MASTER

Incentive regulation on cross border connections

van den Reek, W.J.

Award date:
2008

MASTER

Incentive regulation on cross border connections

van den Reek, W.J.

Award date:
2008

Incentive Regulation on Cross-Border Connections

Willem van den Reek

TU/e

NMa Directie Toezicht Energie (DTe)

Date: MSc. Thesis

Student: January 2008

Willem van den Reek
Program: 0519584

Technology and Policy
Department of Technology Management
Eindhoven University of Technology

Supervision: Eindhoven University of Technology
dr. ir. G.P.J. Verbong

DTE
ir. H.M. de Jong
ir. P.G.M. Giesbertz

Summary

Goal of the study: *propose a design for such an incentive plan which encourages TSOs to maximise cross border capacity made available to the market, in the Central West European Regional Energy Market.*

The main objective of the European Commission for the European energy market is to have a working internal energy market with open competition and effective regulation in place by January 2009. According to the Commission, a real European grid should work as a single grid. In order to reach this goal, sufficient cross border capacity is an essential factor. In the ERI action plan 2006 for the Central West European Region the problem of a lack of transmission capacity is already explicitly mentioned. In this paragraph the Transmission System Operators (TSOs) are requested to submit a joint proposal for a regional incentive scheme, allowing the maximisation of the amount and utilisation of firm cross-border capacities in the Central-West region. Until now no such proposal has been presented, therefore the involved regulators have taken challenge to come up with such a proposal.

A TSO is the operator of the high voltage electricity grid in a certain area and is responsible for safe and stable operation, expansion and maintenance of the electricity network, which transmits electrical power from generation plants to the regional or local electricity distribution operators. This TSO will then be by definition a natural monopolist. Although it is generally accepted that a monopolist is the optimal choice to maintain the electricity transportation grid, this still creates problems. Economic theory states that the presence of a monopolist leads to inefficiencies in the productive (capacity available to the market) as well as qualitative (reliability of transportation) sense. Literature states that regulation can be used as a means to solve the problems that are created when a natural monopoly is established.

Electricity grid TSOs within the European Union must comply with the regulatory obligation to maximise the cross border capacity they allocate to the market ((EC) 1228/2003 article 6). However they are forced to make a trade-off between grid safety and border capacity. Within the current regulatory framework, it is often in the TSO's best interest to trade capacity for quality, which can lead to allocative inefficiencies. Regulators in the Central West European Market have become wary that the TSOs might have become too conservative in there calculations for cross border capacity.

Within most markets there is an information asymmetry between the Regulator and the TSO, which makes it hard for the Regulator to establish if the TSO is functioning optimally. This would not be a problem if the operator and the regulator would have completely the same objective. In that case regulation would not be necessary, because the government could not

improve results by applying regulation to the operator. In practice however, the objectives of the regulator are often different from the operator. This problem is also known as the principal-agent problem.

The goal of this study is to propose a design for such an incentive plan which encourages TSOs to maximise cross border capacity made available to the market, in the Central West European Regional Energy Market. This research has tried to follow the approach as suggested by the Meta model which has led to three design proposals: These three proposals try to cover a wide spectrum of possibilities for regulation, but still attempt to approach the design objectives as much as possible. The objectives are: Strong Incentives for the TSO, Easy Implementation, least Opposition Among TSOs and Regulators, low regulatory cost and unambiguous measures for TSO Performance. In each of the proposals the capacity for which a target will be set, is calculated according to the following formula: **NTC = Capacity offered at the day-ahead market + nominated month and year capacity – the result of netting.** After this the following proposals have been identified:

- ***Straightforward Ex- Ante Bonus/Malus regulation:*** In this design there is a bonus and a malus for the TSO for respectively under and better performance than the target. In this proposal, clarity and information to the TSO are regarded as the main principles. Therefore the TSO knows beforehand what the target and the bonus and malus are on a daily basis and what direction of the flow will be rewarded.

- ***Bonus Regulation:*** Unlike previous proposal, this time no malus is introduced for not being able to reach the target, only a bonus is used. The height of this bonus per MW extra capacity from the target is established beforehand. This time only the extra capacity made available in the direction of the price difference will be rewarded, this is established afterwards.

- ***Market Simulation Regulation:*** This proposal tries to simulate the reality of the market as much as possible. Again a certain target level is to be introduced by the regulator up front. But instead of establishing beforehand what the bonus or malus per extra MW capacity would be, this is now linked to market prices for capacity and thereby established afterwards.

All designs have been capped to limit the total risk for TSOs. When comparing the three proposals for incentive regulation, the Bonus Regulation scheme promises to be the best option tot start with. What this option lacks in strong incentives for the TSO by excluding a malus, it makes up for by reducing the chances on 'un-fair' regulation. When starting with introducing incentive regulation there are many uncertainties. Regulation that lessens the importance of setting exact targets and has less harmful effects to the TSO might therefore be preferred during this phase. At a later moment when there is a level playing field for TSOs and the effects of the regulation have become clearer, it may be preferred to shift to another incentive scheme that also introduces a malus, e.g. the Market Simulation Regulation scheme. This increases the incentive stimulus and makes more advanced regulation.

In order to establish efficient regulation there are some requirements that need to be arranged first, no matter what incentive scheme is introduced. Starting with the requirement that **regulation must be implemented on both sides of a border.** If there is no agreement between two regulatory offices on the introduction of the regulation than it is impossible to introduce the regulation at that border. One-sided implementation is out of the question, because TSOs are dependent on each other's actions. Further, **grid-safety can not be compromised**. Security measures can not be tampered with in order to create extra capacity. Also, **the nominated capacity must be absolutely 'firm'**. If due to capacity increase based on the actions of the TSO the risk on curtailment increases than it would be unfair to pass these costs to other market participants while the TSO is the one to profit from this. And last, a **level-playing field for TSO should be created in order for the regulation to function properly.** This should be done through unbundling of TSOs from their former owners and through the synchronisation of instruments for increasing capacity, available to the TSO. Because TSOs are dependent on each other for the creation of capacity it will be hard for TSOs to increase their performance, if TSOs have different goals or not the same instruments to bring about increases in capacity.

Preface

With this report I've reached the end of my time as a student in Eindhoven. Although it certainly has been interesting to work on this research, I could have a imagined nicer, less stressful ways to end my life as a student. But now that the report is finished I look back on my life as a student with great pleasure.

This research wouldn't have been possible without the help of my supervisors at DTE Paul Giesbertz and especially Hanneke de Jong who have both been very helpful, pleasant and stimulating to work with. And of course, I would like to express my gratitude to my supervisor at the TU Geert Verbong who has been of great assistance and support.

Further I would like to thank anyone who has supported this research starting with my colleagues at DTE, the people at TenneT and all the others. Furthermore I would like really to thank my friends who have been a great distraction when necessary and helpfull criticising my report. And of course my parents for their never ending support.

.

Index

1 Introduction

We take electricity for granted in our everyday lives. Without thinking, we turn on the lights or use the telephone and expect it to work. But, what if this is not the case? Failures in electricity supply have lead to serious economical and also social problems including riots and even deaths in the past.

The high voltage grid is an essential factor concerning security of electricity supply. Not only has this grid been built for efficient electricity distribution, it has also been created as a means to guarantee security of electricity supply. By coupling large areas through interconnectors (cross border high voltage connections) the need for sufficient reserve capacity is relaxed, and fluctuations in power quality due to failures in productions or other network errors are being reduced.

The logic for this is simple, without coupling a failure in electricity production within a certain area had to be solved by a relatively small number of other production units. By increasing this area, the lack of capacity can be spread over many production units which all have to contribute a small part. This has been one of the main reasons for creating interconnectors with neighbouring countries. The positive economic result of this is that a country needs less reserve capacity.

Changing Role

The role of these interconnectors has changed over time. No longer is their sole purpose to ensure secure network operations. They are now also playing an essential role in the creation of a single European energy market in which they are often considered bottlenecks in the system.

EU regulation (EC) 1228/2003 defines "interconnector" as follows: A transmission line, which crosses a border between member states and links two national transmission systems together.

The EU clearly recognised that the consolidation of an internal energy market is 'the policy line that ensures fair prices to citizens and industries' (EU Site DG-COM 2007). According to the EU a competitive market will positively affect prices for consumers and companies. Furthermore it is also vital for the emissions trading mechanism to work properly.

EU

The main objective of the European Commission (hereafter: Commission) is to have a working internal energy market with open competition and effective regulation in place by January 2009. According to the Commission, a real European grid should work as a single grid. In order to reach this goal, sufficient cross border capacity is an essential factor. The DG Competition's Sector Inquiry of the European Energy market has come up with the preliminary findings that the lack of electricity market integration mainly results from:

- *Insufficient interconnecting infrastructure between national electricity systems;*
- *Insufficient incentives to improve cross border infrastructure;*
- *Inefficient allocation of existing capacities.*

Source Sector Inquiry 2007 DG Competition

Natural monopoly

It is a well-known economic theory that effective competition stimulates economic efficiency and that this is expected to lead to increased social welfare. This assumption has been the driving factor behind the deregulation and privatisation of the electricity sector all over the world including the European Union. However, for some technologies this statement does not hold and competition might not be feasible from an economic point of view. Sometimes the character of the technology and demand create an environment in which it is economic more viable to serve the market with a single large firm instead of a series of small competing firms. This theory also applies to the case of electricity grids, in which economies of scale are an important factor. Considering the size of the high voltage electricity distribution market and the large capital investments required it would be uneconomic to have more than one Transmission System Operator (Hereafter: TSO). A TSO is the operator of the high voltage electricity grid in a certain area. This TSO will then be by definition the natural monopolist. The TSO is responsible for safe and stable operation, expansion and maintenance of the electricity network that transmits electrical power from generation plants to the regional or local electricity distribution operators.

Although it is accepted that a monopolist is the optimal choice to maintain the electricity transportation grid, this still creates other problems. Economic theory states that the presence of a monopolist leads to inefficiencies in the productive (capacity available to the market) as well as qualitative (reliability of transportation) sense.

Electricity grid TSOs within the European Union must comply with their regulatory obligation to maximise the cross border capacity they allocate to the market ((EC) 1228/2003 article 6). However in their role as TSO, they are forced to make a trade-off between grid safety and border capacity, which leaves the TSO with space for their own interpretation. Within the current regulatory framework, it is often in the TSO's best interest to trade capacity for quality, which can lead to allocative inefficiencies (Ajodhia, 2006).

Goal of the study

The latest Energy Sector report of the Directorate General Competition (DG-Competition, 2007) about the European electricity market has shown that there is a large price difference for electricity between countries.(*Figure* **1**)

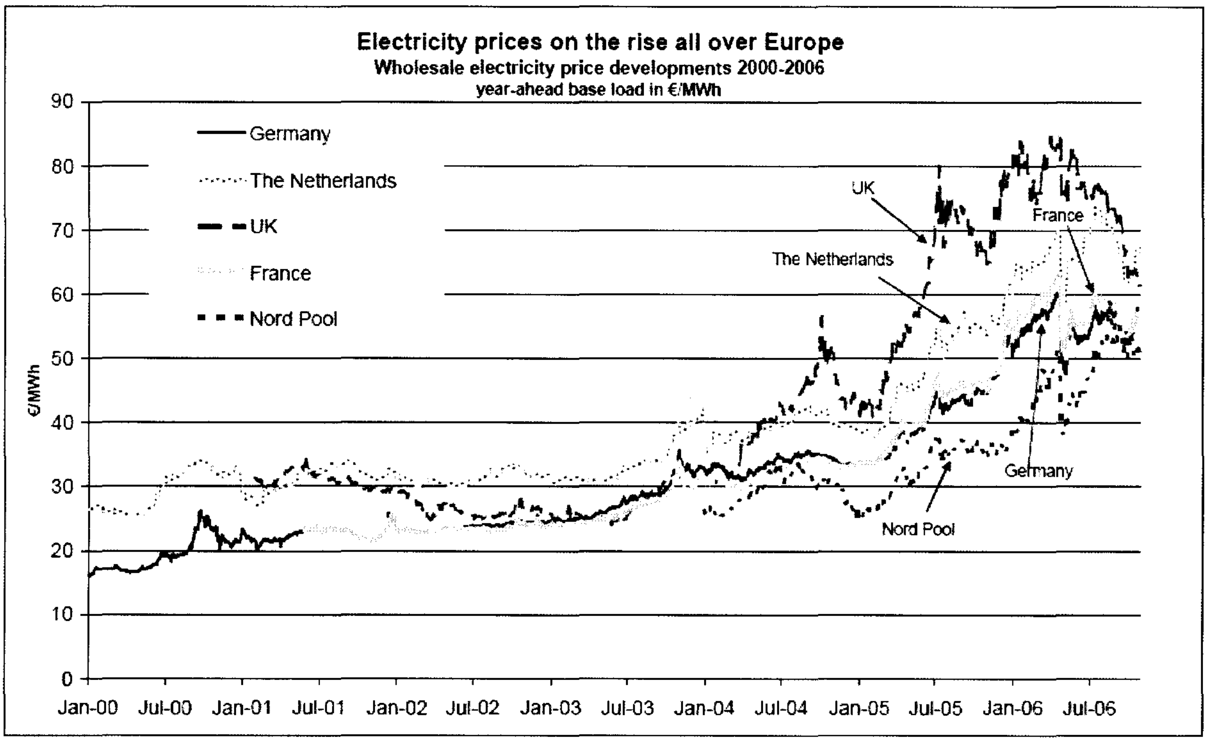


***Figure** 1: Source: Sector Inquiry 2007 DG Competition.*

Take for instance the Netherlands: the above figure shows that there is a large price difference between the Netherlands and Germany and France. These countries are willing to export but often lack the transmission capacity to do this. The need for more cross border transmission capacity has thus been recognised in this Sector Inquiry report of 2007. Because we are dealing with cross-border connections there is always more than a single TSO involved, this automatically places the subject in an international context.

It is the goal of the EU to create a single energy market for whole Europe. The problem is that the national energy markets within the EU are not equally developed. In order to create a single energy market the EU has divided the EU countries over regions known as Regional Energy Markets (hereafter REM) that are more or less equally far in their developmental progress when it comes to energy supply, distribution and transportation. In a later stage it is the goal of the European Commission to unite all these regions into a single European energy market.

For the whole EU the European Commission has created an Advisory Group of independent national regulatory authorities who assist the Commission in creating the internal market for electricity and gas. Each region has its own action plan, called an Electricity Regional Initiative (hereafter: ERI) Action plan, which sets the development goals for that region. The problem of stimulating cross-border capacity utilisation in the Central West Europe Regional Energy Market has also been raised in this European Regulators' Group for Electricity and Gas (hereafter: ERGEG).

Because this problem has been also been raised within the ERI (ERGEG, 2006a) and because of the international nature of this problem, the scope of this research will not be that of a single country. It is chosen instead to take that of the whole regional market Central West Europe. The main reason for choosing this specific market is that this research was initiated by the Dutch Regulator DTE (Directie Toezicht Energie). In this Regional Energy Market (REM) the Dutch regulator together with the Dutch Transmission system operator TenneT take part and coordinate together with other regulators and TSOs the regional initiatives on the subject of regulation and fulfilling the goals as set in the ERI Action Plan. The Central West Europe REM (Regional Energy Market) is one of the biggest and most complex regions in Europe, which makes this region interesting as a focus for this research. . In the Central West European RCC the 5 regional regulators of Germany, Belgium, France Luxembourg and the Netherlands are organised. The ERI action plan 2006 for the Central West European Region Paragraph 5 explicitly mentions the problem of lack of transmission capacity. In this paragraph the TSOs are requested to submit a joint proposal for a regional incentive scheme, allowing the maximisation of the amount and of the utilisation of firm cross-border capacities in the Central-West region. (ERGEG, 2006a). The goal of this study is to propose a design for such an incentive plan which encourages TSOs to maximise cross border capacity made available to the market, in the Central West European Regional Energy Market.

Problem owner

Although this research has been initiated by DTE, this research will not take the viewpoint from a single government or regulator, instead this research will be from the perspective of the responsible Regional Coordination Committee (hereafter: RCC) of which DTE is a member. This Committee is a part of ERGEG and is responsible for implementation and working out the targets as set by the ERGEG within a specific region. Because the RCC is responsible for these targets, it will be better to take the viewpoint of the RCC of the Central West European Regional Energy Market, instead of that of a single government or regulator in this region.

Although the final design proposal will be designed to be useful to the RCC, the examples and references to specific situations will most of the time be based on the Dutch situation. This is done because this research was initiated by DTE. Due to the geographic complex position of the Netherlands, the Dutch problems are expected to be representative for other countries in this region in most cases. A specific overview of the Situation in the Netherlands can be found in Appendix B.

Why an incentive plan?

Literature states that regulation can be used as a means to solve the problems that are created when a natural monopoly is established. Within most markets there is an information asymmetry between the Regulator and the TSO, which makes it hard for the Regulator to establish if the TSO is functioning optimally. This would not be a problem if the operator and the regulator would have completely the same objective. In that case regulation would not be necessary, because the government could not improve results by applying regulation to the operator. In practice however, the objectives of the regulator are often different from the operator. This problem is also known as the principal-agent problem. (Ajodhia, 2002; S. V. Berg et al., 2004; Vickers & Yarrow, 1988)

Basically literature offers three basic approaches in dealing with the problems resulting from these principal-agent problems, namely: a) subjecting the operator to competitive pressures in order to overcome its market power, b) gathering information on the operator and the market in order to be able to micro-manage the operator, and c) controlling market power by applying incentive regulation.(S. V. Berg et al., 2004)

Because here we are dealing with a natural monopoly, option A is not a viable option, as the nature of a natural monopoly states that direct competition is not desirable. Surrogate competition like "yard stick competition" requires comparable operators in comparable environments that would be too complex to use in this industry. The other option, option B is not desirable either. In our case it is for the regulator impossible or economically not viable to have the same expertise and information as the operator, disputing option B as the optimal solution.

Therefore option C, an incentive plan, is proposed. A performance based incentive plan would make it the TSO's own interest to change priorities that they comply with the market/regulator's best interest without the need for the regulator to introduce competition or direct regulation in which the government specifically tells the TSO how to handle. But how should this incentive plan be shaped?

This leads to the following research question:

What are the most feasible options for an incentive scheme that stimulates TSOs to maximise the capacity of cross border connections made accessible to the market?

The term 'framework' in this question, refers to the total set of technical, economical and legal rules in which the problem is situated.

In order to answer the above question the following sub-questions will be introduced:

1) What approaches to optimise existing cross-border connections using incentive plans currently exist, or what lessons can be learned from similar initiatives?

2) Which kinds of incentives are applicable? And how to dimension the scheme to create a situation/incentive in which social welfare will be optimized?

3) How can this initiative be designed and implemented for the best fit within the existing regulatory and legal framework?

Scope of the research.

In short the scope in this research will be from an international level, that from the RCC of the Central West European Energy Market. It must be emphasised that this research will focus solely on the question how to stimulate TSOs to maximise the capacity, made accessible to the market, on existing infrastructure. This study does explicitly not try to stimulate investments in new interconnector capacity, which is regarded as a different subject.

Structure of the Report

The goal of the study is to propose one or more designs for regulation that would solve the problem. Therefore this research is structured as a design study. The report will be structured as follows: starting with the methodology in chapter 2; in this chapter the research model is introduced, and here is explained what research methodologies will be used in order to answer the research questions.

In the next chapter the theory behind the problem of regulation through incentive plans is explained. This chapter also contains a stock taking of the theory on incentive regulation already used in the industry. Also an analysis of existing incentive regulation that might be useful to the research is provided.

Chapters 4,5,6,7 focus on describing the current situation of the problem introduced in the introduction. This is done through creating a stakeholder analysis, policy analysis, and a technical and economical analysis.

These chapters will be the basis for the last chapter, chapter 8; this chapter contains the results of these chapters in the form of design prerequisites and variables. These prerequisites and variables are the basis for the final policy design proposals.

2 Methodology

2.1 Introduction

In the previous chapter the problem, the lack of transmission capacity at high voltage interconnectors has been introduced. Furthermore, the ambitions of the problem owner, the RCC of the Central West European Union, have been explained.

This chapter discusses the methodology used in this study to answer the research questions. The first paragraph will describe the Meta model that was used to conceptualise the design process used in this study.

The second paragraph first provides a brief introduction on the methodology on data collection. It then discusses the different methods of data collection that are linked to the different types of research. In the next paragraph, the methodology used for this study will be specified. First, a selection will be made between the different types of research approaches available for this particular study. Then the type of research approach that will be used for each of the research questions will be discussed. The subsequent research phases will be introduced. The next paragraph will go into more detail on this issue. Here the sub-research questions for each research phase will be discussed.

2.2 Design research model

The essence of this research project is to propose an incentive scheme that tries to optimise the capacity on cross-border connections made accessible to the market. A proper approach to institutional design studies in the complex socio-technological environment like energy networks, is recommended by Koppenjan and Groenewegen (2005). In this research, the definition of "Institutional" is seen as the underlying set of rules and social structures that govern the behaviour of the actors. They recommend the 'meta' model as introduced by Herder and Stikkelman (2004). The 'meta' model describes the workflow during a conceptual process design, covering the actors, their roles, their goals, their activities and their tools. This model does not have a theoretical foundation but is a useful heuristic tool to set in order the activities that should be undertaken in design processes; however, the tool has empirically proven its use in many design studies. Some small adaptations will have to be made mostly because some parts of the model are specifically designed to deal with quantitative data.

Meta Model

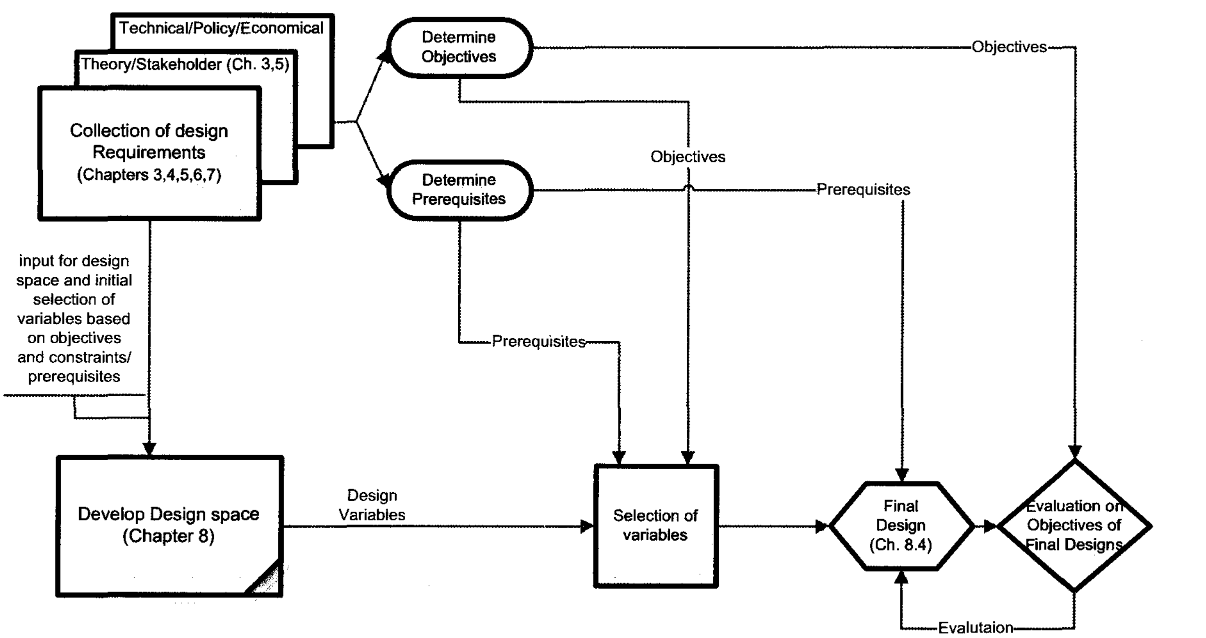


Figure 2: Adapted version of the Herder and Stikkelman Model (2004)

Explanation of the model

The meta-model is a generic model that describes the design process. It distinguishes between two types of activities. The first activity is mostly concerned with data analysis and requires the following steps:

1. Creating a stakeholder analysis and technical, economical, and policy framework.

2. Defining a list of functional requirements. This is a list of objectives and prerequisites, derived from stakeholders and technical and legal limitations placed upon the design derived from the created frameworks and stakeholder analysis.

