Regulatory Approaches to Managing Investment Uncertainty

An ICER paper

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1 Introduction

Investments in energy infrastructure, such as pipes, wires, transformers and generating plants are normally long lived. Typically the life of such assets may be 40 years or more.

There are different ways in which investors in such assets seek to make a profit over such long periods. Purely commercial investments rely on signing contractual commitments with other market participants. An investor in a power station might sign contracts with electricity suppliers for at least part of the output of the proposed plant so that a secure stream of income is established. Other types of investment rely on a regulated income stream in order to achieve a return on that investment. Once the investment is made (and is agreed to be efficient by the regulator, or in the wider public interest) then the capital cost of the investment is included in the regulated asset base and the cost recovered through regulated tariffs.

This report addresses the issue of regulated investments. In these ways, investors are shielded from uncertainties which would increase their investment risk and their cost of capital. Such risks could include uncertainties over the future volume of demand, technology changes, and changes in market prices. The ability of investors in network infrastructure to access capital with a relatively low cost of capital compared with normal market investments benefits both the investors and also consumers. Consumers, as a result of these regulatory mechanisms, pay lower prices than would otherwise be the case.

The commonly used approaches to regulating investments (cost plus or rate of return, and price cap or revenue cap regulation) have worked well in the relatively stable conditions which have prevailed:

- Rate of return: cap on the return on capital invested or equity;
- Price cap: cap on the unit price;
- Revenue cap: cap on allowed recoverable revenues

The latter two approaches are sometime also known as CPI-X, or RPI-X regulation.

These approaches to regulating network investments have enabled investors to have considerable certainty that they will receive a fair return on their investments and, as a result, the cost of capital of the investments of regulated utilities under such regimes has normally been low compared to unregulated industries. This has benefitted consumers since this regulated approach has minimised the overall cost of the system and thus tariffs.

These regulatory approaches, whilst successful, have some disadvantages when the context changes significantly. Where there are changes which are not easily predictable during the regulatory period, there are likely to be risks associated with the resulting uncertainty. In these circumstances, the additional risks must be managed effectively to minimise them, and ultimately must be borne by either the network operator (investor) or consumers (network tariff payers), or a combination of the two. The task of regulators in these circumstances is to ensure that the regulatory approach is effective at ensuring these risks are properly managed, and that risks are allocated appropriately between investors and consumers, whilst also ensuring that necessary investments take place.

The commonly used forms of regulation mentioned above are principally designed to encourage efficient investment, and in some cases to encourage greater efficiency gains by the network operator. Consequently, where an investment is considered as essential, but its risk is increased as a result of uncertainties resulting from, for example, a lack of information, then the inclusion of the investment in the regulated asset base passes the risks associated with the investment to consumers. This situation might arise, for example, in the case of a power line to connect a new wind generation site to the network, but where the actual capacity of wind generation is unknown, as well as the timing of when the wind generation plants will be built.

Regulators in many countries have sought to address the issue of how effectively – and actively - to manage risks associated with essential investments. In order to achieve that outcome, it is essential to identify the entity best able to manage those risks and to ensure that they have a clear interest in doing so. This issue has become of increasing importance in many countries as a result of changes in technologies (such as smart meters and smart grids) and policy decisions by governments which have increased substantially investments in renewable generation.

This paper examines a number of approaches to managing uncertainties and the risks which result from these changes. The overall aim is that managing risks effectively will ultimately benefit energy consumers (as well as investors and energy utilities)

2 Methodology

In order to assess the approaches adopted to the regulation of investment during periods of uncertainty, the methodology applied has been:

- To gather information through a series of case studies. The case studies cover a range of perspectives and different aspects. The case studies are listed in Annex 1;
- To undertake an analysis of the risk management principles to be applied to regulated investments in idealised circumstances;
- To make an assessment of the case study material to determine common themes, together with a comparison to the idealised risk management principles; and
- Two workshops have been held to examine the principles and case study material. The workshops included representatives from regulatory authorities, regulated utilities, external experts and financial institutions.

3 Summary of main findings

In many countries, the circumstances in which energy investments are made is increasingly subject to prospective change which results in uncertainty. Managing the risks associated with uncertainty is therefore of growing concern. In the case of regulated assets, national regulatory authorities can have a significant effect on how these risks are managed. Risks which result from uncertainty about future developments cannot always be eliminated or reduced. However, active management of identified risks can minimise their potential impact and cost.

