# Benchmarking Transend's Cost Performance:

# Analysis and Evidence

Pacific Economics Group, LLC
Economic and Litigation Consulting

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# 1. Introduction

Transend is preparing its first revenue requirements application to submit to the Australia Competition and Consumer Commission (ACCC). The ACCC will set Transend's allowed revenues over the 2004-2009 period. Benchmarking has played an important role in previous ACCC revenue determinations for transmission network service providers (TNSPs), and this will almost certainly also be true for Transend.

In conjunction with its ACCC application, Transend engaged Pacific Economics Group LLC (PEG) to advise on benchmarking issues. We were to analyze the Company's operation and maintenance (O&M) cost performance relative to available data in Australia and New Zealand (ANZ). The primary ANZ data sources to be evaluated were the *CEO Transmission Forum Benchmarking Group Report* (CEO), parts of which are made available to and published by the Electricity Supply Association of Australia (ESAA), and the International Transmission Operation and Maintenance Study (ITOMS) undertaken by UMS Group.

The conclusions of our report can be briefly summarized. Relative to the seven TNSPs in ANZ, Transend registers approximately average performance on most indicators presented in the CEO study. The Company is in the middle of the pack on both O&M cost indicators and on the circuit availability measure of reliability. However, Transend's performance on the other reliability measure (system minutes of unsupplied energy) is considerably worse than for any other TNSP.

The Company's performance on ITOMS is qualitatively different. While Transend is an approximately average performer compared with the entire ITOMS sample, it is at or near the bottom among the ANZ TNSPs. This is true for both of the more comprehensive benchmark measures computed by ITOMS and for benchmarks developed for most of the subfunctions.

We believe the differences between Transend's performance on the CEO and ITOMS studies may be explained, in part, by the methodologies employed in ITOMS. ITOMS undertakes a number of adjustments and normalizations that are designed to promote "apples to apples" comparisons among sample companies. However, some of these adjustments and normalizations are questionable and may have exacerbated cost differences rather than ameliorated real variations in business conditions that are beyond company control. We identify several assumptions employed in the ITOMS study that may unfairly disadvantage Transend when comparing its performance to other TNSPs.

In addition, there are important differences between Transend and most other TNSPs that tend to raise the Company's O&M costs and reduce some reliability measures. Among the most important of these factors are:

- Transend's output (*e.g.* peak load transmitted) is relatively small, which limits the realization of economies of scale
- Transend's service territory contains long distances between generation sources and load centers; this gives rise to low economies of density, which tends to raise costs since the Company must employ relatively large amounts of assets for each unit of power transmitted
- Almost all power in Tasmania is generated from hydro-based sources; these hydrogenerators are geographically dispersed and distant from load centers, thereby reducing density economies, but complete reliance on hydropower may also contribute to reliability problems and restrict operating flexibility in ways that raise O&M costs
- Tasmania has more extensive rainfall and vegetation than other Australian States, which tends to raise Transend's maintenance costs
- Transend owns assets that were assigned to distribution companies in other States; these assets impose additional maintenance costs and may impair reliability performance, since these components tend to be less reliable
- Transend has the oldest transmission lines and second oldest substations, on average, among TNSPs in ANZ; some TNSPs have recently emphasized that asset age raises O&M costs and will compel new capital and operating expenditures in future years

Each of the factors above increases the amount of assets that must be maintained and/or prevents Transend from attaining operating efficiencies that are potentially available to other TNSPs. Properly accounting for these factors is therefore likely to improve Transend's O&M cost performance relative to other firms. However, the lack of data within ANZ makes it impossible to quantify the impact of these factors on O&M costs.

The report is organized as follows. Chapter Two provides a conceptual framework by briefly discussing some salient benchmarking issues, past ACCC benchmarking, and the merits of alternative benchmark measures. Chapter Three considers TNSP business conditions and cost drivers in ANZ. Chapter Four evaluates Transend's performance in the CEO and ITOMS studies and briefly critiques these benchmarking approaches. Chapter Five presents concluding remarks.

# 2. Benchmarking Issues and Choices of Indicators

## 2.1 Benchmarking Basics

Benchmarking is designed to make inferences on relative performance. When applied in utility regulation, the performance measures of interest almost invariably pertain to costs. Cost differences can be evaluated using a well-developed theoretical framework and any one of a number of sophisticated empirical techniques.

According to economic theory, the cost of an enterprise depends on the amount of work it performs and the prices it pays for inputs used in production. Theory also provides some guidance on the relationship between these factors and cost. For example, cost is apt to be higher as input prices and the amount of work performed increase. However, theory allows for great variation in the responsiveness of cost to changes in these variables.

Cost efficiencies are realized when differences in cost are smaller than the differences in outputs. When this is true in the provision of any single output, the unit cost declines as production expands. Because cost efficiency depends on the scale of operations, these are known as economies of scale.[1]

It is important to control for firms' realized scale economies in benchmarking analysis. This is particularly true for utilities such as TNSPs, since it is widely believed that large economies of scale are inherent in the provision of network services. Indeed, the assumption that unit costs will decline as output expands explains why networks are not subject to competition, since cost efficiencies will be lost if the market is served by multiple firms rather than a single utility. The extent to which TNSPs achieve scale economies depends on demands in their assigned service territories. These demands vary markedly and are almost entirely beyond TNSP control.

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[1] Another type of production economies is related to the scope of a firm's product offerings. For example, a firm may be able to provide two products more cheaply than if they were provided separately by stand-alone enterprises. This is an example of economies of scope.

This fact reflects a more fundamental issue in benchmarking analysis. Compared with firms in competitive industries, utilities have much less ability to influence their operating conditions. Utilities have an obligation to provide specified essential services to customers in an assigned territory. They cannot choose to serve only certain segments of the marketplace or to produce their products in alternative locations. Because TNSP networks deliver power across assigned geographic areas, the characteristics of these areas can affect the cost of service. Population, customer, geographic and economic conditions substantially across territories and affect the costs of constructing, operating and maintaining delivery networks. Benchmarking studies should attempt to control for the impact of these operating conditions when making cost comparisons across TNSPs. Below we describe some important operating conditions that can affect TNSP costs.

*Economies of Density*

Economies of density refer to how densely output is concentrated along a fixed network. For example, consider two TNSPs with maximum demands of 1000 MW in their service territory. TNSP1 delivers 1000 MW to a single bulk delivery point that is 10 km from the generator supplying this power. TNSP2 delivers 100 MW to 10 different delivery points, each of which is located 10 km from the generator supplying the power. Both firms serve the same peak demand, but TNSP2 requires ten times as many km of line to meet the demand since output in its territory is less densely concentrated. All else equal, a lack of density economies implies more assets will be used to transmit power, which raises both capital and O&M costs (*e.g.* because the additional assets must be maintained).

*Customer Mix and Load Factor*

The mix of customers served and the peakedness of their demands, as measured by variables such as load factor, can also affect asset deployment and utilization. Residential and small commercial customers tend to have lower load factors, while industrial and other large customers typically have less peaked demands and higher load factors. For a given level of peak demand, utilities have fewer MWh of deliveries as their load factors decline.

Differences in load factors can particularly influence cost benchmarks expressed relative to MWh. The reason is that network systems must be built to accommodate peak demands, so the costs of building and maintaining transmission networks are primarily driven by MW. If unit costs are derived by dividing costs by MWh, costs will not be expressed relative to the main cost driver. This does not distort cost comparisons among TNSPs with similar load factors, but it tends to disadvantage firms with lower load factors. To see this, consider two TNSPs that have equal peak demands but the load factor of TSNP1 is greater than for TNSP2. Costs for TNSP1 and TNSP2 are expected to be the same, but TNSP2's worse load factor leads to fewer MWh deliveries. It follows that cost divided by MWh will be greater for TNSP2 than for TNSP1.

Load factor and customer mix are often related to load density. Higher load factor customers contribute to economies of density. Other factors that can affect economies of density are population density in the service territory and the amount of service territory that is effectively unserved. All else equal, less densely populated territories and larger areas of unserved territory lead to fewer density economies.

*Hydro-generation*

A predominance of hydro-generation in the service territory can also affect TNSP costs. This is, essentially, an attribute of a TNSP's assigned customer base since TNSPs provide connection services to generators. Hydrogeneration is linked to specific geographic sites that are often a great distance from the load centers to which power must be transmitted. In addition, hydrogeneration sources can be smaller than thermal generation stations and will function erratically for "run of the river" generators that only operate if there is sufficient river flow. Since hydrogeneration can compel TNSPs to transmit power long distances and rely on a large number of dispersed generators to serve a given load, extensive reliance on hydro-generation often reduces economies of density.

At least two other features of hydrogeneration are noteworthy with regard to cost and reliability performance. The first is that extensive reliance on hydro-generation can lead to primarily radial transmission networks with less asset redundancy than other TNSPs. This design, in turn, is partly due to the fact that hydrogeneration sources are linked to specific sites that are often distant from load centers. It is cost prohibitive to have meshed or otherwise non-radial networks given a large geographic dispersion of supply sources and demands. If distribution connection points lack redundant capacity, the failure of any network component will be reflected in some amount of unsupplied energy. This will not necessarily be the case for TNSPs with non-radial networks.

Hydro-based generation can also restrict operating flexibility and raise costs. For example, it is more difficult to release circuits for maintenance without disrupting supplies in primarily radial systems. In an effort to maintain reliable supplies and to minimize the costs to customers of interruptions, TNSPs may undertake maintenance work at night and pay overtime wage rates. This type of cost has been recognized in other contexts in revenue applications to the ACCC. It is likely to be even more prominent for networks designed to transmit hydro-generated power.

*Terrain and Vegetation*

Other topographical and environmental factors can affect TNSP cost. It is typically more expensive to operate in mountainous areas or other challenging terrain. In practice, such areas often have low population densities that lead to low economies of density. Extensive vegetation can also raise the costs of maintaining right of way and lead to greater contact between trees and transmission lines. Such contacts can disrupt power flows and lead to unsupplied energy. While vegetation is difficult to measure directly, it tends to be correlated with rainfall and other precipitation.

*Asset Age*

The age of assets can also affect TNSP costs. Older assets are generally more expensive to maintain and need to be replaced sooner than newer assets. Some TNSPs have recently highlighted the importance of asset age as a driver of their current costs and future operating expenditure (opex) and capital expenditure (capex) plans.

## 2.2 ACCC Benchmarking

Benchmarking is well established in Australia. The ACCC used benchmarking to evaluate allowed opex in its previous revenue decisions for Transgrid and Powerlink. Opex was generally considered separately from capex and service standards, although it was recognized that these variables are inherently interrelated. The ACCC and its consultants also relied only on data that could be made publicly available for benchmarking.

These proceedings have noted the importance of controlling for differences in business conditions in benchmarking. In fact, the ACCC has found that different business conditions make it very difficult to compare cost levels across TNSPs. The most common benchmark has been operating costs per replacement value, which was deemed "one of the more robust comparisons (across TNSPs) because it is independent of voltage levels, distance and energy transfers."

Accordingly, the ACCC has focused on O&M costs per asset value when setting allowed opex in revenue decisions. It has judged the adequacy of opex by examining recent trends in operating costs per asset value. Declines in this indicator have generally been seen as evidence of efficiency gains and diminished scope for reducing opex in the future. The ACCC has also used this benchmark to set target opex levels. In the Transgrid proceeding, the company's O&M costs per asset value had been about 4%, and the ACCC consultant thought a target value of 3.5% was appropriate and attainable. Achieving this target would require a $5 million reduction in opex. The ACCC reduced opex by 75% of the recommended target, or $3.75 million. In doing so it mentioned the uncertainties associated with benchmarking, which evidently militated in favor of a more cautious approach.

## 2.3 Appropriate Choices of Indicators

Operating costs per asset value has been the main benchmark used by the ACCC. This section will briefly evaluate this benchmark relative to available alternatives. We begin by addressing the merits of comprehensive benchmarks that address a firm's entire cost performance (*e.g.* total costs) or partial benchmarks focused on a particular aspect of performance (*e.g.* operating costs). We then examine the two main alternative cost benchmarks that have been considered for evaluating operating expenditures.

### 2.3.1 Partial versus Comprehensive Benchmarks

A comprehensive benchmarking approach evaluates all aspects of an enterprise's performance. As such, it is necessarily "holistic." In contrast, partial benchmarks evaluate only subsets of performance. Researchers may attempt to obtain more comprehensive performance appraisals by evaluating a suite of partial benchmarks.

A number of comprehensive benchmarking techniques can be used to analyze performance. The salient alternatives include total factor productivity (TFP) analysis, econometric cost functions, stochastic frontier analysis (SFA), and data envelope analysis (DEA). A complete assessment of these alternatives is complex and well beyond the scope of this report. However, one major benefit of all comprehensive benchmarking methods is that they are designed to control for a wide range of business conditions and to evaluate capital and operating costs simultaneously. The disadvantages of comprehensive benchmarking methods are that it is more complicated, typically has greater data requirements, and usually does not provide detailed assessments of a firm's efficiency in performing specific functions or activities.

In contrast, partial benchmarks are much simpler to compute and easier to understand. Partial indicators can also control for some differences in operating conditions. For example, partial factor productivity (PFP) comparisons across companies and across time do control for differences in input prices.

However, there are many well-known problems with using partial measures. One is that the very simplicity of partial benchmarks do not allow them to control for differences in many business conditions faced by utilities. As discussed above, simple cost comparisons across TNSPs can be distorted by factors including differences in realized economies of scale, economies of density, and in service territory characteristics. Cost comparisons that do not control for these and other factors beyond company control can be misleading.

