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Gert Brunekreeft

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Herausgeber/ Editor:

Bremer **Energie** Institut

College Ring 2 / Research V

28759 Bremen

Tel. +49 (0) 421 - 200-48 88

Fax +49 (0) 421 - 200-48 77

info@bremer-energie-institut-de

www.bremer-energie-institut.de

Ansprechpartner:

Nele Friedrichsen

Tel. +49 (0) 421 - 200-48 83

Fax +49 (0) 421 - 200-48 77

E-mail friedrichsen@bremer-energie-institut.de

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On the role of international benchmarking of electricity Transmission System Operators facing significant investment requirements

Gert Brunekreeft[1]
Jacobs University Bremen
College Ring 2
D-28759 Bremen
Germany

Email: g.brunekreeft@jacobs-university.de

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Abstract: Electricity networks currently face massive investment requirements. This paper argues that, given the investment requirements, (international) benchmarking is not an adequate tool for the regulation of transmission system operators (TSO). Errors in the outcomes of benchmarking will likely distort network investment and therefore the costs of doing it wrong are high. The paper discusses options to reduce the weight of benchmarking in TSO regulation and options that do not rely on benchmarking at all. Overall, facing massive investment requirements, it seems desirable to switch to a regulatory system with ex-ante investment approval and away from ex-post benchmarking.

Keywords: electricity, network, regulation, benchmarking, uncertainty
JEL-classification: D42, G00, L51

1 Introduction

According to the European electricity transmission system operators (TSO), the required European transmission grid expansions up to 2022 sum to more than 51,000 km with total investments expenditure of €104 billion (ENTSOE, 2012). The study explicitly points out that no less than 80% of the expansions are driven by the integration of renewable energies. Other reasons for grid upgrades are market integration, supply security, and CO2 emissions mitigation. Notably, ENTSOE (2012) estimates some €23 billion for subsea cables. By comparison, the Network Development Plan (NEP, 2012) for Germany, published May 30, 2012, estimates grid expansion to 2022 in a range between €19 - €23 billion. The main

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bottleneck in Germany is the north-south connection to transport wind from north to south. For the USA, Brattle consultants, Pfeifenberger and Hou (2011) estimate between \$50-\$100 billion for incremental transmission expansion to integrate renewables and total transmission investment for reliability and replacement reasons between \$240-\$320 billion up to 2030. These large numbers drive much of current transmission policy, business and regulation.

The problem for regulation in the face of these massive investments is well summarized by Helm (2009, p. 316): "Put simply, the problem of rate-of-return regulation was too much investment, and operating cost inefficiency. It was to turn out that the problem of RPI-X was just the opposite: too little investment, but with operating cost efficiency." Indeed, incentive regulation as it has developed, was intended to secure efficient costs, given inefficiencies thought to have accrued before liberalization. The challenge now is to develop a regulatory system which simultaneously promotes and facilitates network investment and sets incentives for investments at efficient costs: in sum, the regulatory system should aim for "efficient investment".

In practice, a widely used approach for incentive regulation is the ex-ante determination of a revenue-path for the entire regulatory period, where the revenue is determined by the RPI-X correction factor. RPI stands for inflation, and X is the expected productivity increase of the regulated company. Often, an important part of the X-factor is determined with the help of benchmarking, which is an efficiency comparison among more or less comparable companies. If the benchmarking qualifies a firm as inefficient compared to its peers, this company is expected to catch up with its peers and make significant efficiency improvement. Consequently, the X-factor and thus the reduction in allowed revenues will be relatively high.

This paper discusses the role of international benchmarking in the regulation of electricity transmission system operators (TSOs). These are two aspects: international benchmarking on the one hand and TSO benchmarking on the other hand. These aspects and their combination seriously impede comparability which makes benchmarking particularly problematic.

The main aims and outline of the paper are as follows. Section 2 first puts the relation between regulation and risk into perspective of the literature. Section 3 discusses a selection of problems of international TSO benchmarking. In these two sections, it will be argued that ex-post benchmarking as part of the TSO regulation is not at ease with large investment requirements. Moreover, whereas benchmarking of an existing network cannot affect the investment decisions of the past, benchmarking in the face of investment affects and possibly distorts (delays) investment decisions at the cost of social welfare. The “costs of doing it wrong” are different with or without investment. Lastly, these worries intensify because international TSO benchmarking appears not adequately robust, rendering doubts about the results. Sections 4 and 5 focus on alternative approaches. Section 4 discusses a selection of proposals how benchmarking results can be applied more cautiously. Section 5 then covers approaches without ex-post benchmarking. Section 6 concludes the results.

2 Network investment, regulation, benchmarking and uncertainty

The electricity sector has entered a new world where investment is the driver of the regulatory models. Brunekreeft (2011) studies how the regulatory models (yet predominantly for distribution networks) for a number of European countries have been stepwise adjusted with more cost-pass-through elements to allow for cost-increasing investments. By definition, investment concerns the future and the future is uncertain. One of the main challenges of the regulatory model is how to deal with increasing uncertainty. Of course, this issue is not new, but relevant, because the sector is facing such high investment requirements. From an economic perspective, this is a crucial difference. Regulating and benchmarking of an already existing network cannot directly affect the investment decisions as these were made in the past; regulation and benchmarking of a network where investment decisions still have to be made affect the investment decision itself and create possibly large economic effects.

This paper focuses on the effects of benchmarking as part of regulation. The main source of uncertainty is unpredictability of outcomes combined with opaque calculations (no publicly available data). In other words, benchmarking results determine the revenue stream for the assets. If the benchmarking is robust and predictable the remaining uncertainty equals the uncertainty of the competitive market. However, if benchmarking is not robust and outcomes are not predictable, benchmarking itself adds a source of uncertainty. Interestingly, in a recent numerical study for the transmission network Mulder (2012, p. 177) makes a comprehensive analysis of the financeability of network investments under different regulatory scenarios in the Netherlands and points out that financeability may not be secured if the TSO is not able to achieve its required efficiency improvement (X-factor). In other words, if real efficiency improvement is less than prescribed by the X-factor, revenues fall short of investment requirements. This is exactly the point to be stressed in this paper. The X-factor as determined by the benchmark is merely a proxy of the real potential of productivity improvement.

Following the numerical analysis in Mulder (2012), the benchmark results and thus the X-factor may make the difference between cost-recovery or under-recovery of the investment. Clearly, the latter case will jeopardize the investment.

This benchmarking uncertainty is the focus of our analysis. The effect of regulation and benchmarking on risk is far from obvious and the literature is ambiguous (cf. also Brunekreeft and Meyer,2011). As illustrated below, there is quite a bit of empirical and theoretical literature on the effects of regulation, but unfortunately hardly anything on the effects of benchmarking on risk.

