share of unexpected gains it expects to keep (i.e. the unexpected gain less the amount given to customers or customer gain).

If we assume that the level of unexpected gains falls in direct proportion to the customer share of the gain (in percentage terms), the relationship can be represented by the figure below.

Figure 3.2:
Illustrative Relationship between Unexpected Gains
& the Share Transferred to Customers



In the figure above, the top decreasing line labelled "Overall Gains" shows the total unexpected gains as a function of the expected share to be passed to customers. Unexpected gains are shown declining as the expected share to be passed to customers increases. That is, the DCS operators' incentives to reduce costs and improve efficiency are weakened to the extent that customers receive a larger the share of unexpected gains.

The customers' gain is shown as the lower line that increases, and then decreases, as a function of customer share. The lower line allows for both the share and its affect on incentives, its height being the product of the two:

Customer Gain = Unexpected Gains X Customer Share.

The figure shows that if unexpected gains fall as a direct proportion to customer share, then the "optimal" share for customers is 50 per cent of unexpected gains.

A simple calculation can be used to illustrate the trade-off. It is assumed hypothetical "maximum" unexpected gains of $100, and a simple trade-off between unexpected gains achieved by the DCS operator and customer share of unexpected gains, as shown in the figure above. The table below sets out the calculation as follows:

Under the above assumptions:

- If the DCS operator expects to keep all unexpected gains (i.e. the expected customer share is zero), the DCS operator will make all $100 of the maximum unexpected gain; its share is $100 while the customer receives zero.
- If the DCS operator expects to keep 75% of any unexpected gain (i.e. the expected customer share is 25%), the DCS operator will make $75 of unexpected gains; its share is $56.75 while the customer receives $18.75.
- If the DCS operator expects to keep 50% of any unexpected gain (i.e. the expected customer share is 50%), the DCS operator will make $50 of unexpected gains; its share is $25 while the customer receives $25.
- If the DCS operator expects to keep 25% of any unexpected gain (i.e. the expected customer share is 75%), the DCS operator will make $25 of unexpected gains; its share is $6.25 while the customer receives $18.75.
- If the DCS operator expects to keep no unexpected gain (i.e. the expected customer share is 100%), the DCS operator will make no unexpected gain; both it and the customer receive zero.

In summary, customer benefits would be $25 if they received a share of 50 per cent, and *less if their share were more or less than 50 per cent*.

Table 3.3
Customer Gains in Relation to Different Sharing Ratios

Expected Customer Share (%)	Unexpected Gain ($)	DCS Operator Share ($)	Customer Gain ($)
0	100	100	0
25	75	56.25	18.75
50	50	25	25
75	25	6.25	18.75
100	0	0	0

The EMA has tested how sensitive this result is to the specific assumption made about the trade-off between efficiency and incentives. Varying our "proportional" incentive effect assumption can produce different optimal shares. We checked the results against a range of assumptions and found that the simple picture in the figure above was relatively robust. For example, if efficiency gains fall off less quickly with the customer share, say in proportion to its *square*, the optimal customer share only increases to 58 per cent.

The EMA consider that customers' interests in cost reduction are likely to be best served by allowing a company share of 50 per cent. This level of sharing factor will be equitable for both the DC operator and consumers.

Comment is invited on:

- Setting the Sharing Ratio equal to 50%

3.6. Updating the CCS Benchmark Costs

The PCF utilises a number of indices designed to capture annual changes in:

- The fixed benchmark costs of CCS;
- Electricity prices;
- The price of water to commercial buildings; and
- The price of "other" variable cost components of CCS.

The next sections discuss how the EMA proposes calculating each of these indices.

3.6.1. Indices

The EMA considers that the indices chosen for updating the PCF should ideally reflect the likely variation in the costs represented by each component of the formula.

3.6.1.1. Fixed Cost Index

The PCF uses the Consumer Price Index (CPI) to update the fixed costs of CCS. The CPI is a convenient index to use as it is published by the Singapore Department of Statistics each month.

Having considered the other indices available in Singapore,[3] the EMA proposes using either the CPI or the GDP Deflator. These two indices are likely to be more stable over time (e.g. as they are free from exchange rate effects) than the alternatives available.

3.6.1.2. Electricity, Water and Other Variable Costs and Services Indices

3.6.1.2.1. Electricity Index

Under the PCF, the contribution to the DCS operator's overall revenue made by the allowance for electricity costs (per kWh) in a year *t* equals the previous year's allowance (allowance for year *t-1*) indexed by the percentage change in electricity prices in year *t*.

The EMA proposes that the electricity component of the PCF be indexed by the actual change in electricity prices. At present this implies using published tariffs for the index. The EMA notes that the electricity industry in Singapore is going through a period of reform and restructuring. New arrangements are being introduced that will affect the pricing of both electrical energy and its transportation.

If (when) a commercial customer connected at 22 kV becomes contestable (i.e. becomes free to negotiate and buy electricity from the supplier of his choice) a published tariff by which the electricity component of the PCF can be indexed is unlikely to remain available. In this case, it will be important to set out a principle by which the index is replaced with an arrangement that uses the best available information and is as objective as possible.

If published tariffs are not available, the preferred option may be to base the index on a market price for a consumer of a similar type or consumption level.

3.6.1.3. Water and Other Costs and Service Indices

Similarly, under the PCF, the contribution to the DCS operator's overall revenue made by the allowance for water costs[4] in a year *t* equals the previous year's allowance (allowance for year *t-1*) indexed by the percentage change in the price of water supplied to commercial buildings in year *t*.

The EMA proposes that the water component of the PCF should be indexed by the actual change in the price of water supplied to commercial buildings. Again this implies using published tariffs for the index.

The EMA understands that the PUB intends to supply NEWater (i.e. water recycled from waste water) for air-conditioning cooling towers in the near future. If this is the case the water component of the formula would need to reflect the price of NEWater.

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[3] For example, the Wholesale Price Indices.

[4] Water to a commercial consumer is charged for on the basis of a flat fee per cubic metre.

Regarding the index for updating other variable costs and services, the EMA will not know if there exists such other costs until the benchmark exercise has been undertaken, during which the required data for determining the benchmark costs will be gathered and compiled. The EMA will establish a view on updating any such costs once the data collection exercise has been completed.

Comment is invited on:

- The proposed approach for the calculation of the electricity index
- The proposed approach for the calculation of the water index

3.7. Connection Costs and Other DCS Costs to Be Paid by Building Owners

As well as paying a price for the district cooling service (i.e. the DCS price), commercial buildings will pay a DCS connection charge and will also pay some DCS costs directly (e.g. equipment in secondary side). In summary, in order to receive district cooling services, commercial buildings will pay:

1. A DCS price (based on the price control formula and benchmark methodology proposed by the EMA);
2. A DCS connection charge; and
3. Additional DCS costs (paid directly by the commercial buildings).

Given that the EMA's regulatory objective is to ensure that commercial buildings *overall* do not pay more than the benchmark costs of a CCS, the EMA is considering compensating commercial buildings for the additional DCS costs they will pay (through connection charges and other costs) in order to receive DCS. The rest of this section discusses these costs in more detail.

3.7.1. DCS connection charge

Each building owner will pay the cost of the building's connection to the off-take point of the District Cooling Distribution pipes at the Common Service Tunnel (CST). The DCS connection charge will depend on two variables, capacity and distance. Therefore, the connection charge will depend on the characteristics of each building. The connection charge will be a one-off payment. The following table summarises the *estimated* DCS connection costs to be paid by commercial buildings.

Table 3.4
***Estimated* DCS Connection Charge**

HEX Capacity (MWr)	Estimated cost within substation ($)	Estimated pipe cost (CST to substations) $/m	
1.5	62,000	150mmDia	$330
5	138,000	250mmDia	$540
11	238,000	400mmDia	$880
13	271,000	450mmDia	$980
16	327,000	500mmDia	$1,100
20	394,000	600mmDia	$1,400

Source: Singapore District Cooling Pte Ltd.

The EMA wishes to ensure that the total charges to be paid by commercial buildings are not higher than the CCS benchmark costs. Therefore, the EMA considers that these connection charges should be taken into consideration in the calculation of the DCS price.