The second activity concerns the actual design activities, which are done along the following steps:

1. Developing the design space by making choices about the form of the design and by determining the design variables

2. Combining design variables into a design.

3. Reflecting on these designs on the basis of the objectives and prerequisites.

(Koppenjan & Groenewegen, 2005)

The strong point of using this model is that it offers a possibility to conceptualise the design process in such a way, that the design of the institutional arrangements (policy) as well as technical limitations and requirements can be implemented. According to Koppenjan and Groenewegen (2005) the model also offers two important building blocks for institutional design, namely:1)'a programme of functional requirements on which design efforts should be based and 2) a segregation of the design space and the identification of design variables as crucial components of institutional design.' (Koppenjan & Groenewegen, 2005)

Adaptations to the model

The model could be criticised in that it overemphasises the first stream of activities and underexposes the actual activity of making a design (proposal). Another weak point is that it does not explicitly mention any crucial feedback moments. Simply testing separate design variables with the criteria is in most cases not enough. This can easily be overcome by adapting the model in such a way that after execution of a test, it offers the opportunity to adapt and improve the design in a feedback process. This test however could not be done in this study due to lack of sufficient detailed information.

2.2.1 Design requirements

Within the meta model, the first step in making an institutional design is to identify the design requirements. This is typically done through consultation of stakeholders. Next to such a stakeholder analysis, this research also makes use of analyses of the technical and policy framework. Together, these analyses will be used to determine which requirements can for instance be derived from the national or European regulation, the technical limitations and possibilities, and the requirements and limitations as found through the stakeholder analysis. (*Figure* **3**)

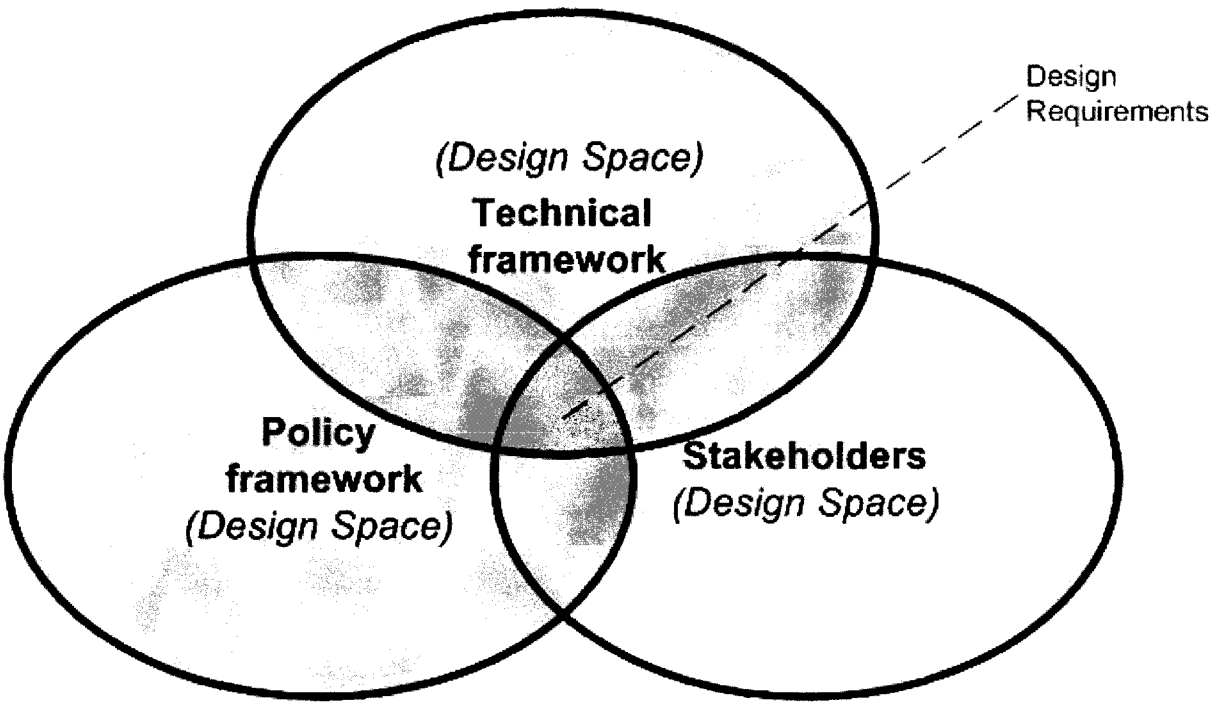


Figure 3***: Graphical Display of the use of Stakeholder,Technical and Policy Analyses in the search for Design Requirements***

In other words, requirements are seen by the model as some capability that somebody needs or wants to have fulfilled by the design. However, often there are lots of different types of requirements which are used in the model, and there are also objectives, goals and prerequisites or constraints which, in most cases, are referred to as requirements. The difference between a constraint and requirement may not always be clear but arguing whether a constraint is or is not a requirement it is often not very useful at all. It is more useful to consider which requirements are useful or necessary inputs to a design plan.

The model first of all uses functional requirements or objectives, which are things that a system has to do, e.g. make a calculation or make a decision. On the other hand, non-functional requirements (sometimes called qualities or attributes) are the qualities that a system has to have. Things like performance, usability, maintainability are all non-functional requirements. E.g. in this case what fail rate is considered safe? Project goals are the reasons for doing a project. In other words these goals are a type of 'high level requirement', all the other requirements add to meeting the project goals. And finally there are constraints which are specified influences that affect the way that we meet the requirements. The most common constraints are time, money and specified technology (Robertson & Robertson, 1999). In this study a separation between objectives and prerequisites will be sufficient to describe the problem. Any more detailed division in types of design requirements will not lead to better results and would the process make unnecessary more complex.

2.2.2 Design space and design variables

To make a policy design, it is necessary to identify the design space and to have an overview of the design variables. The design space is the whole group of available variables. More commonly said this part contains what variables can we use to reach our goals. E.g. if we want to get from A to B what road, vehicle etc can we use to reach B. The design variables of an institutional design often consist of parties, relations, policy instruments and economic tools. According to literature, this group of variables concerns mostly making agreements about:

- Parties who are involved and who are not
- Their characteristics and resources
- Responsibilities and tasks
- Efforts and investments to be made
- Allocation of costs, benefits and risks
- The availability of information
- Sanctions for agreements not kept
- The juridical codification of agreements

(Klijn & Koppenjan, 2004; Ostrom, 1990; Williamson, 1979)

2.3 Research methodology data collection

This paragraph will introduce the overall research methods that will be used to answer the main question as introduced in the introduction and its sub questions. A distinction can be made between the main question that focuses on a design problem and the sub questions that are mostly analytical in nature. The sub questions which are mostly analytical in nature will require a descriptive research approach. Therefore the research methodology used will mostly be of a descriptive character because the focus will be on describing the current situation, without making any judgements. Baarda en De Goede (2001) recommend the necessary empirical, qualitative data necessary for conducting this descriptive study to be generated through desk studies and interviews with stakeholders.

The design part of the study invoked by the main research question will involve (ex-ante) evaluation based on self designed criteria, to make sure that the recommendation will, at least from an ex-ante perspective, improve the incentive of the transmission network operator to increase cross border capacity.

The data collection methods that will be applied to collect data for executing the research methodology are diverse: stakeholder requirements will be formulated by the means of oral interviews, alternatives will be generated by desk study and interviews, the actual testing of the possible design alternatives will be conducted by means of oral interviews and desk study. In the beginning the interviews will be open and unstructured to ensure that the interviewee can express as much knowledge and ideas as possible. Later-on this will shift to a semi structured interview structure to be more effective.

The objective of the main question is to come up with a design for a proper incentive scheme, which promotes more efficient use of the capacity. The solution must be likely to improve capacity while maintaining quality. This should be a 'workable' solution, which more or less fits current regulatory framework. "The workable solution" will be judged by experts in the field.

The designs proposed by the author will be based upon theoretical desk research for literature on incentive regulation, open interviews with experts and through open desk research in policy and technical documents. From this, an inventarisation will be made of the existing uses of incentive regulation and try to draw lessons from this which may be of use for this design proposal. The design space and requirements will be assessed by experts on certain criteria. This is done through semi-structured interviews and will be further evaluated through open questions for improvements.

3 Theory

This chapter provides an overview of what literature states about natural monopolies, the regulation of natural monopolies, principal agent theory and incentive regulation. Lessons, which are of use for the final design of an incentive scheme, will be drawn from this research.

In the first paragraph of this chapter a short introduction to the literature in this field is given. It is explained that after restructuring, the European energy market has been split in two playing fields; market and monopoly. Next, the characteristics of a natural monopoly are given and it is explained why, according to literature, a TSO can be considered a natural monopoly. In the third paragraph shows that there is an actual need for regulation in the case of a natural monopoly due to the principal agent problem, and that incentive regulation is in this case the best option. Finally a stock taking is given of existing literature on incentive regulation of natural monopolies in electricity networks.

3.1 Industry Structure

During the 1990s, many developed and developing countries began restructuring and privatising public sectors to improve performance. These reform programmes usually began with the privatisation of state-owned enterprises. Electricity networks have not escaped this process of privatisation and reorganisation. Within this industry, this has led to the need for separation of potentially competitive segments (generation and retail supply) from the remaining network (Joskow, 2005). These remaining segments (distribution and transmission) are assumed to have natural monopoly characteristics and continue to be subject to price, network access, service quality and entry regulations necessary for the creation of a competitive wholesale and retail market (Joskow, 2005).

Although a lot of the research on "restructuring" has focused on the potentially competitive segments that have been deregulated (e.g. wholesale and retail electric power markets), the performance of the remaining regulated network segments (networks) and the performance of new incentive regulation mechanisms in this segment are also of considerable economic importance. Research in this field has been focusing especially on price and investment regulation in distribution networks, which are of significant importance to the final price for the consumer. (Joskow, 2005; Kwoka, 2006)

3.1.1 Classification for a Natural monopoly

Transmission systems, with its high fixed costs are often quoted as typical examples of a natural monopoly in many publications of economic literature. The main argument is that electricity networks require heavy investments in capital goods which make economies of scale applicable. Building more than one network next to each other would be very uneconomical as it would raise the price of the network for both providers and therefore increase total cost. Nevertheless, are these arguments sufficient proof for classifying transmission systems as a natural monopoly? One could say that that economies of scale and scope are also applicable to for instance the chemical industry while these are not examples of natural monopolies (Kwoka, 2006).

3.1.2 TSO as a Natural Monopoly

An industry is said to be a case of natural monopoly if one firm can produce a desired output at a lower social cost than two or more firms. A reason for this could be that due to the nature of that industry there are sources of economies of scale or scope. (S. V. Berg & Tschirhart, 1988)

The underlying source of this phenomenon is known as subadditvity of costs (Ahodja 2004). The term 'subaditivity of costs' implies that the cost of producing the whole quantity that the markets demands by a single firm is lower than the cost of producing the same quantity by two or more firms. verage costs decrease over all levels of output that is over the entire range demand curve In this situation economies of scale are true for any situation. (For further information on this subject and other forms of natural monopolies, see Apendix A)

According to Farrer (1883) there are 5 typical characteristics of a natural monopoly:

1. Capital intensity and minimum economic scale
2. Non-storability with fluctuating demand
3. Locational specificity generating 'location rents'
4. Necessities, or essential for the community
5. Involving direct connections to customers

These specific attributes of natural monopolies as described by Farer fit perfectly to electricity networks. Because electricity demand fluctuates significantly and electricity is non-storable, networks have to be build based on peak load specifications. This makes large investments in overcapacity a necessity, creating purely through its size a barrier of entry for possible competitors to enter the market. Locational specificity generating 'location rents' suggests that one firm will obtain at least a local monopoly. The combination of necessity and direct connections to consumers makes it an essential facility which implies large market power and the risk of market power abuse. This makes regulation necessary. The most general source of economies of scale are large fixed costs, which means that there are costs which must be incurred no matter how many units of output are produced (Train, 1991). The same cable/line is required to transport any amount of power at the same fixed cost, whether use once or a lot. The same characteristics which apply to the whole network apply also apply to the interconnectors which therefore classify as a natural monopoly (Gilbert & Newberry). A limited and fluctuating need for interconnector capacity depending on the market size and market conditions, combined with the large investments requirements, make this a risky market for private investors.

3.1.3 Conclusion

The operation of electricity networks and the interconnectors are widely seen as a class example of a natural monopoly. It may be concluded that TSOs are in most cases natural monopolists by nature. This economic position used to be statutionary but there are many more arguments based on market and technology conditions, which underline that it is in the interest of the market to consider the operation of electricity networks and the interconnectors a natural monopoly, which makes it unfeasible to introduce competition as a means to solve efficiency problems.

3.2 Arguments for Regulation of a TSO

Although it is generally accepted that a monopolist is the optimal choice to serve the market, this will still create economic welfare problems. Economic theory states that the presence of a monopolist leads to inefficiencies both in a productive (capacity available to the market) as in a qualitative (reliability of transportation) sense. Regulation can be used as a means to solve these problems; therefore countries almost always establish regulatory agencies to improve sector performance comparative to no regulation (Case & Faire 1999; Viscusi & Kip 2000). In this chapter economic welfare concepts within a natural monopoly will be explained after which the theories behind the reasons for regulating a TSO will be. Chapter 3.2.3 concerning the principal agent problem will go deeper into the theoretical causes of these problems and provide a solution that is offered by literature.

3.2.1 Efficiency: Welfare concepts in Natural Monopoly Situations

When left unregulated and without a threat of government intervention a profit maximising TSO under natural monopoly conditions has no incentive to increase output to a 'socially desirable' level. In order to optimise its profits a monopolistic operator could limit output to receive monopoly rents, which results in what is called deadweight loss (Case & Faire 1999; Viscusi & Kip 2000). This limited output will result in higher prices. Consumers that continue to buy capacity at the higher price suffer a loss, but the additional revenue that the monopolist obtains by charging the higher price exactly compensate for this loss. Deadweight loss occurs when consumers who are repelled by the higher monopoly prices suffer a loss that is not compensated for by the extra profits of the monopolist

Allocative efficiency occurs when firms produce those goods and services that are most valued by society. Efficiency in a market involves comparing the marginal cost with the benefit gained from its consumption resulting in marginal benefit. Allocative efficiency is measured by the total social surplus produced, which is the sum of producer and consumer surplus. Producer surplus is simply profits (Viscusi & Kip 2000)

In our case, the operator could benefit from congestion revenues (price differences between markets or auction revenues) which may result from not maximising capacity. This income may outweigh the revenue loss resulting from lower volumes transported. (RBB, 2006) From a purely economical viewpoint this would make it the TSOs interest to lower transmission capacity in order to optimize profits. This is only one of the incentives a TSO might have to lower capacity. Lowering interconnector capacity increases not only the surplus for the TSO, but in the case of a high price region, also that of producers in that region who are in some cases still able to influence the TSO through their old ties. On the other hand, consumer surplus is reduced because these actions increase prices for all consumers in the area. From the regulators point of view, allocative efficiency will not be reached in this case.

In this paragraph it has been explained that monopolistic conditions will result in a sub optimal outcome when left unregulated. But what is optimal? As was explained here, welfare and allocative efficiency have various meanings to different actors; therefore the viewpoint of the actor is of influence on the final outcome.

3.2.2 Demand for regulation

Market Power

Because of the nature of natural (network) monopolies, operators/owners must unavoidably be subject to social/regulatory control. The status of monopolist reduces incentives for efficient production or quality. But also being the sole owner on an essential network facility provides the network owner with considerable market power and makes it vulnerable to abuse. Privatisation makes this call for regulation even more urgent. When commercial motives come in to play more incentives for the abuse of market power by the monopolist are introduced. (Viscusi, Vernon, & Harrington, 1995; Vogelsang, 2002)

Cost of Supply/Capacity available to the market

Electricity cannot be supplied without transmission lines. Electricity is in western countries considered an essential facility, to which everyone should have access at a reasonable price. In a regulated market, the costs to supply the relatively expensive customers (sparse populated areas) are often subsidised with income from relatively cheap customers (densely populated towns). Within a pure market environment without regulations, these expensive customers would have no market access at all or only at very high cost.(Huygen, 1995)

Quality

Interruptions in the supply may cause serious economic damage. The produced electricity must be made available at the moment of the demand, due to the fact that electricity cannot be stored easily at reasonable cost which is the case within the Netherlands. For this reason, it is considered of vital importance that the supply is secure and reliable, so that the chance of interruptions is minimized. Regulation is used to ensure this quality. (Huygen, 1995); (Powell & Starks, 2000)

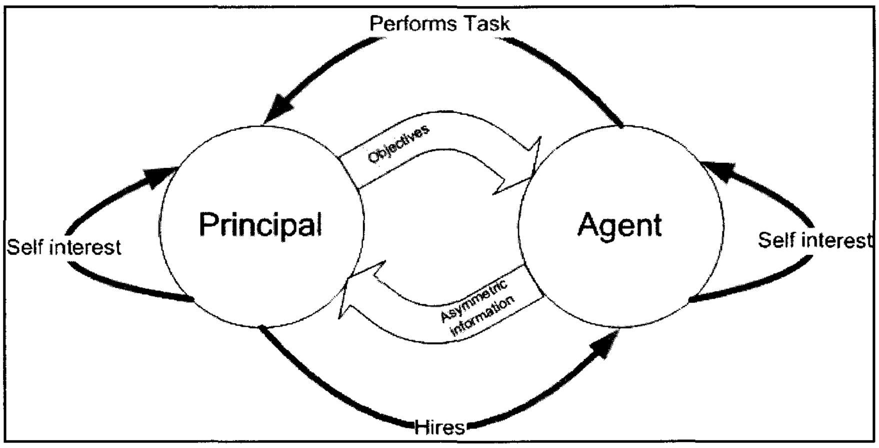
Ownership

Whether the regulator is regulating a publicly owned operator rather than a privately owned operator changes the nature of some issues considering regulation. For example, the interests of a privately owned operator may vary considerably from those of a publicly owned operator. It may also prove to be less costly for the government to use direct control of a public enterprise instead of economic incentives for a private operator. Also at the political level, there may be differences as a government's promise not to engage in political interference with industries is less credible with public ownership than with private ownership. (S. V. Berg et al., 2004)

As explained earlier, utility operators have significant market power which would enable them in hampering competition. Because electrical operating decisions are often judgment calls made in real time, regulators will have difficulty distinguishing denials of access that are needed to maintain reliability from ones whose purpose is to harm competitors. Although the EU has set rules concerning ownership of transmission operators, the main message from these rules is that operators are not allowed to have any interests in production. On the other hand is it not illegal for production companies to own their old transmission networks when they follow certain criteria as legal unbundling ('separating the books'). There is still considerable debate going on in the European Union if current regulation is enough to make sure that the TSOs are not operating in other interests than as pursued by the European Commission. According to Michaels (2000) it can be questioned if non-profit transmission companies will ever be totally independent from influences from their old owners at all. According to Michaels old practices and the feeling of belonging to the former production company with which they often share facilities die hard.

3.2.3 The regulatory problem of principal agent relationships

Not only ownership is at the source of some of these regulatory issues, also the division of management and ownership can create the risk that both are pursuing different objectives. Because the regulator delegates day-to-day decisions to corporate management, so called 'principal-agent' problems may arise even with public ownership. Using incentives to address these problems requires regulators of public enterprises to identify the objectives of the managers and provide incentives for improved performance as "[m]anagers of public enterprises are generally more affected by political influence, government budgeting, and bureaucratic management than their counterparts in privately-owned operators"(S. V. Berg et al., 2004). Incentive theory generally focuses on tasks that are too complicated or too costly to do oneself and thus the "principal" hires an "agent" with specialised skills or knowledge to perform the complex task in question. According to Eisenhardt (1989) this is the case within most regulated monopolies, in which the government (principal) hires an agent to supply the market with its services or goods. (S. V. Berg et al., 2004; Eisenhardt, 1989)



Because of the complexity of the tasks, the principal/regulator in many cases lacks information or is unable to interpret the information available to him. This lack of proper information makes it hard for the regulator to establish if the utility is functioning optimally. This would not be a problem if the operator and the regulator would have the same objective. In that case regulation would not be needed at all, because the government could not improve the agent's results by applying regulation. In practice however the objectives of the regulator are often different from the operator. This relationship and the problems which may arise, are explained by what is called the principal agency theory. (Ajodhia, 2002; S. V. Berg et al., 2004; Vickers & Yarrow, 1988)

Principal agency theory identifies two kinds of problems that may occur in agency relationships. The first group of problem situations in which agency problems may arise are those when a) the objectives, goals and expected efforts of the principal and agent differ. In literature, this lack of effort on the part of the agent is often referred to as 'moral hazard'. While at the same moment b) the problem of 'information asymmetry' occurs, situations in which it is difficult or expensive for the principal to verify what the agent is actually doing. The problem here is that the principal cannot verify that the agent has behaved appropriately and the agent does not bear the full consequences of its actions.

The second situation in which principal agent problems may occur, results from the problem of risk sharing. This situation arises when the principal and agent have different attitudes toward risk. The problem here is that the principal and the agent may prefer different actions because of the different risk preferences (Eisenhardt, 1989).

The unit of analyse in this theory is the contract central in the relationship between the principal and the agent. The focus of the theory is on determining the most efficient contract providing a solution to these problems. Regulatory schemes are viewed by economic theory as incomplete contracts, of which the terms are revised over time, and which might leave the agent and regulator with considerable room for their own interpretation. (Mayer & Vickers, 1996) At the heart of principal agent theory is the trade-off between a) the cost of measuring behaviour and b) the cost of measuring outcomes and transferring risk to the agent. [1](Eisenhardt, 1989)

---

[1] *In short agency theory makes the following assumptions concerning humans, organisation and information. It is useful to critically consider these assumptions when applying these theory. The following assumptions about humans are made on which this theory is based:*

-humans suffer from bounded rationality

-are risk aversive

-act in self interest.

The following organisational assumptions are made:

-there is a partial goal conflict among participants

-the occurrence of Information asymmetry between principal and agent.

Finally, Information is seen as a purchasable commodity. (Eisenhardt 1981)

Risk Aversion

As it is a well known part of the agency theory literature, the optimal contract between an agent and a principal depends for a large part on the agent's risk perception and willingness to take risks. It can be shown that when the agent is risk aversive, while assuming that the principal is risk neutral, then the principal will have to provide incentives to introduce risk sharing (Laffont & Martimort, 2000). If the assumption of a risk aversion is relaxed (Harris & Raviv, 1978) and the agent becomes less risk averse (e.g., a wealthy agent), it becomes more attractive to pass risk to the agent by using an outcome-based contract (Eisenhardt, 1989). On the other hand, if the opposite occurs and the agent becomes more risk averse, it is increasingly expensive to pass risk to the agent. A trade-off needs to be made between passing risk to the agent and the cost required to do this (Chong, 2004).

Risk perception is an important aspect in understanding the relationship between the regulator and the TSO. In essence, the TSOs (agents) are highly risk aversive. Risk is often perceived by the TSO as a technical risk. Technical failures in the high voltage grid have big consequences and within current regulatory framework, TSOs are for a large part assessed on these characteristics. However, there are also economical instruments such as counter trading and redispatching(further explanation on these terms can be found in paragraph 5.2) to solve capacity problems to a large extent. Keeping this in mind, it is possible; at least to some extend, to turn this technical risk in an economic risk. Following the reasoning in the above paragraph the wealthy TSO may become less risk aversive and it may be attractive to pass risk to the TSO using an outcome-based contract (e.g., an incentive scheme).

3.2.4 Solution for the Principal agent problem

Literature offers three basic approaches in dealing with the problems resulting from these principal agent relationships namely: a) subjecting the operator to competitive pressures in order to overcome market power, b) gathering information on the operator and the market in order to be able to micro manage the operator, and c) controlling market power by applying incentive regulation. (S. V. Berg et al., 2004)

Because we are dealing here with a natural monopoly option A is not a viable option, as the nature of a natural monopoly states that direct competition is not desirable. Surrogate competition like "yard stick competition" requires comparable operators in comparable environments. Weyman-Jones (1995) Argues that there are three major obstacles to the use of yardstick regulation in the electricity sector of which comparability between companies is the most important. Comparable environments are hard to find in the electricity industry and especially in the niche of cross border connections. Each border has its own characteristics based on load flows and cooperation between different TSOs, these characteristics may vary significantly over time and it would therefore be too complex to use yardstick competition in this part of the industry. (Weyman-Jones, 1995)

The other option, option B is not desirable either. Because in the case of TSOs it is for the regulator impossible or economically not viable to have the same expertise and information as the operator. This is the main reason to install a separate TSO in the first place, instead of managing the grid themselves. This eliminates option B as the optimal solution.

For these reasons the option C an incentive plan" is proposed. A performance based incentive plan would make it the TSO's own interest to change to priorities to comply with the market/regulator's best interest without the need of the regulator to introduce competition or direct regulation. According to Eisenhardt (1989) this is not only often a more economically viable solution than so called "hard" regulation but also provides better incentives to innovate as is explained by Pfeifenberger (2003). Why this is will be elaborated on in the next chapter.