The case studies illustrate different aspects of risk management and the approaches that a number of regulatory authorities have adopted to the management of those risks. A principal means available to regulators to manage investment risks is to ensure that the management of those risks is undertaken by the entities best able to do so, and that those entities have a clear incentive to actively manage the risks as effectively as they are able. However, regulators have also adopted strategies which include enhancing their analysis of the nature of risks so that they are better able to understand them (e.g. Mexico) and incentivising innovation in order to find new solutions to ameliorate identified risks (e.g. Italy).

The options available to regulators for managing the risks inherent in regulated investments depend on a number of factors. These factors include the nature and state of development of the regulatory framework; the level of development of the energy market; and the types and extent of government policies which intervene in the market. In some cases, the market arrangements may be, for historic reasons, restrictive to the entry of new services.

Incentive arrangements implemented by regulators to manage the risks associated with future uncertainties depend on the specific circumstances which prevail in their market. It would seem that there is scope in many countries to enhance the effectiveness of incentive regulation as circumstances allow.

4 Managing and mitigating uncertainty

4.1 Policy frameworks

The energy policy frameworks established by governments establish the boundaries within which national regulatory authorities and other actors are able to operate. The policies provide the tool set available to regulators to enable them to act, restrict the scope of their operations, and often contain areas of direct intervention by governments with the aim of achieving wider public policy goals relating to sustainability, competitiveness or security of supply.

Some of the case studies offered for this report describe policy frameworks in which regulators and grid operators are bounded. These frameworks differ from each other and affect the tools, approaches, and facilities developed and used for managing the risks associated with future uncertainties.

A major theme in all of the case studies is the growth in penetration of non-programmable renewable generation as a result of government policy interventions to tackle climate change. The effects of a major (subsidised) growth in renewable generation include:

- Displacement of traditional (including thermal) generating capacity from the merit order;
- Growth in the requirement for programmable (flexible) capacity, including from the demand side;
- Higher requirement for reserve capacity, including from the demand side;

- New investments in the grids are required to connect new renewable generation sites which are normally in different places geographically to traditional generation plants and of smaller capacity (and so there are many more of them for the same level of capacity); and
- Gas networks will need to react more quickly to the requirement of the electricity networks for flexibility.

These effects give rise to uncertainty because they reflect significant changes to the traditional model of power generation in which large, often thermal, generating plants have provided the services that the system operator requires to ensure system security. Managing these uncertainties is essential if system security is to be maintained at current levels and in ensuring that the costs of managing uncertainty are minimised.

Some of the uncertainties are (this is an illustrative, not exhaustive, list):

- Future sources of reserve and flexible capacity, particularly in respect of future demand side involvement;
- The extent and timing of technical innovation;
- The location and size of new sites for renewable generation (network development to connect new sites normally takes longer than the construction of renewable generating plants); and
- Future size of the gas market in many countries which, in turn, gives rise to concerns over stranded assets.

4.2 Regulatory approaches

A range of different approaches and tools have been developed by regulators for managing and mitigating the risks associated with future uncertainties.

The traditional approach to regulating investments in networks has been to provide network companies with an assurance that they will get a fair return over a long period on their network investments, provided the investments are judged by the regulator to have been made efficiently. The widely used methodologies for achieving this are cost plus (in which investors get a defined rate of return on their investment, plus recovery of their operating costs) and price or revenue cap regulation (also known as 'RPI-X,' in which investors receive a defined rate of return on their efficient investments, less an amount assumed for efficiency gains, plus recovery of their operating costs which often also are subject to requirements for efficiency gains).
The price or revenue cap approaches have been designed to encourage greater cost efficiency over the regulated period. Both approaches place a significant burden on identifying early on which investments will be 'efficient'. In the case of rate of return, regulatory approval for investments is normally given before the investment is made, which places the burden of judgement on the regulator. Usually the regulator is not the best placed entity to make such judgements on specific investments. In the case of price and revenue cap regulation, regulatory approval for investments is normally given after the investment has been made (i.e. at the end of the price control period) on the basis of an ex post view of whether the investment has proven to be efficient. This approach places the burden of judgement on the investor.

In the case of essential investments made at a time when there is significant uncertainty about future changes which may impact the efficiency of that investment (for example, it has been difficult to determine whether or when to invest in the installation of smart meters, not least because the technology and standards have been evolving), it is very difficult to provide adequate assurance to the investor. The outcome may be that the investment is not made, or that the investor asks the regulator to approve the investment as eligible for a regulated return. In the latter case, this means that the regulator is asked to pass the risk flowing from uncertainty on to consumers.