3.7.2. DCS costs paid directly by DCS consumers

In addition to the DCS price and the DCS connection charge, DCS consumers will pay directly for some equipment for their secondary side (e.g. pumps, controls, electrical equipment) and its maintenance.

Given that the objective of the regulatory framework is to ensure that *overall* DCS consumers do not pay for DCS more than they would have to pay for an average CCS, the EMA proposes estimating the average levels of these costs for commercial buildings, and deducting them from the CCS costs gathered from the sample buildings, to calculate the benchmark costs to be used in the PCF. In addition, the EMA will take into consideration any savings that commercial buildings will enjoy for using DCS instead of CCS (e.g. building space).

This would ensure that *overall* DCS consumers do not pay for DCS more than they would have to pay for an average CCS.

Comment is invited on:

- The appropriate methodology to account for the one-off connection charge paid by building owners
- The proposed general approach to account for the costs paid directly by building owners

4. RATE OF RETURN FOR DISTRICT COOLING SERVICES

This section presents the methodology and *preliminary* estimation of the DCS operator's cost of capital (or rate of return).

The methodology proposed by the EMA for the calculation of the cost of capital is the Weighted Average Cost of Capital (WACC). The WACC is the most widely used method by regulatory authorities for calculating the costs of capital. This approach is based on the fact that companies can raise capital through either debt or equity. The relative return required for equity and debt is different, because debt holders enjoy a prior claim on a company's earning stream and therefore face different levels of risk. Thus, the cost of capital for a company is a weighted average of the two instruments, with the weightings determined by the relative levels of debt and equity in the company's asset base, or the company's "gearing".

The following sections discuss in detail the EMA's *preliminary* proposals to calculate the DCS' WACC. Based on the responses to this Consultation Document, the EMA will review its preliminary proposals and prepare its final decision. Appendix A provides a description of the WACC formula and the general principles underlying the calculation of WACC.

4.1. Estimating Cost of Equity

The sections below set out the EMA's *preliminary* estimation of the parameters used to derive the DCS operator's cost of equity, and follow the methodology set out in Appendix A.

The cost of equity parameters are:-

- Beta;
- Risk free rate;
- Equity risk premium; and
- Inflation expectations.

Each of these is discussed in turn.

4.1.1. Estimating Beta

The DCS operator is not a publicly quoted company. The DCS operator will be a subsidiary of Singapore Power, which is also unlisted. This means that it is not possible to estimate directly the DCS operator's beta, or that of its parent directly. In this instance, the standard approach is to use the beta risk of comparator companies that share similar risk characteristics to the DCS operator in Singapore.

The EMA has examined listed companies engaged in the provision of DCS. DCS companies also tend to undertake a wide range of other activities, and therefore, the EMA has not been able to isolate a "pure play" DCS beta. Moreover, there are very few examples of quoted companies operating the system and assuming the investment risk. Quoted DCS companies tend to be involved in equipment supply and servicing. This involves quite different risks from a pure DCS operator.

The EMA believes the DCS operator's business and market characteristics are most like those of a utility service provider. The DCS operator will incur significant capital development costs, assume capital investment risk, enjoy exclusivity and operate under a system of price regulation. These fundamental characteristics suggest utility operators might offer the most appropriate proxies for the DCS operator's beta risk.

Thus, in the first instance, the EMA examined utility company betas in Singapore and South East Asia, on the basis that they share fundamentally similar risk characteristics with a DCS business and geographical proximity.

The EMA has also looked at non-competitive utility businesses (essentially network energy businesses) in UK and Australia. The EMA initial conclusion is that network utilities appropriately capture the expected market structure of the DCS operator. Section 4.1.1.5 discussed in more detail the relevance and selection of comparators and potential differences in respective beta risks, on the basis of differing business risks.

4.1.1.1. Estimating beta values

There are two key issues to resolve prior to the estimation of beta values. These are:-

- The appropriate time-frame over which to estimate the betas; and,
- The method of de-leveraging our observed equity betas to derive comparable asset betas.

These two issues are discussed below.

- The appropriate estimation time-frame

Broadly, there are two alternatives:-

  - Long term historic betas, for example, estimated over a five year period. Estimating betas over a long time-frame would captures the market's historic assessment of risk associated with the business activity.
  - Betas estimated over the most recent period, for example, the most recent two-year period. This will capture the market's perspective on more recent risk exposures.

There is a trade-off between these two approaches. Five year estimates are more likely to give regression results with lower standard errors, i.e. more "robust" estimates. On the other hand, they present a more dated picture of the risk exposure of the particular company, and therefore less pertinent to future risks. In order to obtain the most up-to-date market measure of risk, it is generally preferable to use 2-year betas.

However, it is also important to consider other factors, such as excess market volatility, that might make short-term estimates of beta risk an inaccurate estimate of actual risk going-forward. Section 4.1.1.3 presents both 2-year and 5-year estimates, and discusses the appropriate time-frame on the basis of the regression results.

To ensure that robust estimates are derived from the market data, the EMA proposes to estimate betas over a 2-year and a 5-year period using weekly data. Weekly data is preferred to ensure sufficient data points to derive robust betas. Each company's returns are regressed against the domestic all share index for its home country.

4.1.1.2. Estimating asset betas from observed equity betas

There are two adjustments that need to be made to observed equity (or regression) betas to derive asset betas.

- The Blume Adjustment process

First, the raw betas (or historical betas, i.e. those betas obtained from the regression of the company's stocks against the market index) are adjusted according to a simple deterministic formula:

$$\beta_{\text{Equity-adjusted}} = (0.67)*\beta_{\text{Equity-raw}} + (0.33)*1.0.$$

This is referred to as the Blume technique. Blume tested to see if historic beta estimates were unbiased estimates of future betas. Blume demonstrated a tendency for estimated betas to regress towards their mean value of one. The adjustment formula above captures this tendency.

- Allowing for financial risk

A company's beta is a function of the business risk particular to the company and the extent to which these risks are magnified by the operating and financial leverage decisions of the company. The analysis should focus on estimating *asset* betas, which capture only the business and cost risks associated with each company, to the exclusion of financial risk. An asset (or de-levered) beta is a beta with zero assumed debt. On this basis, betas across companies can be compared.

To estimate the cost of equity the un-levered betas have to be "re-geared" to accord with the expected average capital structure of the DCS operator over the next control period.

The Modigliani-Miller equilibrium is the most common approach to adjusting equity betas.

Modigliani-Miller (MM) equilibrium: $\beta_{equity} = \beta_{asset} * (1+(1-T_c)/(1-\rho*T_i)*(D/E))$

Where T_c is the corporate tax rate, T_i is the imputation tax credit rate, ρ reflects the utilisation of the imputation tax credit, D represents a company's debt, and E represents a company's equity.

The corporate tax rate (T_c) and the imputation tax rate (T_i) are specific to the tax jurisdiction of the company. Singapore currently operates a full imputation tax system. Under this system, corporate tax paid is imputed as a tax credit on profits distributed as dividends. Effectively, distributed corporate income is therefore subject to tax only once and at the marginal income tax rate of the shareholder. Proposed changes to the imputation tax law imply that dividends will only be taxed once at the corporate tax rate (irrespective of the marginal tax rate of the shareholders). Thus, historically the imputation tax rate has been equal to the corporate tax rate, and can be considered to be at least as great as the corporate tax rate going forward. Therefore it is assumed that T_c is equal to T_i in both de-levering Singapore based comparator betas and re-levering DCS's estimated beta.

However, not all imputation tax credits are used. In the above formula, this effect is captured by ρ. The utilisation of tax credits is a function, inter alia, of domestic-foreign investors, the proportion of domestic investors who are non-taxpayers, and, importantly, the dividend pay-out ratio. These factors are company specific and very difficult to estimate. This issue has been extensively discussed in the Australian regulatory context, where it was decided to adopt a value of 0.5.[5] The EMA proposes to follow the Australian precedent and adopt the same value to lever and de-lever comparator and DCS's betas.

For the comparator companies in other tax jurisdictions, it is proposed to follow the national tax imputation rules, and assume a ρ value equal to 0.5, where the imputation system exists.