3.3 Incentive Regulation

Principal Agent theory provides the basis for the use of incentive regulation. First, it needs to be established what is meant by incentive regulation. In general, it means that the regulator delegates certain decisions to the firm and that the firm can obtain profit increases from positive effects/results. Incentive regulation makes use of the firms' information advantage and profit motive. Thus the regulator enforces less regulation but rather rewards outcomes (S. V. Berg, 2000; Vogelsang, 2002). Incentive regulation can also be seen as a contract which passes risk to an agent by rewarding certain outcomes.

Economists have emphasised incentive regulation as a response to information problems concerning:

- The problem of monitoring performance
- The problem of specifying performance targets.

Incentive regulation can partly overcome information problems. Lewis and Garmon (1997), define the aspects as follows: "Incentive regulation is the use of rewards and penalties to induce the utility to achieve desired goals while the utility is afforded some discretion in achieving goals." They note that there are three important elements of this definition:

1) Instead of using command and control to motivate the utility to perform, incentive regulation internalises these goals and provides encouragements for the utility to perform.

2) Instead of the outside regulator dictating the performance goals unilaterally which might be unreasonable or too soft, the utility has influence in setting goals or performance targets.

3) The utility chooses how to achieve goals. Specific actions are not prescribed by the regulator, which allow the utility to utilise its internal information and to establish internal incentives appropriate for improved performance which might lead to better results than under full control. (Garmon & Lewis, 1997)

Opponents often argue that explicit rewards are unnecessary because utilities often operate under the statutionary obligation to be efficient. Pfeifenberger and Weisman (2003) dispute this by arguing that this view, that rewards are unnecessary, ignores the proven efficiency increases under incentive regulation because this belief in the statutionary obligation is based on the hypothesis that the firm knowingly withholds innovations. This view does not recognise the lack of incentives as 'a requisite to improve knowledge of new innovations', and that it does not view innovation as a discovery process in which the firm is unable to withhold innovations they do not yet know of. (Weismann & Pfeifenberger, 2003)

The interests of regulators themselves

In addition to the so called 'perverse' incentives of the agent, regulatory commissioners and government authorities can have their own agendas as well. It is well known practice that regulators or politicians can also engage in opportunistic behaviour (S. V. Berg, 2000). Politicians might pressure utilities just like agents in the principal-agent-theory. Regulators and politicians have access to unique confidential information which they might use to pursue their own (political) aspirations. This is opposed to the 'public interest' theory of regulation in which policy makers and politicians act only with social interest in mind (S. V. Berg, 2000). Another important factor which may influence the interest of regulators or politicians is explained in the capture theory. This theory explains that powerful companies/utilities may "capture" politicians and induce regulators to act in the best interests of utilities or other essential facilities rather than the best interest of society. (Stigler, 1971) A proper example of this is the case of the California crisis in 2000. (De Vries, 2004)

3.4 Common incentive regulation

Literature reveals that there are four primary approaches to incentive regulation used in the electricity industry. This paragraph shows that the overall purpose of these approaches has been mostly about regulating the overall price level. But what lessons can be drawn from these approaches? Apart from showing where and how incentive regulation is already being used in the electricity industry, analysing these four forms of incentive regulation will help in emphasising important aspects on which our incentive scheme should focus. The four main approaches to incentive regulation in the electricity industry are:

- price cap regulation
- rate of return (or cost of service) regulation
- revenue cap regulation (profit sharing)
- benchmarking (or yardstick) regulation.

This paragraph will evaluate and describe these four common incentive regulations and try to asses what aspects can be applied to the case of interconnection capacity. After these four have been explored, this paragraph will continue to evaluate transparency (which is often introduced as a side effect to incentive regulation) as an incentive, and finally explore some cases of incentive plans as being used today.

3.4.1 Price Cap Regulation

One of the earlier forms of incentive regulation that have been used in Europe has been price cap regulation, sometimes known as RPI – X regulation. This was first introduced by Littlechild in 1993 in a report to the British government on the regulation of British telecom. Later on this has also been applied to the regulation of electricity networks (Vogelsang, 2002).

In short price cap regulation can be described as the regulator who limits (caps) the price an operator is allowed to ask for its services. This allows the operator to make profit (or losses) from its services and provides an incentive for efficiency. The prices of the services are annually adjusted for:

- an inflation factor that takes care of the economy-wide price level or of the level of input prices
- an X-factor that reflects efficiency improvements of the firm
- an Y- factor that allows for the pass through of specific cost items outside the firm's control
- In fixed intervals of typically up to 3-5 years the price caps are reviewed and adjusted.

The X-factor is often obtained as a result of efficiency benchmarking and negotiations between the company and the regulator (Viljainen, Tahvanainen, Lassila, Honkapuro, & Partanen, 2004). The X-factor is anticipating the difference between the efficiency increase of the operator and the average firm in the economy with respect to inflation in input prices and changes in productivity. (Baldwin & Cave, 1999; S. V. Berg et al., 2004) This regulation scheme in which prices are regulated differs from rate-of-return regulation, in which utilities are permitted a set rate of return on capital, and with revenue-cap regulation where total revenue is the regulated variable. (Bernstein & Sappington, 2001)

3.4.2 Rate of return regulation (ROR)

The central idea behind this type of regulation is that in a monopoly firms should be required to charge the price that would come to exist in a competitive market, which is equal to marginal efficient costs of production plus a market-determined rate of return on capital. The regulator determines a revenue requirement based on a firms accounting cost, which are based on results of previous years. These costs include taxes operating costs and allowed returns. The returns are based on what the regulator perceives as a "reasonable" rate. Then the regulator determines a tariff structure designed to recover aggregate costs (Liston, 1993). Like other incentive schemes, these tariffs are being periodically reviewed. The rate of return formula can be represented as:

Revenue requirement = Total Cost - Variable Costs + ROR x rate base (Liston, 1993)

The rate base is defined by the regulator as the asset value on which the allowed rate of return can be earned which may be fair value, reproduction cost, or original cost(S. V. Berg et al., 2004).The main advantage of ROR regulation is that it allows regulators, in a relatively simple way, to limit monopoly pricing through a close monitoring of the firm's profits.

Prices a utility is allowed to set, are directly linked to a firm's individual costs. The firm will often be allowed to recover all of its costs, including a fair return on invested capital. This so called "cost-plus" characteristic of ROR reduces the firm's incentive to produce at minimum cost. Therefore, if the firm would make extra costs, the firm will be allowed to recover these costs by setting higher prices. This has been one of the main criticisms of rate-of-return regulation, that it even encourages cost increase. And if the allowable rate is set too high, it also encourages the adoption of an inefficiently high capital-labour ratio which is often referred to as the Averch-Johnson effect. This effect can be found in a situation where the allowed rate of return on capital (rate base) is higher than the cost of capital (Liston, 1993). An interesting reply to this is introduced by Gilbert and Newbery (1988) who argue that cost minimising behaviour can be introduced into this regulatory scheme by excluding the unused grid capacity from the rate base. So only the effectively used capacity will be used in this calculation. This is called used-and-useful rate-of-return (UUROR) regulation, and is designed to prevent overcapitalisation. A problem which might result from this regulation, is that the use of UUROR by the regulator, and thereby to withhold compensation to the firm, can harm the relationship with the utility and might also encourage underinvestment(Gilbert & Newbery, 1988; Liston, 1993).

Although price cap regulation is perceived to be superior to rate of return regulation in that it better achieves efficiency increases, price cap and rate of return regulation do have similarities. Of course both try to prevent unwanted monopolistic behaviour by the regulated firm, and both kinds of regulation attempt to achieve this goal by directly regulating prices. Furthermore, just like rate of return regulation or even a rule like price cap regulation, it considers only how prices should be changed from year to year; it does not tell a regulator how to set them in the first year. (Alexander & Irwin, 1996; Liston, 1993)

3.4.3 Revenue-cap

Revenue cap regulation is quite similar to price cap regulation. However, instead of setting a price cap, in this case the regulator also establishes an I – X index (interest index minus performance index), although it is now called a revenue cap index and allows the operator to change prices of the product(in this case price for capacity) as long as the percentage change in revenue does not exceed the revenue cap index(S. V. Berg et al., 2004). Although revenue cap regulation is quite similar to price cap regulation, with price cap regulation the regulated utility faces a risk on what quantities are sold, this risk is less when revenue-cap regulation is applied (Alexander & Shugart, 1999). This is the case in electricity transmission where the demanded quantity is totally out the control of the regulated firm. Revenue cap regulation may be more appropriate than price cap regulation in situations where costs do not vary appreciably with units of sales. A positive aspect of revenue capping compared to price capping is that it relieves the regulator from overseeing the complex price structures and accounting structures, which might cause high regulatory costs.(Green, 1997) (Alexander & Shugart, 1999)

3.4.4 Benchmarking (yardstick) regulation

Benchmarking or yardstick regulation as it is sometimes referred to, compares similar companies' performance. This form of regulation rewards those with higher performance and penalises those with lesser performance, or both. The advantages of yardstick regulation includes, providing companies with incentives to improve efficiency but it also helps overcome the problems of information asymmetries between companies and regulators. Although yardstick regulation has often been used in the regulation of parts of the electricity distribution industry it has mainly focused on price regulation in the past (Filippini & Wild, 1999) and has not been applied to the regulation of interconnector capacity. (Weyman-Jones, 1995) The problem with applying this kind of regulation to the problem of interconnector capacity, is that an TSO is dependent on other TSOs for it's performance. But also requires similar network conditions, as is explained earlier (Weyman-Jones, 1995). Therefore this form of regulation is considered not very useful as a source of inspiration to this research.

3.4.5 Transparency incentive

Although not mentioned in the list of the most common incentives above, there is another incentive which is often introduced less explicitly or simply as a result from other incentive schemes. However this kind of incentive is not to be ignored. Literature shows that next to financial incentives, transparency can also be turned into an incentive for the agent to perform better. Of course, better information to the principal will partly solve the agency problem. However, a useful tool could be to require the company to publish information about its performance. By exposing the company's performance to the public, quality and performance is made observable. The idea is that public criticism will persuade the company to deliver sufficiently high quality and performance. The main advantage of this instrument is that it requires little regulatory action, and that it is relatively simple to introduce. However, the effectiveness can be questioned; public influence on a monopolist may not be as effective as can be expected in a competitive market. By providing unnecessary difficult technical explanations, the company could sometimes easily explain poor performance of quality to the public.(Ajodhia, 2002)

3.4.6 Lessons learned from similar incentive regulation in practice

OFGEM

OFGEM, the English energy regulator, presented a plan very similar to the goal of this research. It is called "capacity release incentive" and has been used for regulating its TSOs (gas and electricity) and has been implemented in the English electricity act. The goal was to provide the English TSO, National Grid. with strong financial incentives to invest in the transmission system, where it is efficient to do so, in response to signals of market participants. Therefore, the plan differs from our plan in that it focuses on incentives for investment. The plan was shaped as a rate of return regulation with a cap and a floor. The plan concentrates on several interesting aspects that will be described here. Starting with; how did they define transmission capacity? The "baseline" or target level in this case has been based on the transmission capacity measures for the period 2001/02 to 2005/06. To define the baseline transmission capacities, National Grid determined the maximum import and export transmission capacities at individual connection points and calculated transfer capabilities across the system boundaries. National Grid was required to offer for sale all of this baseline transmission capacity in the form of tradable, financially firm rights. National Grid was allowed to keep the revenues from the sale of any incremental transmission capacity up to a cap calculated as a reference to a maximum allowed rate of return, which was significantly higher than the rate of return it is allowed under its price control (6.25 per cent). Revision: the plan is up for revision every 5 year. Firm, tradable long-term rights for users: Users of the transmission system were able to purchase financially firm transmission access rights for several years ahead. The financial firmness of the transmission access rights was guaranteed by requiring National Grid to buy-back any rights at market prices it has sold but was unable to deliver physically. Floor: National Grids risk was limited by guaranteeing that it will be allowed to recover at least a floor rate of return, although this floor will be lower than the level of its regulated rate of return. (OFGEM, 2002)

DTE Quality regulation

DTE determines on a yearly basis the tariffs for the grid operators in the Netherlands. This is done according to the following formula.

$$TI_t = \left(1 + \frac{cpi - x + q}{100}\right) TI_{t-1}$$

TI represents total allowed income for the grid operator and the *CPI* consumer price index, *x* an efficiency correction and *q* represents a quality term called the *q*-factor. This q-factor changes the allowed income of the grid operator based on their grid quality performance. DTE sets a *q*-factor goal for each company based on the realised yearly average time of power loss per connected unit. If the company is able to perform better than this level, this is rewarded with the permission to raise tariffs. On the other hand, poor performance will result in lower tariffs. The range in which tariffs may change is being capped at a 5% deviation from the normal total allowed income level. The company is protected from force majeure incidents. In the regulation, force majeure is seen as circumstances beyond one's control, through which the company is unable to perform up to standards. The circumstances may include war, floods or earthquakes. In this case the company is responsible for supplying the evidence to appeal for force majeure. (DTE, 2007)

3.4.7 Conclusion

Incentive regulation is nothing new within the framework of regulating electricity networks. American and British regulators have a long history of inventive regulation usage, when regulating TSOs. Especially price regulation of network use has been strongly developed in these countries.

The incentive feature used in the most basic forms of incentive regulation is to allow for the regulated entity to keep additional profits. The challenges for the regulator are to know how much additional profit is needed to induce the operator to improve performance and to know whether the additional efficiency gained is worth the additional profits allowed, but also if the incentives created will really lead to the expected outcomes. Smaller incentives are needed for easy efficiency gains compared to more difficult efficiency gains.

Price cap regulation, rate of return regulation, revenue cap regulation and benchmarking (or yardstick) regulation are the most common and basic forms of incentive regulation used in the electricity industry on which many variations have been made. This chapter has shown the weak and strong points of these incentive schemes, these points can be useful to this research when setting design variables or prerequisites. According to literature a price cap combined with sliding scale has apparently been used most in more related markets. Some of the most prominent aspects are:

- the introduction of an inflation factor that takes care of the economy-wide price level or of the level f input prices
- an X-Factor that reflects efficiency improvements of the firm
- an Y- factor that allows for the pass through of specific cost items outside the firm's control

These aspects prove to be useful to this research as these aspects relate to changes to the scheme over time. A review period or regulatory lag as it is sometimes called in which the price caps and regulation is reviewed and adjusted is typically set at periods of 3-5 years.

Most incentives schemes are designed in such a way that it is relatively easy for the regulator to watch TSO performance (e.g. revenue regulation in which only revenues are watched) and keep regulatory cost tot a minimum. It is shown in this chapter that benchmarking is too complex a mechanism to be useful as a solution to the problem of border capacity. However there are certain aspects such as transparency which might be helpful as a solution. Coercing the TSO to be publicly more open about its actions will make the TSO more self-critical and aware that its actions are being watched.

Although the goals of OFGEM and DTE's incentive plans presented in this chapter are not in line with the goals of this research, there are several interesting aspects to this plan and this goal. An important aspect treated in this chapter concerns; dealing with risk. Dealing with risk is typically done by adding a cap and floor to the incentive plan. To prevent the regulation to become to risky to the agent.

4 Policy Analysis

This and following chapters will try to provide insight in the overall framework in which the regulation will be implemented. The overall framework will be split in a policy, technical, economical framework and an actor analysis. This starts with a chapter describing the policy framework, which explains how current regulation is made and where current regulation can be found. Furthermore the current set of rules most applicable to this case will be analysed. As expressed in the main question the goal of this research is to stay as much as possible within the current regulatory framework. Extensive knowledge of how this framework is therefore essential to define the necessary prerequisites to ensure this. Understanding where regulation is made and what consequences this has for the design implementation will also provide insight at what level our scheme should be implemented, and who will be responsible for implementation.

In the next chapter, a stakeholder analysis is provided describing the goals, powers and motives of the most important actors in this field. There are many actors with different, often conflicting, goals. Providing more insight in these goals and motives help shaping efficient regulation and prevent the creation of perverse incentives and other unwanted side effects.

The technical framework will explain the technical problems concerning high voltage border trade, and explains how TSO calculations are currently being done. Understanding of this process is essential to understand certain prerequisites and problems, and to be able to formulate variables that arise from technical limitations and practices.

The economic framework will explain the economical relevance of the regulation and how cross border trade is currently organised. Understanding how the scarce border capacity is currently being sold or divided (congestion management), is essential to understand when information about capacity is needed.

4.1 Policy framework

Within the European Union there are three main bodies who impose laws on market participants and regulated bodies. These bodies are A) the European Union which imposes directives, regulations and guidelines on the member states; B) the member states themselves; and C) their regulatory bodies. The relevant rules concerning the liberalisation of the energy sector encloses the European guidelines and directives with relation to electricity, the national laws (in the Netherlands: Electricity Law 1998) and secondary regulation (e.g. ordinances (AMvB's), ministerial regulations and policy regulations). These rules also include the European legislation on cross-border connections.

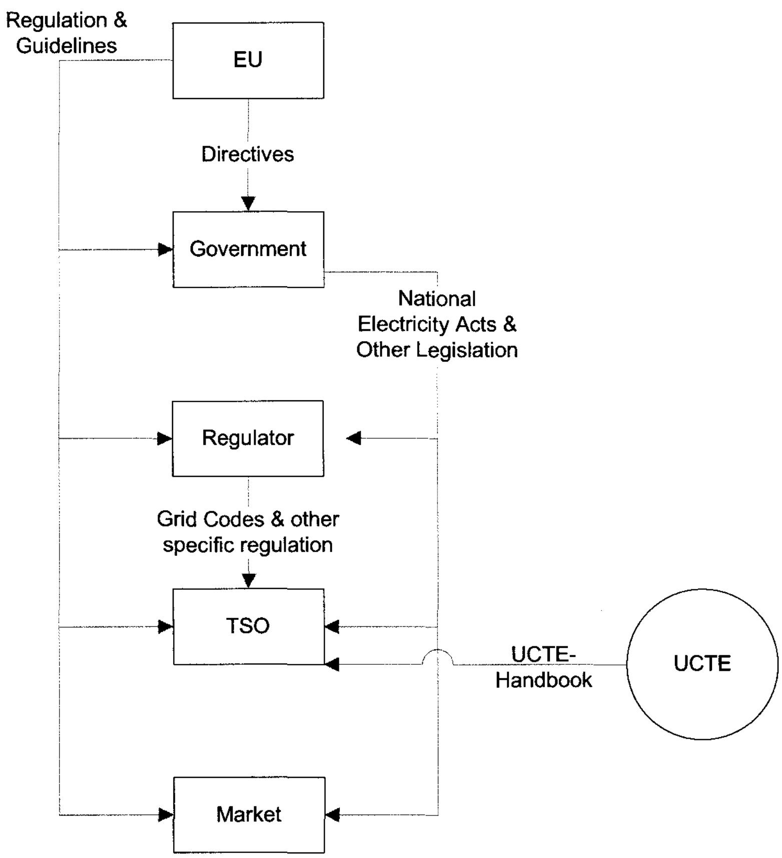


Figure** 4: **Policy Framework Based on De Jong, 2004

4.2 EU and national Level Legislation

EU

Due to the nature of the role of interconnectors in electricity networks, they are sensitive to nationally driven regulation (e.g. a country could protect its internal energy market by closing the borders). As a result a certain level of supranational regulation will be necessary to ensure a 'level playing field' on a European scale (De Jong, 2004).

The European Union uses several policy instruments to implement its decisions. Apart from a not legally binding advice, its main instruments are directives and regulations. European directives have to be implemented in national regulation on the members states own account. Directives require member states to achieve a particular result but do this without dictating the means of how they are required to achieve that result. This contrary to regulations which are obligatory in all its elements and are directly applicable in all Member States (De Jong, 2004).

The key legislation in the European process of creating a single internal market for electricity is the Electricity Directive 2003/54/EC (replacing former directive nr. 96/92/EG). This directive has been implemented by all member states since July 2004. Together with this directive, a second law, "Regulation on cross-border trade in electricity (EC) 1228/2003" was implemented. This directive sets rules for transmission of electricity between member states and tries to establish fair regulation concerning cross-border trade in electricity as well as promote competition recognising the specific characteristics of the regional and national markets. (Aarts & de Pree, 2005)

The latest legislation on the subject of the European electricity market "Directive 2005/89/EC" dates from 18 January 2006. This legislation concerns new rules concerning measures to safeguard security of supply and infrastructure investment. The directive has to be implemented by all Member States by 24 February 2008 but does not concern important or interesting new legislation on the subject at hand. (EU, 2007a)

The relevant parts of the electricity regulation (EC) 1228/2003 are: first of all Article 6 paragraph 3 which states the statutory obligation for TSOs to offer market participants the maximum capacity of the transmission systems which are used to transport the border crossing currents. This is done in agreement with the accepted safety codes used for reliable system operation. This directive however does not contain any guidelines about what the ruling safety codes or reliable system operation should be or where these can be found which makes this a debatable topic in that this may vary from country to country.

(6,3).The maximum capacity of the interconnectors and/or the transmission networks affecting cross border flows shall be made available to market participants, complying with safety standards of secure network operation.

Article 6 paragraph 5 concerns the possibility of netting. Netting can be explained as follows: electricity is capable of flowing only in one direction. This is simply import or export, depending on the location of production and demand. Take for instance the hypothetical situation where two countries are only connected to each other over a single line. The TSO has calculated that at a specific moment the interconnection line is capable of transporting 500MW import and 500 MW export. Based on the contracts and nominations it becomes clear that at this border a power flow can be expected of approximately 300MW import and 500MW export. Because electricity will only flow in one direction the actual net resulting power flow over the line will in reality be 500-300 = 200MW export. This is what is called netting. When this practice is applied that the line is capable of transporting at least another 300MW export extra, which could be made available to the market at for instance a later auction. In short netting is taking notice of the import and export nominations when calculating the capacity made available to the market. Article 6 already requires TSOs to use netting in their calculations, however in reality this is not always the case (H.M. de Jong, P.G.M. Giezbertz , personal communications, 2007). For simplicity this research will assume that all TSOs are already netting their power flows. This is done because enforcing netting on TSOs requires a different approach then through incentives but also because netting is an important factor in measuring TSO performance as will be explained later.

(6.5).Transmission system operators shall, as far as technically possible, net the capacity requirements of any power flows in opposite direction over the congested interconnector line in order to use this line to its maximum capacity. Having full regard to network security, transactions that relieve the congestion shall never be denied.

In addition to this Annex (9 nov. 2006 2006/770/ec) 4.2 states:

(4.2)Having full regard to network security, the nomination of transmission rights shall take place sufficiently in advance, before the day ahead sessions of all the relevant organised markets and before the publication of the capacity to be located under the day-ahead or intra-day allocation mechanism. Nominations of transmission rights in the opposite direction shall be netted in order to make efficient use of the interconnector.

Article 6 paragraph 6 states how the current congestion revenues (auction income) may be used.

(6.6) Any revenues resulting from the allocation of interconnector capacity shall be used for one or more of the following purposes:

(a) Guaranteeing the actual availability of the allocated capacity;

(b) Network investments maintaining or increasing interconnector capacities;

(c) As an income to be taken into account by regulatory authorities when approving the methodology for calculating network tariffs, and/or in assessing whether tariffs should be modified.

This article whows that the congestion revenues are among other things allowed to be used to guarantee actual availability of the allocated capacity. This is a very open rule and there is little jurisdiction on how to specifically interpret this rule. At least this money can be used for economical instruments such as buying back capacity from the market in cases of emergency as is being done today.

National

National Governments are obliged to promote the goals as imposed by the European Directives within their own legal system. (In the Netherlands this is the Electricity Law 1998). Apart from this they are allowed to create their own legislation as long as this is not in conflict with European directives or regulations as set by the European Commission. In addition they are required by European directives to establish a regulator to ensure proper operation of the energy market. (2003/54/EC)

The European Commission is made up of the representatives of various governments of the EU. Through this part of the European Union, representatives submit in consultation with the other members, draft proposals for European regulation. Government representatives take part in the Florence/Rome forums which are the relevant regional forums with respect to the development of binding guidelines. (EU, 2004)

4.3 Regulators

In article 23 of 2003/54/EC the European Commission orders Member States to appoint one or more competent regulatory authorities. These authorities have to be completely independent from the interests of the electricity industry and are responsible for ensuring non-discrimination market access, effective competition and the overall efficient functioning of the market. In the Netherlands this directive has been implemented in Electricity Law 1998 and has lead to the establishment of DTE, which has been made responsible for compliance of market parties and regulated bodies with these laws. (Transport, 2004)

An extra note to this directive is that it does not require the regulator to be separate from existing government structures. A separate regulator is thought of as the most desirable model but not required though. The Directive does allow for the possibility that a regulator's decision can be reviewed by the relevant Ministry (Ministry of Economic Affairs in the case of the Netherlands).

