Transmission Pricing and Transmission Price Control*

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Price Control

The introduction of economic regulation is caused by the need to monitor and control the activities of companies in markets where full and fair competition cannot be relied upon to protect consumers' and other's interests. Generally, if full and fair competition exists then there is no need for regulation in order to protect the interests of consumers. However, where competition is not possible (in case of market failures, e.g., natural monopoly, public goods, etc.), economic regulation is required, generally to prevent the abuse of market power by dominant or monopolistic industry participants.

Regulation in the line-bound energy industries can be defined as the action of state authorities to limit (profit maximising monopolistic) utilities in the use of one of their strategic parameters such as price, quality, quantity, investments (e.g., capital intensity, plant type). In this sense, regulation is used to prevent abuse of market power by incumbent monopolistic utilities. Regulation represents a codified, continuous monitoring of utilities and control of certain parameters if parameter thresholds (e.g., prices, profits, revenues, etc.) are exceeded.[1] Usually, regulation allows for a "fair rate of return" so that strategic management decisions such as investment in regulated businesses/industries are evaluated similarly as in competitive industries: no undue profits are to be earned, but profitability of regulated businesses must be such as to allow for continuous operation of the business, including replacement investments.

Rate of Return Regulation

Under the rate of return regulation regime, costs of service provision are passed through onto customers. In addition, utilities are allowed a "fair" rate of return on the rate base (either equity or total fixed assets) that is also levied upon customers. This regulation method is synonymously labelled "cost of service" or "cost-plus" regulation (with the allowed rate of return representing the "plus" element).

Explicit per unit revenues (average prices) are derived by averaging forecast cost (plus "rate of return") data over expected units to be supplied:

$$P_t = \frac{\mathrm{TC}_t + \mathrm{ROR}_t \cdot \mathrm{RB}_t}{Q_t},$$

where:

P – price/average revenue;
TC – total cost;
ROR – (allowed) rate of return;
RB – rate base;
Q – quantity sold; and
t – time index.

Rate of return regulation is flexible and responsive to the regulatory authority's wishes concerning service quality and other matters, because the regulatory authority can allow or disallow any costs it chooses. On the other hand, rate of return regulation is complex and could be potentially distortional because it requires the regulatory authority to judge and "second-guess" detailed business decisions made by the monopolist.[2] Moreover, under conventional "rate of return" regulation, the rates of regulated network service providers are reviewed on a regular basis and have to be adjusted (so-called "regulatory review") to lower levels if cost savings have been achieved in the interim (since the last review). Network service providers thus only benefit from cost savings to the extent that regulatory reaction to cost savings is

* This is the final part of the article "Transmission Pricing and Transmission Price Control" by K. Petrov. See *RusEnergyLaw Journal* #5'2004 for the beginning of the article.

[1] See, e.g.: *Kahn, A. E.* (1971): The Economics of Regulation: Principles and Institutions, Vol. I, II, John Wiley and Sons, Inc., New York; Weizsäcker, C. C. v. (1982): Staatliche Regulierung — positive und normative Theorie, in: Schwezerische Zeitschrift für Volkswirtschaft und Statistik, Heft, Vol. 3.

[2] Incomplete information on the regulator's side is a major problem in all of the above-described drawbacks of "rate or return" regulation. Most apparent is the "cost immunisation" problem. The regulator is not in a position to ultimately judge whether certain inputs would have been required under efficient operation (e.g., whether the staffing is at an appropriate level or whether it is excessive) or whether incurred prices of inputs (e.g., staff wages) were at appropriate levels where no exact comparator exists. The utility is practically allowed to pass all costs actually incurred through to customers.

lagged (so-called "regulatory lag"). If the "regulatory lag" is short – one or two years – incentives for cost savings are suppressed almost completely. In such a framework, network service providers are said to operate dynamically inefficiently. Additionally, the "rate of return" regulation creates overcapitalization (over-investment in fixed assets) incentives (Averch–Johnson effect) and potentials for increases in capital costs.

Numerous regulatory methodologies have been developed to counteract the deficiencies of "rate of return" regulation.[3] All these alternative methodologies focus on the establishment of incentive mechanisms from "rate of return" to "profit sharing," or further to "cap" regulation, or again through comparative approaches such as "yardstick" regulation rather than individual assessment of network service providers.

Yardstick Regulation

Yardstick regulation is not based on an assessment of the cost position of individual utilities but upon a comparison of prices or cost positions and cost determinants between firms. Under a "yardstick" mechanism based on price information, utilities are not allowed to charge higher prices than some statistical mean price that is calculated over all utilities unless this was justified by "special conditions."[4]

This form of price control was suggested by Shleifer (1985). Each in a group of comparable regional monopolists has a price cap determined by the average cost of the others in the group. In this model, operating costs C_i of firm i depend on the amount of effort expended by the firm $C = C(e)$. For $n \geq 2$ identical firms, the regulator defines for each of them the allowable cost.

$$\overline{C}_i = \frac{1}{n-1} \sum_{j \neq i} C_j .$$

Under a cost-based "yardstick" approach, utilities could apply for certain rates according to some standard regulation method (e.g., "rate of return"). The regulatory authority then compares detailed cost components between utilities and disallows any parts of cost components that appear excessive upon comparison with other utilities.