4.1.1.3. Empirical Evidence

Table 4.1 presents empirical evidence for quoted utility and DCS operators in Singapore and Malaysia.

In Singapore, there are only two listed utility companies, SembCorp Industries and Asia Power. SembCorp has energy and water utility interests, as well as significant engineering activities. Asia Power is predominantly an electricity generation company, operating in

[5] "A WACC for the Gas Industry", Report for ACCC, Professor Kevin Davis, March 1998.

China, but with a Singapore listing. Their asset beta values range from 0.42 (SembCorp, 2-year estimate) to 0.77 (Asia Power, 2-year).

For DCS equipment suppliers and operators, there are two quoted companies in the region, Malakoff and Metacorp. These are both listed in Malaysia. In both cases, DCS equipment supply and operation constitute a very small proportion of overall revenues, and therefore their beta values largely reflects the systematic risk associated with their predominant utility (in the case of Malakoff) and general investment (Metacorp) activities. Therefore, their betas are very poor proxies for DCS operations. Malakoff is a potentially useful comparator as a utility business.

Table 4.1
Utilities and DCS operators (Singapore and SE Asia)

Comparator	**Description**	**2 year- 3/00-3/02 Weekly Data**			**5 year- 3/97-3/02 Weekly Data**		
		Asset	**Equity**	**Standard error**	**Asset**	**Equity**	**Standard error**
Singapore							
SembCorp Industries Ltd.	Utility (17%); Engineering (52%)	0.42	0.76	0.13	0.57	0.9	0.09
Asia Power Ltd.	Electricity generation	0.77	0.95	0.17	0.72	0.89	0.15
Malaysia							
Malakoff Bhd	Predominantly utility; DC relativly minor	0.35	0.66	0.09	0.40	0.93	0.07
Metacorp Bhd	Investment holding; DC (4.5%)	0.81	1.06	0.3	0.89	1.21	0.09

Source: analysis of Bloomberg data. Betas have been unlevered using the following unlevering formula: $\beta_{equity} = \beta_{asset}$ *(1+(1-Tc)/ (1-ρTi)*(Debt/Equity)). The gearing and effective tax rates used for the unlevering are taken as of end of financial periods, averaged over the time periods in question. Where the effective tax rate is not available, the corporate tax rate for the country in question has been used instead. Imputation taxation is based on the national tax system. A ρ value of 0.5 was used for all tax jurisdictions. Betas have been calculated with respect to the domestic market. The raw betas (or historical betas, ie those betas obtained from the regression of the company's stocks against the market index) have been adjusted according to a simple deterministic formula:* $\beta_{Equity\text{-}adjusted} = (0.67)*\beta_{Equity\text{-}raw} + (0.33)*1.0$*. This adjustment is made to reflect the assumption that a security's true beta will move towards the market average (of one) over time. Note: Where a full quotation period is unavailable, we have used the maximum quotation period.*

Table 4.2 sets out beta values for energy utilities in UK and Australia. These energy companies were selected to reflect the betas of utility companies operating in *non-competitive* utility markets. The four selected companies operate energy network assets in their domestic markets. This type of market structure approximates to the competitive market of

Singapore District Cooling, which will enjoy exclusivity rights in the provision of cooling services.

These data show that the average asset beta over a two-year period for our set of comparators is 0.25. For the longer five-year period, the average asset beta is 0.39.

Although short-term betas offer more up-to-date market evidence on beta risk, we have concerns about the low beta values for the two-year period, particularly for the two Australian based comparators. A possible explanation for the lower estimates is the increase in market volatility. In recent years, as a result of fears of a global recession, the collapse of the technology and telecoms sectors, and the events of September 11th, it could be argued that there are good reasons to believe the equity market is more volatile than investors expected. As a consequence of this volatility, beta estimates of certain stocks can be biased downwards.[6] It is also important to note that the two-year estimates of beta values for the Australian comparators have relatively high standard errors, and are not robust. For these reasons, the EMA considers that the longer term betas provide a better estimate of true beta risk.

Table 4.2
Comparator Asset Betas

Comparator	**Description**	**2 year- 3/00-3/02 Weekly Data**			**5 year- 3/97-3/02 Weekly Data**		
		Asset	**Equity**	**Standard error**	**Asset**	**Equity**	**Standard error**
UK							
National Grid Group Plc.	Electricity transmission in UK.	0.40	0.61	0.12	0.53	0.72	0.09
Viridian Group	Electricity network owner	0.32	0.5	0.11	0.33	0.45	0.08
Australia							
Australian Gas Light Co. Ltd.	Energy network operator; generator; management.	0.10	0.17	0.18	0.33	0.47	0.11
United Energy.	Energy network owner; core business - electricity distribution in Melbourne	0.19	0.34	0.16	0.36	0.66	0.17
Average		**0.25**	**0.41**		**0.39**	**0.58**	

Source: analysis of Bloomberg data. Betas have been unlevered using the following unlevering formula: $\beta_{equity} = \beta_{asset}$ *(1+(1-Tc)/ (1-Tiρ)*(Debt/Equity)). The gearing and effective tax rates used for the unlevering are taken as of end of financial periods, averaged over the time periods in question. Where the effective tax rate is not available, the corporate tax rate for the country in question has been used instead. Imputation taxation is based on the national tax system. A ρ value of 0.5 was used for all tax jurisdictions. Betas have been calculated with respect to the domestic market. The raw betas (or historical betas, ie those betas obtained from the regression of the company's stocks against the market index) have been adjusted according to a simple deterministic formula:* $\beta_{Equity\text{-}adjusted} = (0.67)*\beta_{Equity\text{-}raw} + (0.33)*1.0$. *This adjustment is made to reflect the assumption that a security's true beta will move towards the market*

[6] Cooper and Currie (1999) have highlighted this issue.

average (of one) over time. Note: Where a full quotation period is unavailable, we have used the maximum quotation period.

4.1.1.4. Conclusions from Empirical Evidence

The EMA draws the following conclusions from the empirical evidence:-

- In general, it is difficult to isolate pure play DCS betas. The only available comparators in SE Asia (and worldwide) tend to be larger industrial or utility concerns, with only a small percentage of revenues. The EMA does not think that their business risks "match" the prospective operating and business environment of the DCS operator in Singapore. Our comparator DCS companies business interests tend to concern equipment supply and servicing, rather than the actual supply of chilled water.

- The EMA believes that the DCS operator's business environment – with capital investment risk, exclusivity rights and regulated prices- is like a utility business. We present beta values for three quoted utility companies in South East Asia, SembCorp, Asia Power (both in Singapore), and Malakoff (in Malaysia). However, they all operate in potentially competitive energy generation markets, in contrast to the prospective market structure of the DCS operator. This reduces their value as comparators.

- UK and Australian energy network owners offer suitable comparators. These companies operate predominantly in network utility markets. This approximates to the expected market structure of the DCS operator.

Based on its *initial* assessment, the EMA considers that the UK and Australian energy network operators are useful comparators. However, the EMA may consider other possible comparators proposed by relevant parties during the Consultation Process. The EMA prefers longer-term 5-year betas because short term betas appear less robust (particularly in the case of Australia). Over the preferred five-year time period, this set has an asset beta of approximately 0.4.

The following section considers the specific business risks of the DCS operator that need to be taken into account in setting its beta on the basis of the comparator set.

4.1.1.5. DCS operator's Business Risks

There are also a number of fundamental characteristics that influence beta values. These are generally grouped into *business risks*, and the effects of *operating* and *financial* leverage. The particular business risk of a company is a function of, inter alia, its:-

- competitive market structure;

- regulatory environment;
- specific market characteristics, e.g. customer profile; and
- cost risks.

The sub-set of UK and Australian energy network utilities operate in non-competitive utility markets. This is approximate to the DCS operator's expected market structure. Thus, the key issue to consider is the prospective regulatory environment vis-à-vis the comparator set, specific market characteristics, and potential costs risks. Each of these issues is discussed below.

- Regulatory Environment

The key consideration in the regulatory environment is the structure of the price or revenue cap. This indicates the level of risk, in terms of demand and cost risks, assumed by the regulated company.

