The cost of capital for TenneT

A REPORT FOR DTE

March 2006

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Executive summary

This report provides an estimate of the appropriate cost of capital range to apply to the Dutch electricity transmission network (TenneT). The estimate of the cost of capital is an input in setting the X-factors for the next regulatory period (starting in 2007). The report assesses the appropriate methodologies for deriving the cost of capital and estimates the key parameters in the calculation. The estimates are based on up-to-date financial market data and information on comparator firms. The approach taken in this analysis is consistent with the previous analysis for DTe on the cost of capital for GTS and the regional distribution networks.

The cost of capital for TenneT is estimated using a real pre-tax weighted average cost of capital (WACC), with the cost of equity calculated using the Capital Asset Pricing Model (CAPM). The WACC reflects the two main types of finance used to fund investment: debt and equity. This approach bases the estimate of the cost of capital on a measure of the opportunity cost of funds. The main parameters in the calculation are therefore estimated from financial market data and from information on comparator companies with similar characteristics to TenneT.

There are a number of reasons why the CAPM is considered the preferred methodology.

- The CAPM approach to estimating the cost of equity is well established, solidly grounded in finance theory and straightforward to apply in practice.
- The WACC-CAPM methodology is the most common choice of regulators and private companies.
- Basing the estimate of the cost of capital on financial market data for comparator companies, rather than data on the company's current cost of finance, has a number of advantages. First, it should ensure that the cost of capital is set at an efficient level that reflects the underlying market cost of raising finance. Second, the use of external benchmarks should provide appropriate consistency in the estimates of the cost of capital over time.
- Uncertainty relating to the appropriate value of parameters, notably the equity risk premium and the Beta value (and any concerns that the CAPM methodology does not explain all of the differences in equity returns) can be dealt with by:
  - recognising the uncertainty in the estimates through identifying an appropriate range for some of the parameters and therefore a range for the overall WACC;
  - cross-checking, where possible, the results of the CAPM approach against other evidence on the cost of capital; and
  - allowing the parameters to be estimated in a conservative way or by taking these factors into account when choosing appropriate parameter values.

- No other asset pricing model provides a credible and practical alternative to the CAPM. These models (such as the Arbitrage Pricing Theory) have not been adopted widely in practice and have their own (statistical and conceptual) shortcomings.

Table 1 shows the calculation of the pre-tax WACC for TenneT based on the parameters identified in the previous section.

	Low	High
Nominal risk-free rate	3.7%	4.3%
Debt premium	0.8%	0.8%
Cost of debt	**4.5%**	**5.1%**
Equity risk premium	4.0%	6.0%
Asset beta	0.28	0.28
Equity beta	0.58	0.58
Cost of equity	**6.0%**	**7.7%**
Gearing	60%	60%
Tax rate	29.1%	29.1%
Nominal pre-tax WACC	**6.1%**	**7.4%**
Inflation	1.25%	1.25%
Real pre-tax WACC	**4.8%**	**6.1%**

Table 1: Estimate of the real pre-tax WACC for TenneT

Source: Frontier Economics calculations

The estimated ranges for the real pre-tax WACC for TenneT are appropriate for a number of reasons.

- **The methodology is robust and consistent with regulatory best practice** - as discussed above, and in more detail in Section 3, the CAPM is considered to be the most robust available methodology for calculating the WACC. Furthermore, the methodology is used by the majority of regulators and by companies. It is therefore consistent with best practice for estimating the WACC.
- **The cost of capital estimate takes account of the regulatory regime applied to TenneT and also possible changes in industry structure**. The system of price regulation applied to TenneT is relatively low risk. The revenue cap ensures that TenneT is not exposed to any significant volume risk. In addition, potential changes to industry structure (such as the transfer of high voltage assets from the regional networks to TenneT) should not have a material impact on the cost of capital.

- **The estimates of the parameter values have been rigorously determined and reflect all available evidence** – as discussed in Section 4, care has been taken to ensure that the estimates for each of the parameter values in the WACC formula are consistent with available financial evidence and are consistent with both financial theory and regulatory precedent:
  - the value of the nominal risk-free rate is consistent with the average yield on 10-year government debt in the Netherlands over a horizon of up to five years;
  - the value of the debt premium is based on an assessment of comparator data for similar companies with an investment grade credit rating;
  - the estimate of the equity risk premium is consistent with international evidence on the ERP, survey evidence and evidence from models of ERP expectations;
  - the asset beta value is based on an in-depth analysis of comparator data for similar companies – with a range of methodologies for estimating betas assessed – and incorporates a Bayesian adjustment and conversion from equity betas using the standard Modigliani-Miller formula;
  - the value chosen for the asset Beta reflects the fact that the assessed risk for TenneT is below the average for the group of comparator companies as a whole;
  - the equity beta is directly converted from the asset beta estimate using the assumed gearing level and the level is consistent with the low risk regulatory regime that DTe applies to TenneT;
  - the gearing level is consistent with the levels assumed by other regulators and with the gearing levels of similar companies;
  - the tax rate is equal to the corporation tax rate that TenneT is currently expected to face during the regulatory period; and
  - the inflation rate assumption is consistent with the inflation forecast of the CPB.

The set of comparator companies used to estimate the Beta is almost identical to the set used in assessing the cost of capital for the regional networks. The analysis based on this comparator set, and the other elements of the cost of capital calculation carried out in this report, were undertaken prior to responses being received on DTe consultation procedure for regional networks.

1 Introduction

This report provides an estimate of the appropriate cost of capital range to apply to the Dutch electricity transmission network (TenneT). The estimate of the cost of capital is an input in setting the allowed revenue for TenneT for the next regulatory period (2007 to 2010). The report assesses the appropriate methodologies for deriving the cost of capital and estimates the key parameters in the calculation. The estimates are based on up-to-date financial market data and information on comparator firms.

The report is structured as follows.

- Section 2 summarises the regulatory regime that DTe expects to apply to TenneT.
- Section 3 assesses the main methodological issues involved in estimating the cost of capital.
- Section 4 details the estimation of the key parameters in the cost of capital calculation.
- Section 5 provides the calculation of the overall weighted average cost of capital for TenneT.

2 The regulatory regime for TenneT

2.1 INTRODUCTION

The regulatory regime that will be applied by DTe to TenneT in the period 2007 to 2009 is a relevant factor in determining the appropriate cost of capital. The regulatory regime has an affect on the level of risk faced by the regulated business and this feeds through into the cost of finance. An assessment of the regulatory regime is also useful in identifying appropriate comparator businesses used in the estimation of the cost of capital parameters, in particular the appropriate value for Beta. The regulatory regime that is applied to TenneT is described below.

2.2 DESCRIPTION OF THE REGULATORY REGIME APPLIED TO TENNET

TenneT is the transmission system operator (TSO) in the Netherlands. The principal functions that it undertakes are (1) as the manager of the national high voltage grid and (2) as the system operator for the Netherlands. TenneT performs other tasks, for example to facilitate the operation of markets[1]. The regulatory regime described below applies to the first function – the manager of the high voltage grid[2].

DTe determines the allowed revenue for TenneT for a four year regulatory period, the next price control covers the period 2007 to 2010[3]. Prices are set to allow TenneT to recover 'standardised economic costs', which include the following:

- operating and maintenance costs;
- depreciation costs; and
- a return on invested capital (including an allowance for corporation tax expenses).

Specifically, the form of regulation applied to TenneT is a revenue control. This means that DTe applies a volume correction to TenneT's price cap. The allowed revenue that TenneT receives (after the volume correction has been retrospectively applied) is independent of the volumes delivered. As a result, TenneT is not exposed to any risk associated with volume uncertainty.

Another feature of the regulatory regime is that the costs that feed into the calculation of the allowable revenue are based on an assessment of efficient costs. The allowable revenue is adjusted annually to reflect the movement in the consumer price index and the x-factor, where the x-factor represents the

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1 TenneT owns a stake in the Amsterdam Power Exchange.

2 Other duties that TenneT is required to undertake are regulated separately by DTe.

3 This decision depends on the relevant legislation being passed. In the event that the legislation is not passed then an annual control will be set.

efficiency improvement (that has been set for the regulatory period). The efficiency parameters for both operating expenditure and capital expenditure are based on an international TSO benchmark.

2.3 REGULATORY REGIME AND THE COST OF CAPITAL

The nature of the regulatory regime may affect the cost of capital in a number of ways. The most important of these are the form of the price control that is applied to the industry and more general concerns regarding regulatory risk.

Firstly, the form of the price control could affect risk and the cost of capital in the following ways.

- **The length of the price control.** The greater the length of the price control the greater is the exposure of the utility to general economic and political conditions. This greater exposure to these factors will result in a higher cost of capital.
- **The form of the revenue control.** Regulated tariffs could be set on the basis of a revenue cap or a price cap (or a hybrid of the two). The impact that this has on the cost of capital will depend on the volatility of volumes in the sector and on the cost structure. If volumes are sensitive to general economic conditions and costs are largely fixed in the short-term then a price cap regime will place higher risk upon the utility than a revenue control (e.g. as applied to TenneT).
- **Cost pass-through.** The regulatory regime may allow certain costs to be automatically passed through to customers. Such pass-through structures will reduce the risk faced by the utility.
- **Use of yardstick or company specific cost information.** The use of yardstick comparisons to set prices may increase the risk compared to a regime that is based on company specific. The reason for this is that the yardstick information may not reflect the specific cost and revenue circumstances of an individual utility. If differences between companies in the yardstick sample are relatively small then the risk difference between yardstick and company specific regimes will also be small.

Secondly, regulatory risk covers broadly any action taken by the regulator that is considered to increase risk to investors and therefore potentially feed through into a higher cost of capital.

It is important to consider the impact of the regulatory regime both in terms of choosing appropriate comparators for assessing the parameters of the cost of capital (see Section 4 for more details) and in setting an overall level of the cost of capital that is appropriate for the industry and the specific form of regulation.

The regulatory regime that DTe apply to TenneT can be characterised as low risk. The factors that underpin this low risk regime include the following:

- the length of the review period is relatively short[4] for TenneT;
- the fact that TenneT is subject to a revenue cap rather than a price cap significantly reduces the risks faced by the business – and, in particular, reduces the exposure of the business to cyclical factors; and
- the fact that the revenue allowance is determined based on an assessment of the costs actually incurred by TenneT, subject to an factor for efficiency improvement.

2.3.1 Regulation and asymmetry of returns

It is sometimes argued that the cost of capital for regulated utilities should take account of asymmetric risks that result from the system of regulation. This argument is based on the view that the regulated utility is exposed to greater downside risk than upside risk. This is derived from a view that the regulator would not intervene to assist the utility if *ex post* returns were low, but that the regulator would intervene to clawback excessively high returns.

If this situation is realistic then the utility will have greater downside risk. This skewness of returns will violate the basic assumptions underpinning CAPM. Although there is no well-established approach for incorporating asymmetry into the CAPM framework there is some academic work that indicates that it would result in an increase in the cost of capital

In considering whether an adjustment for the skewness of returns is appropriate the first stage is to assess whether the regulatory regime does in fact introduce any degree of asymmetry. The price setting mechanism described above that DTe applies to TenneT does not result in any asymmetry between upside risk and downside risk. The regulatory approach ensures that TenneT can recover efficiently incurred costs and earns the cost of capital on its investment. Therefore, the DTe's approach does not contain any asymmetry and so it is not necessary to consider an adjustment for asymmetric risk.

There is the possibility, of course, that investors might believe that the regime is (or could be) asymmetric and demand some compensation for taking this risk. In this case it is not clear that adding a premium to the cost of capital is the right approach for tackling this perception. A better response would be to take steps to convince investors that their perceptions were incorrect. The appropriate steps may vary from one regulatory jurisdiction to another but could include:

- public statements by the regulator;
- public statements by the minister or government department; or
- regular meetings and exchange of information between regulatory staff and the investment community.

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4 For example, the price control period of upto four years for TenneT compares to the five year price control reviews that are common in the UK.

Ultimately, whether the regulatory regime does introduce asymmetry can only be assessed on a case-by-case basis. If investors are genuinely concerned then there are likely to be steps that the regulator can take to reassure them that do not involve adjustments (which are likely to be arbitrary) to the cost of capital.

2.3.2 Risk and the assessment of efficient costs

A separate issue is whether a regulatory regime that sets prices on the basis of an assessment of efficient costs will result in increased risk and a higher cost of capital. A regulatory regime based on efficient costs will mean that a company that is inefficient will, before taking account of other factors, earn a return less than the rate of return set by the regulator.

Any impact on the cost of capital will depend on the following two factors.

- First, whether the decision by the regulator not to fund certain costs (on the basis that they are inefficient) is a non-diversifiable risk. In this case it would be expected to increase the Beta value and the overall cost of equity.
- Second, whether the regulatory approach results in a higher level of total risk that prompts the company to choose a lower level of gearing.

In principle, we would expect the level of inefficiency of a particular company to be a diversifiable risk that would have no impact on the cost of equity. There is no reason to expect that the regulator's assessment of inefficiency would be affected by general economic or financial conditions.

In terms of impact of total risk, an individual company is best placed to assess the total risks that it is exposed to and to choose a level of gearing that is appropriate to that level of risk. As explained in Section 4.5 below we would advise a regulator to take account of companies' decisions on gearing when choosing the (notional) level of gearing to use in the calculation of the cost of capital. Under this approach it is not necessary to make any additional allowance in the cost of capital for the risk that a particular company is not able to recover inefficient costs.

2.3.3 Impact of changes in industry structure

At present eight of the regional electricity networks provide services on a high voltage grid (110/150kV). According to the unbundling Bill, the Government (the Cabinet) intends to let TenneT take responsibility for the operation of these high voltage networks. The Cabinet intends to implement this from the start of a new regulatory period, but no earlier than 2008. Therefore, although there is no formal legislation on this issue, the structure of the companies being regulated (including TenneT) may change in the coming years.