The minimum set of duties of the regulator are covered in paragraph 25 article 23, the separate member state's regulatory authority additional powers are not specified in this directive. The minimum set includes approval of network access tariffs and conditions, including transmission and distribution. Paragraphs 1 and 4 taken together give regulators responsibility over the following items relevant to interconnectors capacity for which they must both keep in check and intervene if necessary:

- management and allocation of interconnector capacity
- mechanisms to deal with congested capacity within the national system
- the time taken by transmission and distribution undertakings to make connections and repairs

European regulators used to be organised in the Council of European Energy Regulators (CEER) which is a non-profit organisation which brings together energy regulators from member states in the European economic area. Although this organisation still exists a main part of their tasks have been replaced by the ERGEG (European Regulators' Group for electricity and gas). By the decision of the European of 11 November 2003 (EC,2003b) ERGEG has been created, which is a group of Member States' regulators with the aim of assisting the European Commission (EC) in consolidating the internal energy market, in particular with respect tot the preparation of draft implementing measures.

In the Netherlands the regulator is responsible for creating technical codes. This is secondary law that describes the way in which TSOs have to act towards other TSOs and users of the network. The codes describe among other things network operations, and the measurement and exchange of information and system services. In the Netherlands there are three different codes: the grid-, system-, and measurement code of which the first two are most applicable to the subject of interconnector capacity.

4.4 UCTE-Handbook (technical regulation)

With the liberalisation and integration of the European electricity market networks became more and more dependent on each other for their safety and reliability operations while on the other hand state influence was being marginalised. In the often state-owned vertically integrated companies before liberalisation of the energy market, there had been less need for strong enforceable regulation. The commitment to common rules for cooperation was driven by "peer pressure" and "mutual responsibility" among countries. (UCTE, 2007) This used to be done on the bases of agreement within the UCTE[2] for over fifty years. The replacement of the vertically integrated government monopolies with the new market structures promoting competition and international trade caused a major increase in border crossing electricity flows. This led to the need for enforceable European security and reliability standards for all interconnected regions and their TSOs. Therefore, the UCTE Operational Handbook has been developed. This 'book' contains a number of technical and organisational rules and recommendations that form a common guideline for smooth operation of the power system(UCTE, 2007).

A multi-lateral agreement (MLA) was signed by all Members in June 2005 which made the Operation Handbook binding and enforceable on all TSO members. However, because of the jurisdiction of a MLA, the rules in the UCTE Operational Handbook can never be used when conflicting with decisions as put down by governments/regulators or the European Union in codes or laws. This overruling system has been incorporated in the Dutch System Code paragraph 2.2.2. Therefore each country is still allowed to create different rules other than put down by the UCTE.

---

[2] The "Union for the Co-ordination of Transmission of Electricity" (UCTE) is an organisation of TSOs that coordinates the operation and development of the electricity trans-mission grid of western and central Europe

5 Stakeholders

As explained in the theory, incentive regulation is being used to solve the problems that arise from lack of information and conflicting interests among actors. This chapter will try to provide insight on incentives, goals, powers and influences of the involved actors/stakeholders.

5.1 ERGEG and the Regional Initiatives

On 11 November 2003 by Decision 2003/796/EC the European Commission set up the European Regulators' Group for electricity and gas (ERGEG), as an advisory group of independent national regulatory authorities who assist the Commission in creating the internal market for electricity and gas. The aim of ERGEG is to provide a framework in which the national authorities of the EU Member states cooperate with the Commission with the goal "to work towards the creation of a single, efficient and effectively competitive electricity market, while at the same time ensuring security of supply and system reliability"(ERGEG, 2007). From regulation (EC) 1228/2003 can be concluded that ERGEG has the task to advise and assist the European Commission, on its own initiative or when asked to do so, on the topic of consolidation of the internal European energy market. ERGEG does not have the jurisdiction to take juridical binding decisions. Nevertheless the activities of ERGEG will often have a regulating effect due to the fact that the advise given to the European commission concerning the "design-comitology[3] guideline" (Decision 1999/468/EC) is not binding on its own but the content of the advise can become juridical binding when taken over in the "binding- comitology guidelines".(Lavrijssen, 2006) Its Members are the heads of the national energy regulatory authorities in the 27 Member States. These Regulators have a double role as they are involved in both the regional initiative as well as in national governments. ERGEG has divided the region in seven 'Regional Energy Market' projects (REM): Baltic, Central-East, Central-South, Central-West, Northern, South- West and the UK and Ireland.

---

[3] Design-comitology guideline: An instrument of the European commission to implement legislation on European level (ECT). This instrument provides for the Commission to be assisted by a committee to create legislation, in line with the procedure as put down in Article 202 of the Treaty establishing the European and is known as "comitology". Advisory committees: these give their opinions to the Commission, which must try to take account of them.(EU, 2007b)

The seven regions together have similar overall aims but focus on problems specific to these regions. These regions are split based upon geographical location and similarities in problems and level of progress in these countries. An overall monitoring process will ensure that progress towards a single energy market is not hampered by the regional initiatives.

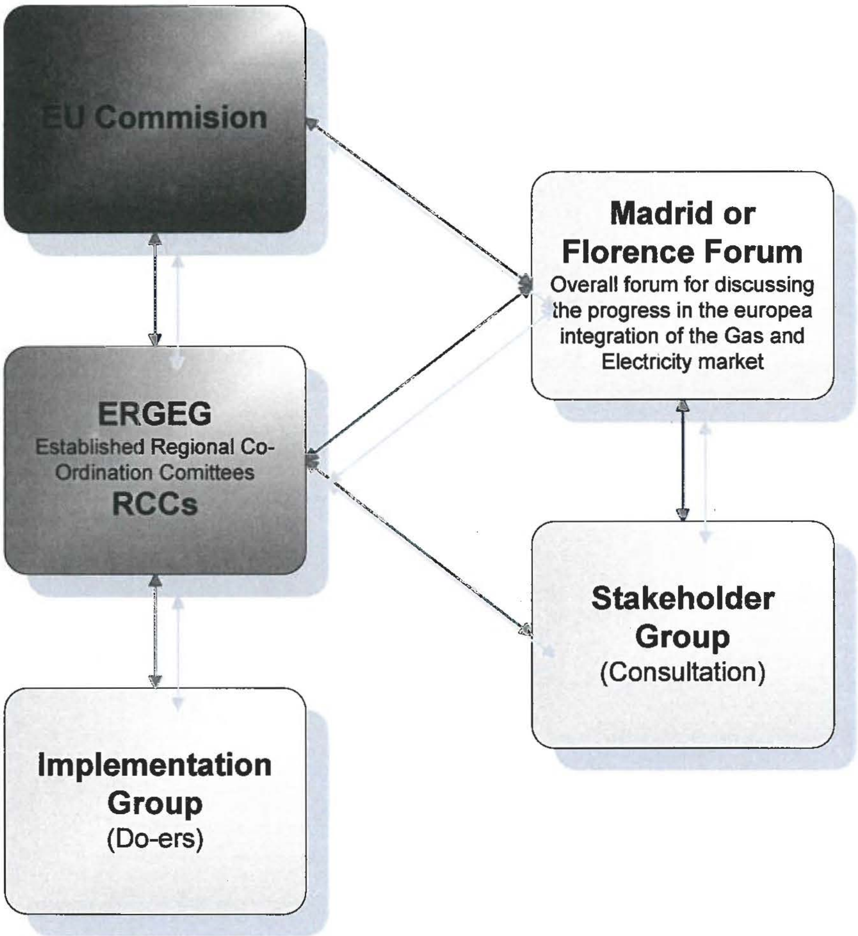


Figure 5: ERGEG Organisational Structure (Based on (ERGEG-Website, 2007))

Each regional initiative project will bring together regulators, companies, governments, the European Commission and other stakeholders from that specific region. This is done according to the following three group structures:

- Regional Co-ordination Committee (RCC) (Regulators)
- Implementation Group (IG) (TSOs + Regulators)
- Stakeholders Group (SG) (Stakeholders+ TSOs + Regulators)

This research will focus on the Central Western Regional initiative which includes the following countries Germany, France, Belgium, Luxembourg, the Netherlands.

Regional Co-ordination Committee (RCC)

The RCC is the responsible committee, and has the authority for working out the targets as set by ERGEG for the region. In the RCC the regional regulators are organised, and in this function they are chairing both of the other groups of ERGEG (Figure 6). The role of the RCC includes acting as overall co-ordinator of the tasks facing the Region and providing leadership, strategy and decisions. The RCC's duties could therefore include the establishment of and lead over the regional projects and activities such as mini fora, defining the way of work, involving stakeholders and setting up priorities, milestones and deliverables in line with the general EU/ERGEG objectives, in suitable collaboration with Member States and the Commission' (ERGEG, 2006b). The RCC is made up of the 5 regulators within central-west region as is shown in *Table* 1: *RCC Regulators*

Belgium	CREG
Netherlands	DTE
France	CRE
Germany	BNetzA
Luxembourg	ILR

Table* 1*: RCC Regulators

Regional Implementation Group (IG)

In order to take action and implement the proposals as created by the RCC commitment is required from all stakeholders that are related to the task/problem. These stakeholders include mainly the TSOs(*Table* **2**), exchanges and regulators of the relevant region. The task of the IG is implementing proposals from the RCC, change market rules and business practices, as well as undertake studies on behalf of the RCC(Figure 7). According to the ERGEG the IG is to be seen as both a potential information resource to the RCC, and as useful for the practical implementation of projects.

Belgium	ELIA
Germany	RWE Transportnetz Strom, E.ON-Netz
Luxembourg	CEGEDEL
France	RTE
The Netherlands	TenneT

Table** 2: **TSOs in the Central West European REM

Regional Stakeholders Group (SG)

The overall objective of the regional initiatives is to encourage the creation of regional markets through practical proposals, in order to succeed in such a complex environment it is crucial to involve all stakeholders in these initiatives.

Apart from the directly involved TSOs, regulators and market exchanges these proposals also affect traders, suppliers, shippers, consumers and producers which should be involved for successful implementation (EFET, IFIEC, Eurelectric). Consultation of members of this group can provide the group with valuable information. Market participants should for example be able to express their views on the need to address particular issues, how these issues might be addressed, and how they may be affected. Stakeholders will also have views on the rate of progress and on those who are holding up progress, which can be very helpful in achieving the regional goals.

5.2 TSOs

Supply of and demand for electricity is being balanced via the electricity grid. Independent grid operators look after this balancing and facilitate the transmission of electricity over the high voltage grids. TSOs are further responsible for the safe operations and maintenance of these high voltage networks.

Following transparent rules the TSOs guarantee non-discriminatory grid access to the variety of electricity market players. According to the organisation for cooperation among European Transmission System Operators (hereafter: ETSO), TSOs in the European Union internal electricity market are entities operating independently from the other electricity market players. This conflicts with the beliefs of other market players such as the European Directorate for Competition (Sector Enquiry, 2007). Although TSOs and producers have been partially separated from each other by law, there are reasons to believe such as commercial interest from TSO holding companies that separating ‘the books’ and legal unbundling is not enough to guarantee an independent operating TSO with public interest as its main priority, especially in the light that this law does not require ownership separation.

The TSOs have the task to operate and maintain the electricity grids in a certain area. TSOs are often considered to be public or private regulated utilities that operate under a "statutory obligation" to be efficient, and operate in the public interest.

TSOs are not “commercial” market participants as they are regulated companies. However they have the power to influence the market environment, especially where regulation falls short. This influence is quite clear in the case of the interconnectors as will be explained later. The main goals of the TSOs are to operate and maintain the electricity grid at the lowest cost while maintaining the highest quality(TenneT, 2007; UCTE, 2007).

Commercial interests

Regulation (EC) 1228/2003 article 6.6 states that any revenues resulting from the allocation of interconnector capacity shall be used for: A) guaranteeing the actual availability of the capacity; B) network investments, increases or maintenance; C) an income which will be used to establish network tariffs.

Although TSOs are refrained by this article from commercial interests resulting from auction revenues this does not stop them from having interests in more auction revenues (F.A. Nobel, T.v. Moll, H.E.J. Heus personal communication, July 29, 2007). And even on other aspects they still may pursue goals other than simple public interest. Other more perverse interests of for instance management might be discrimination between companies, empire building, growth, increased budgets more jobs, higher wages. (James, 2000; Serralles, 2006)

And although TSOs are forbidden to have any interest in the field of production they are often allowed to have commercial interests in the form of daughter companies in other fields such as is for instance the case of TenneT's daughter company BritNed or through TSO owned power exchanges. It is not unthinkable that there may arise situations in which the TSO is tempted to choose the interests of their daughter company over those of the public interest. E.g. in the case of daily capacity calculations the TSO might be tempted to lower the capacity of regulated interconnectors to favour the use of their commercial interconnectors (an example of such an commercial interconnector are the plans for the BritNed Cable between England and the Netherlands).

Unbundling

As long as there is no law that forces full unbundling of the old vertically integrated structures the old ties with production companies might still influence the operations of TSOs. Directive 2003/54/EC paragraph 10 allows for two alternative arrangements for unbundling of these assets. The first alternative is the creation of an independent TSO, either legally or through separate ownership, whose sole purpose is to manage, maintain and operate the networks. The second alternative permitted is a vertically integrated utility, separating both the management and accounting of the TSO from power generation and its other commercial activities. If this approach is followed, the directive requires a set of safeguards to be place for the protection of confidential or sensitive commercial information of the users of the TSO.

TSO ownership and management varies significantly among member states in this region which might influence the interests of the separate operators. E.g., TenneT is 100% owned by the Dutch government while Elia is for almost 30% (Elia, 2007)owned by the single biggest electricity producer in Belgium, Electrabel. A major part of the German TSO's shares are also still owned through holding companies by their former vertically integrated owners (e.g, E.ON & RWE) with which they still share names and even websites. According to (J.O.P. Tessensohn, personal communication, May, 2007) this influence is still visible as for instance the German TSOs often still have to ask for permission from the holding company when it comes to decisions with the creation of a single separate European TSO.

Belgium	Legal-Unbundling
France	Separation of Management
Germany	Legal-Unbundling
Luxembourg	Separation of Management
Netherlands	Ownership Separation

Table* 3*: Stage of unbundling: Legal Unbundling -> Separation of Management-> Ownership Separation

Table **3** shows that in the Central West European REM TSOs are currently at different stages in the unbundling process, with the Netherlands as the single country with a fully unbundled TSO. It is the Commission's view (DG-Competition, 2007) that the legal unbundling is not sufficient to ensure that a real competitive European market for electricity can develop. In particular, the Commission considers that 'legal unbundling does not suppress, in its view, the natural conflict of interest that stems from vertical integration'(DG-Competition, 2007). Regulation is only partly able to solve this problem of conflicting interests. The Commission recognises that regulators are not in any event able to fully address these disincentives which are for instance to adequately invest in networks and operation methods(Council, 2007; McMichael, 2007).

Another positive aspect of full separation could be that TSOs could also more easily exchange potentially market sensitive information increasing effectiveness in planning and cooperation(Council, 2007).

One of the problems for incentivising TSOs to maximise the level of cross-border capacities could come from the fact that the nature of capacity rights is currently based on physical arguments instead of financial. This physical nature implies that TSOs always emphasise the "network security argument" to advocate that it is not possible to increase the level of capacities instead of viewing network security measures as an economical problem. Looking at the problem from a more economical viewpoint, implies that more attention is paid to the cost of solving the problem, e.g. through countertrading, than through technical security limitations which could be lifted through the use of economical instruments. In that respect, transforming the physical nature of capacity rights into a financial one (i.e. right to obtain the price differential between two countries) might be useful in creating a different way of thinking among TSOs. (C. Gence-Creux, Personal Communication, May 2007)

Incentives

But even without these external influences of ownership and other unbundling issues there might be disincentives for TSO's to operate the network as efficiently as possible. Even within the company itself there might be forces that influence the behaviour of the company in a negative way. Management of TSOs might focus on their own private incentives such as: company growth, expanding their business units, their staffing levels and the value of assets under their control, as this provides them with higher status or higher salary. This could lead to more investments in new assets instead of optimising the existing assets. But also the way capacity revenues at the border are being used to support network investments might incentivise growth pursuing management to increase congestion revenues at the cost of border capacity. Due to the way capacity auctioning (explicit) is currently organised at certain borders it would be desirable for a growth pursuing TSO to keep the border congested. At the moment explicit auctioning will lead to higher auction revenues for the TSO as long as there is congestion at the border. This is due to the business model used on these auctions in which capacity will only get a price as long as there is congestion. For implicit auctioning this problem is not much different and it might still be in the TSO's best interest to maintain a price difference between two regions in order to be able to receive auction revenues. A higher balance on the income account of the auctions might increase income through interest and might even help the growth pursuing TSO in convincing the regulator to allow investments.

Although it is an important goal of the TSOs to maximise cross-border capacity, this does not mean this has always top priority. E.g. solving loop flows by investing in a stronger network within a country might relief the load on interconnectors, however expanding a network is very expensive and it might therefore be cheaper not to invest.

TSO ownership of an electricity exchange is common practice in many other European countries in which the exchanges are often commercial daughters of the TSO holding company. This is motivated by the need for TSOs to optimise electricity transmission capacity. Because this might work as an incentive for TSOs to make efforts in optimising the capacity at the border and thereby provide them with the proper incentives (APX, 2007).

TSO Cooperation

Electricity utilities have been co-operating for over 50 years with the objectives to maximise system reliability and quality of supply, while optimising the use of reserve capacity resources. Four regional organisations have emerged over time from this co-operation:

- TSOI, the association of TSOs in Ireland
- UKTSOA, the United Kingdom TSO association
- NORDEL, the Nordic TSOs
- UCTE, TSOs of the countries of Western and Central Europe

The geographic combination of these organisations have been roughly based upon the boundaries of synchronously interconnected areas. UCTE coordinates the operation and development of the electricity trans-mission grid of western and central Europe (not to be confused with the Central West European Regional Initiative which only contains 5 countries)

TSO instruments

What can TSOs do in the case of lack of capacity? Regulation 1228/2003 article 6 states in paragraph 1: "Network congestion problems shall preferentially be solved with non transaction based methods, i.e. methods that do not involve a selection between the contracts of individual market participants."

And in paragraph 2: "Transaction curtailment procedures shall only be used in emergency situations where the transmission system operator must act in an expeditious manner and redispatching or counter trading is not possible. Any such procedure shall be applied in a non-discriminatory manner. Except in cases of 'force-majeure', market participants who have been allocated capacity shall be compensated for any curtailment."

This second paragraph of article 6 limits the options for TSO to counter problems due to activities which might increase border capacity severely. Curtailment, counter trading and redispatching are the only tools available to TSOs to solve problems on the interconnector and will be explained in more detail here.

Counter trading

In the case that the net power flow results in congestion problems, the TSO creates a 'second-market' in which the TSO requests 'ill-placed' generators to reduce production and 'better-placed' generators to increase production in order to relieve the congestion. TSO's actually go on the market and buy and sell the electricity on both sides of the interconnector.. These actions often involve costs to the TSO and will also be covered in the overall network tariffs.(Hakvoort & De Jong, 2007)

Redispatching

In order to avoid physical overloading of an interconnector, the TSO has the authority to directly intervene in the location of generation. The TSO can do this by increasing the output of 'better-placed' generators and decreasing the output of 'ill- placed' generators(Krause, 2005). To resolve the problems the TSO then requests compensation from generators who had to decrease their outputs (since variable generation costs have been avoided) and will then pay generators who increased production. The resulting costs are being covered in the network tariffs(Hakvoort & De Jong, 2007). Under re-dispatching, there is no second market with bids but the TSOs assess which nominations of generators are in excess of the available capacity and decide, which generators will be limited and which will be increased.

Curtailment

The final option the TSO has to solve network overload problems is curtailment. In this event the TSO buys back/takes back capacity rights from the market. The TSO does this at a predefined price level, which varies per country. In the Netherlands TenneT is obliged to compensate the seller of these capacity rights at 110% of price paid for the capacity. This however leaves the seller of the capacity with a problem in that he is unable to fulfil his contracts. At the moment a discussion has started among regulators, traders, TSOs and producers how to deal with this problem and how much compensation should be paid for the curtailed capacity. The region's regulators stance has been defined as favouring curtailment compensation at full market spread.

5.3 EU and national governments and their interests

The aim of the EU is to create a single market. Interconnector capacity between countries is seen as en essential enabling prerequisite in the pursuit of this goal. The role of interconnector capacity in the creation of a single market means, that there should be enough cross-border capacity to guarantee possibilities for working competition.

However the EU is a mix of many national countries which often still pursue their own national interests instead of that of the EU as a whole. This may lead to lack of action from the EU to pursue these goals, as some countries are reluctant to open-up their markets, or expose their former champions to competition. Guidelines of the EU in contrast to EU regulation might leave Member States with too much space to pursue their own goals while still complying with these rules.

5.4 Producers & Traders

Generally producers as being commercial entities are expected to have two main goals at heart: increasing profits while increasing market share, and limiting risk (EFET, 2007). The interests of producers on the subject of interconnector capacity depend on the location of the production unit. Price levels may vary significantly from region to region over time. If we take the situation in which there are two interconnected regions in which one is on average a high price region and the other a low price region then the Producers in the high priced region have best interest to have the available capacity limited as much as possible. This in order to stop competing producers in the low price region from entering the market and thereby lower the overall price level. For producers in the lower price region it is in their best interest to have as much interconnector capacity as possible as this increases their market. Another positive aspect for these low price region producers is that due to the connection with a high price area prices in the low price area may go up. This leads to increases in profits for producers.

The effect of electricity price influences by foreign producers is dependent on the size of the internal market compared to the cross-border capacity. Countries with a large internal market will be less affected by low priced electricity imports than smaller markets.

In the case of explicit auctioning producers might be able to influence the used capacity by bidding at the interconnector auction. (E.g. buy capacity not in order to use it but to refrain it from the market to drive prices up). (Draft marktmonitor, 2006) Furthermore they are able to influence the need for capacity at the border by increasing or limiting production (capacity). Evidently this statement needs to be put into perspective with the market power each producer has which can be for instance in the case of France or Belgium very high.

The European Federation of Energy Traders (hereafter: EFET) is a group of more than 60 european energy trading companies dedicated to stimulate and promote energy trading. EFET states in its call for incentive regulation for TSOs that is vital to create efficient competition to ensure that traders and trading producers are able to hedge (safeguard) their long-term financial positions, in order to offer long-term contracts and price prognoses to customers within another member state. "Traders will generally not be able to bear the risk of congestion on the grid, especially if the regional wholesale market is not yet well developed" (EFET, 2007). In the absence of being able to hedge these risks, new entry into that market will be discouraged, especially for small market participants without sufficient physical production capacity (power plants) to overcome the lack of supply in the case of curtailment. (EFET, 2007)

6 Technical Framework

This chapter will start with explaining and elaborating on the attributes of electricity. Some of the characteristics, such as the impossibilities with steering electricity and the non storability of electricity, are at the heart of the problem of electricity trade and production. In the second part the mechanisms of capacity calculations as being done by TSOs are explained. This will help understanding the problem of how capacity is currently calculated, the problem of information and the dependence on other TSOs for capacity calculations.

6.1 Electricity Attributes

Electricity has a complicated set of physical and economic attributes that complicate the task of implementing certain market mechanisms. These attributes must be fully recognised and understand in order to come to a proper understanding of the problems.

According to Joskow (2003) these attributes include:

a. Storage: Electricity cannot be stored economically or in large quantities. This results in the process that demand must be satisfied with "just-in-time" production. Generating and transmission capacity available must be available to the network at (almost) exactly the same time that the electricity is consumed. This has an enormous impact on the way auctions and trading is being exercised in this market. Electricity and transmission capacity are traded as options because real demand at an exact moment can only be predicted by approximation.

The physical flow of electricity does not follow economic contracts but uses the network as described by Kirchhoff laws on electricity. Network congestion, frequency and voltage control require that supply and demand must be cleared at all times at every location in the network. Congestion in combination with the non-storability aspect of electricity may limit the geographic expanse of competition significantly, this is especially the case on cross-border connections which are unlike the national network not viewed as copper plates(a network which has no network restrictions, all network limitations are to be solved by the TSO).

b. Elasticity: The short-run demand electricity is very inelastic in relation to the spot price which allows high price levels, before demand will be limited by consumers. On the other hand the short run supply of electricity is also very inelastic during very high levels of demand when capacity constraints are approached. When capacity constraints are approached it is very hard to increase capacity in the short run. As a result, spot electricity prices are very volatile and unusually vulnerable to the opportunities for suppliers to exercise market power by limiting production capacity at moments when demand is very high.

c. Loop flows: Unlike DC networks, the physics of power flows on AC networks can hardly be steered or guided in specific directions, the paths of power flows are based on the law of least resistance. This induces additional complex interactions between generators at different points on the network. Not only at the national level but especially at the international level where interconnector capacity is limited this may cause severe problems 'creating unusual opportunities for suppliers to take actions unilaterally to affect market prices, complicating the definition of property rights, and creating coordination and free riding problems'. (Joskow, 2003)

6.2 *Transfer capacity definitions and calculation*

First we need to provide a proper definition of transfer capacity, this is a topic that often leads to misunderstandings even among experts. A proper distinction needs to be made between programmed transactions (scheduled exchanges) and physical flows.

