Bulletin

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From engineering to economics

EMPLOYING SIMULATION TOOLS TO APPRAISE NETWORK INVESTMENTS

In network industries, investment planning has traditionally been driven by technical objectives: for example, to relieve constraints, to maintain a capacity reserve margin, or to replace assets at the end of their deemed life. In the new regulatory environment, however, operators need new tools based on economics to help them assess the impact of investments on profitability and shareholder value. In this bulletin, we describe a practical application to electricity transmission network planning.

Traditionally, network operators have defined their own capacity reserve targets, and then invested to meet these. In a world without any guarantee of cost recovery, they need to ask more fundamental questions. Is investment necessary, or could our corporate objectives be met through operational measures? Should we try to relieve the technical constraints completely, or only in part? And if investment is the best option, when should it be undertaken?

Network operators have to measure their performance by the same standards as firms in competitive parts of the industry. They must forecast revenues and costs, in a complex and risky environment. And what is more, quality targets and congestion constraints have to be assessed within the same decision-making process.

From our practical experience in the new planning environment, Frontier Economics and Consentec have developed a four-step approach to network planning, to enable operators to respond to the new challenges. This step-by-step approach involves (1) *identifying* the key drivers of investment profitability, (2) *developing* a modelling approach to investment appraisal, (3) *applying* the model to specific company requirements, and (4) *valuing* the investment and operational options.

IDENTIFYING KEY PROFITABILITY DRIVERS

Investment appraisal centred on profitability is essential whenever the operator has no guarantee of recovering his costs. This may even be the case under so-called "cost-plus" regulation, since price adjustments typically lag behind changes in cost and capital costs are subjected to regulatory reviews.

Even under cost-plus regulation, the network operator needs to understand the extent to which the cost of investment will be offset either by an increase in allowable revenue, or by reduction in other costs. The analysis therefore needs to identify the impact on costs at the transmission level, the distribution level, and across the business as a whole.

- At the *transmission level,* investment may have an impact on the cost of congestion management or the procurement of reactive power. For example, by relieving network congestion, investment may reduce the need to depart from least-cost dispatch of generation plant. The value of the investment to the company critically depends on who is allowed to reap the benefits of lower congestion costs: the network operator on the one hand, or generators and traders on the other.

- At the *distribution level,* investment may have an impact on the costs of maintaining quality standards, with respect to voltage and network reliability. These costs in turn need to be set against the penalties that may be incurred if contractual or regulatory quality targets are not met. Any investment appraisal has to reflect the link between quality and allowable revenue.

- At all *network levels,* investment may be expected to have an impact on the cost of maintenance and network losses. It is important, however, to quantify the extent to which a reduction in costs will offset the cost of investment.

In practice, companies have at least some degree of choice between replacement investment and increased maintenance, or between capacity additions and higher congestion costs. They need an integrated simulation of technical, regulatory and commercial factors to carry out such a complex analysis.

DEVELOPING A MODELLING APPROACH

The dramatic regulatory changes that have taken place in network industries require the modelling tools used for investment appraisal to be redesigned. The traditional approach has been first, to subject investment plans to engineering-based simulations and to check whether reliability could be ensured even in "worst-case" scenarios. The operator would then select the investment plan with the lowest apparent cost from among those plans that passed the technical tests. The new planning environment requires an approach that integrates engineering, regulatory and commercial analysis. The framework must be capable of allowing the return on investment to be fully analysed. Four types of performance measure need be brought together in the integrated model.

- **Revenue.** Revenues may change through adjustments of network charges, charges for system services or charges for loss compensation. A detailed analysis of the link between costs and revenue is needed.

- **Cost.** Operating expenditure has to be modelled in a way that takes account of the physical structure of the network and the market environment, leading to projections which account for the expected evolution of demand, electricity wholesale prices, and so forth. Such analysis necessarily requires a link between engineering-based and financial modelling.

- **Risk.** The traditional approach to analysis of rates of return, built around worst case scenarios, has to give way to analysis based on realistic scenarios with respect to demand (load) and generation developments. Associating a probability with each scenario allows a proper risk analysis to be developed.

- **Service quality.** In addition to (or instead of) quality criteria that the network operator defines from a technical perspective – for example, the n-1 capacity reserve target – network operators have to approach quality standards from the customer's perspective. Such standards could, for example, be based on the number or average duration of interruptions. The operator then has to establish the relationship between these quality measures, costs and revenue.

APPLYING THE MODEL

Integrating engineering-based and financial tools allows the approach we have described to be implemented. Simulations can be built up from three modules, each of which must be calibrated to the particular circumstances of the network operator concerned.