The revenues from high-voltage grid (110/150 kV) transport are currently included in the calculation of the price control for the regional electricity networks. The risks associated with such activity should, therefore, have been taken into account when determining the industry average WACC and the industry X-factor for the regional companies. There is therefore a question of whether the value of the WACC for TenneT would be affected by the proposed change.

The riskiness of the activities that would be transferred to TenneT are the same as the riskiness of its existing activities. In addition, these assets would be subject to the same form of regulation as the current assets. As a result, the transfer of high-voltage assets from the regional networks to TenneT should not have any impact on the cost of capital of TenneT.

3 Methodology for calculating the cost of capital

3.1 INTRODUCTION

In this section we evaluate the appropriate methodology available for calculating the cost of capital. The evaluation is based on a wide range of evidence, including:

- decisions by other regulators;
- corporate finance theory; and
- the practical application of finance theory by corporations and finance practitioners.

It is recommended that the cost of capital for TenneT is estimated using a weighted average cost of capital (WACC), with the cost of equity calculated using the Capital Asset Pricing Model (CAPM). This approach will base the estimate of the cost of capital on a measure of the opportunity cost of funds. The main parameters in the calculation will therefore be estimated from financial market data and from information on comparator companies with similar characteristics to the electricity transmission network. This is the same approach that DTe has adopted in estimating the cost of capital for GTS and the regional distribution networks.

There are a number of reasons why the CAPM is considered the preferred methodology.

- The WACC reflects the two main types of finance used to fund investment: debt and equity.
- The CAPM approach to estimating the cost of equity is well established, solidly grounded in finance theory and straightforward to apply in practice.
- The WACC-CAPM methodology is the most common choice of regulators and private companies.
- Basing the estimate of the cost of capital on financial market data for comparator companies, rather than data on the company's current cost of finance, has a number of advantages. First, it should ensure that the cost of capital is set at an efficient level that reflects the underlying market cost of raising finance. Second, the use of external benchmarks should provide greater consistency in the estimates of the cost of capital over time.
- In practice the application of the CAPM approach requires rigorous estimation of the main parameters. In particular, there can be uncertainty regarding the appropriate values for the equity risk premium and the Beta value. This issue is best dealt with through careful choice of the methodology for estimating each of the WACC parameters (see Section 4). It is also important to note that empirical studies have shown that the CAPM

methodology does not explain all of the difference in equity returns between companies. Our preferred methodology reflects these factors in three ways:

- first, recognising the uncertainty in the estimates through identifying an appropriate range for some of the parameters and therefore a range for the overall WACC;
- second, by cross-checking, where possible, the results of the CAPM approach against other evidence on the cost of capital; and
- third, by allowing the parameters to be estimated in a conservative way or by taking these factors into account when choosing appropriate parameter values.

- Nevertheless, there is no other asset pricing model that provides a credible and practical alternative to the CAPM. These models (such as the Arbitrage Pricing Theory) have not been adopted widely in practice and have their own (statistical and conceptual) shortcomings.

3.2 WACC FORMULA

The estimate of the cost of capital should take into account the two principal sources of investment capital – debt and equity. The standard formula for the weighted average cost of capital (after taking account of corporate taxes) is a weighted average of these two sources of debt:

$$WACC_{pre\text{-}tax} = g \times r_d + [(1\text{-}g) \times r_e] / (1\text{-}T)$$

Where:

r_d is the cost of debt

r_e is the cost of equity

g is the proportion of finance that is debt i.e. g equals (debt/[debt + equity])

T is the corporate tax rate.

Section 4 details the estimation of all the parameters in the WACC calculation.

3.3 METHODOLOGIES FOR WACC DETERMINATION

The methodological basis for the determination of the WACC is rooted in modern finance theory, and the asset pricing models that have been developed as that theory has evolved.

The choice of appropriate methodology should take account of the following factors:

- the theoretical foundations of the methodology;
- ease of practical application;
- regulatory precedent; and

- DTe's objective of maintaining a transparent regulatory regime.

The choice of methodology is not itself influenced by the characteristics of the electricity transmission network. The methodology is chosen on the basis of 'best practice' principles rather than sector- or company-specific issues.

3.3.1 CAPM

Methodology

The most well-known, and most widely-used, asset pricing model is the CAPM. The CAPM relies on the assumption of a rational investor, who creates an optimal portfolio from different assets taken in certain proportions, so that the resulting combination offers the best possible trade-off between risk and return. Although the appetite for risk is different for each investor, the CAPM makes a general assumption that all investors are risk-averse: in other words, an investor will take on more risk only if compensated with a higher return.

The CAPM makes some other important simplifying assumptions, which allow the cost of equity for a company to be determined using a simple formula. The most important of these assumptions states that all existing information is freely and instantly available to all investors, and they all make the same conclusions based on this information in regard to the expected returns and risks of securities. In other words, all investors are assumed to have the same market perceptions.

A key implication of this assumption, and a well known result of the CAPM, is that all investors will have a portfolio that includes all available risky assets and the proportion of risky assets held will be the same for all investors. Specifically, each investor will hold a riskless asset and a portfolio of risky assets. The proportion invested in the riskless asset will depend, among other factors, on the risk aversion of the investor. However, once the amount to be invested in the portfolio of risky assets is determined, the investor will choose to hold all risky assets in his portfolio and all investors will buy the same risky assets in the same proportions. This optimal portfolio of risky assets is called the market portfolio.

The CAPM shows[5] that the appropriate cost of equity is calculated as follows:

$$r_e = r_f + \beta \text{ x } (r_m - r_f)$$

Where:

r_f is the risk-free rate;

β (Beta) is the measure of relative (or non-diversifiable) risk of the company or industry; and

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5 For a detailed derivation see, for example, Sharpe, Alexander and Bailey, *Investments*, Prentice Hall: New Jersey, 6th edition, 1999.

r_m is the expected return on the market. The difference between the market return and the risk-free rate is known as the equity risk premium (ERP)[6].

Non-diversifiable, or systematic risk, measured by β, is part of the total risk of the company that is related to the market: when the return on the market moves up or down, the return on the company's equity will move by more than the market return (if β is greater than 1 in absolute terms) or less than the market return (if β is less than 1 in absolute terms).

Each company also has unique, or company-specific, risk that is not related to the overall market risk. However, in a sufficiently large portfolio this company-specific risk is close to zero: as some securities go down as a result of an unexpected bad news, others go up as a result of unexpected good news, and on average any such fluctuations cancel out. As a result, unique risk does not enter the formula for calculating a company's equity risk premium. Investors get rewarded only for bearing the systematic part of the company risk, because they can and are expected to diversify away the unique risk.

Usage by regulators and companies

CAPM's clear theoretical foundations and simplicity make it by far the most widely used tool for practical cost of capital estimation. International surveys of Chief Financial Officers (CFOs) of private companies show that the CAPM is the most widely used tool for estimating the cost of equity. In the US, over 70% of respondents reported using the CAPM (Figure 1). In Europe, the share of respondents who use CAPM was around 50%, while the second and third most popular methods were the use of average historical returns and the use of some version of a multi-factor CAPM[7].

6 This is sometimes referred to in the literature as the Market Risk Premium (MRP).

7 Brounen, Dirk, de Jong, Abe, and Koedijk, Kees, *Corporate Finance in Europe – Confronting Theory with Practice*, Working Paper, Erasmus Research Institute of Management (ERIM), Erasmus Universiteit Rotterdam, Jan. 2004.

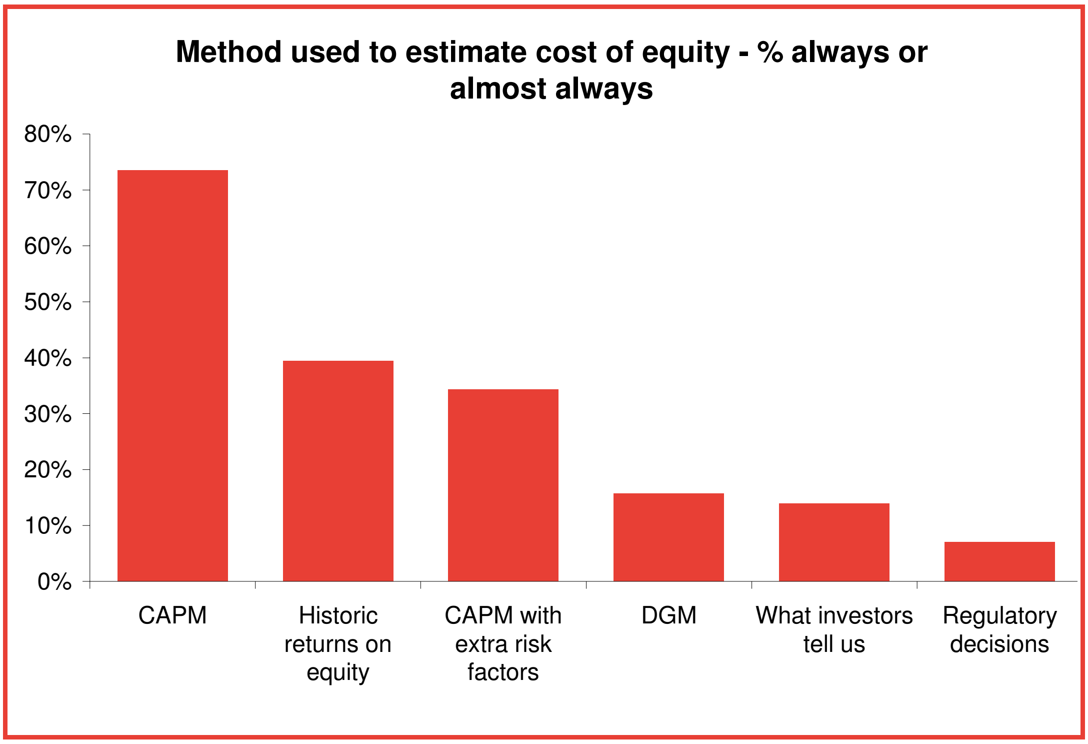

Figure 1: Methods used to estimate the cost of equity-survey of 400 US CFOs

Source: Graham and Harvey, The theory and practice of corporate finance: evidence from the field, *Journal of Financial Economics, May 2001*

The CAPM approach has been used by DTe in its previous determinations of the cost of capital. It is also widely used by utility regulators in Europe and elsewhere. Consequently the use of CAPM is consistent with the best practice approach adopted by corporations and regulators.

Assessment of the CAPM model

The CAPM approach has a number of important strengths that explains its popularity.

- **The model is derived from clear theoretical foundations**. The concept that equity investors will hold a portfolio of assets and will be concerned with the impact of an individual investment on the portfolio as a whole is a very powerful one.
- **The CAPM formulation is transparent and easy to implement**. The difference in required return between different activities is captured in a single parameter – the Beta. In other asset pricing models differences in the riskiness of activities may be reflected in a number of different parameters.
- **The results are relatively easy to interpret.** This is because, under the CAPM, the Beta can be considered to be independent of the performance of the company under consideration. Other models are driven by factors, such as the market / book ratio, which will depend on the performance of the company. In these cases it is more difficult to interpret the evidence in terms of setting a forward-looking cost of capital.

- **The CAPM approach is well-established.** In particular, it has been consistently used by regulators and corporations as the principal methodology for estimating the cost of equity.

There are a number of weaknesses with the CAPM framework, though these weaknesses are often present with alternative models as well.

- **One limitation of the CAPM is the assumption that the cost of equity depends only on the degree of non-diversifiable risk in a given stock.** Clearly, other factors may play a role as well, and there is a body of evidence suggesting that investors care about more factors than just the non-diversifiable risk. There is substantial ongoing research trying to incorporate such other factors into applied models. Some of the well-known advances in this area are the multi-factor extensions of the CAPM, which assume that the cost of equity depends on several factors rather than just one[8]. However, all such models have a number of statistical problems associated with them, they are still in the development phase, and no single methodology has been commonly accepted as a practical tool. The models are therefore not considered to be credible alternatives to the CAPM.
- **Recent research suggests that a carefully specified "conditional" CAPM – i.e., one in which the parameters vary over time – usually performs better than a non-linear model.** But this methodology is also only at the development stage[9].
- **An issue with the practical application of the CAPM is uncertainty over forward-looking estimates, which have to be proxied by historical data.** It is appropriate to take account of this uncertainty when deciding how to value the parameters – as discussed in Section 4 – rather than simply choosing to not use CAPM because of this potential shortcoming. This uncertainty will apply equally to other asset pricing models.

One particular issue is that TenneT is state-owned and could be considered to have a non-diversified shareholder. This raises the question as to whether the CAPM is still an appropriate approach in this case. In practice this issue should not invalidate the use of CAPM. The ownership structure of TenneT means that it is not possible to observe the cost of equity using market data. However this can be overcome by using market data on comparator companies.

The second issue is whether the ownership structure should be taken into account in estimating the appropriate cost of capital. There are two main reasons why the ownership structure should not affect the assessment of the cost of capital.

- First, ownership by the public sector does not necessarily imply that the investor is not diversified. A government shareholder will be involved in /

8 A famous example is the Fama and French multi-factor model, where the two additional factors are company size and book-to-market ratio. Another group of alternative models is based on the Arbitrage Price Theory (APT), which is discussed below.

9 Wright, Stephen, Robin Mason and David Miles, *A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K.* On behalf of Smithers & Co Ltd, 2003.

exposed to many other sectors of the economy. As a result, a public sector shareholder may have a comparable degree of diversification to a private sector shareholder.