An important other aspect which needs to be emphasised, is that the possibilities for import/export transactions within the European transmission systems between two countries depend on all realised transactions in the whole network. This includes other transactions than only those based on contracts between the two considered networks. Due to parallel flows or loop flows, which are the direct consequence of physical laws of electrical flows in the interconnected networks there are many more flows to be considered. Thus, the maximum possible use of the physical capacity between two given countries/networks depends to some extent on all local as well as on all distant actions (European production plans and consumer loads).

The Total Transfer Capacity TTC, that is the maximum exchange programme between two areas compatible with operational security standards applicable at each system if future network conditions, generation and load patterns were perfectly known in advance(ETSO, 2001).

The above definition makes clear that the TTC is always based on a prediction of the given power system scenario, i.e. generation schedule, consumption pattern and available network. This data is used to build up a mathematical model of the power system (load flow equations). In order to determine the TTC, TSOs normally “simulate the exchanges between the two systems by increasing (step by step) the generation in one region and reducing correspondingly the power injection in the other area within the scope of a certain power system scenario” (TenneT, 2002). The way in which generation is increased and power injection is reduced is chosen by the TSO performing the simulation. Furthermore, each TSO individually calculates the TTC or other relevant values for its relevant flow gates using its own assumptions.This procedure is then carried out for all relevant pairs of adjacent regions. TSOs generally calculate TTC values only bilaterally between pairs of control areas without considering the effects on the TTCs in other regions. In such a ‘non-coordinated’ situation, TSOs inform each other about the TTC and other values they have individually determined on shared flow gates. If a discrepancy exists between the TTC and other values calculated for the same flow gate, the lowest value is taken and used for capacity allocation to the market (Nordel, 2006; TenneT, 2002). This information leads to assumptions of the voltages and currents at the network nodes which are essential to assess system security.

Therefore, more coordinated calculation approaches will most likely lead to a more accurate and efficient determination of the transmission capacity available for the market. At present, coordinated calculation is still uncommon within the European electric market. However, recent European regulation (Commission Decision, 2006) rules that coordination between TSOs must include all the steps from capacity calculation and optimisation of allocation. (Article 3.5 Commission Decision 2006/770/EC). Thus evaluation of TTC between two electrical areas requires:

1. To make a choice of a local power system scenario
2. To define a base case which involves the sharing of full information among TSOs to build up the global load flow model
3. To apply an agreed procedure for carrying out the calculations.

(ETSO, 2001)

After the TTC has been established a security margin called 'Transmission Reliability Margin (TRM)' is calculated, which together with the TTC results in the Net Transfer Capacity (NTC) (in reality this TRM is often held constant by the TSO as a result of experience).

The Transmission Reliability Margin TRM is a security margin that copes with uncertainties on the computed TTC values arising from:

a) Unintended deviations of physical flows during operation due to the physical functioning of load-frequency regulation

b) Emergency exchanges between TSOs to cope with unexpected unbalanced situations in real time

c) Inaccuracies, e. g. in data collection and measurements

(ETSO, 2001)

The Net Transfer Capacity NTC that is defined as: NTC = TTC-TRM

NTC is the maximum exchange programme between two areas compatible with security standards applicable in both areas and taking into account the technical uncertainties on future network conditions(ETSO, 2001).

Extensive and accurate data is essential to the TSO for the purpose of making exact network assumptions. The more accurate this information is the lower the security margin for inaccurate data and calculations needs to be.

6.3 Safety rules (n-k definitions)

Article 4 of EC Directive (EC) 2003/54/C5 concerning measures to safeguard security of electricity supply and infrastructure investment, requires Member States or regulators to ensure that TSOs set the minimum operational rules on network security. For the Central West European area this article refers to the set of rules and recommendations as put down in the Operation Handbook of the UCTE. (PBPOWER & KTH, 2006). This also concerns the principles on network security for interconnectors. One of the main principles on this is what is called the N-*k* ooutage condition which generally specifies the rules for design of redundancy when k transmission system elements are out of service. In this case the absolute voltage level on the other elements is not allowed to rise above design specifications.

Although this EC Directive refers the UCTE Operational Handbook N-k definitions on network security still vary from country to country.

For instance **UCTE Handbook** (Operational Handbook-P3A) which is referred to by EU regulation defines the 'N-1' security criterion as 'any probable single event leading to a loss of power system element and that should not endanger the security of interconnected operation (either cascade tripping or loss of load)'. After such an event has occurred the handbook also requires TSOs to return to 'N-1' conditions "as soon as possible" without any further definition. (PBPOWER & KTH, 2006). Other members of this region define this principle differently.

In *France* the N-*k* is defined as follows: 'The 'N-*k*' (N-*k* where *k* varies between 1 and 2) rule defines the maximum level of risk, evaluated by reference to the 'product of probability of an event x load interrupted (MW)'. For example the loss of a double circuit line leading to an interruption of 1500MW would not be acceptable.'(PBPOWER & KTH, 2006)

While In *the Netherlands* the N-1 criterion is such that a fully operational grid requires secure transmission of such input and output as the connected parties require, even if one network element fails. Further requirements are specified for when equipment is out of service for maintenance this is called the N-2 condition. (PBPOWER & KTH, 2006)

From above examples can already be concluded that no country uses the same N-k condition. Therefore in order to come to proper net-safety regulations, first of all definitions among countries in the Central West European market need to be harmonized. To be in compliance with European directives it would be best to take the UCTE Handbook definitions as design requirements or even more rigid ones.

7 Economical Framework

Energy prices and importance of cross border capacity

Because of the non-storable nature of electricity and the absence of short-term price elasticity for consumers, small variations in supply may have a large impact on prices. If you look at Figure 8 it is shown that the marginal production unit is responsible fort the final electricity price. Extra capacity may therefore have a major impact on the overall price level within a certain area.

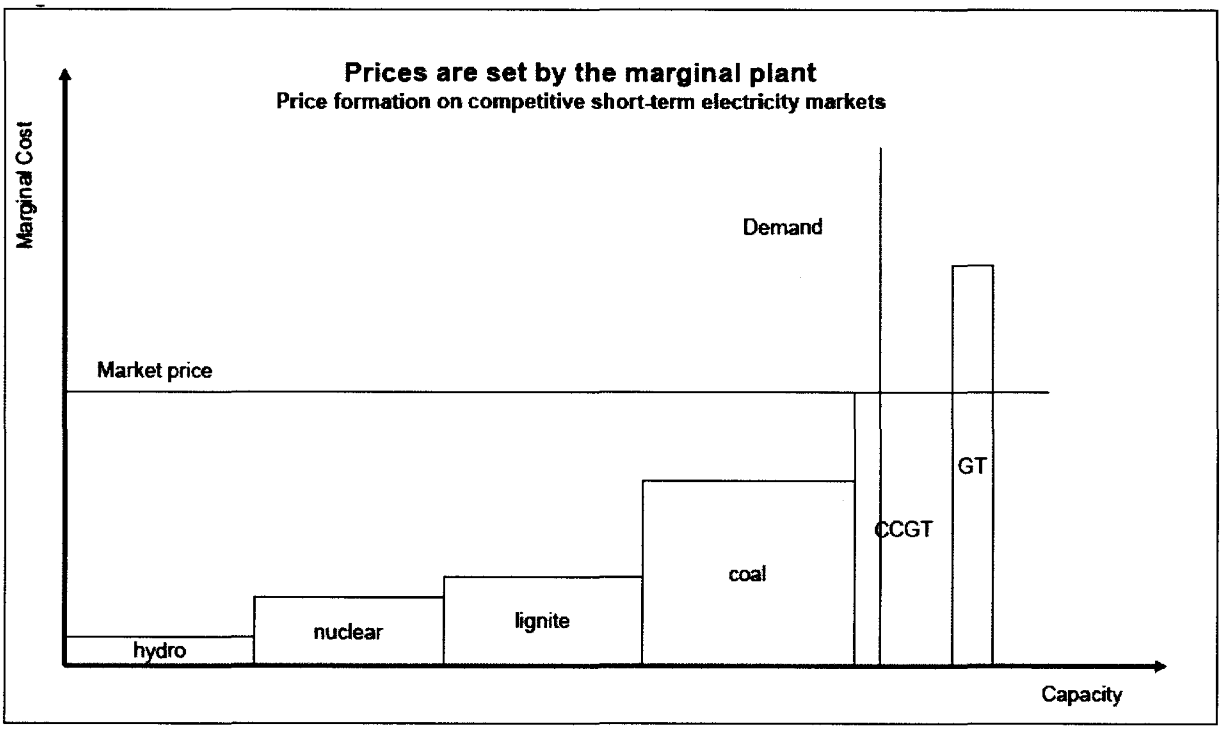


***Figure** 8: Price setting for Electricity source EU Energy Sector Inquiry 2005-2006*

Transmission capacity has become more and more important for the total supply and is therefore important for the final price of electricity. If we take for instance the Netherlands which has approximately a total peak demand of about 20,000 MW than the total border capacity of about 3,850 MW is a relatively large part of the total supply. This is especially important when considering the fact that total production capacity within the Netherlands is lower than the total demand, making the Netherlands dependent on foreign imports.

7.1 Congestion Management

Cross border capacity is a scarce good for which demand often exceeds total supply. This requires market models to distribute this scarce good over the market. In Europe, different management models are being used. For example, the cross border capacity between the Netherlands and Germany is assigned through a coordinated explicit auction, Belgium and the Netherlands use market coupling, whereas the France-Belgium cross border capacity is assigned by the principle of first come first served. Market coupling is currently seen as the best model, markets within this region are expected to shift to this model in the next few years. Therefore the design of the regulation requires that this does not conflict with the market coupling model.

Explicit Auctioning

Explicit auctioning as is currently undertaken at the important Dutch-German border is done as follows: cross-border electricity transfer capacity is auctioned in three different kinds of auctions, the day, month and year auction. Above-mentioned auctions include the auctioning of capacity in each of both directions of the interconnectors.

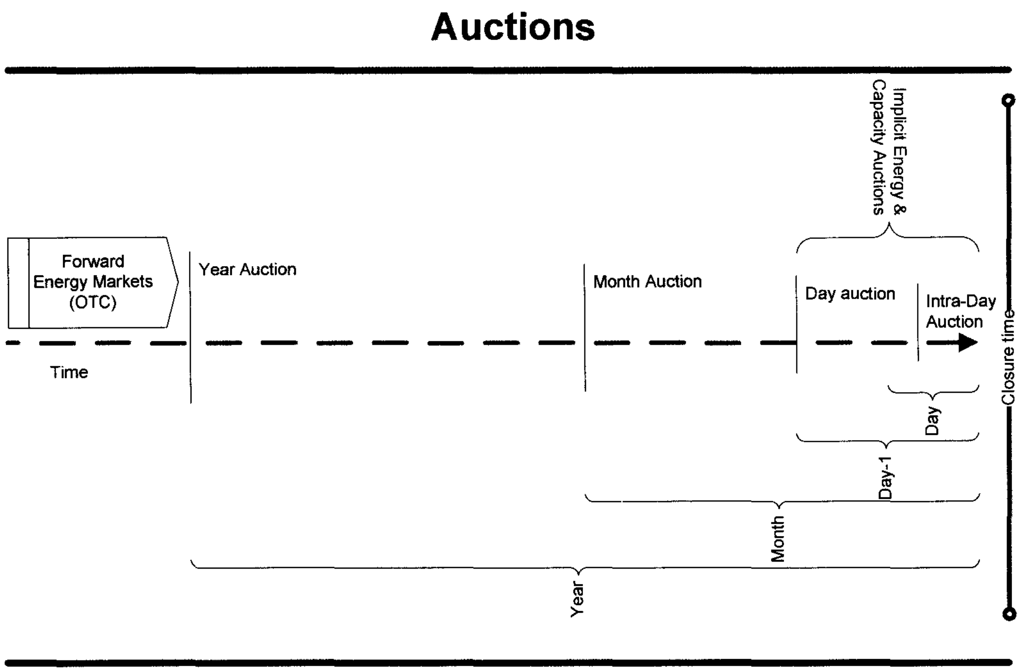


Figure 9: Example Time Frame Auctions

In the Netherlands, explicit capacity auctions are held at three different time moments: day month and year (Figure 9: Example Time Frame Auctions). Each auction auctions a part of the total transmission capacity and this process may vary from implicit to explicit auctioning and from country to country.

Year Auction

At the end of the year, the auction will be held for the capacity of next year. At this auction participants will obtain capacity for every hour of the next year and is done in two rounds each auctioning half of the capacity.

When designing regulation it is important to understand how congestion management is being organised in a certain region. The congestion management models are of influence on for instance the timeframe at which capacity should be made available but also on the economic valuation of transport capacity.

Month Auction

In the Netherlands Every tenth working day of the month this auction is held in order to obtain capacity for the next month. The capacity will be obtained for every hour of the month.

Day Auction

During the day auction participants can obtain capacity sold for every hour separately for the next day. Every morning at half past eight the available capacity is published, until nine o'clock participants have the possibility to send in biddings for transport capacity for the next day. At nine o'clock, the actual auction takes place. Every participant is allowed to bid for a set maximum volume per participant and this way a price is established. The price will be formed through the mechanism of the lowest bidding price that dictates the overall price. Unlike most other congestion management models, a limited connector capacity will lead to higher prices for capacity. In the perfect situation, the limit of this price would be the price difference between two interconnected areas however due to not matching time frames for the spot and capacity auction uncertainty arises as final price differences can only be predicted at the capacity auction. This may distort the final price and result in a less than optimal price.

Implicit Auctioning

Implicit auctioning is the opposite of explicit auction. In this form of congestion management electricity is traded together with border capacity. So where in explicit auctioning the trading of electricity and allocation of the transmission capacity are two separate steps, market coupling is an implicit auction where the trading of electricity and the allocation of capacity are merged into a single operation.

8 Design of Alternatives

After the first descriptive and analytical part of the study which forms the basis for Design space, a design can be made by using the structure as suggested by the Meta model.

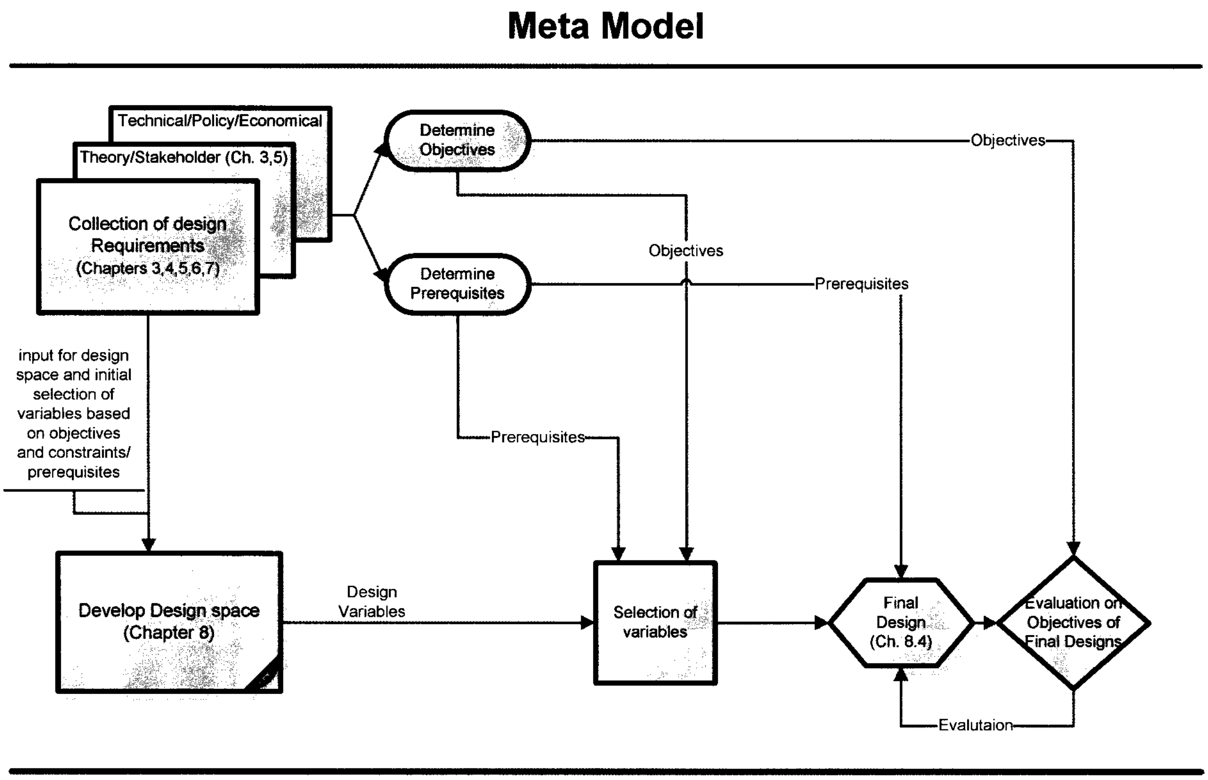


Figure 10: Adapted version of the Herder and Stikkelman Model (2004)

During the first stage, the design requirements, consisting of a list of objectives and prerequisites will be made. This list has been derived from the stakeholder and framework analyses and has been discussed with several stakeholders at DTE, TenneT and experts at the Technical University of Eindhoven. This list will set the objectives and prerequisites that are important to a proper design. These requirements will also function as a 'filter' for the second stage of this design study.

During the second design stage, so called variables will be collected and simultaneously filtered and analysed if they are in line with the objectives and prerequisites. This will limit the number of options available on the basis of these variables.

During the last stage of the design a number of selected variables will be combined to construct several design proposals covering a wide spectrum of solutions to the problem in line with the design objectives and prerequisites.

8.1 Design objectives

1. **Strong Incentive for TSO**

   As explained in the stakeholder analysis and based on the theory of the principal agent theory, TSOs are subject to many different and often conflicting interests. Therefore, efficient and effective regulation requires proper incentives to make sure it is interesting for TSO to actually emphasise the importance of the regulation's goals. Strong incentives may be helpful in creating an environment which the interests of the TSOs on both sides of the border comply and that everyone has the same priorities.

2. **Easy Implementation**

   Easy implementation in this report is defined as: 'Best fit within current regulatory framework'. When it comes to implementation of new regulation, time can be a significant factor, especially at an international level, for instance EU directives usually take over four years to complete. Adapting existing regulation takes time and effort, the more the regulation fits within current framework the easier its implementation.

3. **Least opposition among TSOs and regulators**

   Choosing and creating regulation that suits TSOs and regulators best, will make the implementation process easier, faster and more efficient.

4. **Low regulatory cost**

   Regulatory cost should be kept as low as possible. The goal is to have the TSO work more efficient this should not be undone by increasing the regulatory costs. One should look at the returns of increased capacity for society and the costs of alternatives to regulate such as an audit.

5. **Easy and unambiguous measures for TSO performance.**

   Easy performance measures keep regulatory costs low, but also maybe even more important, makes sure there will be no misunderstandings among TSOs and regulators.

8.2 Design prerequisites

1. **The regulation must be implemented on both sides of a border.** One-sided implementation is out of the question; because TSOs are dependent on each other's actions it would be unfair to subject only one of them to the risk of an incentive plan. As explained TSOs might have different priorities but are dependent on each other for cross border capacity calculations and infrastructure.

2. **Grid-safety can not be compromised**, *(the established n-2/n-1 safety level (Net-codes) can not be compromised, other safety-rules like those proposed in the UCTE handbook, could be included in the regulation after deliberation with the regulator). (Paragraph 6.3)*

3. **The nominated capacity must be absolutely 'firm'** *(full market spread compensation).* Although the discussion concerning this subject is still going on, it is the opinion of the author that this is a helpful prerequisite for proper functioning of the regulatory scheme. If due to actions of the TSO the risk on curtailment increases then it would be unfair to pass these costs to other market participants. Not only would subjecting the TSO to the full costs increase the market awareness of their actions, this would also create a less risky market environment for other market participants.

4. **It should be possible to implement the regulation in countries that are not able to implement this regulation at all borders.** There will always be countries in the region that are bordering and connected to countries that are not implementing the regulation. Therefore, it is essential to make sure that this regulation will also function in those countries. E.g. it should be possible for a country like Germany to have the possibility to implement this regulation on the Dutch border while not doing so at the Polish border.

5. **Level-playing field for TSOs.** Although TSOs are fully responsible for the interconnector they are only partly able to influence the interconnector capacity. There are many external factors influencing the capacity of which the decisions of other TSOs are very significant. As explained before TSOs together have to agree what capacity can be made available to the market.

Following the reasoning of the principal agent theory and based on the legal structures of ownership and management of some TSOs, there are clues that there might be different goals or priorities among TSOs. That this suspicion exists was confirmed with personal experience during interviews at TenneT (Personal Communication J.O.P. Tessensohn, R. Beune, 16 August, 2007 Arnhem). Other TSOs might fear that because there are always two TSOs responsible for the capacity calculations that some TSOs might be damaged by the regulation while they have not had influence on the outcome of not achieving the goals as set by the regulation because of differences in priorities.

For example if we look at a country with a dominant, almost monopolistic producer, and this producer is also (co-)owner of the only or most important TSO of that country through for instance a holding company. If the holding company is able to influence this TSO to be conservative in its capacity calculations, this might be positive for the holding company. But under an incentive scheme with capacity targets such an action might negatively affect the TSO on the other side of the border on its incentive income.

A complete level-playing field, in which all TSOs have the same goals, priorities and instruments to achieve these, will be an almost impossible goal on a short term. Therefore it can be questioned if this should be seen as a prerequisite or as an objective. In this study it is proposed to be seen as a prerequisite because it is outside the scope of this study how to ensure a level playing field and therefore not a goal of this study. It is also seen as essential to ensure fair regulation. A strong incentive may be only a part of the solution, in creating a level playing field in which all TSOs have the same goal. One of the most important factors ensuring a level playing field would be separation of ownership from the production companies.

Other prerequisites.

Some models for regulation require different economical or policy instruments or different market structures. E.g. some models for regulation requires intra-day trade or require extra (policy) instruments for the TSO such as the ability for counter trading already during the auction phase. Because these requirements are not applicable to all forms of regulation these will be referred to if necessary in the context of the concerning variables.

8.3 *Design Space: Collection of variables*

8.3.1 Variables for Performance indicators

➤ Measuring performance

When creating an incentive scheme one always needs a scale to measure and compare performance. If good behaviour is to be rewarded it is necessary to establish what good performance is. Simply said: 'how can an increase in capacity made available to the market best be measured and what is considered a 'normal' performance level?'. The best indicators for performance would probably be the TTC or NTC, because these are already extensively used and refer best to the goal of the incentive scheme. With this indicator the regulator is able to set a 'target level' of how much is expected from the TSO. The importance and use of these indicators is not expected to change in the near future, even after the introduction of flow based capacity calculation mechanisms.

- *TTC*

  A problem with using the TTC as a performance indicator or target is that this still allows the TSO to incorporate certain security margins such as the TRM without consequences for its bonus/malus. Therefore, the NTC is to be preferred over the TTC.

- *NTC*

  The technical NTC is based on scenario calculations and defined as the TTC – TRM (as explained in chapter 6.2). This is what theoretically could be made available to the market. The problem with the NTC is that this value varies over time when more information about the expected load flows and weather conditions becomes available. After d-2 (two days ahead of the final use moment) when year and month capacities have been nominated the NTC may change, based on this extra information. So it is important to choose a specific timeframe when choosing NTC as a performance indicator.

  Netting

  Another problem is what to do with netting. It is possible to allow the results of netting to be calculated in the indicator. This might stimulate TSOs to use netting as an instrument to increase the capacity made available to the market (which is currently often not common practice). However, netting is already required by law and therefore enforceable on a TSO by the regulator.

Including and allowing the effects of netting in the indicator could create problems for the regulator in setting a solid target because it is hard to predict beforehand how big the effects of netting will be. The effect of netting will increase as price differences become smaller or when more long term contracts have been signed over the border. If netting would be included and price differences are small this might help the TSO in reaching the target without any effort. To overcome this problem and pick a value that best represents the capacity made available to the market would be not to use the NTC in it's official definition but to use the following: Capacity offered at the day-ahead market + nominated month and year capacity – the result of netting.

