Europe Economics

Risk Allocation Mechanisms for Highly Anticipatory Infrastructure Investments in the Energy Sector

9 March 2020

Europe Economics
Chancery House
53-64 Chancery Lane
London WC2A 1QU

Tel: (+44) (0) 20 7831 4717
Fax: (+44) (0) 20 7831 4515

www.europe-economics.com

Contents

1 Introduction ... 3
1.1 Objectives of the research ... 3
1.2 Methodology ... 4
1.3 Report outline ... 5
OVERARCHING ISSUES ... 7
2 Justifying Highly Anticipatory Infrastructure Investment ... 8
2.1 Framework to assess costs and benefits of investments ... 8
2.2 Valuation of impacts ... 9
2.3 Dealing with risk and uncertainty ... 10
3 Approach to Risk Allocation ... 14
3.1 Selecting an appropriate risk allocation mechanism ... 14
3.2 Appropriate balance of risk for consumers ... 15
COMPENDIUM OF RISK ALLOCATION MECHANISMS ... 17
4 Mechanism to Defer Decision till Information Is Better ... 18
4.1 Price control reopeners or interim reviews ... 18
5 Regulatory Mechanisms Based on Ex Post Information ... 21
5.1 Ex post prudency test ... 21
5.2 Capex trigger ... 24
5.3 Ex post removal of stranded assets from RAV ... 27
5.4 Error correction mechanism ... 29
5.5 Caps and collars on return on investment ... 31
5.6 Funding through outcome delivery incentives ... 35
6 Mechanisms Affecting Allocation between Consumer Groups ... 39
6.1 Ring-fenced funding from customers who use the new infrastructure ... 39
6.2 Economic depreciation ... 41
7 Market-based Mechanisms ... 44
7.1 Negotiation between infrastructure provider and customers ... 44
7.2 Market-based investment incentive ... 47
8 Mechanisms Involving Subsidy ... 50
8.1 Capital grants from government ... 50
8.2 Demand assurance ... 52
9 Other Risk Allocation Mechanisms ... 56
9.1 Management incentives ... 56
9.2 Availability-based payments ... 59
10 Conclusions ... 62
10.1 Overarching issues ... 62

10.2 Compendium of risk allocation mechanisms 62
Appendix 1: Reference List 65
List of general sources consulted 65
List of sources consulted in relation to specific risk allocation mechanisms 65

1 Introduction

In this chapter we first summarise the objectives of the research, followed by a summary of the research methodology employed. Finally, we outline the structure of the report.

1.1 Objectives of the research

Investment in energy infrastructure can be made in anticipation of future demand, to meet current demand, or a combination of both. When infrastructure is developed to meet demand that has not yet materialised, but is anticipated to materialise at some point in the future, it faces a level of uncertainty over the extent of its eventual use. This means that there is a material risk that the new infrastructure becomes stranded, raising the question of how this risk should be apportioned between stakeholders.

In its role as an advocate for consumers in the regulated markets, Citizens Advice would like to be equipped with the necessary tools to engage constructively in discussions over how best to apportion the risks of highly anticipatory infrastructure investments in the energy sector in Great Britain. Consequently, Citizens Advice has commissioned Europe Economics to answer the following questions in the course of the project:

- What mechanisms could be used to limit or share the financial risk for energy bill payers in the context of highly anticipatory energy infrastructure investments in GB? Which groups would consequently bear risks and pay for the project during development, construction, and operation?
- Which mechanisms may be more or less suitable for different kinds of investments and projects?
- What is the appropriate balance of risk for consumers (and how should this be defined)?
- What is best practice in terms of how highly anticipatory investments should be justified and evidenced?
- How do the specific mechanisms affect the cost of capital?

1.1.1 Highly anticipatory infrastructure investment

Anticipatory infrastructure investment refers to investment in infrastructure for which firm user commitment is not obtained at a particular point in time.[1] When this infrastructure investment is 'highly anticipatory' it generally means that there is a very high level of uncertainty about future utilisation of the infrastructure. Due to the uncertainty over end-user demand, highly anticipatory investments create financial risks because of the possibility of asset stranding. In the energy sector, asset stranding can be problematic for consumers since a large proportion of the financial risk of infrastructure investment can be passed on to bill payers through the inclusion of investment in the Regulatory Asset Value (RAV) of energy network companies. National targets for decarbonisation and the drive towards alternative, renewable sources of energy may compound this risk at the present time because they increase uncertainty over the future shape of the energy sector, and hence raise the risk of asset stranding.

1.1.2 Risks associated with highly anticipatory infrastructure investment

In the context of highly anticipatory investments by definition the most relevant risk faced by companies considering whether to undertake these investments is demand risk, i.e. the risk associated with the possibility that demand for the new infrastructure does not materialise or does so at a level lower than anticipated.

[1] Strbac et al. (2016), 'Delivering future-proof energy infrastructure', http://www.biee.org/wpcms/wp-content/uploads/Future-proof_energy_infrastructure_Imp_Cam_Feb_2016_NIC.pdf

Consequently, our analysis has focused on the demand risk associated with these investments, while also considering other types of risks where appropriate.

The demand risk associated with these projects may arise from a range of factors, such as changes in end-customer demand for energy, changes in the geographical patterns of energy flows, changes in the balance of gas versus electricity consumption, changes in government policy (e.g. on decarbonisation) affecting demand for the new infrastructure, or the emergence of a new technology that reduces demand for the existing technology embodied in the infrastructure project or that reduces the competitive price that can be charged for the output (in a non-regulated setting).

1.2 Methodology

The first section of the report presents some overarching issues relating to highly anticipatory infrastructure investments. These include a general framework that firms may apply in carrying out cost-benefit analysis to justify these highly anticipatory investments, and discusses some options that can be used take account of risk and uncertainty associated with these investments, including real options theory. Then it provides some guidance on the selection of an appropriate risk allocation mechanism under different circumstances, and describes some key considerations relating to determining an appropriate balance of risk for consumers.

The list of risk allocation mechanisms considered in the second part of the report in the context of highly anticipatory investment has been developed through a combination of a focused review of selected recent and most relevant literature, and the experience and expertise of the project team.

All risk allocation mechanisms were then examined with regards to the following aspects:

- Description of the tool – where we present the key features of each mechanism in the context of highly anticipatory investments.
- Impact on risk allocation – where the key impacts of the tool with regards to how demand risk associated with highly anticipatory investments is apportioned between different parties under each mechanism.
- Circumstances where tool is relevant – where the context in which each mechanism is most likely to be suitable for highly anticipatory infrastructure investments is identified.
- Advantages and disadvantages – where the key advantages and disadvantages associated with each risk allocation mechanism are explored.
- Case study of mechanism in practice – for 12 of the mechanisms examined, we provide a case study setting out an example of how the particular tool has been applied in practice.
- Impact on cost of capital – we perform a qualitative analysis of how each tool could affect the market cost of capital[2] of regulated companies and the allowed return that regulators need to provide.

1.2.1 Establishing a counterfactual

When analysing the impacts of a mechanism on risk allocation or the cost of capital or considering the relative benefits and disadvantages of a risk allocation tool, it is necessary to specify a "counterfactual" as a benchmark against which the impact of the mechanism can be assessed. In general, depending on the circumstances in which each tool is applied, we consider two counterfactuals throughout the study.

- First, for mechanisms which relate to a price control setting, we use as our counterfactual a scenario in which the cost of the highly anticipatory investment is part of the firm's ex ante capex allowance and goes into the firm's RAV, meaning that the company undertaking the investment is assured of cost recovery even if the asset becomes physically stranded. We use this as our counterfactual because this would be the standard approach in a regulatory context.

[2] The cost of capital is the expected return required by investors to provide finance for an investment.

- Second, for mechanisms which are relevant primarily outside a price control setting, we consider a counterfactual in which the firm is assumed to be fully exposed to demand risk, as it would typically be the case for an investment decision made in a free market environment.

1.2.2 Impact on cost of capital

The impact of each tool on the cost of capital was analysed in relation to both the regulated company's market cost of capital and the allowed rate of return provided by the regulator. Below we explain each of these impacts in turn.

First, let us explore the impact on the company's market cost of capital. Under the Capital Asset Pricing Model (the standard approach to estimating the cost of capital), risks are classified into two groups –specific and systematic risks. Specific risks are those risks that only apply to a particular asset class. Investors can protect themselves against specific risks by holding a diversified portfolio of assets, meaning that these risks do not affect a company's cost of capital. By contrast, systematic risks are risks that are characteristic of the entire market and are hence non-diversifiable. Therefore, under this framework only systematic risks affect the cost of capital. With regards to highly anticipatory investment, to the extent that demand for the infrastructure is driven by macroeconomic variables, this will mean that the firm is exposed to greater systematic risk. This will increase the cost of capital for the highly anticipatory infrastructure project.

Second, if a risk allocation mechanism exposes the firm to downside demand risk, the regulator may also need to set the allowed rate of return on the Regulatory Asset Value (RAV) above the cost of capital if it wished to incentivise the firm to carry out highly anticipatory investments. The reason for this is as follows. Given that the firm will earn much less than the cost of capital if demand does not materialise, the firm would need this to be offset by the potential to earn more than the cost of capital in a scenario in which demand does materialise in order for the ex ante expected return at the point of investment to equal the cost of capital.

1.3 Report outline

The report is organised as follows:

The overarching issues chapters present our guidance on best practice in justifying highly anticipatory infrastructure investment and on which mechanisms are most applicable for different contexts.

- Chapter 2 provides our guidance on justifying highly anticipatory investments in energy infrastructure.
- Chapter 3 provides our guidance on how to think about the section of a risk allocation mechanism and about most appropriate balance of risk for consumers.

The compendium of risk allocation mechanisms describes the various risk-sharing tools which may be used to allocate the risks associated with highly anticipatory investments across different stakeholders.

- Chapter 4 presents a mechanism which allows a regulator to defer a decision until the available information is better.
- Chapter 5 explores regulatory mechanisms which are based on ex post information.
- Chapter 6 describes mechanisms that affect risk allocation between customer groups.
- Chapter 7 presents market-based risk allocation mechanisms.
- Chapter 8 explores risk allocation mechanisms involving a subsidy from the government.
- Chapter 9 looks at other risk allocation mechanisms, including management incentives and availability-based payments.
- Chapter 10 concludes with a summary of which mechanisms may be most relevant under different circumstances.

Appendix I presents the list of references consulted for the identification of risk allocation mechanisms and the case studies used to illustrate these tools.

Overarching Issues

Europe Economics

2 Justifying Highly Anticipatory Infrastructure Investment

Uncertainty over the nature and extent of future demand for infrastructure poses practical challenges for energy companies in developing investment plans. How should they decide whether to propose investment in specific projects in the context of uncertainty about what the future will look like? Whilst anticipatory investments may prove less costly than having to expand infrastructure in the future, how can they justify investment when there is substantial uncertainty around the demand projections on which the investment is based?

In this chapter we first present a general framework that firms might use in carrying out cost-benefit analysis to justify these investments. This is followed by a brief discussion on how these costs and benefits may be monetised. Finally, we present a high level description of approaches that can be used to take account of risk and uncertainty in this context, particularly the demand risk which is the defining characteristic of highly anticipatory infrastructure investments.

2.1 Framework to assess costs and benefits of investments

It is important that the assessment of investment options follows a reasonably structured process, to help ensure that all relevant considerations are taken into account. The following questions summarise key issues that should be addressed:

- What is the rationale for the highly anticipatory investment? The starting point is to consider whether there is a robust justification for the highly anticipatory investment. If this is not the case, then the investment should not be pursued.
- What are the goals associated with the highly anticipatory investment? Once the rationale for an investment has been identified, the next step is to produce a clear statement of objectives, which plays an important role by helping to promote a focused approach to the identification and assessment of investment options.
- What are the possible options for the highly anticipatory investment? The assessment should assess a range of investment options which could meet the stated objectives. In addition, it is also necessary to specify what is referred to as a "counterfactual" as a benchmark against which the impact of each investment option can be assessed. In the context of a highly anticipatory investment, the counterfactual may normally comprise the "do not invest" decision. In circumstances where not investing is not an option (e.g. because the company has a legal obligation to provide a service), the counterfactual is likely to be the "do minimum" option.
- What are the impacts of each potential outcome? The impacts associated with each potential outcome should be identified and, as far as possible, quantified. Due to the uncertain nature of highly anticipatory investments, the risks and uncertainties surrounding the potential investment options (including the counterfactual of "do not invest") should be thoroughly analysed and taken into account.
- Which is the best option? Once the costs, benefits and risks associated with the potential investment options have been assessed, the company undertaking the project needs to decide whether any of the investment options should be pursued. Where benefits and costs can be quantified, the appropriate decision rule is to select the investment option which gives rise to the highest net present value (NPV), calculated as the present value of benefits less the present value of costs.

When considering highly anticipatory energy infrastructure investments, companies should also address the following three points:

- Alternative risk allocation mechanisms should be considered. In particular, companies should consider how the demand risk associated with highly anticipatory investments should be allocated between the company and its customers. A compendium of risk allocation tools is presented in the second part of this report. Section 3.1 gives some guidance on the selection of an appropriate risk allocation mechanism under different circumstances.
- Companies should conduct distributional analysis on each of the different investment options and risk allocation mechanisms to see how costs, benefits and risks are shared between parties in each case. Section 3.2 provides a discussion of some key considerations relating to determining an appropriate balance of risk for consumers.
- Companies should also engage with relevant stakeholders (e.g. household and industrial customers). When weighting the evidence obtained from different parties during the engagement process, companies should be transparent regarding the weight given to each of the views expressed. In considering views from residential customers, particular attention should be given to the views of vulnerable consumers, where appropriate.

2.2 Valuation of impacts

In this section we discuss techniques that may be used to monetise the costs and benefits associated with highly anticipatory investment options. We note that monetising of the impact may not be possible on all occasions, in which case the respective costs and benefits should be discussed and evaluated qualitatively.

A resource should be valued at its opportunity cost, defined as the value that the resource would have in its next most productive use. If the benefits of an investment option are lower than the costs when calculated on this basis, then the investment will reduce efficiency because resources will be re-allocated away from more productive uses.

2.2.1 Market values

Where there is a market value for a particular good or service, it will normally be appropriate to use this value in carrying out the impact assessment. This is because, in the absence of distortions, market prices reflect underlying opportunity costs.

However, there may be situations in which it would be appropriate to adjust market prices when valuing the costs and benefits associated with investment options:

- Tax differences — where market prices are affected by the application of a different tax rate to that particular good or service (compared with the tax rate applying to other goods and services in the economy), then adjustments should be made to remove these distortions.
- Market power — prices may be higher than opportunity cost if companies operating in a particular market have market power and have used this to increase prices above competitive levels.

Consideration should be given to whether there may be significant changes in relative prices through time (i.e. after allowing for the effects of general price inflation) which need to be incorporated into the analysis. For example, prices of scarce natural resources might be expected to increase in the longer term, or high-technology products may fall in price due to innovation.

2.2.2 Non-market impacts

Investment options can often give rise to costs and benefits for which there is no market value (e.g. change in air quality). Nonetheless, an assessment of the associated costs and benefits should seek to place a monetary value on such impacts where possible. This may be done by seeking to derive estimates for:

- Customer "willingness to pay" for an increment of the outcome; or
- Customer "willingness to accept", defined as the amount of compensation required to induce consumers to accept a negative outcome.

There are two main approaches that can be used to arrive at such estimates:

- Revealed preference — this involves estimating the value that consumers are implicitly placing on an outcome by their observed behaviour in a similar or related market. Examples include:
  - The premium on house prices in an area offering environmental amenity could be used to estimate the value of that amenity.
  - The higher wage rate for dangerous occupations (compared to alternative jobs that might be open to the workers in question) could be used as an indication of the value that workers place on their own safety.
- Stated preference — this involves undertaking surveys or interviews of consumers to elicit information directly on their preferences. There are different ways in which this can be done, including:
  - Contingent valuation studies which ask consumers directly how much they would be willing to pay for particular outcomes.
  - Choice modelling, which involves asking consumers to identify their preferred choice from a series of alternatives.

For certain common non-market impacts, it may be possible to use values drawn from existing studies or government appraisal guidelines rather than conducting primary research. Examples of non-market impacts which have been studied include time, the prevention of a fatality or injury, and carbon emissions. However, the appropriate value to use may differ according to circumstances (e.g. the value of time is likely to depend on the income of the people affected).

2.3 Dealing with risk and uncertainty

Below we explore various approaches used to deal with risk and uncertainty in the context of investment decisions. First, we provide a high level overview of the techniques that exist for taking account of uncertainty within cost-benefit analysis, including techniques such as sensitivity and scenario analysis. Second, we describe real options analysis which involves the use of option valuation techniques to assist in investment appraisal.

2.3.1 Approaches for addressing uncertainty in cost-benefit analysis

There are various ways in which the risks and uncertainties associated with highly anticipatory energy infrastructure investments can be analysed. Below we provide a summary of the techniques that may be used in these cases (with the exception of real options theory which is discussed in more detail in section 2.3.2).

Sensitivity analysis involves changing the value used for one input variable at a time, in order to investigate whether the conclusions of the analysis are affected. For variables subject to risk, the choice of values to use in sensitivity analysis would be informed by the known probability distribution. Where variables are subject to uncertainty, a range of plausible values should be used.

Scenario analysis involves constructing scenarios in which the values used for a number of variables may differ. For example, scenarios might be intended to reflect potential outcomes under different "states of the world."

This type of analysis can help analyse how robust different investment outcomes are to a range of scenarios. In some situations, it may be possible to attach indicative probabilities to different scenarios, allowing calculation of the expected value of net benefits for each outcome.

Monte Carlo modelling involves running many repeated simulations in which the values used for input variables are drawn randomly from specified distributions. By carrying out many model runs each with a different set of randomised inputs, the overall variability of outcomes can be analysed. It is important to consider whether input variables are correlated or independently distributed, and to reflect this in the modelling exercise. Dedicated software packages are available to carry out this type of analysis.

Ranges should often be used when presenting estimated benefits and costs, perhaps based on the results of sensitivity or scenario analysis, or Monte Carlo modelling. Where investment outcomes are very uncertain, then ranges are likely to be relatively wide; conversely, ranges may be narrow when investment outcomes are more certain. The use of ranges makes clear to the decision-maker the extent of uncertainty, whereas the presentation of only a central estimate of benefits and costs can give a misleading impression.