In the light of growing risks associated with future uncertainty in relation to investments in network infrastructure, a number of regulators have developed enhanced approaches to managing these risks. Regulators play an important role in allocating the costs of regulated investments, such as transmission, distribution and interconnection investments, through the tariff setting process. In addition, different approaches are applied to the financing of investments and to the setting of revenues when there are uncertainties. The incorporation of innovation into the revenue setting process is a further area where uncertainties must be managed, including encouraging network operators to actively seek benefit from technical developments such as smart grids facilities.

A number of regulators have developed and introduced enhanced regulated incentive arrangements. The Netherlands has in place an approach which is based on incentive (RPI-X) regulation for low risk investments. However, the approach has a facility for identifying essential investments where the level of risk is higher because they are exceptional. In the case of exceptional investments, the tariff is set annually rather than over the normal five year regulatory period. This approach acknowledges that some projects may be essential, but may need different treatment if they are to proceed.

In France, the regulator has introduced an incentive regime to increase the level of interconnection with neighbouring markets. The TSO must demonstrate that the project increases economic welfare (notably a lower cost of electricity) in order for the investment to proceed. The incentive arrangement provides financial rewards and penalties for cost efficiency and the timely implementation of the investment project, and for the efficient operation of the increased capacity. The scheme contains a ceiling and floor on the levels of reward and penalty that the TSO can obtain. This approach identifies that it is the transmission company that is best placed to manage the risks associated with the development of interconnector infrastructure, whilst recognising that it is not in full control of the outcome. By providing a reward and penalty incentive regime with limits set through a ceiling and floor arrangement, the regulator has aligned the commercial interests of the network company with the wider public interest objective of increasing economic welfare.

In Great Britain, the regulator has introduced a new regulatory approach called RIIO (Revenue setting using Incentives to deliver Innovation and Outputs). The RIIO approach is predicated on identifying outputs which the network company is required to achieve. The core outputs are subject to an incentive (RPI-X) price control which is set over an eight year period. The longer time period is intended to give greater certainty for investors on those outputs where there is reasonable certainty. A package of financial incentives is overlaid on the price control which provides rewards and penalties (subject to caps and collars) aimed at encouraging efficient performance by the network companies in relation to specific outputs. Incentives include encouragement for innovation for a limited period. The RIIO framework also includes an uncertainty mechanism which is intended to manage risks associated with essential major investment projects which occur within the eight year price control period. For these projects, regulatory approval is required. If approved, the project is defined as a further output under the RIIO framework. The RIIO approach is intended to provide a comprehensive framework for regulating networks including in respect of managing risks resulting from uncertainty.

A more specific approach to encouraging innovation has been applied by the Italian regulator. As a consequence of extremely high penetration of renewable generation (both solar and wind), it was recognised that much greater access to flexible capacity would be required in order to ensure system security. The Italian regulator decided to apply incentives to encourage a limited number of pilot projects aimed at demonstrating and developing the technology of electricity storage. Two types of storage technologies were targeted. For “energy-driven” applications, the selection criteria were related to the anticipated mitigation of curtailments of renewable (wind) generation as a result of network congestion. In this case, a criteria was that the storage projects could be replaced with normal network infrastructure in due course, so only removable storage systems were allowed. The second storage application is “power-driven”, i.e. it is able to provide additional system stability, thanks to its extremely fast response to frequency perturbation. The TSO was incentivised and payments under the scheme were dependent on performance of the pilot projects.

To qualify for an incentive payment, the “energy-driven” storage pilot projects must exceed a threshold level of avoided congestion curtailments for a given volume of energy stored; whilst in the case of power-driven storage application the pilots, that have been located in major islands (Sicily and Sardinia because, there, RES penetration and a consequent reduction of thermal generation may result in serious system instability under certain conditions) will be aimed also at defining a benefit indicator as a target reduction in risky situations that could lead to energy not supplied (ENS). This approach is aimed at encouraging innovation in a way which addresses developing problems identified in the Italian grid.

An extremely important feature of the demonstration project approach is that information gathered through the pilots is widely disseminated to other market participants to encourage wider commercial application.