In the case of the DCS operator's price framework, the framework has the following characteristics:-

1. Permitted prices will be the lower of the following two options:-
   - The price-cap will be set equal to the benchmarked costs of a conventional cooling system.
   - However, if the actual cost of DCS provision is below the benchmark cost, then the price-cap will be set equal to the costs of the DCS service (including a reasonable rate of return) plus a performance incentive.
2. If the CCS costs are lower than the DCS' actual costs, then the price-cap allows for "unrecovered costs" to be continuously rolled-over to subsequent financial years.
3. On the other-hand, if the costs of CCS are higher than own-costs, the DCS operator will be permitted to retain a proportion of the cost differential. If the "cost-sharing" parameter is zero it will retain all of the cost differential. If the parameter value is 1, its permitted revenue will be in line with its *audited* costs (i.e. expected rents will be zero).
4. The key risk to the operator is that the price ceiling is effective over the entire project life, and therefore the operator fails to recover its actual costs. Otherwise, the price formula appears to allow full cost-recovery over the project period.

This is a rather unique pricing formula and is difficult to compare to the comparator set. However, the EMA notes that energy networks tend to be subject to revenue caps, which are generally viewed as low risk. The EMA's preliminary preferred comparator set also enjoys the "security" of regular price-reviews. Price reviews present an opportunity for prices to be re-set in line with actual costs, and thereby mitigate risk for the regulated company.

However, as discussed, in the instance where the price-ceiling is binding, prices will not be set to allow cost recovery. This suggests that the proposed regulatory environment is relatively higher risk than these comparators.

- Specific Characteristics of the Market

This section discusses the particular characteristics of the DCS market vis-à-vis the utility comparators.

The operator is supplying a different product - chilled water - compared to our energy network utility companies. If the nature of the demand for this product is significantly different from the demand for energy, then the comparators will not be very useful comparators. Unfortunately, there is no evidence on the demand characteristics for DCS. The key determinant of beta risk is income elasticity. However, from a qualitative perspective it is plausible to assume that DCS has "utility" good characteristics, that is, characterised by a relatively low income elasticity.

The characteristics of the customer base also influence the systematic risk of a business. The DCS operator is expected to serve commercial customers. In the utility service there is evidence to suggest that business users show greater income elasticity of demand for utility goods than consumers. Ceteris paribus, this implies the DCS operator will incur higher risks than our comparator set.

- Cost risk factors

A company's operating leverage influences its beta risk. Operating leverage is formally the ratio between the percentage change in total costs and the percentage change in output. In simpler terms, it is a measure of the degree to which costs are fixed and therefore non-variable with output. Mainstream financial theory asserts that the higher the operational leverage, the greater the beta value, since any given change in revenues cannot be offset by adjusting the cost base[7]. In effect, the higher operating leverage or cost-fixity of a business "magnifies up" the demand risk factors. However, it is difficult to estimate the operating leverage of a company. A proxy estimate that is often used is the ratio of capital expenditure to operating expenditure, although this ignores the fact that opex can also be fixed in the short-run.

It is important to note that the DCS technology is based on high fixed costs and low opex. This suggests a high degree of cost-fixity. A high level of cost-fixity also characterises energy network utilities. Thus, given the difficulties of deriving an exact measure of operating leverage, the EMA concludes on qualitative grounds that the respective levels of cost-fixity are similar.

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[7] See for example, Morin, R., "Regulatory Finance - Utilities Cost of Finance", 1994, page 364.

4.1.1.6. *Conclusions on beta parameter value*

It has been examined the beta evidence for :-

- DCS companies
- Utility companies in Singapore and SE Asia
- Network energy companies in UK and Australia

The EMA's initial assessment suggests that energy network companies provide good proxy values for the beta of the DCS operator. This is because their non-competitive utility businesses are similar to the expected operating characteristics of the DCS operator. The initial preferred comparator sub-set of UK and Australian energy network companies has an asset beta of approximately 0.4 over our preferred five-year period.

The specific business risks associated with DCS, particularly with regard to the regulatory environment has been considered.

The risk implicit in the regulatory environment is the risk that the price-ceiling is binding over the entire project life. In this instance, the DCS operator will not be allowed to recover its actual costs. However in the case that the price-ceiling is not binding the price-formula allows for full cost-pass through. The price-cap also incorporates a "volume adjustment factor" that ensures the DCS operator does not incur volume risk.

Other risk factors that differentiate DCS provision from the initial comparator set have been considered. These are the nature of the product, the characteristics of the customer base, and the operating leverage of DCS. It is assumed the provision of "chilled water" has similar demand characteristics to other utility products. It is also assumed that the relative operating leverage of the DCS provider is similar to network utilities. The business customer base, however, imposes higher systematic risk on the DCS provider.

In conclusion, the specific risk factors, notably the risks associated with the regulatory regime and the customer base, suggest our initial comparator set beta average of 0.4 represents a lower estimate of DCS operator's risk. The EMA therefore suggests a beta risk in the range of 0.5 to 0.6. These values may need to be reviewed if other relevant comparators are identified during the Consultation Process.

Comment is invited on:

- The proposed initial comparators for the calculation of the beta of the DCS operator
- The proposed approach to the calculation and proposed level of the beta risk for the DCS operator

4.1.2. The Risk-Free Rate

In theory the risk free asset should be an asset that displays zero covariance with the market portfolio, that is, an asset with a beta value of zero. However, in practice, a riskless asset does not exist and instead the EMA proposes to use the yield on government debt as the closest proxy to the return on a theoretical risk free asset.

The market for government debt in the relevant market, the Singapore All Share Index, consists of wide number of debt instruments, differentiated by the *maturity* of the debt and other debt characteristics (such as the coupon rate). There is also access to *present and historic* yield data.

From this diverse set of sovereign debt issues, the most appropriate government debt issue is that which most closely approximates the theoretical expected risk free rate over the control period. On this basis, the EMA notes that:-

1. "Spot" rates on government debt are preferable to historic rates. If capital markets are efficient, current yields will reflect all expectations of interest rates going forward and thus most closely approximate to the risk free rate parameter the CAPM model. However, since risk free rates can be volatile in the very short term, the EMA considers it appropriate to calculate a 3-month short-term average of recent bond market yields. This method minimizes very short-term fluctuations in rates while capturing the most up to date information and inflation expectations incorporated in the current yields.
2. Regarding the *maturity* of the debt, the preferred theoretical position is to choose a maturity that is consistent with the *investment horizon*. However, the CAPM framework does not define the actual length of an investment horizon. Based on the practice used by other regulators, the EMA proposes to use a 5-year period.

Table 4.3 presents a range of Singapore government debt issues, with the EMA preferred proxies for the risk-free rate in bold. The preferred measures of the riskfree rate are 3-month average spot rates for Singapore government debt, with maturities corresponding to end of 2007 (based on a five year investor horizon).

Therefore, the EMA's initial proposal is a risk-free rate equal to 3.02 per cent, the approximate "interpolated" mid-point of the bonds maturing in 03/2007 and 07/2008.

Table 4.3
Singapore Government Debt Issues

Issue date	Maturity date	Current YTM[1]	3 month average YTM[1]	Standard deviation
23/10/1998	15/10/2005	1.935	2.232	0.16
01/03/2000	**01/03/2007**	**2.587**	**2.808**	**0.14**
01/07/1998	**01/07/2008**	**3.027**	**3.231**	**0.16**
12/01/1999	15/01/2009	3.152	3.366	0.18
03/07/2000	01/07/2010	3.422	3.619	0.18
02/07/2001	01/07/2011	3.581	3.748	0.16
01/07/2002	01/07/2012	3.71	3.744	0.08
03/09/2001	01/09/2016	3.998	4.186	0.20

Source: Bloomberg, EMA analysis of Bloomberg data. (1): YTM denotes "yield to maturity"

Comment is invited on:

- The proposed level of the risk free rate

4.1.3. Equity Risk Premium

The equity risk premium (ERP) is the difference between the expected return on the market portfolio and the expected return on a risk free asset, (formally stated as $E[r_m] - E[r_f]$).