Relatedly, partial benchmarks typically do not allow one to evaluate the uncertainty associated with benchmarking. Any benchmarking exercise will be imprecise and likely fail to capture the impact of certain factors on cost (*e.g.* because of lack of available data). However, some benchmarking techniques enable researchers to quantify this lack of precision and the confidence associated with the computed benchmark. Confidence intervals and related measures allows researchers to evaluate whether computed cost differences are statistically significant or more likely the result of benchmarking uncertainties. With rare exceptions, partial benchmarks do not permit such judgments.

It is also widely recognized that a utility's O&M expenses will be affected by its capital spending. Asset replacement and maintenance are often substitute activities, so companies face trade-offs regarding capital and O&M inputs. Partial benchmarks do not capture these tradeoffs. There are also no straightforward ways for normalizing partial benchmarks for variables, such as asset age, that reflect the maintenance-replacement tradeoff confronting utilities. Benchmark measures that focus on only a single factor such as O&M spending can therefore provide a misleading indicator of overall performance.

However, in spite of their well-known problems, partial benchmark measures are far more common in Australia. This has been true not only for both the ACCC and State regulators. We believe this tendency is due, in part, to Australian regulators' preference for the "building block" approach to CPI-X regulation. By treating O&M and capital spending separately, this approach naturally lends itself to partial rather than comprehensive benchmarks. The ACCC's *Draft Regulatory Principles*, although not finalized at the time of this report, indicate a marked preference for a building block approach to CPI-X regulation. We therefore believe that the ACCC is likely to favor partial rather than comprehensive benchmarks for the foreseeable future.

With this assumption in mind, we turn to the issue of what partial benchmark measure is more appropriate for Transend. Our analysis below does not imply a general endorsement of any particular partial benchmark, but rather is designed to evaluate the merits of the specific benchmark alternatives likely to be considered by the ACCC. Comprehensive benchmarking methods permit more holistic assessments and can control for a wider range of business conditions but, it must be acknowledged that comprehensive benchmarking is unlikely to be feasible using the limited TNSP data in ANZ. However, these methods can be explored using more extensive international datasets.

### 2.3.2 O&M per Asset Value versus O&M per MWh

The two main (partial benchmark) choices for ACCC opex benchmarking are O&M per asset value and O&M per MWh. Both of these measures are available through the ESAA. As discussed above, the ACCC has focused on O&M cost per asset value, in part because this measure is "independent" of voltage levels, distance, and energy transfers.

PEG agrees that O&M cost per asset value is more appropriate than O&M cost per MWh for benchmarking Transend's O&M cost performance. One reason is that comparisons of O&M cost per MWh are more likely to be distorted by differences in a TNSP's realized economies of scale. This benchmark normalizes cost by what is arguably a transmission network output (MWh), or at least is correlated with the main driver of transmission cost. As described above, a firm's realization of scale economies reduces its costs per unit of output. Larger TNSPs that have realized greater economies of scale are therefore likely to exhibit better cost performance on O&M cost per MWh than smaller TNSPs realized scale economies. This result stems from differences in TNSP outputs rather than the company's underlying success in managing costs.

However, we also believe that O&M costs per asset value fails to control for important conditions that can affect costs. For example, this benchmark does not control for differences in input prices, this is likely to disadvantage TNSPs serving high wage markets. O&M per asset value also fails to adjust for differences in scale economies although not as severely as O&M per MWh. All else equal, this factor tends to advantage larger TNSPs. O&M per asset value also does not adjust for the additional costs associated with a system designed to transmit primarily hydro-generated power or that must contend with extensive vegetation or difficult terrain.

Density economies depend in part on the amount of network assets needed to provide output. O&M per asset value clearly incorporates a TNSP's stock of assets into the metric, so this benchmark is arguably less distorted by differences in economies of density than the alternative. However, it is not clear that O&M per asset value adequately controls for differences in density economies, since that is not the fundamental purpose of this metric. Ultimately, it is an empirical question whether O&M per asset value comparisons across TNSPs are distorted by differences in density economies.

O&M per asset value also fails to control for differences in the age of assets. It may be argued that this effect can be captured if O&M cost is expressed relative to the depreciated capital stock since accumulated depreciation reflects asset age. In fact, including depreciation in the "asset value" is likely to accentuate rather than correct for this distortion. Since older assets are more depreciated, depreciation reduces the net asset value appearing in the denominator of the O&M to asset value ratio. This tends to raise this ratio, thereby compounding the higher direct maintenance costs that appear in the numerator.

Even though O&M cost per asset value is the most appropriate indicator, we believe it is important to keep these conditions in mind when making benchmarking determinations. Researchers should also attempt to evaluate, however imperfectly, the impact of these factors on relative O&M cost performance. As noted, researchers may be able to make more robust benchmarking inferences through comprehensive benchmarking methods or by drawing on larger international databases.

# 3. Business Conditions in ANZ

Because even the best partial benchmark available in Australia is likely to be distorted by business conditions, it is important to have some understanding of differences in the salient operating conditions ANZ's TNSPs. This chapter presents information on a host of these conditions. This information will, in turn, be used when analyzing the available benchmarking information in ANZ. We begin by briefly describing Transend's system and operating conditions. We turn next to data on many relevant business conditions in ANZ.

## 3.1 Transend's System and Operating Conditions

Transend owns and operates the transmission network in Tasmania. Its system is not currently connected to the mainland, although this will change when the Basslink interconnector is built. Tasmania is also not currently part of the National Electricity Market (NEM), but it will become a member when its system is interconnected. Because it is not part of NEM, Transend currently undertakes system operations functions (*e.g.* generation dispatch and scheduling) that are performed by NEMMCO in the NEM States. All of these costs are excluded in the comparisons that follow to ensure comparability.

Almost 100% of power in Tasmania is generated from hydroelectric sources. Transend currently transmits power from 28 hydropower stations. All but two are relatively small "run of the river" generators that operate sporadically. Tasmania's hydrogeneration facilities are predominantly in the south or west of the State. There are two main load centers. One is the far north of the island, where three large industrial customers account for over 50% of load. The second is the State's commercial and residential center in Hobart, located in southeast Tasmania. Loads are accordingly a considerable distance from where hydropower resources have been developed, and Transend must deploy a significant amount of assets to transmit power supplies to load centers.

One consequence of this is that Transend operates a primarily radial transmission network with less asset redundancy than most TNSPs. It is cost prohibitive to have non-radial networks given the geographic dispersion of supply sources and demands in Tasmania. The lack of redundant capacity for most of the network implies that failures of network components will likely be reflected in some amount of unsupplied energy. This is often not the case for TNSPs with non-radial networks.

Transend's transmission assets also differ from those of other TNSPs in ANZ. In mainland Australia, the transmission system ends with the transformer that steps down power to distribution level voltage. Transend not only owns this transformer but also operates and maintains the associated 6.6 kV breakers, buswork and switchgear. In addition to imposing additional costs vis-à-vis other transmission networks, these components also tend to be less reliable and contribute to unsupplied energy that, in other Australian states, would be attributed to the distribution company.

## 3.2 Operating Conditions for TNSPs

Table One presents data on Business Condition Variables for ANZ's six stand-alone TNSPs in 1999/2000, as well as the mean values for each variable. We have grouped these business conditions into four categories.

- *Size of Operations* refer to various measures that reflect the size of outputs provided or overall network assets for each TNSP. The four variables are total maximum demand (MW), total energy delivered (GWh), the length of network line in kilometers, the total number of substations, and the kilovolt circuit kilometers (KVCK) of line; this last measure was computed by multiplying each km of line by its kV rating and summing these products for all types of lines. KVCK is a composite variable that reflects both total voltage and total km of line in a single measure.
- *System Density Measures* are various measures of each TNSP's concentration of output. System density tends to be inversely related to population density and the amount of assets used to deliver a MW of power. The three system

# Table 1: Business Condition Variables

| | Transend | Transgrid | Powerlink | SPINet | Transpower | ElectraNet | **Mean** |
|---|---|---|---|---|---|---|---|
| **Size of Operations** | | | | | | | |
| Maximum demand (MW) | 1,596 | 11,573 | 6,323 | 7,839 | 5,030 | 2,649 | 5,835 |
| Energy delivered (GWh) | 9,843 | 66,235 | 36,953 | 46,054 | 33,880 | 11,597 | 34,094 |
| Length of Line (km) | 3,497 | 11,670 | 10,308 | 6,521 | 16,155 | 5,566 | 8,953 |
| KVCK (sum of kV*km line) | 544,104 | 834,900 | 2,182,037 | 1,671,871 | 2,675,482 | 1,102,629 | 1,501,837 |
| Number of substations | 45 | 72 | 80 | 46 | 181 | 68 | 82 |
| | | | | | | | |
| **System Density Measures** | | | | | | | |
| Population/sq km territory | 6.9 | 8.1 | 2.1 | 21.0 | 14.5 | 1.5 | 9.0 |
| km line/MW | 2.19 | 1.01 | 1.63 | 0.83 | 3.21 | 2.10 | 1.83 |
| (Number of substations*100)/MW | 2.82 | 0.62 | 1.27 | 0.59 | 3.60 | 2.57 | 1.91 |
| | | | | | | | |
| **System/Territory Characteristics** | | | | | | | |
| Load Factor | 70.4% | 65.3% | 66.7% | 67.0% | 66.3% | 50.0% | 64% |
| % circuits underground | 0.34% | 0.17% | 0.16% | 0.17% | 0.02% | 0.18% | 0.17% |
| State average rainfall (mm) | 1,166 | 621 | 910 | 661 | 1,308 | 306 | 829 |
| Hydro % total MW capacity | 90.2% | 2.2% | 7.6% | 5.8% | 60.0% | 0.0% | 27.6% |
| Hydro % GWh generated | 99.8% | 0.1% | 1.9% | 1.0% | 69.0% | 0.0% | 28.6% |
| | | | | | | | |
| **Asset Age** | | | | | | | |
| Average age transmission lines | 43.2 | * | * | * | * | * | 43.2 |
| Average age substations | 36.0 | * | * | * | * | * | 36 |

- density measures are State population per square kilometer of territory, km of line per MW, and number of substations per MW.
- *System/Territory Characteristics* are various miscellaneous factors related to the TNSP's assigned customer base or service territory that may affect its O&M cost. The five characteristics are load factor, percent of circuits that are underground (underground circuits are more expensive to construct but often cheaper to maintain), average rainfall in the state, and the shares of generation capacity and total GWh generated accounted for by hydroelectric sources.
- *Asset Age* refers to the average age of transmission lines and substations, respectively. These data cannot be identified for individual TNSPs so values for all firms but Transend have been suppressed.

It can be seen that, with a couple exceptions, there is little variation in either load factor or the percent of underground circuits across TNSP. The load factor exception is for ElectraNet, whose load factor is considerably below that of the other firms. As previously discussed, ElectraNet's lower load factor is likely to bias O&M per MWh cost comparisons to its disadvantage.

Transend has a notably greater percentage of underground lines than other TNSPs. While this difference is large in relative terms, it amounts to about 0.17% additional circuits underground compared with other Australian TNSPs. Such a small difference in the proportion of circuits underground is unlikely to have a significant impact of costs. Because these business conditions are otherwise so similar across TNSPs, we believe they are unlikely to contribute to differences in recorded costs and will not consider them further.

Graphical information on the other business conditions is presented in Figures One through Twelve. The first three figures show how the TNSPs compare in terms of MW, GWh, and length of line, respectively. Each shows the scale of Transend operations is much smaller than that of other TNSPs. Scale differences are especially large in terms of MW, which is widely believed be the main driver of transmission cost.