- Second, to the extent that a diversified investor has the lowest cost of capital for a particular activity, a diversified investor will set the efficient cost of finance. Regulators will want to take account of efficient costs (financing and other) in setting prices to ensure that prices are set at the right level – in terms of encouraging efficient consumption and investment decisions. In this regard, there are a number of examples where regulators have applied the CAPM approach to utilities owned by the government or by local municipalities[10].

3.3.2 Other asset pricing models

The theoretical finance literature contains numerous alternative asset pricing models for estimating the cost of equity. These include arbitrage pricing theory (APT) and developments of the CAPM (including consumption-CAPM and multi-factor models). To date, corporations or regulators have not adopted these models to any degree. These models may have performed better in predictive tests than the standard CAPM but they lack the conceptual coherence of the CAPM framework. We therefore think it is inappropriate to use these alternative models to estimate the cost of capital for TenneT.

Arbitrage Pricing Theory

One of these alternative approaches is the Arbitrage Pricing Theory (APT). While the CAPM starts with an explicit model of investor behaviour, the APT rests on a more primitive assumption: that there should be no arbitrage opportunities in an economy. In addition, the APT assumes that the payoff of a risky asset is generated by a certain number of factors, all of which influence the total payoff in a linear way.

The APT uses these two assumptions to derive a prediction about expected rates of return in risky assets. When the number of factors is just one, and that factor is the market portfolio, the APT prediction reduces to the CAPM equation.

The main difficulty with the APT lies in its empirical application. The APT itself does not identify which are relevant factors or how many factors there will be. As a result there has been a lengthy academic debate regarding the identification of the appropriate factors. This partly explains why the APT has failed to gain popularity with regulators or corporations as a practical method for assessing the cost of capital.

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10 In addition to previous DTe decisions, other examples of regulators using the CAPM for publicly owned companies include CER's regulation of the gas transmission company in Ireland, the CAA's regulation of Manchester Airport and E-Control's regulation of the gas transportation companies in Austria..

Extensions of CAPM

To take account of the possibility that asset returns are influenced by more than one factor, a number of straightforward multi-factor extensions of the basic CAPM theory have been developed, such as the consumption CAPM (CCAPM) and the intertemporal CAPM (ICAPM). In the CCAPM, the additional factor influencing the cost of equity is assumed to be the aggregate consumption (or anything correlated with it). In the ICAPM, it is assumed that there exists a limited number of "state variables" (e.g., technology, employment, income, the weather) that are correlated with assets' rates of return.

An example of a multi-factor model developed from an empirical analysis is the three-factor model developed by Fama and French which includes market size and book-to-market ratio as additional explanatory variables. The book-to-market ratio may have been a factor in explaining historic US equity returns, however, it has not performed as well empirically for other markets. Furthermore, it does not provide any information for a regulator setting the rate of return for a utility.

Although plausible conceptually, multi-factor models have failed to establish themselves, which explains why they have not gained any significant popularity for practical cost of capital estimation compared to the CAPM.

3.3.3 Dividend Growth Model

The most commonly used alternative approach to estimating the cost of equity is the Dividend Growth Model (DGM)[11]. The DGM is based on the premise (the dividend discount model) that the value of a company's equity is the net present value of the future stream of dividends per share.

This concept for valuing equity can be converted into a model of the cost of equity by assuming that the future growth rate of dividends is a constant. Under this assumption, and by rearranging the formula, the DGM is derived:

$$r_{e(nominal)} = \textit{dividend yield per share} + \textit{nominal expected dividend growth rate}$$

The advantage of the DGM (like CAPM) is that it is simple to understand and to implement. On the downside, the dividend per share growth rate is usually based on analyst expectations, and there is large uncertainty about this parameter. As a result, the out-turn cost of equity estimate that the model delivers is highly sensitive to this assumed growth in dividends paid.

Dividend forecasts are often available for a period of up to five years but assumptions need to be made regarding investor's expectations for dividend growth beyond that point. Alternative scenarios for dividend growth can produce a wide range for the estimated cost of equity.

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11 The DGM is more widely used by regulators in the US. For example, this model was used in 6 out of 8 US energy decisions cited in the report *International comparison of WACC decisions*, NECG, September 2003.

One option that is often employed is to use the DGM to estimate the cost of equity for the market as a whole, as opposed to a particular equity. The advantage of this is that there is less uncertainty regarding the future growth rate of dividends for the market than there is for dividend growth for an individual company. The estimate of the cost of equity can then be used to estimate the equity risk premium in the CAPM model. This approach has been used in a number of studies.

Our view is that the DGM is not an appropriate approach for estimating the cost of equity for TenneT due to the uncertainty surrounding future dividend growth. However, it is a useful model for cross-checking the view of the overall cost of equity for the market and we have benchmarked our findings using this approach (see Section 4.4.1).

3.3.4 Other evidence on expected investment returns

A further source of information is evidence from market investors. For the cost of equity, additional evidence could come in the form of data from market transactions (flotations or equity issues) or from surveys of investor expectations. If such evidence is available it can serve as a useful crosscheck to the core analysis.

There are a number of advantages and disadvantages to evidence of this type. The main advantages are that:

- the information reflects the direct views of the financial community or is based on data from recent financial transactions – as a result it should measure the actual costs of raising finance;
- the evidence is up-to-date, based on recent transactions or current survey evidence; and
- the information is, in some cases, transparent - which reduces the scope for disagreement between the regulator and the regulated companies.

However, the disadvantages of this evidence are that:

- the evidence from surveys may be biased, reflecting the vested interests of the participants;
- evidence from market transactions may be limited / infrequent – the evidence may also relate to all activities undertaken by the floated company rather than the specific regulated activities of interest; and
- interpreting some of the evidence may require analysis and assumptions – for example, the cost of equity could be estimated but only by making assumptions about future cashflows.

In 2000 the UK Competition Commission considered the relevance of survey evidence in establishing the appropriate ERP. The Commission was cautious about attaching too much weight to this evidence:

> *"The survey and other evidence discussed above leads to quite a wide range of figures. This evidence may be subject to biases which are difficult to quantify and assess: fund managers*

> *may have the incentive to quote lower figures to make their achievements look better but, on the other hand, if they know the use made of the evidence, they have the incentive to quote higher figures since they benefit directly from a higher cost of capital for regulated companies. Probably for this latter reason, the evidence tends not to be derived from rigorously structured surveys.*"[12]

While it would not be appropriate to rely solely on survey information, evidence such as this could form part of the evidence base. In the case of regulated energy companies in the Netherlands, the absence of quoted companies indicates that investors' surveys are unlikely to feature in the estimation of the cost of capital.

3.3.5 Summary on alternative approaches to the cost of equity

Alternative asset pricing models have been developed to address the conceptual and empirical weaknesses with the CAPM framework. None of these models have established themselves as a credible alternative to the CAPM and, hence, the CAPM remains the principal method for estimating the cost of equity. Nevertheless, the information provided by other models – notably the DGM - and other evidence on required equity returns can provide useful benchmarks to cross-check the results of the CAPM calculation.

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12 UK Competition Commission, *Sutton and East Surrey Water plc*, September 2000, para 8.28.

4 Parameters of the WACC calculation

4.1 INTRODUCTION

This section of the report estimates the parameters of the WACC calculation for the regional networks – principally using the CAPM approach. The section considers the preferred methods for estimating these parameters as well as calculating the appropriate values.

4.2 FORMULA FOR THE WACC

As discussed earlier, the standard formula for the weighted average cost of capital (after taking account of corporate taxes) is a weighted average of these two sources of debt:

$$WACC_{pre\text{-}tax} = g \times r_d + [(1\text{-}g) \times r_e] / (1\text{-}T)$$

Where:

r_d is the cost of debt

r_e is the cost of equity

g is the proportion of finance that is debt i.e. g equals (debt/[debt + equity])

T is the corporate tax rate.

4.3 COST OF DEBT

The cost of debt is typically expressed as the sum of the risk-free rate and debt premium. This aids comparisons across companies, countries and time. The risk-free rate is also a key parameter in the cost of equity calculation.

The primary source of data on the risk-free rate are the yields on government backed debt. The majority of government debt is issued with the interest rate fixed in nominal terms, although some governments have issued debt with the interest rate fixed in real terms where the investor is compensated for actual changes in the price level. This debt is called index-linked debt.

The assessment of the risk-free rate has focused on nominal debt. Regulators currently tend not to use index-linked bonds for estimating the risk-free rate, because of concerns that yields on such bonds in different countries may be biased, for different reasons.

In the UK, some classes of large financial institutions are obliged by their internal or other guidelines to hold index-linked bonds for risk hedging purposes. That increases demand for such bonds, and correspondingly suppresses their yields. This is one reason why the real risk-free rate observed from index-linked securities is consistently lower than a comparable real risk-free rate deduced by Bank of England from nominal government bonds by taking out inflation.

In other countries, for example in France, there is a concern that yields on index-linked government bonds could be currently overestimating the true real risk-free rate, because of the low liquidity and the corresponding premium on the yield of such bonds.

Finally, it is worth noting that the majority of debt issued by the regulated utilities is denominated in nominal terms. This would imply that is appropriate to use the nominal risk-free rate as the benchmark for setting the cost of capital.

4.3.1 Estimating the nominal risk-free rate

The risk-free rate depends on market conditions in the economy and is not therefore influenced by any company specific factors. As a result, although the appropriate value for the risk-free rate may vary over time the calculation will not vary from industry to industry in the Netherlands.

It is possible to estimate the risk-free rate of return from market data on interest rates and government bond yields. For mature and well-developed economies the yield on government debt is seen as a good proxy for the true risk-free rate[13]. It estimating the cost of capital to be applied to the Netherlands it is appropriate to consider the evidence on yields on debt issued by the government of the Netherlands as the basis for setting the risk-free rate[14].

The main issues to consider in developing an estimate of the risk-free rate are:

- the appropriate maturity of debt; and
- whether to use current rates or long-term averages.

Maturity of debt

Interest rates will typically rise with the maturity of the debt. This is illustrated in Figure 2, which shows the yields on Netherlands Government loans since 1996. It shows that the interest rate rises with the maturity of the debt.

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13 The probability of default on this debt is extremely low. As a result the yield provides a reasonable estimate of the concept underlying the risk-free rate – the return that investors require to defer consumption from one period to the next.

14 More generally, for each parameter in the CAPM, the objective is to produce the best estimate appropriate for the electricity transmission network in the Netherlands. For some variables the best available evidence may be reflected in national data while for others evidence from international markets may be preferable. Available evidence from a range of sources should be considered and the best available estimate chosen from that data. It is not necessarily inappropriate to use national data for some parameters and international evidence for others, provided all information used provides the best available estimate of the parameter for the energy network in the Netherlands.

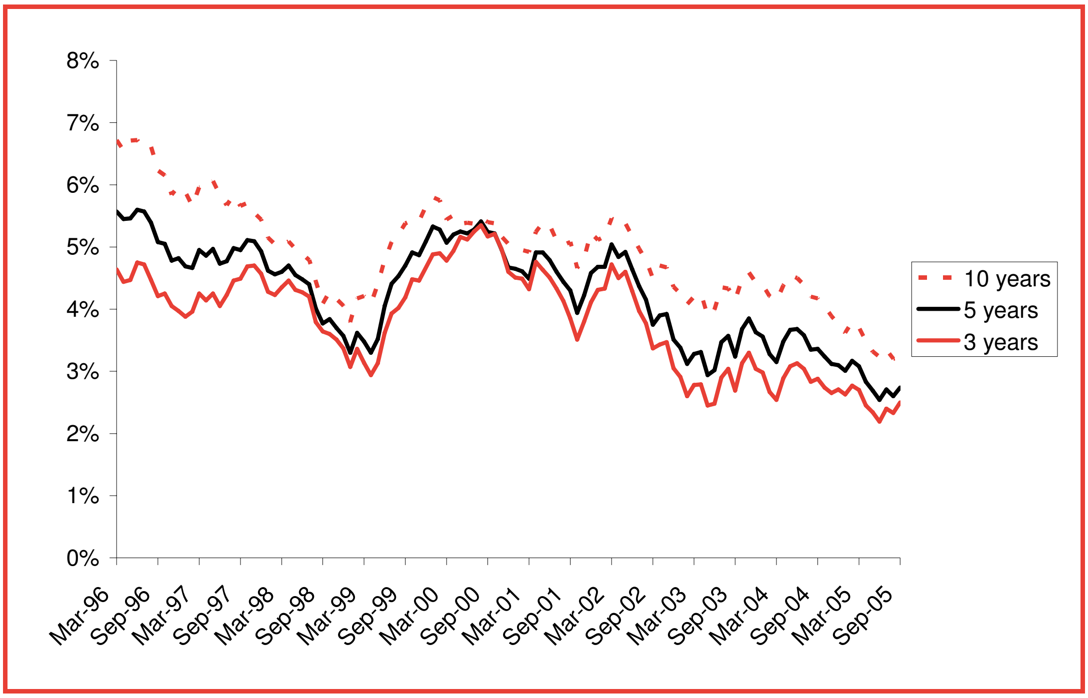

Figure 2: Yields on Dutch government bonds

Source: Bloomberg

Over this period for the Netherlands, each additional year of maturity adds 10 basis points (0.1%) to the interest rate.

In deciding the appropriate maturity to use in estimating the risk-free rate, there are a number of factors to take into account.

- **Short-term interest rates are a better proxy for the true risk-free rate.** Part of the explanation for the term structure of interest rates is that long-term government debt is more risky than short-term government debt. Although the risk of default on long-term government debt is still very low, it will be higher for long-term debt than short-term debt and this will be reflected in the interest rate. Furthermore, longer-term debt will also be exposed to greater inflation risk (this is discussed further below). As a result, the short-term interest rate will tend to be a better approximation of the true risk-free rate.
- **Consistency with the equity risk premium estimate.** The ERP is calculated as the return on equities in excess of the return on government debt (see section below). The choice of maturity used to estimate the risk-free rate should be consistent with the maturity used to calculate the ERP.
- **Short-term interest rates are more volatile.** One advantage of using longer-term interest rates is that short-term interest rates are typically more volatile than longer-term interest rates. Short-term rates respond more to changes in government policy and to changes in inflation expectations. For a regulator that is looking to estimate a risk-free rate that will be appropriate for a number of years (for example, price control period of 3 to 5 years) there is an advantage in using a more stable measure of interest rates.