Performance-Based Regulation

Performance-based regulation (PBR) was introduced as an alternative to cost-of-service regulation in the United States' electricity sector in the late 1980s and early 1990s. The primary objective of PBR is to inject competitive market incentives into monopoly markets and weaken the link between costs and rates. Performance-based regulation builds on "rate-of-return" regulation. In addition, selected "performance" targets are set for the utility in quantitative but non-monetary terms. If performance targets are achieved, these will come along with cost savings. The cost savings will not fully (or they will not immediately) have to be passed through to customers. Thus utilities are, for example, allowed a higher rate of return if performance targets were previously met. Potential categories of performance targets are: construction cost, transportation losses, system reliability (measured as problems in voltage or pressure stability, outages, time to restore supply upon outages), customer satisfaction (e.g., measured as numbers of customer complaints). It should be emphasised that the philosophy and major ideas beyond PBR coincides to some extent with the term "incentive regulation" that is frequently used in the European regulatory theory and practice. On the other hand, incentive regulation is usually associated with forms of regulatory cap controls that generally rely upon extended regulatory lag and fixing of efficiency increase requirements, factors that are not directly considered in the basics of PBR.

The use of performance indicators gives the companies incentives to increase their operating and investment efficiency and reduce cost. If a company is able to achieve better performance than the target set, it can retain some of the earnings resulting from cost savings. On the other hand, PBR requires individual negotiations between utilities and regulatory authorities in the process of selecting target categories and target levels (high regulatory burden). Such an approach is only feasible if regulators face a limited number of regulatees or if target schemes can be blueprinted for a number of regulatees.

Cap Regulation

Given that regulation is seen as a set of instruments to mimic market conduct, "cap" regulation can be used to reproduce competition. In competitive industries, intermediate profits can be earned if product or process improvements give an "inno-

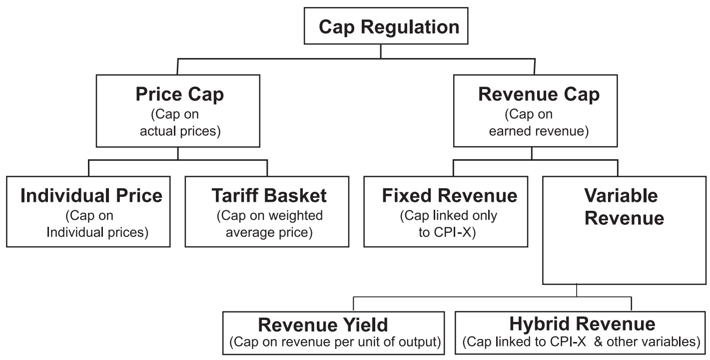
[3] See *Joskow, P. / Schmalensee, R.* (1986): Incentive Regulation for Electric Utilities, in: Yale Journal of Regulation, Vol. 4, No.1; Laffont, J. J. / Tirole, J. (1993): A Theory of Incentives in Regulation and Procurement, Cambridge, The MIT Press.

[4] See *Shleifer, A.* (1985): A Theory of Yardstick Competition, Rand Journal of Economics, Vol. 16, pp. 319–327.

vator" some competitive advantage over his rivals. This advantage can only be sustained as long as competitors do not imitate the innovation (this may be restricted by patent legislation). In competitive capital-intensive industries, this intermediate advantage is usually sustainable over several years. In analogy, regulated utilities are allowed to maintain "intermediate profits" gained through exceeding the productivity improvement target for periods of three to five years by instituting a corresponding lag between "regulatory reviews."

A number of forms of cap regulation exist (see Figure 1). They are separately analysed in the following Subsections.

Figure 1. **Forms of Cap Regulation**



Price Cap Regulation

Under price cap regulation, a restriction is imposed on the growth rate of average revenues or particular prices.[5] Usually, average revenues are indexed to some inflation indicator (e.g., the RPI or the CPI). In addition, regulated utilities are obliged to reduce their prices each period according to some assumed productivity growth rate (so-called "X-factor") that is to be determined by the regulator.

The starting level and the development path of prices are fixed such that under normal conditions, the utility will earn a "fair" rate of return in each period. This implies the imposition of a time path of price ceilings for a period usually extending over several years according to the following formula:

$$P_t = (1 + \mathrm{CPI}_t - X_t)P_{t-1}$$

where:

P – price cap based on projected data for the regulated services for year t price;

CPI – annual percentage change in the Consumer Price Index;

X – productivity growth rate; and

t – time index.

Prices may be controlled individually (individual price caps) or grouped into "baskets" (tariff basket price caps).

Individual Price Caps

With individual price caps, the regulator sets the upper limit for each individual price. This is the most direct form of price control but its application is limited to situations where the number of services provided is small and stable and costs are easily identifiable.

Under a price cap, if the actual quantity demanded is greater or less than that forecast, then revenue will increase or decrease, respectively. The effect of this change in revenue on the firm's profits, and rate of return on capital, will depend on how its costs change with the change in volume. If the average cost of producing the service does not change with a change in the volume sold, then under a price cap, total costs will move in proportion with total revenue and there will be no change in the firm's profit and return on capital. On the contrary, if the average cost falls with a decrease in demand, then under a price cap, total revenue will increase more than total costs. If the volume sold increases and there will be an increase in the firm's rate of return on capital. The opposite will happen if there is a fall in demand.

Hence, the appropriateness of the price cap, as opposed to other forms of the cap, for a utility will depend on the nature of its cost function.

Tariff Basket Price Caps

The alternative is an average price control, or "tariff basket." With these, prices are grouped into baskets on the basis of the services to which they apply. A representative weighted average price for the basket is calculated. An upper limit or cap is then applied to the weighted average price.

[5] Implementation of price cap regulation, under the name "RPI-X regulation," has been advocated by Littlechild (1983) as an alternative to rate of return regulation. It has been adopted in a large variety of circumstances, most notably in the regulation of telecommunications in Great Britain and the United States. See: Littlechild, S. C. (1983): Regulation of British Telecom's Profitability Report to the Secretary of State, London, UK, Department of Industry.

This allows for some variation between the changes that can be made to individual prices within the basket provided that the weighted average price for the basket is within the regulated cap.