Consistent with prevailing views amongst both academics and finance practitioners, The EMA's approach to estimating the ERP relies primarily on the results obtained from the analysis of the average difference over the long term between realised returns on the market portfolio, and those on a risk free asset (the so-called *ex post* approach).

The arithmetic mean approach is consistent with the hypothesis that financial markets are efficient, with equity returns serially independent. The EMA believes this is consistent with the majority academic viewpoint and current evidence regarding the efficiency of equity markets.

4.1.3.1. Ex post Approach

The ex post approach calculates the average differences between realised (i.e. historical) returns on (a proxy for) the market portfolio and realised returns on (a proxy for) the risk free asset. This presumes that the expected ERP is constant over time and that realised premiums converge towards this expectation when averaged over sufficiently long periods (i.e. there is no systematic bias between expectations and outturns).

There is no right time period to use when analysing historic data to estimate the ERP. Using long-term historic averages is most likely to overcome the possibility of systematic bias between expectations and outturns. Long-term averages of returns are most appropriate if it is assumed that the equity risk premium is constant over the measurement period and will remain constant in the future. The EMA prefers the use of long-term historic average estimates of the ERP on this basis.

The EMA does not have access to long-run ERP estimates for the relevant market, Singapore. It is important to note that the ERP is a function of investor preferences and the standard deviation of the market portfolio. Assuming that investors' risk preferences are relatively consistent across countries, well-diversified markets outside of the reference market (see Section A.3) are also relevant in determining the ERP. Table 4.4 therefore presents long-run ERP estimates for major worldwide equity markets.

Table 4.4
LBS/ABN AMRO Estimates of the Long Run Ex-Post Equity Risk Premium

	ERP relative to Bills		ERP relative to Bonds	
	Arithmetic	**Std. dev.**	**Arithmetic**	**Std. dev.**
Australia	8.5%	17.2%	8.0%	18.9%
Japan	10.0%	28%	10.4%	33.3%
UK	6.5%	19.9%	5.6%	16.7%
USA	7.5%	19.8%	6.9%	19.9%
World average[1]	7.5%	N/a	6.7%	N/a

Source: LBS / ABN AMRO (2001)"Millennium Book II, 101 years of investment returns". The estimates are based on 100 years of data, with 1922/3 excluded for Germany where hyperinflation had a major impact on the risk premia and bills returned. (1) The countries included in this average are: Australia, Belgium, Canada, Denmark (from 1915), France, Germany, Ireland, Italy, Japan, Netherlands, Spain, Sweden, Switzerland (from 1911), UK and USA.

4.1.3.2. *Regulatory Precedent*

There is no regulatory precedent on the estimation of equity risk premium for regulated companies in Asia in the public domain. Therefore, the EMA has looked to the UK, Australia and US for a precedent.

In the case of the UK, the estimates of the equity risk premium rely heavily on small sample survey evidence of the equity risk premia by CLSE (1999)[8], NERA (1998)[9] and other evidence from Investment Bank analysts. These sample surveys are based on too small a sample size, unsound methodology, and the results have been misinterpreted. Therefore, the EMA cannot place any weight on UK regulatory precedent in drawing conclusions for the DCS operator.

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8 Credit Lyonnais Securities Europe (1998), "Risk and Return in the UK water sector: An independent survey of institutional investors", Credit Lyonnais Securities, London

9 NERA (1998) Survey of Financial Markets on Cost of Capital Issues

It is preferred to look at more robust results in other European regulatory domains, as well as Australia and the US. In particular, the US decisions are subject to intense legal scrutiny and the EMA believe their rate-case evidence is more reliable.

In the Netherlands, the electricity regulator DTe published its guidelines for price cap regulation in the period from 2000 to 2003 whereby it "*considers it reasonable to fix the market risk premium between 4% and 7%*[10]". This was derived on the basis of the available data and responses from the sector. This is in line with the decision of OPTA Commission in assessing the telephone tariffs. More recently, the telecommunications regulator OPTA published its decisions for KPN, using an ERP estimate of 6.0%.

In the US, although the CAPM is not widely used to estimate the cost of equity, the most widely quoted source used in rate of return cases of the equity risk premium is the Ibbotson data. The method recommended by Ibbotson is to compute, for each year, the excess of the stock market return over the long-term Treasury bond yield prevailing at the beginning of that year, and then arithmetically average them over the years. The result is an estimate of 8.0%. The final adopted figures are generally in the range of 5% - 8%. Such estimates are based on detailed survey data from the IBES database, and historical evidence. The Table 4.5 shows an example of the ranges accepted.

Table 4.5

Recent Decisions Regarding the Equity Risk Premium in the US

Decision	ERP estimate	Comments
Connecticut Department of Public Utility Control Decision 98-01-02 (February 1999) for Connecticut Power & Light Company	6.52%, 5.89%	Different witnesses performed the CAPM calculation with different ERPs. These are the ERPs used in the CAPM calculations that the Commission approved of.
Maine Public Utilities Commission, Decision 97-580 (March 1999) for Central Maine Power Company	7.40% - 8.90%	The Commission uses CAPM analysis as a check on the DCF method, and employs this range of ERPS, based on witnesses' recommendations.
Public Service Commission of Utah, Decision 97-035-01 (March 1999) for Pacificorp, dba Utah Power and Light	7.8%	Use CAPM as check to DCF model.
Connecticut Department of Public Utility Control Decision 99-04-18 (January 2000) for Southern Connecticut Gas Company	6.13%	The Commission used a Risk Premium Method to check DCF. The ERP is the arithmetic average from 1974-1998.
Public Utility Commission of Oregon Order 99-697 (November 1999) for Northwest Natural Gas	8.5%	Commission chose the ERP for use in CAPM.

10 "Guidelines for price cap regulation of the Dutch electricity sector in the period from 2000 to 2003", Netherlands Electricity Regulatory Service, February 2000

In recent decisions, Australian regulators have concluded that the market risk premium is most likely to lie in the range of 5.0% to 6.0%. The most recent regulatory decision by the ACCC in the price review of Sydney Airports used an equity risk premium of 6%. In the electricity sector, on the other hand, independents experts have used 6.5% in their submissions for electricity distribution pricing. In May 1999, one market practitioner noted that "*[it] believes 6 per cent [equity risk premium] to be a reasonable, if not conservative, estimate*".[11] Nevertheless, Australian gas and electricity regulators have chosen to set the equity risk premium in the range of 5% - 6%.

4.1.3.3. Conclusions on the equity risk premium

With regard to the appropriate ERP for Singapore, the EMA note:-

- Evidence on ex-post returns in major equity markets worldwide suggests an ERP in the range of 6 to 7%.
- Survey evidence and regulatory decisions by UK and other European regulators suggests a lower ERP, in the range of 3 to 5%. However, these estimates are largely based on non-robust survey evidence.
- Evidence from rate case hearings in the US, which are subject to legal scrutiny, suggest an ERP in the range of 6 to 8%.

Taking a balanced view of this evidence, the EMA considers that the appropriate ERP for Singapore could be in the range of 5 to 7%.

Comment is invited on:

The appropriate value of the ERP

4.1.4. Inflation

The EMA inflation forecasts are based on Consensus Forecasts, which reflects an average of private sector and non-governmental expectations of inflation. The appropriate timeframe for this parameter is 5 years, consistent with the term of the nominal risk free rate.

11 Grant Samuel & Associates Pty Ltd, Valuation of Cultus Petroleum NL in relation to the takeover offer by OMV Australia Pty Ltd.

Table
Inflation Outlook

Country	2002	2003	2004	2005	2006	2007-2011
Singapore	1.3	1.9	2.1	2.0	1.8	1.9

Source: Consensus Forecasts: Global Outlook 2001-2011

Given these figures, the average forecasted inflation rate for Singapore to the end of 2007 is 1.8%.

4.1.5. Initial Conclusions on Cost of Equity Finance

Bringing together the discussion of the different CAPM parameter values, Table 4.6 summarises EMA's proposed values for the four key parameters of the cost of equity finance for the DCS operator.