Other options

- *Price convergence between areas*

  It is also possible to focus on price convergence between areas. In this case it is possible to set a maximum accepted price difference between two areas as a target for the TSO, instead of, for instance, a minimum level of capacity. If the price difference between the areas falls within a certain accepted percentage range, the TSO would then be rewarded with a bonus. Else, the TSO would get a malus.

  Although price convergence and investment is in an absolute sense outside the scope of this research, (which focuses on more efficient usage of the interconnector line) it is certainly in line with the goals of the European Union. Using this target would have the advantage that it would limit perverse incentives for the TSO to create more capacity than demanded by the market in order to get a reward. The downside is that this target is completely out of the influence of the TSO and may fluctuate significantly over time. This would also create a strong incentive for the TSO to make more investments in new infrastructure instead of using the existing infrastructure. Total price convergence may furthermore not be the absolute goal, because it may be more expensive to build enough capacity for these last few MW than there would be economic gains from this extra capacity.

- *Capacity usage*

  At less congested interconnectors, it could be an option to set the indicator and target to refer to the percentage interconnector congestion. As long as there is less than 100% congestion at the interconnection lines the TSO would be rewarded, and when the line is congested a fine could be used as an incentive to solve this. This would have partly a positive effect on investments (which is out of the scope of this research) but could also have a negative effect as this provides perverse incentives to invest in more than necessary capacity (although a time lag between the decision on investment and the completion of the project is quite long). The major problem of this option is that for instance on the German-Dutch border the demand for capacity is of such a magnitude that less than 100% congestion will be very hard and almost impossible to reach, and thereby such an incentive scheme would be unreasonable to the TSO.

8.3.2 Variables for Accuracy in measuring performance

➢ Export vs. Import targets

Export and import capacities, which follow from TSO calculations, will differ from each other in practically all situations. Setting a single target that does not discriminate between import and export, would therefore be inefficient. Especially because based on the price balance at a certain moment, between two countries, one of them will be valued over the other. Not only will one direction be valued more than the other, it would also be quite easy for TSOs to reach a target on export/import that is in the opposite direction of the price difference. In this case the incentive reward system is not efficient and this money is not well spent, as this would be spent on unused capacity.

- Frequency of the target

What timeframe will be used for the target? (e.g. will there be a target set for every separate hour/quarter?) Or will an average/sum over a short period of time such as a daily, weekly, monthly average do as well, or maybe even a total aggregated capacity of for instance 24x a line capacity of 3500 MW = 84.000 MW a day?

It will be most clear-cut when there is a strict target, which holds to every single hour of the day. TSO performance will be assessed on an hourly basis. Averaging over for instance a day or month will lead to situations in which it is in the interest of the TSO to optimise the connections at times when this is less needed. The TSO will optimise risk and income and will therefore use this principle to optimise capacity at hours with less demand because this will result in the least risk for the TSO.

- Variation in the target over time

It is possible to vary in the economic valuation of the bonus and malus for specific periods, but it is also possible to do this with the target level. The target level may vary along with demand, or other structural circumstances. An example might be weather conditions; during certain seasons e.g. during winter the load flows are structurally more unpredictable due to an increase in wind energy. This results in higher safety margins, which lead to lower NTC values. It might therefore be justified to change the target with these structural changes in network conditions and environment, and expect higher performance from the TSO during certain periods than during others.

The choice here is to what extend this will this be used, and will the valuation of certain periods vary or will only/also the target value change? Will this target vary by the hour (peak/base load), by part of the day (day/night) or maybe by season? The more precise this is done the more precise the regulation, but this also increases costs, as someone has to research the proper target.

To vary by season might be a good option. An analysis of the details on reservations for wind energy in the Netherlands shows that wind specific reservations are only being done during winter seasons (first and the last quarter of the year). These reservations are not only of significant economic value; the size of the capacity decreases are also quite significant and during increasingly long periods in time. An indication of these reservations and their social cost is shown in *Table* **4**. These reservations are expected to increase even further in the near future due to increases in wind energy production parks.

	% Hours Reservations per Month	% Capacity Decrease	Indication Cost missed Trade Opportunities Import (APX Prices)	Indication Cost Missed Trade Opportunities Import + Export
2006 Q1	11%	0,56%	€ 525.000,00	€ 568.000,00
2006 Q4	36%	4%	€ 3.726.000,00	€ 4.034.000,00
2007 Q1	47%	6,63%	€ 3.059.000,00	€ 3.822.000,00

Table** 4: **Calculations on Wind Reservations in the Netherlands based on information provided by TenneT and APX done by the author.(wind reservations are only done during the first and las quarter of the year)

8.3.3 Variables for Economical Valuation

- Valuation of different Periods

A differentiation could be made in rewards for different periods? Otherwise said, will hours, days, weeks etc. be valued differently according to their importance? There are moments at which the risk for the TSO is higher than for other hours, but the importance of these hours on the overall price levels in a country increases during those hours as well. Examples could be to value peak hours higher than base hours. But also during certain periods this could be done e.g. mid summer and mid winter are usually periods with a higher overall electricity demand than other periods. To recognise this increase in risk for the TSO and to make sure the TSO emphasises the importance of these hours/periods it will increase the efficiency of the regulation to value such hours more.

- Import/Export Valuation

Differentiating the bonus malus between export/import is also an option. The reason for differentiation between these two would be that both countries value each option differently dependent on the price level at that moment in that country. Differentiating this reward should be done in similar ways on both sides of the borders to prevent problems in dedication among TSOs.

Varying this reward over time (e.g., depending on the direction of the price difference) would increase the efficiency of the regulation, but it would also increase the complexity. However this is a necessary option to prevent perverse incentives. It would be very easy for the TSO to release loads of capacity for import while the price difference is in the other direction. This would lead to a situation in which the TSO will always reach it target without any positive effects for society. The problem here is, when in the process of setting a target, the decision will be made concerning what direction (import or export) will be rewarded.

Ex-post vs. Ex-ante valuation of Import and Export targets

The import/export valuation can be established ex-ante as well as ex-post. But what consequences does this have. In the ex-ante situation the valuation reward the TSO will receive for extra capacity could be done on the base of predictions by the regulator but also based on the information available from the month and year auctions. Weekly or daily predictions would be even more accurate but will provide the TSO with less time to react. In the case of intra-day trade, the day-ahead auction would be the best indicator of what direction the price difference will be. Specified organisations such as the Brattle group are well suited to make such predictions but are quite costly. However ex-ante reward valuation will provide the TSO with a more stable regulatory environment than with ex-post regulation.

In the ex-post situation, in which the regulator decides afterwards based on the actual outcome of the price difference what direction of import or export will be rewarded, there will be significantly more risk for the TSO. However, as a prominent market player this actor is expected to be well equipped to make these predictions themselves and manage this risk. Incentive regulation is often seen as an instrument to simulate the pressures to which companies are subjected in a free-market environment. Choosing for ex-post valuation and subjecting the TSO to this particular risk is directly linked to pressures that would occur of if the TSO would be placed in a market environment and more in line with the perception of incentive regulation as an instrument to simulate market pressure.

- <u>Intraday rewards?</u>

What should be done in the case when an intra-day market is created, as is expected to happen in the future? Will the capacity offered at the day-ahead- auction be rewarded equally as the capacity offered at the intra-day auction? And will intra-day capacity be rewarded at all? It is also possible to use both, but will these possibilities be rewarded equally? The closer the moment of capacity determination is to the moment of programme nomination the better the TSO is able to calculate the NTCs and scenarios. This allows for the possibility to increase the offered capacity available to the market. However the day-ahead market is far more liquid than the intra-day market (DTE Marktmonitor, 2007). The chances that extra capacity on the intra-day market are being used are smaller than on the day-ahead market. The same holds for capacity made available on less congested hours. Releasing capacity on these hours or trade moments allows TSOs to engage in 'gaming behaviour'. This means that TSOs could choose to release extra capacity (which in normal situations would lead to safety problems) to the market at moments when they know that there is a great chance that this capacity will not be used. This allows them to release more capacity that is of no use to the market while the TSO still gains a bonus. Obviously this would be a waste of money.

Aside from the problems of setting a target and choosing a reference point another variable could be how to set the initial target level. Will this be set higher than the reference point or lower because of the uncertainties of the assumptions on which the regulation is based? (ETSO, 2000)

➢ <u>Possibilities for linking rewards to performance</u>

Linking rewards to performance is an important aspect in the regulation. It is necessary to have at least some notion about the level of risk the TSO will be subjected to and to what extend the TSO is able to influence the performance outcomes.

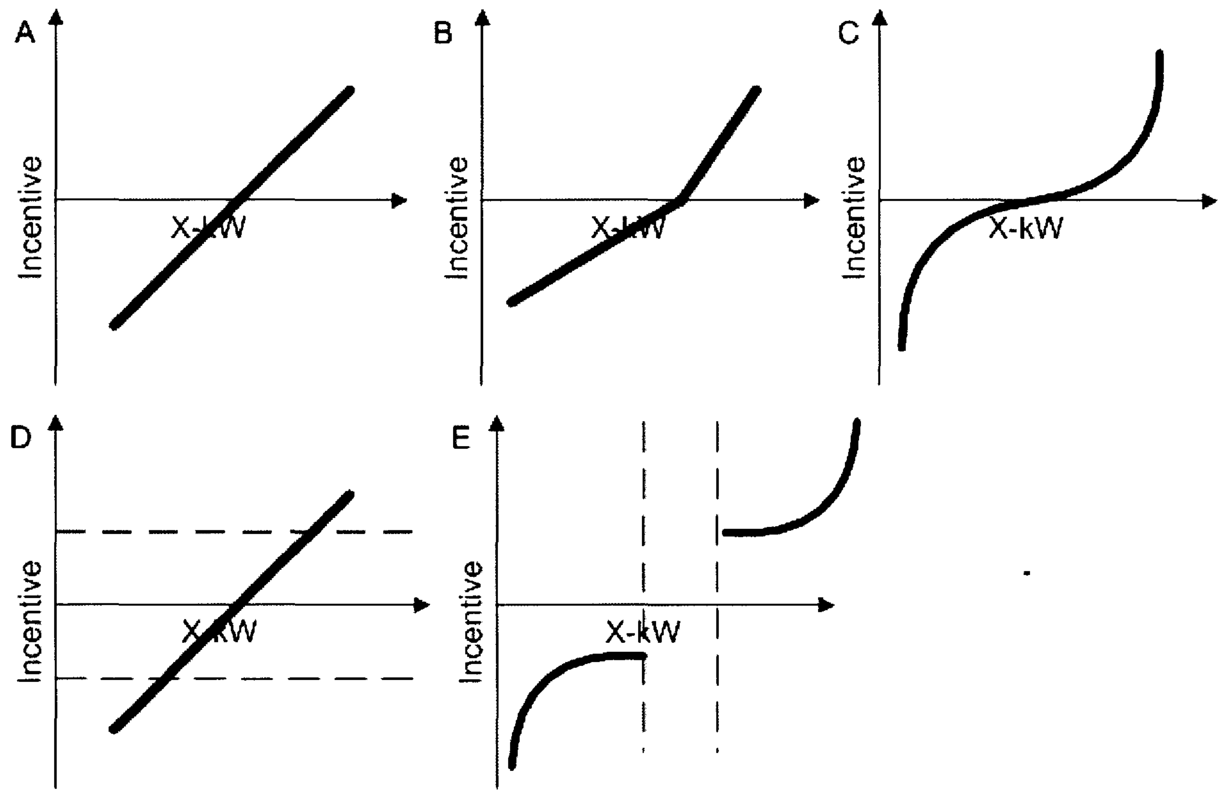


Figure 11: Illistrations of Linking Reward to Performace

- *Strictly Linear: (Figure 1.A)*

  Good as well as bad performance will be coupled equally linear with rewards or penalties. This means that every improvement or deterioration from the target will be equally rewarded or penalised. This makes the incentive very clear cut but lacks a lot of refinement, which could improve performance. It is to be expected that with every increase in performance the risks and necessary efforts for the TSO will incrementally increase. Applying a strict linear relationship does not value this increase in efforts and risks appropriately.

- *Semi-linear (Figure 1.B)*

  A small variation to the linear relationship explained above, would be to make a difference in valuating the bonus malus differently. By increasing the bonus compared to the malus would limit the risk for the TSO. This could be a useful attribute in situations or environments which make it hard for the regulator to make predictions about the risk the TSO will be subjected to (e.g. lots of wind energy). Doing so would decrease the effect if the incentive to the TSO but could help facilitating implementation by meeting TSO objections on risk.

- *Exponential (Figure 1.C)*

  Instead of a linear relationship between performance and reward, this form links them exponentially. This form of relationship recognises that marginal increases in capacity are accompanied by marginal increases in necessary efforts/risks. This rewards higher performance increases better and more realistically. It also limits the risk for the TSO in the case of little underperformance, possibly due to small wind fluctuations. This would result in smaller fines than would be the case when linking linearly. However, for larger deviations from the target in which the actual capacity made to the market is significantly lower than the target, the risk for the TSO also increases exponentially urging the TSO to solve these problems.

- *Capping (Figure 1.D)*

  When introducing a risk/reward scheme it is hard to predict what the effect of such a scheme will be for the TSO, it is therefore wise to cap the total risk and reward a TSO will be exposed to. If the TSO is structurally unable to reach the target, due to a failing scheme or due to external influences, a cap on the total financial risks for the TSO would help keep this risk limited. But also capping the total reward a TSO is able to receive makes sure that the costs of the regulation will be kept within normal range. A downside to this variable is that it also limits the effect of the incentive.

- *Threshold (Figure 1.E)*

  Another option is to introduce a threshold level in which deterioration or improvement from the target does not result in a fine or reward. A reason to do so is that there are many external influences which affect the TTC and thereby the NTC on which the TSO has no or little influence. Small fluctuations in the NTC can be expected at all times unaffected by the actions of the TSO. Introducing a threshold level within the capacity levels will not affect the bonus/malus construction but would limit the effect of these common fluctuations.

➢ <u>Cost of Curtailment, Redispatching, Counter Trading etc.</u>

At this moment the TSO is allowed to socialise (spread the costs over society) the costs for redispatching, curtailment and counter trading. This is done by allowing the TSO to reclaim these costs through the total network tariffs and congestion revenues.

Not incorporating these costs (directly or indirectly) into the incentive regulation will result in situations promoting perverse incentives for the TSO, to take a lot of risk on redispatching and counter trading to increase the rewards from the regulation while passing the cost to society.

Therefore next to any other variable in the malus part of the regulation, it should always contain a link with the cost of redispatching/counter-trading. Depending on the risk a regulator wants to expose the TSO to, a choice has to be made to expose the TSO to full costs or to part of these costs through the incentive scheme.

According to European legislation (1223/2003 article 6.6) is it possible to use congestion revenues in order to guarantee the sold capacity. This includes the costs of redispatching and counter trading, but it also seems to point to the possibility to use this to pay for the costs of guaranteeing financially firm capacity. Although current legislation is not specified to this subject of financially firm capacity. This means that the bonus/malus system could also be coupled indirectly to these costs. So instead of fully including these costs in the regulation it would also be possible to do this partly, by including some form of penalty to the use of redispatching, counter trading and curtailment but not exposing the TSO to the full risk.

Linking the costs of these measures to the bonus/malus will positively affect the risk on perverse incentives (and possibly but marginally to net safety). Fully incorporating these costs in the regulation will allow the TSOs make a better judgement on the financial risks of their decisions. On the other hand the risk of making costs for counter trading, redispatching and curtailment will be more severe at moments that the extra capacity is more useful to the market. This might lead to risk aversive behaviour at the wrong moment; it is therefore an option to limit the risk for the TSO by only indirectly linking these costs to the bonus malus regulation for instance by capping these costs at a certain level. If the costs are higher than the TSO will be allowed to reimburse these costs from the congestion revenues.

8.3.4 Other Variables

- <u>Implementation: Level of Introduction</u>

At what policy level should the incentive scheme be introduced and what policy instruments are needed? Should this be implemented in a European directive or possibly a European law or would implementation at a national level such as in the national electricity laws be more appropriate? Other options would be to do this through the use of codes, or through a covenant between regulator and TSO. Although higher levels will provide stronger policy instruments, especially when introduced at EU level when it comes to international conflicts, it will also hamper implementation. The higher the level the longer it will take to introduce the regulation.

- <u>Implementation: Review period</u>

A certain revision period after which the whole incentive scheme will be reviewed is an absolute necessity. What length should this period be (regulatory lag)? The longer the review period, the more predictable the policy will be to the TSOs and the better they are able to estimate the gains of long-term investments. A down side to a long review period is that if the TSO is able to reach the target easily, the TSO is able to profit from this easy profit for longer periods making the incentive scheme needlessly costly. It could therefore be wise to shorten this period in the first few years, to reduce the effects of possible failing policy when it becomes clear that the assumptions on which it is based were wrong. After a few years when the scheme has proven its worth and is working properly this period could be extended. This principle has been used by OFGEM in the past and is still being used in many of their incentive schemes. A review of the policy is always necessary after large changes have been made in the infrastructure of the networks (for instance, when a new interconnector has been built).

Another option might be to continuously increase the target over time (like an X-factor construction) which means an increase of a certain percentage each year. This assumption is based on an expected yearly increase of productivity in the TSO and is meant to keep pressure on the TSO to keep on improving. Setting this annual increase too optimistically might create problems for the TSOs to reach their target, as they are unable to continuously increase their output.

A method used to calculate the appropriate X-factor is to compute historical values and to take an average of these values as a proxy for the current X-factor. But the use of historical productivity differential will be difficult if the incentive scheme is introduced for the first time. A common approach is to take the average industry factor productivity increases or to use comparisons with similar foreign companies. However many TSOs are already subjected to some form of regulation including an X-factor. Because this X-factor is based on total company factor productivity increases this X-factor could also be used for this regulatory scheme. (Kuhlmann, 2006)

- Implementation: Offer the TSOs a menu of options to choose from.

Because all borders are different and to reduce opposition under TSOs, one could propose to allow the TSOs to choose from several incentive scheme options during the introduction phase. The regulators could offer the TSOs the option to choose from two kinds of incentive schemes for instance: a) one offers an incentive plan with a high risk but also high rewards. Or b) to pick an incentive scheme which offers low rewards but also low risks. Because it is necessary to introduce similar schemes on both sides of the border, the TSOs should agree among themselves which one to pick.

- <u>Net safety</u>

Net safety can never be compromised to undesirable levels! But how to effectively monitor as an incentive to maximise capacity will also introduce incentives to forfeit safety? A few options are possible:

- *Report to the Regulator*

Currently this is already being done; it can be questioned whether the way this is done is still sufficient after the introduction. Currently the TSO has very strong incentives to keep the net as safe as possible and thereby require less regulatory checks. A more extensive way of reporting may be necessary after introduction. In the case of very strong incentives it may also be necessary to subject this report to external control as the TSO is able to manipulate this.

- *TSO-TSO check*

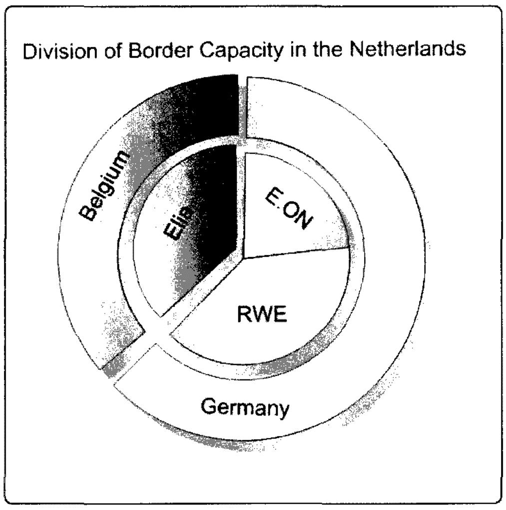
TSOs audits the other TSOs on net–safety. This proposal is based on the assumption that due to the incentive regulation TSOs will become more critical towards each others actions, because both are dependent on each others actions for their performance results. Apart from the possibility that incentive regulation may lead to the situation in which one TSO actively encourages the other TSO to make more capacity available to the market are both TSO still very dependent on each others actions for net safety. Another assumption is, that compared to an audit by the regulator, TSOs have more expertise on the subject of good performance and net safety than the regulator. This makes this option a more effective instrument.

- *N-2 measurement*

A measurement of how many times N-2 safety regulation is accidentally compromised could provide some form of indicator for the regulator how much risk the TSO is taking. Currently this is not being done.

➢ <u>Will all borders that become subjected to the regulation be treated as a pool or separately?</u>

How to deal with implementation of the regulation when there is more than a single border connection in a country? The assumption is that not all countries will be able to implement this scheme at all borders (e.g. implementation at the Dutch-German border but no implementation at the German-Polish border).



It is often possible for TSOs to optimise the capacity at one border at the expense of another border which is not explicitly allowed at the moment, in the Netherlands there is an internal TSO agreement for a standard division of the total NTC over the foreign TSO connections. It might increase the effectiveness of the regulation if TSOs would be allowed to increase the capacity at one border at the expense of others. Especially if this leads to more overall capacity, but also when this would enable them to optimise borders with the largest price difference, this would help increase the overall welfare. In some cases this could cause production capacity supply and demand problems within a country if taken too far (e.g. the Netherlands does not have sufficient production capacity within its borders to meet demand). For that reason one could limit the extend to which TSOs are allowed to tweak these capacity connections and allow TSOs for instance to only increase or decrease borders for only 10% of its total capacity. A prerequisite here would be that only the borders that are subjected to the same incentive regulation are allowed to be tweaked at the expense of each other. Otherwise, this would create a perverse incentive for the TSO to optimise the 'incentive'-border at the expense of the 'non-incentive'-border.

Introducing this variable will affect the complexity of the regulation and requires more extensive checks by the regulator. However many of these checks need to be done nonetheless, especially in the event of a country with a 'non-incentive'-border. But even without regulation there are cases in which these checks will need to be introduced. An example might be the BritNed cable; although not allowed, the TenneT holding would profit from decreasing the capacity of other connections to increase the usage of this commercially exploited line.

When not taking the price difference into account in the decision to optimise capacity, the best option would be to create a single target value for all borders and connections pooled together (e.g. in the Netherlands 3850MW). In such a situation TSOs would be capable of optimising total capacity over all connections. However, because differentiation between import and export is necessary to prevent optimisations in capacity flowing against the direction of price differences. This problem makes it impossible to set a single target for the whole pool of connections of a country, since at the same moment the directions of the flows may differ according to the price differences.

Another option is to specify a separate target for each border or TSO connection. The first choice for this would be to set a target for each border because then TSOs are able to optimise the total flow over a border without specific target per interconnection or TSO. Nevertheless, this could lead to problems in situations such as in Germany where there are two TSOs at a single border. These would have to cooperate and split the incentive income among themselves (e.g. based on the thermal capacities of the lines), these TSO agreements may lead to problems as both will be reluctant to give up income and thereby may not be able to reach the optimum capacity. The last option is therefore to set a target per TSO connection. This is the current situation with NTC calculations in for instance the Netherlands. There is a standard division how the total NTC is to be divided over borders and TSOs. This division is based on agreements not on optimising the daily NTC (W.L. Kling, Personal Communication, 8 September, 2007).

- <u>What needs to be done in the case of' 'force majeure'.</u>

During the year there may be external factors influencing the capacity regardless of the efforts of the TSO. The cause of this might be for instance a storm which knocks down a line, lots of wind causing many wind production related problems or even a large production plant which needs to be taken out of order for a long time. To create reasonable regulation that is fair towards TSOs, these kinds of influences need to be dealt with. This shouldn't be a problem as long as the regulator and TSO agree what is considered 'force majeure' but in the end the regulator should decide.

8.4 Selection of variables and design of alternatives

Following the Meta model this chapter tries to establish several design proposals. Based on the design space summarised in paragraph 8.3, a number of selected variables will be used to construct several proposals for the design of an incentive scheme. These proposals try to cover a wide spectrum of possibilities, but still attempt to approach the design objectives as much as possible. (Figure 12: Proposals)

In each of the following proposals the capacity for which a target will be set, is calculated according to the following formula:

NTC = Capacity offered at the day-ahead market + nominated month and year capacity – the result of netting.