2.3.2 Real options theory

A financial option is the right but not the obligation to engage in a financial transaction. A range of option valuation techniques have been developed to value financial options. Real options analysis uses similar techniques to value options that exist in investment planning.

To illustrate, the following are examples of real options that may be relevant to energy company business plans:

- Option 1: The option to expand. Energy companies may over-size facilities or build the flexibility for future expansion into their design in case future demand for the facility is greater than expected. In this scenario, real options valuation would allow a value to be placed on this flexibility.
- Option 2: The option to wait (also called option to defer). In some investment appraisals, there may be a choice between investing now in the context of uncertainty about future use of a facility, or waiting to make the investment decision until more information becomes available. Taking the former option would require the investor to receive a higher return to compensate for the destruction of the option of waiting. Real options valuation can be used to value the option of waiting, thus helping to guide decisions about when investment should take place.

In addition to the above examples, a range of other real options are also discussed in the literature.

The real options value of an investment project can differ from the net present value (NPV) obtained using standard discounted cashflow (DCF) techniques. For example, Ofgem discusses four conditions under which the answers obtained through the application of these two different approaches can be materially different.[3] These conditions include:

- The cost of the investment is at least partially irreversible (sunk).
- There is a significant element of uncertainty attached to the investment opportunity both regarding the underlying asset's volatility and the time to exercise the option.
- There exist investment opportunities allowing a flexible response to new information from management.
- The investment decision is relatively marginal in the sense that real options analysis can suggest a different investment decision compared with that suggested by the NPV analysis.

[3] Ofgem (2012): "Real Options and Investment Decision Making", p.8, available at: https://www.ofgem.gov.uk/publications-and-updates/real-options-and-investment-decision-making

Further, Ofgem also describes three key reasons why real options analysis can be useful in the energy sector.[4]

- First, given that investments in energy infrastructure are likely to be long-lived and irreversible in nature, there is a significant value in making the right decision regarding an energy infrastructure project.
- Second, the range of possible investments may involve options with different managerial flexibility attached to them, which may not be reflected in standard NPV calculations.
- Finally, current decarbonisation targets create uncertainties regarding future forms of energy production in the UK, therefore increasing the value of flexible investment options in energy infrastructure.

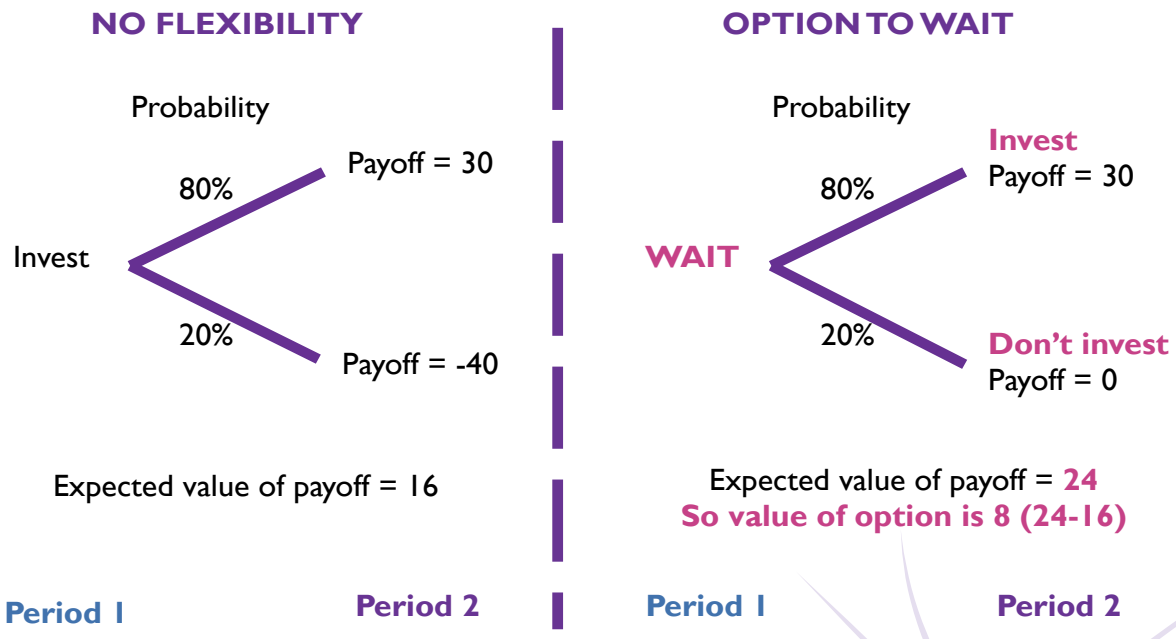
A simple way to value real options is to use a decision tree relating to a highly anticipatory investment. Let us assume that a company undertaking the investment faces two options: one offering no flexibility regarding the timing of the investment decision, and the other offering the flexibility to wait and make a decision regarding the investment when the available information is better. To calculate the value of the option to wait, let us assume that there are two possible outcomes under either investment option:

- Demand materialises, in which case there will be a positive payoff of £30m if the infrastructure is built;
- Demand does not materialise, giving a negative payoff of -£40m if the infrastructure is built, or a payoff of zero if the infrastructure is not built.

Let us assume that the probability of demand materialising is 80 per cent, and that the probability of demand not materialising is 20 per cent.

These probabilities and payoffs are shown in the decision tree below.

Figure 2.1: Decision tree to illustrate real options analysis



Source: Europe Economics.

The advantage of the second investment option is that the company can wait until Period 2 when more information on future demand is available, and can take a decision at that stage to invest only if demand materialises (but not to invest if demand is not materilising). By contrast, if the firm goes ahead with the first

[4] Ofgem (2012): "Real Options and Investment Decision Making", p.9, available at: https://www.ofgem.gov.uk/publications-and-updates/real-options-and-investment-decision-making

investment option and invests in period 1, it has constructed the infrastructure whether or not investment materialises in Period 2.

As shown in the decision tree above, the expected value of the payoff from the first investment option offering no flexibility regarding the timing of the investment decision is £16m, calculated as a weighted average of the payoffs associated with each possible outcome of the investment (with the weights given by the probabilities that each outcome will occur). Similarly, the expected value of the payoff under the option to wait is £24m, also calculated as a weighted average of the payoffs associated with each possible outcome. The difference between the expected values of the payoffs under the two scenarios represents the value of the option to wait. Therefore, the value of the option in the case of this hypothetical example is £8m.

In this case, the implication of this decision tree analysis is that there would have to be some additional benefit from investing in Period 1 worth at least £8m in order for it to be worthwhile going ahead with the investment now rather than waiting until Period 2 when there will be more information available about future demand.

3 Approach to Risk Allocation

In this chapter we first present guidance on the circumstances under which the various risk allocation mechanisms explored in the second part of the report may be considered, followed by a discussion of some key considerations relating to determining an appropriate balance of risk for consumers.

3.1 Selecting an appropriate risk allocation mechanism

Table 3.1 below provides some guidance on the selection of an appropriate risk allocation mechanism under different circumstances.

Table 3.1: Circumstances under which risk allocation mechanisms can be considered

Question	Tools to consider if answer is "yes"
Is greater information on need for highly anticipatory investment likely to emerge during price control?	Price control re-openers / interim review
Does the regulator wish price controlled firms to share demand risks around highly anticipatory infrastructure with customers?	Capex trigger
	Error-correction mechanism
	Caps and collars to return on investment
	Ring-fenced funding from customers who use the new infrastructure
Will the highly anticipatory investment drive some key customer outcome?	Funding through outcome delivery incentive
Is the highly anticipatory infrastructure discrete, with scope for separate user charges?	Caps and collars to return on investment
	Ring-fenced funding from customers who use the new infrastructure
Will usage of the highly anticipatory infrastructure vary substantially through time?	Economic depreciation
Will the highly anticipatory infrastructure be used mainly by large customers, some of whom already want it?	Negotiation between infrastructure provider and customers
Is there a market in which capacity created by the highly anticipatory investment can be sold?	Market-based investment incentive
Is the highly anticipatory investment driven by government policy?	Capital grants from government
	Demand assurance
Does the firm have no private sector shareholders?	Management incentives
Is the highly anticipatory investment project about investment in generation capacity?	Availability-based payments

Source: Europe Economics analysis.

The questions in the table above reflect the conditions under which the different mechanisms explored in this report may be relevant to use. Therefore, all of the mechanisms listed against questions that get answered "yes" may be considered. However, in order to identify which of these potentially relevant mechanisms will actually be suited to the specific investment project, the full compendium entries for potentially relevant mechanisms that are presented in the second part of this report should be consulted.

We note that not all mechanisms are mutually exclusive – for example, economic depreciation could be used with any price control mechanism.

Furthermore, some mechanisms may be considered for use under multiple circumstances and therefore enter the table on more than one occasion. For example, ring-fenced funding from customers who use the new infrastructure can be relevant as a risk allocation mechanism where the regulator wishes regulated companies to share demands risks around highly anticipatory investments with customers, while it may also be used for infrastructure which is stand-alone or discrete and where there is scope for separate user charges.

At the same time, two of the risk-sharing tools (ex post removal of capex from RAV and ex post prudency test) that we explore in this report do not appear in the table above, as these mechanisms are not recommended for use in the context of highly anticipatory investments in energy infrastructure due to the serious disadvantages associated with them.

3.2 Appropriate balance of risk for consumers

Risk allocation is the process of apportioning risks to particular parties.

There is no clear criteria for deciding the 'optimal' risk allocation between parties, as what is appropriate depends on the risk in question and the means of the relevant parties. Regulators can take steps to minimize the effects of certain risks or to mitigate some risks.

When considering the appropriate balance of risk for consumers (and by extension for other parties such as the company undertaking the highly anticipatory investment, company managers or taxpayers), it is generally appropriate to allocate risks in line with the following considerations:

- Ability to control risk – risks are most likely to be managed efficiently if they are borne by the party or parties which have the greatest ability to control those risks. For example, in cases where a risk is wholly outside the control of a firm's management, and / or the risk may materially increase the company's cost of capital or the probability of financial distress, then it may be appropriate for the regulatory framework to include mechanisms that pass some or all of the risk on to customers.
- Ability to bear risk – some party or parties may be less able to bear risk.
- Risk aversion of relative parties – for example, there may be scope for allowing a lower risk allocation coupled with higher average prices for certain customers, and more volatile prices for other customers.
- Interaction with incentive schemes – limiting price volatility tends to transfer risk to firms, which in turn may strengthen incentives for efficiency.
- The party responsible for 'triggering' the risk – one respondent to Ofgem's 2018 RIIO-2 proposals noted that the risks of highly anticipatory investments should be borne by those who trigger them.[5] This could be where a new customer connecting to the network triggers the need for additional capacity.
- Potential effects of the risk allocation. Would certain options involve price volatility to the extent that it causes severe hardship to certain consumer groups, or could a risk if realised cause a firm financial difficulties so as to jeopardize its ability to operate?

In thinking about the allocation of the demand risk associated with highly anticipatory investments between firms and consumers, two key considerations should be borne in mind:

- If the firm is protected from the demand risk associated with highly anticipatory investments, the risk will instead be borne by consumers (or citizens in general, in the case of mechanisms involving taxpayer-funded subsidies). This means consumers (or citizens in general) may end up paying for the cost of stranded assets, especially since the firm would face reduced incentives to do due diligence on the original investment proposal.

[5] Ofgem (2019), "Sector Specific Methodology – Core document", p 72, para 9.72. https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_core_30.5.19.pdf

- On the other hand, if the firm is exposed to most or all of the demand risk associated with highly anticipatory investments, then there is a danger that firms will not go ahead with highly anticipatory investments, or that they will require a higher allowed rate of return (above the cost of capital) if demand does materialise, to compensate them for the risk of asset stranding. If such investment does not go ahead, the achievement of consumer benefits and wider public policy objectives (e.g. decarbonisation) could in some cases be jeopardised. If a higher allowed return is provided in the event that the investment is a success in order to maintain incentives for firms to invest, then consumers would end up paying higher charges than otherwise when demand does materialise.

In practice, it is likely that the optimal approach will involve some sharing of the demand risk between firms and consumers. The precise allocation would need to be decided on a case-by-case basis in line with the considerations listed earlier.

In addition, under certain circumstances it may also be appropriate to consider the allocation of risk across different groups of customers or citizens, such as:

- Current and future customers – for example, it may be appropriate to give careful consideration to the allocation of risk between current and future customers in cases where the usage of the highly anticipatory infrastructure is likely to vary substantially over the lifetime of the asset.
- Users of the new infrastructure and the wider customer base of the company – for example, in cases where the new infrastructure will only be used by a specific consumer group, it may be appropriate to recover the costs associated with the investment through a separate user charge for the specific group.
- Energy bill payers versus citizens in general – if a risk allocation mechanism involves a grant or subsidy where the cost of these payments is recovered through general taxation, this may have a lesser impact on low-income citizens than recovering the cost of the payments through energy bills (given that general taxation is progressive, whereas energy bills are regressive).
- Fuel poor consumers – companies should consider the number of fuel poor consumers on their network and the impact of the risk allocation mechanism on the potential bill faced by these consumers both now and in the future. Where relevant, companies should consider whether there is any action that they can take to alleviate the bill impact on these consumers.

COMPENDIUM OF RISK ALLOCATION MECHANISMS

Europe Economics

4 Mechanism to Defer Decision till Information Is Better

4.1 Price control reopeners or interim reviews

4.1.1 Description

Interim reviews (or reopeners) enable the regulator to take action within the price control period to reset or adjust targets, cost allowances or other parameters. At an interim review the regulator reviews evidence and adjusts the price control to take account of costs related to particular events, such as significant external shocks or material changes in circumstances.

There are several options for the design of interim review mechanisms. Interim reviews can be either symmetric (where both the company and the regulator can request one) or asymmetric (where only the company can request one). The scope of the review may be investment-specific (i.e. it only considers costs related to a specific investment or event) or company-wide (i.e. the interim review may become a full price review considering other issues such as efficiency savings and other costs). The events under which an interim review can be requested may be defined by the regulator (e.g. through notified items that are set at the beginning of the price control period) or left open, and there may also be a materiality threshold that needs to be passed before an interim review is considered appropriate.

In the context of highly anticipatory investments, interim reviews could be used to defer a decision on whether funding for an investment should be provided through the price control until greater information is available on whether there is a need for the investment. In particular, instead of a decision on whether to allow funding for a highly anticipatory investment project having to be taken during a periodic price control, an interim review procedure would allow the decision to be taken later on partway through the price control. At the same time, it would allow a decision to be taken ahead of the following price control review if sufficient evidence of the need for the investment project were to emerge.

Different options for how an interim review procedure might be triggered for a highly anticipatory investment might include the following:

- The regulator might agree a date for such an interim review in advance, if there is an expectation that there will be greater clarity about the need for the investment project by that date (e.g. due to an expected decision by government which will affect the need for the infrastructure).
- The company might have the right to request an interim review if it considers that there is now strong evidence in favour of the highly anticipatory investment.
- The interim review might be triggered if the government or another public body takes a decision that suggests a need for the investment project (e.g. giving the go-ahead to a nuclear power station, necessitating upgrade work on the transmission network).
- The interim review might be triggered if exogenous data suggests that the case for the highly anticipatory investment has grown stronger (e.g. if growth in renewables generation passes a pre-determined threshold that may point to a future need for transmission reinforcement).

4.1.2 Impact on risk allocation

An interim review reduces the need to make allowances for highly anticipatory investment projects at price control determinations and allows for circumstances which were uncertain at the time of the previous determination (such as future demand or utilisation of the anticipatory investment) to be taken into account without having to wait for the end of the price control period.

Compared with a counterfactual of approving the investment project upfront at the price review, an interim review reduces the risk to the general customer base of paying for stranded assets. However, it may create a risk for customers that will want to use the additional infrastructure that it won't be available when they need it due to the delay in starting the investment project. It may also create associated risks for the company (for example network constraints because the additional infrastructure has not been put in place in time).

Once a highly anticipatory investment has been approved at a price review, the risk of asset stranding is then borne entirely by the customer base rather than the firm, given the approved investment would enter the RAV and the firm will be guaranteed cost recovery.

Furthermore, the reopener may also result in additional risk to the company if at the review of the highly anticipatory investment the regulator considers issues other than the investment that trigger the review to occur. If the regulator is able to consider all issues it deems important this may lead to substantial additional risk to the company resulting from the review.

Interim reviews may also increase the risks borne by customers, in the event that following the price reopener decision regarding highly anticipatory investments customers face higher bills due to changes to the costs incurred by the regulated companies.

4.1.3 Circumstances where tool is relevant

An interim review mechanism may be appropriate in the case of a highly anticipatory investment where there is likely to be additional information available in the future about the need for the investment, without this information coming so late in the process that waiting for it would jeopardise the ability of network companies to deliver the new infrastructure by when it is likely to be needed.

The costs of interim reviews for both the regulator and the regulated company can be variable, as the type of event being assessed is likely to have an effect on the associated workload. In general, however, interim reviews can be costly and therefore are reserved for significant cost impacts. The use of a materiality threshold, below which a review is not permitted, avoids the expense of a review for issues which might only have a small impact on the overall price control. At the same time, setting a materiality threshold that is too high might lead to the mechanism becoming redundant.

In the case of high value projects under RIIO-ED1, Ofgem specifies a £25m limit for major schemes to fall under this category. Furthermore, Ofgem also requires electricity distribution network operators seeking to reopen the price control to demonstrate that their net total forecast expenditure of both ex ante schemes and new schemes less ex ante funding is greater than one per cent of average annual RIIO-ED1 base revenue.[6]

Items used to trigger interim reviews should be clearly definable cost items that are not open to interpretation.

[6] https://www.ofgem.gov.uk/sites/default/files/docs/2013/02/riioed1decuncertaintymechanisms_0.pdf

4.1.4 Advantages and disadvantages

Advantages

A price control reopener gives the company strong incentives to do due diligence when it is considering investment in highly anticipatory infrastructure, as the company faces the risk of not recovering the cost of the investment if the infrastructure becomes stranded and therefore the capex costs associated with the investment are not included in the RAV.

The mechanism could also prevent customers from paying for assets which have ended up not being used.