The Australian regulator has developed an approach for managing the risk associated with the rapid development of renewable generation which has exceeded the ability of the network to expand capacity to keep pace. In this case, the regulator has changed the approach for generators seeking access to the network. In the past in Australia, access to the network was on a non-firm basis. The effect of this is that where a generator has to be constrained off (i.e. told to reduce its output) by the TSO, the generator receives no financial compensation for its lost output. If access rights are firm, then the generator can expect to receive financial compensation for the value of lost output if it is constrained off. As a result of the system of non-firm access rights, new generators connecting to the network had no interest in the effect of their plant on congestion on the network since these costs were shared with other plants which were already connected.

As a result, congestion could be exacerbated in some locations. In order to address this problem, the Australian regulator introduced a system whereby generators could purchase firm access rights, thus insuring themselves against the commercial cost of being constrained off. Under this system, those generators in areas subject to congestion can be expected to purchase firm access rights, which give a clear indication to the TSO on which locations need system reinforcement. The cost of providing compensation to generators holding firm access rights is spread across generators which have non-firm rights. Under this approach, an incentive is provided through the network access regime which is targeted at the specific problem identified.

In France, it was identified that the rules for the connection of new renewable generation to the network gave rise to risk for renewable generation developers, although all risk to the network company was avoided. The system was based on first come first served with the application of a deep connection charging policy in which the generator wishing to connect who triggers the need for reinforcement of the network beyond the connection (i.e. deeper into the grid) is required to pay a proportion of the cost of the necessary reinforcement. The consequence of these two factors was that the first applicant for the connection to the network would bear the relevant costs of the necessary reinforcements to the network, whilst later applicants could potentially free ride on the enhanced network capacity resulting from this reinforcement. In effect, this arrangement allowed the network company to avoid the risk associated with the future uncertainty of how much new generation capacity would connect by passing on a proportion of the costs of reinforcement to an individual generator. As a result, there was evidence that less developed areas of the French network were being avoided by renewable generation developers. In consequence, a new system was introduced, whereby sites could be identified in which applications for generation connections would remain valid for a long (10 years) period. The costs of necessary reinforcement would then be allocated to all of the successful connections. In this case, the small risk that reinforcements would be underutilised was transferred to network tariff payers.

The PJM Market Operator identified that the growing penetration of unprogrammable renewable resources was changing the requirements to meet system security standards, whilst at the same time technology developments were leading to new types of resources becoming available which could potentially meet this changing need more efficiently than traditional resources. However, the existing market arrangements for system security services (principally frequency response in this case) were not developed sufficiently to enable new services to enter the market. In response to the need to develop the market arrangements, FERC issued a new Order which allowed PJM to develop suitable new market rules.

The new market enabled the valuation of frequency response services according to the actual performance of the service provided, so new services (such as electricity storage) that could provide needed services in different ways to traditional providers could be appropriately rewarded.

In this case, the technology risk identified by the market operator was addressed by enabling a market-based solution which was based on valuing outcomes and was not specific to particular technologies.

5 Methods of assessment and analysis

Regulators have developed better analytical tools to help them to assess the nature of risks which are associated with perceived uncertainty. Good analysis can help to understand these risks as well as the prospect of the risk becoming a reality.

The Mexican regulator developed statistical models based on both stochastic and deterministic approaches which helped the regulator to analyse in more depth the impact of a significant growth in generation from photovoltaic sources. The use of these models helped the regulator to have confidence that more PV generation would be very likely to coincide with periods of peak demand in Mexico and so would help to ensure system adequacy and would reduce the prospect of loss of load.

The Electric Power Research Institute (EPRI) developed a methodology with the US Department of Energy which is aimed at enhancing the capacity of regulators to undertake a cost benefit analysis (CBA) including an assessment of the societal and economic welfare benefits resulting from proposed projects. EPRI points out that CBA analysis is particularly relevant in the case of projects which are not essential from a system security perspective but where the justification revolves around its wider benefits.

The Italian regulator developed a number of analytical indexes useful for identifying special conditions resulting from high penetration of renewable generation connected to distribution networks. As distribution networks are designed and operated radially, these indexes are based on the identification of “reverse power flows” from medium voltage distribution networks towards high voltage transmission networks. Those indexes are being implemented to enable the regulator to (i) set criteria for assessing requests from renewable generators for new connections to the distribution grid; (ii) to select those distribution grids that are suitable for the development of smart grid pilot projects; and (iii) in the near future, to assess the effect of high RES penetration on distribution network losses.

The development of analytical tools is essential and needs to continue in order to enhance the capability of regulators to assess prospective changes and the associated risks resulting from uncertainty.