- **Medium-term maturities are more consistent with corporate debt financing patterns.** A further factor in favour of focusing on longer-term interest rates is that it should be more representative of the financing behaviour of companies. Companies will typically have a debt portfolio with a mix of maturities, but it would not be unusual for a utility company to have an average debt maturity of between 5 and 10 years.

In forming a view of the appropriate risk-free rate we have considered evidence on yields with maturity of 5 years and 10 years; European regulators typically use a 10-year maturity for assessing the risk-free rate.

Time period for assessing data

The majority of regulators base the assessment of the risk-free rate upon current market data. Typically estimates are based on the trends over a recent period rather than market rates on a given day. The period over which interest rates are assessed may vary from two or three months to a number of years. The reasons for taking an average over a reasonable period are:

- market interest rates may be relatively volatile over short-periods of time;
- to the extent that short-term changes in interest rates reflect underlying changes in investors' expectations these changes may not be reflected in the available data on the other components of the cost of capital (ERP, Beta and debt premium) – reflecting these changes only in the risk-free rate may not be appropriate; and
- in a regulatory process, there is an advantage in building in a degree of certainty and stability in the calculations during the course of consultations and draft price controls.

A period around two years provides, in most cases, a sensible balance across these factors. Data from the Central Bank of the Netherlands indicates that the average yield on 10-year government debt over this period has been 3.7%.

Time period (to December 2005)	Yield on 10 year maturity – average over period
6 months	3.3%
1 year	3.4%
2 year	3.7%
3 year	3.9%
5 year	4.3%

Table 2: Yield on Netherlands Government debt

Source: Eurostat

Table 2 shows average yield over periods from six months to five years, and reveals that the government debt yield is currently below the five year average. Given the current low level of yields, it would be prudent to take account of the data over a longer period in assessing the appropriate forward-looking risk-free rate. Over the past five years the average yield has been 4.3%. Taking account of the evidence over a two year period (3.7%) and a five year period (4.3%) indicates that a sensible range for the nominal risk-free rate is 3.7% to 4.3%.

Summary on the nominal risk-free rate

The risk-free rate is used in the estimation of the cost of equity and the cost of debt. Care needs to be taken to ensure that the appropriate debt maturity, time period and inflation adjustment (see below) are used to estimate the risk-free rate.

Based on the evidence presented above a range of 3.7% to 4.3% for the nominal risk-free would appear to be appropriate.

4.3.2 Estimating the debt premium

The second element of the cost of debt is the debt premium – the additional return expected by debt investors to invest in corporate debt compared to government debt.

Companies have a number of options, including:

- banks loans;
- syndicated loans;
- finance leases;
- commercial paper; and
- corporate bonds.

Public domain data is typically only available for quoted corporate bonds[15] and these are the primary source of data used to estimate the debt premium. The debt premium is therefore measured as the redemption yield on corporate debt minus the risk-free rate. The government bond used to estimate the risk-free rate should be of the same maturity as the corporate bond[16].

Our approach to estimating the appropriate debt premium for the electricity transmission network is to analyse data on corporate bond premium for a range of comparator companies that are similar to TenneT. In general the use of comparator data is sensible because it provides a larger sample of data and allows an assessment of the debt premium under different credit ratings and levels of gearing. In the case of the regional networks, the absence of quoted data on the companies' debt further underlies the importance of comparator data.

15 A regulator could ask companies to provide information on bank loans and other sources of debt finance. However, even then a key advantage of quoted corporate debt is that the yield on the debt will be updated to reflect current investor expectations.

16 In other words, the debt premium on a 20 year corporate bond should be estimated with reference to the yield on a 20 year government bond; a 10 year corporate bond compared to a 10 year government bond; and so on.

Choosing comparators

The process of identifying comparators is more straightforward in the case of the debt premium than is the case with Beta (see below). There are two reasons for this:

- the range of factors that determine the debt premium is relatively small; and
- more importantly, the combined impact of these factors is captured in a single measure – the credit rating.

Companies that issue quoted debt will seek a credit rating from one or more of the established credit rating agencies (e.g. Standard & Poors, Moodys). The credit rating provides a composite and forward-looking measure of the risk of default of the debt. The rating agency's assessment will take into account factors such as:

- level of gearing;
- volatility of cash-flows;
- industry characteristics; and
- form of regulation.

Note that for companies that also have other activities besides network activities the rating may not be entirely relevant for a pure stand-alone network company. The reason for this is that the rating will be determined by the risk characteristics of the group as a whole. Furthermore, for a group of similar industries there will be a strong correlation between the credit rating and the debt premium. As a result, the possible set of comparators can include all companies with quoted debt that operate within similar industries.

Figure 3 shows how the debt premium has fluctuated over time, based on data for European corporate bonds. The fluctuations in debt premium are more pronounced for the lower credit rating, with the premium on 'BBB' showing greater volatility than the premium for 'AA-' or 'A' rated bonds. Over the five period since 2001 the average debt premium has been 0.5% for 'AA-' rated bonds, 0.7% for 'A' rated bonds and 1.1% for 'BBB' rated bonds.

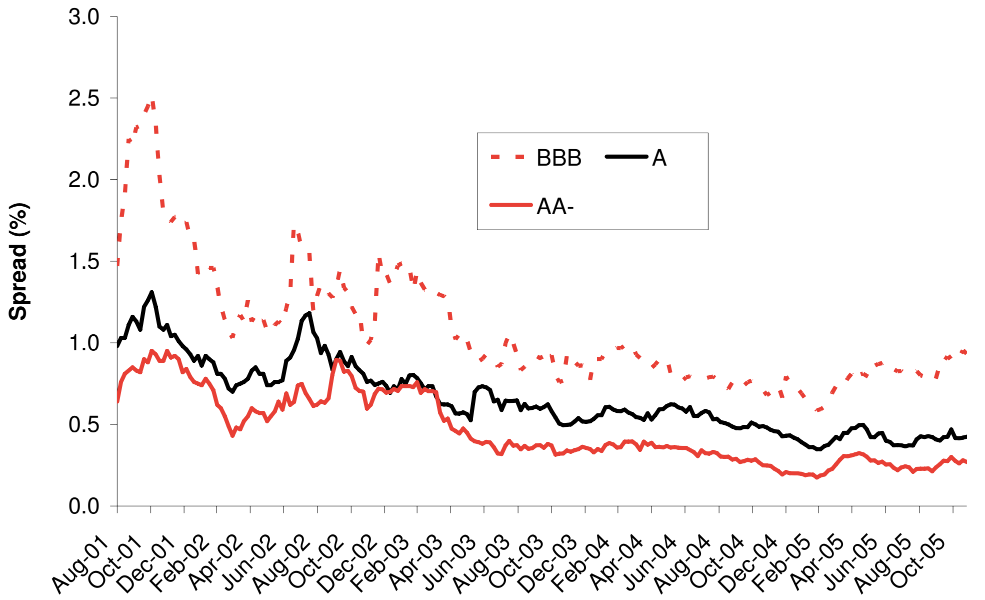

Figure 3: Debt premium on European corporate bonds – 10 year maturity

Source: Bloomberg

Gearing will be an important determinant of credit rating. As gearing increases we would expect the credit rating to decline and the debt premium to increase. If the comparator data were based on companies with lower gearing and better credit ratings than that proposed for the WACC calculation for TenneT then appropriate adjustments would need to be made. We discuss the level of gearing for TenneT further below.

Evidence on the debt premium

The sample of comparators chosen to estimate the debt premium are shown in Table 3. The comparators are different to those used to estimate the TenneT' Betas as data availability varies depending on whether we are looking for similar companies with quoted debt (as here) or similar companies with quoted shares (as for the Beta). In particular, not all companies that have quoted debt have quoted shares, and vice versa. Furthermore, the factors used to identify appropriate comparators are fewer and more generic in the case of the debt premium calculation.

Company	Maturity of bond – as of December 2005	Market gearing	Credit rating
Red Electrica	8 years	56%	AA-
Energias de Portugal	12 years	39%	A
Essent	7 years	NA	A+
Eneco	4 years	NA	A
Transco	11 years	NA	A
Scottish Power	11 years	39%	A-
United Utilities	12 years	48%	A-
Iberdrola	7 years	42%	A+
RWE	10 years	32%	A+

Table 3: Corporate bond sample

Source: Bloomberg

Table 3 also shows the maturity of debt and the current Standard & Poors credit rating and market gearing. The comparators have been chosen to satisfy the following characteristics:

- companies that focus on energy networks;
- debt with a maturity of around 10 years; and
- credit ratings focussed around a 'single A' rating.

A 'single A' rating represents an appropriate benchmark for default risk of the regional networks under the proposed gearing assumption of 60%. We consider the reasonableness of this gearing assumption below.

Figure 4 shows the debt premium for the sample of corporate bonds over the past two years. Since the beginning of 2004 the premium has varied between 20 basis points and 100 basis points – with, not surprisingly, a higher premium for the bonds with a lower credit rating.

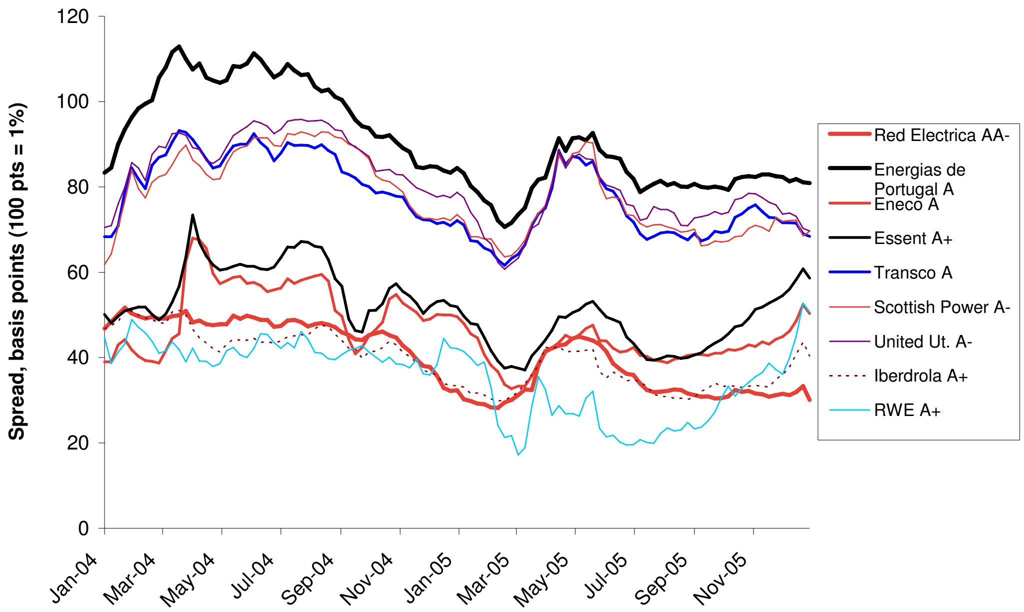

Figure 4: Corporate bond spreads

Source: Bloomberg, Standard & Poor's

Table 4 summarises information presented in Figure 4, showing the average values of debt premium for each company in the sample, from September 2003 to September 2005. This suggests that a range of 0.5% to 0.9% is appropriate for a 'single A' credit rating, based on the two years of data. The data for the Dutch utilities in the sample shows that the debt premia of the Dutch companies are currently at the lower end of the range.

Company	Average debt premium (basis points)
Red Electrica	40
Energias de Portugal	91
Essent	52
Eneco	47
Transco	78
Scottish Power	78
United Utilities.	81
Iberdrola	40
RWE	35

Table 4: Average debt premium by company, January 2004 to December 2005 (basis points)

Source: Bloomberg; Frontier calculations

In order to establish an appropriate value for the debt premium to apply to TenneT there are a number of additional factors that need to be considered. These are:

- longer-term evidence on credit spreads;
- the impact of issuance and transaction costs; and
- the impact of any risk factors affecting TenneT.

These factors are considered below.

- **Longer time-horizon.** There is an argument for basing the assessment of the debt premium on the same time period as the assessment of the risk-free rate[17]. The risk-free rate has been assessed over a period of two to five years. In terms of setting the appropriate debt premium for the next regulatory period, the more recent evidence from the two year sample is more relevant than the five year sample. Nevertheless, it is sensible to attach some weight to the longer-term evidence.

  The data on the debt premium in Table 4 covers a two year period, and indicates a range of 0.5% to 0.9% for 'single A' rated debt (with an average of around 0.6%). The data on 'single A' rated European corporate bonds showed a debt premium that averaged 0.71% over the five years to November 2005 (see Figure 3). This indicates that debt spreads have declined a little in recent years – a fact that is borne out by the Figure. As a result of the fluctuations in the debt premium seen over the past five years it is appropriate to choose a value for the premium that is at towards the top of the range implied by the more recent evidence.

- **Issuance costs.** The debt premium results in the Table 4 above do not make any allowance for transaction costs associated with issuing debt. These costs will be relatively small when spread over the life of the debt. Using a value from towards the top of the identified range will make adequate allowance for such costs.

- **Risk factors for TenneT.** The final issue to consider is whether TenneT faces higher risks than the sample of comparator companies. This is relevant for assessing debt premium and the appropriate level of gearing. The assessment in Section 2 concluded that TenneT operates in a relatively low risk environment – taking account of the regulatory regime and other factors. For example, the relatively short regulatory period and the process for compensating for volume movements indicates that there is no case to adjust the evidence from comparators to reflect the risk faced by the TenneT.