The weights are typically based on either the revenue or quantity shares of each service in the basket. These weights may be fixed at the start of the regulatory period and then held constant throughout the period, or alternatively, reset at suitable intervals.

Under a tariff basket, the limit on allowed price increases is expressed in terms of a ratio of 'notional' revenues. The tariffs proposed by the regulated service providers should satisfy the tariff basket constraint if this ratio is less than a given cap. This cap is, in turn, determined on the basis of a CPI-X formula. The form of tariff basket is set out in the equation below:

$$1 + \mathrm{CPI}_t - X_t \geq \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} p_{ij}^{t+1} q_{ij}^{N}}{\sum_{i=1}^{n} \sum_{j=1}^{m} p_{ij}^{t} q_{ij}^{O}} ,$$

where the regulated service provider has n tariff categories, which each have up to m components;

p_{ij}^{t} is the price being charged in year t for component j of tariff i;

p_{ij}^{t+1} is the proposed price for component j of tariff i in the coming year $t+1$;

q_{ij}^{N} and q_{ij}^{O} are the forecasted or historic quantities of component j of tariff i that will be used in the price control (N indicates that quantities apply for the new year and O that quantities apply for the old year);

CPI_t is the annual percentage change in the Consumer Price Index; and

X_t is a percentage figure determined by the regulator and reflects generally the productivity improvement requirements.

Under the presented tariff basket formula, tariffs are approved on the basis of an allowed ratio between two notional revenues: one based on proposed prices and the other on current prices. However, the actual revenue earned by the regulated network business will depend upon the actual tariffs applying to the actual quantities sold of each of the charging parameters. If the regulated network business sells an additional unit, of whatever charging parameter (kWh, kW or customer number), the marginal revenue it earns will be equal to the tariff applying to that extra unit. As a result of this link between marginal revenue and tariff structure, the proposed tariff basket form of control provides the regulated service providers with an incentive to set their tariff structures to reflect the underlying cost structure, in order to minimise profit risk.

Proponents of a tariff basket argue that it can give a less intrusive form of regulation with lower costs of regulation and strong incentives for efficiency. However, controls, like these that are based on existing price structures, can have the effect of limiting price or product development. As explained above for a single price cap, the appropriateness of a tariff basket as a form of price control will depend on the extent to which costs move in proportion to a change in volume. For example, if costs move in proportion to changes in volume, then there will in general[6] be no change in the utility's rate of return, if there is change in volume from that forecast, assuming there is no factor compensating for the changes. However, if the costs do not move in proportion to volume,[7] the utility will face a risk of a fall in rate of return if volumes decrease and the benefit of a rise in return if volumes increase.

Revenue Cap

Under "revenue cap" regulation, a restriction is imposed on the growth rate of total revenues.[8] Total revenues can either be fixed in nominal terms over the regulatory period, or a mechanism similar to that used under "price cap" regulation can be used: total revenues are indexed to some inflation indicator (e.g., the RPI or the CPI). In addition, the regulated companies are obliged to reduce their total revenues each period according to some assumed productivity growth rate. In the simplest form, this implies the imposition of a time path of total revenue ceilings for a period usually extending over several years according to the following formula:

$$R_t = (1 + CPI_t - X_t) R_{t-1} ,$$

where:

[6] The relationship between profit and volume will depend partly on the extent to which the utility can re-balance prices within the basket. For example, a utility may be able to increase its rate of return by increasing the price of a service for which demand has grown and decreasing the price of a service with falling demand.

[7] The networks are characterised by scale economies and therefore a tariff system based on "pure" marginal costs is not able to raise sufficient revenue for cost recovery. In order to ensure cost recovery, tariffs should be increased above marginal costs. Although theoretically the cost recovery should be ensured through an additional charge that does not depend on the usage (kWh, kW), the practical solutions usually consider an energy and/or capacity charge and incorporates the sunk cost in the tariff design through usage-dependant tariff components.

[8] See IPART, Independent Pricing and Regulatory Tribunal of New South Wales (1999): Regulation of Network Service Providers. Price Control Issues and Options, Discussion Paper 34, March.

R_t - revenue cap based on projected data for the regulated services for year t;[9]

CPI_t - annual percentage change in the CPI;

X_t - productivity growth rate; and

t - time index.

With price caps, the limit is applied to the actual price or an average of the actual prices charged. With a revenue cap, the upper limit is applied to the revenue earned. Like price caps, revenue caps can be applied to segments of the regulated business rather than to the businesses a whole. For example, separate revenue caps may be established for household and business customers, or for different categories of service.

The different types of revenue cap are explained in the following Subsections.

Fixed Revenue Cap

Under a fixed revenue cap, allowed revenues are set equal to target revenues for the duration of the review period and are adjusted each year only for general price inflation and any assumed productivity increases.[10] This is a relatively simple form of control, with low implementation and administration costs. It provides the regulated service providers with guaranteed revenue, regardless of the volume or level of service it is called upon to provide to customers. If in any year, customer demand varies from the level expected at the time that the target revenues were set, the actual level of revenue collected will either exceed or fall short of the cap. A correction mechanism will then return the surplus to customers or make up the shortfall.