Disadvantages

A potential disadvantage of interim reviews as a risk-sharing mechanism is that they require input from the regulator to arrive at a new determination. This mechanism gives a substantial degree of discretion to the regulator to decide how the new information will be incorporated in the price control. Interim reviews may also introduce instability in the regulatory process and create uncertainty about regulatory commitment (although this could be mitigated by setting out the time and frequency of the reopener windows at the beginning of the price control period).

Furthermore, it may also reduce the incentives for companies to undertake highly anticipatory investments since if the asset becomes stranded the capex costs associated with the investment would not be introduced in the RAV meaning that the company would not be able to recover the cost of the investment.

In addition, an interim price review may also be too early to determine how actual demand for the new infrastructure is going to develop compared to initial expectations.

Finally, the costs of undertaking an interim review may be significant, both for the regulator and regulated companies.

4.1.5 Impact on cost of capital

Whether a highly anticipatory investment project is approved at a periodic price review or at a subsequent interim review, in both cases investors are assured of cost recovery through the RAV mechanism once regulatory approval has been given. In the light of this, it seems unlikely that taking the decision on highly anticipatory investment projects at interim reviews will have any material impact on the company's cost of capital.

5 Regulatory Mechanisms Based on Ex Post Information

5.1 Ex post prudency test

5.1.1 Description

An ex post prudency test is a test applied to an investment to determine whether or not it should be included in the RAV and hence whether a company should be able to earn returns on it.

There are two potential approaches to ex post assessment:

- the concept of "used and useful", focusing on the current utilisation of the assets rather than whether the decision to invest was appropriate at the time of the decision;
- considering whether the investment was appropriate according to circumstances at the time of the decision (even if with hindsight the investment may have been inappropriate).

Typically this tool involves an estimate of the required investment being made at the time of the price determination and incorporated into the RAV, so allowing the company to earn a return and depreciation on the investment. At the next price determination an ex post review occurs, and the ex-ante figures are replaced with outturn figures of investments which have passed the prudency test.

In general, the prudency standard is whether the investment undertaken was reasonable, rather than efficient. Ex post assessment can take into account later information that may indicate that the investment was imprudent or negligent (i.e. unreasonable). However, it is far more difficult for a regulator to decide, even given later information, whether an investment was efficient. Thus the standard against which a regulated company's investment decisions are assessed may well be lower than those for companies in a competitive market.

In the context of highly anticipatory investments, an ex post prudency test could be used to determine whether an investment should be included in the RAV at the end of the price control period. In particular, this allows the regulator to defer the decision on whether a company should be guaranteed cost recovery on highly anticipatory investments until the next price review when more information regarding the future demand or utilisation of the investment is available. Therefore, ex post reviews are in contrast with the regulator approving a highly anticipatory investment ahead of the price control period when actual outturn figures are not available.

5.1.2 Impact on risk allocation

In the period before the ex post determination of whether an investment should be included in the RAV is undertaken, this ex post mechanism essentially transfers the risks associated with highly anticipatory investments from consumers to the regulated company. Consequently, if the regulator decides to exclude a highly anticipatory investment from the RAV, then the company would not be able to recover the cost of that investment. However, once a highly anticipatory investment has been included in the RAV following the ex post prudency test, the risks associated with the asset becoming stranded are borne by customers as the company would be guaranteed cost recovery on the investment.

The mechanism allows the regulator to reduce the risk of allowing capital expenditures that seem reasonable at the time of the price determination (on an ex ante basis), but that turn out to overestimate the future demand for these investments. Therefore, ex post reviews reduce the risks associated with consumers paying for investments that do not align with their priorities or needs. Nonetheless, customers may also face risks stemming from the required infrastructure not being (fully) available or operational during the price review period due to the company delaying the investment or deciding not to undertake it in light of future demand uncertainties and the risks that it faces.

5.1.3 Circumstances where tool is relevant

An ex post prudency test could be a relevant tool where an anticipatory investment in infrastructure is made to meet future demand that has not yet materialised and therefore information regarding utilisation of the infrastructure might only become available during the price control period.

Ex post reviews can be used to adjust the RAV to exclude investments which were not efficiently incurred. They are particularly relevant when regulators are considering how much of an overspend a company should be allowed to earn a return on.

However, given that the mechanism would create strong disincentives for investment in highly anticipatory infrastructure (see the discussion of disadvantages below), it is likely to be unsuitable for contexts in which policy-makers wish to encourage highly anticipatory investments in order to meet strategic policy goals.

5.1.4 Advantages and disadvantages

Advantages

It means that customers do not bear the costs of inefficient investment decisions, since these will not be included in the price cap calculations. Therefore, the ex post prudency reduces the risk for customers through transferring it back to the company and/or the investors.

Having an explicit test to determine either whether the investment was appropriate at the time or if it has been 'used and useful' (and the potential for some investments not to be included in the RAV) may encourage companies to undertake investments based on efficient principles rather than on potentially distorted incentives driven by the use of the RAV is setting price controls.

Disadvantages

Relying on ex post assessment creates uncertainty for companies when investing, and therefore it may deter investment, in particular where the investment is made in anticipation of future demand which is yet to materialise.

This potential disincentive to invest is exacerbated in the case of highly anticipatory investments by the fact that an ex post review based on whether the asset is "used and useful" would create asymmetries in the outcome for companies. In particular, if demand for the infrastructure materialises, the firm's reward would be limited to earning the allowed rate of return (rather than gaining the full commercial value of the infrastructure); whereas if demand does not materialise, it not only loses any chance of earning a return but also has to write off the cost of the investment. If the allowed return has been set at the cost of capital (as regulators would typically aim to do), then such an investment would have an expected return[7] that is below

[7] In this context, the term "expected return" is being used in a technical sense. Given there is uncertainty around investment projects, there will be various possibilities for how high or low the return from the investment will be. The expected return of the investment is calculated by multiplying each possible outcome by the probability that it will occur, and then summing across all possible outcomes.

the cost of capital (given that the firm has no scope for upside gain in the event of success but is fully exposed to downside risk in the even to failure). In this situation, the company would not invest.

The analysis of projects to determine prudency of highly anticipatory investments can be resource-intensive, both for the regulator and the regulated company.

A disadvantage with this form of regulation is that it, to some extent, substitutes regulatory judgement for commercial judgement by entitling the regulator to decide whether an anticipatory investment by regulated companies was reasonable. Regulators may not be well-placed to decide what investment was reasonable, and to that extent this approach may introduce regulatory distortions and inefficiencies. Further, the end of a price control period may be too early to determine whether infrastructure built during that price control period is going to be utilised in the long run. It may therefore be difficult to assess whether infrastructure is "used and useful" at this early stage.

5.1.5 Case study of the mechanism in practice

Case study 5.1: Australian Energy Regulator: Ex post review process

The Australian Energy Regulator (AER) applies ex post measures in order to improve the efficiency of capital expenditure within the energy sector in Australia. In its 2013 guideline,[1] the AER has set out its methodology to incentivise efficient and prudent capital expenditure over the next regulatory period. The review process is based on the following two elements:

- Ex post statement: the AER is required to prepare a statement of efficiency and prudency of the capital expenditure that will be included in the RAV. The main purpose is to receive reassurance about the efficiency and the prudency of the capital spend by the regulated company, and to obtain information on the type of investment being included in the company's RAV.
- The AER may exclude some parts of the capex from being included in the roll forward of the RAV.[1] This also allows the AER to ensure that the customers do not pay for investments on network services which do not meet the capex criteria set out by the regulator. Any exclusion of some part of capex would be informed by assessments undertaken by the regulator.

The timeline for the ex post review process starts during the regulatory period itself when the AER monitors capex projects and collects data with a view to enabling the ex post reviews. The regulator may also consult with the regulated companies before the submission of business proposals to discuss any areas of concern or provide supporting information for the ex post reviews. Once companies have submitted their business proposals and the AER has published its issues paper setting out its preliminary view, stakeholders are given the opportunity to respond formally. This is followed by the draft determination and a similar consultation period, after which the AER publishes its final determination which includes its decision regarding any capex excluded as well as the reasons for doing so. The AER consults with regulated companies on a regular basis during the entire determination process.

The ex post review consists of two stages. At the first stage, the AER performs a high-level assessment of the capex performance of the regulated company. This initial analysis seeks to understand whether the regulated company has incurred a cumulative overspend against its allowance while also considering the company's capex history. The AER may also consider the key drivers of any potential overspend (and whether these are within the company's control); and, if relevant, it may compare the company's performance with that of other providers through benchmarking analysis. Where the assessment does not identify significant concerns regarding the company's capex performance, the AER may conclude that the regulated company has been broadly efficient and that no further analysis is required.

In case the first-stage review finds that a cumulative overspend occurred over the relevant period, the AER would advance the assessment to the second stage of the process. During this stage, the AER performs a

more detailed analysis of the capex drivers, as well as of the project management and planning employed by the regulated company. This involves an assessment of the main elements affecting capex, the company's justification of the overspend and, in the absence of a clear justification, the proportion of the amount of the investment that is inefficient. If, after the evaluation the overspend meets the capex criteria for efficiency and prudency the firm's RAV will not require any adjustment. However, if there is no justification for excessive capex, the AER would then intervene by excluding some parts of capex from the RAV.

Source: Australian Energy Regulator (2013): "Capital Expenditure Incentive Guideline for Electricity Network Service Providers", available at: https://www.aer.gov.au/system/files/AER%20capital%20expenditure%20incentive%20guideline%20-%20November%202013.pdf

5.1.6 Impact on cost of capital

An ex post prudency test exposes the regulated firm to demand risk, since whether the investment will be included in the RAV will depend on whether demand has materialised ex post. To the extent that demand for the infrastructure is driven by macroeconomic variables, this will mean that the firm is exposed to greater systematic risk. This will increase the cost of capital for the infrastructure project.

In addition, the regulator would need to set the allowed rate of return on the RAV above the cost of capital if it wished to incentivise the firm to carry out highly anticipatory investments. The reason for this is as follows. Given that the firm will earn much less than the cost of capital if demand does not materialise (since the investment will be excluded from the RAV and the cost of the investment will have to be written off), the firm would need this to be offset by the potential to earn more than the cost of capital in a scenario in which demand does materialise in order for the ex ante expected return at the point of investment to equal the cost of capital.

5.2 Capex trigger

5.2.1 Description

There may be uncertainty around whether particular capex projects are required or what should be the timing of investment. Where the charges set by the regulator allow for a guaranteed level of revenues based on projected levels of capex, there may be an incentive for companies to delay the investment in order to back-load financing costs, even where such deferral of the investment is not efficient.

A mechanism which may be used to address these problems is the capex trigger. Capex triggers involve making allowances in charges conditional on the occurrence of particular events or on the achievement of certain project milestones. Different types of capex triggers may relate to:

- Timing – e.g. capex costs associated with a project can start to be recovered only when new assets are commissioned for use.
- Volume – e.g. the inclusion of a capital investment or project in price limits is triggered when demand reaches certain thresholds.

Furthermore, triggers can be both positive and negative:

- Positive – revenues are increased if an event occurs, e.g. if particular investment is deemed necessary.
- Negative – revenues are decreased if an event does not occur, e.g. if project milestones are not reached.

When designing the trigger mechanism, the regulator needs to decide what proportion of revenues should be at risk for not meeting the triggers. For positive triggers this is relatively simple, with, for example, the company not receiving a revenue allowance for investment which is unnecessary, but for negative triggers (where the investment is already being carried out) it is more complex.

A capex trigger could be a relevant tool in the context of highly anticipatory investments given the potential uncertainty regarding the appropriate timing of the investment (or whether the investment should take place at all). In this context, triggers may be based on either:

- Project milestones, in which the firm is assured of cost recovery if it delivers the work; and
- Demand or usage of the new infrastructure passing a certain threshold, which exposes the firm to demand risk as it would be investing without knowing for sure whether the trigger would be met at some point in the future.

In the sections below we explore the implications for each of these triggers.

5.2.2 Impact on risk allocation

In the case of triggers based on project milestones, the company would not be exposed to demand risk associated with the highly anticipatory investment as it is assured of cost recovery as long as the project milestones are delivered.

In contrast, where the trigger is based on demand or usage of the new infrastructure passing a certain level, the mechanism does expose the firm to some (or all) of the demand risk associated with the investment as some (or all) of the firm's revenues will be at risk for not meeting the triggers. The extent of the additional risk borne by the firm will eventually depend on the amount of the revenue that is conditional on the trigger event.

5.2.3 Circumstances where tool is relevant

Trigger mechanisms are not suitable for all capex projects. In order for this type of risk-sharing mechanism to work effectively, a number of conditions need to hold, including:

- It must be possible to define an appropriate trigger relating to the investment project. For example, a trigger might relate to a set threshold for demand, or the commencement of a project.
- There needs to be an objective way to determine whether the trigger event has taken place or not.
- It must be possible for the regulator to work out in advance what an appropriate adjustment to revenue would be in the event that the trigger event occurs, so that this can be incorporated into the trigger mechanism in the company's price control formula.

5.2.4 Advantages and disadvantages

Advantages

In the case of triggers based on project milestones, this option may be used to incentivise investments related to wider policy goals as the company does not face any demand risk associated with the investment.

Moreover, this option can also deliver benefits to those customers that use the new asset and would not have been able to do so in absence of the highly anticipatory investment.

When triggers are based on demand or usage of the new infrastructure passing a certain level, an advantage of the mechanism is that it incentivises prudent investments on part of companies as well as giving them strong incentive to do due diligence when considering highly anticipatory investments as the company will not recover the cost of the investment if demand does not materialise or does so at a level lower than the pre-specified threshold for the trigger to be met.

Disadvantages

In the case of triggers based on project milestones, a disadvantage of the mechanism is that it may not incentivise prudent and efficient investments in highly anticipatory infrastructure as the company would not be facing any demand risk associated with these projects.

Furthermore, customers may end up paying for assets that they do not use or benefit from if demand for the new asset does not materialise.

When triggers are based on demand or usage of the new infrastructure passing a certain level, this option may not be very effective in incentivising highly anticipatory investments (such as those relating to wider policy goals) due to the risks born by companies if the new asset becomes stranded.

Furthermore, trigger mechanisms (especially those involving negative triggers) may be complex to design.

5.2.5 Case study of the mechanism in practice

Case study 5.2: Civil Aviation Authority: Treatment of Terminal 5 at Heathrow

The Civil Aviation Authority (CAA) wanted to enable BAA (which later became Heathrow Airport Holdings) to implement a £7.4bn 10-year investment programme, which included building Terminal 5 at Heathrow.[8] The CAA recognised the fact that the proposed investment programme would represent significant increases in charges to users, but thought that these were necessary in order to meet growth in demand and deliver desired service quality.

The Competition Commission (which later became the Competition and Markets Authority) recommended that the price cap at Heathrow should be conditional on achieving five trigger points for stages of completion of Terminal 5.

The CAA felt that the triggers linked to Terminal 5 at Heathrow, and Pier 6 at Gatwick, would mitigate the general incentive provided by RAV-based regulation to defer investment once price caps were set.

The CAA decided that, in the price cap formula for Heathrow airport, triggers would be included which would reduce the maximum allowable charges when the airport had not achieved particular capital investment project targets on time. They would be calculated as follows:

$$TRIGGER_t = DTR_t + ERS_t + VCR_t + CTBWP_t + S1WP_t$$

where DTR_t was a component based on the completion date of the diversion of the twin rivers, ERS_t was a component based on the early release stands, VCR_t was a component based on the handing over to NATS of the visual control room, $CTBWP_t$ was a component based on the core Terminal 5 building being weatherproof, and $S1WP_t$ was a component based on Satellite 1 being weatherproof.

The values of the different components to be taken account of in a particular year would depend on the year in which the project was completed.

By way of example, the following table shows the different values of DTR_t (i.e. the first trigger in the above formula) which could be used in each particular year. In its decision paper, the CAA included equivalent tables for each of the components.

Table 5.1: The different values of DTR_t that could be used in the price cap formula

Year in which percentage reduction to revenues is applied

[8] CAA (2003): "Economic regulation of BAA London airports (Heathrow, Gatwick and Stansted) 2003-2008 CAA decision" and CAA (2004): "Decision on the detailed specification of the capital expenditure triggers in the price cap conditions for Heathrow and Gatwick Airports"

	2003/4	2004/5	2005/6	2006/7	2007/8
Year completed					
2003/4	0	0	0	0	0
2004/5	0	0	0	0	0
2005/6	0	0	MB/6	0	0
2006/7	0	0	2	MB/6	0
2007/8	0	0	2	2	MB/6
Not completed	0	0	2	2	2

Source: Civil Aviation Authority (2003) "Economic regulation of BAA London airports (Heathrow, Gatwick and Stansted) 2003-2008, CAA decision"

MB is the number of complete months or parts of months between the beginning of the financial year and completion of the project.

For each of the Heathrow triggers the reduction in maximum charges was some two per cent in respect of each whole year delay, or pro rata by month.

Source: Civil Aviation Authority (2003) "Economic regulation of BAA London airports (Heathrow, Gatwick and Stansted) 2003-2008, CAA decision"

5.2.6 Impact on cost of capital

In the case of triggers based on project milestones, the company would not be exposed to demand risk associated with the highly anticipatory investment. Consequently, capex triggers in this case are unlikely to have any material impact on the company's market cost of capital or the allowed rate of return set by the regulator.

When triggers are based on demand or usage of the new infrastructure passing a certain level, the company does face at least some the demand risk associated with the investment as if demand does not materialise or does so at a low level such that the appropriate trigger is not met, then it would not be able to recover the costs of the investment. To the extent that demand may be driven at least partly by macroeconomic factors, this will increase the company's exposure to systematic risk, and therefore increase the cost of capital for the investment. Furthermore, the regulator may need to set the allowed rate of return on the investment when the trigger is passed at a level above the cost of capital to offset the downside risk, so as to maintain incentives to carry out highly anticipatory investments.

5.3 Ex post removal of stranded assets from RAV

5.3.1 Description

There may be occasions where the costs of particular assets are included in allowed capex and are added to the RAV, but the asset becomes stranded once it has been built, meaning that the asset is either not used or under-used as compared with initial expectations.

Fully or partially removing any stranded assets from RAV ex post can be regarded as a controversial tool to be applied by regulators, as it may undermine the RAV concept of investors being able to earn a return on investment carried out by company. Furthermore, there could also be significant risks attached to such a mechanism as a (full or partial) ex post removal of stranded assets from RAV could result in a loss of customer and investor confidence which in turn may raise financeability issues for the company (where the company might not be able to raise the funds required to finance its investment programme).