6 Good practices

The case studies accompanying this report demonstrate a range of approaches which have been developed for the management of risks associated with uncertainty. The approaches can be described in the following way:

a) Some risk (i.e. through exposure to a possible financial penalty and reward) should be allocated to the entity best able to manage that risk in order to align their commercial interest to the wider public interest.

The case studies illustrate a number of ways in which regulators have developed incentive arrangements which expose regulated entities to potential (but limited) penalties and rewards (i.e. ceiling and floor financial incentives) in return for achieving defined outcomes consistent with the effective management of identified risks. As well as defining the penalty and reward arrangements, it is essential that the targets that must be met to trigger rewards (or penalties) are clearly defined.

The case studies illustrate that the approaches to the incentivisation of regulated entities are still developing and would benefit from further collaboration between regulators to share experiences.

b) The arrangements for appropriately rewarding infrastructure projects with higher levels of risk (relative to other comparable projects) should consider the time period for recovering efficient costs and rewards.

Price controls for regulated entities usually last for 4 or more years. This provides significant certainty to investors and provides a level of incentivisation to improve efficiency since the savings from efficiency can be retained by the entity for the remainder of the regulatory period. In the case of investments where there is significant risk relative to other comparable projects resulting from uncertainty about future change, then the normal regulatory period may not be appropriate.

The time dimension is an essential aspect for regulation in order to cope with systematic risks. The RIIO approach applied in Great Britain illustrates this point: lower risk investments have an 8 year regulatory period, whilst higher risk projects are looked at individually and are likely to have a much shorter regulatory period. On the other hand, in order to give certainty, some regulators have introduced specific incentives for strategic investments enduring for a period longer than an ordinary regulatory period.

The case studies illustrate that regulators have identified this issue and have responded by introducing mechanisms through which project specific price controls (and incentives) can be introduced within a price control period. In this way, appropriate incentives can be set for a specific essential, but relatively risky, project separately from the normal price control.

c) The tools available to regulators to manage risks may extend beyond price controls or rate setting.

The case studies demonstrate that where a very specific issue is identified then there may be regulatory tools other than price controls and rate setting which are appropriate. In the case of the Australian regulator, network access tariffs were used as a mechanism to deliver commercial incentives to market participants. This remedy was specific to the circumstances in Australia and aimed at a well-defined issue.

This illustrates that all regulatory options should be considered.

d) Analytical tools for the assessment of uncertainty and the associated risks are of central importance.

Although risks associated with uncertainty cannot be removed, it is important that the level and potential impacts of the risks are well understood before measures to manage risks are designed. Risks stemming from future uncertainty can be investigated through the use of analytical techniques which help to weigh the risks of different potential outcomes. The use of stochastic analysis as a complement to deterministic analysis is a good example since stochastic analysis (e.g. 'Monte Carlo' simulation) enables the prospects of many different possible outcomes to be considered and the relative likelihood of particular outcomes assessed. Further useful tools include locational indexes that can help regulators to identify selectively the most critical network situations that may require specific regulatory treatment.

Regulators should continue to share information on the development and application of analytical tools.

e) Pilot projects can be a useful way to prove new techniques and technologies

A number of regulators (including in Italy and Great Britain) have allowed limited regulated funding to encourage pilot projects to encourage innovation and demonstrate the application of new technologies. An important feature of these successful approaches is that information gathered through the pilots is widely disseminated to other market participants to encourage wider commercial application. In this way, the benefits of new technologies and innovative approached can be delivered more quickly to consumers.

Annex 1 – Case studies

- Case study by ACM (The Netherlands)
- Case study by AEEGSI (Italy): Pilot projects for energy storage systems operated by a TSO in a context of high res penetration: the case of Italy
- Case study by AEEGSI (Italy): Simplified locational indexes used by the Italian energy regulator to selectively deal with the impact
- Case study by AEMC (Australia): Optional Firm Access (OFA) - A new model for generator access and investment in transmission
- Case study by CRE (France): New regulatory framework to foster electricity interconnection development at the French borders of distributed generation
- Case study by CRE (Mexico): New regulatory framework to foster solar energy integration into the Mexican power sector
- Case study by EPRI: Cost/Benefit Analysis and Challenges for Investing in the Grid
- Case study by PJM: Electric Market Incentives for Distributed Resources
- Case Study by OFGEM (UK): Regulatory approaches to uncertainty (UK - Ofgem's RIIO framework for regulating energy network companies)
- Case study by RTE (France): Schemes for the Connection of Renewable Energies to the Network (S3REnR)

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