**Figure 1**

## Maximum Demand (MW)

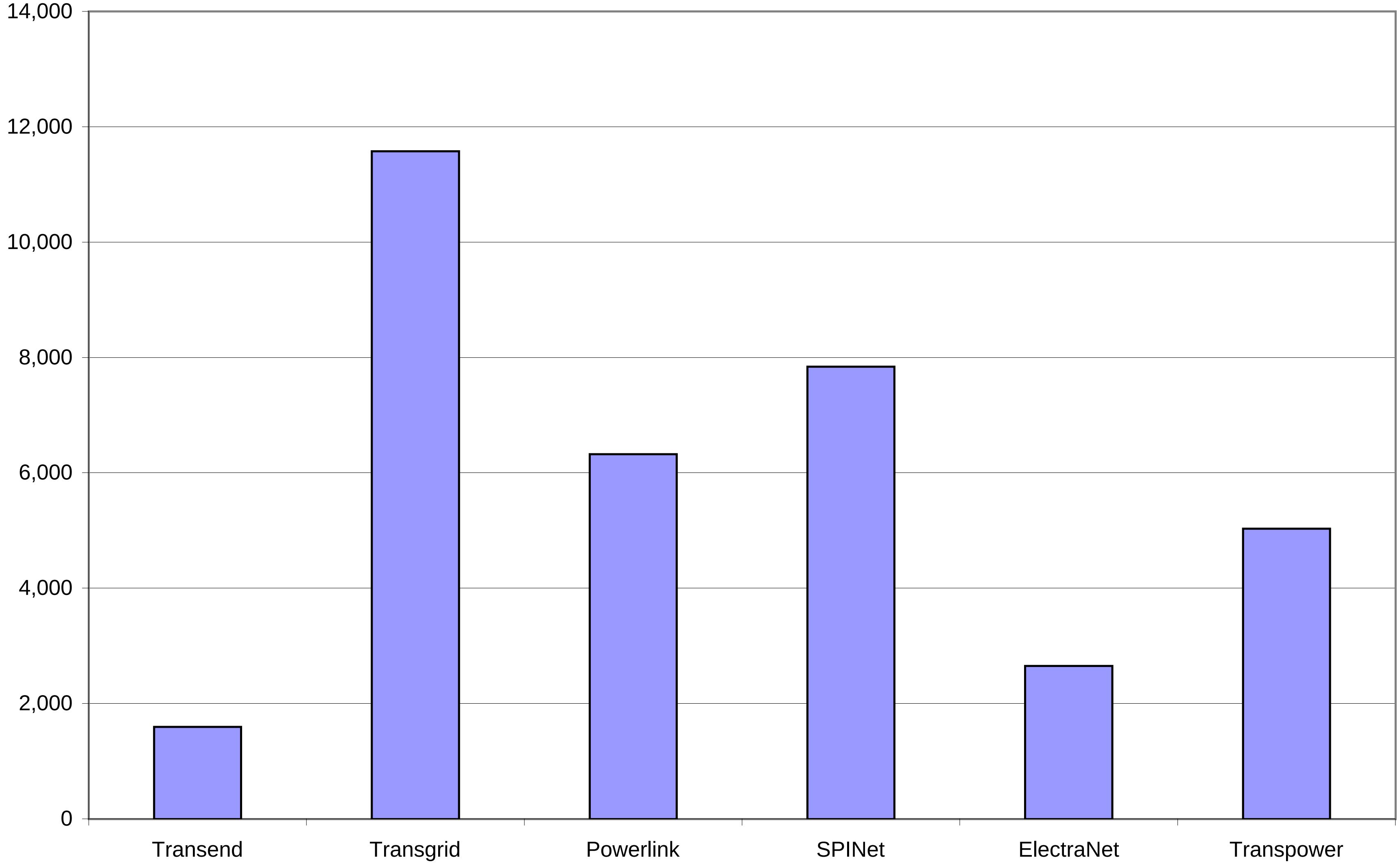


**Figure 2**

## Energy Delivered (GWh)

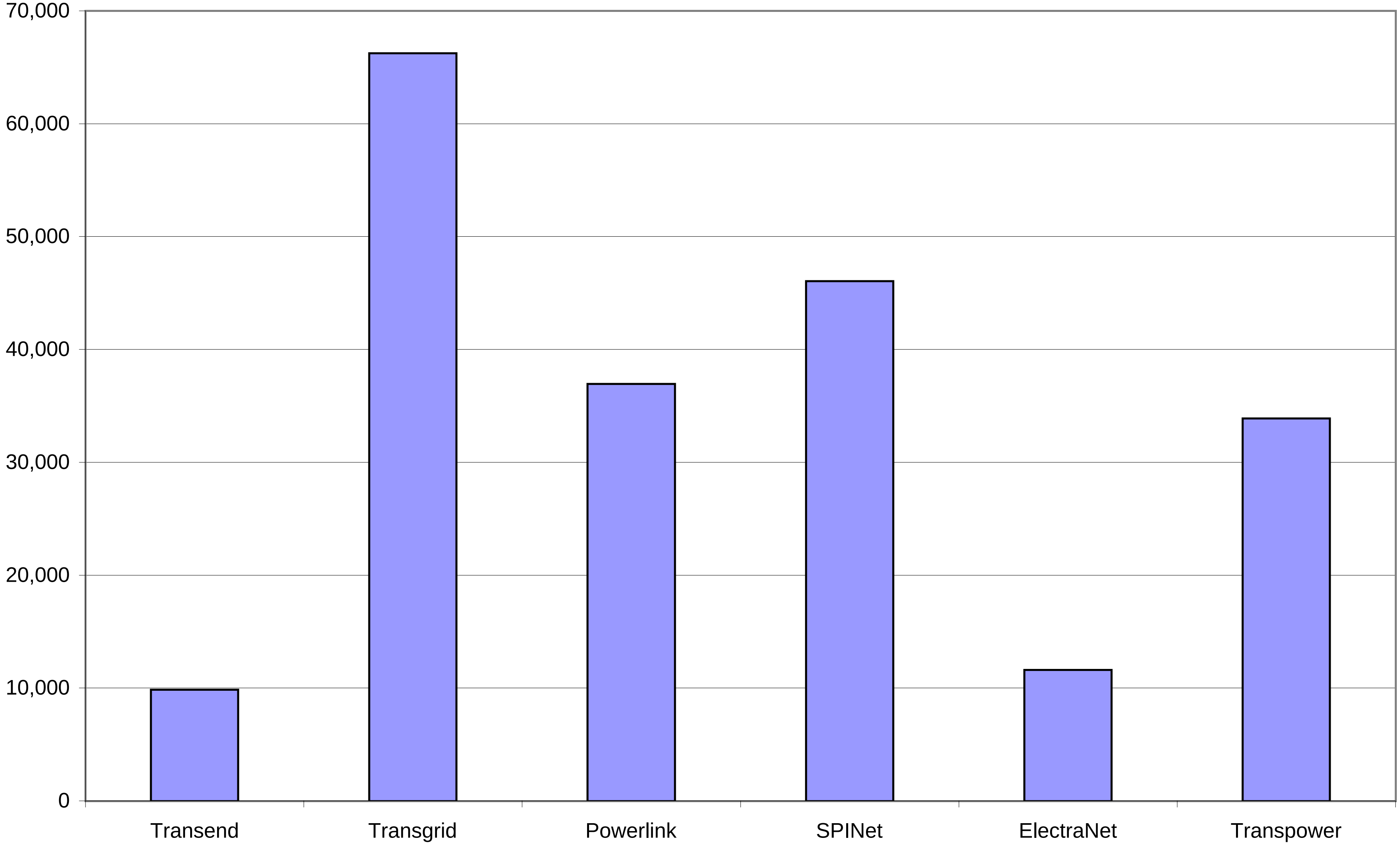


**Figure 3**

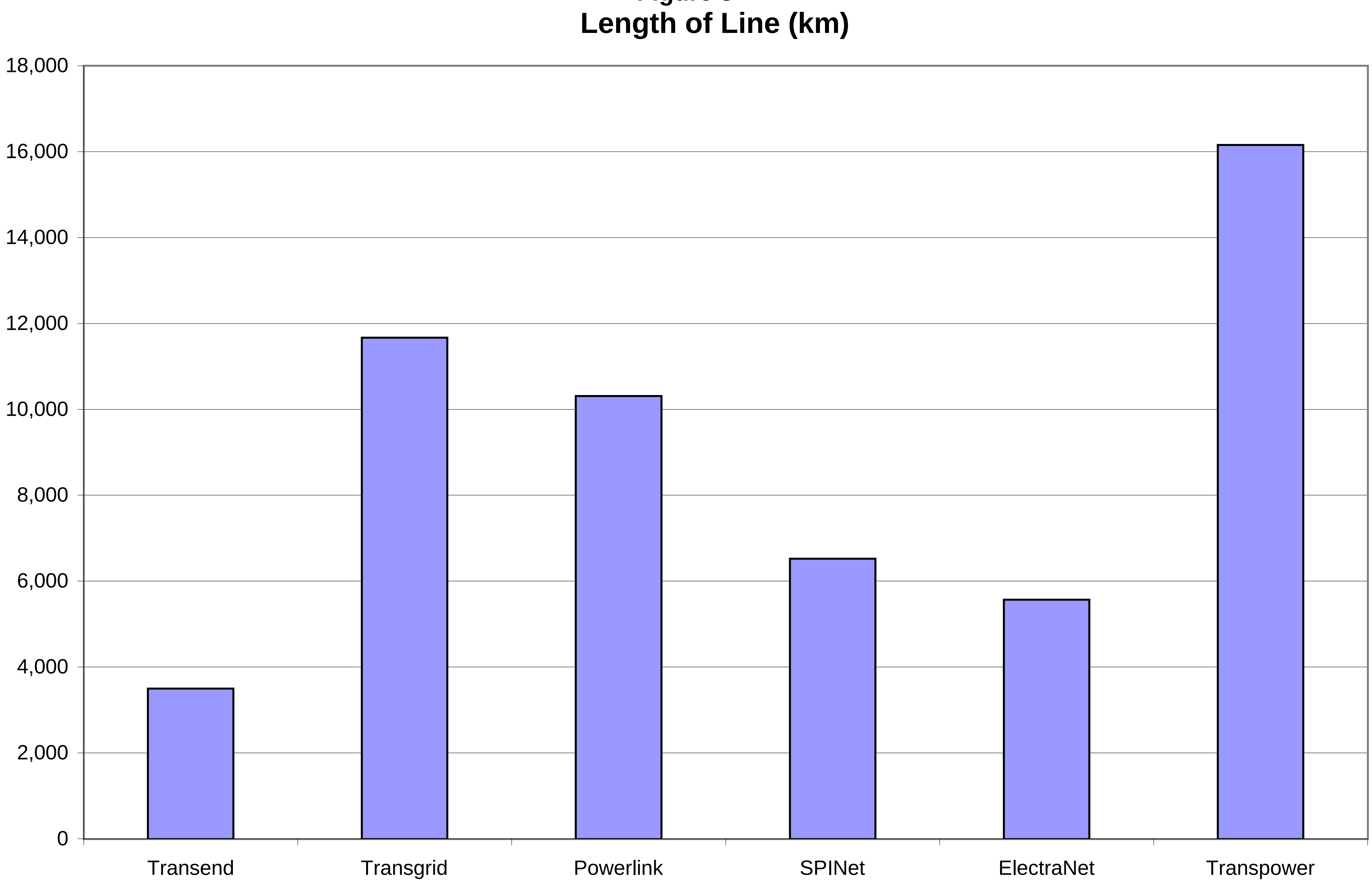

Length of Line (km)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Transend
Transgrid
Powerlink
SPINet
ElectraNet
Transpower