Under this control method, the impact of unexpected variations in costs is borne by the regulated service providers, at least until the next review. In the circumstances where this may create an incentive for more prudent cost risk management, it accords with the general objectives of incentive regulation. However, when variations in costs are the result of unexpected changes in customer demand, there are potentials for perverse incentives to be created, with the risk of unintended consequences. During the establishment of revenue targets, regulated service providers will have an incentive to inflate their estimates of demand growth, as a way of minimising the risk of higher-than-expected growth depressing their profits. Once revenue targets have been set, there will be an incentive for regulated service providers to minimise all the costs depending on the units transported and the number of consumers. This may lead to postponing new connections and/or network infrastructure investments resulting in unsatisfied customer demand as well as a general decline in service levels. There is some potential for the difference between actual revenues and the level warranted by service volumes to increase progressively towards the end of the control period, adding to the risk of demands for regulatory intervention and interperiod price adjustment problems. Unless it can be argued that the probable demand forecast error for the network service cost drivers will be small, fixed revenue caps appear to carry material financial risks for regulated service providers.[11] As a consequence, there is a likelihood of introducing regulatory distortions into the provision of services.

Variable Revenue Cap

(1) Revenue Yield Cap

Using this kind of cap, the regulator calculates the maximum average revenue by dividing the total revenue by total output of the regulated service provider. It sets a cap on the maximum average revenue each regulated service provider is allowed to earn per unit of output (that is, its maximum average charge per kWh of electricity distributed) for the first year of the regulatory period. It also determines a CPI-X formula for adjusting this average revenue per unit in each subsequent year of the period, and can set limitations on the amount by which some or all individual prices (within the tariff system) can increase. The regulated service provider is able to rebalance prices (increase or decrease individual prices), so long as the weighted average of its distribution prices does not exceed the set maximum average charge per kWh, and it complies with any limitations imposed by the regulator. The level of the revenue yield control is set on the basis of the benchmark revenue established by the regulator, together with a forecast of the expected volume of output. If the volume of output turns out as expected, the regulated service provider will receive 100% of its revenue. Where regulated service providers sell in excess

[9] This gives the maximum revenue that the network business is allowed to earn in year *t* to cover the provision of its regulated services.

[10] See IPART, Independent Pricing and Regulatory Tribunal of New South Wales (1999): Regulation of Network Service Providers. Price Control Issues and Options, Discussion Paper 34, March. DTe (1999): Price Caps Regulation in the Electricity Sector, Information and Consultation Document.

[11] Under a strict formulation of the control, any changes in the underlying cost drivers are not reflected in the allowed level of revenue. There is therefore a danger that the regulated service provider will earn sustained excess profits, or face sustained losses if cost drivers turn out to be different from the forecasts. This risk has led to cost-pass through formulations of some pure revenue controls, in order to take account of unpredictable changes in costs.

of the volume expected, their revenue will be in excess of the benchmark revenue. Conversely, if they sell less than the expected volume, their allowed revenue falls below the level anticipated when the price control was set.

Under a revenue yield cap, there is an inherent incentive to expand volumes and this might be in conflict with demand management initiatives. The regulated service provider will have a strong disincentive to participate in such programs, as it reduces the revenue they are allowed to earn under the price control. Regulated service providers may therefore fail to consider demand management initiatives, even when it would be economically efficient to do so.

Under the revenue yield approach, the allowed average revenue need not be systematically related to costs, since it is based on a single measure of quantities to proxy services that in reality have many different dimensions of output and unit costs. As output increases for one service, allowed revenues increase proportionately, whereas costs may not. This upholds the incentive for the regulated service provider to expand volumes by the cheapest means possible.[12]

Finally, under the revenue yield approach allowed revenue is closely tied to the quantity transported, and therefore the regulated service provider bears considerable revenue risk if load growth is significantly different from that which was forecast. Costs, on the other hand, are unlikely to match movements in load so closely, given that network services tend to be characterised by a high proportion of fixed costs. The regulated service provider is therefore likely to bear a significant amount of financial risk associated with the volatility in profits.

(2) Hybrid Revenue Cap

Effectively, in an average revenue yield cap regime, the profit increase due to volume effects is a result of lagged regulatory adjustment. An automatic adjustment mechanism may then prevent excessive profits from being earned between regulatory reviews.[13] In a pure revenue cap regime, distortions could occur when customer-driven changes in costs cannot be recovered by the regulated service providers.

Given the weakness of revenue yield cap and pure revenue cap, hybrid revenue cap regulation schemes have been developed. Under such regimes, the allowed revenues are linked by a predetermined formula to another variable or group of variables (in addition to CPI-X), for example, level of demand, selected cost drivers or performance measures. Allowed revenues are therefore not known in advance, but are determined by the formula once the values of the independent variables are known.[14] In practice, regulators typically use a fixed revenue component combined with annual revenue drivers that may be based on service volumes, cost, or performance-related variables. For example, customer numbers, energy consumption, energy demand, length of network lines and system losses are among the variables included in the hybrid cap control formulas used by regulators. The major advantage of such price control schemes is that they sustain the link between cost and regulated revenues during the regulatory period and mitigate the risk exposure for regulated service providers.

An example of a variable revenue cap formula is given below:

$$R_t = R_{t-1}\left(\alpha \frac{Q_t}{Q_{t-1}} + \beta \frac{C_t}{C_{t-1}} + \delta\right)(1 + \mathrm{CPI}_t - X_t)$$

where:

R_t – revenue cap based on projected data for the regulated services for year t;

α – "quantity weighting factor." This represents the proportion of total required revenue that is assumed to vary with a change to

[12] Since there is no necessary link between marginal revenues and marginal costs under revenue yield formula, there is a danger of systematic trends in cost and revenue drivers, such as a shift in demand conditions leading to persistently higher profits or losses. Persistently higher profits, not anticipated by the regulator at the time the price control was set, may prompt calls for intervention to reopen a price review. Persistent losses borne by the company will put at risk its willingness and ability to continue to provide the network service. The lack of a proportionate link between revenues and costs under this form of control therefore exposes the regulated service provider to a degree of risk, and may increase unnecessarily the cost of capital. See Office of Regulator General, Victoria (1998), Consultation Paper No 4, December and Office of Regulator General, Victoria (2001), Electricity Distribution Price Review, Form of Price Control.