With regards to highly anticipatory investments, this mechanism may be used by regulators to remove assets from the RAV that become stranded over the lifecycle of the investment so that customers would not be charged for these assets. Nonetheless, the benefits and risks associated with such a decision on part of

regulator should be carefully examined as it may well discourage companies from undertaking highly anticipatory investments in the future that could deliver benefits to customers in the long-term.

5.3.2 Impact on risk allocation

In the absence of a mechanism allowing a regulator to remove assets from the RAV ex post, companies may earn depreciation and a return on assets that are either not utilised or are under-utilised. Therefore, by allowing for the full or partial removal of assets from the RAV if they become stranded, the mechanism essentially transfers the risks associated with asset stranding to the regulated firm.

At the same time, the regulator might be able to put certain limits on the increase in risk for the companies by providing guidance as to the circumstances in which it could remove stranded assets from the RAV, or by removing only some (but not all) of the costs of stranded assets from the RAV.

5.3.3 Circumstances where tool is relevant

Allowing stranded assets to be removed from the RAV once the investment has been made is likely to strongly discourage companies from making investments in assets where stranding is a possibility. Therefore, the mechanism is unlikely to be suitable in circumstances where policy-makers wish to encourage highly anticipatory investments in order to meet wider policy objectives.

More generally, this risk allocation mechanism has some serious disadvantages (discussed below), and these are of such magnitude that there are likely to be few if any contexts where this mechanism represents an optimal way to deal with the risk that highly anticipatory investments may become stranded.

5.3.4 Advantages and disadvantages

Advantages

This mechanism would prevent customers from paying for assets which have ended up not being used.

The mechanism also gives the company strong incentives to do due diligence when it is considering investment in highly anticipatory infrastructure, as the company faces the risk of not recovering the cost of the investment if the infrastructure becomes stranded.

Disadvantages

The key disadvantage of this mechanism is the regulatory uncertainty it creates, and the potential impact of this uncertainty on the ability of companies to finance their investment programmes. In particular, the mechanism is likely to be seen by investors as undermining the commitment that regulators have historically shown to honouring the RAV. This would be likely to seriously harm incentives for undertaking infrastructure investments, particularly those that are highly anticipatory in nature, due to inherent uncertainties around future demand and utilisation of the infrastructure. Firms may find that they are unable to raise finance for their investment programmes due to unwillingness on the part of investors to take on the risk.

Implementing the mechanism would also give rise to complex practical challenges. For example:

- It would require the regulator to have a process in place for identifying infrastructure assets that have become stranded, so that the costs of the relevant assets can be removed from the RAV. Companies are unlikely to volunteer the information to the regulator given that it will lead to reductions in revenue, and hence the regulator would need to monitor utilisation of assets at a sufficiently disaggregated level to identify stranded assets.
- Given that utilisation of some highly anticipatory infrastructure assets may rise over time, the fact that utilisation is low in the early years of the life of the asset would not necessarily mean that the asset will

be stranded long term. Hence, it would be difficult and potentially arbitrary to decide on a "cut-off date" that should be used for an assessment as to whether assets have become stranded. If assets are removed from the RAV at this cut-off date and utilisation of the physical infrastructure subsequently rises, it would potentially create the need for a process to add the costs of the relevant infrastructure back into the RAV.

- The mechanism would raise questions about the treatment of infrastructure that has low utilisation but creates other benefits — for example, by increasing network resilience to storms or asset failures, or by creating a real option value by allowing the network to accommodate additional demand should it materialise in the future. If such assets are removed in their entirety from the RAV, the regulator would be failing to recognise the value of these assets to customers. Firms would be disincentivised from investing in such assets, to the potential detriment of customers.

5.3.5 Impact on cost of capital

Ex post removal of stranded assets from RAV exposes the regulated firm to demand risk, since if demand for the asset does not materialise investors would not be able to earn a return on the investment. To the extent that demand for the infrastructure is driven by macroeconomic variables, this will mean that the firm is exposed to greater systematic risk. This will increase the cost of capital for the infrastructure project.

Under this risk allocation mechanism, the regulator would need to set the allowed rate of return on the RAV above the cost of capital if it wished to incentivise the firm to carry out highly anticipatory investments. The reason for this is as follows. Given that the firm will earn much less than the cost of capital if the asset ends up being stranded (since the investment will be removed ex post from the RAV and the cost of the investment will have to be written off), the firm would need this to be offset by the potential to earn more than the cost of capital in a scenario in which the asset is not stranded in order for the ex ante expected return at the point of investment to equal the cost of capital.

5.4 Error correction mechanism

5.4.1 Description

An error correction mechanism (ECM) is an automatic revenue adjustment that is tied to one or more uncertain, exogenous variables, such as the volume of demand, recognising the fact that some events and outcomes are beyond the control of a regulated company. It involves price adjustment procedures to prevent companies from experiencing in full the impact of unplanned and uncontrollable changes in circumstances (for example in the volume of demand for a specific asset or investment), through adjusting revenues up or down by pre-specified amounts if the out-turn for the relevant variable differs from what was assumed. An ECM uses the best estimate of the relevant variable (e.g. volume of demand for the asset) as a baseline and corrects for any deviations from it.

Revenue adjustments might be linear (i.e. revenues adjust in proportion to the decrease or increase in the volume of demand) or could vary non-linearly with volume (e.g. a schedule of revenue adjustments might be developed that set out changes in revenue with certain 'step-changes' in volume). The latter might be useful if the investment was subject to "lumpiness" (i.e. significant investment projects being triggered when demand passes certain thresholds) or economies of scale.

With regard to highly anticipatory investments, an ECM could be a relevant mechanism for a regulator to consider using as it would allow the risks around future demand to be shared between the company and its customers.

5.4.2 Impact on risk allocation

The use of an ECM exposes the regulated company to some or all of the demand risks associated with highly anticipatory investments, since if firms invest ahead of demand they will only fully recover their costs under the ECM if demand actually materialises.

However, the extent of the firm's risk exposure to demand risk under an ECM depends on the size of the revenue adjustment for any given deviation in demand from its expected level. An ECM could be calibrated such that the firm is fully exposed to demand risk, by setting the size of the revenue adjustments equal to the costs of the highly anticipatory investment required to meet any increment to demand. Alternatively, the revenue adjustments could be set at a lower level, so that the firm is only partially exposed to demand risk.

5.4.3 Circumstances where tool is relevant

In the context of highly anticipatory investments, ECMs can be used where the regulator wishes to share the demand risk associated with the new infrastructure with customers (i.e. not all demand risk is borne by the regulated company).

ECMs need to be determined in relation to an objective and measurable variable that is also outside the control of the company (e.g. new demand connections, volume of distributed generation). Moreover, a good understanding of how changes in this variable would affect the costs faced by the firm (e.g. by requiring highly anticipatory investment ahead of time) is required in order to calculate the appropriate adjustment that should apply to revenues.

5.4.4 Advantages and disadvantages

Advantages

ECMs provide automatic adjustments, which minimise regulatory discretion. As they are fixed at the outset of a price control period, ECMs provide an incentive for the company to maintain cost efficiency and keep efficiency gains.

Disadvantages

A disadvantage of ECMs is that they are sensitive to a correct estimation of future demand baselines and associated costs and revenues. Further, the variable used as the basis for determining whether an adjustment should occur needs to be objective and measurable.

In addition, it may be difficult to determine whether the exogenous variable that drives the uncertainty is truly exogenous and not at any risk of being manipulated (for example, a firm might manipulate demand if through shutting down one piece of infrastructure it forced customers to use the new asset subject to the error correction mechanism).

Other potential issues likely to arise include determining the appropriate trigger or point beyond which the mechanism should kick in and the size of adjustments.

5.4.5 Case study of the mechanism in practice

Case study 5.3: Ofgem RIIO-ED1 smart meter volume driver

Ofgem introduced an ECM in its RIIO-ED1 electricity distribution price control for some specific costs. One such cost was related to electricity distribution network operators (DNOs) being called out to consumer premises during the roll-out of smart metering. While there was little uncertainty regarding the

unit cost of call outs (these were benchmarked across DNOs), at the time of the determination it was unclear what proportion of smart meter installations would require a DNO to attend.

Ofgem provided an ex-ante allowance based on a two per cent call out rate. This was set at the lower end of DNO forecasts of intervention rates at the time and the regulator noted that this was likely to be a prudent level given the low number of smart meters installed. Ofgem stated that the volume driver would apply if actual volumes of call-outs were higher or lower than this ex-ante percentage. Ofgem also decided against the application of a deadband for this mechanism.

The ECM was be combined with a tapering mechanism, which reduced the allowance per call out as the volume increased. The rationale behind the tapering mechanism was to remove incentives for DNOs to pick up costs for call outs which were not within their remit. The tapering mechanism would also account for likely economies of scale as the number of call-outs increases.

Source: Ofgem (2013): "Strategy decision for the RIIO-ED1 electricity distribution price control – Uncertainty mechanisms", available at: https://www.ofgem.gov.uk/sites/default/files/docs/2013/02/riioed1decuncertaintymechanisms_0.pdf

5.4.6 Impact on cost of capital

ECMs expose the regulated company to demand risk associated with the highly anticipatory investment as it will only fully recover the costs of the investment under this mechanism if demand materialises to the extent anticipated. In the case of demand for the new infrastructure is drive by macroeconomic variables, this may mean that the market cost of capital for the firm increases as it could be exposed to greater systematic risk.

Furthermore, compared to a scenario where the capex associated with the highly anticipatory investment is included in the RAV which allows the company to recover the costs of the investment, the regulator may also need to set the allowed rate of return above the cost of capital to compensate the firm for the additional downside risk that it will take from investing in highly anticipatory investments.

5.5 Caps and collars on return on investment

5.5.1 Description

Regulators may put upper and lower limits on the return on investment a regulated company and investors are earn through the application of caps and collars. If the realised (actual) return on an investment achieved by the company over a specific period exceeds a pre-specified upper bound (i.e. a cap), the company and would not be able to earn further returns from the investment concerned. At the same time, even if the actual return on investment is below a pre-specified lower bound (i.e. a collar), then the company would still earn a return on the investment at the level of the collar.

Caps can be symmetric (such that compared to a situation where the expected return from the project equals the cost of capital, potential upward or downward adjustments to the actual return earned are symmetric) or asymmetric (where either the maximum upward adjustment or the maximum downward adjustment is higher).

Caps and collars may also be used in conjunction with other risk-sharing mechanisms. For example, coupled with an error correction mechanism, increases in revenues could be capped at a certain level.

With respect to highly anticipatory investments, caps and collars can be applied to put bounds on the returns that the company is allowed to earn on these investment projects. Caps and collars would also be an effective tool where the objective is to ensure that return on investment would not be affected by further changes in future demand or other exogenous variables.

Depending on the goals and wider potential policy objectives associated with highly anticipatory investments, regulators may resort to asymmetric or symmetric caps and collars:

- In cases where a regulator only wants to put limits on the potential downside of an investment, then it may only specify a collar for the particular highly anticipatory investment, therefore allowing the company a guaranteed minimum return at the level of the collar, with potential unlimited gains (returns) from the project if actual demand is significantly higher than anticipated.
- Similarly, where the regulator's aim is to limit the potential upside of the highly anticipatory investment, it can do so through setting a cap for the project or investment concerned. In this case, the maximum allowed return from the investment cannot exceed the level of the cap, while the mechanism would still leave the company exposed to the downside in full, meaning that if actual demand is much lower than anticipated, then they may not be able to recover its costs.
- Finally, a regulator may decide to set both a cap and collar to limit the update and downside associated with the highly anticipatory investment at the same time.

In addition, if the infrastructure is stand-alone and under separate ownership from wider networks (e.g. an interconnector owned by an independent company), then a cap and collar raises the question of where any surplus revenue goes (if returns go above the cap), or where funding comes from to make up for any revenue shortfall (if returns go below the collar). One possible answer is that the money could be passed to or received from monopoly energy network companies who pass the effect through to their wider customer base. In the case of returns going above the cap, another answer would be to reduce charges for use of the stand-alone infrastructure. Nonetheless, the reverse is unlikely to work when returns are below the collar, as it may not be feasible to increase charges to users of the stand-along infrastructure when demand is low without driving away the customers who are there.

5.5.2 Impact on risk allocation

While in general caps and collars can be used to put limits on the risks borne by regulated companies, the precise impact on risk allocation between companies and other parties would depend on the particular design of the mechanism (i.e. whether symmetric or asymmetric caps and collars are set). As a risk-sharing tool, this mechanism enables the regulator to apportion risk between the customer and company as it deems appropriate.

At one end of the spectrum the regulator may decide to limit only the upside associated with the investment through setting a cap. In this case, the regulated company would be still exposed to and bear the downside risk up until the level of the cap stemming from demand risk associated with the highly anticipatory investment. At the same time, below the level of the cap customers would not incur any costs associated with the investment if demand for this does not materialise.

At the other end of the spectrum, it would also be possible for the regulator to put a bound only on the downside risk associated with the highly anticipatory investment, which would guarantee a certain level of return (set at the level of the collar) that can be earned by the company, even if demand for the investment does not materialise. Therefore, under this scenario the risks associated with the investment are transferred to the consumers up to the level of the collar. This is because when the company would otherwise be earning a return below the collar as a result of anticipated demand not materialising, customers would incur higher charges in order to ensure that the company still earns the minimum return that it has been guaranteed.

In addition, the regulator may also set both caps and collars on the return on investment, where the company would be guaranteed a return on a highly anticipatory project or investment between these pre-determined upper and lower bounds. Outside these limits (i.e. below the collar and above the cap), the risks would be borne by customers. Consequently, caps and collars may also result in greater uncertainty over the future pathway of the costs incurred by customers.

5.5.3 Circumstances where tool is relevant

Caps and collars can be applied to specific projects that are measurable and discrete (e.g. new demand connections, volume of distributed generation) and have a separate revenue stream associated with them.

Further, collars may also be appropriate in circumstances where the regulator (or other policymakers) might want to encourage and incentivise a certain investment (for example in the context of wider policy goals or where the investment is expected to deliver significant benefits to consumers over the long-term), even if demand may be significant lower than expected during the initial phases of the project. In this case the company would be allowed to earn a higher return on the investment than it would in the absence of the mechanism in recognition of the potential future benefits delivered to customers.

5.5.4 Advantages and disadvantages

Advantages

Caps and collars on risk-sharing mechanisms have the advantage of limiting the risk exposure of the company if it underperforms against a target (e.g. if the outturn of demand for a highly anticipatory investment is lower than anticipated), and limiting the gains that a company receives from out-performance (e.g. if demand turns out to be higher than anticipated). This could be particularly relevant in the context of highly anticipatory investments where there is uncertainty about how the performance of the company may evolve over the years in response to exogenous factors (such as the volume of demand), or if there were possible events or situations that might affect performance.

Caps and collars on the return on investment can be tailored to the specificities of each highly anticipatory investment project that has a separate revenue stream. An advantage of an asymmetric cap is that it can take into account whether it is more likely that the specific project will over- or under-perform in relation to the target.

In addition, a cap on the return on investment to be earned by the company may also benefit customers, in the form of lower prices if a high level of demand materialises.

Disadvantages

A potential disadvantage of caps and collars on returns from highly anticipatory investment is that the incentives for management to increase utilisation of new infrastructure disappear when the upper bound (cap) is reached. (This is not an issue, however, if demand for the infrastructure is completely outside management control.)

If the cap and/or the collar on the return on investment in infrastructure are set at a level deemed too low by the company in comparison to the level of risks associated with the highly anticipatory investment, they may not be willing to undertake the investment in the first place, which may also disadvantage customers who would have wanted to use the additional infrastructure.

On the other hand, if the cap and/or the collar is level set at a level too high compared to the risks borne by the company, then it would have no or limited incentives to propose investments that are prudent and align with customers' needs and potential future demand. Hence customers may end up incurring costs for investments that do not align with their priorities and preferences.

Caps and collars may also result in greater uncertainty over the future pathway of the costs incurred by customers.

5.5.5 Case study of the mechanism in practice

Case study 5.4: Ofgem: Cap and floor regime for the GB-Belgium interconnector

In 2014 Ofgem[9] published its final decision regarding the introduction of a cap and floor regime for the proposed 1GW electricity interconnector between Richborough in Kent, Great Britain and Zeebrugge in Belgium (also referred to as project Nemo). In the impact assessment undertaken prior to the final decision, Ofgem highlighted a number of principles it applied to designing the cap and floor regime for project Nemo. These principles – among others – included taking accounting of the commercial viability of the project and the wider benefits offered to customers (such as security of supply or competition and market integration across Europe) as part of the regulatory framework; measures to protect consumers from the consequences of excessive returns earned by the owners of interconnectors; and developers' ability to earn returns proportionate to the level of risk borne by them.

Consequently, the resulting cap and collar regime applied by the regulator aims to facilitate and stimulate competition and investment while also ensuring that there exists both an upper and lower bound associated with the risks and rewards of the project. As Ofgem explained, the presence of a floor would be able to reduce some of the uncertainty stemming from price fluctuations in the wholesale market. Moreover, the provision of a cap would protect customers from unlimited gains on the part of the developers.

The cap and floor regime came into effect when the interconnector became operational in early 2019.[10] Furthermore, it is set as a cost-based regime[11] for 25 years with a flat time profile for caps and collars (£80m per year and £50.4m per year, respectively, in 2013/14 prices) in real terms. The determination of the cap was based on an equity return benchmark whereas for the floor a cost of debt benchmark was applied. The regime is subject to periodic reviews every 5 years when the regulator will assess the revenues over the relevant period to establish whether the cap or floor has been triggered. In the event that the revenues earned are above the cap, the excess revenue would be returned to the transmission system operators in Great Britain and Belgium (on a 50:50 basis) which then would also reduce the network charges incurred by customers. If revenues are below the cap, then developers would need to be compensated via additional payments from transmission system operators and in turn, from customers via higher network charges.

Source: Ofgem (2013): "Cap and floor regime for application to project NEMO: Impact Assessment", available at: https://www.ofgem.gov.uk/sites/default/files/docs/2013/12/nemo_ia_final_0.pdf and Ofgem (2014): "Decision on the cap and floor regime for the GB-Belgium interconnector project Nemo", available at: https://www.ofgem.gov.uk/sites/default/files/docs/2014/12/final_cap_and_floor_regime_design_for_nemo_master_-_for_publication_1.pdf

5.5.6 Impact on cost of capital

While in general caps and collars can be used to put limits on the risks borne by regulated companies, and therefore reduce the demand risk it faces with respect to highly anticipatory investments (compared to a counterfactual of a commercial investment where the firm is fully exposed to demand risk), the precise impact on risk allocation between companies and other parties would depend on the particular design of the mechanism (i.e. whether symmetric or asymmetric caps and collars are set).