The type of regulation affects risk. Risk and uncertainty have been issues in the regulatory debate, starting with the so-called "buffering hypothesis" by Peltzman (1976), which claims that cost-pass-through regulation absorbs shocks and is therefore risk decreasing. In contrast, incentive-based (RPI-X) regulation explicitly shifts risk to the company, although the effects are different for cost and demand shocks (see Wright et al., 2003; Grout and Zalewska, 2006).

Based on the capital asset pricing model (CAPM),[2] it is important to distinguish systematic from non-systematic risk. Non-systematic risk (eg. a management mistake) is not related to the risk of the market portfolio (eg. financial crisis) and can be diversified. In contrast, systematic risk (eg. demand fluctuations induced by macro-economic development) is correlated to the market portfolio and cannot be diversified. The theoretical literature assumes that non-systematic risk does not affect risk-beta and only systematic risk increases the risk-beta. In other words, non-systematic risk is a real risk for the company, but not a risk for which efficient financial markets would pay a risk-premium. For the management of the company these are genuine risks and diversification may hardly be an option. Actually, legal restriction on what a network company is allowed to do beyond the network business may limit the company's possibilities to diversify. However, for the investor, with a large portfolio of which a network company would be one asset, non-systematic risk can be diversified.

The empirical studies paint an ambiguous picture. The first issue to note is, in contrast to what is sometimes claimed, that the risk-betas for network companies are positive, albeit modest. It means that a network company is not a risk-free business. However, this does not tell us anything about the effects of regulation or benchmarking on risk-betas. Frontier

[2] CAPM stands for the widely used Capital Asset Pricing Model, which was developed in the 1960s by Sharpe, Lintner, and Mossin, (cf. Brealey and Myers, 1996). The risk-beta comes from the CAPM model and expresses the risk of the asset and determines how much the capital market requires as a risk premium for investing in this asset. A higher risk-beta means that the market requires a higher rate of return from this asset.

Economics (2008, p. 43) does not find an empirical relation between the type of regulation and risk-betas. The authors claim explicitly that regulation and benchmarking are non-systematic risks which can be diversified. Kobialka and Rammerstorfer (2009) find no lasting effects of regulatory change, but do confirm short-term effects (i.e. shorter than 10 days). These findings contrast somewhat to other studies. The seminal work by Grout and Zalewska (2006) studies the effect of profit-sharing sliding scales on risk-betas and find that the cost-based approached (i.e. high risk sharing) have lower cost of capital. Moreover, Alexander et al. (1996 and 2000) find a higher risk-beta for high-powered regulatory systems. Schaeffler and Weber (2011, pp. 8-10) provide an excellent and critical overview of the literature and conclude that "policies increasing firm risk, for instance switching from rate-of-return to incentive regulation, lead to higher betas. One can thus conclude that regulation itself is an important determinant of the cost of equity of utilities."

The points above are critical on several accounts. First, it is not obvious how to include the type of regulation as a dummy in the statistical analysis. Simply using either "incentive-based" or "cost-plus" may not reflect the actual risk very well. Compare the following three forms of regulation:

- Suppose, like in Austria for distribution networks, that investment costs can be passed through as soon they actualize; they enter the ex-post benchmark at the start of the subsequent regulatory period. The cost-pass-through aspect is risk-reducing, while the ex-post benchmark increases risk.
- Suppose a US-like cost-pass-through system. The essence of this system is the rate hearing (cf. Joskow, 1989). Charges and revenues are fixed until the next rate hearing allows an adjustment; a rate hearing can be requested both by the company and the regulator. Cost changes can be passed through only after allowance in the rate hearing and are thus ex-post per definition. NERA (2011, p. 26) argues that the US system reduces risk as compared to (continental) European-type of incentive regulation (benchmarking-based RPI-X). In addition, Moody's (2009, p.8) argues that the US-type is riskier than upfront investment allowances (i.e. a UK-style of regulation).
- Suppose, like the system in the UK, that the forward-looking estimated investment budget is subject to ex-ante approval, after which the revenue cap is determined for 8 years, while after 4 years revenues can be adjusted. On the one hand, ex-ante budget approval reduces risk; on the other hand, additional cost uncertainty, once the revenue cap has been determined, increases risk.

Second, the CAPM is a one-factor model which relies on risk-betas. Other models and approaches exist, which change the picture by including more factors. In particular, the three factor Fama-French model should be mentioned. NERA (2011, p. 8) quotes a study by Graham und Harvey (2001), which claims that 70 percent of the financial community relies on CAPM. Slightly more sceptical, a study by Baker (1998, p. 274) relying on interviews with fund managers claims that "while the textbook measures of risk (variability of return and beta of the portfolio) are regarded as largely irrelevant (...) in their investment decision making." Schaeffler and Weber (2011) criticize that many regulators rely exclusively on the CAPM approach and do not check the results with other models. All in all, we may conclude that CAPM does have a steady place in theory and practice, but there are also other factors which influence decision making.

The studies above are empirical analyses of indicators like equity or asset betas, however they do not explain the measured types of uncertainty. For this purpose, it is revealing to study the methods of credit rating agencies. Moody's (2009, p.5) describes its credit risk assessment methodology in detail, summarized in the following table:

Rating Factor/Sub-Factor Weighting

Broad Rating Factors	Broad Rating Factor Weighting	Rating Sub-Factor	Sub-Factor Weighting
Regulatory Environment and Asset Ownership Model	40%	Stability and Predictability of Regulatory Regime	15.00%
		Asset Ownership Model	10.00%
		Cost and Investment Recovery	10.00%
		Revenue Risk	5.00%
Efficiency and Execution Risk	10%	Cost Efficiency	6.00%
		Scale and Complexity of Capital Programme	4.00%
Stability of Business Model and Financial Structure	10%	Ability and Willingness to Pursue Opportunistic Corporate Activity	3.33%
		Ability and Willingness to Increase Leverage	3.33%
		Targeted Proportion of Operating Profit Outside Core Regulated Activities	3.33%
Key Credit Metrics	40%	Adjusted ICR (or FFO Interest Cover)	15.00%
		Net Debt/RAV (or Fixed Assets)	15.00%
		FFO/Net Debt	5.00%
		RCF/Capex	5.00%
Total	**100%**		**100.0%**

Figure 1: Credit risk factors in the methodology of Moody's Global.
Source: Moody's Global (2009)

The effects of the overall regulatory environment are captured by the two categories "regulatory environment" and "efficiency and execution risks", which jointly account for 50 percent of the overall assessment. The details of the sub-factors are insightful.[3]