[13] Consider, for example, a situation when the price control ties revenue closely to the volume of energy consumed but underlying costs are not greatly affected by changes in volumes; i.e., the variable cost of distribution is low compared to the fixed cost. If there is an unexpected increase (decrease) in demand, profitability will also increase (decrease) under the operation of the price control, compared with the level initially anticipated. Persistent excess profits are not consistent with the objectives of monopoly regulation in promoting efficiency and protecting consumers. Persistent losses are inconsistent with safeguarding the investment of regulated businesses, will discourage new investment and result in the potential unwillingness to continue providing the regulated services. A form of price control which permits revenues and costs to move out of line with each other therefore exposes the regulated firm to a degree of risk, and is a suboptimal outcome from an economic efficiency perspective.

[14] In the 1994 UK price review, the electricity regulator, OFFER, altered the form of the control so that, whereas previously revenue increased proportionately with the number of units sold, it would now increase at half the rate. The Director General of Electricity Supply concluded that: "On the evidence available to me, it does not seem that distribution business costs can be said to move entirely with units sold. At the same time, I am conscious of the importance of retaining a general incentive for companies to seek out and meet the needs of their customers. To balance these considerations, I propose to halve from 100 to 50 per cent the weight of units in the 'revenue driver' of the price control and to relate the remaining 50 per cent to customer numbers. This should avoid any artificial disincentive in the distribution price controls to the companies' pursuit of energy efficiency, while at the same time, retaining an appropriate marketing incentive."

the quantity of units distributed in the case of the network business. (In more specific terms, it equals the proportion of total required revenue that is allowed, with regard to the revenue cap, to increase by the same percentage as the percentage change to the annual quantity of units distributed/sold.);

Q_t – projected quantity of units distributed/sold in year *t* (kWh);

β – "Customer weighting factor." This represents the proportion of total required revenue that is assumed to vary with a change to the number of customers of the business concerned. (In more specific terms, it equals the proportion of total required revenue that is allowed, with regard to the revenue cap, to increase by the same percentage as the percentage change to the number of customers.);

C_t – forecast number of customers in year *t*;

δ – "Residual Factor." This represents the proportion of total required revenue that it is assumed does not vary with a change to the quantity of units sold or the number of customers. In more specific terms, $\delta = 1 - \alpha - \beta$;

CPI_t – annual change in the CPI; and

X_t – productivity growth rate.

The hybrid price control forms reduce the economic distortions resulting from pure forms of revenue and price cap control. The weakened link between volume and allowed revenue implies a reduced incentive on the regulated service provider to bias prices in favour of low marginal cost services in order to expand volumes. It also lessens the bias against participation in demand management programmes as an alternative to network investment. However, by retaining a link between allowed revenue and output, a hybrid control avoids the disincentive present under a pure revenue cap to encourage new connections and, potentially, to artificially discourage load growth.

In the absence of competition in the Russian electricity networks, the FEC should protect customers by acting as a proxy for normal competitive forces. A good regulatory regime should provide companies with similar opportunities and incentives to those they would face in a competitive market. However, in mimicking market forces, the FEC also needs to balance this duty with the need to protect the interests of network owners in order to ensure that the Transmission Operator (FNC) earns a reasonable rate of return on their efficient investments.

To carry out this role, the FEC needs to monitor the companies' performance. It is preferrable to adopt a light-handed approach to doing this. One of the reasons to propose this approach is that it will provide incentives for the FNC to focus its attention on delivering the best service to customers, rather than debating costs with the regulator. The second important reason is that it is inappropriate for the regulator to micro-manage the network service providers. The external position of the regulator, the lack of operational business competence and the information asymmetry between regulated service providers and regulator predetermine the unsuccessful outcome of regulatory micro-management policy.

The CPI-X framework includes a number of price control options. The international experiences demonstrate no clear trends towards one preferred solution (detailed discussions are contained later in this report). The current price control of NGC in England & Wales is based on pure revenue cap (no revenue driver is included). National Grid Company preferred this method and argued that other form of variable revenue caps (with explicit adjustment of allowed revenue) would boost demand and introduce an undesired bias against demand side management. Pure revenue caps are applied also by ACCC (the federal regulator in Australia) to the transmission service providers in Victoria and New South Wales.

Differently, the Norwegian regulator applies a variable revenue cap (revenue driver is energy) to regulate Stattnet. The Netherlands applies tariff basket approach for TenneT, however, with predetermined fixed output (quantity) levels. Similarly, the Energy Agency of Slovenia imposed, at the beginning of 2003, a tariff basket approach on the Slovenian TSO ELES.

One option would be to apply revenue cap for transmission. Revenue cap is a form of economic regulation with low regulatory involvement; i.e., it supports the light-handed regulation approach. One additional important advantage of revenue caps is that they support revenue stability; i.e., the revenue does not fluctuate with changes of demand. For the last reason, revenue caps are sometimes preferred by the practitioners for the purposes of transmission price control. The second option is to use a tariff basket cap. The advantages of the tariff basket include: strengthening links between marginal revenue and tariff structure; keeping the link between revenue and costs; minimising complexity and absence of forecasts and correction factors.