[9] We note that the decision regarding the cap and floor regime was reached in collaboration with CREG (Commission de Régulation de l'Électricité et du Gaz), the Belgian Energy Regulator.

[10] Capacity on the interconnector to purchase became available via an implicit day ahead auction from 30 January 2019 with delivery on 31 January 2019. For further information, see: https://www.elia.be/en/news/press-releases/2019/01/20190115-nemo-link-announces-go-live-date

[11] In particular Ofgem has used the following 'building blocks' for the regime: assessment of efficient building costs, return on capital, and assessment of operating costs.

In the case of a cap on the return on investment which would leave the company exposed to the downside demand risk associated with highly anticipatory investment, whether the company would be able to earn a return on the investment will depend on whether anticipated demand for the new infrastructure or project has materialised. To the extent that demand for the infrastructure may be driven by macroeconomic variables, this would mean that the firm may be exposed to greater systematic risk, which in turn could increase the cost of capital for the project.

However, if a collar on the return on investment is set by the regulator, then the company would be guaranteed some level of return on the new infrastructure project (at the level of the collar), regardless of whether demand for the investment will materialise, thereby reducing the demand risk borne by the company. In turn, this may decrease the cost of capital for the infrastructure project.

5.6 Funding through outcome delivery incentives

5.6.1 Description

Outcome or output delivery incentives[12] are mechanisms used by regulators to ensure that regulated companies deliver outcomes that matter to customers and the environment, while giving companies flexibility on how to deliver these commitments. The outcomes framework encompasses the following two main elements:

- Performance commitments, which are services companies should deliver to customers; and
- Outcome delivery incentives (ODIs), which are the financial or reputational consequences attached to the performance commitments in the event of outperformance or underperformance against those commitments.

Performance commitments could be divided into two further sub-categories: common performance commitments which in general relate to companies' core activities, and bespoke performance commitments which are company-specific, and hence are tailored to customers' preferences and each company's circumstances.

Recent regulatory practice[13] has put a greater emphasis on the need for companies' outcome delivery incentives to be informed by high-quality customer engagement, in order to ensure that service commitments and the associated payments proposed by regulated companies are reflective of customers' needs and priorities.

In the context of highly anticipatory investments we identified three possibilities for how ODIs may be used, each of which has different implications for the level of control that the company has over the outcome for which it is remunerated:

1. ODI based around delivery of additional capacity

In this case, so long as the infrastructure is built, the firm will earn ODI payments, and so the ODI can (with appropriate parameters) act as a straightforward cost-recovery scheme. The firm would not be exposed to any demand risk.

2. ODI based around accommodation of additional demand

[12] The term "outcome delivery incentive" is used by Ofwat whereas Ofgem uses "output delivery incentive". The description of this regulatory tool mostly draws on the outcome delivery incentive framework developed and used by Ofwat in its PR19 determinations, although we note that Ofgem has used similar tools as part of the RIIO price controls.

[13] See, for example, Ofwat's PR19 final determinations Policy summary documents, available at: https://www.ofwat.gov.uk/wp-content/uploads/2019/12/PR19-final-determinations-Policy-summary.pdf

Under this approach, the ODI is based around accommodation of additional demand / generation on the network (or in a specific area of the network). In this case, the ODI becomes similar to a revenue driver (discussed as another tool in section 5.4). The firm would be exposed to demand risk.

3. ODI based around a wider outcome

Under this approach, the ODI is based around a wider outcome (e.g. level of interruptions) where the firm will have to carry out the highly anticipatory investment to be able to maintain performance if additional demand does materialise. In this case, whether the firm earns ODI payments depends not only on its investment decision, but also on demand and on other factors which may also affect the level of interruptions. When deciding whether to invest, the firm would need to consider the change in the expected value of ODI incentive payments with and without the additional infrastructure, and compare this with the cost of the investment.

In each case, the parameters of the ODI (such as level of target, level of incentive payments) could either be calibrated on the basis that the firm would be expected to recover 100 per cent of the investment cost through the ODI (subject to demand materialising in the case of options 2 and 3 explained above), or on the basis that only some of the investment cost would be recovered through the scheme with the rest allowed for in base cost allowances.

5.6.2 Impact on risk allocation

An ODI based around the delivery of additional capacity would not expose the company to any demand risk associated with the highly anticipatory investment as if the additional capacity is delivered it would earn ODI payments, even if demand for the new infrastructure does not materialise or does so at a level lower than anticipated.

When the ODI is based around the accommodation of additional demand, the mechanism becomes similar to an error correction mechanism based on demand. The impact of the error correction mechanism, an automatic revenue adjustment, on risk allocation is discussed in section 5.4.2.

In cases where the ODI is based around a wider outcome, if the company decides to undertake the highly anticipatory investment (which would allow it to maintain performance through accommodating the additional demand using the new infrastructure) then it would face some of the demand risk associated with the new infrastructure as the recovery of at least some of the investment cost would be subject to demand materialising. Under this scenario the extent to which the company would be able to recover the full cost of the investment through ODI payments – when demand for the new asset develops as anticipated – would depend on the exact calibration the parameters of the ODI (such as level of the target and the attached incentive payment) in question.

5.6.3 Circumstances where tool is relevant

In the context of highly anticipatory investments, funding through an ODI could be especially relevant when the rationale for the highly anticipatory infrastructure is to maintain or improve performance in relation to some key customer outcome (such as the level of interruptions).

5.6.4 Advantages and disadvantages

Advantages

An ODI is based on the delivery of additional capacity could be used to incentivise investments related to wider policy goals, as the company does not face any demand risk associated with the investment. Moreover,

this option can also deliver benefits to those customers that use the new asset and would not have been able to do so in absence of the highly anticipatory investment.

Where the ODI is based around the accommodation of additional demand or generation, the mechanism becomes similar to an error correction mechanism based on demand. For a discussion of the advantages of the mechanism under this scenario, please refer to section 5.4.4.

Under the scenario where the ODI is based around a wider outcome, an advantage of the mechanism is that it incentivises prudent investments on part of companies as well as giving them strong incentive to do due diligence when considering highly anticipatory investments as the company will not recover the cost of the investment if demand does not materialise or does so at a level lower than the target. It also gives the company strong incentives to examine whether or not the investment project being considered is the cheapest and most effective way to improve performance in relation to this outcome, thus promoting efficiency in the achievement of customer benefits.

Disadvantages

In the case where the ODI is based on the delivery of additional capacity, a disadvantage of the mechanism is that it may not incentivise prudent and efficient investments in highly anticipatory infrastructure as the company would not be facing any demand risk associated with these.

Furthermore, customers may end up paying for assets that they do not need or consider a priority in cases where demand for the new asset does not materialise.

Where the ODI is based around the accommodation of additional demand or generation, the mechanism becomes similar to an error correction mechanism based on demand. For a discussion of the disadvantages of the mechanism under this scenario, please refer to section 5.4.4.

Under the scenario where the ODI is based around a wider outcome, this option may not be very effective in incentivising highly anticipatory investments, including those relating to wider policy outcomes, due to the risks stemming from uncertainties around customer uptake.

Furthermore, depending on the exact calibration of the ODI parameters, ODIs may be complex to design and monitor, and can involve significant costs for companies and the regulator during the review process.

5.6.5 Case study of the mechanism in practice

Case study 5.5: Ofwat PR19 cost recovery performance commitments

As part of its PR19 "delivering outcomes for customers" framework Ofwat reviewed and allowed over 670 performance commitments across the 17 water and wastewater companies operating in England and Wales.

Of these, some fall under the category of cost-recovery performance commitments where the regulator has allowed water and wastewater companies to recover the cost of certain schemes proposed, provided that they meet the following two criteria: (i) have a clear customer benefit and support for the scheme, and (ii) the scheme is not funded through another mechanism, such as an additional cost allowance. In addition, Ofwat has set the financial consequences attached to the outcomes as outperformance only, in order to incentivise innovative activity which companies may not undertake otherwise.

Furthermore, in certain cases the regulator also allowed the targets for these performance commitments to be set to zero, which in turn would allow to recover the costs of a specific scheme incurred through outperformance payments only.

For example, the 'access to daily water consumption data' bespoke performance commitment aims to incentivise Southern Water to make access to water consumption data easier for its customers through

the installation of devices that provide customers with daily water consumption data. This will then assist them in their choices in relation to water consumption while also having an effect on customer bills and long-term supply-balance issues. As the definition of the measure highlights, the performance commitment reflects the number of residential properties that are fitted with such a device. Southern Water argued that the performance commitment requires active participation by customers and therefore it cannot directly control the uptake of devices. In addition, the company also stated that no cost allowance was made in relation to their expenditure and therefore it would only be able to recover the costs of these devices through outcome delivery incentive outperformance payments. In its draft (and subsequently) final determinations Ofwat has acknowledged that "the company is not in direct control of uptake of devices" and allowed the incentive payment to be set as outperformance only.[14,]

Source: Ofwat (2019): "PR19 Final determinations Delivering outcomes for customers policy appendix", available at: https://www.ofwat.gov.uk/wp-content/uploads/2019/12/PR19-final-determinations-Delivering-outcomes-for-customers-policy-appendix.pdf, Ofwat (2019): "PR19 final determinations Southern Water – Outcomes performance commitment appendix", available at: https://www.ofwat.gov.uk/wp-content/uploads/2019/12/PR19-final-determinations-Southern-Water-%E2%80%93-Outcomes-performance-commitment-appendix.pdf and Ofwat (2019): "PR19 Draft determinations Southern Water – Delivering outcomes for customers actions and interventions", available at: https://www.ofwat.gov.uk/wp-content/uploads/2019/07/PR19-draft-determinations-Southern-Water-Delivering-outcomes-for-customers-actions-and-interventions.pdf

5.6.6 Impact on cost of capital

In the case where the ODI is based around the delivery of additional capacity, the company would not be exposed to demand risk associated with the highly anticipatory investment. Consequently, the mechanism under this scenario is unlikely to have any material impact on the company's market or allowed cost of capital.

Where the ODI is based around the accommodation of additional demand, the impact of the mechanism on cost of capital becomes similar to that of an error correction mechanism, discussed in section 5.4.6.

Under a scenario where the ODI is based around a wider outcome, the company does face at least some the demand risk associated with the new highly anticipatory infrastructure as if the company undertakes the investment and demand does not materialise or does so at a level lower than expected such that the investment proves unnecessary to the achievement of customer outcomes, then it would not be able to (fully) recover the costs of the investment. To the extent that demand may be driven at least partly by macroeconomic factors, this will increase the company's exposure to systematic risk, and therefore increase the cost of capital for the investment. Furthermore, the regulator may need to set the allowed rate of return on the investment that is implicitly built into the incentive payments for achieving the outcome at a level above the cost of capital to offset the downside risk, so as to maintain incentives for highly anticipatory investments.

[14] On the other hand, Ofwat did not allow the targets for this performance commitment to be set at zero (as proposed by Southern Water in its business plan), stating that it would not provide sufficient incentives to the company for the roll-out of devices and that Southern Water can seek to encourage uptake through effective customer engagement for a small number of its customers. Furthermore, Ofwat stated that its enhancement (cost) allowance allowed for the costs of 17,644 devices over the five-year regulatory period (corresponding to annual targets of 3,529 devices for each year of the price control period), noting that the company would receive outperformance payments for any properties where meters are installed above this target.

6 Mechanisms Affecting Allocation between Consumer Groups

6.1 Ring-fenced funding from customers who use the new infrastructure

6.1.1 Description

Under this risk allocation mechanism, the costs of a specific infrastructure project would be recovered only from those customers that actually use the new infrastructure, rather than being recovered from charges to the firm's entire customer base.

Ring-fenced funding from customers who use the new infrastructure ensures that only customers that use the infrastructure pay for it. It is a tool through which the company is able to protect customers from paying for an asset that is only being used by other customers or for investments in new infrastructure that connect new customers in the same area.

In the context of highly anticipatory investments the ring-fenced funding mechanism may be used to protect the general customer base from being charged for new assets or investments that will be used only by a specific customer group and which may therefore not deliver benefits to the generality of customers.

6.1.2 Impact on risk allocation

A ring-fenced funding mechanism can be used by a company to account for the differences between customer groups with regards to their utilisation of different assets and infrastructure. This is done through the company being able to spread the risk of these asset across customers in a way that is reflective of their usage of the asset and infrastructure. Therefore, through this mechanism the company is able to protect customers from being charged for assets or infrastructure they are not using or benefitting from.

Consequently, while the allocation of risk associated with these assets and infrastructure changes between different customer groups, the mechanism in general is unlikely to impact risk-sharing between the regulated company and its overall customer base. However, in the context of highly anticipatory investments if demand does not materialise or does so at a level lower than anticipated, then the demand risk associated with the new asset could be transferred to the company as it may be infeasible to charge the whole amount of the infrastructure to the customers who use it, as it may deter them from using it altogether.

6.1.3 Circumstances where tool is relevant

This risk allocation mechanism can be used for infrastructure which is stand-alone or discrete and where it is clear which customers are using it. For example, it would potentially be applicable where a company has invested in new infrastructure aimed to deliver a service to a new development.

This risk allocation mechanism is unlikely to be appropriate for investment in common assets used by many customer groups (e.g. upgraded capacity on a transmission network), unless the need for the investment can be clearly traced to a particular group (e.g. new connectees).

6.1.4 Advantages and disadvantages

Advantages

The main advantage of ring-fenced funding is that it allows a company to charge different groups of customers for new assets or infrastructure according to their use of the asset or infrastructure in doing so the customers only pay according to their usage of the infrastructure.

In the context of highly anticipatory investments, this mechanism incentivises companies to do due diligence before making such investments, as they would be exposed to a potential shortfall of revenue if not enough customers materialise for the company to recover its costs.

Disadvantages

The main disadvantage of the mechanism is that for certain assets and infrastructure, it may be difficult to determine which customer group(s) will benefit from these. Furthermore even if customers benefitting from investments in new assets or infrastructure could be identified, there should be no spill overs from these investments to the group(s) not being charged. For example if there are network reinforcements (a lumpy investment) that a firm makes in order to be able to provide energy to a new development, then any potential future developments that are going benefit from this reinforcement should be accounted for when deciding how much customers from the new development should pay.

The mechanism might also increase overall complexity as companies would need to set special charges for those customers who use the asset.

Furthermore, if fewer than expected users materialise, unit charges would be higher for those that do use it, potentially reducing usage further. This would actually move the outcome further from the economically efficient approach, which would be to charge on the basis of marginal cost to increase utilisation of the asset.

Whereas, if insufficient users materialise to allow cost recovery, the company would be exposed to losing some of the cost of its investment. In particular, this mechanism could have the same negative effects on investment incentives, and the allowed rate of return needing to be higher than the cost of capital as discussed in the case of the ex post prudency test or the ex post removal of capex from RAV.

6.1.5 Case study of the mechanism in practice

Case study 6.1: Ofwat: Infrastructure charges in the water sector

In England[15] when a property is connected to the public water or wastewater system for the first time, the relevant water or wastewater company is able to impose an infrastructure charge for each new water or wastewater connection. This charge is additional to the costs of any physical connection work and allows water and wastewater companies to recover the cost of the new infrastructure laid by them. Ofwat, the water regulator in England and Wales sets the requirements[16] in relation to these charges that developers and other new customers pay water and wastewater companies in these cases.

The New Connection Rules published by Ofwat in 2018 aim to ensure that charges for new connections enable and encourage efficiency, are fair, and give certainty to companies and customers alike. The rules also make it clear that infrastructure charges levied by water and wastewater companies could be used to recover network reinforcement costs incurred where new water mains, public sewers or connections were provided under an agreement (including an agreement with a retailer in the business retail market)

[15] The charges are applicable to water and wastewater companies "whose areas as wholly or mainly in England only", p. 1, Ofwat (2018): "Charges Scheme Rules, Wholesale Charging Rules and Charging Rules for New Connection Services (English Undertakers) decision document", available at: https://www.ofwat.gov.uk/wp-content/uploads/2019/01/18-12-20-Charging-Rules-decision-document-.pdf

[16] Under the Water Industry Act 1991, as amended by the Water Act 2014.

or where these were provided as part of companies' statutory duty. Therefore, the rules allow companies to recover costs for investments in infrastructure from customers that are the users benefitting from these new connections.

Furthermore, the rules state that these charges could be set both as a fixed charge per connection or calculated using a set formula. The rules also note that the infrastructure charges levied may differ depending on the circumstances or geographical area concerned, as long as these differences reflect differences in the costs incurred by companies.

Source: Ofwat (2018): "Charges Scheme Rules, Wholesale Charging Rules and Charging Rules for New Connection Services (English Undertakers) decision document", available at: https://www.ofwat.gov.uk/wp-content/uploads/2019/01/18-12-20-Charging-Rules-decision-document-.pdf

6.1.6 Impact on cost of capital

Under a ring-fenced funding mechanism the company undertaking the highly anticipatory investment could be exposed to additional demand risk if demand for the new asset does not materialise or does so at a level lower than anticipated as it may be infeasible to charge the whole amount of the infrastructure to the customers who use it. In cases where demand may be driven at least partly by macroeconomic factors, this will increase the company's exposure to systematic risk, and therefore increase the cost of capital for the investment.

In addition, as the firm is exposed to greater risk due to this mechanism (i.e. the firm will bear the cost if anticipated customers do not materialise), the regulator may choose to compensate the firm for this additional risk attached to highly anticipated investments by uplifting the allowed cost of capital above the calculated cost of capital.

6.2 Economic depreciation

6.2.1 Description

When using a RAV-based approach to price regulation, regulators need to provide firms with sufficient revenues to cover, among other things, depreciation and a return on past and projected investments in the business. The first of these building blocks — depreciation — can be calculated in a number of ways. Below we explore one of these potential approaches,[17] namely economic depreciation.

Economic depreciation seeks to identify the optimal profile of cost recovery over time by mimicking the operation of a competitive market. In simple terms, if an asset is under-utilised then the ability of the firm in a competitive market to recover costs is diminished, as prices charged will be driven by the market and not by the firm's investment. Firms will not be able to raise their prices simply to make up for any under-utilisation of their investments.