**Figure 4**

**Hydro % of Total MW Capacity**

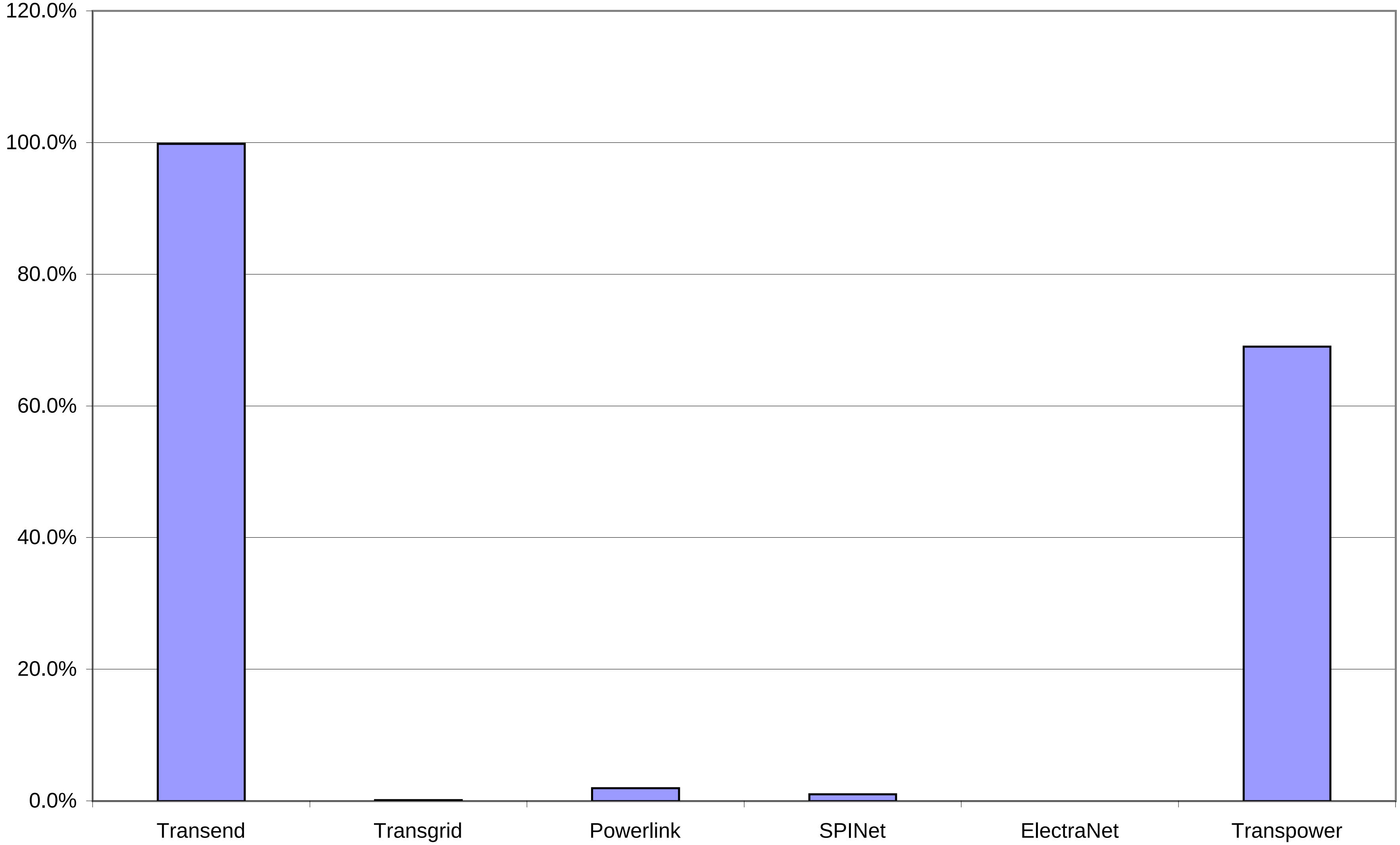


**Figure 5**

## Number of Substations Per MW

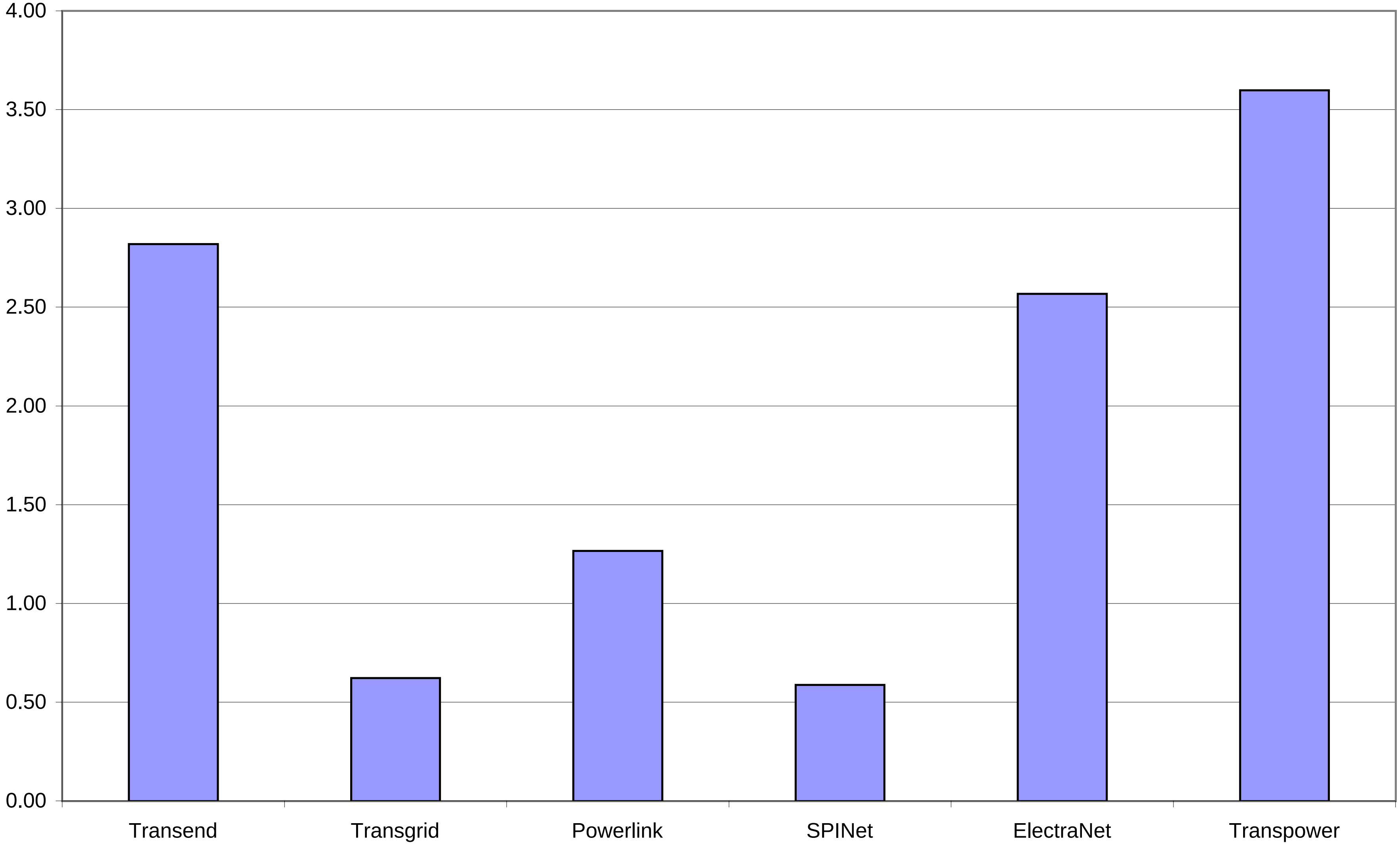


**Figure 6**
## KM Line Per MW

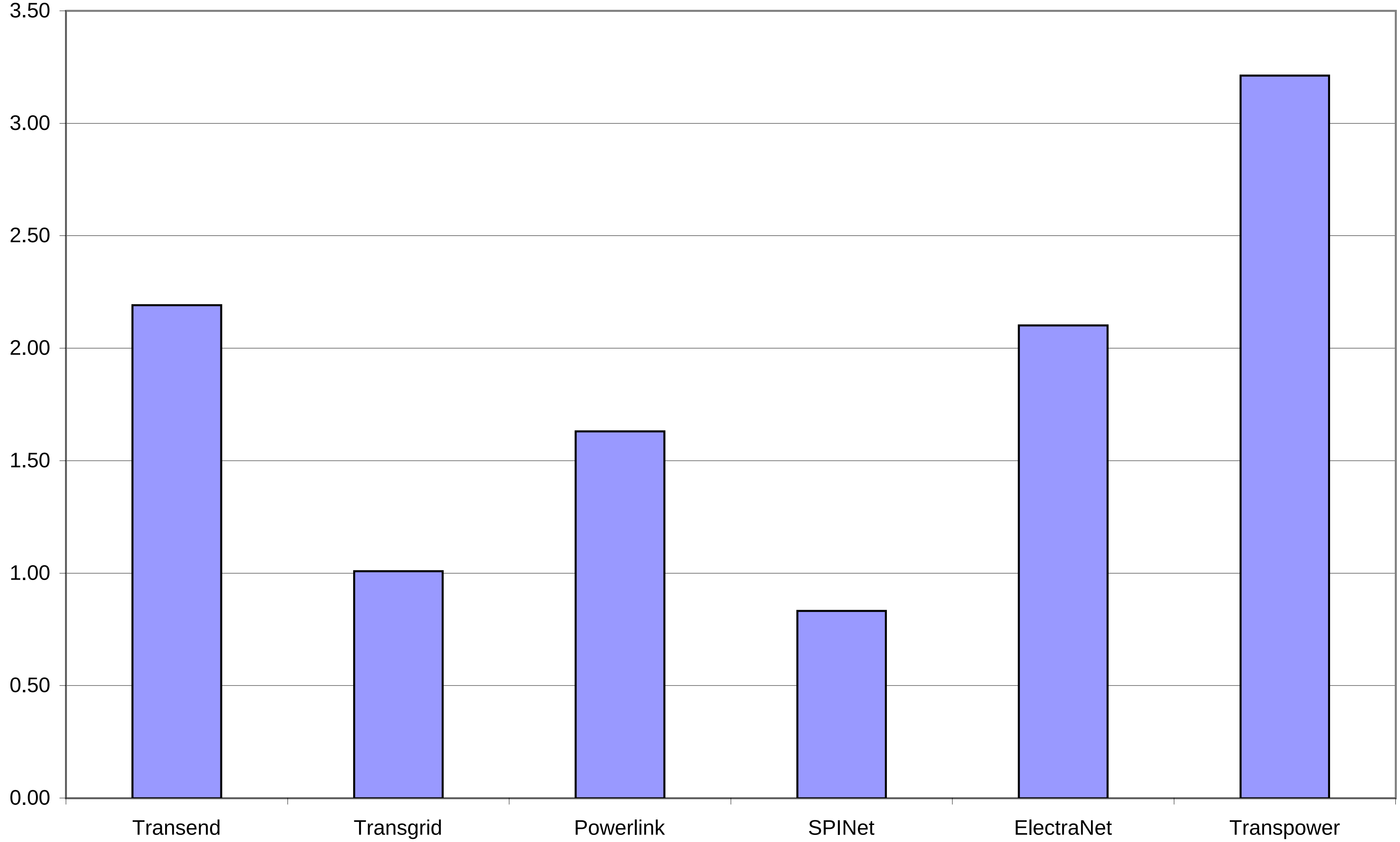


**Figure 7**

**State Average Rainfall**

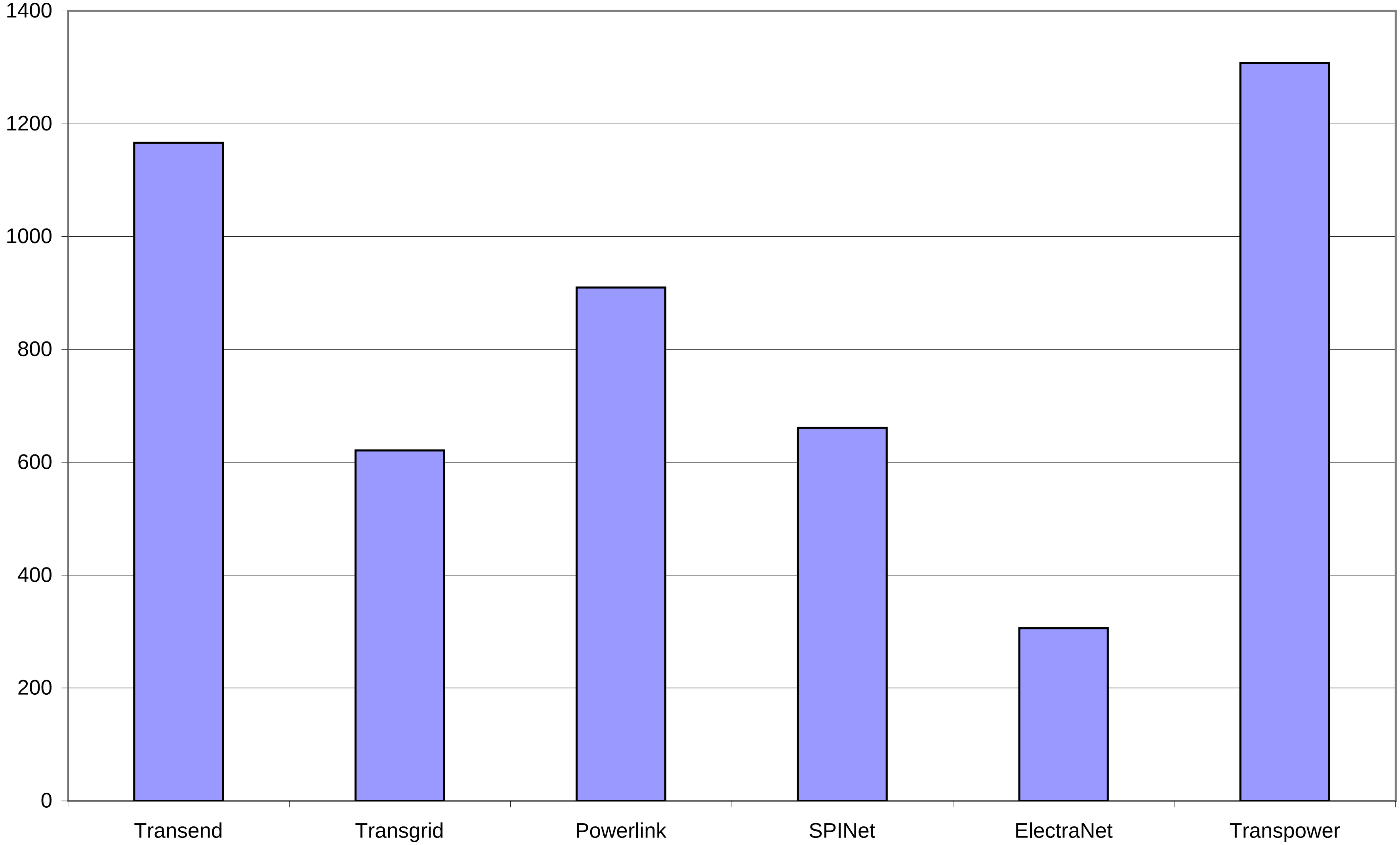


**Figure 8**

**Average Age Transmission Lines**

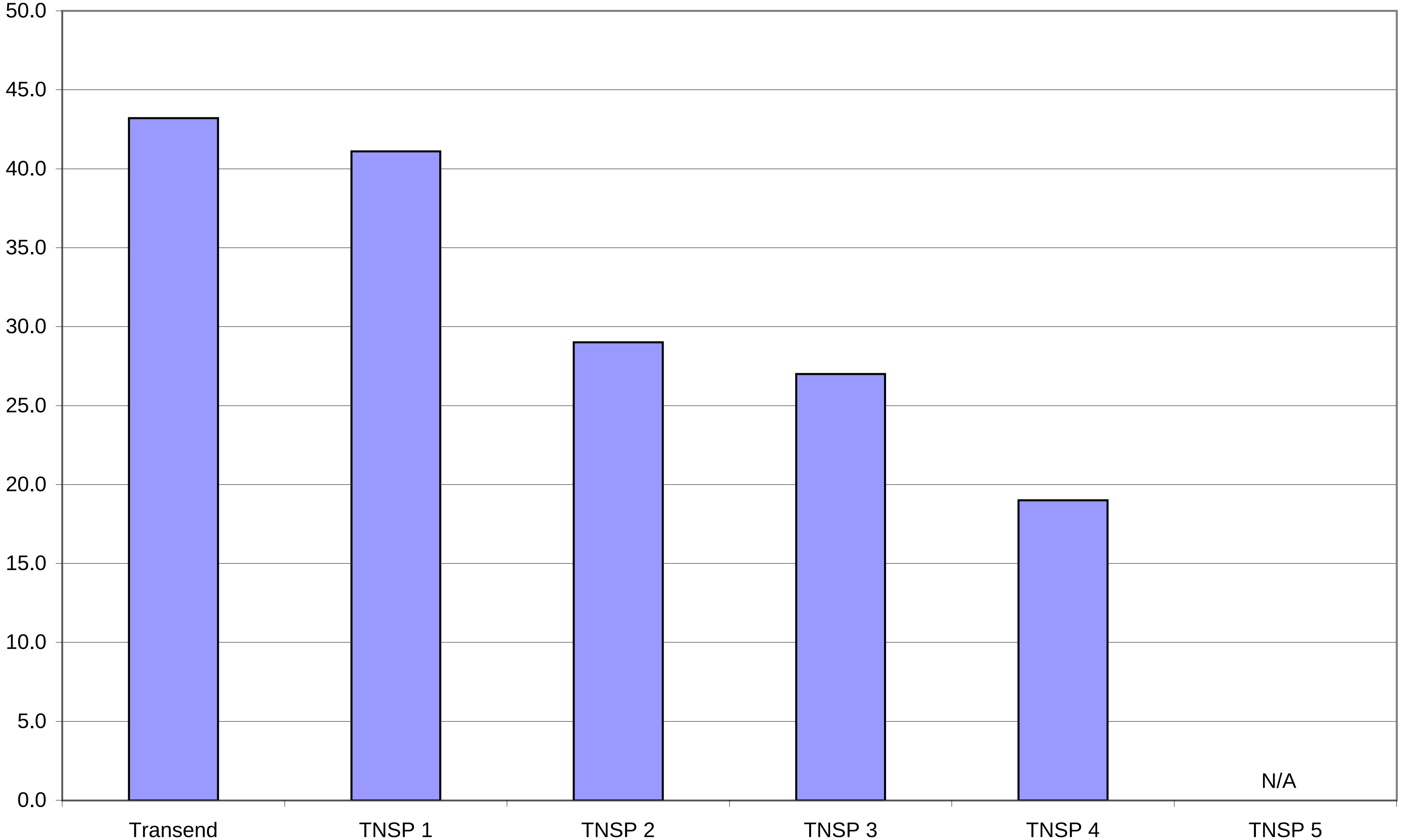
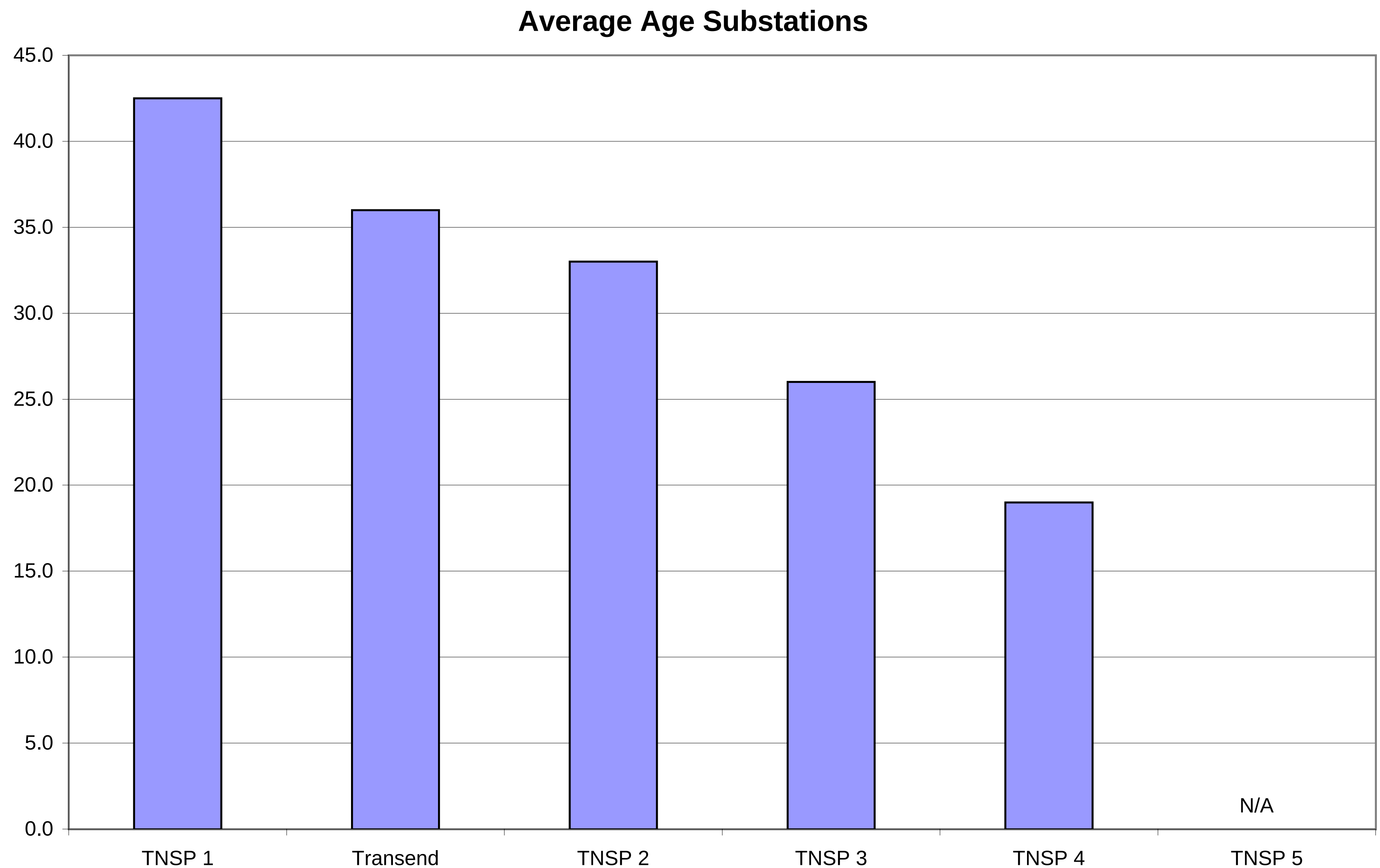


**Figure 9**


Average Age Substations
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
N/A
TNSP 1
Transend
TNSP 2
TNSP 3
TNSP 4
TNSP 5

The TNSP closest in scale to Transend is ElectraNet, and it's peak demand is 66% is greater. It is widely believed that there are economies of scale in transmission operations, and Transend's small scale almost certainly prevents it from achieving scale economies relative to other TNSPs.

Figure Four presents information on the percentage of MW capacity accounted for by hydroelectric sources. This Figure shows that Transend and Transpower overwhelmingly transmit hydro-generated power, while every other TNSP transmits little or no hydro-generated power. The additional costs and reliability problems associated with a predominantly hydro-based system therefore apply to both Transpower and Transend and tend to raise their costs compared to other TNSPs. However, these factors are likely to be significantly greater for Transend since it has essentially no alternative to hydroelectric power, while 40% of generation capacity in New Zealand is not hydro-based.

Figure Five and Six display information on two measures of density economies: number of substations per MW, and km of line per MW. Higher values of these variables indicate less densely concentrated demands. It can be seen that SPINet and Transgrid enjoy the greatest economies of density. This reflects the fact that most of their demands are located in very large, metropolitan areas (Melbourne and Sydney, respectively). In contrast, Transpower, Transend, and ElectraNet exhibit markedly fewer density economies, with Transpower having the least dense network. Powerlink's economies of density are intermediate between these two classes of firms.

Comparing the different system density measures in Table One, it is also clear that population density is not always highly correlated with the asset-based density measures. Transpower has the lowest system density in terms of km per MW or substations per MW, but the second highest population density per square km of territory. One reason for this disparity may be the importance of hydro generation. Since hydro assets tend to be located further from load centers than thermal generation, more assets are needed to transmit power. This contributes to lower density economies even if overall population density is relatively high.

Figure Seven presents information on State Average Rainfall. Again, it can be seen that Transpower and Transend display markedly greater values for this indicator than the other TNSPs. Their average rainfall (1237 mm) is nearly twice the mean for the other four TNSPs (625 mm). Greater rainfall is likely to be correlated with greater maintenance costs and thus greater O&M costs per asset value, all else equal. Failure to control for this factor will tend to bias benchmarking comparisons against Transend and Transpower.

Figures Eight and Nine present information on the average age of transmission lines and substations. It can be seen that Transend has the oldest transmission lines, on average, and the second oldest substations. Older assets are more expensive to maintain and tend to raise O&M costs per asset value. Failure to control for asset age is therefore likely to bias benchmark comparisons against Transend.

In addition, some TNSPs have recently emphasized that replacing older assets will compel greater capital expenditures over the next several years. We did not investigate whether this is likely to be true for Transend, and doing so would require more information on the age profile of specific assets. Nevertheless, these data show that Transend's overall asset base is considerably older, on average, than that of most other TNSPs. One would expect TNSPs with generally older assets to have greater allowed capital replacement expenditures in the future.

This analysis of business conditions suggests that Transpower is the best single "peer" TNSP for Transend. Both firms have low economies of density and transmit primarily hydro-generated power in a territory with relatively heavy vegetation. The only other TNSP with similarly low density economies is ElectraNet. However, ElectraNet has fewer O&M cost pressures from extensive vegetation and a hydroelectric generation base. Both ElectraNet and (especially) Transpower also transmit substantially more output than Transend, which tends to promote scale economies and improve their relative cost performance.