Although Moody's does not mention benchmarking, logically, it should be concluded that robustness and stability of the benchmarking method and the predictability of the results are immediately covered by the first sub-factor. Interestingly, Moody's (2009, p. 8) refers to ex-ante approved cost-increases (and corresponding tariff schemes) as assessed favorably. The third sub-factor makes an unambiguous statement that any delay in cost recovery is assessed negatively; in other words, the regulator should favor ex-ante investment allowances or complete cost-pass-through. The delay in cost-pass-through is a critical point of incentive-based regulation if costs are increasing, leading to postponed investments (cf. Brunekreeft and Borrmann, 2011). Strictly speaking, the higher costs associated with investment expenses will not be included in the revenue cap until the start of new regulatory period. This is the flip side of the same coin of incentive regulation (however, costs are normally decreasing). Therefore, for a number of years the higher costs associated with investment are not recovered. This effect can be large and can easily cause the actual rate of return of the investment to fall below the allowed WACC.[4] If the allowed WACC reflects the "true" cost of capital, then obviously, the effect of the delay means that capital markets will be skeptical. There are several ways to address this problem, one of which is by adjusting the allowed WACC. Zechner (2008, p. 23) suggests to add an investment premium to the WACC to compensate for this effect, of which a variation was actually implemented in Austria. The fifth sub-factor (cost efficiency) is the likeliness that the performance targets set by the regulator can be achieved (Moody's, 2009, p. 13). In other words, Moody's methodology assumes an inverse relation between X-factor and credit rating. Lastly, although not directly related to regulation, nevertheless insightful, the sixth sub-factor (capital program) relates large and lumpy investment programs (as compared to company's size) to lower credit ratings.

Overall, it seems plausible to conclude that regulation and benchmarking do increase risk and are likely to affect the cost of capital. In absolute terms, the changes of the WACC may

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[3] We should bear in mind that Moody's assesses risk purely from the firm's perspective, and does not include a social welfare perspective. The mere fact that something increases Moody's risk perception does not necessarily imply that it is bad for social welfare. The points below are only part of a larger picture.

[4] WACC stands for Weighted Average Cost of Capital.

appear small; however, a small increase in WACC times a multiple-billion investment program may make a significant difference.

Ex-ante investment approval versus ex-post benchmarking

Facing the massive investment requirements, the more general development is a shift from ex-post to ex-ante approaches. The risk of irreversible investment is well-known: once the investment has been made, the investor will simply have to accept external circumstances and regulatory conditions. Regulated investments have to be approved by a regulator one way or the other. This being the case, an investor will seek ex-ante approval instead of having to rely on ex-post approval.

For the following it is useful to differentiate between two separate regulatory tests: 1) is the investment "useful", and 2) is the investment at "efficient costs". These tests can be done ex-ante or ex-post or as a hybrid combination of the two. In the budget allowances as in the UK's RIIO both usefulness and cost-efficiency are tested ex ante (see also section 5.1). An all-inclusive ex-post benchmarking (including usefulness of the network) without an ex-ante check would be a full ex-post approach. The DSO regulatory model in Germany would be an example. A hybrid system distinguishes these two aspects. The usefulness of the investment (should the new line be built at all?) can be subject to ex-ante approval, whereas cost-efficiency (eg. the type and material of the pylons) is subject to an ex-post test, for which benchmarking would be an example. Importantly, the specific benchmarking model should then exclude the test for "usefulness" of the investment and concentrate on "cost-efficiency" given the network. If the regulator opts for an ex-ante usefulness test, the ex-post benchmarking should in fact exclude the first check in order to avoid double testing. It would be inconsistent to approve an investment with an ex-ante usefulness test, after which an ex-post benchmarking would qualify the same investment as not useful. A hybrid approach reduces uncertainty (of "usefulness") significantly vis-a-vis an all-inclusive ex-post benchmarking. Yet, also in the hybrid form with a reduced ex-post benchmarking method, significant uncertainty remains surrounding the cost-efficiency test. We will argue in section 5, that it is perfectly feasible to design a regulatory system which refrains from ex-post benchmarking altogether. The UK example (RIIO) testifies to the fact that full ex-ante approval is possible and arguably more appropriate nowadays, given high investment needs.

3 The problem of international TSO benchmarking

Benchmarking has become a very popular tool in the regulation of electricity networks (Jamasb and Pollitt, 2001). The primary aim of benchmarking is to de-link regulated revenues from underlying costs, by determining the regulated revenue cap on the cost developments of other companies. In doing so, benchmarking mimics the incentives of competition, called "as-if"-competition. The idea was developed in its extreme form of yardstick competition by Shleifer (1985). This key notion of incentive regulation is indeed a powerful property of benchmarking.

Notwithstanding the advantage, there are downsides. First, as explained above, benchmarking increases uncertainty. Second, benchmarking is man-made "as-if-competition" for a world which is in fact a monopoly. It is difficult to mimic competition. The carbon copy of competition is as good as the design of the benchmark. Third, this difficulty is exacerbated if comparability gets more problematic, either by lack of data, or by too much external noise. This section will discuss the downsides of benchmarking eyeing especially international benchmarking of TSOs. Whereas the results of non-international benchmarking of distribution network operators (DSO) may be sufficiently reliable, things are problematic with international TSO benchmarking. Note the two aspects: international and TSO. Comparing TSOs (in contrast to DSOs), especially an international comparison is notoriously problematic (cf. Haney and Pollitt, 2012).

In a European context, the E3-GRID project developed by SumicSid (2009a) is a widely used method for international TSO benchmarking. Due to its relevance, we illustrate the dominant points below based on E3-GRID.

The main problem with international TSO benchmarking is that the outcomes are not robust. This is demonstrated by the fact that the spread of efficiency scores is large and that small adjustments of the benchmarking model can have large effects, while taking a different benchmarking model can change the picture completely. For example, while the Dutch TSO TenneT is considered one of the most efficient European TSOs with 100 percent in one model (including population density as a control variable), it becomes less than 50 percent efficient in another model (excluding population density and including CAPEX before 2000) (SumicSid, 2010). Thus, the spread for TenneT is between 50 and 100 percent. An outcome of below 50 percent is unrealistically low, which raises serious doubts on robustness. This is not an exceptional case.[5] It means that benchmarking should be used with a great degree of caution, or even replaced by other more robust methods, as described in subsequent sections.

3.1 Discussion of specific E3-GRID difficulties

In the latest TSO benchmarking, SumicSid applies the E3-GRID project (cf. eg. SumicSid 2009a), which includes 22 TSOs from a total of 19 countries. E3-GRID mainly relies on Data Envelopment Analysis with TOTEX an input, and Normalized Grid and Renewable Power as the two main outputs, as well as Population Density as a control variable (which explains the name "TOTEX NDR"). We will briefly describe and discuss this approach below.