Economic depreciation therefore takes into account the change in the asset's earning power over time, i.e. the discounted present value of expected future revenues from the output produced by the asset, less the present value of associated future operating costs. Factors such as utilisation are therefore taken into account, and price limits can be set to reflect more accurately the cost recovery over time that would occur in a competitive market.

In the context of highly anticipatory investments the application of economic depreciation that reflects the expected usage of the new asset means that the company cannot increase the prices it charges even if the

[17] Another frequently used method is depreciation based on an accounting approach where the cost of an asset is depreciated in equal annual instalments over the life of the asset. Under this approach, the level of customer prices will change according to utilisation of the asset; in order to generate the same revenue during times of under-utilisation (i.e. a lower volume of users), the company will be entitled to charge higher prices.

asset becomes stranded (i.e. it is not used or is underutilised by consumers) in the future when the anticipated demand does not develop as expected.

6.2.2 Impact on risk allocation

As economic depreciation takes into account the change in the earning potential of an asset over its lifetime, the regulator is able to set the prices in a way that also reflects periods of asset under-utilisation. Therefore through the application of an economic depreciation policy the regulator shifts the demand risk associated with the new infrastructure investment from consumers back to the company, in comparison to using accounting depreciation where in periods where the asset is under-utilised compared to initial expectations the company would be able to raise its prices to generate the same revenue.

Consequently, the application of economic depreciation is effective in taking account of different levels of utilisation over an asset's lifetime such that the risk borne by current and future customers is reflective of the usage of the asset. Therefore through the depreciation policy the regulator adjusts the prices in a manner that reflects expected usage of asset, which in turn allocates risk appropriately between current / future customers.

6.2.3 Circumstances where tool is relevant

Economic depreciation can be used to adjust the RAV to take into account the usage of an asset and subsequently adjust the cost that can be recovered by the firm over the price review. It is particularly relevant where usage of the new highly anticipatory infrastructure is likely to vary substantially over the asset's lifetime, which then allows a regulator to consider how much of the demand risk associated with the investment should be borne by current and future customers.

6.2.4 Advantages and disadvantages

Advantages

Compared to accounting depreciation, economic depreciation would charge less depreciation in the early years when expected volumes are low, with more charged in later years as the anticipated volume of demand increases. This would prevent current customers paying for assets which are only expected to be utilised (if the investment turns out well) by future customers.

As this mechanism can be used to limit the cost of under-utilisation of an asset that can be transferred to consumers, in the case of highly anticipatory investments, firms are more likely do their due diligence to ensure their investment in the new asset is prudent.

Disadvantages

To develop economic depreciation profiles requires that assumptions are made about a range of factors, including forecasts of variables (such as the future price of the Modern Equivalent Asset)[18], which are not straightforward to derive. The use of economic depreciation could thus lead to very complex models which lack transparency.

Furthermore, the calculation of cost of capital under economic depreciation can also be complex as this is normally calculated based on the written-down value or book value of the asset. However, as the economic depreciation is different from accounting depreciation (book value depreciation), the regulator cannot rely

[18] A modern equivalent asset (also modern equivalent replacement asset) is a notional asset which has the same service potential to the existing asset. This is important in the context of calculating economic depreciation as it is hard to exactly calculate what the value of today's asset will be in a few years (adjusted for depreciation).

on the standard book value of the asset. Therefore, the regulator has to calculate the cost of capital in a way that spreads the depreciation of the asset over time according to usage of the asset over time.

6.2.5 Case study of the mechanism in practice

Case study 6.2: Ofcom: Mobile termination rates in the UK

In 2004 Ofcom, the telecommunications regulator in the UK, imposed conditions on various mobile phone operators which limited the charges that they could levy for mobile voice call termination on 2G networks. Ofcom used a Long Run Incremental Cost (LRIC)[19] model to derive the most appropriate cost figures to form the basis of regulated termination charges.

Ofcom considered the timing of the recovery of costs to be an important issue, since investment by operators was ongoing and the charge control period was significantly shorter than the period over which investment costs would be recovered. In their LRIC model, economic depreciation was used as the means to spread costs through time and so influence the timing of cost recovery. Under economic depreciation, cost recovery is deferred from earlier years, in which utilisation is lower, to later years, in which higher levels of utilisation are experienced.

The economic depreciation profiles in the LRIC model reflect assumptions about a number of key variables:

- The discount rate (cost of capital) — the lower the discount rate, the lower the financing cost of investment that needs to be recovered in any year.
- Future changes in the price of the Modern Equivalent Asset (MEA) — the greater the expected future reductions in the price of the MEA, the more that depreciation needs to be front-loaded. An incumbent mobile operator will only be able to compete against future entrants and earn a reasonable return if it brings forward cost recovery.
- Changes in operating costs over time (both for a given asset over time and between different asset vintages, i.e. purchased in different years) — the more that operating costs of an asset increase with the age of the asset (e.g. increasing maintenance costs due to wear and tear), the more that depreciation should be brought forward.
- Utilisation profile (changes in output from changes in utilisation of the assets modelled over their lifetime) — this would have different effects on regulated prices depending on whether competitive or contestable markets are assumed.

Source: Ofcom (2005) 'Wholesale mobile voice call termination markets – a proposal to modify the charge control conditions', available at: https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale

6.2.6 Impact on cost of capital

Compared to a scenario in which depreciation based on an accounting approach is used, under economic depreciation the firm will bear some additional demand risk associated with the highly anticipatory investment. If demand for the new asset is influenced by macroeconomic variables, then the mechanism will increase the company's market cost of capital.

Furthermore, the regulator may also decide to uplift the allowed return above the cost of capital to provide an upside when the project turns out well, in order to compensate the firm for the additional downside risk that it will bear from investing in highly anticipatory investments.

[19] Long run incremental cost (LRIC) is a forward-looking cost that a company needs to include in its accounting. Long run incremental costs are gradual costs a company is able to predict and plan for over the long term.

7 Market-based Mechanisms

7.1 Negotiation between infrastructure provider and customers

7.1.1 Description

A regulator may decide to allow user participation in the regulatory process by allocating some of the work more typically carried out by the regulator to be taken forward instead by the regulated companies and their customers. In the UK, regulators such as the Civil Aviation Authority (CAA) refer to such processes as "constructive engagements". In the United States and Canada these are also known as "negotiated settlements".

Typically, the regulator can provide guidance on what the issues are to be negotiated on, as well as how the negotiation process should be carried out. The regulator also states what weight will be given to the outputs of the negotiations, i.e. whether they will be binding, or alternatively under what circumstances they might not be followed.

In the context of highly anticipatory investments, a contract could be negotiated between the company carrying out the investment and large industrial customers wishing to use the new infrastructure to share the demand risk associated with the infrastructure project. Other issues that the two parties may negotiate on can include matters relating to the timing of the new infrastructure investment, the anticipated volume of demand and service requirements associated with the project, the sizing of capacity, and the level of capex associated with the investment programme.

The process of negotiation could be carried out on a commercial basis between the infrastructure provider and infrastructure users, or the negotiations could be facilitated by regulatory involvement.

7.1.2 Impact on risk allocation

Through this mechanism the regulator does not mandate how risks should be allocated between the company (infrastructure provider) and customers (infrastructure users), but it gives them the opportunity to negotiate the allocation of risk associated with the highly anticipatory investment amongst themselves.

Therefore, the impact of this mechanism on risk allocation may vary from case to case, depending on the outcome of the negotiation process. At one end of the potential risk allocation spectrum, the regulated firm may face all downside demand risk associated with the highly anticipatory investment, while at the other end of the spectrum, customers may agree to bear all risks.

The issue of counterparty risk also needs to be taken into account. In particular, if the industrial customer(s) accepts some of the demand risk associated with the project but later goes into administration, then the demand risk may end up falling back on the infrastructure provider.

7.1.3 Circumstances where tool is relevant

A negotiation process between the infrastructure provider and customers can be relevant under either of the following two circumstances. First, it could be applicable where there is a limited number of infrastructure users such that direct negotiation with them is feasible (for example, a generation plant, or a new housing or industrial estate); or second, where an organisation exists (or can be set up) that represents the interests of future infrastructure users in negotiations.

Further, not all regulatory issues are suitable for resolution through negotiated settlements. For example, if the infrastructure needs to be delivered to fulfil the company's statutory duties then it may not be possible to settle aspects such as the delivery dates through negotiation. Some of the issues associated with highly anticipatory investments for which this tool is most likely to be appropriate are outlined in the description of the tool above (such as service requirements associated with the infrastructure investment).

7.1.4 Advantages and disadvantages

Advantages

Each highly anticipatory investment is unique in nature as there are different sources of uncertainty attached to every investment. Through this mechanism the parties can agree on an approach (including a risk allocation between the two parties) that is tailored to their needs and expectations in each particular case.

Furthermore, as there is direct communication between the firms and customers, the mechanism allows for more flexibility in resolving issues arising from highly anticipatory investments.

The mechanism allows parties to negotiate and agree on issues of particular significance to them such as the distribution of downside demand risk from the highly anticipatory investment. This also means that none of the parties would face downside demand risk that they did not explicitly agree to bear.

Disadvantages

Given that future demand is by definition uncertain in the case of highly anticipatory infrastructure investments, there may be many cases in which there are insufficient large customers willing to commit in advance to use of the new infrastructure for a negotiated contract to be put in place. Further, even where there is a large industrial customer which knows that it plans to use the new infrastructure, it may decide not to get involved in negotiations in the hope that the infrastructure will end up being funded through the traditional regulatory process without it having to underwrite the investment in any way.

Negotiated contracts for highly anticipatory infrastructure may work to the disadvantage of the parties not involved in the negotiations, for example to future users of the new infrastructure, as the process may not reflect their views on the particular issues discussed throughout the negotiation (such as the distribution of demand risk). Indeed, it is possible that existing users involved in the negotiations may negotiate an approach with the infrastructure provider that is designed to foreclose use of the new infrastructure to future potential users that may compete with them in downstream markets. Furthermore, provisions may also need to be made for incorporating wider public interest issues and for addressing government concerns.

As the negotiations amongst the parties involved may take place behind closed doors, there can be a concern that the process will be less transparent.

Another disadvantage of this mechanism is that, failure to agree on a settlement would mean default to a traditional regulatory process, thus meaning the process of negotiation has led to a waste of time and resources. Furthermore, the regulator may not accept the negotiated outcome as binding.

In some instances, direct negotiation might disincentivise firms from carrying out highly anticipatory investments. For instance, where the infrastructure is capacity-constrained, incumbent users could seek to use the negotiations to limit the scope of future investments in new capacity so as to keep out new potential users, with the infrastructure provider rewarded in the negotiations (e.g. through less exposure to demand risk).

The negotiation process may also be time- and resource-intensive for all parties involved.

7.1.5 Case study of the mechanism in practice

Case study 7.1: Federal Energy Regulatory Commission: Negotiation settlement in the US

In the United States, the transmission of electricity, natural gas and oil in interstate commerce is regulated by the Federal Energy Regulatory Commission (FERC).[20]

The FERC facilitates negotiation proceedings between various parties in order to set rates for interstate pipelines, which reflect the interests of both the pipeline and the ratepayers. This also includes ensuring that the pipeline can earn a reasonable return on the investment.

Cases filed under Section 4 of the Natural Gas Act involves a hearing by the FERC's litigation staff where an agreement is typically reached. If the relevant parties fail to negotiate a settlement in the proceedings, the FERC can also arrange a hearing in front of an Administrative Law Judge.

By way of example, on 1 July 2009, Maritimes & Northeast Pipeline L.L.C. (Maritimes) filed a case with the FERC to reduce its transportation rates. Furthermore, the filing also requested an increase in the Fuel Retainage Percentage which would allow Maritimes to recover the increased fuel costs it faced.

On 30 July 2009 the FERC approved the proposed reduction in transportation rates as well as the changes to both the fuel rates and calculation methodology proposed by Maritimes. The latter was subject to a technical conference to be held on 11 September 2009. The conference allowed the FERC to obtain further information regarding the filing while also providing an opportunity to discuss any issues and concerns arising from the changes proposed by Maritimes regarding the fuel rates and its calculation methodology.

After the conference the FERC's trial staff facilitated substantive negotiations between all parties in order to achieve a settlement that was "just and reasonable" and therefore in accordance with the Natural Gas Act. Once the settlement was agreed, on 30 April 2010 the FERC approved the rates agreed in the settlement as it found these to be "fair, reasonable, and in the public interest".

Source: The FERC's role in "Cost-of-Service Rate Filings", available at: https://www.ferc.gov/industries/gas/gen-info/rate-filings.asp and Offer of settlement (in relation to "Maritimes & Northeast Pipeline, L.L.C. Docket Nos. RP09-809-000, RP09-809-001, and RP09-809-002") available at: https://www.ferc.gov/CalendarFiles/20100430123433-RP09-809-000.pdf

7.1.6 Impact on cost of capital

The impact on the cost of capital from this mechanism may vary from case to case, depending on the demand risk ultimately faced by the company.

If as a result of the settlement most of the demand risk related to the highly anticipatory infrastructure is borne by the firm, and to the extent that demand for the new infrastructure may be driven by macroeconomic variables, this would mean greater exposure to systematic risk for a firm, which in turn cost would increase the cost of capital for the project.

In contrast, if the majority of the demand risk attached to the highly anticipatory investment is borne by the large industrial customers that sign the contract, then there would not be much impact on the cost of capital of the infrastructure provider (compared with a counterfactual of the firm being guaranteed cost-recovery through a RAV mechanism).

[20] Description of FERC, available at: https://www.ferc.gov/about/ferc-does.asp

7.2 Market-based investment incentive

7.2.1 Description

Market-based investment incentives can sometimes be used by regulators to link investment incentives faced by network companies for highly anticipatory investments to market demand for the additional capacity generated through the investment. The rationale for this approach is to provide the company with incentives to invest efficiently in infrastructure that is needed to match the anticipated future demand for additional capacity.

A pre-requisite for such incentive schemes is that there should be a market (or it must be possible to set up a market) which allows additional capacity to be sold to users. The company undertaking the investment can then be given an incentive arrangement which allows it to gain from making additional infrastructure available when the revenues associated with the sale of additional capacity exceed the cost of investing to make it available. Consequently, the company can reap the rewards from the highly anticipatory investment through making available and selling the incremental capacity, thus moving away from a baseline level of outputs in response to market signals.

Market-based investment incentives may be used within a wider price control, and can therefore represent an add-on feature rather than a replacement for RAV-based regulation. The wider price control would continue to cap the price that the firm can charge for the baseline outputs specified as part of the price control settlement, with market-based incentives affecting the revenues that firm can earn by making a discretionary investment to sell incremental capacity above the baseline level of outputs in response to market signals.

7.2.2 Impact on risk allocation

Compared with a counterfactual of a regulator including the capex relating to the highly anticipatory investment in the RAV at the start of the regulatory period, a market-based investment incentive mechanism increases the demand risk faced by the company, but reduces the risk that consumers will end up paying for stranded assets.

7.2.3 Circumstances where tool is relevant

In the context of highly anticipatory investments a market-based incentive is relevant where there exists a market for selling additional capacity generated through the new investment.

At the same time, to base an incentive scheme on market signals there must either be an existing market for network capacity or it must be possible to set one up.

If a market for additional capacity does not already exist, the ease with which such a market for additional capacity could be set up will vary depending on the characteristics of the sector and the utilisation of (future) potential customers. Typically, such a market will only be feasible if there are a limited number of entry or exit points on the network, with a sufficient number of users at entry or exit points to ensure effective competition.

7.2.4 Advantages and disadvantages

Advantages

Market-based investment incentives are a pro-competitive regulatory tool which potentially moves highly anticipatory investments closer to that which would occur in a competitive market in terms of scope and scale, and so may be thought of as incentivising efficient investment.

If appropriately designed, market-based investment incentives could in theory remove the problem of firms facing incentives under RAV-based regulation to invest in assets that face a high risk of stranding, since at the margin firms' decisions about whether or not to invest will be driven by market signals rather than RAV-based regulation.

Market-based incentives may also lower the costs faced by the regulator and the regulated company compared to mechanisms that require regulatory scrutiny of capex associated with highly anticipatory investments.

As the downside demand risk of the highly anticipatory investment is borne by the company, consumers would not pay for any additional capacity for which demand does not materialise, and therefore is not sold on the market.

Disadvantages

Assets typically have long asset lives, and the market demand for capacity in later years of these asset lives is only likely to be revealed nearer the time. Hence, there is a question as to what proportion of the future capacity rights made available by an investment need to be sold at the time of investment for the capex to be deemed an efficient response to market signals. If the threshold is set either too low or too high, then investment incentives may be distorted.

Market-based investment incentives can only be used where there is a market signalling the future anticipated demand for capacity (or such a market can be set up), and therefore it may be expensive to design / set up the relevant market and the associated market-based investment incentive.

7.2.5 Case study of the mechanism in practice

Case study 7.2: Ofgem: Capacity outputs incentive

In its 2002-2007 price control decision for Transco, Ofgem introduced a new incentive scheme to improve the way Transco invests in gas transmission capacity on its National Transmission System (NTS). The incentive mechanism was intended to provide better incentives for Transco to invest efficiently in NTS capacity in a timely manner.

The new scheme involved auctioning capacity. The auctions were intended to provide Transco with better information on the market value of capacity. The aim was that Transco would respond to the price signals by investing where it was efficient to do so.

Under the scheme Transco's allowed revenue would be directly related to the outputs it delivered on the National Transmission System (NTS). The key features of the scheme were:

- In setting Transco's allowed revenue under the price control, Transco and Ofgem would agree defined capacity levels at entry and exit on the NTS.
- Transco would then auction these agreed levels of capacity via a series of five-yearly, annual, monthly and daily auctions.
- Transco would keep any additional revenue from investing to deliver capacity over and above those levels for the duration of the price control.

- Transco would be required to buy back capacity at market prices for any period where the agreed level of capacity was unavailable for whatever reason (for example if investment was delayed or because of maintenance).

Transco conducted its first auction to enable shippers to access the national transmission system up to 15 years ahead in January 2003.