- The **engineering module** simulates trade interaction on the network, and the resulting power flows, based on load and generation scenarios. This module also produces an estimate of operating expenditure and network service quality parameters.

- The **revenue forecasting module** projects the likely revenue stream over time. This revenue stream is based on capital cost calculations, the estimates of operational expenditure derived from the engineering module and revenue adjustments for quality, taking into account the tariff and other rules set by the regulator. This module also serves to analyse the exposure the operator may have to regulatory risk.

- The **financial module** draws together revenue and cost information, transforms it into cash-flow information, and finally facilitates the financial appraisal of the investment.

Such an analysis allows the company to consider how alternative investment options might relieve congestion in different ways, and what impact this would have on costs, revenue and ultimately on the return on investment.

VALUING THE OPTIONS

Let us now look at a transmission operator that plans to relieve congestion through an expansion of transmission capacity on a specific route. We assume that transmission capacity on this route is 800 MW short of what customers demand at peak times. We start by assuming that the regulator has subjected the infrastructure charges to a price-cap regime, under which he revisits price controls every five years, but allows the operator the benefits from outperforming efficiency targets in the intervening period (2000-04). At the same time, we assume there is sliding-scale regulation for congestion cost, the cost of losses and cost of voltage control. The company has to pass 50% of any cost savings on to network users.

The results from the analysis of this fictitious, though realistic, example suggest that partial alleviation of the congestion (adding 500 MW of transmission capacity in 2002) would reduce total cost. However, such investment would not represent a good return to shareholders, as net present value (NPV) of free cash flows for the firm would fall. This is because use-of-system charges are capped and cannot rise immediately on the increase in investment cost.

Congestion costs would drop, as could be expected, and the model also picks up the reduced cost of losses as a second-order effect. However, under the sliding scale rule, the benefits that rest with the operator are too small to make the investment worthwhile.

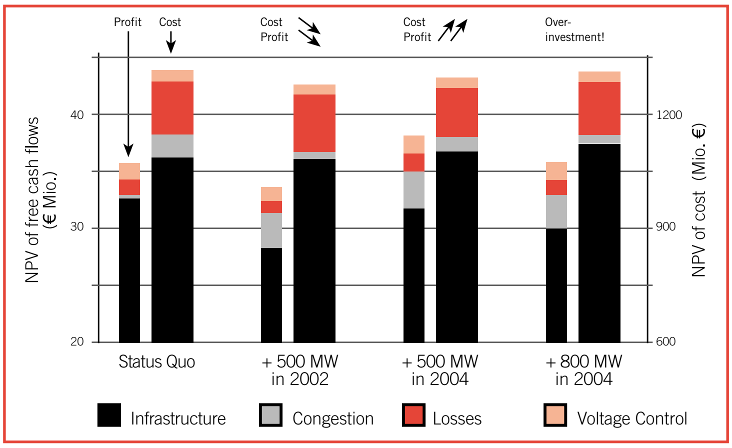

Figure: Sample results from a demonstration model

Let us therefore suppose that the network operator considers postponing the investment to 2004. With a price review imminent in 2005, this would allow the operator to influence the regulator's expectation of increased infrastructure costs, and the increase in revenue is more likely to coincide with the increase in costs. In this case the investment, which would clearly reduce costs, would also increase shareholder value.

Rather than build an extra 500 MW, however, does it make sense to relieve the congestion completely, building an extra 800 MW of capacity? The model indicates that shareholder value would be lower. The reason is that the 800 MW congestion only occurs for a small number of hours per year. The congestion cost arising during these hours does not justify the more extensive investment, given the additional cost it implies.

ARENA FOR DEBATE

Although we have demonstrated our analytical approach with respect to a very specific situation, it is possible to generalise some of our findings.

- The valuation of any investment hinges on the incentive power implicit in the regulation of distinct services provided by the network operator.
- Cost-minimising investment options are not necessarily those that maximise shareholder value.
- It may be neither cost-minimising nor value-maximising to remove a quality problem completely, or to relieve congestion entirely.
- Where revenue is adjusted to costs, but only after a lag, the timing of any investment may be critical.

As our example has illustrated, regulatory incentive mechanisms do not automatically work to the public interest. In fact specific regulatory rules may remove the incentive to invest, even when investment may help to reduce costs and benefit network users. Regulators and regulated firms are naturally suspicious of each other when it comes to the design of a regulatory regime, making dialogue difficult. Our approach may provide a neutral framework for an objective discussion between network operators, network users and the regulatory authorities.

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