SumicSid (2010, p. 29) gives an overview on how various regulators apply the results. The E3-GRID study includes quite impressively no less than 19 countries (22 TSOs). Haney and Pollitt (2012) paint a diverse picture for a wide range of countries, where TSO benchmarking takes place at all. Moreover, it should be noted that not all regulators actually use the results directly for the revenue cap (i.e. the X-factor). For instance, Austria participates in the E3-GRID benchmark, but the results are not used for the regulation of the TSO. The UK system RIIO contains an international benchmark, but this is not used for an ex-post efficiency check (see section 5.1). The last example, as pointed out by Haney and Pollitt (2012), in Peru the benchmarking results are used as a guide in negotiations.

The main idea of E3-GRID is illustrated by figure 2:

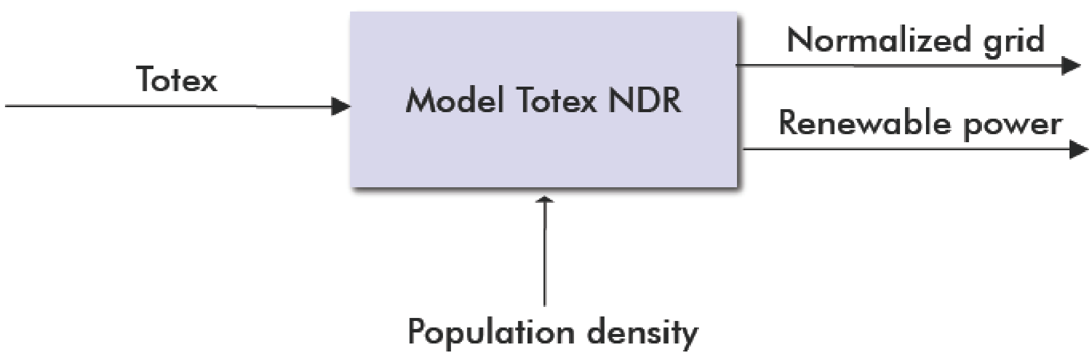

Figure 2: Structure of "E3-GRID"
Source: SumicSid, 2010, p. 6.

[5] Unfortunately, there is no public document with an overview, since the information is confidential. The statement relies on personal communication with TSOs.

The key element of the model is the "*Normalized grid (NG)*" (sometimes also called "Grid Volume" or "Size of Grid"), which is a "normalized grid metric, based on a system of techno-economic weights" (SumicSid, 2009a, executive summary, no page numbering). Basically the "normalized grid" (NG) metric is calculated as the sum of the grid assets times their respective estimated cost factor. This gives a hypothetical cost of the network "as it is". The NG approach measures whether the grid "as-it-is" has been invested at efficient costs; it does not assess the grid architecture itself. The main advantage of the NG approach is that it takes the network as given. It means that a country's perculiarities which determine the architecture of the network, are taken into account by definition. For instance, if a TSO must reinforce its network in order to allow large-scale integration of offshore wind, then the normalized grid increases on the one hand, and TOTEX on the other hand.

This is a good illustration of the hybrid approach mentioned above. Whereas the usefulness of network expansion can be subject to an ex-ante test (eg. with the Network Development Plan), the E3-GRID benchmarking concentrates on an ex-post test whether the expansion was at efficient costs. With the NG-approach, E3-GRID does not assess the usefulness of the expansion, only the cost efficiency.

The second output of the model is "*Renewable power*". It is defined as the "installed capacity of renewable generation in the service area" (this may include or exclude hydro). To be precise, SumicSid (2009a, executive summary, no page numbering) states: "A higher incidence of renewable and decentralized energy resources connected to the electricity grid causes significant costs not only in dimensioning for high intermittent power flows, such as wind, but also due to general reinforcements due to location far from load centers, more complex grid management due to unforeseen interactions from distribution networks operating in active and islanding modes, and evolving standards for control and monitoring."

The advantage of the NG-approach is also its drawback; by being a catch-all, it is difficult to add control variables, like renewable power and population density. It seems that the combination of outputs is difficult to interpret. We illustrate this difficulty with the variable renewable power (RP).

Assume for case 1 a TSO (TSO-1) with substantial RP-connection to its network and assume that a network-reinforcement is required. This implies that NG and also TOTEX increase. At the same time, however, RP increases. This may well imply double counting, meaning that this TSO might set the efficiency benchmark by the simple fact that it has substantial RP vis-a-vis a TSO without RP.

Assume for case 2 a TSO (TSO-2) which merely transmits the RP-power, without own RP-connection and assume that this TSO has to reinforce its network to do so. Both TOTEX and NG increase; the benchmarking stops here and everything seems to be fine. However, if the TSO-1 of case 1 is the peer in the benchmark, TSO-2 is deemed inefficient by the fact that TSO-1 is “more efficient” merely because RP is included as an output.

To conclude, the benchmark of course should account for Renewable Power as an important driver of network development. The point made here, however, is that it is simply not obvious how to do that and not the only factor to consider.

The approach does not consider future investment needs for which grid companies need to take preparatory measures. Even if significant investments will be carried out in the future, the NG output will only increase once these assets have been fully built. TOTEX, in contrast, will already increase during and before the assets are under construction. Such expenses may incur e.g. for the acquisition of human resources for grid planning and construction or in form of compensation payments to landowners. These preparatory costs are not reflected in the output while their costs have already taken effect.

3.2 Country-specific differences are large

A major difficulty with international TSO benchmarking is broad country specific differences. This ranges from fundamental geographic or demographic differences, divergencies in generation mix to detailed legal deviations (e.g. labor, tax or environmental laws). These issues have been widely discussed (cf. eg. Haney and Pollitt, 2012). Here we discuss briefly a few points concerning the recent E3-GRIDS international TSO benchmarking.

Agrell (2012, slide 26) discusses differences in labor markets (salaries, labor laws and unions, other conditions). The author notes that local labor markets are not uniform. To eliminate this, Agrell suggests a sector correction mechanism. Although this seems wise, it is yet another inaccuracy built into the model. These differences will work out on OPEX. First, differences in wage levels will obviously have a direct impact on relative costs, and second, differences in labor markets may trigger substitution effects between input factors. When specific labor laws increase the cost of labor, there will be a substitution effect away from labor towards other input (eg. build a new line to save on maintenance). The latter effect may be more troublesome, since it will be hard to control for these effects. Even if a correction factor controls for direct differences, the substitution effect would still be there and affect the benchmarking outcome.

A good example, which comes directly from E3-GRID, is the difference in population density (measured in population per km^2). SumicSid (2009a, executive summary) writes:

> "Operators in densely populated areas incur higher costs in planning, constructing and maintaining grids due to direct (equipment choice, access conditions, monitoring) and indirect effects (higher urbanization drives meshed layouts with higher complexity, high load incidence drives costly maintenance schedules and requires shorter fault remedial times)."