Taking account of these factors, we would propose a debt premium for TenneT of 0.8% (80 basis points). This is towards the top of the range for the debt premium in the sample over the two year period of analysis. The average debt premium for the sample of 'A' rated comparators over the period was 0.6%. The

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17 The rationale for this is that on occasion the movement in the risk-free rate and the debt premium will be correlated.

proposed debt premium is also higher than the debt premium included in the yield of the Dutch companies in the sample.

4.4 COST OF EQUITY

The principal methodology for estimating the cost of equity is the CAPM formulation. To re-cap the CAPM formula for the cost of equity is:

$$r_e = r_f + \beta \text{ x } (r_m - r_f)$$

Where:

r_f is the risk-free rate;

β is the equity Beta (the measure of non-diversifiable risk of the company); and

$(r_m - r_f)$ is the equity risk premium (ERP)

The risk-free rate has been addressed in the previous section. The remainder of this section considers the estimation of the ERP and the Beta.

4.4.1 Equity risk premium

The nominal ERP is additional return, above the nominal risk-free rate, that investors expect for holding the portfolio of risky assets. Evidence on the ERP is available from a number of sources:

- data on historic ERP from a number of countries;
- models of ERP expectations; and
- survey evidence on ERP expectations.

In addition, it is sensible to benchmark the estimate of the overall cost of equity for the market (i.e. the risk-free rate plus the ERP, given that the market Beta is equal to one by definition) against other sources of information on the overall cost of equity (e.g. estimates derived from the Dividend Growth Model). For a given risk-free rate, this provides a test of the reasonableness and consistency of the ERP estimate.

International evidence on the historic ERP

There is a wealth of data available on the returns on equity relative to the returns on relatively risk-free assets such as Government bonds. Data on financial market returns are available for a range of countries and in many cases the dataset extends back over 100 years. These datasets are typically used as the starting point for the estimation of the ERP.

Arithmetic and geometric mean estimates from historic data

In estimating the cost of capital using the CAPM we are interested in the expected annual return on equities relative to bonds. In terms of historic data, the arithmetic mean is analogous to the expected annual return. Nevertheless, the issue of whether the historic ERP should be estimated using the arithmetic mean or the geometric mean[18] has been the subject of much debate[19]. The main points in the argument are as follows:

- the arithmetic mean will be higher than the geometric mean (unless the returns are constant over time in which case the arithmetic and the geometric mean will be the same);
- if returns are uncorrelated over time then the arithmetic mean will be the appropriate basis for predicting future returns and therefore the correct benchmark for estimating the ERP; and
- however, there is evidence of some degree of mean reversion in returns over the medium-term[20]; in this case the observed arithmetic mean (measured over a short period e.g. annual data) may overstate the forward-looking ERP.

The Smithers report for the UK regulators concludes that it has no strong preference for either approach but cautions that one should be aware of the potentially significant differences between the two. The authors of the report note that there are plenty of influential academic economists expressing views in favour of using each method[21].

In summary, there is concern that historic estimates based on annual arithmetic means will overstate the forward-looking ERP. As a result, it is sensible to take account of both arithmetic and geometric means in forming a view of the appropriate ERP.

<u>Dimson, Marsh and Staunton</u>

One of the most comprehensive analyses of historic ERP data is a dataset created by Dimson, Marsh and Staunton. This analysis covered 16 countries over the period 1900 to 2004.

Figure 5 shows the historic ERP based on an arithmetic mean calculation and a geometric mean calculation. It shows the results for the "world" index (the total

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18 The arithmetic mean is the simple average of the individual period (in this case annual) returns. The geometric mean of a sample of N periods is the Nth root of the compound return.

19 The Smithers report has a useful summary of the literature (p23 – p27).

20 This is illustrated by the evidence, from the Dimson, Marsh and Staunton analysis, that the 10 year arithmetic mean is consistently lower than the average annual arithmetic mean (Dimson, Marsh and Staunton, 2005, Global Investment Returns Yearbook - ABN AMRO/London Business School).

21 For example, according to Wright at el (Wright, Mason and Miles, A study into certain aspects of the cost of capital for regulated utilities in the UK, 2003), Campbell and his various co-authors tend to prefer the geometric average, while Fama and French have, in different papers, applied the arithmetic average. Copeland at el. (Copeland, Tom, Tim Koller, and Jack Murrin. *Valuation*. McKinsey, 2001) find, based on a review of several academic studies, that there appears to be significant long-term negative autocorrelation in historical stock returns, and so they are not independent. Based on this result, the authors believe that the true market risk premium lies between the arithmetic and geometric averages. Dimson, Marsh and Staunton in a paper that extends and updates their previous study of global evidence on the equity risk premium (2002) and in (2005), argue that in the future volatility of stock market returns will be lower than it has been over the last century. They conclude that historical estimates of the risk premium based on the arithmetic average should be adjusted downward to take account of this change.

for the 16 countries in the sample) and for the Netherlands. The ERP for this "world" index over the 105-year period was 4.0% as a geometric mean and 5.1% as an annual arithmetic mean. The ERP for the Netherlands was 3.7% (geometric) and 5.8% (arithmetic).

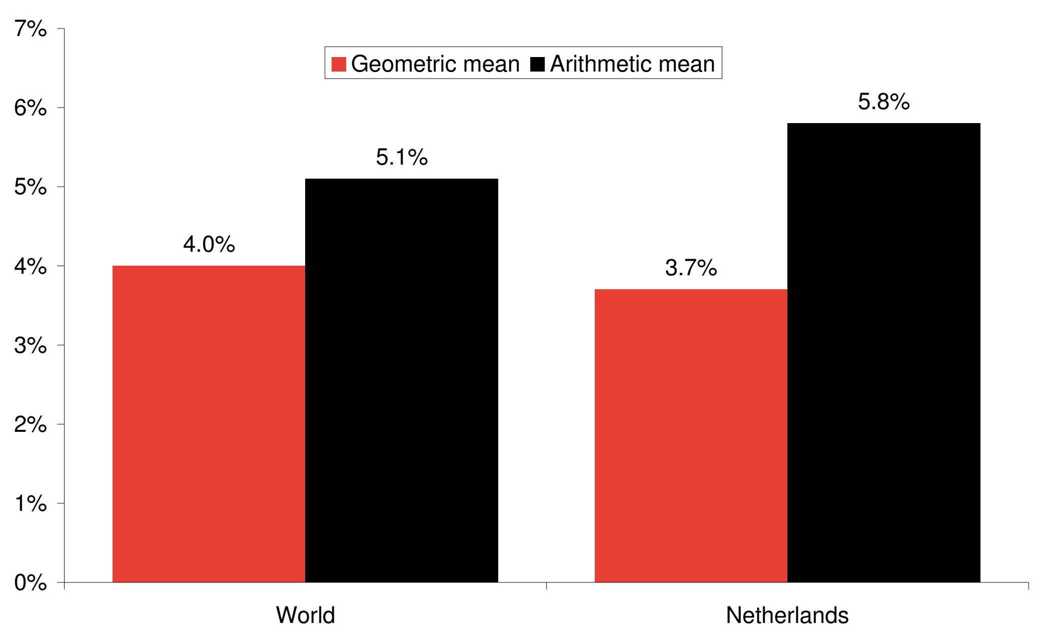

Figure 5: International evidence on the ERP: 1900 to 2004

Source: Dimson, Marsh and Staunton, 2005, Global Investment Returns Yearbook (ABN AMRO/London Business School)

Other studies

The Dimson, Marsh and Staunton dataset is the most comprehensive in terms of the number of countries covered, but there are other studies of historical equity and bond returns.

- Ibbotson Associates publish an annual report – Stocks, Bonds, Bills and Inflation Yearbook – with data on US capital market returns. This dataset shows that, over the period 1926 to 2001, the realized arithmetic equity premium in the US was 7.0%.
- A study by Siegel[22], analysed US data over a longer period (1802 to 1998) and concluded that the average premium of equities over bonds (on an arithmetic basis) was 4.7%.

Relevance of historical data

In assessing the relevance of the historical data there a number of factors that need to be considered.

22 Siegel J, *The shrinking equity premium,* Journal of Portfolio Management 26(1), 1999.

- First, there is significant variation in equity returns and the confidence intervals around estimates based on dataset going back even 100 years are relatively wide.
- Second, the confidence intervals around the estimates can be reduced by taking even longer periods (e.g. the Siegel analysis). However, the narrower confidence interval has to be offset against the question as to whether data from the 19th century represents a good basis for estimating forward-looking equity returns.

There is also the question as to whether the forward-looking ERP for the Netherlands should be based primarily on evidence from the Netherlands or from international equity markets. Dimson, Marsh and Staunton consider that any variation across countries in historical returns does not imply that future expected returns will vary in a similar way across countries. The historic equity returns for an individual country will reflect the specific circumstances and relative economic performance of the country over that time period. They argue that on a forward-looking basis investors should not expect these differences to continue. As a result, in assessing future returns it is appropriate to consider the evidence from a range of countries (i.e. it is appropriate to use the ERP for the "world" index).

In the case of the Netherlands, the historic data on returns for the Netherlands equity market are similar for the average returns achieved by other major economies over the same period. This provides additional reassurance that these average returns of the "world" index provide a useful foundation for projecting future returns in the Netherlands.

The international evidence on historic ERP provides a range of values from around 4% to 7%. Our assessment indicates that a narrower range of 4.0% to 6.0% is appropriate. In reaching this view we have taken account of all the historic evidence but we have placed greater weight on the Dimson, Marsh and Staunton evidence for the world equity indices and Siegel's very long-term analysis of the US data, and less weight on the Ibbotson evidence for the USA (which lies above this range). The reasons to place less weight on the evidence from the Ibbotson study are:

- the Ibbotson study has a shorter time period than the Sigel analysis and therefore there is a greater confidence interval surrounding the results;
- the US economy has performed strongly (relative to other economies) over the period covered by the Ibbotson study and therefore may overstate the forward-looking premium for world indices; and
- the Dimson, Marsh and Staunton analysis, by looking at returns for 16 economies, provides the largest evidence base for assessing forward-looking returns.

Nevertheless, the uncertainty around the historical evidence on equity returns means that it is important to look at other sources of the evidence on the forward-looking ERP.

Other evidence on the ERP

There are a number of other sources of evidence on the ERP that can be used to supplement the historic data. The most important of these are: models that use additional variables to adjust the historic returns data; and survey evidence on investors' expectations.

Models of adjusted historic returns or forward-looking estimates

Academic studies have modelled investors *ex ante* expectations of equity returns based on time series data of equity returns and other macro-economic variables. Examples of these studies include the following[23].

- The Fama and French model (2001)[24]. The approach in this paper infers the desired equity return based on a formulation of the Dividend Growth Model (where the expected equity return is equal to the current dividend yield plus the expected dividend growth rate). Applying this approach to the US produces an estimate of the ERP of 3.6% (covering the period 1872 to 1999).
- Ibbotson and Chen (2001)[25] apply a similar approach to Fama and French, using historical data on earnings growth and GDP per capita to proxy dividend growth. This analysis obtains estimates of the ERP for the USA of 5.9% and 6.2%.
- Cornell (1999)[26] applied a version of the dividend growth model which based the assessment of future dividend growth on investment analysts' projections for the first five years followed by a transition to the long-term nominal growth rate of the economy. Applying this approach to 1996 data he estimated a forward-looking ERP of 4.5%.
- Dimson, Marsh and Staunton (2003) assess the appropriate forward-looking risk premium based on adjustments to the historic evidence. The adjustments reflect views on equity market volatility going forward and long-term changes in capital market conditions. They conclude that the prospective arithmetic risk premium would be around 5%.

These studies generate a wide range of estimates for the ERP, though there are two main themes emerging from this evidence:

- first, these studies tend to produce estimates of the ERP below that suggested by the historic data; and
- second, many of these studies are still consistent with a range of the ERP of 4% to 6%.

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23 See *The Market Equity Risk Premium*, New Zealand Treasury, May 2005 for a summary of this evidence (http://www.treasury.govt.nz/release/super/tp-tmerp-may2005.pdf).

24 Fama, Eugene F. and French, Kenneth R., *The Equity Premium* (April 2001). EFMA 2001 Lugano Meetings; CRSP Working Paper No. 522.

25 Ibbotson and Chen, *The supply of stock market returns*, Ibbotson Associates, 2001.

26 Cornell B, *The equity risk premium: The long-run future of the stock market,* New York NY Wiley, 1999.

Survey evidence of ERP expectations

Various surveys of ERP expectations have been undertaken. These surveys have covered financial economists, company finance officers and investment analysts. A summary of this evidence is provided below in Table 5. ERP expectations from financial economists and company finance officers tend to be in line with the observed historic data while the expectations from investment analysts and fund managers tend to be lower. In general the majority of the survey evidence suggests that a range of 5-6% is appropriate for the ERP, although the evidence from banks and fund managers points to a lower value.

Evidence	Description	Value for ERP
Welch, 2000	Survey of over 100 financial economists - mainly US	6%
Welch, 2001	Update of survey of financial economists	5%
OXERA	March 2000 survey of ERP used by UK companies	5%
Bruner *et al* (1998)	US survey of corporations and financial analysts	Corporate users favour range 5% - 6%
UK financial institutions	Views from investment banks and fund managers since 1997	Most estimates lie in range 2 - 4%

Table 5: Expectations for ERP

Sources:

Bruner R, Eades K, Harris R and Higgins R (1998), 'Best practices in estimating the cost of capital: survey and synthesis', *Financial Practice and Education*, Spring / Summer

The OXERA (2000) report and the evidence from UK financial institutions were cited by the UK Competition Commission in the report *Vodafone, O2, Orange and T-Mobile: Reports on references under section 13 of the Telecommunications Act 1984 on the charges made by Vodafone, O2, Orange and T-Mobile for terminating calls from fixed and mobile networks,* (2003, p190).