# 4. Cost and Quality Performance for ANZ Transmission Utilities

ANZ's seven TNSPs participate in two main benchmarking studies: the *CEO Transmission Forum Benchmarking Group Report* (CEO) and the International Transmission Operation and Maintenance Study (ITOMS) undertaken by UMS Group. Both of these studies are limited in the sense that they do not consider costs associated with system assets at less than 100 kV voltage levels. The CEO study is also much less detailed than ITOMS. This chapter will examine the information presented in the CEO and ITOMS studies. We also evaluate the merits of the benchmarking methodologies themselves.

## 4.1 CEO Study

The CEO study presents benchmarking information on five main measures: system minutes of unsupplied energy; circuit availability; O&M cost per transmission asset value; O&M cost per MWh delivered by the transmission system; and the lost time injury frequency rate. The first two of these indicators apply to service reliability, the next two reflect O&M cost performance, while the last reflects employment safety.

A number of steps are taken to ensure comparability of data across companies. Transmission is standardized to apply to assets of 100 kV and above. Costs associated with generation and dispatch, control centers, energy trading and settlements are excluded since TNSPs have historically differed in the extent to which they performed these functions. Participants who have been closely involved with the study since its inception have assured PEG that they believe the data are generally accurate and defined comparably across companies. Efforts are also continually made to improve data quality and comparability, and all data provided are subject to a number of screening processes and data validation and verification checks.

Summary information on the cost and quality indicators over the 1996-2000 period is presented in Tables Two through Five. These tables show that Transend tends to be in the middle of the pack on the O&M cost indicators. The Company's average

## Table 2: Performance Data-Operating Cost/MWh Delivered ($A)

| Company/Utility | 1996/97 | 1997/98 | 1998/99 | 1999/00 | Avg. | Rank Avg. | Rank Last Year |
|---|---|---|---|---|---|---|---|
| Transend | 1.31 | 0.96 | 1.58 | 1.39 | 1.31 | 2 | 3 |
| Transgrid | 1.84 | 1.78 | 1.58 | 1.56 | 1.69 | 4 | 5 |
| Powerlink | 1.42 | 1.37 | 1.26 | 1.40 | 1.36 | 3 | 4 |
| Transpower | 2.55 | 2.23 | 1.65 | 1.29 | 1.93 | 6 | 2 |
| SPI PowerNet | 1.10 | 0.84 | 0.84 | 1.02 | 0.95 | 1 | 1 |
| ElectraNet SA | 1.73 | 1.90 | 1.70 | 1.67 | 1.75 | 5 | 6 |
| Western Power | 4.29 | 3.68 | 3.44 | 3.73 | 3.80 | 7 | 7 |

## Table 3: Performance Data-Operating Cost/Transmission Asset Value (%)

| Company/Utility | 1996/97 | 1997/98 | 1998/99 | 1999/00 | Avg. | Rank Avg. | Rank Last Year |
|---|---|---|---|---|---|---|---|
| Transend | 3.10 | 2.40 | 3.79 | 3.11 | 3.10 | 3 | 3 |
| Transgrid | 5.20 | 4.80 | 4.60 | 4.20 | 4.73 | 6 | 6 |
| Powerlink | 3.04 | 3.00 | 2.60 | 2.30 | 2.88 | 2 | 1 |
| Transpower | 4.20 | 4.85 | 3.78 | 3.32 | 4.04 | 5 | 4 |
| SPI PowerNet | 3.40 | 2.86 | 3.00 | 3.72 | 3.25 | 4 | 5 |
| ElectraNet SA | 2.70 | 3.12 | 2.73 | 2.73 | 2.82 | 1 | 2 |
| Western Power | 5.60 | 5.15 | 4.82 | 4.94 | 5.19 | 7 | 7 |

## Table 4: Performance Data-Circuit Availability (%)

| Company/Utility | 1996/97 | 1997/98 | 1998/99 | 1999/00 | Avg. | Rank Avg. | Rank Last Year |
|---|---|---|---|---|---|---|---|
| Transend | 99.76 | 99.52 | 99.13 | 99.17 | 99.40 | 5 | 2 |
| Transgrid | 99.43 | 99.10 | 99.37 | 99.42 | 99.33 | 4 | 5 |
| Powerlink | 99.35 | 99.15 | 99.24 | 99.13 | 99.25 | 3 | 1 |
| Transpower | 99.00 | 99.10 | 99.18 | 99.24 | 99.13 | 1 | 3 |
| SPI PowerNet | 99.54 | 99.62 | 99.69 | 99.60 | 99.61 | 7 | 6 |
| ElectraNet SA | 99.24 | 99.26 | 99.67 | 99.63 | 99.45 | 6 | 7 |
| Western Power | NA | NA | 99.01 | 99.42 | 99.22 | 2 | 4 |

## Table 5: Performance Data-Total System Minutes (Mins)

| Company/Utility | 1996/97 | 1997/98 | 1998/99 | 1999/00 | Avg. | Rank Avg. | Rank Last Year |
|---|---|---|---|---|---|---|---|
| Transend | 3.06 | 16.20 | 15.30 | 24.92 | 14.87 | 7 | 7 |
| TransGrid | 1.59 | 1.21 | 0.55 | 4.23 | 1.90 | 2 | 3 |
| Powerlink | 1.10 | 2.15 | 2.98 | 8.03 | 4.75 | 4 | 5 |
| Transpower | 6.60 | 1.80 | 7.10 | 2.10 | 4.40 | 3 | 2 |
| SPI PowerNet | 0.46 | 0.21 | 1.18 | 0.37 | 0.56 | 1 | 1 |
| ElectraNet SA | 4.27 | 10.35 | 2.41 | 12.00 | 7.26 | 5 | 6 |
| Western Power | 14.70 | 8.20 | 7.86 | 7.82 | 9.65 | 6 | 4 |

O&M cost per asset value is the third lowest of the seven TNSPs over this period. This indicator is also third lowest in the last sample year (1999/2000). Average O&M cost per MWh is second best over the fall period, but third best in the last sample year.