The case of TenneT illustrates the point. The Netherlands are indeed densely populated, which makes TenneT a natural candidate for the control variable "population density". After running the E3-GRID DEA SumicSid found that the effect of population density for TenneT is implausibly strong (possibly an outlier) and causes methodological problems with the DEA-approach. To be precise, the problem is that the Netherlands are so densely populated, that TenneT creates a standing alone position in the DEA with this driver. The authors recommend to use the alternative "unit-cost method" basically excluding the population density control variable altogether (cf. SumicSid, 2010, p. iii). This emphasizes an important point: a small change to by-pass a difficulty causes a large change in results.

Geography can have an effect e.g. if roads or water has to be crossed, causing higher construction costs and requiring different pylons. Various accounting rules will have a direct effect on CAPEX and possibly an indirect impact through substitution, similar to the effects of different labor laws explained above. Lastly, divergencies in environmental laws will have a consequence as well. For example, different requirements for painting poles or noise abatement cause different costs.

Another possible distortive effect may arise from specific national regulatory measures, not appropriately reflected in the benchmarking model. This could be the case if in the process of calculating network charges, parts of the costs have been declared as stranded costs and therefore not accepted in the tariffs. These costs clearly cannot be regarded as being part of the regulated asset base. To avoid double counting, the benchmarking model needs to account for this. If these costs, which were excluded from the regulatory cost base for the purpose of determining network charges, are included in the benchmark, the company would effectively have to pay twice for this "inefficiency". More generally, the benchmarking method should secure consistency with these kinds of national measures.

3.3 How to deal with the consequences of NIMBY?

One of the main hurdles to transmission network expansion is the NIMBY problem. NIMBY stands for "Not In My BackYard", and expresses political or public opposition to large infrastructure projects, in this particular case, new transmission lines. Although opposition is strongest for visible overland lines, it also exists for underground cables. In the case of some TSOs NIMBY can lead to substantial additional costs, which might often be considered inefficient in an international benchmark.

In the context of transmission lines there are three basic streams to address the NIMBY problem. First, there may be alternatives to least-cost transmission expansion. These alternatives may be more costly compared to the transmission lines, but may be cheaper if the external costs of the NIMBY problem are taken into account. Likely alternatives would be a power plant on the unconstrained side of a line to relieve congestion, different technologies (eg. underground cables instead of overland lines) or different routes. A second stream would be to mitigate opposition by stakeholder involvement. This may involve lobbying, information exchange, possibly in an early planning stage, as well as ownership involvement. A third stream is to compensate the damage, or more generally formulated, to use economic instruments to address the problem.

On all three accounts, the costs of transmission expansion increase and the question arises how these additional costs enter the benchmark. Clearly, if one TSO faces high costs to deal with NIMBY while one of the peers does not and the benchmarking does not take account of this, the first TSO is deemed inefficient although the source of additional costs is beyond its control. Three main difficulties arise. First, empirical literature for transmission expansion is poor, implying that we do not have a good idea on the magnitude of the NIMBY effect and more importantly on the differences between countries. Second, it seems that in such cases, usual economic tools may not always apply (cf. Frey and Oberholzer, 1997), which may imply that it is no longer clear what exactly "efficient" means. Third, as indicated above, there can be various ways to address the problem. The preferred way is depends on costs and effectiveness. The problem is that different cost sources may enter the benchmark differently or not at all. For example, staying within the context of the E3-GRID, building a longer line to circumvent an area of natural beauty enters both TOTEX and normalized grid and would therefore be taken into account. Extensive stakeholder involvement would enter TOTEX but not NG, and would thus be deemed inefficient. Lastly, new technologies, like underground DC cables, still need extensive testing, thus will be picked up as inefficient by the benchmark.

3.4 The value-added of a TSO: The "cost of doing it wrong"

TSOs have a very significant impact on the value chain of electricity supply and in fact on the total economy. Being the backbone of the system, blackouts have widespread consequences. At the same time, the costs of transmission are relatively minor (usually not more than 2-3 percent of the end consumer's bill). Subsequently, the potential savings of improving efficiency are also small compared to the total benefits of a TSO. This asymmetry suggests that regulation and benchmarking should be cautious, as the "cost of doing it wrong" may be significantly higher than the "benefits of doing it right". In different words, this argument was picked up by SumicSid whilst applying E3-GRID (see SumicSid, 2009a, p. 29).

For the precise argument it should be realized that regulation is necessarily imperfect and will always over- or underachieve the hypothetical correct outcome. Moreover, regulation is always subject to uncertainty and information problems. With regulation of the past (for an existing network), the cost of doing it wrong are not very large in terms of economic efficiency, because decisions are in the past and cannot be affected any more. The costs of doing it wrong are "merely" income redistribution. In other words, over- or undershooting of benchmarking of an already existing network results in a somewhat higher or lower X-factor and thereby allocates more or less surplus to consumers or shareholders, but has no consequences on the network itself, because the investment decision was in the past. This is crucially different for regulating the future, which is necessarily the case in the face of investments: the cost of doing it wrong involves distorted network investment, which comes at a high costs to society, especially if it affects the energy transition. In other words, if benchmarking is correct the benefits for society are somewhat lower TSO charges. If the benchmarking is flawed, investment may be affected with a potentially large, value-added loss. If these "cost of doing it wrong" would include a delay of the energy transition (say, a delay of connection of offshore wind), the cost for society may be high indeed. This asymmetry in effects argues forcefully in favour of being very cautious.

4 TSO regulation with a reduced weight of benchmarking

It is one question how to *do* benchmarking, it is another question how to *apply* the results. Above we have discussed difficulties with international TSO benchmarking. Below, alternatives to "how to use benchmarking-results" are presented and discussed. The main point to stress is that benchmarking results should not be seen as ultimate truths to be implemented literally. Instead they should serve as guidelines to good regulation. The ideas presented below are not finalized proposal, but intended to stimulate further discussion.

4.1 Balancing risk and incentives

With cost-pass-through regulation both the power of incentives and the risks for the investor are low. With incentive-based (RPI-X) regulation the power of incentives is high but so are the risks for the investor. In between, sliding-scale mechanisms try to balance these counter-effects. With a sliding scale of x%, the company gets to retain x% of additional savings made over and above the agreed level, while the remainder must be passed through to end-users. Reversely, the company bears x% of additional costs over and above the agreed level and is allowed to pass through the remainder to end-users. Clearly this mechanism balances between the power of incentives and allocation of risk. Grout and Zalewska (2006) study a sample of privatized U.K. companies, and U.K. and U.S. control portfolios, between 1993 and 2000, using the single-factor market model and the three-factor Fama-French model. The authors find empirical evidence on risk sharing lowering the costs of capital.