Welch, I., 2000, 'Views of financial economists on the equity premium and other issues', *Journal of Business* 73 (October): 501-37

Welch I (2001), *The equity premium consensus forecast revisited*, working paper, Yale School of Management

Our analysis indicates a range for the nominal ERP of 4% to 6%. The lower end of the range is consistent with the upper bound of the range suggested by survey evidence from UK financial institutions and the estimates of US ERP from academic models of ERP expectations. The upper end of the range is consistent with the international evidence on the arithmetic and geometric mean and other survey evidence on the ERP.

Using a value for the real risk-free rate of around 2.5% to 3.0% (see below) this gives an overall figure for the real cost of equity for the market of between 6.5% and 9.0%.

This range for the real cost of equity for the market can be benchmarked against two types of evidence:

- evidence on historic equity returns in the market; and
- the return on equity implicit in current market earnings yield.

If the range for the real cost of equity of the market is reasonable relative to these benchmarks, then the ERP estimate can also be assumed to be reasonable (for a given real risk-free rate).

The Dimson, Marsh and Staunton dataset shows that the average return on equity for the period 1900 to 2004 was 5.7% in geometric terms and 7.1% in arithmetic terms. These values lie towards the bottom of our identified range for the cost of equity of the overall market.

A common approach to assessing the total expected return on equities is to use the current earnings yield on the market as a proxy estimate for the expected return on equity[27].

Table 6 shows the estimate of the cost of equity using this method for the equity markets of the Netherlands, UK and the USA. The calculation is based on the average earnings yield on the markets over the past year.

This approach suggests that the cost of equity for the market as a whole is 5.2% for the USA, 7.4% for the Netherlands and 6.8% for the UK. These are at or below the overall cost of equity for the market resulting from our analysis (6.5% to 9.0%).

Market	Earnings yield
Netherlands – AEX	7.4%
UK – FT-allshare	6.8%
USA – Dow Jones Index	5.2%

Table 6: Expected return on equity based on earnings yield

Source: Financial Times, 11th January 2006

This evidence suggests that the current market expectations of the ERP are at the bottom of (or even below) the range of 4% to 6%.

27 The earnings yield may understate the expected return on equity to the extent that firms can generate earnings growth from existing assets (i.e. through productivity improvement). Rates of productivity improvement in developed economies have been relatively low. For example, annual growth in total factor productivity in the OECD between 1996 and 2004 has been 1.1% (source OECD).

Summary on the equity risk premium

Historic data across a range of countries is consistent with a nominal ERP of 4.0% to 7.0%. The arithmetic mean of historic data, which defines the top of this range, may overstate the forward-looking ERP.

Models of ERP expectations and survey data are a useful supplement to historic data. Taken together this evidence supports a range for the expected nominal ERP of 4% to 6%.

4.4.2 Beta

The previous sections outlined the CAPM formula for the cost of equity:

$$r_e = r_f + \beta \text{ x } (r_m - r_f)$$

In this formula, parameter β is the equity Beta, the measure of non-diversifiable risk of the company's equity. The asset Beta is the related concept, which measures the non-diversifiable risk of all assets of the company (including those financed by debt).

TenneT is a publicly owned company that is not quoted, so direct estimation of the equity Beta is not possible. As a result, an appropriate value for the Beta is calculated based on the Betas of a set of comparable quoted companies. This involves two main issues:

- the choice of the set of comparators; and
- the choice of estimation method.

These issues are discussed in turn in the following sections.

Choice of comparators

The choice of comparators must begin with the understanding that all companies and regulatory regimes are inherently different at least in some respects, and to find an exact match may be very difficult, if at all possible. Instead, the choice of comparator companies should be made on the basis of factors that would be expected to affect Beta.

- **Network operations should be significant**: electricity or gas network activities should comprise a substantial, ideally dominant, part of companies' activities.
- **All company operations should be similar** in terms of their risk characteristics. This includes the following aspects:
  - diversification to other industries with markedly different risk profiles (e.g., financial investment industry, residential construction) should be minimised;

   - to the extent that a company is involved in non-energy operations, those should preferably fall within the utilities sector;
   - within the energy sector, diversification to other products (oil, propane etc) and other stages of the supply chain (upstream production, downstream energy services) should be minimised where possible.
- **Quoted companies should be large enough** to ensure that there is active trading and sufficient price variation for their stock. In general, delayed market reaction to events affecting infrequently trading stocks may cause Beta estimates calculated on daily data to be lower than Beta estimates calculated on a lower-frequency data. Delayed market reaction is more likely for small companies. As a result we limited the sample only to companies with an annual turnover of over $100 million. In addition, for these companies we analysed the actual trading frequency of the stock. This was measured as the percentage of market trading days where the particular stock was traded. Over the last two years all companies were traded on over 90% of days, with most comparators trading on around 97% of days[28].
- **The regulatory risk of the sample of comparator companies should be similar to that of the regional networks in the Netherlands**. As discussed in Section 2 the form of regulation can have an impact on the risk and Beta. The key factors that will determine the degree of regulatory risk (as it affects the Beta) will be the length of the price control and the mechanisms for the pass-through of industry-wide or unavoidable costs. The companies in the sample are regulated under a mix of regimes; price cap, rate of return and other cost of service regimes. This mix of comparators is appropriate given the regime to be applied to TenneT.

The Annexe to this paper describes in more detail the process followed for identifying appropriate quoted comparators for TenneT. One difficulty faced in choosing the set of comparators is that there are a very limited number of pure-play electricity transmission companies. There was a choice therefore between:

- a small sample of pure-play electricity transmission companies; and
- a larger sample that includes comparators that are heavily involved in energy networks but not necessarily in electricity transmission.

We chose a larger sample of comparators on the basis that the smaller sample would be more likely to exhibit volatility in the estimation of Betas. A sample of 14 companies has been chosen, four of which are primarily involved with electricity networks with a high share of transmission (25% or more of the total company activities). The remaining companies are network businesses subject to

28 Over the last five years, one company in the sample (Transener) was traded on only 78% of days. However, we still felt that this company was worthwhile to include in the sample, firstly because the frequency of its trading rose to above 90% in the second part of the period, and also because it is one of the rare examples of "pure-play" publicly traded electricity transmission companies (another such example is Red Electrica in Spain). As explained below, the lower liquidity at the beginning of the sample period is less of a problem as since part of the sample is only used for weekly estimates (where trading frequency is less of an issue than for daily estimates).

a broadly similar regulatory regimes and risk factors as the other four companies. These companies are listed in Table 7. The comparator set is almost identical to that used for the regional networks (it excludes Terasen which has been de-listed following a take over and it includes Transener, the Argentine electricity transmission company).

Company	Country
Transener	Argentina
Australia Gas Light	Australia
Envestra	Australia
Canadian Utilities	Canada
Emera	Canada
Red Electrica	Spain
Transco	UK
Scottish Power	UK
United Utilities	UK
Viridian	UK
Atlanta Gas Light	USA
Atmos Energy	USA
Duquesne Light Holdings	USA
Exelon	USA

Table 7: Comparator sample for electricity and gas distribution Betas

Details of the comparator companies are provided in Annexe 1. Although the chosen comparator set allows robust estimates of Beta to be obtained there remains an issue that the risk profile of the comparator companies is, on average, greater than the risk profile faced by TenneT. At the end of the section we consider the best way of addressing this issue.

Methodology for estimating Betas

Once the set of comparator companies has been selected, a number of decisions need to be made regarding the estimation methodology itself. These decisions are as follows.

- **Choice of data frequency and sample period.** Our preferred approach is to estimate Betas using returns with daily or weekly frequency. This approach is expected to provide the most precise Beta estimate (because of the larger sample), particularly as there is no difference in the degree of correlation of market returns when daily, monthly and annual data is used. We looked at periods from one to five years, and have chosen the period of two years for the daily data and five years for the weekly estimates. This period allows us to focus on the recent risk profiles of the comparator companies, and at the same time provides robust estimates (sample size of around 500 for the daily estimates and 250 for the weekly estimates).

- **Choice of market index.** We have analysed Beta estimates against national equity indices and a world equity index. We used the national indices for the final estimates to reflect any concern that national stock markets are not yet fully integrated.
- **Method of correcting raw Beta estimates.** We have applied a Bayesian adjustment to the raw Beta estimates, the Vasicek method. This method treats estimates for different comparators differently, applying a smaller adjustment to those estimates that were more robust to begin with (based on their statistical properties).
- **Method of converting from equity to asset Beta.** Equity Betas have been converted into asset Betas using the Modigliani-Miller formula and assuming a zero debt Beta. This approach takes account of corporation taxes, and we apply the debt premium later in the final WACC formula.
- **Choice of the range of Beta values.** We ranked the Beta estimates for all comparators from the smallest to the largest, and took the 25th percentile to represent the low end of the Beta range, and the 75th percentile to represent the high end of the Beta range[29]. This approach allows us to take into account variation in comparator Betas, while not focusing exclusively on the extreme minimum and maximum values.

Each decision is discussed in more detail below.

<u>Choice of frequency and sample period</u>

Unlike many other financial or macro variables that are available at the most at monthly frequency, stock market data is usually available at daily frequency. This offers the possibility of using, for example, daily, weekly or monthly data for Beta estimation, but also opens the problem of choice: which frequency is "better" or "more correct" to use?

Under certain assumptions, the highest frequency data available (i.e., daily in most cases) is superior to other frequencies because it provides the highest precision of Beta estimates. These assumptions are:

- stock returns are uncorrelated, in other words, the return today does not depend on the return yesterday, and is driven instead only by market fundamentals; and
- the link between the stock return and the market return is the same for all frequencies.

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29 The 25th percentile of a group of numbers is the number which is higher than approximately 25% of all numbers in the group, but lower than the remaining 75% of numbers. The 75th percentile is the number which is higher than approximately 75% of all numbers in the group, but lower than the remaining 25% of numbers.

Using data of lower frequency (for example, monthly) will still produce an unbiased estimate of Beta, but the standard error of this estimate will be much larger, making it less precise[30].

This potential advantage of the daily data depends crucially on whether both assumptions stated above are correct.

- *Correlated stock market returns* - if the stock market returns exhibit high correlation at daily frequencies but less so on weekly or monthly frequencies, the choice would depend on which factor creates larger imprecision: low frequency of data or high correlation. Ultimately, this can be addressed through empirical analysis.
- *Link between stock return and market return is not the same for all frequencies*: for rarely traded stocks more than a day may pass until some information that has affected the market would affect that particular stock as well. Using daily data with no changes to the estimation procedure in such a situation could bias the estimate of Beta downward.

Having analysed the Beta estimates for our comparator sample under different frequencies, we are satisfied that it is justified to use daily estimates as a possible basis for the estimation. In particular, there is no concern regarding the extent to which stock market returns are correlated for different time periods as we find that, in our sample of data, daily company returns are better correlated with stock market returns than is the case with higher frequencies of data (e.g. monthly). This indicates that there are no statistical difficulties with daily estimates for the companies in our sample.

To counter the fact that Beta estimates using weekly or monthly data are less precise than daily estimates, they are typically estimated using longer time periods (e.g. 2 to 5 years). In contrast daily estimates can be obtained from shorter time periods (e.g. from a sample of one year's data). As a result, the rationale for using daily data is stronger when the time period for estimation is relatively short. This could be due to:

- limited data availability; or
- concern that there have been structural changes in the industry during the past five years that could have affected the Beta estimates.

Neither of these factors is a particular concern with our sample of comparator companies. In the light of these factors, we have chosen to estimate Betas using two frequency / sample combinations.

- daily estimates over a two year sample; and
- weekly estimates over a five year sample.

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30 One other advantage in using daily data is that no decision has to be taken about the day on which to measure returns. With weekly or monthly data, estimated betas can be sensitive to the point in the week or month when returns are measured. In the case of the weekly estimates presented below we took the average value across the five days of the week.

This choice allows us to focus on the risk profiles of the comparator companies on a short-term and medium-term perspective, and at the same time provides robust estimates (sample size of around 500 for the daily estimates over two years and 250 for the weekly estimates over five years). It also allows us to confirm that the Beta estimates are not unduly sensitive to the choice of frequency or time period.

Choice of market

When estimating the Beta, DTe can use a national index or an international index. In deciding which index to use the following factors should be considered.

- How integrated are individual country equity markets with international financial markets? If equity returns for a company are driven primarily by the views and expectations of domestic investors then it may be misleading to estimate a Beta based on an international equity index.
- The use of an international equity index, however, is a simple and sensible method for dealing with companies that have significant international diversification in their activities or their investor base.

In our estimation of the Beta for TenneT we compare estimates based on both national and international indices. The evidence shows that estimates based on the world index are typically somewhat lower than estimates based on a national index. Given the potential concern that national stock-markets are not completely integrated, our preferred approach is to focus on the estimates based on the national index.

Bayesian adjustment

The weighted average Beta of all companies in the market is one by definition (as the Beta of the market portfolio). When extreme values of Beta (i.e. substantially different from 1.0) are observed, then this may reflect a large standard error of the estimate, or some other factor, rather than reflecting the true degree of relative risk.

This provides the rationale for the common practice of adjusting estimated Betas towards unity using some Bayesian adjustment methodology. The two widely used methods are Bayesian-Vasicek adjustment and Blume adjustment.

The Blume adjustment simply multiplies the estimated raw value of Beta by 0.667, and adds 0.333 to the product. This constant weighting method moves all estimates of Beta towards a value of 1.0 regardless of the robustness of the raw estimate.