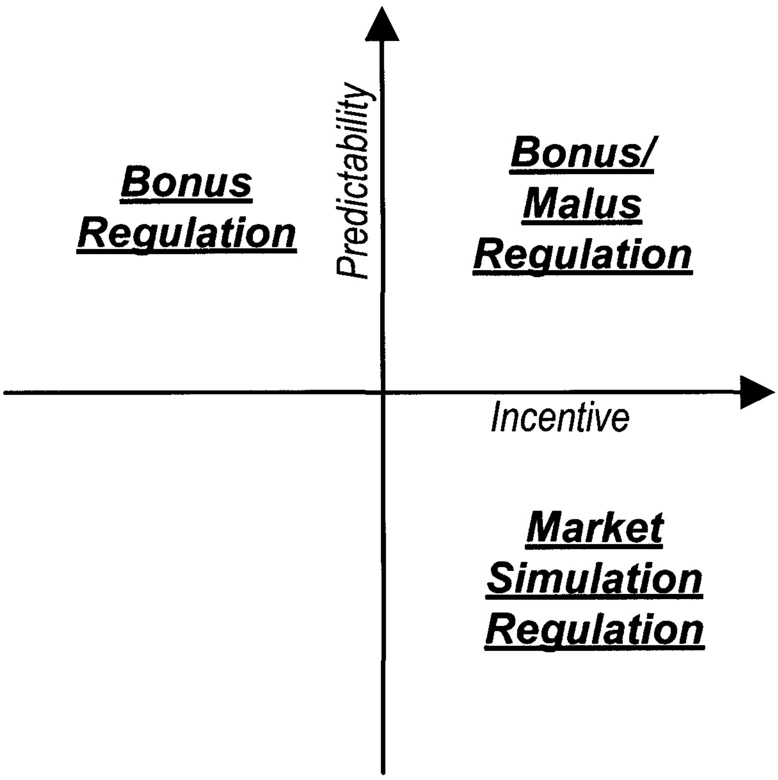


Figure 13: Proposals

Proposal 1: *Straightforward Ex- Ante Bonus/Malus regulation*

In this proposal, clarity and information to the TSO are regarded as the main principles. A clear form of regulation would be to set target for the TSO on a daily even for certain parts of a day basis, and state beforehand (ex-ante), which direction (import or export) will be subjected to the bonus/malus regulation. By providing this information beforehand it is clear to the TSO which direction should be emphasized, this way the TSO is able to anticipate these decisions with appropriate measures. A cap and floor are introduced on the bonus malus system to limit the total risk the TSO is exposed to and to limit the regulatory cost. For all incentive schemes presented here holds that it is a new incentive scheme which is being introduced for which the results are uncertain. It may therefore be appropriate to consider an initial period, in which the sharing factors (how bonus/malus is related to performance) are asymmetric (*Figure* **16**) with the malus factor being lower than the bonus factor. Under these circumstances, it is wise to set the bonus, malus, cap and floor in such a way that the expected outcome is about zero or at least financially positive to the TSO to prevent regulatory failure or unfair regulation towards the TSO.

Alternative options that might be considered are, to use a linear sharing factor in which the bonus and malus factor are symmetric (*Figure* 14 A); this alternative introduces more risk to the TSO than the asymmetric approach. The other alternative is to use an exponential sharing factor as is shown in Figure 15 C. This last option recognizes the marginal effort and cost increases that are needed for marginal capacity increases.

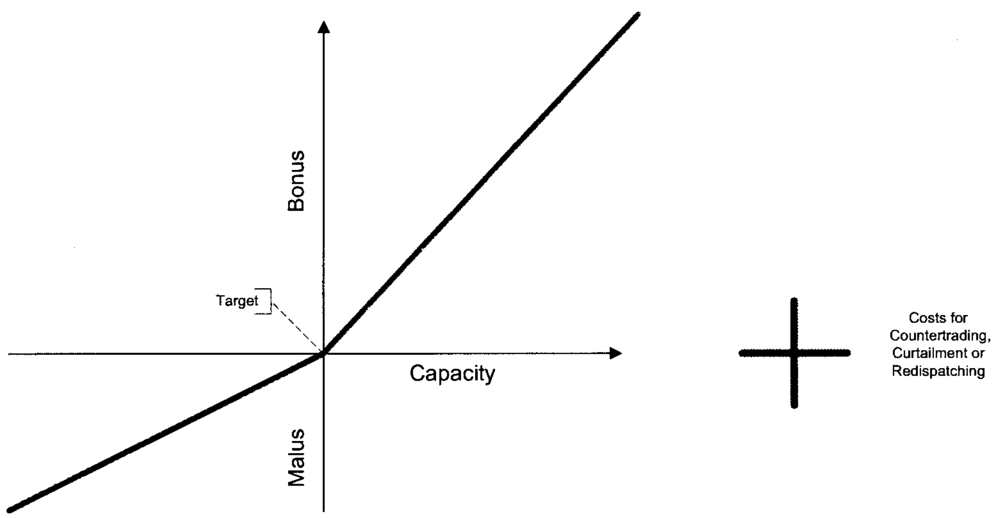


Figure** 16: **Illustration of Proposal 1

Because the direction of the price difference is important to the bonus/malus system, the target will have to be specified for each border. Any positive deviation from this Target will be granted a bonus and any negative deviation will be subjected to a malus.

The TSO will also be subjected to a fixed fine when costs have to be made for safety measures such as countertrading or redispatching. This fine is chosen to be fixed for each time these measures will be used, to limit the risk for the TSO and to ensure that this risk can be calculated appropriately. The real costs for these safety measures are allowed to be passed to the congestion revenues.

The maximum TSO income in this proposal is to us a certain percentage of the average auction price for capacity. In order to do this the average auction price over precious year is calculated; next a certain percentage (e.g. 60% bonus and a 40% malus) of this price is taken and used as a bonus or malus per megawatt. The total bonus or malus a TSO is allowed to receive is capped at certain mw that is considered safe.

Advantages:

- incentives for the TSO due to the introduction of a malus and a bonus
- The ex-ante information allows the TSO to make balanced decisions and to calculate risk accordingly

Disadvantages:

- There is need for extra administration to provide the ex-ante regulation. This increases regulatory costs and creates extra risk on the TSO
- TSOs are forced to respond to this regulation in order no to be subjected to a malus even if they are already performing at top performance. This might create resistance among TSOs towards this form of regulation.

Proposal 2: *Bonus Regulation*

Again a specific target is set beforehand by the regulator. Unlike what is done in the previous proposal, this time no malus is introduced for not being able to reach the target. Like previous proposal this regulation also requires only extra capacity in the direction of the price difference to be rewarded, in order to prevent rewards for 'useless' capacity. It is recommend to do this ex-post which is cheaper. This is recommended because in contrast with the first proposal the TSO is now free to respond to any situation without the threat of a malus; the consequences of choosing to make optimisations in, what is afterwards recognised to be, the wrong direction are limited. The TSO is expected to be sufficiently able to make predictions about the price direction and calculate this risk appropriately. The costs for countertrading redispatching and curtailment should at least partly be paid from the bonus. This is done in order to prevent the TSO from creating too much extra capacity on the risk of needing these security measures, for which the costs could be drawn from the auction revenues. In contrast to the first option it is here proposed to subject the TSO to the full costs, or at least a certain percentage of the cost of these security measures.

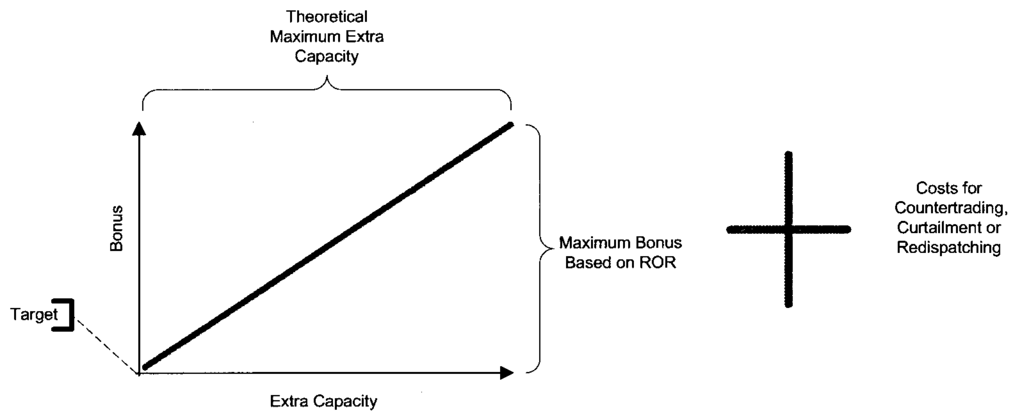


Figure** 17: **Illustration of Proposal 2

Because no malus has been introduced, this incentive proposal requires a less specific target compared to the first proposal as mistakes in setting a target will not result in a fine for the TSO. A single target which holds for every hour during a whole season or possibly year could be used. If the TSO is forced to reduce capacity, due to for instance the influence of seasons or due to 'force majeure' for short periods of time, there will be no 'unfair' punishment in the form of a malus to the TSO. Only opportunity costs for not receiving a bonus are to be calculated by the TSO and thereby providing an extra incentive to be careful when pulling back capacity from the market. This reward should only hold for sold capacity and not for all capacity created in order to prevent rewarding excess capacity at times when there is little demand

The proposal here is to grant the TSO a maximum income, capped at what would be a normal rate of return in the hypothetical situation in which the total auction revenues would be invested in new infrastructure. For many TSOs this would have been the 'normal' income in case the total revenues would have been invested in new infrastructure.

Example Calculation

An example of how this calculation would work is to take the total amount of auction revenues from previous year say € 10.000.000,-. And calculate a normal rate of return of for instance 10% over this total amount of revenue, which makes 10.000.000 * 10% = € 1000.000,-. Next calculate a target 'normal' or 'average' level of capacity based on previous experience and a theoretical maximum. Say for instance at a border the average NTC capacity in 2005 and 2006 was about 3600 MW, and the theoretical maximum NTC value at this border is about 4000 MW. The cap will therefore become active from 4000MW and higher. Now divide this € 1000.000, - over all hours in a year (365*24 = 2190), this makes a total maximum income for each hour of 1000.000/2190 ≈ € 457,-. Each hour the TSO is theoretically able to create an extra 400 MW, which makes a bonus of 457/400 ≈ € 1, 15 per MW extra capacity for each hour.

Advantages:

- Less administration is required as there is less need for specified targets
- Due to the lack of a Malus system the expected TSO resistance is expected to be minimal compared to the other schemes.
- The condition of a level playing field is relaxed due to the lack of a malus

Disadvantages:

- Due to the lack of a Malus this proposal is compared to proposal 1, the incentive here will be less strong
- Might lead to easy profits for TSO, so it is important the amount of bonus is less than the added value of providing extra capacity for society
- The amount of bonus is not directly related to the market value of extra capacity

Proposal 3: Market Simulation (Ex- Post).

This proposal tries to simulate the reality of the market as much as possible. Again a certain target level is to be introduced by the regulator out front. This can be done based on for example a monthly average of previous years. But instead of establishing beforehand what the bonus or malus per extra MW capacity would be, this is now linked to market prices for capacity and thereby established afterwards. This reward should only hold for sold capacity and not for all capacity created in order to prevent rewarding excess capacity at times when there is little demand. The maximum price or malus per megawatt is capped a t a certain target level in order to limit the risk.

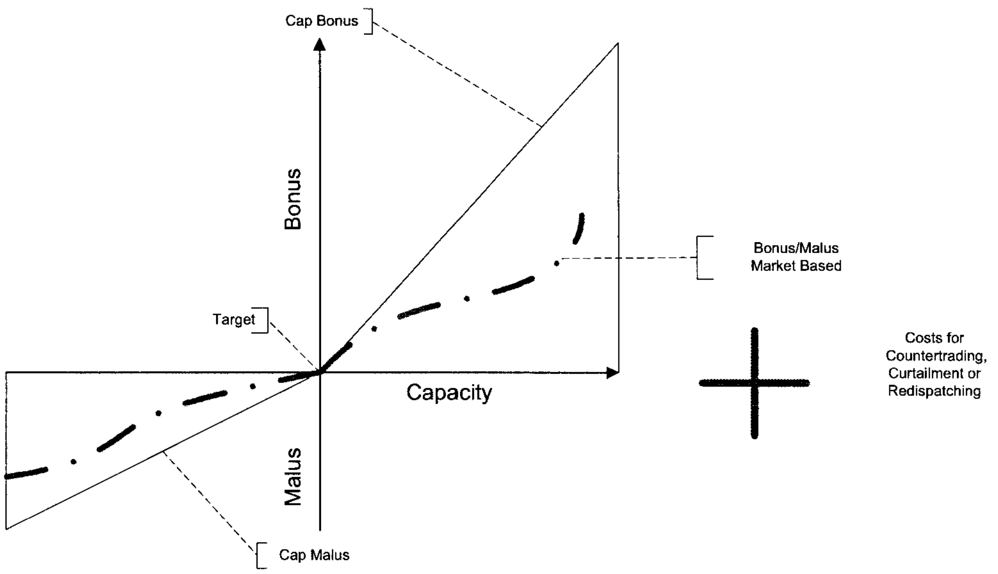


Figure** 18: **Illustration of Proposal 3

Following the line of the proposal to simulate the market, it is best to subject the TSO to the full cost of measures that guarantee capacity such as countertrading and curtailment. This is needed in order to prevent the TSO from taking too much risk with money that it is allowed to socialize through network tariffs.

Because the effects of this form of regulation are hard to predict it may be necessary (especially in the beginning) to introduce a cap and floor. But also to establish strict rules concerning force majeure in order not to run the risk of creating too much risk for the TSO.

For more effectiveness the TSO should be allowed to optimise capacity over borders as much as possible, therefore a total target capacity which includes al borders should be sufficient. This way the TSO is incentivised to optimise those borders with the largest price difference because the capacity made available at these borders is automatically rewarded with a higher bonus than at the other borders. However this should be allowed only at borders that take part in the regulation.

Advantages:

- The moments that extra capacity is more important to the market are automatically emphasized in the Regulation.
- Less administration or research is required because much is established afterwards.

Disadvantages:

- More risk to the TSO as there is no guarantee that the extra capacity will be rewarded; this might cause the TSO to be conservative when investing in more capacity.
- Hard to predict how big an incentive this will be to the TSO as this varies from day to day

Factors concerning all three proposals

Decisions are required concerning the factors: level of Introduction, establishing a review period, or allowing the TSO to choose from a menu of options. These factors are no different to each proposal but are important to proper implementation. For the benefit of faster introduction it is here proposed to introduce the regulation at a lower level in the beginning through for instance a covenant. This gives all parties space to adapt to the regulation while in the meantime preparations can be made for higher level introduction. Although higher levels will provide stronger policy instruments, especially when introduced at EU level when it comes to international conflicts, it will also hamper implementation. The higher the level the longer it will take to introduce the regulation.

The review period and an X-factor; because of the uncertainties about the effects of the regulation it is proposed to start in the beginning with a review period of about one year in which the whole scheme is evaluated. After a couple of years, when more is known about the effects and impact of the regulation, this period can be extended to a typical 3 to 5 year period (based on OFGEM experience as described in paragraph 3.4.6). By extending this period the policy will be more predictable to the TSOs and the TSO is now better able to estimate the gains of long-term investments and take long term effects into account when taking action. A review of the policy is always necessary after large changes have been made in the infrastructure of the networks (for instance, when a new interconnector has been built). After several years the regulators may choose to introduce an X-factor to keep pressuring the TSO for increasing performance. In the beginning the effects of the regulation may be uncertain; already introducing an X-factor during this period may increase this uncertainty.

For easier implementation and reducing resistance among TSOs (by allowing them some control over the incentive regulation) it is recommended to Offer the TSOs a menu of regulation scheme options to choose from. It is recommended to provide the TSOs with the option to choose from one form of regulation but than allow them to choose from adjusted versions of the bonus malus factor and the cap and floor. As explained it is necessary to introduce similar schemes on both sides of the border, therefore TSOs should agree among themselves which one to pick.

Alternative Proposal: Audit (no-regulation)

Next to incentive regulation it is good to evaluate alternatives. An important alternative to incentive regulation would be to establish no incentive regulation at all. The heart of the problem of what is explained in the Principal Agent theory is the asymmetric information available to the regulator and the TSO. As explained in previous chapters, incentive regulation is a tool that could help establishing trust in this relationship and solve the problems resulting from asymmetric information. Therefore instead of aligning the goals of the regulator and TSO through incentives the alternative solution to this problem would be to solve the problem of asymmetric information. This way the regulator would be able to establish if the TSO is pursuing the same goals and is doing its job effectively. For that reason the problem could also be solved without any regulation at all, but through establishing an extensive audit. In this audit a panel of external experts should analyze current TSO practices and company processes and evaluate current TSO performance and possibilities for improvements.

Advantages:

- Cost of the regulation can be precisely calculated beforehand
- No financial risk to TSO
- One time investment for several years.
- Information problem is partly solved
- No implementation needed
- No level playing field among TSOs required

Disadvantages:

- No incentive for the TSO to innovate
- No financial incentive to improve behaviour in the long term

8.5 *Reflection on the Objectives*

Reflection on the objectives as provided in paragraph 8.1.

1. **Strong Incentive for TSO**

   All three proposals provide a financial incentive for TSOs to increase capacity made available to the market. The only exception here is proposal 2 which doesn't provide a malus for performance below the target. Although a high bonus could make up for this lack of incentive this would automatically increase the cost of the regulation.

   Proposal 3, which links the bonus/malus factor to market prices, is a more sophisticated approach; because this proposal recognises the variation in market need for capacity through higher bonus and malus factors.

2. **Easy Implementation**

   None of the proposals require adaptations to EU legislation. These matters can be dealt with at lower levels such as national legislation or even preferable through the creation of new technical codes in which the legislation is embedded. In order to do this at a national level it must be emphasised that the regulation will be harmonised among the participating countries. This should be dealt with at an ERGEG level as this requires a regional approach. If it is chosen to embed these rules in regulation instead of trough the use of a covenant, this has the advantage that resistance among TSOs is less problematic for easy implementation as this is more easily enforcable. A covenant allows TSOs to disregard the agreements at any point.

   As explained in Chapter 4.1.1 European legislation allows congestion revenues to be used to guarantee actual availability of the interconnector. This regulation is expected to allow the use of this money for the financing of such an incentive scheme. If after legal consultation this might not be the case there are many other ways to finance this. For instance through the network tariffs.

3. **Least opposition among TSOs and Regulators**

   The more risk on extra costs involved for the TSO the more expected resistance. The more likely the TSOs are to benefit from the regulation the more likely they are to accept a regulatory scheme. Proposal 2 poses the least risk to the TSO because of the lack of a malus system. The only risks here are opportunity costs and costs for countertrading and redispatching.

Proposal 3 and 1 both create a financial risk for the TSO for not performing up to targets set by the regulator. The difference here is that due to extensive information the TSO is better able to calculate the risks in proposal 1 than in proposal 3.

4. Low regulatory cost

When ranking the lowest regulatory cost is proposed by proposal 2 as this requires the least administrative costs. Although based on the behaviour of the TSO this might also produce a high TSO income and thereby increasing the regulatory costs. Proposal 1 is ranking the most expensive as ex-ante establishment of bonus malus levels and predictions on price differences require the most administrative costs.

5. Easy and unambiguous measures for TSO performance.

Each proposal uses the same NTC calculations for measuring TSO performance and setting a target therefore no distinction between the proposals can be made.

9 Conclusion

As within many other markets, in the Central West European Energy market there is an information asymmetry between the Regulator and the TSO. This information asymmetry makes it hard for the Regulator to establish if the TSO is functioning optimally. This would not be a problem if the operator and the regulator would have completely the same objective. In this research however has been established that there are many indications that the objectives of the regulator might differ from the TSO. One of these reasons might be the lack of unbundling of many TSOs from their former owners, commercial interests of the TSOs themselves but also the focus on net safety which is often perceived as a pure technical limit with technical solutions while these solutions can also be looked upon as economic transactions.

This lack of information and suspicion of different goals touches the heart of the problem, this is what is described in literature known as a Principal Agent problem. Literature research has revealed that establishing incentive regulation might be the best solution to this case of principal agent problem which focuses on cross border connection capacity made available to the market.

An analysis of the European legislation has shown what instruments are available to the regulator in order to create efficient regulation, how this regulation should be implemented and by whom this could be done most efficiently. This analysis has also shown what instruments are available to the TSO to create extra capacity and how these are paid for.

Further technical analysis has revealed that TSO performance can best be measured through the use of NTC values calculated according to the following formula:

Day ahead NTC = Capacity offered at the day-ahead market + nominated month and year capacity – the result of netting.

This measure also mentions the phenomenon of netting, which is an important aspect when looking at ways to measure TSO performance. Netting is regarded in this research as something that should be enforced by the regulator on TSOs and not through the means of incentive regulation.

An economic analysis, of how capacity is currently being made available to the market, shows that the time frame is important to the decision when to set a capacity target and when to measure TSO performance.

Together these analyses have lead to a number of factors on which decisions have to be made in order to come to proper regulation. But also a list of variables that could be used as instruments could be used as 'bricks' to construct an incentive plan that promotes capacity made available to the market.

This has lead to three proposals for incentive legislation that together cover a wide range of options:

	Strong Incentives for TSO	*Easy Implementation*	*Opposition Among TSOs and Regulators*	*Regulatory Cost*	*Unambiguous TSO Performance*
Bonus/Malus Regulation	++	+/-	+/-	-	++
Bonus Regulation	+	+/-	++	+	++
Market Simulation Regulation	++	+/-	-	+	++
Alternative regulation: Audit	+/-	++	++	+/-	++

When comparing the three proposals for incentive regulation, the Bonus Regulation scheme promises to be the best option. What this option lacks in strong incentives for the TSO by excluding a malus it makes up for by reducing the chances on 'un-fair' regulation. When starting with introducing incentive regulation there are many uncertainties. Regulation that lessens the importance of setting exact targets and has less harmful effects to the TSO might therefore be preferred during this phase. At a later moment when there is a level playing field for TSOs and the effects of the regulation have become clearer, it may be preferred to shift to another incentive scheme that also introduces a malus e.g. the Market Simulation Regulation scheme. This increases the incentive stimulus and makes more advanced regulation.

Although the alternative to set up a professional audit has many advantages over the proposals for incentive regulation, it does have a big downside; promoting internal incentives for innovation in the long term. This is an important positive aspect of incentive regulation. Auditing is done once after which the TSOs should incorporate the recommendations but there is no incentive to keep on innovating on the long term.

Requirements

In order to establish efficient regulation there are some requirements that need to be arranged first no matter what incentive scheme is introduced. Starting with the requirement that **regulation must be implemented on both sides of a border.** If there is no agreement between two regulatory offices on the introduction of the regulation than it is impossible to introduce the regulation at that border. One-sided implementation is out of the question, because TSOs are dependent on each other's actions. Further, **grid-safety can not be compromised**. Security measures can not be tampered with in order to create extra capacity. Also, **the nominated capacity must be absolutely 'firm'** If due to capacity increase based on the actions of the TSO the risk on curtailment increases than it would be unfair to pass these costs to other market participants while the TSO is the one to profit from this. And last, a **Level-playing field for TSO should be created in order for the regulation to function properly.** This should be done through unbundling of TSOs from their former owners and through the synchronisation of instruments for increasing capacity, available to the TSO. Because TSOs are dependent on each other for the creation of capacity it will be hard for TSOs to increase their performance, if TSOs have different goals or not the same instruments to bring about increases in capacity.

10 Discussion

This section will discuss the report's practical and scientific implications. Practically this report aimed to explore the possibilities and requirements for incentive regulation which encourages TSOs to maximise cross border capacity made available to the market, in the Central West European Regional Energy Market.

Limitations of the research

As most academic reports, this report might have its shortcomings and these are discussed below. Also, where possible, options on how to counter those shortcomings in future research are given.

One of the major limitations of this research is that most respondents and interviewees are from the Netherlands with only a few exception. Budgetary and linguistic limitations of the author have been the main reason behind this. Many of the conclusions and examples presented in this report will therefore first of all be valid for the Dutch case. But in light of the European level discussion this report advices to take place, the prerequisites and proposals should perhaps be tested for other European countries as well. It could therefore be used as a basis for the research on other countries markets and situations.

Another part that is missing is a practical test of the proposals. This however would have required thorough information and knowledge on internal TSO company mechanisms that were not available to the author. For instance knowledge about how much effort would be needed or what costs have to be made for what efficiency gains. This is something this report's conclusions would benefit from, and future research should perhaps focus on.

Furthermore the question how large the bonus/malus should be, to be of interest to the TSO, is something that should be established. This however is probably best found trough trail and error after implementation. In this light it is important that the cost of regulation will not be higher than the gains for consumers and companies. For countries in which the market price can be significantly affected by changes in cross border trade in energy, such as countries with a relatively small internal market, it may however be very hard to calculate the total gains as the total price level may change with capacity increases.