Table 4.6
Initial Proposals on Cost of Equity Parameters

Parameter	Proposal
Nominal Risk free rate	3.02%
Equity Risk Premium	5-7%
Asset Beta	0.5-0.6
Inflation	1.8%

4.2. Estimating the Cost of Debt and the Level of Gearing

The cost of debt can be expressed as the sum of the risk free rate and the company specific debt premium. The company specific debt premium is driven by several factors, most notably credit ratings based on financial characteristics such as market capitalisation, earnings, volatility and business risk. As a company's gearing increases the debt premium will tend to increase as a reflection of the increased financial riskiness of the company, i.e. that more cash flow needs to be generated from operations and investments in order to meet interest payments.

The EMA proposed approach to estimating a cost of debt and optimal gearing for the DCS operator is to consider market based evidence on the costs of debt for a comparator set (whose volatility of cash-flows is driven by the same fundamental factors).

In theory, the approach to estimating debt and gearing should be based on a minimisation problem, i.e. minimising the cost of equity and debt finance. However, in the absence of a strong theoretical framework, a more practical approach is to estimate of the cost of debt and optimal gearing for DCS operator by "fixing" the rating of the company, consistent with common industry behaviour. From this "fixed point" it is possible to derive consistent cost of debt and gearing values.

The EMA assumption is that the DCS operator must maintain at least a 'single A' credit rating status in order to finance its capital investment programme efficiently. This inference is based on the industry "norm" as evidenced by our comparator set, as presented below.

4.2.1. Market Based Evidence on the Cost of Debt

Table 4.7 presents all available recent debt issues by the wider comparator set. As these data show, the typical rating for National Grid Group and Australian Gas and Lighting is an S&P rating of single A. The table also presents debt costs for SembCorp, although unfortunately its debt is not rated. Its very low debt premia are consistent with a triple A rating, although it is assumed that this low rating reflects an implicit sovereign guarantee.

Taking a medium debt term, a single A rating appears to be consistent with a debt rating of between 72bps (NGG, based on one observation) and approximately 130bps (AGL Co., based on two observations).

Evidence from American Corporate bond spreads suggests that a medium term single A rating is consistent with a spread of approximately 120ps.

The EMA therefore proposes that a bond spread of 120bps is consistent with a single A rating.

Table 4.7
Initial Comparator Debt Costs

Company name	Issue date	Maturity date	Coupon	Coupon currency	Moody's rating	S&P rating	Spread over government bond
National Grid Co Plc	02/02/1999	02/02/2024	5.875	GBP	A1 /*-	A	124.28
National Grid Co Plc	27/07/2001	27/07/2028	6.5	GBP	A1 /*-	A	121.86
National Grid Co Plc	07/02/1996	29/03/2006	8	GBP	A1 /*-	A	72.444
Average							**106.195**
Australian Gas Light Co. Ltd.	14/04/1998	15/04/2008	6.375	USD	A2	A	143.249
Australian Gas Light Co. Ltd.	17/06/1999	15/07/2002	6.375	USD	A2	A	73.543
Australian Gas Light Co. Ltd.	01/08/2002	15/09/2009	6.4	USD	A2	A	116.406
Australian Gas Light Co. Ltd.	14/04/1998	15/04/2018	6.75	AUD	N/A	A	203.721
Australian Gas Light Co. Ltd.	17/05/2002	15/10/2007	6.75	AUD	N/A	A	103.689
Average							**128.122**
Sembcorp Industries Ltd	07/06/2001	07/06/2004	3.21	SGD	N/A	N/A	61.028
Sembcorp Industries Ltd	06/06/2001	06/06/2008	4.125	SGD	N/A	N/A	69.778
Sembcorp Industries Ltd	31/10/2000	31/10/2005	4.125	SGD	N/A	N/A	59.444
Average							**63.417**

Source Bloomberg.

Table 4.8
US Corporate Bond Spreads

Term	3 years	5 years	7 years	10 years
Spread (bps)	95	116	131	149

Source: www.bondsonline.com, 29/08/02; for all US corporates using bridge evaluators.

4.2.2. Gearing

Table 4.9 presents gearing decisions by the wider comparator set. The Table also presents the corporate tax rate for the country where the company is listed. This is because gearing assumptions are primarily a function of fundamental cash-flow volatility and the tax benefits of debt.

The comparator set gearing decisions range from 0.22 (Asia Power) to 0.51 (Malakhoff Bhd). The set of UK and Australian comparators have an average gearing of 0.41; the Singapore and SE Asia set has an average gearing of 0.38. With relatively low tax rates in Singapore compared to other comparator tax jurisdictions, we would expect companies to take on less debt (because the tax benefits of debt are commensurately lower). However, there is no clear relationship between tax and capital structure for our initial comparator set. This is probably explained by the fact that corporate structure decisions are more complex than traditional corporate finance theories suggest. The EMA's initial proposal is to use an optimal gearing level for the DCS operator of 0.4, in line with the wider comparator set.

Table 4.9
Initial Comparator Capital Structure Decisions (2000-02)

Comparator	Gearing (Debt/ Debt + Equity)[1]	Corporate Tax Rate[2]	Typical debt rating
UK and Australian Co.			
National Grid Group Plc	0.34	30%	A
Veridian Group Ltd	0.35	30%	-
Australia Gas Light Co Ltd	0.47	36%	A
United Energy Ltd	0.49	36%	-
Average	*0.41*	*0.33*	
Singapore and SE Asian			
Sembcorp Industries Ltd	0.49	26%	-
Asia Power Ltd	0.22	26%	-
Malakoff Bhd	0.51	28%	-
Metacorp Bhd	0.27	28%	-
Average	*0.38*	*0.27*	

[1] *Source: Bloomberg;* [2] *Source: KPMG Corporate Tax Rates Survey- January 2002. We have taken the corporate tax rate for the country of listing. The actual corporate tax rate might differ for companies who report earnings (and pay corporate taxes) in third countries.*

4.2.3. Initial Conclusions on Cost of Debt and Capital Structure

Table 4.10 sets out the EMA initial gearing and debt assumptions for the DSC operator.

Table 4.10
Initial Proposals for the Gearing and Debt Parameters

Parameter	Value
Target credit rating	Single A
Debt premia	120 bps
Gearing	0.40

Comment is invited on:

- The initial proposals for debt premia and gearing level for the DCS operator

4.3. Taxation

4.3.1. Approach

There has been considerable academic and regulatory debate worldwide surrounding the use of pre- or post-tax formulations of the rate of return, the appropriate conversion formula and the application of statutory or effective tax rates. In principle this stems from:

- A fundamental tension between regulation on the basis of RPI-linked real revenues and a taxation system which operates in nominal terms; and
- Differences in timing between the depreciation allowed for taxation and that allowed for regulatory purposes.

The effects of these two factors means that the use of a simple formula to take account of taxation in converting from a post tax WACC to a pre-tax WACC is only an approximation. Even if the second effect is ignored, the impact of inflation in a RPI-lined revenue regime is sufficiently complex since rising price levels cause real taxable income and regulatory return on equity to diverge in two, potentially offsetting, ways. Essentially, inflation drives a wedge between:

- depreciation allowed for regulatory purposes and depreciation allowed for taxation purposes; and
- nominal interest rates (which are fully deductible for tax purposes) and real interest rates (which is the true cost of debt used in determining regulatory profits).

The level of inflation will determine to what extent these two effects are material.[12]

There are a number of ways to convert from a nominal post-tax WACC to a real pre-tax WACC, depending on whether you allow for taxation effects before or after "scaling" for inflation effects. However, there is no clear rationale for preferring one formula above another.

The proposed approach is based on the "Historical" (or "CSFB") approach. This approach converts a nominal post-tax WACC to a real pre-tax WACC by adjusting for taxation prior to adjusting for inflation. Formally, this approach can be set out as:-

- **Step 1** Convert nominal post tax WACC to nominal pre tax WACC by adjusting for the statutory tax rate.
- **Step 2**: Convert nominal pre tax WACC to real pre tax WACC by adjusting for inflation using the Fisher equation.