Service reliability measures are often much more variable than cost benchmarks. One reason is that service reliability depends on weather-related factors (*e.g.* lightning, strong winds, extreme heat that can cause lines to sag and transformers to malfunction) that are themselves highly variable. In addition, service reliability measures can be highly sensitive to a small number of events. For these reasons it is usually more appropriate to consider reliability performance over a multi-year period rather than in any given year.

For circuit availability, it can be seen that Transend registers the third best average performance over this period. In contrast, Transend's has far more system minutes of unsupplied energy than other TNSPs. This is true even for more restricted measures of unsupplied energy (*e.g.* unsupplied energy on radial circuits) and even if the outage event stemming from customer works is excluded from the data.

The dramatic differences in Transend's relative performance on these reliability metrics merit explanation. One contributing factor is that a high percentage of Transend's power deliveries go to a small number of large customers. A single outage affecting these customers will result in a relatively large amount of unsupplied load on the system. The unavailability of a single circuit is therefore likely to have a greater impact on unsupplied energy for Transend than for most other TNSPs.

Another contributing factor may be that Transend operates a primarily radial transmission network with less asset redundancy than most TNSPs. This design, in turn, is partly due to efforts to minimize the costs of transporting power from distant hydrogeneration sources to load centers. If any circuits that lack redundant capacity become unavailable, it will result in some amount of unsupplied energy. This will not necessarily be the case for TNSPs with non-radial networks.

Transend's transmission assets also differ from those of other TNSPs in ANZ. As noted, Transend's assets include components that were allocated to distribution companies in mainland Australia. In addition to imposing costs vis-à-vis other transmission networks, these components tend to be less reliable and contribute to unsupplied energy that, in other Australian states, would be attributed to the distribution company.

Overall, the "raw" CEO data suggest that Transend is an average but not outstanding cost performer among TNSPs in Australia and New Zealand. It is also an average performer with respect to circuit availability. However, because of load and system design circumstances that are unique to Tasmania, the Company registers far more system minutes of unsupplied energy than other TNSPs.

However, it must be recognized that the CEO study does not control for important differences in business conditions. Among these conditions are differences in input prices, scale economies, hydro-based systems, rainfall and vegetation, and asset age. The business condition data presented in Chapter Three demonstrate that Transend has the smallest scale of operations, greatest reliance on hydropower, the oldest transmission lines, and the second oldest substations among TNSPs in ANZ. Each of these factors is expected to raise transmission O&M cost. This implies that, if the CEO benchmarking study controlled for these factors, Transend's cost performance would likely improve relative to other TNSPs.

We have no information on Transend's input prices (*e.g.* prices paid for labor) compared with other TNSPs. However, it is generally acknowledged that the cost of living is higher in Sydney and Melbourne than in most other parts of Australia. It seems reasonable to assume that the input prices facing Transgrid and SPI PowerNet are therefore higher than for other TNSPs. Properly controlling for this factor would therefore improve these firm's benchmarked operating costs relative to other TNSPs.

On the other hand, Transend may face higher prices for outsourced services than other firms. Tasmania is a much smaller market than other ANZ jurisdictions. There may accordingly be smaller pool of contractors bidding to provide services. Less competitive markets often result in higher prices or, in this case, higher wages paid for outsourced labor. This may at least partially offset the higher cost of living in other locations. Resolving this issue would involve additional empirical research.

**Figure 10**

**O&M Cost and Density**

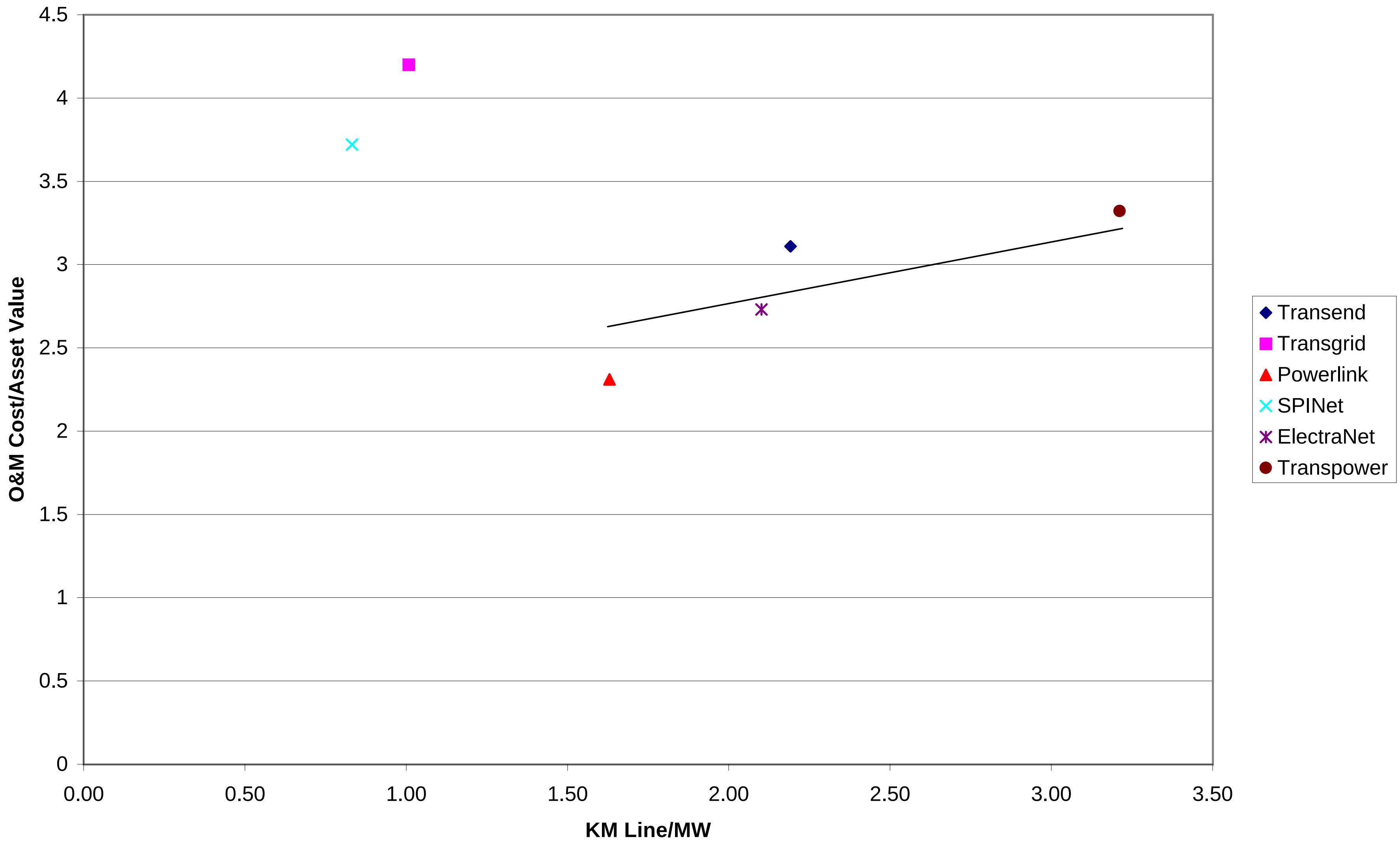
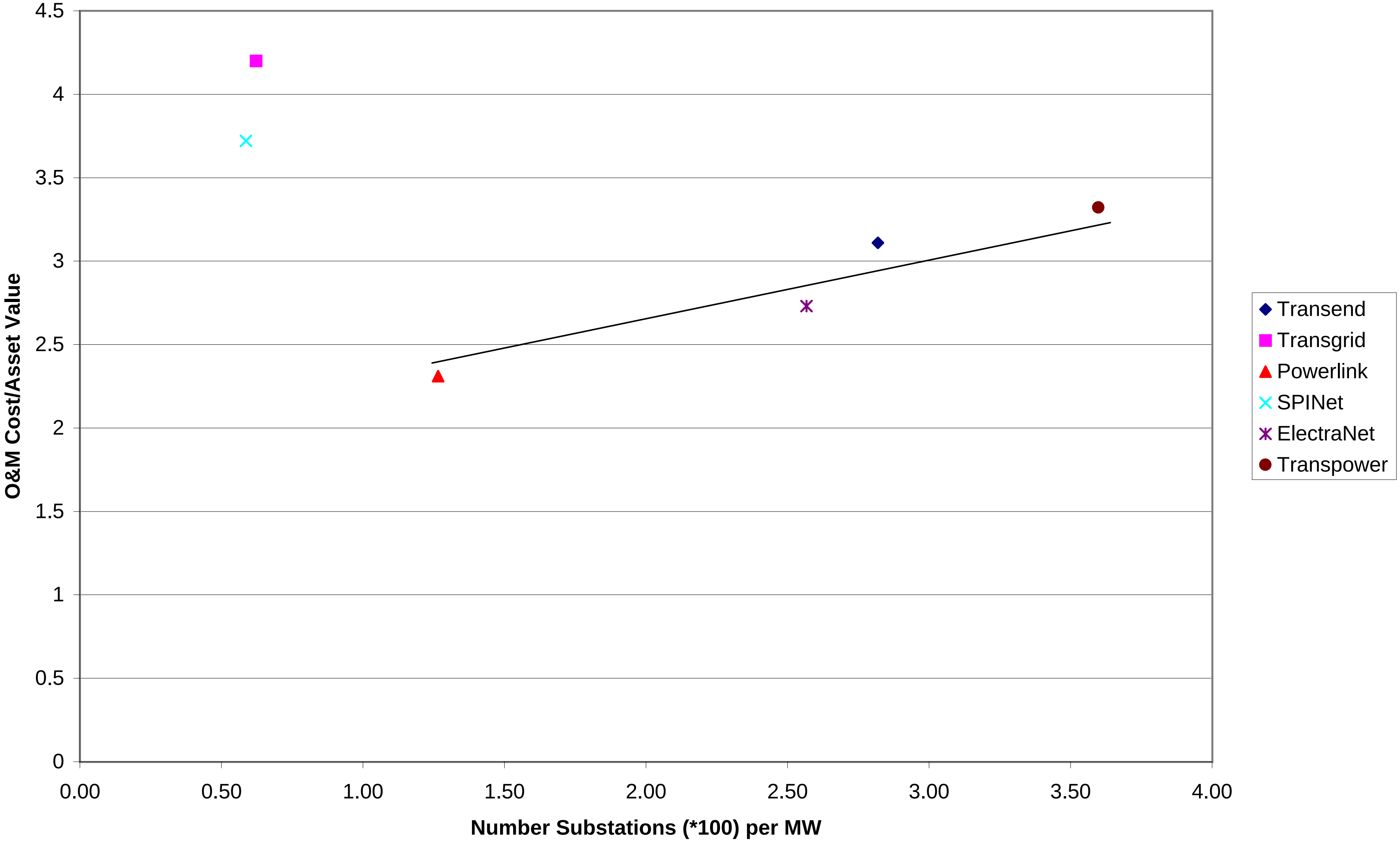


**Figure 11**

**O&M Cost and Density**



In the previous Chapter, we noted that whether O&M per asset value controls for differences in network assets needed to deliver power (*i.e.* economies of density) is an empirical issue. We present some preliminary information on this issue in Figures 10 and 11. These Figures graph 1999/2000 O&M costs per asset value against km line per MW and number of substations per MW, respectively. It can be seen that, in both Figures, the cost observations for Transgrid and SPI PowerNet lie well above those for other TNSPs. One possible explanation is the higher input prices confronting these firms. This factor makes it difficult to compare these TNSPs with others.

Turning to the other four TNSPs, it can be seen that there are generally positive relationships between the O&M cost measure and km of line per MW and number of substations per MW. Recall that higher values of these variables indicate that there are fewer economies of density. These figures therefore suggest that economies of density exist and are not entirely eliminated when O&M costs are expressed relative to asset value. It follows that, if economies of density were controlled for, the cost performance of Transend would likely improve.

It is also an open issue whether differences in rainfall are, in fact, correlated with maintenance costs. Some information on this point is presented in Figure Twelve, which graphs 1999/2000 O&M costs per asset value against average State rainfall. Again, the observations for Transgrid and SPINet are well above those for other firms, and this may be due in part to their higher input prices. For the other four TNSPs, the visual evidence supporting a positive relationship between costs and rainfall is less striking than with density economies, but there does seem to be a generally positive relationship. This suggests that properly controlling for this factor may tend to improve Transend's relative cost performance.