As explained in the theoretical chapter there is a school of thought that 'semi'-public companies are already expected to operate in the public interest. Keeping this in mind it can be expected that some people might be opposed to “rewarding” a company for optimal performance that it is already expected to deliver.

Measures that might increase the effect of the regulation

Throughout the research it has become clear that TSOs see the risks of creating too much capacity mainly as a purely technical risk instead of a something that can be fixed trough economical measures. This causes TSOs to be extra conservative. It must however be emphasized that not all threats to net safety can be countered trough “economical” actions such as countertrading or redispatching, Therefore by pressurising the TSO to increase capacity might sometimes lead to situations in which net safety compared to current situation might be compromised. This could lead to a discussion in which the TSO is demanding that governments have to make clear what fail rates are accepted in order to allow TSOs to make a sensible economic consideration about the creation of extra capacity.

In theory intra-day trade would help the TSO to increase the total available capacity. After the day ahead market and closer to the final nomination hour there is more information about wind en production patterns reducing the uncertainty of the scenarios and thereby possibly allowing the TSO to increase the capacity available to the market.

Counter trading is an instrument that is currently only allowed as a repair measure after the market has done its work. Allowing this instrument to be used earlier in the process would allow the TSO to actively engage in the location of the expected electricity flows. Doing so this could enable them to increase the possible capacity that can be made available to the market.

11 Literature

Aarts, V. P., & de Pree, J. K. (2005). *Kaderpocket Energierecht 2005/2006.* Den Haag: SDU

Ajodhia, V. S. (2002). *Regulating Electricity Networks: Yardstick Competition and Reliability of Supply.* Delft University, Delft.

Ajodhia, V. S. (2006). *Regulating Beyond Price "Integrated Price-Quality Regulation for Electricity Distribution Networks"*

Technische Universiteit Delft, Delft.

Alexander, I., & Irwin, T. (1996). Price caps, rate-of-return regulation, and the cost of capital. *Public Policy for the Private Sector, World Bank note No. 87.*

Alexander, I., & Shugart, C. (1999). Risk, Volatility and Smoothing: Regulatory Options for Controlling Prices. World Bank and European Bank for Reconstruction and Development.

APX. (2007). APX Website. Retrieved 1-4-2007, from http://www.apxgroup.com/index.php?id=223

Baldwin, R., & Cave, M. (1999). *Understanding regulation : theory, strategy, and practice.* Oxford ;; New York: Oxford University Press.

Berg, S. V. (2000). Introduction to the Fundamentals of Incentive Regulation. In S. V. Berg (Ed.), *Infrastructure Regulation and Market Reform: Principles and Practice.* University of Florida: Public Research Centre.

Berg, S. V., Jamison, M. A., Center", P. U. R., Florida", U. o., Farid, G., Toulouse, U. d., et al. (2004). Body of Knowledge on the Regulation of Utility Infrastructure and Services: Developed for The World Bank [Electronic Version], 255 from http://www.regulationbodyofknowledge.org/.

Berg, S. V., & Tschirhart, J. (1988). *Natural monopoly regulation : principles and practice.* Cambridge [England]: Cambridge University Press.

Bernstein, J. I., & Sappington, D. E. M. (2001). Corrigendum to "How to Determine the X in RPI-X Regulation: A User's Guide" Telecommunications Policy, 24 (2000) 63-68. *Telecommunications Policy, 25*, 537-537.

Chong, E. (2004). *Yardstick competition vs. individual incentive regulation: What the theoretical literature has to say?* , Universite Paris, Paris.

Council, E. (2007). *Communication from the Commission to the Council and the European Parliament: Prospects for the internal gas and electricity market SEC(2006) 1709 SEC(2007) 12* Retrieved. from http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0841en01.doc.

De Jong, H. (2004). *Towards a Single European Electricity market: An integral process approach: Designing and implementing a regulatory framework for interconnector functioning to facilitate efficient market integration.* Delft: Section Energy & Industry: Delft University of Technology.

De Vries, L. (2004). *Securing the public interest in electricity generation markets: the myths if the invisible hand and the copper plate.* . Technische universiteit Delft Delft.

DG-Competition. (2007). *European Wholesale Electricity Markets in 2003, 2004 and 2005*: European Comission

Competition DG

London Economics in association with Global Energy Decisions.

DTE. (2007). *Bijlage B bij Methodebesluit: Nederlandse Mededingingsautoriteit Nummer: 102282-21 Betreft zaak: Methodebesluit Q-factor regionale netbeheerders elektriciteit derde reguleringsperiode Onderwerp: Technische beschrijving van de methode tot vaststelling van de Q-factor*. Retrieved. from http://www.dte.nl/images/Bijlage%20B%20Methodebesluit%20Q-factor%20RNB%20E_tcm7-88575.pdf.

EFET. (2007). *Key principles in the treatment of electricity transmission capacity rights and their linkage to day ahead allocation mechanisms.*

Eisenhardt, K. M. (1989). Agency Theory- An Assesment and Review. *Academy of Management Review, 14*(1), 57-74.

Elia. (2007, 27-11-2007). Elia Website. from http://www.elia.be/

ERGEG. (2006a). Central West Electricity Regional Energy Market : Action Plan 2006.

ERGEG. (2006b). *The Creation of Regional Electricity Markets An ERGEG Conclusions Paper*

Retrieved. from http://www.ergeg.org/portal/page/portal/ERGEG_HOME/ERGEG_DOCS/ERGEG_DOCUMENTS_NEW/ELECTRICITY_FOCUS_GROUP/ERGEG_REMCREATION-CONCLUSIONS_2006-02-08.PDF.

ERGEG. (2007). ERGEG Website. Retrieved 10-11-2007, from http://www.ergeg.org/

ETSO. (2000). *Net Transfer Capacities (NTC) and Available Transfer Capacities (ATC) in the Internal Market of Electricity in Europe (IEM)*: ETSO.

ETSO. (2001). Definitions of Transfer Capacities in Liberalised Electricity Markets [Electronic Version] from http://www.etso-net.org/upload/documents/Transfer%20Capacity%20Definitions.pdf.

Definitions of Transfer Capacities in liberalised Electricity Markets, (2001).

EU. (2004). *Florence Forum Strategy Working Paper: Medium term vision for the Internal Electricity Market*. Retrieved. from http://ec.europa.eu/energy/electricity/florence/doc/florence_10/strategy_paper/strategy_paper_march_2004.pdf.

EU. (2007a). Directorate-General for Energy and Transport: Legislation. Retrieved 4-2007, from http://ec.europa.eu/energy/electricity/legislation/index_en.htm

EU. (2007b). EU Website. Retrieved 06-06-2007, 2007, from http://europa.eu/

Farrer, T. H. F. (1883). *The state in its relation to trade*. London: Macmillan and Co.

Filippini, M., & Wild, J. (1999). *Yardstick Regulation of Electricity Distribution Utilities Based on the Estimation of an Average Cost Function*. Paper presented at the New Equilibria in the Energy Markets: The Role of New Regions and Areas.

Garmon, C., & Lewis, T. (1997). *Fundamentals of Incentive Regulation.* Paper presented at the PURC/World Bank International Training Program on Utility Regulation and Strategy.

Garmon, C., Lewis, T., & (1997). *Fundamentals of Incentive Regulation.* Paper presented at the PURC/World Bank International Training Program on Utility Regulation and Strategy.

Gilbert, R., & Newbery, D. M. G. (1988). Regulation Games. *C.E.P.R. Discussion Papers, 267.*

Green, R. (1997). Has Price Cap Regulation of U.K. Utilities Been a Success? *Public Policy for the Private Sector*(132).

Hakvoort, R. A., & De Jong, H. M. (2007). *Congestion management in Europe: Taking the Next Step.* Delft: Delft University of Technology, .

Harris, M., & Raviv, A. (1978). Some Results on Incentive Contracts with Applications to Education and Employment, Health, Insurance, and Law Enforcement. *The American Economic Review, 68*(1), 20-30.

Herder, P., & Stikkelman, M. (2004). Methanol-Based Industrial Cluster Design: A Study of Design Options and the Design Process. *Ind. Eng. Chem. Res. , 43*, 3879-3885.

Huygen, A. E. H. (1995). *Electricity regulation in the Netherlands : new guide to Dutch electricity law.* Leiden, The Netherlands: DSWO Press, Leiden University.

James, O. (2000). Regulation Inside Government: Public Interest Justifications and Regulatory Failures. *Public Administration, 78*(2), 327-343.

Joskow, P. (2003). Electricity Sector Restructuring and Competition: Lessons Learned. *Cuadernos de Economía (Latin American Journal of Economics), 40*(121), 548-558.

Joskow, P. (2005). *Incentive regulation in theory and practice : electricity distribution and transmission networks.* Cambridge, Mass.: MIT Center for Energy and Environmental Policy Research.

Klijn, E. H., & Koppenjan, J. F. M. (2004). *Institutional design in networks:Elaborating and analysing strategies for institutional design.* Paper presented at the Paper for the Eighth International Research Symposium on Public Management (IRSPM VIII), Budapest University of Economics and Public Administration,Hungary.

Koppenjan, J., & Groenewegen, J. (2005). Institutional design for complex technological systems. *Technology, Policy and Management, 5*(3).

Krause, T. (2005). *Congestion Management in Liberalized Electricity Markets - Theoretical Concepts and International Application.* Zurich: Swiss Federal nstitute of Technology

Kuhlmann, A. (2006). What is the X-Factor in the German Electricity Industry? [Electronic Version]. *IFO Working Paper 34, 34* from http://www.cesifogroup.de/pls/guest/download/Ifo%20Working%20Papers%20(seit%202005)/IfoWorkingPaper-34.pdf.

Kwoka, J. (2006). The Role of Competition in Natural Monopoly: Costs, Public Ownership, and Regulation. *Review of Industrial Organization, 29*(1), 127-147.

Laffont, J.-J., & Martimort, D. (2000). Mechanism Design with Collusion and Correlation. *Econometrica, 68*(2), 309-342.

Lavrijssen, S. (2006). De European Energy Regulators Group en de voltooiing van de interne energiemarkt. *Tijdschrift voor Energierecht*(6).

Liston, C. (1993). Price-cap vs rate-of-return regulation. *Journal of Regulatory Economics, 5*(1), 25-48.

Mayer, C., & Vickers, J. (1996). Profit-sharing regulation: an economic appraisal. *Fiscal Studies, 17*(1), 1-18.

McMichael, S. (2007). Does ownership unbundling go a bridge too far for Memberstates. *Shepherd and Wedderburn E-Bulletin*.

Michaels, R. J. (2000). Can Nonprofit Transmission Be Independent? *Regulation, 23*(3), 61-66.

OFGEM. (2002). *NGC system operator incentive scheme 2003/04 - 2005/06 Initial consultation document: Ofgem's framework for the National Grid Company plc's (NGC) System Operator (SO) incentives to apply from 1 April 2003.* Retrieved. from http://www.ofgem.gov.uk/Markets/WhlMkts/Archive/57-13sep02a.pdf.

Ostrom, E. (1990). *Governing the Commons. The Evolution of Institutions for Collective Action,* . Cambridge: Cambridge University Press.

PBPOWER, & KTH. (2006). European Commission Directorate-General for Energy and Transport. Study on the Technical Security Rules of the European Electricity Network [Electronic Version]. *FINAL REPORT 62236A/001 REV 2* from http://ec.europa.eu/energy/electricity/publications/doc/security_rules_pb_power_february_2006.pdf.

Powell, S., & Starks, M. (2000). Does Reform of Energy Sector Networks Improve Access for the Poor? *Public Policy for the Private Sector*(209).

RBB. (2006). *Economics Cross border Market power in wholesale markets.* The Hague: ministry of Economic Affairs the Netherlands.

Robertson, S., & Robertson, J. (1999). *Mastering the requirements process.* Harlow ;; Reading, Mass.: Addison-Wesley.

Serralles, R. J. (2006). Electric energy restructuring in the European Union: Integration, subsidiarity and the challenge of harmonization. *Energy Policy, 34*(16), 2542-2551.

Stigler, G. J. (1971). The Theory of Economic Regulation. *The Bell Journal of Economics and Management Science, 2*(1), 3-21.

TenneT. (2007). Website. Retrieved 01-06-2007, 2007

Train, K. E. (1991). *Optimal regulation : the economic theory of natural monopoly:*

Cambridge : MIT Press.

Transport, D. E. a. (2004). *Note of DG Energy & Transport on Directives 2003/54/EC and 2003/55/EC on the Internal Market in Electricity and Natural Gas.* Retrieved. from http://ec.europa.eu/energy/electricity/legislation/doc/notes_for_implementation_2004/role_of_regulators_en.pdf.

UCTE. (2007). UCTE Website. Retrieved 2-5-2007, 2007, from www.ucte.org

Vickers, J., & Yarrow, G. (1988). *Privatization: An economic analysis.* Cambridge, MA: The Mit Press.

Viljainen, S., Tahvanainen, K., Lassila, J., Honkapuro, S., & Partanen, J. (2004). *Regulation of Electricity Distribution Business.* Paper presented at the Nordic Distribution and Asset Management Conference 2004.

Viscusi, W. K., Vernon, J. M., & Harrington, J. E. (1995). *Economics of regulation and antitrust* (2 ed.). Cambridge, Mass.: MIT Press.

Vogelsang, I. (2002). Incentive Regulation and Competition in Public Utility Markets: A 20-Year Perspective. *Journal of Regulatory Economics, 22*(1), 5-27.

Weismann, D. L., & Pfeifenberger, J. P. (2003). Efficiency as a Discovery Process: Why enhanced Incentives outperforms Regulatory mandates. *The Electricity Journal, 16*(1), 55-62.

Weyman-Jones, T. (1995). Problems of Yardstick Regulation in Electricity Distribution. In M. Bishop, J. Kay & C. Mayer (Eds.), *The Regulatory*

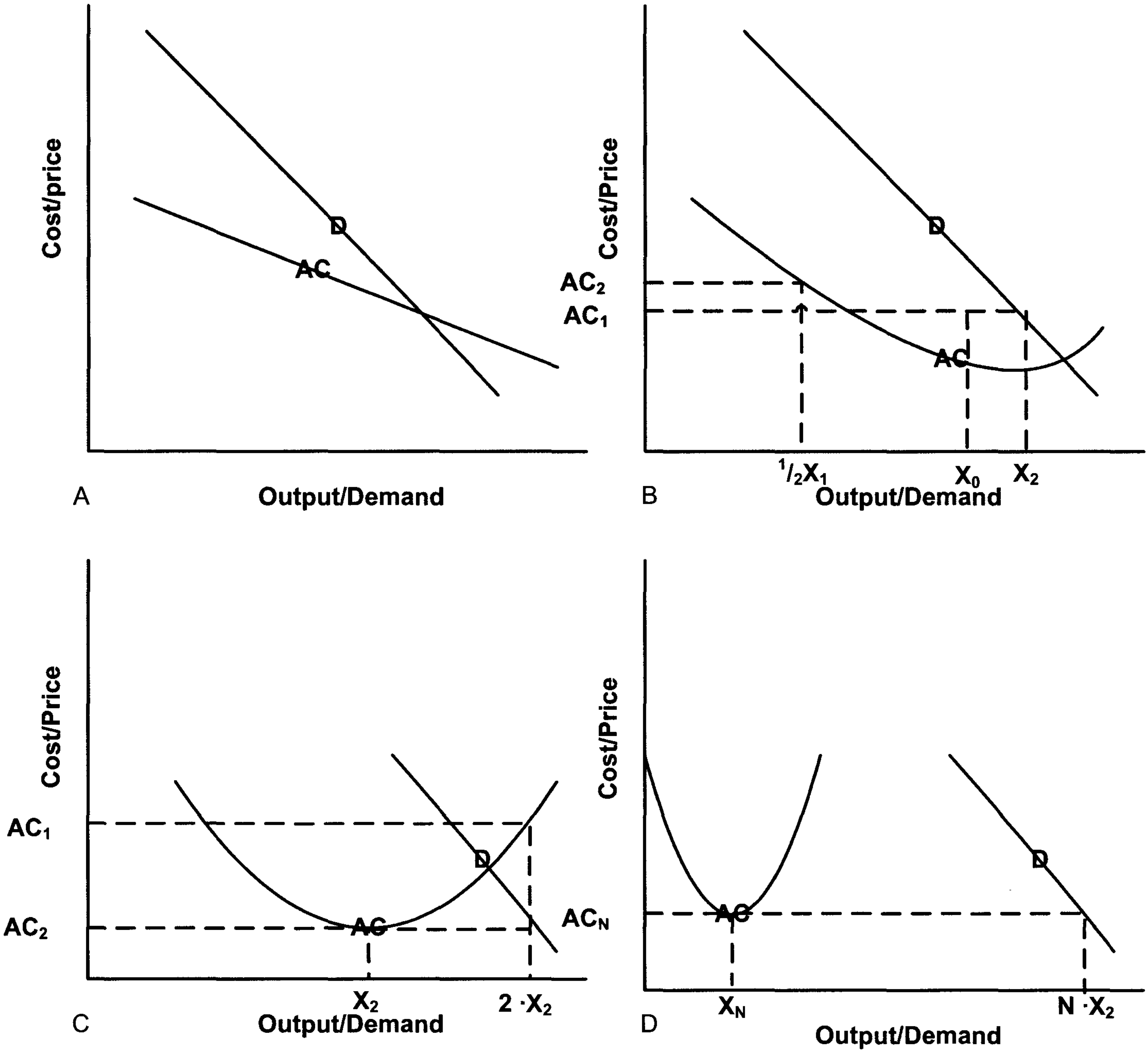
Challenge. Oxford: Oxford University Press.

Williamson, O. E. (1979). Transaction-Cost Economics: The Governance of Contractual Relations. *Journal of law and economics 22*(2).

12 Appendix

12.1 Appendix A

Economies of scale can exits over some ranges of output but not necessary all ranges. For example at low levels of production scale economies may be present, while at larger output levels the exact opposite; diseconomies of scale may occur. This is depicted in drawing B below, here another form of a Natural monopoly is depicted, in which economies of scale exist over a smaller range of output and where demand it close to the bottom of the U-shaped average cost function. Economies of scale continue only to output Q0 after which diseconomies of scale set in. One firm could supply only to output Q1 at an average cost of AC1. If two firms would supply this output split equally than each firm would incur averages costs of AC2>AC1. If the market is to be split unequally their average costs would differ. But the total costs with two firms would always exceed that with one firm. At any division of output production with two firms cost more than with one firm, indicating that a natural monopoly exists. (Ahodja/Train) The number of these monopolists within a certain area (e.g. country) depends to the size of economies of scale and its related Minimum Efficient Scale compared tot the market size. (Train 1991) In particular a natural monopoly exists in the production of one good only if economies of scale exist over a sufficient range of output relative to demand, 'where sufficient' is defined by the situation. Therefore some countries like Germany may have more than one TSO exploiting their own local Natural monopoly. (Ahodja 2004; Train 1991)



Sources:(Ahodja 2004;(Train, 1991);(Viscusi et al., 1995)

In the case of diseconomies of scale a natural monopoly will continue to exist until demand splits the market equally between firms. In this case as depicted in drawing C, two firms will both produce an output X2 at average cist if AC2, A single firm producing all output 2*X2 would incur higher average costs. This situations is referred to as a Natural duopoly. Opposed to these monopoly situations is situation D in which economies of scale are no longer the case at a level of output that is small compared to market demand. In this case the minimum cost of production is already reached with more firms. (Ahodja 2004; Train 1991)

12.2 Appendix B

The Dutch Situation

The Dutch high voltage (50 kV) transportation grid has currently 5 foreign interconnections at 380kV divided over the Belgian(2) and German(3) Border. This number of interconnections will be expanded in the future with a connection to NordNed and the English grid.

According to TenneT, the current overall transport capacity available to the market over these connections is about 3600MW in normal situations, which in optimal situations could be expanded to 3850MW. (http://www.tennet.org/images/Toelichting_Import_Export_tcm41-12084.pdf). This means that in normal situations there is a total import capacity of 3600 and an equal amount for export.

http://www.tennet.org/images/TTranspbalans%20NL%2E061_tcm41-13429.pdf

	Year auction	Month Auction	Day Auction (ATC)	Total (NTC)
ELIA - TenneT	234	313	±500	±1050
RWE - TenneT	261	377	±1100	±1700
E.ON - TenneT	155	159	±500	±800

- Available capacity per TSO in MW

http://www.tennet.org/bedrijfsvoering/transportgegevens/Berekende_transportcapaciteit/Veilig_beschikbare_transportcapaciteit_export.aspx

The actual capacity of these connection 5000 MW TTC – 300MW TRM for special operations which makes 4700 MW NTC transport capacity available to the market. However due to foreign transfer limitations caused by fluctuating load flows on the European grid this transfer capacity available to the market will never be reached in real life situations. (TenneT,RBB Economics)

Current connections

- **Belgium**

The 2 connections with the Belgian grid are situated at Maasbracht and Geertruidenberg/ Borssele. These connections are not solely used for the trade between Belgium and The Netherlands but Belgium has also large transit currents running over it's grid due to a lot of commerce between France-The Netherlands and France-Germany . This is the result of a lack of interconnections between Germany-Belgium and France-Germany which therefore produce large transit currents over the Dutch grid.

- **Germany**

At the German border there are three connections positioned at: Meeden, Hengelo en Maasbracht. In 2003 TenneT and E.ON have tried to increase the capacity at this border by 1.000 MW by installing a phase-shifting-transformer. However until now this has not led to any results. TenneT claims that this is due to fluctuations in the load flows and the fluctuating power supply of windmills in Germany near the Dutch border.

Future connections

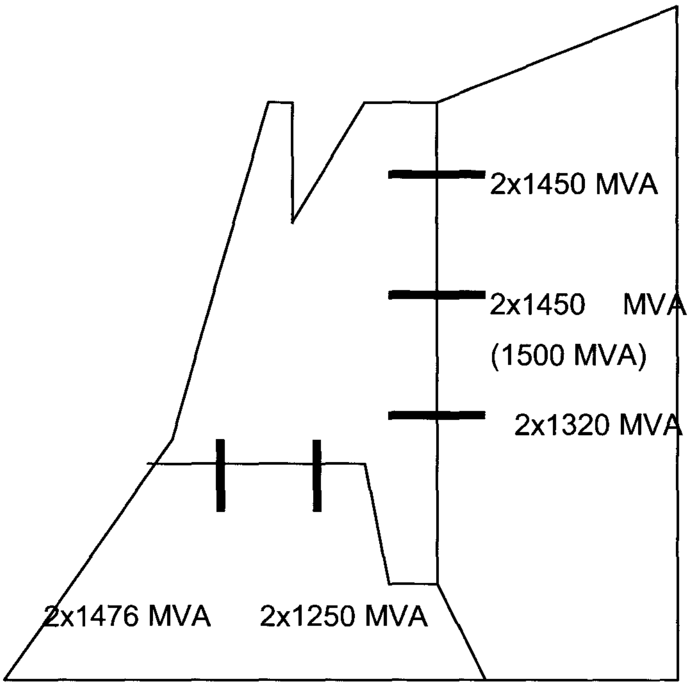
- **Noorwegen**

With the construction and occupation of the so called NordNed cable, which connects the Dutch grid with Statnett in Norway a connection is established with Nord Pool. This connection which is to be occupied at the beginning of 2008, an exchange capacity of 600 MW is made available to the market. Unlike other land based connections in which grids are coupled, this connection is not subject to changes in load flows because this is a HVDC connection.

- **England**

Through daughter company Nlink is TenneT is currently involved in a joint venture with the English TSO National Grid Transco which is looking for possibilities to exploit a HVDC connection between the Dutch and UK grid with a capacity of between 800 MW and 1320 MW.

Physical connection capacity



Thermal Capacities

2x1450	MW
2x1450	MW
2x1320	MW
2x1467	MW
2x1250	MW
______ +	
13874	MW

Interviewees and Communications

ir. R. Beune
Chief of Technology, department of System Operation,
TenneT TSO B.V.

Drs. C. Gence-Creux
Economist
Head of Department "Cross-Border Power Trade"
Commission de Régulation de l'Energie (CRE)

Drs. H.E.J. Heus
monitoring & development
TenneT TSO B.V.

Prof. ir. W.L. Kling
Par time Prof. At Technical university of Delft & Eindhoven: Electrical Power Systems
Par time Advisor at TenneT TSO B.V.
Active member of international commissions such as: Unipede, UCTE, Eurelectric, CIGRE and CIRED.

Ir. T.v. Moll
monitoring & development
TenneT TSO B.V.

Ir. F.A. Nobel
beleidsmedewerker, Tennet
monitoring & development
TenneT TSO B.V.

Ir. J.O.P. Tessensohn
Business planner
TenneT TSO B.V.