Large fluctuations of actual rate of return and large deviations from the target rate increase risk. As explained above, Moody's (2009) assesses a higher X-factor as a lower probability to achieve the efficiency target and thus increases (credit) risk. To reduce the risks of extremities, the X-factors could be designed to be non-linear, in order to limit the deviations of the targeted rate of return. The following approach is conceivable. The X-factor need not be constant (as it usually is), but could be designed to depend on the deviation from real (or projected) to the targeted rate of return. The level of the X-factor for year t could be function of the difference between realized rate of return and allowed WACC in year t-1. To reduce risks, a non-linear X-factor designed this way would shave the (negative and positive) peaks. This proposal aims to mitigate the impact of extreme values. Another way of looking at the same proposal is that the basic model is a targeted rate-of-return cost-pass-through regulation combined with a set of risk-splitting incentive mechanisms.[6]

[6] Obviously though, while this would reduce the impact of the X-factor (and thereby the impact of benchmarking), at the same time, the power of the incentives will also be reduced.

4.2 Negotiation models and stakeholder involvement

An important development with a potentially large impact on the regulatory model is "stakeholder involvement". Even if a formal regulatory model exists, it could be more in the background, precisely because stakeholder involvement would create a disciplinary effect. In fact, if stakeholder involvement is sufficiently strong and well-balanced, the role of the regulator might be passive, allowing more scope for negotiations.[7] The scope of negotiations in electricity network regulation is unclear. It is a new development and the discussion is just starting. Nevertheless, examples of the development towards negotiated settlements are available.

In the process of implementing RIIO in the UK, which is momentarily taking place, any interested stakeholders are invited to participate in the process (cf. Ofgem, 2011b).

As already pointed out above, one way to deal with the NIMBY problem is to strengthen stakeholder participation. A particularly interesting example is currently in process in Northern Germany, where there is a debate on offering citizens the opportunity to participate in ownership of new transmission lines. The current procedure focuses on local stakeholders, who are actually damaged by the transmission investment. The hope is that "ownership participation" significantly improves acceptance of such projects.[8] As a side-effect, however, end-users would start to be owners of the infrastructure. As stakeholders then gradually would become owner and consumer at the same time,[9] the role of the regulator starts to reduce to being mediator between the interests of different stakeholders.

Littlechild (2006) und Littlechild und Cornwall (2009) discuss the case of the Office of Public Counsel in Florida. In essence, the OPC serves as negotiator with the utilities. If utilities and OPC are in agreement on a price plan, the regulator will usually approve. The main merit of such a system is that it can shorten regulatory procedures and reduce costs. Doucet und Littlechild (2006) discuss the case of the National Energy Board (NEB) in Canada, which leaves scope for negotiation between investors and stakeholders for oil and gas pipelines. The NEB determines a default rate of return, but the rest of its task is passive and mainly restricted to approving or rejecting a price plan provided by the stakeholders. As in

[7] There is an important difference with the former option of "negotiated TPA" which deleted form the electricity directives. Negotiated-TPA was a substitute to regulated-TPA, and therefore in the negotiations the regulated option as a fallback option did not exist.

[8] We should note, however, that this is in preliminary stage and effects are unproven so far.

[9] A comparable development takes place with „prosumers" connected to distribution networks which reflects that consumers may become producers (of solar energy) at the same time.

Canada, the US regulators will usually approve as long as stakeholders are in agreement. In Argentina, the so-called Public Contest Method relies almost exclusively on stakeholder involvement. A last example may be the network development plan in Germany, where stakeholder consultation is an explicit part of the process.

Stakeholder involvement has mutually re-enforcing effects. First, the negotiation process to come to an agreeable regulatory approach has a different balance of interests. The negotiations are no longer an exclusive game for regulator and regulated company, but will now include other aspects, which will change the dynamics of the negotiations. Second, stakeholder engagement requires transparency, which per se changes the regulatory game. In sum, the role of the regulator is eased if stakeholders are engaged more effectively in the regulatory process. Stakeholder engagement can reduce the weight of formal regulation.

Clearly there are limits to models of negotiated approaches. Consumers might not be sufficiently well informed in order to participate in the settlements or may not have the resources to do so. Consumers might focus on short-term benefits (low tariffs) instead of long-term benefits (sufficient investment). Negotiations might be very long and investments might be delayed. There will be free-riding incentives in larger groups of stakeholders who share a public good among them to let others do monitoring and negotiations.

From a theoretical point of view, the Coase theorem seems to apply perfectly. In many cases, the number of stakeholders will be very high (high transaction costs); furthermore, costs and benefits may not be unambiguously identifiable (property rights are not well defined). In these cases, negotiated approaches will clearly be problematic and the role of the regulator will have to be pro-active. However, there can be cases where negotiations can work. For example, small consumer-owned networks might be able to settle arrangements without regulation. If it is possible to attribute network expansion costs to new connections (say with a concept of long run incremental costs), and the new connections are not too numerous (say, new renewable generation, interconnectors or otherwise DC-connections), then negotiations would be an option.

4.3 Cautious application

In applying benchmarking, apart from details of the benchmarking model, variables and data, fundamental questions have to be addressed. First, what is benchmarked and second, how are the results implemented into regulation? The regulator has considerable scope to make benchmarking less or more severe.

Not everything needs to be benchmarked. A TSO is a chain of activities, some of which are better suited for benchmarking than others. Different TSOs will typically operate different subsets of these core tasks, which complicates comparability. Technically, it is possible to benchmark different subsets of tasks separately. If company A covers tasks 1 and 2, whilst another company covers only task 1, a direct comparison will be problematic. This is the same problem as benchmarking unbundled versus integrated companies (see Meyer, 2012). However, a separation approach is not without problems. It will be hard to separate cost figures unambiguously. To the extent that these tasks are unbalanced for various TSOs, comparability will again be complicated. Separated benchmarking (or in fact any separated regulatory approach) will induce strategic substitution effects.

There are different forms of benchmarking. On a scale we may distinguish strict mechanical forms on the one hand and rather loose forms on the other hand. One appealing loose form would be to have "monitoring" along "best practice" guidelines; this is very implicit, but gives useful information nevertheless. In addition it would an option to create a platform (with regulators ex-officio) where individual TSOs must justify to each other why they do not use "best practice". A "loose" form sacrifices numerical precision, but gains intuition and predictability.

The results of benchmarking can be transferred mechanically into X-factors, or can serve as guideline in the negotiations to come to an agreed revenue cap. As already mentioned further above, real-world application of the E3-GRID results provides a diverse picture. Especially if results are not robust, strict mechanical application of the results seems hazardous and invite long battles in court.