Transend's cost performance can also be compared to peer TNSPs. As noted, the single best peer for Transend is likely to be Transpower. Cost comparisons between these firms will not be distorted much by differences in rainfall and vegetation-related maintenance. There will also be similar levels of density economies, although this factor will favor Transend somewhat since output along its network is more densely concentrated than for Transpower. On the other hand, Transpower is larger and will

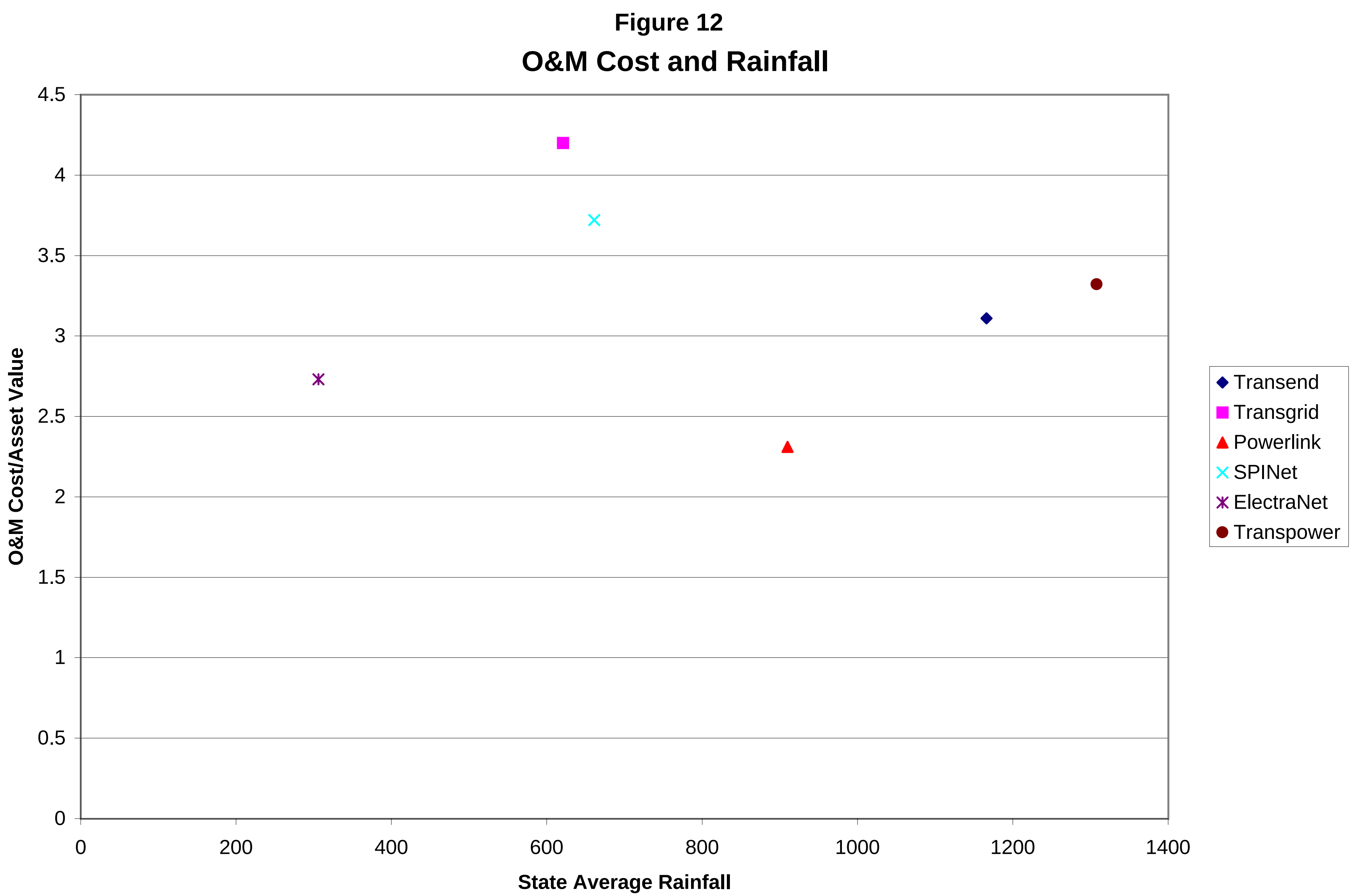


Figure 12
O&M Cost and Rainfall
O&M Cost/Asset Value
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
State Average Rainfall
Transend
Transgrid
Powerlink
SPINet
ElectraNet
Transpower

enjoy more economies of scale, and it transmits somewhat less hydropower than Transend.

In 2000, Transend's O&M cost per asset value was 3.11% and Transpower's was 3.32%. Transend's relative cost was therefore about 15% below that of Transpower on this benchmark. In light of the generally similar business conditions between these firms, this further supports the view that properly adjusting for differences in operating conditions faced by TNSPs would tend to improve Transend's O&M cost performance.

We wish to emphasize that the analysis above is necessarily highly tentative. One should generally be cautious in interpreting partial performance measures since they do not control for a broad range of cost drivers. Indeed, even the simple graphical analysis undertaken here suggests that certain business conditions that are not controlled for (*e.g.* input prices) make it difficult to compare all TNSPs. Additional data and more sophisticated empirical techniques are needed to quantify the impact of differences in business conditions on relative performance. Nevertheless, we believe that the analysis and simple empirical information presented here provides illustrative but tentative evidence that Transend's relative O&M cost performance may be better than what is suggested in the "raw" CEO data. It may also be noteworthy that Transend's current O&M cost per asset value of about 3.1% is below the 3.5% target that the ACCC has established in another proceeding.

## 4.2 ITOMS Study

### 4.2.1 Results

The ITOMS study presents much more information and a more detailed benchmarking assessment than the CEO study. Like the CEO study, however, it is restricted to assets of 100 kV and above. ITOMS is overwhelmingly focused on maintenance activities, but it does present some information on other elements of O&M costs, such as support services (training, scheduling and planning, technical support, and administrative and general), although these are not benchmarked.

The ITOMS study has two comprehensive categories and 15 subfunctions that are subject to "cross hairs" benchmarking. The two comprehensive measures are for overhead line maintenance and substation maintenance. The five subfunctions associated with overhead line maintenance are[2]:

- Overhead line patrol and inspection 100-199 kV
- Overhead line patrol and inspection 200+ kV
- Overhead line maintenance 100-199 kV
- Overhead line maintenance 200+ kV
- Right-of-way maintenance

The ten subfunctions associated with substations operation and maintenance are:

- Breaker maintenance 100-199 kV
- Breaker maintenance 200+ kV
- Transformer maintenance 100-199 kV
- Transformer maintenance 200+ kV
- Relay, SCADA and communications system maintenance
- Compensation equipment maintenance
- Disconnector and earth switch maintenance
- Instrument transformer and other circuit end equipment maintenance
- Substation site and auxiliary plant equipment maintenance
- Substation field operations

For all categories, costs are measured along the horizontal axis while the level of service provided (*e.g.* the level of quality) is plotted on the vertical axis. Both cost and quality of each performance category are scaled relative to the mean of the companies included for the measure.[3] The graph is accordingly divided into quadrants, with the

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[2] In addition, both comprehensive categories include a pro-rating of support costs.

[3] Some TNSPs in the ITOMS sample may be excluded from a particular category either because they do not report any expenditures on that item or because they are "outliers." We evaluate the merits of this practice in the next chapter.

northeast quadrant being the "best" since it reflects above average quality and below average costs. In generally, movements to the right (eastern quadrants) reflect cost reductions, while movements up (to the northern quadrants) reflect quality improvements. The southwest quadrant therefore reflects below average costs and quality and is the "worst" quadrant.

Information on ITOMs overall overhead line maintenance measure is presented in Figure 13. Transend is close to but slightly below the sample average for costs, but well below average in terms of quality. Since it is below average for costs and quality, Transend is in the bottom or southwest quadrant.[4] In contrast, five of the six other ANZ companies were top quadrant performers.

Information on ITOMs overall substation O&M measure is presented in Figure 14. Transend's cost and quality are both slightly below average, so it is also in the bottom quadrant on this measure[5]. All six of the other ANZ companies have lower costs on this category. Three of these companies also have better quality, while two have approximately the same level of quality and the quality of one is well below that of Transend.

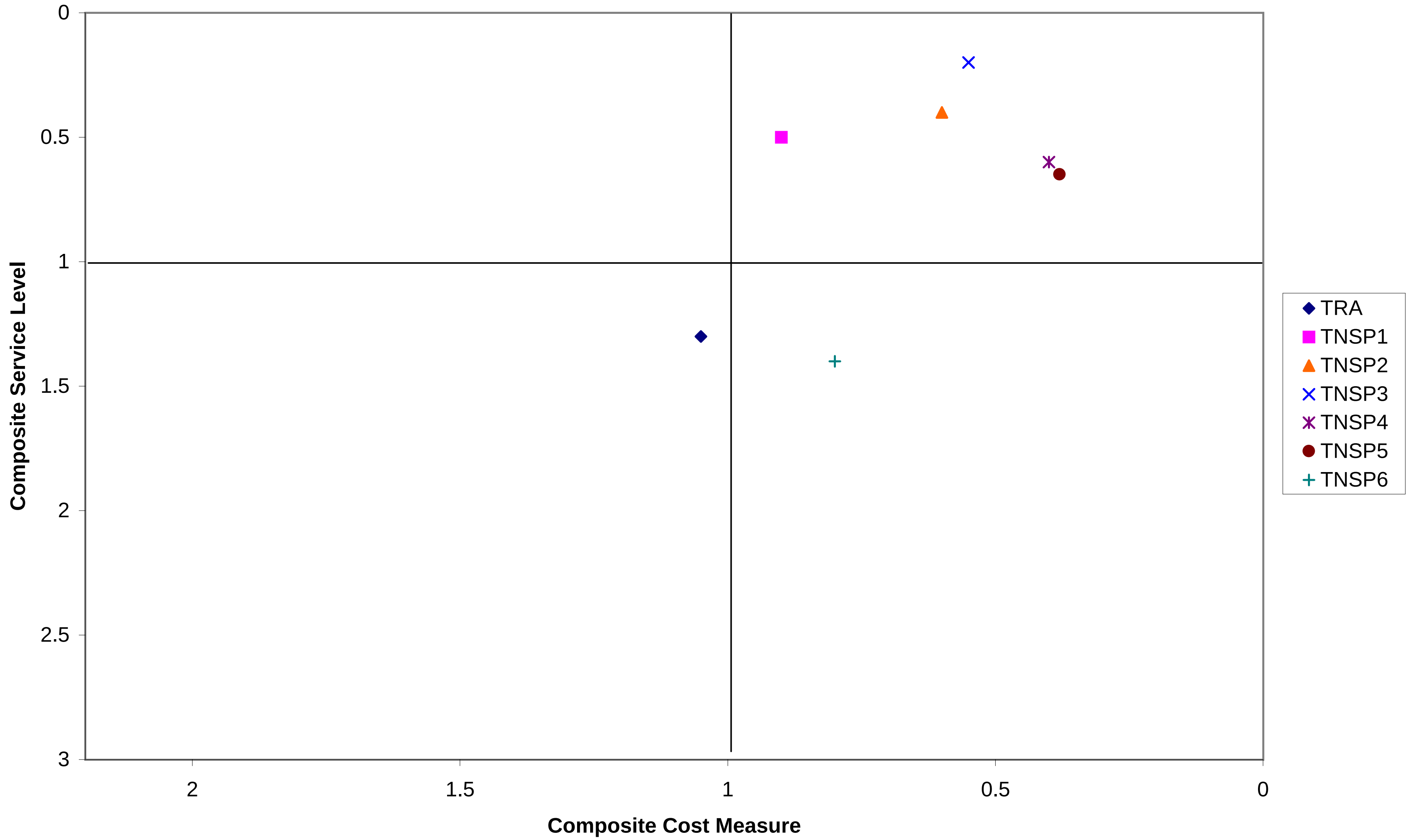
Taken together, Transend's performance on these measures suggests that it is slightly below average in terms of cost and somewhat more below average in quality among the ITOMS sample. However, it is the highest cost firm among ANZ companies and also has lower quality, on average, than the ANZ firms. It also registers bottom quartile performance on each comprehensive measure.

ITOMS also presents data on changes in company performance between the 1999 and 2001 surveys. For overhead line maintenance, Transend's costs fell slightly relative to the sample in 2001, but its quality improved dramatically between 1999 and 2001. The ITOMS report indicates that, on this category, the overall sample reduced costs but quality fell between these years. For substation O&M, Transend's relative costs

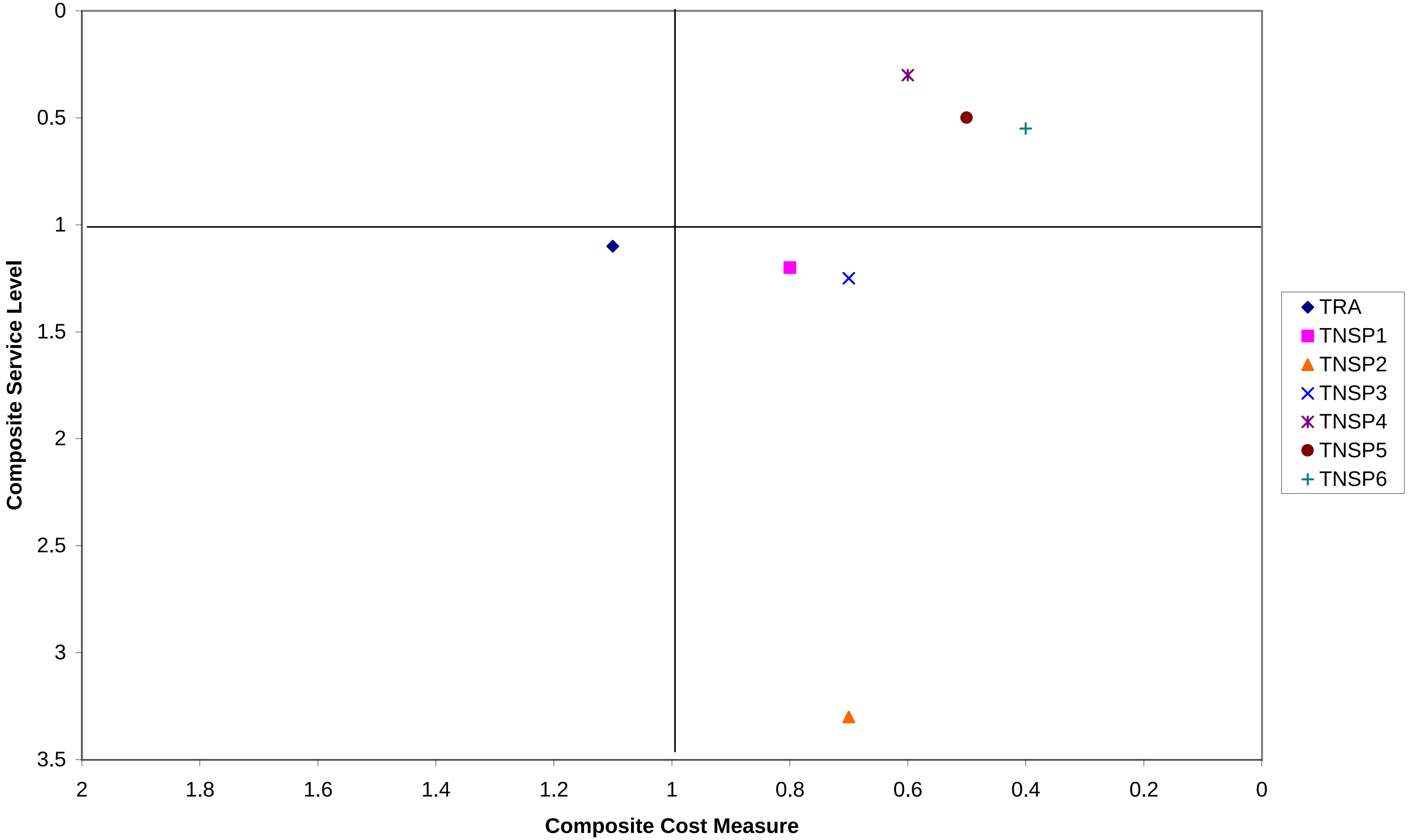
[4] A total of six sample companies were in the bottom quadrant on the overhead line maintenance measure.