The Bayesian adjustment proposed by Vasicek[31] takes a weighted average between the overall market mean (1.0) and the equity's historical Beta. The weights are a function of the quality of the estimated regression for determining the raw Beta. As a result, as the variance of the errors increases, the quality of the historical Beta decreases, and more weight is given to the market mean. If the opposite is true, then more weight is placed on the regression raw estimate.

Our preference is to apply an adjustment to the Beta estimates and to use the Vasicek approach. There are two main reasons for this preference.

- First, some Beta adjustment is appropriate even when it is possible to obtain statistically robust Beta estimates (for example, when daily data estimates are feasible). This reflects a view that forward looking Beta values will, on average, have a tendency to revert towards a mean value of one. This is consistent with the evidence that the CAPM formulation can be a relatively poor predictor of *ex post* equity returns.
- Second, the Vasicek adjustment is preferred on the basis that the degree of adjustment will depend on the statistical reliability of the underlying Beta estimate rather than being fixed adjustment (as is the case with Blume). The more robust the estimate - the smaller the adjustment towards a value of one.

For the majority of companies in the sample the standard error of the original estimate was low and, hence, the size of the adjustment made was small (see Table 8 and Table 9 below).

Method for converting from equity to asset Beta

The equity Beta depends on asset Beta and gearing. When using comparator data, it is appropriate to use comparison asset betas and convert these to an estimate for the equity beta using a company's own gearing level. It is therefore necessary to adjust the estimated equity betas by each comparator company's gearing level to obtain an appropriate estimate of the asset beta for TenneT.

Two commonly used approaches for converting the equity beta to an asset beta are Miller and Modigliani-Miller.

Assuming debt Beta is zero[32], the Modigliani-Miller formula is:

$$\beta_A = \frac{(1-g)}{(1-g) + g \cdot (1-\tau_C)} \cdot \beta_E ,$$

where

β_A is the asset Beta;

β_E is the equity Beta;

31 For a comparison of the Vasicek and Blume adjustments see: Gualter Couto and Joao Duque, *An empirical test on the forecast ability of the Bayesian and Blume techniques for infrequently traded stocks*, Working Paper, ISEG: 2000.

32 This is a commonly applied and generally accepted assumption.

g is the gearing level; and

τ_C is the corporate tax rate.

The Miller approach is a simplified version of the Modigliani-Miller formula, which assumes that there are no corporate taxes:

$$\beta_A = (1-g)\cdot\beta_E$$

At typical levels of gearing both approaches produce broadly similar results. The important points to keep in mind are:

- Consistency may be the most important issue. Either formula can be used, as long as the same approach is applied to all related conversions. This is a straightforward point, but it may become non-trivial if estimates for comparators come from different sources using different methodologies.
- The transformation is particularly relevant if comparators have different levels of gearing. If gearing across the companies is similar, the results after conversion will also be similar to the starting values.

The gearing levels of the comparators in our sample are broadly similar to the gearing assumption applied to TenneT (see below). In this case the results are not sensitive to the choice of adjustment method. We have applied the Modigliani-Miller method, one advantage of which is that it explicitly takes into account the impact of corporation tax rates on Beta.

Beta estimates

The Beta estimates for the comparator firms are provided in Table 8 and Table 9. The Betas have been calculated in two ways:

- using daily data and national indices over a two-year period; and
- using weekly data and national indices over a five year period.

In both cases the equity Betas have been adjusted, to give the asset Betas, using the Modigliani-Miller formula. Estimates with and without the Vasicek adjustment are provided, although as noted above the adjusted values are considered preferable.

Both of the approaches can be justified in terms of the characteristics of the data and the sample size. By considering both we are taking account of more recent evidence (the daily two year estimates) as well as the medium term evidence.

Country	Company	Unadjusted asset Beta	Asset Beta with Vasicek adjustment
Argentina	Transener	0.23	0.24
Australia	Australia Gas Light	0.50	0.52
Australia	Envestra	0.20	0.21
Canada	Canadian Utilities	0.26	0.29
Canada	Emera	0.11	0.13
Spain	Red Electrica	0.35	0.36
UK	Transco	0.37	0.38
UK	Scottish Power	0.40	0.42
UK	United Utilities	0.31	0.32
UK	Viridian	0.35	0.39
USA	Atlanta Gas Light	0.56	0.57
USA	Atmos Energy	0.58	0.58
USA	Duquesne Light Holdings	0.68	0.68
USA	Exelon	0.64	0.65

Table 8: Asset Betas for comparator firms – daily data / two year sample

Source: Frontier calculations

Daily data over two years from 29 Dec 2003 to 29 Dec 2005, national indexes, Modigliani-Miller method.

The Beta estimates using daily data are shown above in Table 8. The Beta estimates using weekly data are presented in Table 9 below. Additional data underlying the estimation of Betas can be found in Annexe 2 of this report.

Country	Company	Unadjusted asset Beta	Asset Beta with Vasicek adjustment
Argentina	Transener	0.29	0.32
Australia	Australia Gas Light	0.15	0.23
Australia	Envestra	0.10	0.13
Canada	Canadian Utilities	0.21	0.26
Canada	Emera	0.07	0.11
Spain	Red Electrica	0.19	0.21
UK	Transco	0.29	0.31
UK	Scottish Power	0.40	0.43
UK	United Utilities	0.20	0.22
UK	Viridian	0.10	0.15
USA	Atlanta Gas Light	0.41	0.43
USA	Atmos Energy	0.34	0.36
USA	Duquesne Light Holdings	0.33	0.38
USA	Exelon	0.29	0.34

Table 9: Asset Betas for comparator firms – weekly data / five year sample

Source: Frontier calculations

Weekly data over five years from 02 Jan 2001 to 26-30 Dec 2005 (averaged across the five start days of the week), national indexes, Modigliani-Miller method.

The choice of the appropriate range for the Beta estimate used for TenneT is based on an assessment of the average, the 25th percentile and the 75th percentile over the sample of comparator firms (as described in more detail above). The analysis is based on the comparator asset Beta values after the Vasicek adjustment has been applied.

The average Beta from the daily and the weekly estimates establishes an appropriate range of the Beta for regional networks. Table 10 below shows these results.

Asset Beta	Daily 2 year	Week 5 year
25th percentile	0.30	0.20
Mean	**0.41**	**0.28**
75th percentile	0.56	0.37

Table 10: Asset Beta range for comparator companies

Source: Frontier calculations

Choosing an appropriate Beta value for TenneT

Table 10 shows the range of asset Beta estimates based on the comparator set of companies. It suggests that a range for the asset Beta of 0.28 to 0.41 would be appropriate for this comparator group. The next issue that we need to address is the appropriate Beta value for TenneT given that TenneT faces lower risks than the comparator group as a whole. The factors that underpin the low risk position for TenneT are briefly set-out below.

- **Revenue cap imposes less risk than a price cap.** Most of the comparators are exposed to volume uncertainty through being subject to a price cap or a hybrid control (a mix of price and revenue cap). Even comparators subject to annual price reviews will be subject to short-term volume uncertainty. Volume risk is one of the key risk factors that is driven by cyclical conditions and therefore may be particularly relevant for assessing Beta. The fact that TenneT is not subject to volume risk is a principal reason for its low risk status.
- **Energy activities focussed on network only.** A number of companies in the comparator set are vertically integrated and have upstream or downstream activities. Experience shows that vertically integrated businesses have a higher cost of capital than the pure network activity. For example, in the previous regulatory control for TenneT it was accepted that the Beta comparators included vertically integrated companies and the appropriate Beta value was chosen based on the lower third of the sample. To the extent that TenneT undertakes non-network activities such as system operation and procurement, these are subject to separate low risk regulation.
- **Diversified activities.** In addition, some of the comparators are diversified into other activities which, like upstream or downstream activities, are likely to be of higher risk. Some of the comparators are diversified into activities such as business process outsourcing, technology solutions and financial services.
- **National scope.** As the national transmission operator TenneT is not exposed to risks or uncertainties that may affect particular regions. Regional variations in economic conditions will tend to be greater than national variations. Most of the comparators in the sample are regional in scope rather than national.

In the light of these risk factors it would not be appropriate to set the value (or range) for TenneT based on the mid-points from the comparator sample. One option would be to adopt the approach taken from the previous TenneT decision and base the Beta value on the estimates from the comparators with the lowest estimates.

Table 11 shows that asset Beta (average of daily and weekly estimates) for the lowest three comparators is 0.19 and for the lowest five comparators is 0.22.

Sample	Asset Beta estimate
Lowest 3 comparators	0.19
Lowest 5 comparators	0.22

Table 11: Asset Beta values based on comparators with lowest Betas

Source: Frontier calculations

On balance we do not consider that it is appropriate to adopt the same approach as the previous TenneT decision. Although the available sample of comparators includes companies with integrated or diversified activities, it is not clear that the problem is as great as it was during the previous TenneT decision.

Instead, we consider that using the lower of the two midpoints implied by the whole sample – i.e. an asset Beta of 0.28 – reflects a realistic assessment of the risks of TenneT relative to the comparator sample. Six of the comparator companies have an asset Beta (averaged across the daily and weekly estimates) of 0.28 or low and eight of the comparators companies have an asset Beta higher than 0.28.

Summary on the Beta

The asset Beta has been estimated based on a sample of quoted companies whose primary activity is regulated networks. The Beta estimates have been obtained using two approaches: daily data over the last two years and weekly data over the past five years.

For the WACC calculation for TenneT we would propose a value for the asset Beta of 0.28. In proposing this value we are taking account of the fact that the risk profile of the sample, taken as a whole, is greater than the risk profile faced by TenneT's network activities.

These numbers are based on the average of the weekly and the average of the daily estimates.

4.5 GEARING, TAX AND INFLATION

The previous sections have described the issues involved in estimating the cost of equity and the cost of debt. The remainder of this section outlines the issues raised by the remaining parameters: gearing, tax and inflation.

4.5.1 Gearing

Gearing is the measure of the proportion of the finance in the business that is provided by debt investors. For a company with published accounts a measure of gearing can be easily obtained from the accounting data (net debt as a % of shareholders' funds plus net debt). However, the appropriate measure of gearing for estimating the WACC is the market value of debt as a % of the market value of the company.

Utility regulators typically calculate the WACC based on a 'notional' level of gearing rather than the actual gearing levels for the companies. This approach has a number of advantages:

- the regulator can identify a range of gearing that is consistent with efficient financing cost – a gearing range that balances the tax advantages of debt with the cost of default risk;
- simplicity – it is not necessary for the regulator to collect and analyse detailed information on each company's capital structure; and
- this approach ensures a consistent treatment across companies when the regulator is setting the WACC for a number of companies within the same industry.

We propose that the WACC for the TenneT is calculated based on a gearing level of 60%. It should be emphasised that this is an assumed gearing level and DTe is not suggesting that TenneT's actual gearing level needs necessarily coincide with this assumption. Indeed it is a matter for the company to determine its own efficient gearing level.

The 60% assumption is considered reasonable for a number of reasons.

- **Consistency with other regulatory decisions** - recent work undertaken for DTe shows that a gearing assumption of 60% is consistent with the decisions of other utility regulators. For example, in the UK in 2004 Ofgem assumed of gearing level of 57.5% to be applied to the electricity distribution companies.
- **Consistency with actual gearing levels in comparator companies** - Table 3 provides details of the gearing level of the comparator companies used to estimate the debt premium. This suggests that gearing for similar companies with investment grade credit ratings can vary (from around 40% to around 70%) but a gearing of 60% is consistent with the financing choices of these companies.
- **Consistency with investment grade credit rating** - Given the relatively low risk regulatory regime (for example, the cost-plus nature of the regime) and the expected low level of business risk that TenneT faces, a gearing level of 60% should enable the company to maintain a solid investment grade rating. As a result the gearing assumption is consistent with the identified value for the debt premium.

4.5.2 Taxation

In setting price controls a regulator has a number of options for the treatment of taxation in the cost of capital. A regulator has two separate choices to make:

- first, whether to include the impact of corporation tax within the estimate of the rate of return or whether to treat it as a separate cost item;

- second, whether the allowance for corporation tax should be based on the standard corporation tax rates or a projection of the amount of tax that the company will actually pay (known as the effective tax rate).

The first choice has clear implications for the appropriate definition of the WACC to be used to set the rate of return:

- if tax is included in the rate of return then a pre-tax WACC should be used to set the rate of return; and
- if tax is excluded from the rate of return, and treated as a separate item in the revenue calculation, then a post-tax WACC should be used to set the rate of the return.

DTe is not expected to treat tax as a separate cost item when assessing the revenue cap for TenneT for the period starting in 2007. A pre-tax WACC is therefore appropriate. Regulators typically adopt an approach of setting a pre-tax rate of return based on standard corporation tax rates. This is the approach adopted for setting a WACC for TenneT.

The standard corporation tax rate in the Netherlands is currently 31.5% but it has been announced that the rate will be reduced to 29.6% in 2006 and 29.1% by 2007. Further reductions towards 26.9% in the following years have been proposed. It is appropriate to take the best possible information on expected tax rates into account before reaching a decision in the price control. For the time being, in calculating the WACC we have assumed a value of 29.1%.

4.5.3 Inflation and the real WACC

The earlier discussion on the risk-free rate related to the nominal risk-free rate. This evidence will feed into the calculation of a nominal WACC for TenneT. To convert this to a calculation of the real WACC to be used in setting the price control it is necessary to adjust the nominal WACC by an appropriate projection of the inflation rate[33]. This raises a number of practical issues.

- **Adjusting nominal rates for inflation forecasts.** The inflation rate applied to the nominal WACC should be consistent with the inflation expectations that underpin the data on the nominal risk-free rate. This could be based on current inflation rates and / or published inflation forecasts.
- **Use of index-linked debt yields.** The real risk-free rate that is implied by the inflation rate assumption can be benchmarked to data on the yields on index-linked debt. For example, the French government has issued index-linked bonds that are based on Euro-zone inflation and this could be a relevant source of data to estimate the real risk-free rate for the Netherlands.