The "The Historical Approach" defines the real pre tax WACC in terms of the nominal post tax WACC as follows:

$$Real\ Pre\ Tax\ WACC_{\ Historical} = Nominal\ Post\ Tax\ WACC/(1-t)-I)/(1+I)$$

Where *the Nominal Post Tax WACC = Re(nominal)*E/V + (1-t)*Rd(nominal)*D/V;* I is the inflation rate; and, t is the corporate tax rate.

4.3.2. Taxation Levels[13]

The standard rate of Corporate Tax on taxable profits in excess of $100,000 is 24.5%. For the first $10,000, the tax rate is 6.125% and on the next $90,000 it is 12.25%. With effect from the Year of Assessment 2003, the corporate tax rate will be reduced to 22%, 11% and 5.5% respectively on taxable profits. It is proposed that the headline rate will be still further reduced to 20% by the Financial Year 2004.

Over the proposed time-frame of the control period we therefore assume that the effective tax rate will be equal to the approximate statutory tax rate of 20%. This is likely to offer the DCS operator some financial "headroom", because of the tendency of effective tax rates to be lower than statutory tax rates over the life of a project. This is because profits defined for tax purposes are generally less than profits defined for regulatory purposes over the project life.

12 Neither of these effects applies in a regulatory framework based on nominal returns on a historic cost asset base

13 Information on current and forecasted tax levels is drawn from "Singapore Budget 2002 Synopsis", Ernst & Young and Arthur Andersen.

Comment is invited on:

- The proposed use of a statutory tax rate of 20%

4.4. Summary: Initial WACC Estimates

Table 4.11 summarises the EMA initial estimation of the DCS operator's WACC. The table presents a "lower" and "higher" case scenario, reflecting an estimated beta range of 0.5 to 0.6 and ERP range of 5 to 7%.

On a *nominal* pre-tax WACC basis, the EMA's initial estimation suggests a WACC in the range of 7 to 9%. The EMA may review these conclusions based on the comments received in response to this Consultation Document.

Table 4.11
Initial WACC estimates for DCS operator

Parameters	**Lower bound (beta=0 5; ERP = 5%)**	**Upper bound (beta=0 6; ERP = 7%)**
Debt/Equity	66%	66%
Gearing (D/D+E)	40%	40%
Inflation	1.8%	1.8%
Cost of Equity		
Asset beta	0.5	0.6
Corporate tax rate	20%	20%
Equity beta	0.79	0.95
Risk free rate nominal	3.02%	3.02%
Equity market risk premium	5%	7%
Nominal post tax cost of equity	7.0%	9.7%
Cost of debt		
Nominal risk free rate	3.02%	3.02%
Spread over risk free rate (debt premium)	120bps	120bps
Nominal Cost of debt	4.2%	4.2%
WACC		
Post tax		
"Vanilla" Nominal post tax WACC	5.9%	7.5%
"Vanilla" Real post tax WACC[1]	4.0%	5.6%
Pre tax		
Nominal pre tax WACC	*7.0%*	*9.0%*
Real pre tax WACC	*5.1%*	*7.0%*

Note: The real pre tax WACC is estimated by adjusting the nominal pre tax WACC for inflation using the Fischer equation.

5. PERIOD OF REVIEW

In general, in deciding the period of a price control formula, a trade-off must be made between productive and allocative efficiency objectives, as well as short and long-term efficiency incentives. If the price control lasts for a long time, the company will have a strong incentive to reduce its costs, since it will be sure of keeping the benefits for many years. By the end of the period, however, prices may be significantly above the company's costs, leading to allocative inefficiency and possible distributive concerns. Further, the company's sustainability could be endangered if the price control turns out to be too demanding. If the price control period is short, the regulator can ensure that prices are always close to the company's costs, protecting sustainability and allocative efficiency. The drawback is that the incentives for productive efficiency may be weakened if the review period is shorter.

In order to determine the appropriate regulatory period for the District Cooling Service, it is important to consider the particular circumstances of the service and the regulatory framework. The PCF proposed is based on the benchmark costs of CCS. It is likely that the DCS operator makes losses in the early years of the service, which would be recouped through profits earned during the following years. Taking this into consideration, the EMA invites comments on the appropriate duration of the first regulatory period.

At the end of the initial regulatory period, the EMA will assess whether the current PCF remains appropriate given the evolution of the DCS operator’s costs and changes in the DC zone’s demand.

Comment is invited on:

- The appropriate duration of the first regulatory period

APPENDIX A. COST OF CAPITAL METHODOLOGY

A.1. Introduction

This Appendix briefly discusses the general principles underlying the calculation of a company's cost of capital.

A.2. WACC Methodology

Companies can raise capital through either debt or equity. The relative return required for equity and debt is different because debt holders enjoy a prior claim on a company's earning stream, and therefore face different levels of risk. Thus, the cost of capital for a company is a weighted average of the two instruments, with the weightings determined by the relative levels of debt and equity in the company's asset base, or the company's "gearing".

A.2.1. The Post Tax "Vanilla" WACC

The most common presentation of the weighted average cost of capital is the "Vanilla" post tax WACC. This represents the post tax return to capital after both corporate tax and any imputation credits have been accounted for elsewhere in a business's cash flows.

(A.1) "Vanilla" Post Tax WACC = r_e*(E/V)+r_d*(D/V)

where,

r_e is the cost of equity;
r_d is cost of debt;
D is a firm's debt;
E is a firm's equity; and
V is the total assets of the firm, that is, V =D+E[14].

A.2.2. The Pre Tax WACC

The pre tax approach focuses on "scaling-up" the post tax rate of return to a pre tax rate of return. The pre tax WACC is usually defined as:

(A.2) Pre tax WACC = r_e * (E/V) * t_{adj} + r_d *(D/V)

Where t_{adj} is tax adjustment factor, explained in detail below. When taking account of the fact that interest on debt is tax deductible, and thereby offers a debt "tax shield", the "scaling-up" of the tax adjustment factor cancels with the tax shield on debt. When an imputation tax system is in place, the appropriate tax adjustment factor reflects the

[14] In the following we will refer to D/(D+E)=D/V as the "gearing" ratio of the company

corporation tax rate and the dividend imputation tax rate. We discuss the imputation tax system in Singapore in more detail in Section 4.1.1.2.

A.3. Reference Market

From the investors' standpoint, the cost of capital should be estimated with reference to the financial market that best represents their investment opportunity set, as the cost of capital for any investment is calculated in relation to the whole portfolio of investment opportunities to which an investor has access. This "set" is commonly referred to as the "market portfolio".

In theory the "market portfolio" should include financially traded as well as non-traded assets. However, in practice WACC parameters are calculated with respect to readily available stock market indices, and therefore the "market portfolio" only captures financially traded assets traded on a stock exchange, to the exclusion of un-listed assets.

It is also necessary to choose between a domestic, regional or worldwide index. If markets are perfectly integrated then investors can hold a global portfolio, and the relevant index is a worldwide index. However, in practice, capital markets are segmented by formal barriers such as foreign investment limits, as well as informal barriers, such as information constraints. In segmented or partially segmented markets, the investor opportunity set is limited and the use of national or regional market indices is more appropriate.

Regulatory precedent suggests that it is only appropriate to use a regional or worldwide index in very highly integrated capital markets, such as member countries of the "eurozone". Therefore, for the DCS case, a national market approach is adopted. The Singapore All Share Index (SESALL) is used, which is a diversified market index consisting of more than 300 Singapore listed companies.

A.4. Principles for Estimating the Cost of Equity

The post tax cost of equity is the return on equities (through dividends and through an increase in the value of shares) that is required to attract investors. In this report the Capital Asset Pricing Model (CAPM) is used to estimate the cost of equity.

A.4.1. Capital Asset Pricing Model (CAPM)

The CAPM approach is the generally accepted methodology by finance practitioners and regulators for determining the cost of equity for input into the calculation of the weighted average cost of capital (WACC). The CAPM can be set out as:-

(A.3) $$E[r_e]=E[r_f]+\beta(E[r_m]-E[r_f])$$

where,

- $E[r_e]$ is the expected return on equity
- $E[r_f]$ is the expected return on a risk free asset
- $E[r_m]$ is the expected rate of return for the market (and thus $E[r_m]-E[r_f]$ is the expected risk premium); and,
- β is a measure of the systematic riskiness of the equity, the equity beta.