Following up on the previous point, the regulator may want to apply a "best of different approaches". Germany illustrates the approach taken for the regulation of the DSOs. Following §12.3 and §12.4a of regulatory ordinance (ARegV 2012), the German regulator makes two distinctions in the calculations of the benchmark. First, the applied benchmarking methods are DEA and SFA. Second, a calculation is made with and without annualized asset values to correct for different asset ages and depreciation rates. Hence, in total there are four different efficiency scores. The ARegV states that from these, the highest efficiency score ("best-of-four") will be chosen. Clearly, a model with "best-of-different-approaches" reduces uncertainty.

Lastly, it may be desirable to install a system of institutional checks and balances to allow for "second opinions". It should be possible that details of the benchmarking are assessed on economic content by a third institution (i.e. other than the network company or the regulator), before parties go to court. A court will and must assess legal content of regulation, which may come to a very different conclusion compared to an economic assessment. In the UK, companies and regulators can refer to the Competition Commission as an arbitrator, which is an example of a system with checks and balances (Geroski, 2004). Such a system, with assessment on economic content will significantly improve reliability and credibility of the benchmarking.

5 TSO regulation without benchmarking

Whereas section 4 discussed different options how to apply benchmarking in a somewhat more cautious form, section 5 will concentrate on two options potentially without benchmarking. First, illustrated with the new regulatory model from the UK, it will be discussed how regulation can be done without ex-post benchmarking, while retaining efficiency incentives. Second, it will be discussed how a combination of ex-ante approval by means of the Network Development Plan and stronger involvement of tendering procedures to secure that efficient costs reduces the need for benchmarking.

5.1 Systematic application of ex-ante investment allowances

After approximately 20 years of RPI-X regulation, the UK regulator Ofgem decided to change the regulatory model to what was labeled RIIO (“Revenues, Incentives, Innovation, Output”). As stated by Ofgem (2010a, introduction) the main driver behind the change is that “If Britain’s energy network companies are to deliver the networks needed for a sustainable energy sector, the way we regulate them needs to change.” The new regime basically applies to all energy networks, but it is implemented in different steps for various energy networks. Implementation of RIIO is currently in preparation for the electricity TSOs.

Important aspects of RIIO (Ofgem, 2010a and 2010b) are the following:

- The duration of the regulatory period has been extended to eight years, with a mid-term review after 4 years. While a longer period gives more planning certainty and provides more incentive power of incentive mechanisms, eight years in a changing environment could render a regulatory framework that does not adequately adjust.
- The definition of output of the network was expanded to six groups of indicators to reflect the wider and more complex tasks of the network. The six indicators are: 1) customer satisfaction, 2) safety, 3) reliability and availability, 4) conditions for connection, 5) environmental impact and 6) social obligations. Note that none of

these is really new or surprising; the innovation is an explicit output indicator in the regulation. Note also, how the main aim of regulation has shifted from the "efficiency goal" to a broader view that is more output oriented. Depending on details, this may significantly complicate the regulatory rule (say, the revenue cap). Thinking one step ahead, in systems with benchmarking, these output indicators should also be part of the benchmarking method if they are a relevant section of the regulatory rule.

- The revenue requirement is determined eight years in advance in a process called „well justified business plans“. This is essentially an ex-ante investment allowance applied in a systematic way. This comprises both testing for usefulness as well as cost-efficiency.
- Because the revenue cap is valid for eight years, RIIO applies a group of mechanisms to deal with uncertainty (Ofgem, 2010b, p. 91). Moreover, around the revenue cap, RIIO applies incentive mechanisms as a risk-sharing device.

The UK system is ex-ante based. The main mechanism relies on ex-ante budget (investment) allowances with ex-post incentive mechanisms. Importantly, because of strong reliance on ex-ante approval, the system does not contain ex-post benchmarking. Formulated differently, the budget allowances secure that the network owners will have the financial returns to facilitate investments, after which the incentive mechanisms try to secure that the investment comes at efficient costs. A combination of ex-ante approval and incentive mechanisms should secure efficiency discipline, making benchmarking redundant.

The RIIO mechanism relies on ex-ante approval. Ofgem requires the network companies to deliver a "well justified business plan" specifying in detail how the company aims to achieve their goals. After several round of negotiation, the approved business plan will be the basis for the revenue cap. Obviously, assessment of the business plan will be difficult. Ofgem applies a set of tools to come to an assessment. Figure 3 reproduces the methods applied by Ofgem (Ofgem, 2010b, p. 63):

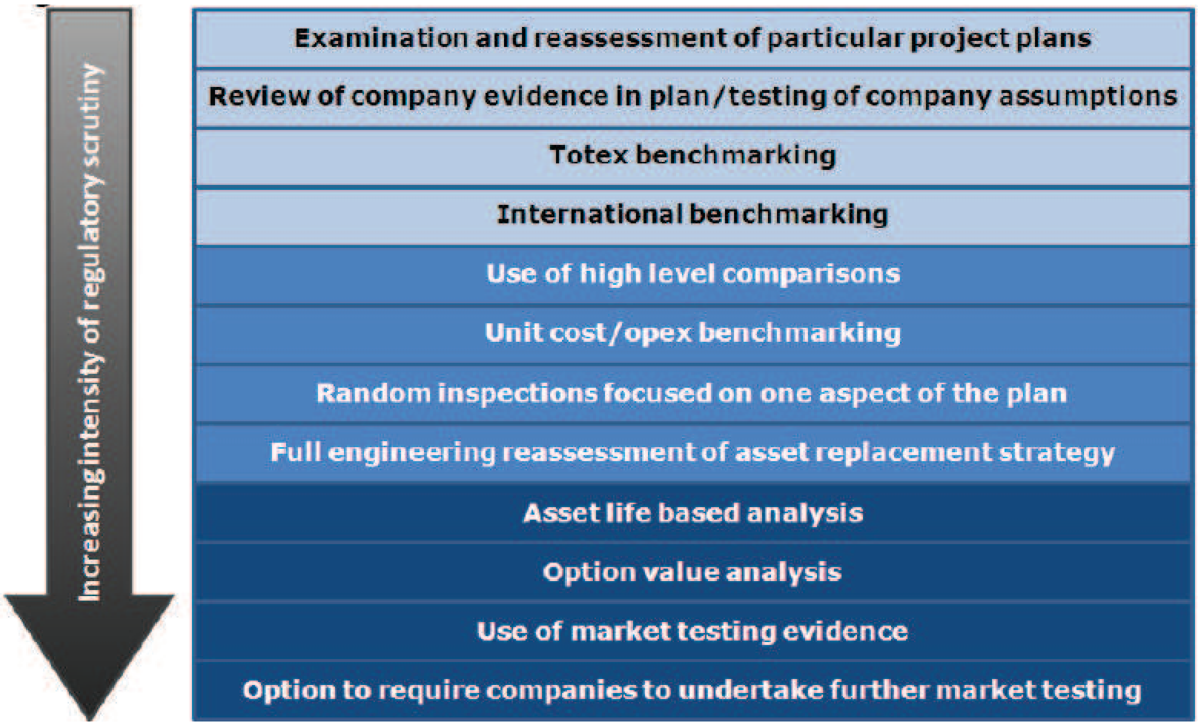

Figure 3: Assessment toolkit for the business plans
Source: Ofgem, 2010b, p.63.