Both of the discussed options (revenue cap and tariff basket) will give the regulated FNC the freedom to manage the structure and level of their prices. This freedom has advantages, but it also brings the risk that the company may change the prices in a way that disadvantages some consumer groups. In comparison with the distribution network businesses, the risk of tariff rebalancing is lower as the FNC provides transmission service only to large users (either distribution companies or large industrial users).[15] If the FEC feels that such risk could occur in the first regulatory period, subsidiary limitations of annual increase of the network charge components could be imposed in order to avoid negative imbalance effects.[16]

Scope of the Regulatory Caps

The philosophy proposed requires that the FEC regulates the price basket or revenue, based on the premise that the regulated charges will bring sufficient revenues to cover the costs of provision of transmission network service (i.e., on revenue/prices of transmission use of network charges)[17] including the efficient O&M and capital costs[18] of the regulated transmission network business for provision of the transmission network service plus the cost of the purchase of energy to cover transmission network losses. The transmission connection service (connection charges) will be regulated as an excluded service[19] (i.e., outside of the proposed caps) and based on the cost of connection including reasonable rate of return on transmission connection assets. All charges collected for provision of non-regulated services[20] provided by the FNC are not subject to regulatory price control and will be excluded from the revenue cap.

Quality of Supply

All types of price regulation face a fundamental problem. In the case of rate-of-return regulation, utilities are generally free to define their own investments and quality levels. In line with economic theory, this tends to create incentives for over-investment in both assets and quality. Not surprisingly, many regulatory regimes therefore focus on preventing this type of inefficiency and to avoid sub-optimally high levels of investment. Simple types of cap regulation, on the other hand, may allow a regulated company to reduce its cost by reducing its quality of supply by cutting investment, maintenance, or personnel with the aim of increasing profits. Consequently, price regulation may thus also provide incentives for under-investment in electricity networks.

Quality of service is just as important to consumers as prices. If standards of service fall but prices remain the same, consumers are effectively suffering an increase in prices. In competitive industries, dissatisfied customers will then either demand lower prices or switch suppliers. Likewise, investors will be less willing to invest if they believe that companies are investing too much or too little in service standards. A monopolistic firm, on the other hand, may try to collect the allowed revenue while reducing product and/or service quality.

Removing the link between prices and costs creates strong incentives for efficiency improvement as any cost savings directly translate into higher profits. However, both theory and practice suggest that, without additional quality regulation mea-

[15] At distribution level, there might be a risk that the distribution network businesses may make relatively larger reductions in the prices paid by large consumers than in the prices paid by smaller consumers. This could raise the companies' profits if smaller consumers are less responsive to prices than larger consumers, so that the company gains more sales to large customers than it sacrifices to small consumers. See also the position of the Dutch Regulator and the Regulatory Office of Victoria (Australia) to this issue: DTe (2000): Guidelines for Price Caps Regulation in the Dutch Electricity Sector in the period from 2000 to 2003 and Office of Regulator General, Victoria (2000): Consultation Paper No 4, December 200, Electricity Distribution Price Review, Form of Price Control.

[16] Another rather conventional and widely used method to place some discipline on the process is a requirement to publish the tariff setting methodology and expose that to critical scrutiny of network users and researchers.

[17] Transmission service includes transmission network service (paid via transmission use of network charges) and transmission connection service (paid via transmission connection charges). Transmission network service is a service associated with the ability of the FNC to transport energy via the transmission network in a reliable and efficient way (including network planning and network construction) and to ensure secure and efficient operation and regular maintenance of the transmission network assets as required in the Technological Rules and the relevant Russian technical standards.

[18] The FNC's annual capital cost consists of annual depreciation plus a reasonable annual return on its invested capital.

[19] Transmission connection service is associated with the ability of the FNC to provide reliable and efficient connection to the transmission network and regular maintenance of the transmission connection assets as required in the Technological Rules and the relevant Russian technical standards.

[20] Contestable markets for some of the network services may exist which means that the price will be established in the competitive environment of the market. The classical example is the debate on the contestability of connection and exclusion of connection charges from the regulatory control. In the UK, this debate led to the deregulation of some of the connection services (e.g., construction of connection, but not design of connection). Another example for contestability is the metering service. Meter installation and meter maintenance could also be potentially competitive. The author is not aware whether similar arrangements exist in Russia currently. Further examples for non-regulated services are the so-called miscellaneous services. Miscellaneous services are services that are different from the transmission service. Examples for such miscellaneous services are: engineering consultancy services; or other related services, such as telecommunications; or generation of electricity in own generation facilities or in capital subsidiaries.

sures, these incentives eventually lead to perverse quality degradation. Even though this may cause additional cost, e.g., for network users, the network operator may still find it more profitable to cut costs at the expense of quality. Thus, under price/revenue cap systems, inclusion of quality regulation elements is imperative. Different authors have recognised that strong cost reduction incentives (driven by the profit motive) result in substandard quality levels. In the telecommunication industry, it is worth noting that in 1996, the Oregon Public Utility Commission terminated its price cap regulation plan for US West due to quality decline.

Theoretically, the economic problem is that from the company's point of view, quality is an external effect. This means that the company's private choices regarding cost and quality do not necessarily lead to the most desirable outcomes from a social welfare standpoint. Regulatory authorities must therefore act to protect consumers' interests by devising incentives to reach socially optimal outcomes. In line with economic theory this will be achieved if the externality is "internalised," i.e., any outcomes of the company's cost and quality choices are made a function of the resulting societal losses.

In short, price regulation generally has to be accompanied by some kind of regulation of quality of supply (for transmission and distribution networks), with the aim of both avoiding distorted and excessive investment and of preventing a decrease in quality and performance standards. Generally, FEC should provide regulated service providers with incentives to increase efficiency and reduce costs in general, at least to maintain present levels of quality and, where applicable, aim at a better cost/quality trade-off.