Source: Ofgem: Review of Transco's price control from 2002 final proposals, September 2001, available online at: https://www.ofgem.gov.uk/publications-and-updates/review-transcos-price-control-2002-final-proposals

7.2.6 Impact on cost of capital

A market-based investment incentive may increase the demand risk faced by the company – relative to a counterfactual where the capex associated with the highly anticipatory investment is included in the RAV – since the firm is exposed to uncertainty regarding the return it would be able to earn from the additional capacity sold on the market. If demand for infrastructure is driven by macroeconomic variables, then the firm may be exposed to higher systematic risk, which in turn could increase the cost of capital.

Furthermore, through a market-based incentive, the company would also be exposed to the downside risk associated with the highly anticipatory investment if anticipated demand does not materialise, and hence the additional capacity generated through the investment is not sold on the market. Therefore, under this mechanism the regulator may need to set the allowed rate of return on the RAV above the cost of capital to offset the downside risk, so as to incentivise highly anticipatory investments.

8 Mechanisms Involving Subsidy

8.1 Capital grants from government

8.1.1 Description

Highly anticipatory investments may relate to government policy goals, such as the UK government's decarbonisation targets, where a solution might be to use capital grants provided by the government to fund investment in infrastructure that enables these policy goals to be met.

The mechanism would typically involve the company submitting an application for the capital grants, which would include producing a plan for the investment, highlighting the anticipated future scale and expected demand for the new infrastructure. The application would then by evaluated by the party providing the funding and may be rejected or approved, with full or partial funding awarded for the proposed investment.

In case of a successful application, capital grants would typically be provided as a one-off payments at the start of the investment process to the company undertaking the highly anticipatory investment. Since this funding would come from the government, the firm would not need to raise finance from investors for capex covered by the capital grants. Consequently, the firm would not need to recover the investment cost from customers through its allowed revenues.

Capital grants would be ultimately be funded from general taxation, and hence the cost of the investment would fall on citizens in their role as taxpayers.

8.1.2 Impact on risk allocation

Capital grants from government remove the downside risk arising from the highly uncertain nature of anticipatory investments from both the company and from customers and transfer it to the government. In turn, the government would recover the subsidy provided through general taxation with the taxpayer being ultimately responsible for the funds provided for the investment.

In turn, this may give rise to the risk that citizens, including those not located in the network's area, end up paying for stranded or under-utilised assets through their tax bills. If the government funds the capital grants out of current taxation, then the entire cost of the investment would fall on current rather than future taxpayers. (This contrasts with what happens when investment is recovered from energy customers through price controls, as in that case firms recover the cost of investment from both current and future customers by earning depreciation and a return on the investment over its lifetime.) On the other hand, if the government funds the capital grants by increasing government borrowing, then the cost of the investment will end up being funded by citizens in the future when the government has to pay back its borrowing through taxation.

8.1.3 Circumstances where tool is relevant

Capital grants for infrastructure investment mean that the company can carry out capex without having to raise funds from investors and without facing any demand risk. Therefore, the mechanism is likely to strongly encourage companies in undertaking investment projects where stranding or under-utilisation is a possibility, making it suitable in circumstances where highly anticipatory investments relate to government policy goals.

The mechanism may also be used in circumstances where policy-makers wish to limit the exposure of the firm to downside risk, but in the case of low demand for the new infrastructure the company would not have a sufficiently large customer base to recover the cost of the investment. For example, this might be the case for a company which invests solely in new infrastructure, and which does not own an existing monopoly network that would allow it to recover the investment cost through a RAV-based price control.

At the same time, given the disadvantages of the mechanism outlined below, the benefits associated with each highly anticipatory investment to be funded fully or partly through capital grants from the government should be carefully considered as it may encourage companies to undertake highly anticipatory investments that do not benefit customers, neither aligning with their preferences and needs.

8.1.4 Advantages and disadvantages

Advantages

Capital grants can be a powerful mechanism in encouraging investment in highly anticipatory energy infrastructure as the mechanism removes the downside demand risk faced by the company.

The mechanism may also be used to support and incentivise wider strategic goals, such as the decarbonisation targets set out by the UK government, through enabling a rapid growth in the infrastructure required to meet these objectives.

Moreover, it may also deliver benefits to those customers who use and benefit from the infrastructure as they would not have been able to do so in absence of the highly anticipatory investment.

Disadvantages

The mechanism would reduce incentives for the company to do due diligence when proposing investment in new highly anticipatory infrastructure, as they would not be exposed to the risk of the infrastructure becoming stranded.

Under this mechanism, citizens (through their tax bills) may end up paying for assets which do not get used or are only partially used and which therefore deliver few benefits to them. Further, these costs would fall on citizens in general, including those located outside the company's service area.

When the award of any grants by the government is subject to an evaluation process, this could give rise to significant costs for both the company and the government alike.

8.1.5 Impact on cost of capital

Capital grants mean that the regulated company will not be exposed to demand risk around future use of the highly anticipatory infrastructure. This gives the same kind of protection against this risk as inclusion of the capex within the company's RAV (which would also guarantee cost recovery).

There may, however, be a number of other ways in which capital grants might affect a firm's risk exposure. For example, it may reduce a firm's exposure to financing risks, since the firm will no longer be exposed to movements in market interest rates over time as it will no longer have to borrow funds to finance the investment. Capital grants might also reduce the firms operational gearing (the ratio of its fixed costs to its variable costs), which may reduce the firm's exposure to risks around changes in consumption volumes across its customer base. It is possible that these effects may reduce the firm's total exposure to systematic risk, in which case the provision of capital grants would reduce the firm's cost of capital.

8.2 Demand assurance

8.2.1 Description

Demand assurance is a mechanism whereby a company undertaking a highly anticipatory investment in new infrastructure would receive a "top-up" payment from the government in cases where demand for the new infrastructure or asset fails to materialise to the extent anticipated.

Under this mechanism the company would initially produce a strategic plan based on the future scale and expected demand for the new infrastructure. The plan set out by the company would need to be approved by a government department or regulatory body upon which the company and investors would receive a guarantee that the company would earn revenue from the investment even if expected demand does not materialise. Every time demand falls short of the anticipated level over the lifetime of the investment, the company would receive a subsidy to help cover the costs of the capital expenditure that was incurred building the infrastructure but that has not been recovered from users of the infrastructure.

There are different options for how much subsidy should be provided to the company in the event that demand does not materialise to the extent anticipated. One option would be for sufficient subsidy to be provided such that (so long as the company keeps its costs at an efficient level) it still covers its cost of capital. Alternatively, subsidy could be provided to ensure that the returns earned by the company (if it keeps costs at an efficient level) do not go lower than some floor that is set below the cost of capital (e.g. not lower than the cost of debt). The advantage of the latter approach is that the company is still exposed to some demand risk, thus giving it greater incentive to make a commercial success of the investment.

Demand assurance aims to assure investors that their investment would be protected in the event that demand for the highly anticipatory investment does not materialise in the manner laid out in the plan, either in quantity or timing.

There are two key possibilities for where the funds for any top-up subsidies might come from:

- They could be provided by the government and recovered from citizens through general taxation.
- They could be provided through a levy on monopoly energy networks that is passed through to energy bill payers.

8.2.2 Impact on risk allocation

Demand assurance removes the downside risk from the regulated company and investors and passes it on to the party footing the bill for the subsidy when demand does not materialise. Depending on the ultimate source of these funds, the third party responsible for paying for demand shortfalls may be citizens in general (through general taxation) or energy bill payers (if the funds are recovered through a levy on monopoly energy networks).

In the event that the subsidy is funded through higher bills paid by the customers of monopoly energy networks, it is likely that the costs of the subsidy may end up being recovered in a regressive way (i.e. low income households may pay a higher proportion of their income towards the levy, given that energy bills are typically a higher proportion of income for low income households). By contrast, it is likely that if the costs of the subsidy are recovered from general taxation, then they will be recovered from citizens in a more progressive way.

8.2.3 Circumstances where tool is relevant

As demand assurance provides a safety net to its investors through a top-up payment when actual demand falls below the anticipated level, it could be used to encourage highly anticipatory investments that relate to wider government objectives such as the UK government's decarbonisation targets.

For example, demand assurance may be relevant in circumstances where an investment relating to decarbonisation is subject to economies of scale, and without assurance being provided to the company that demand will not fall below a certain level, it may not be able or willing to undertake the investment.

The mechanism may also be used to support a rapid uptake of a new decarbonisation technology in markets where the potential customer base is lower or where the market is newly developed, as it removes the downside risk of insufficient demand that would otherwise be faced by the company. Under these circumstances, other mechanisms (such as RAV-based tools) may not allow the company to earn revenues from the smaller customer base if anticipated demand does not materialise.

At the same time, given the disadvantages of the mechanism outlined below, a policy-maker would need to think very carefully before implementing to a demand assurance mechanism. In particular, the policy-maker would need to bear in mind that such a mechanism may encourage companies to undertake highly anticipatory investments that do not benefit customers, with citizens ultimately paying for the cost of top-up subsidies through general taxation.

8.2.4 Advantages and disadvantages

Advantages

Demand assurance can be a powerful mechanism in encouraging investment in highly anticipatory energy infrastructure as the mechanism reduces the downside risk faced by the company and investors if demand does not materialise in the manner anticipated by the company when the investment is proposed.

The mechanism may also be used to support and incentivise wider strategic policy goals, such as the decarbonisation targets set out by the UK government, through enabling a rapid growth in the infrastructure required to meet these objectives.

An advantage of demand assurance over capital grants is that funds only have to be provided if demand does not materialise, thus reducing the potential burden of subsidies on citizens or energy bill payers.

Moreover, it may also deliver benefits to those customers who use and benefit from the infrastructure as they would not have been able to do so in the absence of the highly anticipatory investment.

Disadvantages

The mechanism would reduce (or remove) incentives for the company to do due diligence when proposing investment in new highly anticipatory infrastructure as even if anticipated demand does not materialise, the company would be assured a certain level of return on the investment so long as it controls its costs efficiently. This risk is somewhat mitigated if the mechanism provides a guarantee based on a floor to returns that is below the cost of capital, as in this case the firm would still be exposed to some demand risk.

If the mechanism was designed to assure the company that it would always earn the minimum return regardless of its cost efficiency, then it would remove any incentive on the company to control its costs. In practice, this disadvantage can be mitigated by guaranteeing a certain level of revenue rather than a certain rate of return.

Demand assurance would also reduce incentives for the company to win and retain customers (e.g. through marketing or the provision of a high quality of service), since if there is insufficient demand for the investment

the company will receive a subsidy. Indeed, if demand was substantially below forecast such that the firm had no realistic prospect of earning revenue above the guaranteed minimum, then incentives for winning and retaining customers would disappear. This is because, in such circumstances, the firm would not gain from additional commercial revenue as it would simply be offset by reduced subsidy.

The costs of administering the scheme for both the regulator and the regulated company could be significant.

Depending on the route selected to recover the costs of the top-up subsidies, either citizens in general (through general taxation) or else energy bill-payers could end up paying for assets which are not being used, or which are only partially being used.

Furthermore, if demand falls short of the anticipated level multiple times over the lifecycle of the investment, requiring the government to provide multiple top-up payments, citizens or energy bill-payers might face significant fluctuations in the costs that they bear through the impact of these subsidies on taxes or energy bills.

8.2.5 Case study of the mechanism in practice

Case study 8.1: Heat Networks Task Force

The Heat Networks Task Force, a body comprised of energy industry representatives, proposed demand assurance as a potential investment model in heat networks as a key decarbonisation tool to meet the Government's decarbonisation objectives. Under this model, a heat network developer would produce a strategic development plan detailing the anticipated future scale and customer type based on a reasonable expectation of heat demand of connected buildings. When demand falls short of this level, the developer would receive a payment to cover the cost that is incurred but not recovered from customer bills, covering at least the cost of capital, thus providing a safety net for investors.

The strategic development plan would need to be approved by a regulator, upon which the developer would receive a guarantee that the developer would receive revenue for producing and delivering the expected heat demand over the time period in the plan (suggested to be 25 years). Consequently, the demand assurance model directly aims to assure investors that their investment would be protected in the event that heat demand does not arise in the manner laid out in the plan, either in quantity or timing.

Among the models considered,[21] the Task Force indicated demand assurance as its preferred model, suggesting that this mechanism would reduce the investment risk of heat networks to a level on a par with that of regulated utility networks. The thinking is that, given the major upfront infrastructure investment required for a heat network, there needs to be a way of reducing the risk of the infrastructure becoming under-utilised, or even stranded. With water and energy networks, companies provide an essential service to a very large customer base. This means that the risk of companies not being able to recover the costs of stranded assets in these regulated sectors is very low. The expected differences in heat network sizes, and the uncertainty surrounding whether or not connection to a heat network will be the only option for receiving heat, does not offer investors the same low risk. Demand assurance is the proposed method of providing a similar guarantee of demand through regulation.

However, the source of funds for the payments to developers of heat networks under the demand assurance safety net is unclear. Presumably, the shortfall would either be funded through energy bills (with the funds routed through Ofgem) or they would come from the UK government, and hence be funded by citizens through general taxation. The industry Heat Network Task Force has not provided a concrete proposal on this front, but it suggests that a 'socialisation' of investment costs may be the method that

[21] This included a concession model where a heat network developer would be given exclusive rights by a regulator or authority and a PipeCo model which would separate investment in heat network distribution pipes from that in heat generation and supply.

allows the lowest burden to fall on any one party.[22] It is important to consider how investment costs would be recovered under a demand assurance scheme as the choice would have a bearing on risk allocation and the potential long term distribution of costs under this investment model.

Source: The Association for Decentralised Energy (2018): 'Shared Warmth', available at: https://www.theade.co.uk/resources/publications/shared-warmth-a-heat-network-market-that-benefits-customers-investors-and-t

8.2.6 Impact on cost of capital

Demand assurance reduces the regulated company's exposure to demand risk, since if demand for the new asset or infrastructure does not materialise investors would still be able to earn a return on the investment. Given that demand may be driven at least partly by macroeconomic factors, this will reduce the company's exposure to systematic risk, and therefore reduce the cost of capital for the infrastructure project.

A company building a network under the demand assurance model may or may not be subject to price regulation at the same time. Therefore, there may or may not be a need for a regulator to determine an allowed rate of return on a RAV.

If the company is price regulated, a demand assurance model which removes any downside risk (i.e. by guaranteeing that the firm would receive sufficient revenue to earn its cost of capital, subject to it being efficient) would allow the regulator to set the firm's allowed rate of return on its RAV at the cost of capital (rather than above it), given that there would be no need to allow the firm any potential for upside gain to compensate for downside risk. If the demand assurance model exposes the firm to some downside risk (e.g. by setting a floor on returns at the cost of debt), then the allowed return on its RAV when demand does materialise would need to be set somewhat above the cost of capital.

[22] The Association for Decentralised Energy (2018): 'Shared Warmth' https://www.theade.co.uk/resources/publications/shared-warmth-a-heat-network-market-that-benefits-customers-investors-and-t

9 Other Risk Allocation Mechanisms

9.1 Management incentives

9.1.1 Description

Typically, the design of management incentives and remuneration schemes are decided by the companies themselves, including in the context of regulated markets.

Nonetheless, a regulator might put in place management incentives for regulated companies in cases where the company does not have private sector shareholders. Private sector shareholders are in general likely to focus management attention on the quality of the investment decisions made by the company, as in the case of any upside they gain additional returns. In contrast, debt holders in a company are generally more concerned about the payment of interest and principal[23] and ensuring that the company remains creditworthy. In highly leveraged companies,[24] debt markets can provide some incentives to make prudent decisions and adopt good management practices, for example, to withstand scrutiny by credit rating agencies. Even so, in some circumstances, regulator-led management incentive schemes may be useful in increasing the quality of investment decisions made by the regulated company.

In a context of highly anticipatory investments, management incentives could be relevant in ensuring that the company makes prudent and high quality investment decisions about new infrastructure through linking part of the company management's remuneration package to the outcome of the highly anticipatory investment.

However, it would be important that such an incentive scheme exposed management to some of the downside risk if demand does not materialise, as well as allowing them to benefit from the upside gain if demand does materialise. A remuneration package which allowed managers to gain from the upside but did not expose them to any of the downside risk could lead to worse investment decisions, since managers would have a potential incentive to authorise risky investments knowing that they would gain financially if the investments turned out well but would not be affected if they turned out badly.

Further, such an incentive scheme would need to have contractual force even after the manager has left the company, given that there may be a time period of many years before it becomes clear whether the infrastructure is well used or has become stranded.

In practice, it is likely to be difficult to design an incentive scheme that exposed an individual manager to a potential contractual liability to pay a financial penalty to the firm years in the future (by which time they may have left employment in the firm), since such a scheme might make it difficult to recruit a good manager in the first place. Hence, it is likely that a remuneration scheme for highly anticipatory investments would need to be based around a bonus payment payable years in the future, which would be scaled up if the highly anticipatory infrastructure investments turn out well, and scaled down (possibly to zero) if they turn out badly. In this case, managers would be exposed to downside risk in the form of foregone earnings. To ensure that there were not incentives to authorise investment projects inappropriately, such a bonus would need to be payable even if the manager decided not to authorise any highly anticipatory infrastructure investments.[25]

[23] Initial amount of money lent to the company.

[24] Companies that have a high level of debt.

[25] Another approach would be a management stock option which can only be exercised years in the future when the outcome of the investment decision has become clear. However, this would only encourage management to make wise decisions about whether or not to authorise highly anticipatory infrastructure investments to the extent that the success or otherwise of such investments will have an appreciable effect on the company's future share price.

9.1.2 Impact on risk allocation

Management incentives anchor the remuneration package of company management (i.e. bonuses or any compensation that is paid in addition to the base salary) to the outcome of the highly anticipatory investment undertaken by the company. This means that managers are rewarded or penalised depending on how well the investment in new infrastructure turns out, transferring a small part of the demand risk associated with the investment from customers and taxpayers to company management. However, given that the scale of infrastructure investment will typically be orders of magnitude higher than the remuneration of company management, in practice it will only be feasible to transfer a small part of the demand risk to management through their remuneration packages. Hence, the purpose of this tool is primarily to give incentives to management, rather than to engage in risk transfer.

Given that only a small part of the risk is transferred to company management, within the context of a regulated company subject to periodic price reviews, most of the risk would still be borne by customers. This is because (in the absence of any other risk-sharing mechanism) the capital expenditure associated with the new infrastructure would be added to the RAV by the regulator, allowing the company to earn depreciation and return on the investment from customers. Consequently, if the anticipated demand for the infrastructure does not materialise (i.e. the asset becomes stranded), the company's customer base would continue to bear the costs of the stranded investment through customer charges.