Table 12 shows the implied real risk-free rate based on the range for the nominal risk-free rate identified above. The inflation rate of 1.25% used in the Table is based on the forecast for CPI inflation in 2005 and 2006 published by the

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33 The formula for converting from nominal to real is: *real = [(1+nominal)/(1+inflation)-1]*. When inflation and interest rates are low this is closely approximated by: *real = nominal – inflation*.

Netherlands Bureau for Economic Policy Analysis (the CPB). The most recent forecast was published in September 2005. This is below the CPB medium-term projection of 1.5% and it is likely that, in the medium-term, inflation will rise towards this higher value. Applying a forward-looking inflation rate of 1.5% would reduce the estimate of the real risk-free rate based on the nominal bond yields. However, we have adopted a cautious approach and used the short-term inflation projection of 1.25% in calculating the real risk-free rate.

	Low	High
Nominal risk-free rate	3.8%	4.3%
Inflation rate	1.25%	1.25%
Real risk-free rate	2.5%	3.0%

Table 12: Implied real risk-free rate

Source: Netherlands Central Bank, Frontier calculations

5 WACC calculation for TenneT

Table 13 below shows the calculation of the pre-tax WACC for TenneT based on the parameters identified in the previous section. The range for the real pre-tax WACC is 4.8% to 6.1%.

	Low	High
Nominal risk-free rate	3.7%	4.3%
Debt premium	0.8%	0.8%
Cost of debt	**4.5%**	**5.1%**
Equity risk premium	4.0%	6.0%
Asset beta	0.28	0.28
Equity beta	0.58	0.58
Cost of equity	**6.0%**	**7.7%**
Gearing	60%	60%
Tax rate	29.1%	29.1%
Nominal pre-tax WACC	**6.1%**	**7.4%**
Inflation	1.25%	1.25%
Real pre-tax WACC	**4.8%**	**6.1%**

Table 13: Estimate of the real pre-tax WACC for TenneT

Source: Frontier Economics calculations

The estimated range for the real pre-tax WACC is appropriate for a number of reasons.

- **The methodology is robust and consistent with regulatory best practice** - as discussed in Section 3 the CAPM is considered to be the most robust available methodology for calculating the WACC. Furthermore, the methodology is used by the majority of regulators and by companies. It is therefore consistent with best practice for estimating the WACC.
- **The estimates of the parameter values have been rigorously determined and are considered reasonable** – as discussed in Section 4, care has been taken to ensure that the estimates for each of the parameter values in the WACC formula are consistent with available financial evidence and are consistent with both financial theory and regulatory precedence. In particular:

- the value of the nominal risk-free rate is consistent with the average yield on 10-year government debt in the Netherlands over a horizon of up to five years;
- the value of the debt premium is based on a rigorous assessment of comparator data for similar companies with an investment grade credit rating;
- the estimate of the equity risk premium is consistent with international evidence on the ERP, survey evidence and evidence from models of ERP expectations;
- the asset beta value is based on an in-depth analysis of comparator data for similar companies – with a range of methodologies for estimating betas assessed – and incorporates a Bayesian adjustment and conversion from equity betas using the standard Modigliani-Miller formula;
- the value chosen for the asset Beta reflects the fact that the assessed risk for TenneT is below the average for the group of comparator companies as a whole;
- the equity beta is directly converted from the asset beta estimate using the assumed gearing level and the level is consistent with the low risk regulatory regime that DTe expects to apply to the regional networks;
- the gearing level is consistent with the levels assumed by other regulators and with the gearing levels of similar companies;
- the tax rate is equal to the corporation tax rate that TenneT is expected to face during the regulatory period; and
- the inflation rate is consistent with the forecast of the CPB.

Annexe 1: Selection of comparators for Beta calculation

INTRODUCTION

This annexe describes the procedure that Frontier followed to create a shortlist of international comparators for TenneT. The list of comparators includes 5 companies from 3 countries.

PROCEDURE TO IDENTIFY COMPARATORS

Frontier identified the list of comparators following a two-stage process:

- ***first*, we created an inclusive list of quoted companies** with electricity transmission networks or significant presence in energy networks more generally, and
- ***second,* we chose companies that appeared to be most suitable** based on the summary information available on them.

The following sections describe the sources we used to identify the quoted companies, and the criteria we applied to choose the set of comparators.

IDENTIFYING THE QUOTED COMPANIES

To create a list of quoted companies with electricity transmission networks, Frontier relied on the following sources:

- input from Frontier country energy experts;
- other comparative studies, such as the NECG report "International comparison of WACC decisions" (September 2003); and
- proprietary financial databases to which Frontier is a subscriber (e.g., Thomson Financial), supplemented by information from company websites and latest annual reports.

CHOOSING COMPARATORS

Frontier applied the following general principles to choose the set of comparators among the quoted companies.

- ***Network operations should be significant*:** gas or electricity distribution networks should comprise a substantial, ideally dominant, part of companies' activities.
- ***All company operations should be similar*** in terms of their risk characteristics. This includes the following aspects:

- diversification to other industries with markedly different risk profiles (e.g., financial investment industry, residential construction) should be minimised;
- to the extent that a company is involved in non-energy operations, those should preferably fall within the utilities sector;
- within the energy sector, diversification to other products (oil, propane etc) and other stages of the supply chain (upstream production, downstream energy services) should be minimised where possible.

- ***Quoted companies should be large enough*** to ensure that there is active trading and sufficient price variation for their stock.
- ***Regulatory regime should be comparable to the one in Netherlands***. In particular, we excluded countries for which information about the nature of their regulatory regime is not available.

LIST OF COMPARATORS FOR TENNET

The list of comparator companies for TenneT, and the relevant characteristics of these companies[34], is shown in Table 14 below.

[34] Company size is indicated by the value of turnover and the value of assets.

Country	Company	Electricity trans. share	Electricity distrib. share	Gas trans. share	Gas distrib. share	Other activities	Regulation	Turnover Mln EUR	Assets Mln EUR
Argentina	Transener	100%				None	Revenue cap; 5 years	83	650
Australia	Australia Gas Light		30%		60%	Upstream activities, supply and trade	Revenue cap; not less than 3, typically 5 years	2,457	3,822
Australia	Envestra			15%	85%	None	Price; 5 years, regulator must insert safeguards if longer	177	1,479
Canada	Canadian Ut.	10%	20%	10%	10%	Water, upstream activities	Rate of return	1,928	3,998
Canada	Emera	15%	30%	10%		Upstream activities	Rate of return	777	2,417
Spain	Red Electrica	100%				None	Ex-ante cost plus; annual	961	3,476
UK	Transco	25%	20%	15%	35%	Technology solutions	Hybrid price cap to limit incentives to oversell volume; 5 years	13,077	34,475
UK	Scottish Power	25%	65%			Upstream activities	Hybrid price cap to limit incentives to oversell volume; 5 years	8,542	20,344
UK	United Utilities		40%			Water, business process outsourcing	Hybrid price cap to limit incentives to oversell volume; 5 years	3,035	14,027
UK	Viridian	5%	65%			Upstream activities, supply and trade	Hybrid price cap to limit incentives to oversell volume; 5 years	1,229	1,825
USA	AGL				80%	Supply and trade	Rate of return	1,473	4,534
USA	Atmos Energy				75%	Supply and trade	Rate of return	2,347	2,307
USA	Duquesne LH	10%	70%			Financial services	Rate of return	721	2,117
USA	Exelon	10%			65%	Upstream activities	Rate of return	11,669	33,820

Table 14: Comparator characteristics

Source: Frontier calculations based on annual reports, financial statements, company websites.

Annexe 2: Additional data on Beta estimation

This Annexe provides additional description of the calculations used in estimating the cost of capital for TenneT. In particular, the annexe includes detail of the underlying data and calculations used in estimating the Beta.

Reference index variance assumption used in the Vasicek adjustment

In applying the Vasicek adjustment, we used the following assumptions about the variance of beta across the sample of firms that serve as an approximation to a market index[35]: daily estimates: 0.09; weekly estimates: 0.07.

Unadjusted asset betas

Table 15 shows the asset beta values for the comparator firms without the Vasicek adjustment.

35 The formula for the Vasicek adjustment is

$$\beta_{adj} = \beta_{OLS} \cdot \frac{Var(\beta_{pop})}{Var(\beta_{pop}) + SE^2(\beta_{OLS})} + 1 \cdot \frac{SE^2(\beta_{OLS})}{Var(\beta_{pop}) + SE^2(\beta_{OLS})}$$

where $SE^2(\beta_{OLS})$ is the standard error squared of the OLS estimate of beta, and $Var(\beta_{pop})$ is the variance of beta across the sample of firms that serve as an approximation to some market index.

Country	Company	Daily data	Weekly data
Argentina	Transener	0.23	0.29
Australia	Australia Gas Light	0.50	0.15
Australia	Envestra	0.20	0.10
Canada	Canadian Utilities	0.26	0.21
Canada	Emera	0.11	0.07
Spain	Red Electrica	0.35	0.19
UK	Transco	0.37	0.29
UK	Scottish Power	0.40	0.40
UK	United Utilities	0.31	0.20
UK	Viridian	0.35	0.10
USA	Atlanta Gas Light	0.56	0.41
USA	Atmos Energy	0.58	0.34
USA	Duquesne Light Holdings	0.68	0.33
USA	Exelon	0.64	0.29

Table 15: Unadjusted asset betas for comparator firms

Source: Frontier calculations

Daily data over two years from 29 Dec 2003 to 29 Dec 2005, weekly data over five years from 02 Jan 2001 to 26-30 Dec 2005 (average across 5 possible start days); national indexes.

Unadjusted equity betas

Table 16 shows the unadjusted equity beta values for the comparator group.

Country	Company	Daily data	Weekly data
Argentina	Transener	0.73	0.79
Australia	Australia Gas Light	0.59	0.18
Australia	Envestra	0.54	0.29
Canada	Canadian Utilities	0.36	0.30
Canada	Emera	0.17	0.12
Spain	Red Electrica	0.55	0.30
UK	Transco	0.61	0.48
UK	Scottish Power	0.56	0.57
UK	United Utilities	0.51	0.33
UK	Viridian	0.44	0.14
USA	Atlanta Gas Light	0.82	0.62
USA	Atmos Energy	0.87	0.51
USA	Duquesne Light Holdings	0.98	0.51
USA	Exelon	0.81	0.40

Table 16: Unadjusted equity betas for comparator firms

Source: Frontier calculations

Daily data over two years from 29 Dec 2003 to 29 Dec 2005, weekly data over five years from 02 Jan 2001 to 26-30 Dec 2005 (average across 5 possible start days); national indexes.

Standard errors of equity betas

Table 17 shows the standard errors of the beta estimates. This data is used in the calculation of the Vasicek adjustment. The lower the standard error the smaller the adjustment to the raw beta value.

Country	Company	Daily data	Weekly data
Argentina	Transener	0.07	0.21
Australia	Australia Gas Light	0.07	0.10
Australia	Envestra	0.09	0.09
Canada	Canadian Utilities	0.08	0.08
Canada	Emera	0.07	0.06
Spain	Red Electrica	0.06	0.05
UK	Transco	0.07	0.06
UK	Scottish Power	0.08	0.08
UK	United Utilities	0.07	0.06
UK	Viridian	0.09	0.07
USA	Atlanta Gas Light	0.06	0.06
USA	Atmos Energy	0.05	0.06
USA	Duquesne Light Holdings	0.06	0.10
USA	Exelon	0.07	0.08

Table 17: Standard errors of equity betas for comparator firms

Source: Frontier calculations

Daily data over two years from 29 Dec 2003 to 29 Dec 2005, weekly data over five years from 02 Jan 2001 to 26-30 Dec 2005 (average across 5 possible start days); national indexes.

Market gearing

Table 18 shows the data on gearing used to convert from equity to asset beta values.

Country	Company	Daily data	Weekly data
Argentina	Transener	77%	72%
Australia	Australia Gas Light	19%	28%
Australia	Envestra	71%	73%
Canada	Canadian Utilities	37%	39%
Canada	Emera	46%	50%
Spain	Red Electrica	46%	46%
UK	Transco	47%	49%
UK	Scottish Power	35%	38%
UK	United Utilities	48%	48%
UK	Viridian	27%	35%
USA	Atlanta Gas Light	43%	45%
USA	Atmos Energy	45%	45%
USA	Duquesne Light Holdings	42%	47%
USA	Exelon	31%	38%

Table 18: Market gearing levels for comparator firms applied in asset beta calculations

Source: Frontier calculations

Daily data over two years from Jan 2003 to Dec 2005, weekly data over five years from Jan 2001 to Dec 2005. Market gearing defined as the average total debt (net of cash and equivalents) divided by the sum of the average market cap and the total debt (again, net of cash and equivalents).

Tax rate assumptions

Table 19 shows the tax rates used in calculating the comparator beta values.

Country	Daily data	Weekly data
Argentina	35%	35%
Australia	30%	30%
Canada	36%	38%
Spain	35%	35%
UK	30%	30%
USA	39%	39%

Table 19: Country tax rate assumptions applied in asset beta calculations

Source: OECD

Daily data over two years from Jan 2003 to Dec 2005, weekly data over five years from Jan 2001 to Dec 2005.

THE FRONTIER ECONOMICS NETWORK
LONDON | COLOGNE | MELBOURNE | SYDNEY

Frontier Economics Ltd 71 High Holborn London WC1V 6DA
Tel. +44 (0)20 7031 7000 Fax. +44 (0)20 7031 7001 www.frontier-economics.com