At present, companies only monitor average network performance, using criteria like frequency and duration of interruptions. Generally, such monitoring of average network performance is appropriate under present circumstances. It is the most widely adopted technique for monitoring supply reliability and enables companies' performance to be compared with each other, and with performance in other countries. Federal Energy Commission should require annual reporting from FNC on all transmission system incidents that involve loss of supply to customers (including downstream distribution companies). Because such failures will be infrequent, reporting can relate to each individual incident. In addition, FEC might require that FNC should report on other quality factors for its network, even though these do not relate to loss of supplies. These include the extent to which parts of the transmission network are unavailable for service during the reporting year, and the reasons for such unavailability. Federal Network Company should also monitor voltage and frequency on its system.

Recommendations

General Design of Transmission Service Charges

! Transmission service charges should apply to the networks owned by the FNC, i.e., for 220 kV lines and higher.

! Transmission service charges should be made up of transmission connection charge and transmission use of network charge.

! Short-run signals (in terms of time and location) will be provided by application of nodal pricing on the wholesale market.

! Transmission loss rentals and congestion rentals (surpluses) resulting from the application of nodal pricing should be used to scale down the transmission use of network charges.

Revenue Requirements

! The calculation methodology should be designed to remunerate the FNC's reasonable costs and to provide an adequate return on assets to ensure that capital remains in the industry and that new capital can be attracted to the sector as and when it is necessary.

! The revenue requirements of the FNC should cover:

Operation and maintenance costs: these are the costs incurred by the FNC in operating and maintaining the core transmission network to the Russian technical standards and the requirements of the Technological Rules.

Depreciation costs: these are the costs related to depreciation of the investment in the core transmission network assets (excluding transmission connection assets) during their life in order to accumulate sufficient capital for asset replacement (transmission connection will be discussed later in this document).

Return on assets: the FNC will be allowed to earn a return on its assets.

- Due to the fact that the FNC is a monopoly business, its revenue/prices will be regulated by the FEC.

Transmission Use of Network Charge

- The transmission use of network charge will apply to the transmission network infrastructure reflecting its ability to transport energy in a reliable way and will recover the costs incurred by the FNC in order to ensure secure operation and regular maintenance of the network assets (costs related to O&M, depreciation and financial return on the core transmission network assets), however, reduced the surplus resulting from the application of nodal pricing.
- The transmission use of network charge is set irrespective of the distance transported but takes into account the entry and exit points on the respective transmission regions and network voltage level.
- As nodal prices will provide locational signals, imposing secondary signals through locational pricing for the transmission network infrastructure is not of immediate priority. Hence, it is suggested to allocate the transmission infrastructure costs (revenue requirements) of each transmission region to the respective voltage level operated by the FNC in this region using the postage stamp approach and cost cascading among the voltage levels.
- If secondary locational long-run signals are still preferred by the FEC and/or the FNC, the short-run signals resulting from the application of nodal pricing can be supplemented by locational pricing (e.g., on a zonal basis) for the transmission network infrastructure. In this case, a portion of the revenue requirements should be allocated on a locational basis to the transmission network nodes and aggregated in price zones.
- If locational pricing for the transmission network infrastructure is adopted, it is not recommended to allocate the total revenue requirements on a locational basis but rather to define a percentage of the total revenue requirements (e.g., 50%) that should be allocated on a locational basis. The remaining part will be charged *pro-rata* to the transmission service users.
- Should the FEC and/or the FNC prefer to introduce locational pricing for the transmission network infrastructure, it is suggested to allocate the revenue requirements jointly to the generation and load nodes, the prevailing part to be charged to the load nodes (e.g., 25% to the generators and 75% to the load). If the revenue requirements are allocated by means of a postage stamp concept, it is reasonable to allocate the payment liability entirely to the load entities.
- All transmission service users located in the same transmission region and connected to the same voltage level (or located in the same price zone within the transmission region if locational pricing applies) will pay the same transmission use of network charges.
- In order to improve efficiency signals, the transmission use of network charge can be differentiated by time of use (time of day or season of year) whereas the allocation rules could use the probability not to meet the maximum demand in the transmission network or simple criteria allocating the transmission infrastructure cost to time periods where the demand is higher than a predefined threshold.
- Two options for design of the transmission use of network charges are suggested: **(1)** peak-based regime, where the peak usage is appropriately defined so as to minimise the attractiveness of inefficient charge avoidance (e.g., number of peak hours or peak time period); and **(2)** hybrid tariff structure using energy, demand and fixed charges.
- The definition of peak usage for generators could refer to their rated capacity (maximum net capacity that can be delivered to the transmission network under normal conditions of operation). The definition of peak usage for load entities could refer to their observed load during the settlement period in which system peak load occurs and some number of settlement periods around the peak load or the connected/contracted load.

Transmission Connection Charge

- The transmission connection charge should cover the cost of transmission connection assets (shallow concept) without taking into consideration any reinforcement requirement in the transmission network infrastructure.
- The transmission connection charge should cover the costs of spurs between generating stations and the core transmission network.
- The transmission connection charge should be paid by each transmission service user connected to the federal transmission network and

should reflect the individual cost of the transmission connection assets.

- ! The transmission connection charge should be set to recover the reasonable connection costs (including capital and O&M costs) including a return on the transmission connection assets. The transmission connection charges will be subject to regulatory control.
- ! The transmission connection charge should be denominated in RUB/year and paid by each transmission service user connected to the transmission network.
- ! The transmission connection charge could include a termination payment (in the case that transmission service users connected to the transmission network wish to be disconnected) that should cover the cost of transmission connection assets still not covered till the date of termination and any additional costs resulting from the disconnection.