It is beyond the scope of this paper to go into too much detail, but the use of benchmarking should be mentioned. This is ex-ante benchmarking, and is not a base for determining the X-factor, but rather a base to assess the ex-ante business plan. Thus, the benchmarking method itself may be similar to ex-post benchmarking methods discussed elsewhere in this paper, but the purpose and the use of the benchmarking is entirely different. Perhaps most importantly, should the ex-ante benchmarking be unfavorable, the company can actually change something in its decision to avoid the inefficiency. Ofgem (2010b, p. 88) itself confirms a limited role of ex-post efficiency assessments within RIIO. Benchmarking within RIIO is merely a tool to support the assessment of the business plans.

After the business plans and subsequent revenue caps have been set and approved, the regulatory mechanism makes explicit use of incentive mechanisms to motivate the company in order to deliver output at efficient cost. Ofgem works with output incentives and efficiency incentives (Ofgem, 2010b, chapters 9 and 10). On the one hand, Ofgem plans to introduce financial incentives around the six primary output indicators mentioned above. This is basically a system of rewards and penalties. Obviously, the indicators should be well-defined to make this work. Illustrative are the incentive elements designed what the Dutch regulator implemented for NorNed, which connect the Netherlands and Norway (cf. DTE, 2004). The regulator created explicit incentive schemes for 1) capacity of the line, 2) availability of the line, 3) timely start of operation, and 4) construction costs. On the other hand, a sliding scale (or, sharing factor), with which the company can retain part of the savings, if it improves compared to the agreed business plan, should secure cost-efficiency. There are two key points. First, the level of the incentive factor should be determined. Second, the system relies upon budget over- and underspending; especially in the latter case it will be tempting for the regulator to claw back these savings. Ofgem (2010b, p. 87/88) explicitly commits to refrain from ex-post adjustments. A more sophisticated way of an efficiency incentive mechanism is the "menu of sliding scales", which deals with information asymmetry in an elegant way. Within a range of sliding scales designed by the regulator, the companies themselves choose the level of the sliding scale they prefer. In doing so, the companies choose the risk they wish to take. The mechanism is designed such that a company that expects to need more than allowed by the regulator will choose a high sharing factor and a company that expects to need less than what the regulator allows will choose a low sharing factor. If the mechanism is well-designed, the truth-telling aspect secures that the choices of the company are also in the interest of society.

To conclude, it is feasible to design a regulatory system that keeps control on revenues, facilitates investment and retains incentives for cost-efficiency, without application of ex-post benchmarking.

5.2 Tendering

On both distribution and transmission level we observe a development to include third parties in network development. In the UK, Ofgem moves quite strongly in this direction (see Ofgem, 2011a). There is a range of possibilities (cf. Balmert and Brunekreeft, 2010). For meshed electricity systems, the most likely option would be that the decisions for investment projects may remain centralized, but construction can be decentralized. The key feature is that the designated TSO will initiate and design the project as such, but it can tender off parts of the project. The precise tender can take many forms and is subject to discussion, which would lead beyond the scope of the paper.

This approach can easily be implemented. In fact, the EU electricity directive already obliges the TSO to prepare a Ten-Year Network Development Plan (TYNDP). These are developed by the TSOs in consultation with ministries and regulators. These can serve as the foundation for the usefulness test. It may safely be taken that once a NDP is concluded and approved any investment following from the NDP is deemed useful. In a second step, bits and pieces of construction can then be tendered. If the provided tender is well-designed and there are sufficient competitive bidders, there is no reason to expect an inefficient outcome. Therefore, procurement tendering would secure efficient cost and would replace ex-post benchmarking.

To conclude, the stronger the role for systematically applied procurement tendering processes, the stronger the competition for parts of the projects and the less the need for benchmarking. If we can expect “competition for the field” to increase efficiency discipline, we can reduce the role of benchmarking. There may be substantial scope for tendering approaches to take exactly this role.

6 Conclusions

The environment in which the electricity transmission networks operate has changed considerably in the last couple of years, with consequences for the regulatory approach. Network renewal and especially network upgrades triggered by load remote renewable energies require substantial network investment. Incentive regulation was implemented to exploit the potential for cost-savings, which would subsequently be passed-through to consumers with the X-factor. In this setting, cost-increasing investment did not play a major role in the discussion. In fact, judging from experience in the UK (cf. Helm, 2009), the RPI-X regulation may actually have delayed investment, by setting incentives to what is called asset sweating. This is changing. The investment wave is inevitable, with consequences for the regulatory model which includes the role of benchmarking as a regulatory tool. The regulatory challenge is how to facilitate “efficient investment”.

This paper discusses the role of international benchmarking in the regulation of electricity transmission system operators (TSO), being part of the regulatory model. We note two different aspects: international benchmarking on the one hand and TSO benchmarking on the other hand. These two aspects make comparability problematic. The paper discusses a selection of methodological difficulties and proceeds first with suggestions how the weight or impact of the application of benchmarking in regulation can be reduced and second with a discussion of approaches and developments, which allow to refrain from ex-post benchmarking altogether. Whereas the main line of argument aims to be general, at selected points, the discussion steps into the widely-used TSO benchmarking method E3-GRID (SumicSid, 2009a).

The main conclusions of the paper are the following.

- The type of regulation affects risk. Moreover, there is some, albeit ambiguous empirical evidence that the type of regulation affects the cost of capital. Benchmarking intensifies these effects. The challenge is to design robust methods with predictable and plausible outcomes.
- The main flaw of international benchmarking of TSOs is that the models are not robust. Small changes in the underlying variables have large effects in outcomes. The range of inefficiencies is implausibly large. Comparability appears to be too problematic to come up with predictable and plausible outcomes.
- Given the difficulties of international TSO benchmarking, it would be good policy to apply the results merely as a guide and with due caution. Given the significance of the transmission network, the costs of doing it wrong are high.
- Facing significant investment requirements a regulatory design which does not depend on ex-post benchmarking is preferable. The UK system is a good example where the regulatory system relies on ex-ante investment allowances and additional incentive mechanisms to promote efficient-costs and does not rely on ex-post benchmarking.
- Where approved Network Development Plans can serve for ex-ante approval of network expansion, procurement tendering can secure construction at efficient costs, and thereby can be a substitute to ex-post benchmarking.

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