[5] A total of four sample companies were in the bottom quadrant on the substation maintenance measure

## Figure 13
## Overhead Transmission Line Maintenance



## Figure 14
## Substation Operations and Maintenance



improved but its comparative quality fell between 1999 and 2001. The ITOMS report states that both cost and quality improved between 1999 and 2001 this measure.

Overall, Transend apparently registered a slight improvement in relative cost and slight decline in quality between 1999 and 2001, even as costs for overall sample improved.[6] Although it is close to the average in both years, the Company is nevertheless in the bottom quadrant in 1999 and 2001 for both measures.

ITOMS does not specifically benchmark support costs, but it does present some information on these costs. One indicator is support services as a percent of total O&M costs (line, substation and support). Transend is only slightly above the sample average of about 30% on this measure.

ITOMS also presents data on total O&M costs per MWh and O&M costs per asset value. Transend appears to have the first or second highest costs on these measures in the ITOMs sample. All the other ANZ companies but one register much lower costs on this measure. Interestingly, O&M per MWh and O&M per asset value are also cost benchmarks listed in the CEO study. In ITOMS, however, Transend is well ahead of the other ANZ companies while it is in the middle of the pack or above average in the CEO study. There may be a number of reasons for this, which we examine later in this chapter.

The ITOMS study does suggest some areas of relative strength for Transend. The Company's relay, SCADA and communications equipment maintenance costs and transformer maintenance costs (200+ kV) are each below the sample average and also below nearly all ANZ companies. Transend's compensation equipment maintenance costs are also apparently the best in ANZ and well below the sample average, but this accounts for a small share of benchmarked cost.

In terms of relative weaknesses, one of the most apparent is for right of way maintenance costs. Transend's costs on this indicator are above the sample average and well above those of other ANZ firms. Patrol and inspection costs for 100-199kV assets also relatively high.

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[6] Substation sub-functions account for a greater share of costs than the overhead line sub-functions, so more weight would be placed on the Company's movements in substation performance between 1999 and 2001 when evaluating changes in Transend's total cost and quality positions.

On both the comprehensive categories and most subfunctions, however, Transend is usually only slightly above or below the sample mean performance. The Company does not fare as well relative to the ANZ firms since most of these companies outperform the ITOMS sample.

### 4.2.2 Evaluation of ITOMs Benchmarking Methods

The ITOMs study defines 15 main subfunctions, each with a service level and associated cost, for which benchmarking evaluations are undertaken. Data are gathered from sample companies and carefully screened for consistency and accuracy across the sample. The cost data include wages (base and overtime), profit, supervision costs, an allocation of corporate overheads, and non-labor materials costs. UMS apparently ensures that costs are defined similarly and overheads allocated similarly across companies.

Several steps are taken to improve the comparability of the benchmarks that are calculated. First, all costs are converted to a common currency. This is a much more important issue for ITOMS than for the CEO study because of the international scope of the former.[7] The currency that is chosen is the US dollar, and conversion is based on the average exchange rate in the year for which data are collected. The labor portion of costs is also adjusted for differences in labor costs. For each company, the adjustment is proportional to the difference between the company's average wages in local currency and the average wages paid by US firms, expressed in US dollars.

For most subfunctions, adjusted costs are then scaled by the associated asset. This establishes a type of a unit cost for each subfunction. For subfunctions not directly related to an asset, an analogous process is undertaken to scale costs to factors that purportedly affect the amount of maintenance expenditures. For example, right of way maintenance is scaled to the hectares of right of way that are maintained. Many assets and related factors used to establish unit costs are also adjusted by "normalizer" factors

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[7] The CEO study applies to six Australian TNSP's and one New Zealand TNSP, but the Australian and New Zealand currency movements are often closely aligned.

set by UMS. These factors are apparently designed to control for differences in maintenance intensity associated with different assets.

After developing these unit costs, ITOMS then sometimes removes certain outlying observations from the sample. The remaining observations are then divided by the sample mean values for the unit cost and level of service quality. These mean-scaled observations are then plotted on the charts that appear in the ITOMS report. By mean-scaling the data, the value for each TNSP is expressed relative to one, and a firm's place on each of the axes reflects its percentage difference from the sample mean with respect to adjusted cost (on the horizontal axis) and quality (on the vertical axis).

There are some clear benefits associated with this type of benchmarking. The detailed, process-oriented measures produced by ITOMS focus on specific activities and can direct company efforts towards specific actions that may improve performance. For most subfunctions, the "Best Practice Profiles" also describe specific practices and organizational structures that are associated with especially good performance.

However, there are also problems with the ITOMS approach. Some of these pertain to the general methods used to develop benchmark measures. Other features may partially explain why Transend's performance compared to other ANZ firms tends to be worse on ITOMS than on the CEO study.

Our concerns stem from the adjustments made to control for differences in operating conditions. ITOMS controls for these differences in several ways. Cost data are adjusted for differences in input prices, creating in effect "real cost" (input quantity) data. Each O&M cost component is also adjusted for differences in scale using a quantity and/or asset variable. "Normalizers" are also applied to some quantity variables. While PEG agrees in spirit with many of these adjustments, we have concerns with the details of many adjustments.

*Labor prices*

Labor prices were normalized by multiplying the assumed share of labor costs (50% of the contracting costs for the subfunction) by the ratio of average US wages to the average wages paid by the company. In general, it is appropriate to normalize costs for differences in local labor markets and the wages that firms must pay for labor. If this was not done, firms in relatively high-priced labor markets would be unfairly disadvantaged since their costs would reflect a business condition largely beyond their control rather than their inefficiency.

However, we question the magnitudes of the wage differences used in ITOMS. We cannot reveal these magnitudes without discussing empirical details of the study that must remain confidential. Suffice it to say that some of the estimated wage differentials between Tasmania and other ANZ locations appear implausibly high, and may be distorted by differences in the mix of labor employed as well as differences in the shares of outsourced labor. Economists refer to this problem as one of aggregation bias, and it can occur if the input price adjustment is highly aggregated (such as the average wage for the company) and does not control for differences in the composition of the labor force. To prevent aggregation bias, many benchmarking studies use figures directly from local labor markets rather than the wages paid by sample companies themselves.

Another factor not reflected in the ITOMS adjustment is the competitiveness of the market for outsourced services. Since Tasmania is a much smaller market than other ANZ markets, there may be smaller pool of contractors bidding to provide services. Less competitive markets often result in higher prices or, in this case, higher wages paid for outsourced labor. This may at least partially offset the higher cost of living in other locations.

These factors may be creating biases that tend to raise ITOMS' computed costs for Transend relative to other ANZ firms. These biases would apply across the board to all subfunctions. Therefore, although the labor price adjustments are designed to control for differences in local wages, there is a significant probability that the ITOMS adjustments actually create further distortions.

*Exchange rates*

Another problematic adjustment is the use of current period exchange rates to convert costs into a common currency. It is widely agreed that purchasing power parity (PPP) exchange rates are more appropriate for this purpose, and they are almost universally used in benchmarking studies. The use of current period rather than PPP exchange rates will not bias inter-Australian comparisons since a common exchange rate is used in any case. The bias between the Australian TNSPs and Transpower is also likely to be minor since the Australian and New Zealand currencies often move together.

However, using current period exchange rates will tend to bias ANZ costs relative to those of the rest of the sample. In the sample year in question (2000), the Australia/US exchange rate was below its PPP level. Using current period exchange rates would therefore tend to create a downward bias in the costs for ANZ TNSPs and improve their performance relative to the non-ANZ firms. This bias would apply across the board to all subfunctions.

*Scale and/or Asset Adjustments*

One of the main drivers of power transmission cost is the scale (quantity) of service. There are multiple dimensions to the scale of transmission operations that impact O&M expenses. Relevant output quantity variables include MWh of power receipts (from generators) or deliveries (to large customers and distributor companies), peak customer demand, and the KVCK in the network used to deliver power to customers.

These outputs are properly considered as operating conditions since they are largely beyond a utility's control. ITOMS incorporates output quantities in their analysis by expressing each O&M cost as a unit cost. A *single* quantity variable is used in these unit cost computations.

One important drawback of this approach is that ITOMS implicitly posits a linear relationship between costs and the scaling variable. For example, suppose that two TNSPs face the same business conditions except that one has twice the scale as another. The ITOMS would generally assume that these companies have equal levels of cost efficiency if the costs of the larger company were exactly twice as large as those of the smaller company. This conclusion may not be reasonable when comparing small to large utilities since it is widely believed that there are significant scale economies associated with operating delivery networks. Indeed, the existence of such scale economies is fundamental to why power transmission is commonly viewed as a natural monopoly service. This consideration is important for Transend since it is a relatively small TNSP. Failure to account for scale economies properly may therefore tend to bias cost comparisons against smaller firms.

In addition, scaling by a single variable may not properly consider the multi-dimensional nature of transmission output. Relating cost to a single quantity or asset does not consider the ways in which the interaction between different outputs can affect cost. Econometric models often show that the interaction between different business conditions (*e.g.* MWh and KVCK) can have a significant impact on power transmission cost. The failure to account for these interactions can lead to biases in unit costs.

*Capital-O&M Substitution*

ITOMS results must also be interpreted cautiously because of tradeoffs between O&M and capital costs. There is scope for substituting capital and O&M inputs in TNSP operations. This choice between capital replacement and maintenance is especially pertinent to older assets. Capital-O&M substitution may create more of a bias for relatively aged systems, like Transend's.

The ITOMS study apparently controls for this factor, in part, through the asset normalizers. The effect of these normalizers is to adjust the computed unit costs for differences in asset choices. However, ITOMS does not provide a rationale for the values of these normalizers. If the values for normalizers are not well founded, they may create further distortions rather than appropriate controls for differences in business conditions. In addition, the ITOMS model does not contain any provisions for controlling for the special circumstances associated with transmitting power almost exclusively generated from geographically dispersed hydro-based sources and transmitted to distant load centers.

To summarize, we have several concerns with the benchmarking methods employed in the ITOMS study. Some of these concerns also apply to the CEO study (*e.g.* the failure to control for other business conditions, scaling by only a single quantity, inadequate controls for capital-O&M substitution). While ITOMS attempts to control for some business conditions, we believe the controls are sometimes not appropriate and may exacerbate rather than ameliorate differences between companies. We have identified a number of factors in the ITOMS study that may adversely affect Transend's relative performance. These factors may partially explain the discrepancies between Transend's performance on the CEO and ITOMS studies.

## 5. CONCLUSION

The most reliable, publicly-available benchmarking information in Australia suggests that Transend is an approximately average performer. In the CEO study, the Company is in the middle of the pack on both O&M cost indicators and the circuit availability measure of reliability. However, Transend's performance on system minutes of unsupplied energy is considerably higher than for other TNSPs.

We believe that these "raw" data are likely to understate Transend's real cost performance. The Company operates under a number of operating conditions that make it more difficult to achieve low O&M costs. These include a small scale of operations that limits its scale economies; a low concentration of load along its network, which reduces its density economies; a near-complete reliance on hydro-power, which reduces operating flexibility , raises operating costs and reduces reliability; relatively extensive vegetation; and an average asset age that is the first or second highest in ANZ. Properly controlling for these factors would likely improve the Company's relative O&M cost position. In addition, Transend's asset base includes components that were allocated to distribution companies in other States. These assets are likely to impose further costs and reduce reliability compared with other TNSPs.

Opex benchmarking during Transend's revenue application is likely to focus on O&M costs per asset value. PEG supports this indicator given the ACCC's policy of benchmarking opex, capex and service standards separately and reliance on data that are in the public domain. Given these constraints, O&M cost per asset value is the best available alternative. However, it must be recognized that this indicator will not control for a wide range of operating conditions that can affect cost. The ACCC and its consultants must bear these factors in mind when evaluating Transend's opex performance.'