Transmission Price Control

- ! The regulatory framework must be structured in a way that does not discourage certain sources of finance and investment. The analysis of the credibility of the political and economic environment and the credibility of the regulatory framework are closely interlinked. Investors will only be interested in an engagement in the power industry if there is a transparent regulatory process that is credible and time-consistent. This credibility is largely dependent upon the perceived independence of the regulator.
- ! Under conventional rate of return regulation rates of regulated service, providers are reviewed on a regular basis and have to be adjusted (a process called "regulatory review") to lower levels if cost savings have been achieved in the interim (since the last review). Regulated service providers thus only benefit from cost savings to the extent that regulatory reaction to cost savings is lagged (this lagged reaction is called regulatory lag). Additionally the rate of return regulation creates overcapitalization (over-investment in fixed assets) incentives and potentials for increase of capital costs.
- ! Under cap regulation, a restriction is imposed on the growth rate of prices (basket of prices or individual prices) or revenue. The regulatory cap formulas also include indexes of some inflation indicator (e.g., the RPI or the CPI). In addition, regulated service providers are obliged to reduce their prices (price cap) or revenues (revenue cap) each period according to some assumed productivity growth rate that is to be determined by the regulator.
- ! Decoupling price from costs under cap regulation creates strong incentives for efficiency improvement as any cost saving directly translates into higher profits. However, both theory and practice suggest that, without additional quality regulation measures, these incentives eventually lead to perverse quality degradation.
- ! A number of alternative options for cap control were reviewed and two were pre-selected: revenue cap and tariff basket cap. Both of them are widely used in international practice. Revenue cap is a form of economic regulation with low regulatory involvement where a limitation is imposed on the revenue earned for provision of regulated services. Under tariff basket cap regulation, a limitation is imposed on a basket composed by the weighted (by means of quantities) tariff components charged for provision of regulated services. The important advantage of the revenue caps is that they support revenue stability; i.e., the revenue does not fluctuate with changes of demand. For this reason, the revenue caps are frequently preferred for the purposes of transmission price control. The advantages of the tariff basket cap include: strengthening links between marginal revenue and tariff structure; keeping the link between revenue and costs; minimising complexity and absence of forecast and correction factors. From the two pre-selected options, the revenue cap is preferred.
- ! The philosophy proposed requires that the FEC regulate transmission activities based on the premise that the regulated charges will bring sufficient revenues to cover the costs of provision of transmission network service (i.e., on revenue/prices of transmission use of network charges) including the O&M and capital costs of the regulated transmission network business of the FNC. The transmission connection charges will be regulated as an excluded service (i.e., outside of the proposed cap) and will be based on the cost of connection including a reasonable return on the transmission connection assets. All charges collected for provision of non-regulated services provided by the FNC, if any, are not subject to regulatory price control and will be excluded from the regulatory cap imposed on the transmission network service provision.
- ! Partial decoupling of revenue/price from costs under cap regulation creates strong incentives

for efficiency improvement as any cost saving directly translates into higher profits. However, both theory and practice suggest that, without additional quality regulation measures, these incentives may eventually lead to quality degradation. Therefore supplementary measures for quality control will be necessary. The FEC should require annual reporting from the FNC on all transmission system incidents that involve loss of supply to customers (including downstream distribution companies). Because such failures will be infrequent, reporting can relate to each individual incident. In addition, FEC might require that FNC report on other quality factors for its network, even though these do not relate to loss of supply. These include the extent to which parts of the transmission network are unavailable for service during the reporting year and the reasons for such unavailability.

! As the cap regulation is a new form of price control for Russia, it is recommended to start with a shorter regulatory period, e.g., three years. This will give the FEC the opportunity to balance the incentives and the uncertainties resulting from the lack of experience and reporting of data. The regulatory framework must be structured in a way that does not discourage certain sources of finance and investment. The analysis of the credibility of the political and economic environment and the credibility of regulatory framework are closely interlinked. Investors will only be interested in an engagement in the power industry if there is a transparent regulatory process that is credible and time-consistent. This credibility is largely dependent upon the perceived independence of the regulator. Lack of transparency and clarity on timing and conditions for application of alternatives might increase significantly the regulatory risk in the Russian power sector. The creation of a credible and time-consistent energy regulation is an important factor for the future successful market reform evolution and the attraction of investor capital in the Russian power industry.

Transmission Capacity Rights

If transmission capacity rights will be applied in Russia, the following should be taken into consideration:

! The design of the transmission capacity rights should reflect the detailed features and properties of the wholesale market.

! The conceptual framework for transmission capacity rights should be developed and co-ordinated with evolution of the wholesale electricity market in order to mitigate the risks during the transition period.

! The existing system users should be given the opportunity to receive transmission capacity rights. They could receive transmission capacity rights “free of charge,” however, following strictly defined rules and procedures (including definition of volume and lengths of rights).

! In the case of new market participants (who expect significant transmission congestion), transmission capacity contracts could be obtained from the holder(s) of existing transmission congestion contracts if there are such for sale between the two points. In the case of new investment in the transmission networks, new transmission capacity rights will be issued. □

List of Acronyms and Definitions

ACCC	Australian Customer and Competition Commission
ATS	Administrator of Trade System
CEE	Central and Eastern European Countries
CPI	Consumer Price Index
CRNP	Cost-Reflective Network Pricing
FEC	Federal Energy Commission
FNC	Federal Network Company
FOREM	Federal Market for Energy and Capacity
GenCo	Generation Company
ICRP	Investment Cost Related Pricing
IPART	Independent Pricing and Regulatory Tribunal
LRMC	Long-Run Marginal Cost
NCIS	Network Configuration Information System
NECA	Australian National Electricity Code Administrator
NEM	National Electricity Market
NGC	National Grid Company
O&M	Operation and Maintenance
PBR	Performance-Based Regulation
RNC	Regional Network Company
RPI	Retail Price Index
RPP	Regional Power Pools
SO	System Operator
SRMC	Short-Run Marginal Cost
SupCo	Supply Company
TSO	Transmission System Operator
WACC	Weighted Average Cost of Capital