9.1.3 Circumstances where tool is relevant

Within a regulatory environment, the regulator could require remuneration schemes to be set up for company directors that incentivise management to focus on the quality of highly anticipatory investment decisions by rewarding or penalising them depending on the outcome of the investment (i.e. whether demand for the new infrastructure materialise). Management incentives are most relevant when the company does not have any private sector shareholders and faces limited incentives from debt markets to make appropriate investment decisions. For these incentives to be effective, managers' remuneration should be linked to the performance of the highly anticipatory investment over the long term.

Many companies operate internal management incentive schemes even without being mandated to do this by regulators – for example, outside the regulatory setting managers may be rewarded partly in equity (i.e. stock options). Such schemes allow shareholders to incentivise company management to take decisions that are in the shareholder interest. If a regulator employed another risk allocation tool which exposed shareholders to some of the demand risk associated with highly anticipatory infrastructure investment (e.g. a revenue driver), companies might voluntarily respond by introducing management incentives that linked management pay to the outcomes from these investment decisions. Indeed, a standard stock option would have the desired effect (provided that the date of vesting[26] is far enough in future for the outcome of the highly anticipatory investment to be known and therefore reflected in the stock price at the time of vesting). In this way, companies could ensure that the incentives faced by managers in relation to highly anticipatory infrastructure investment aligned with the interests of shareholders.

This in turn is only likely to be the case for a price regulated company if the regulator has introduced a risk-sharing mechanism that exposes the company to some of the demand risk associated with highly anticipatory infrastructure investments.

[26] Vesting refers to the time at which an employee is allow to exercise an employee stock option.

9.1.4 Advantages and disadvantages

Advantages

By linking remuneration to the outcome of highly anticipatory investments, management incentives could incentivise prudent and efficient investments. Investments where assets become stranded would penalise managers through lower or no performance-related pay being received.

Good management practices may also have an impact on investor confidence and the ease with which the company can raise funds for projects. For example, good management practices may improve the company's creditworthiness and credit rating, which in turn could facilitate the raising of capital for new investments.

The mechanism could be tailored to the needs of each highly anticipatory investment, by linking the performance-related pay component in part or in full to the outcomes of that specific investment project.

Disadvantages

Regulatory input into the use or design of management incentives (which are typically left for companies to decide) could be seen as too interventionist, as the company may have a better idea of the appropriate incentive scheme for its management.

There are a number of specific disadvantages to the use of management incentives in the context of highly anticipatory infrastructure investments. In particular:

- There may be a long time period (possibly even decades) between the decision by management to go ahead with a highly anticipatory infrastructure investment and when it becomes clear whether or not the infrastructure has become stranded. It may be hard to design an appropriate incentive scheme in this context, given that the managers who take the decision may long since have left the company (and may not even be alive any more) when the outcome of the investment decision becomes clear. Further, if incentive payments are only going to be received a long time in the future, they are likely to have less effect on management decision-making in the present.
- While the quality of management decisions will have some effect on whether the firm ends up with stranded assets, in the case of highly anticipatory infrastructure investment there is inherently substantial demand risk which is outside the control of management. Linking management remuneration to whether demand materialises would therefore expose management to windfall gains or losses in their personal remuneration driven by factors outside their control.[27]

9.1.5 Case study of the mechanism in practice

Case study 9.1: Network Rail's Management Incentive Plan 2018/19

Network Rail is the body which owns, operates and develops rail infrastructure in Great Britain. It is a public body, and hence does not have any private sector shareholders.

Network Rail's remuneration package includes incentive pay for its Executive Directors. The revised Management Incentive Plan (MIP) for the 2018/19 period starting on 1 April 2018 amended the structure of incentive pay by replacing the historical annual and long-term incentives with a single potential performance-related payment every year.

The MIP is underpinned by Network Rail's four key principles, namely:

[27] An illustration of how remuneration schemes can lead to windfall gains would be the £75m bonus paid to the former Chief Executive of Persimmon, which was driven by increases in the share price of the company that resulted from the government's Help to Buy policy. A news article on the furore caused by this bonus can be found here: https://www.theguardian.com/business/2018/nov/07/persimmon-boss-asked-to-leave-amid-ongoing-outrage-over-bonus

- Simple – the remuneration scheme should be a transparent framework that is easy to understand;
- Competitive and fair - remuneration should take into account the executive's experience and the complexity of the role;
- Performance and safety - the remuneration scheme is linked to performance in areas which are primordial to Network Rail's success such as safety, train performance and financial management; and
- Aligned with employees – the remuneration structure should be used for all employees not just executives.

To determine whether any performance-related pay applies at the end of the period, executives' performance is evaluated by the Remuneration Committee against a national scorecard encompassing seven broad categories of measures of performance, including a measure of investment based on milestones achieved in relation to enhancement projects.[28] The scores against each of these measures are then aggregated into an overall final score using a pre-determined set of weights.

The plan specifies a minimum level of performance (20 per cent of the maximum available on the national scorecard) below which no annual performance related payment will be made. Similarly, minimum requirements are applied to performance in the financial incentive category as well.

The MIP puts a cap on the maximum aggregate payment to be made to executives, in the event that the highest possible level of performance is achieved. This upper limit is set at 9 per cent of the relevant base salary for the chief executive, and at 20 per cent of the relevant base salary for the chief financial officer. By way of illustration, the base salary for the chief executive for the 2018/19 financial year was £588,000, with a maximum incentive payment for good performance of around £53,000.

Source: Network Rail (2018): "Management Incentive Plan 2018/19", available at: https://cdn.networkrail.co.uk/wp-content/uploads/2019/06/Management-Incentive-Plan-2018-19.pdf

9.1.6 Impact on cost of capital

Management incentives transfer a small part of the demand risk associated with highly anticipatory infrastructure investments from customers to company management and therefore do not affect the risk borne by the regulated company. Consequently, compared to a counterfactual where the capex associated with the highly anticipatory investment is included in the RAV, this mechanism is unlikely to have any material impact on the company's market or allowed cost of capital.

9.2 Availability-based payments

9.2.1 Description

A regulator or government may decide that under wholesale market rules availability-based payments should be made to generation capacity in exchange for the capacity being available to the market in case it is needed, regardless of whether or not it is actually used. In turn, this could be used to ensure that electricity demand by consumers is always met, improving security of supply.

The availability-based mechanism could be based either on fixed payments to generators, or on auctions where the regulator buys capacity in advance at a price which emerges from the auction. Under an auction-based mechanism the regulator will then pay for the amount sold by the company in the auction at the specified price, while the regulated company is required to be ready to provide the corresponding capacity.

[28] The other six broad categories of measures include: safety, financial outperformance, asset management, train performance, locally driven customer measures and route performance.

In the context of highly-anticipatory investments, availability-based payments could be used for investment in generation capacity, where the company undertaking the investment would receive a fixed, predetermined payment for the capacity being available to generate, regardless of whether or not demand has materialised.

9.2.2 Impact on risk allocation

Compared to a counterfactual of a commercial investment where the company is fully exposed to demand risk, availability-based payments in general reduce the demand risk borne by the company and transfer some of it to the party making the availability payments. This is because payments to the company for making generation capacity available are made even if demand for electricity generated using the capacity does not materialise or does so at a level lower than anticipated. However, the owner of the generation capacity would still be exposed to some demand risk, as the level of outturn demand would affect the stream of revenue received for generating electricity.

If the funds used to cover the payments for the company being available to generate electricity are recovered through general taxation, then the third party bearing some of the risk of asset stranding would be citizens in general. On the other hand, if the costs of making availability payments are recovered from energy suppliers (e.g. in proportion to demand) under wholesale electricity market rules, then it would be energy bill payers who would be bearing some of the risk of asset stranding.

The mechanism also reduces the risk that a sudden unexpected change in demand is not covered by the capacity available in the market, benefitting customers who experience greater security of supply than in the absence of this mechanism.

9.2.3 Circumstances where tool is relevant

Availability-based payments ensure that companies receive a predetermined payment for making generation capacity available through a highly anticipatory investment. In the context of the wider policy goals of ensuring security of electricity supply, the mechanism is particularly relevant for highly anticipatory investments in generation capacity. This is because in the absence of the mechanism the potential losses arising from service disruptions or shortages can be significant for customers. (In the absence of availability payments, incentives for sufficient generation capacity to be made available would be likely to come instead from wholesale electricity price spikes at times when capacity is scarce.)

9.2.4 Advantages and disadvantages

Advantages

Availability-based payments reduce the downside risk associated with the asset being stranded for the company, transferring some of it to the party providing the funds for the availability payments. The company then is incentivised to invest in new capacity, given that it would continue to receive a stream of revenue if demand does not materialise. As a consequence, the mechanism may be used to support wider goals, such as the security of electricity supply over the long term. It could also be used to support investment in new low-carbon generation (e.g. new nuclear or renewables generation).

Where the capacity for which the company receives the payment, as well as the associated unit price for availability, is determined under an auction-based mechanism the outcome is likely to be closer to that under a competitive setting. Therefore, the application of an auction-type mechanism can be used to incentive companies to propose efficient and innovative solutions to making capacity available.

Disadvantages

The mechanism would reduce incentives for the company to do due diligence when proposing investment in new highly anticipatory generation, as they would be less exposed to the risk of the infrastructure becoming stranded.

To the extent that the payment made to generators is funded through general taxation, citizens (through their tax bills) may end up paying for assets which do not get used or are only partially used and which therefore deliver few benefits to them.

9.2.5 Case study of the mechanism in practice

Case study 9.2: Integrated Single Electricity Market: Capacity Remuneration Mechanism

The Integrated Single Electricity Market (I-SEM), a single wholesale electricity market operating across the isle of Ireland, operates a Capacity Remuneration Mechanism (CRM) that provides payments for electricity generators in exchange of being ready to supply electricity to the grid when demand arises.

The former mechanism that was operated under the Single Electricity Market (SEM) before the I-SEM went live on 1 October 2018 was known as the Capacity Payment Mechanism (CPM), and was based on a pot of money available to electricity generator companies. Under this mechanism, payments were based on the fixed costs incurred by the generating plant which were low in general. The Single Energy Market Committee (SEMC)[29] then calculated the annual sum paid to each generator.

With the implementation of the I-SEM, the SEMC proposed to maintain capacity payments. However, it proposed substituting the fixed payments to generator companies with an auction system where only generators successful in the auction would receive a payment in order to enhance competition in the market.

Under the CRM, auctions are usually run to provide capacity for the year ahead (T-1 auctions) or for four years ahead (T-4 auctions), with occasional auctions for capacity to be delivered two years ahead (T-2 auctions). During the auction process, both SONI and EirGrid[30] work in collaboration to determine the capacity needs of the island. The final amount of required capacity is set by the regulators and auctions are carried out using an online system. The successful generators will then receive regular payments for each megawatt of capacity that they sold in the auction. If a generator fails to provide the agreed capacity, it may incur substantial charges set by the regulators.

Source: SEM Committee: "Capacity Remuneration Mechanism", available at: https://www.semcommittee.com/capacity-remuneration-mechanism and EirGrid and SONI (2020): "Quick Guide to the Capacity Market and 2021/2022 T-2 Capacity Auction Final Results", available at: https://www.sem-o.com/documents/general-publications/T-2-2021-2022-Final-Auction-Results-Quick-Guide.pdf

9.2.6 Impact on cost of capital

Availability-based payments reduce the company's overall exposure to demand risk, since it receives payments for being available to generate electricity, regardless of whether or not demand materialises. Given that demand may be driven at least partly by macroeconomic factors, this will reduce the company's exposure to systematic risk, and therefore reduce the cost of capital for the infrastructure project.

[29] SEMC is the decision-making authority with respect to issues affecting the I-SEM. SEMC consists of representatives of Commission for Regulation of Utilities (CRU) and the Utility Regulator (UR), the energy regulators of the Republic of Ireland and Northern Ireland, respectively. Further information is available at: https://www.semcommittee.com/who-we-are

[30] The system and transmission operators in Northern Ireland and the Republic of Ireland, respectively.

10 Conclusions

The report considers the risk allocation mechanisms that may be used in the context of highly anticipatory investments, where infrastructure is developed to meet demand that has not yet materialised, but is anticipated to materialise at some point in the future. Consequently, the company undertaking the investment faces a level of uncertainty over the extent of its eventual use.

10.1 Overarching issues

The first section of the report presents some overarching issues relating to highly anticipatory infrastructure investments.

First, we present a general framework that firms may use to justify highly anticipatory investments through cost-benefit analysis. Furthermore, we also describe some options that can be used take account of the risk and uncertainty associated with these investments within cost-benefit analysis, including sensitivity and scenario analysis and Monte Carlo modelling. Finally, we also provide an overview of how real options analysis may be relevant to highly anticipatory investments in energy infrastructure.

Second, we describe some key considerations relating to determining an appropriate balance of risk for consumers. In general, with regards to the demand risk associated with highly anticipatory investments, the following two key considerations are crucial. First, where a company enjoys protection from some (or all) of the demand risk associated with the highly anticipatory investment, then this demand risk would instead be borne by customers (or citizens in general), which in turn may mean that consumers end up paying for stranded infrastructure. Second, if the demand risk associated with the highly anticipatory project is borne by the firm instead, then there exists the possibility that the firm may not be willing to undertake the investment altogether or that it would require a higher allowed rate of return if demand materialises to compensate for the additional risk to which it is exposed. Given these considerations, it might typically be appropriate to use a risk-sharing mechanism which shares the risk between the company and its customers.

10.2 Compendium of risk allocation mechanisms

The second section of the report considers a range of risk allocation mechanisms which may be used under different circumstances. The table below provides some guidance on the selection of an appropriate risk allocation mechanism under these conditions.

Table 10.1: Circumstances under which risk allocation mechanisms can be considered

Question	Tools to consider if answer is "yes"
Is greater information on need for highly anticipatory investment likely to emerge during price control?	Price control re-openers / interim review
Does the regulator wish price controlled firms to share demand risks around highly anticipatory infrastructure with customers?	Capex trigger
	Error-correction mechanism
	Caps and collars to return on investment
	Ring-fenced funding from customers who use the new infrastructure
Will the highly anticipatory investment drive some key customer outcome?	Funding through outcome delivery incentive
Is the highly anticipatory infrastructure discrete, with scope for separate user charges?	Caps and collars to return on investment
	Ring-fenced funding from customers who use the new infrastructure
Will usage of the highly anticipatory infrastructure vary substantially through time?	Economic depreciation
Will the highly anticipatory infrastructure be used mainly by large customers, some of whom already want it?	Negotiation between infrastructure provider and customers
Is there a market in which capacity created by the highly anticipatory investment can be sold?	Market-based investment incentive
Is the highly anticipatory investment driven by government policy?	Capital grants from government
	Demand assurance
Does the firm have no private sector shareholders?	Management incentives
Is the highly anticipatory investment project about investment in generation capacity?	Availability-based payments

Source: Europe Economics analysis.

In the table above, all of the mechanisms listed against questions that get answered "yes" may be considered. However, in order to identify which of these potentially relevant mechanisms will actually be suited to the specific investment project, the full compendium entries for potentially relevant mechanisms presented in the second part of this report should be consulted.

Appendix

Europe Economics

Appendix 1: Reference List

List of general sources consulted

- CEPA (2018), "Review of the RIIO Framework and RIIO-1 Performance"
- CEPA (2018), "Financing for Infrastructure"
- Global Infrastructure Hub (2016), "Allocating Risks in Public-Private Partnership Contracts"
- KPMG (2014), "Offshore Transmission: An Investor Perspective – Update Report"
- Roland Berger (2011), "The structuring and financing of energy infrastructure projects, financing gaps and recommendations regarding the new TEN-E financial instrument"

List of sources consulted in relation to specific risk allocation mechanisms

Chapter 5: Regulatory mechanisms based on ex post information

- Ex post prudency test
  - Australian Energy Regulation (2013) "Capital Expenditure Incentive Guideline for Electricity Network Service Providers"
- Capex trigger
  - CAA (2003): "Economic regulation of BAA London airports (Heathrow, Gatwick and Stansted) 2003-2008 CAA decision"; and
  - CAA (2004): "Decision on the detailed specification of the capital expenditure triggers in the price cap conditions for Heathrow and Gatwick Airports"
- Error-correction mechanism
  - Ofgem (2013): "Strategy decision for the RIIO-ED1 electricity distribution price control – Uncertainty mechanisms"
- Caps and collars to return on investment
  - Ofgem (2013): "Cap and floor regime for application to project NEMO: Impact Assessment"; and
  - Ofgem (2014): "Decision on the cap and floor regime for the GB-Belgium interconnector project Nemo"
- Funding through outcome delivery incentive
  - Ofwat (2019): "PR19 Final determinations Delivering outcomes for customers policy appendix"; and
  - Ofwat (2019): "PR19 final determinations Southern Water – Outcomes performance commitment appendix"

Chapter 6: Mechanisms Affecting Allocation between Consumer Groups

- Ring-fenced funding from customers who used the new infrastructure
  - Ofwat (2018): "Charges Scheme Rules, Wholesale Charging Rules and Charging Rules for New Connection Services (English Undertakers) decision document"
- Economic depreciation

- Ofcom (2005) 'Wholesale mobile voice call termination markets – a proposal to modify the charge control conditions'

Chapter 7: Market-based Mechanisms

- Negotiation between infrastructure provider and customers
  - Description of FERC;
  - The FERC's role in "Cost-of-Service Rate Filings"; and
  - Offer of settlement (in relation to "Maritimes & Northeast Pipeline, L.L.C. Docket Nos. RP09-809-000, RP09-809-001, and RP09-809-002")
- Market-based investment incentive
  - Ofgem: Review of Transco's price control from 2002 final proposals, September 2001

Chapter 8: Mechanisms Involving Subsidy

- Demand assurance
  - The Association for Decentralised Energy (2018): 'Shared Warmth'

Chapter 9: Other Risk Allocation Mechanisms

- Management incentives
  - Network Rail (2018): "Management Incentive Plan 2018/19"
- Availability-based payments
  - SEM Committee: "Capacity Remuneration Mechanism"; and
  - EirGrid and SONI (2020): "Quick Guide to the Capacity Market and 2021/2022 T-2 Capacity Auction Final Results"