The central tenet of CAPM is that investors hold a diversified portfolio of assets, and thereby diversify away the specific risk associated with assets. However, the portfolio still displays non-diversifiable risk, or *beta* risk, which is a measure of the co-movement of a particular asset or portfolio with the overall market portfolio. Beta risk is the only type of risk for which investors receive compensation in terms of higher returns.

Quoted companies' betas can be estimated by observing their share price behaviour relative to the relevant stock market index. Because of concerns about the robustness of a single regression result, it is also common to compare a beta result with "comparator" companies who operate in the same economic sector and are likely to face similar business risks. In the case of unquoted companies, it is necessary to rely exclusively on "comparator" companies as a proxy estimate.

A.5. Principles for Estimating the Cost of Debt

The cost of debt can be expressed as the sum of the risk free rate and the company specific debt premium. The company specific debt premium is driven by the ratings that specialist credit rating agencies, such as Standard & Poor's (S&P's), assign to that company.[15]

In essence, credit ratings are based on a number of financial characteristics such as market capitalisation, earnings volatility, and business risks specific to the company and/or the sector. However, particular regard is paid to the following two financial ratios:

- Funds From Operations (FFO) interest coverage; and
- Interest Coverage defined on earnings basis (where the earnings considered are before interest and taxes, EBIT).

Interest cover, defined as the number of times by which a company can meet its interest payments out of operating profits, is essentially a measure of the surety of interest payments being met. A company with low interest cover is less likely to maintain a premium credit

15 Some companies, particularly large and well known, choose not to be rated but still access the capital markets for debt at appropriate levels.

rating, since the probability of default on interest payments will be relatively high. S&P's particularly emphasises funds flow interest coverage as a rating criterion.

A company with a high gearing ratio is also less likely to maintain a premium credit rating. This reflects the fact that the probability of default on interest payments will be higher if gearing is high. It is clear that credit rating agencies, in determining credit ratings, are concerned primarily not with capital structure per se, but rather with debt service coverage levels, measured on both a cash flow and earnings basis.

A.6. Principles for Estimating Gearing

Finance theory says that the appropriate discount rate for expected future cash flows is the Weighted Average Cost of Capital (WACC) that represents a weighted average of the expected costs of debt, equity and hybrid financing.

It is now generally accepted that changes in the proportion of debt and equity in the balance sheet can, in practice, have significant implications on a company's overall costs of finance. This is the result of a number of factors that occur when gearing is changed:

- Debt risk and interest rate changes;
- Equity risk changes;
- Probability of future default changes;
- Tax position (personal and corporate) changes;
- Investment strategy may change.

Academic theory cannot predict what proportion of overall finance should be raised through debt or equity. In general terms, debt is advantageous because of its low costs and tax deductibility but can be disadvantageous where personal taxes and bankruptcy costs are concerned. The optimal capital structure of a company will normally consist of a mixture of debt and equity finance.

Companies with stable cash flows and low risk profiles can absorb more debt into their balance sheets than most other types of companies. However, to assess the optimal capital structure of a utility, an empirical analysis is required that examines market evidence on how the perceptions of investors, credit rating agencies and financial markets in general are affected by capital structure changes.

In assessing "optimal" capital structure it is important to focus not only on central case scenarios but also on downside scenarios. The possibility, for example, that capital expenditure may be substantially above central case projections may mean that an "optimal" capital structure will allow for unused borrowing capacity to increase debt in adverse circumstances. Some trade-off is likely to exist between minimising the average cost of new finance and minimising the *possibility* of financial distress and bankruptcy.

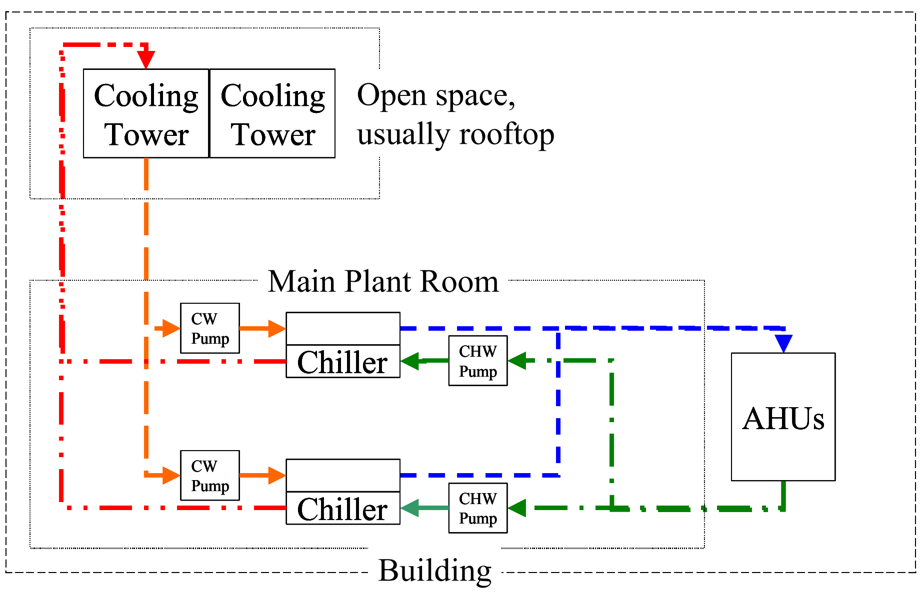
APPENDIX B. BRIEF DESCRIPTION OF THE TWO SYSTEMS

This Appendix briefly describes the characteristics of the conventional air-conditioning system and the district cooling system.

B.1. Conventional Air-Conditioning System

There are primarily four different types of air-conditioning system designs used in buildings in Singapore – water-cooled chiller system, air-cooled chiller system, water-cooled package system and air-cooled direct expansion system. In this section, we describe the most commonly used cooling system i.e. the "water-cooled chiller system". It generally has the highest capital and maintenance costs but the lowest utilities consumption costs as compared to the other three systems. It is usually the most practical and is the most commonly used system for large buildings because of engineering factors. The following figure provides a schematic diagram of this system.[16]

Figure B.1:
Conventional Air-Conditioning System



The water-cooled chiller system core components are (i) water-cooled chiller (chiller), (ii) chilled water pumps (CHW pump), (iii) condenser water pump (CW pump) and (iv) cooling tower (CT). Principle auxiliary components include the pipes, electrical panels, wiring and control systems.

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16 The buildings to be measured for the calculation of CCS benchmark costs use predominantly this type of air-conditioning system.

Chillers produce chilled water (CHW) at a specific temperature, usually 7°C. CHW pumps distribute the CHW around the building, to air-handling units (AHUs) which cool the rooms. As the CHW is passed through the AHUs, the CHW absorbs heat, usually until it reaches about 12.5 °C. The CHW is returned back to the chillers and the cycle begins again. CW pumps pump water coolant, called condenser water (CW), around a separate circuit, and is used to cool the chillers. CW is circulated from the chillers to the CTs, which cools the CW using the atmosphere as a heat sink, and back to the chillers.

The equipment is operated to match the building cooling load characteristics.

B.2. District Cooling Service

The DCS will consist of a central DC plant and a chilled water distribution network. The DC plant consists of water-cooled chillers, brine chillers, CHW pumps, CW pumps, CTs, heat exchangers, ice storage tanks and associated auxiliary equipment and structures. Chilled water for the DCS is stored as ice, produced using brine chillers. The configuration of one brine chiller with a group of ice storage tanks complete with heat exchangers and pumps is referred to as one "loop". The conventional water-cooled chillers and ice storage are used in different configurations to satisfy the cooling demand of the DCS.

The chilled water distribution network consists of distribution pumps, distribution network pipe, "heat exchanger substations" (substations) and associated auxiliary equipment and structures. Each development receives its chilled water from the DC network via the substations that are located in designated rooms within the respective developments. The substations consist of heat exchangers, associated control and meters. The network on the DC end is referred to as the "primary side", while the reticulation within the development is referred as "secondary side". The following figure illustrates the general system.

Figure B.2:
District Cooling System