Economic regulation of TSOs in the Nordic countries

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Preface

NordREG is a cooperative organisation for Nordic energy regulatory authorities. The mission of NordREG is to develop Nordic and European electricity markets.

Network regulation forms a crucial part of regulatory activities. An important task for NordREG is to collect and analyse information on network regulation in Nordic countries. These activities promote deeper understanding as well as development of electricity network regulation in our countries.

During 2012 the network regulation WG has produced this report describing economic regulation of transmission system operators in Denmark, Finland, Norway and Sweden. The report describes the economic regulation of both network and system operations, and in brief the roles and responsibilities of the TSOs.

The working group has consisted of delegates from each regulatory agency: Silje Cathrine Syvertsen, chair of the group (NVE, Norwegian Water Resources and Energy Directorate), Siri Hau Steinnes, co-chair (NVE), Herlita Bobadilla Robles (EI, Energy Markets Inspectorate - Sweden), Göran Ek (EI), Matti Ilonen (EMV, Energy Market Authority – Finland), Simo Nurmi (EMV), Henrik Thomsen (Sekretariatet for Energitilsynet).

Riku Huttunen
Chair of NordREG
Summary

The main topic of this report is the economic regulation of the transmission system operators (TSO) in the Nordic countries (Denmark, Finland, Norway and Sweden). The purpose of this report is to give an overview of the design of the economic regulation and compare the main elements of the regulation between the countries.

There is one TSO in each country. For all countries, the revenues of the TSOs are regulated by yearly decisions. In Finland, Norway and Sweden the regulators set an annual revenue cap. In Denmark, the TSO sets the tariffs according to budget, while the regulator approves the annual report and thereby also approves the tariffs ex post.

The economic regulation of TSOs includes both regulation of system operations and the regulation of network operations. Chapter 3 describes in brief the main responsibilities of the system operator in each country and how the costs related to these tasks are regulated. Norway regulates the system operation costs, where 60 percent of the costs are based on a cost-norm which is evaluated periodically. In Finland and Sweden these costs are considered as non-controllable and are passed through directly in the revenue cap. In Denmark only costs considered as necessary at efficient operation shall be included in the tariffs, and the regulators have the opportunity to exclude costs based on this. There are no benchmark or efficiency requirements in the Danish regulation.

In chapter 4 the main elements of the economic regulation of network operations are described and compared in tables. All countries regulate the network operations of the TSO. In Denmark there are no explicit efficiency requirements, and the regulation is based on a non-profit principle. The TSO only gets a return based on a price adjustment on its capital base as of 2005. In Finland, Norway and Sweden the regulation include efficiency requirements or benchmarking of costs. In Norway this regards 60 percent of total costs related to the network operations (including capital base), while in Finland and Sweden it regards controllable operation costs. Common for the regulation in each of the three countries, is that if operating at efficient level, the TSO will achieve a return on capital equal to a defined WACC. The WACC-models are described in table 7.

All countries except Denmark have an incentive regulation for quality of supply.

In the appendices, the economic regulation of each country is presented in more detail.
1 The national transmission system

The national transmission system connects production and consumption in various parts of the country, provides actors across the country with access to a market place and provides for central points of exchange in all regions. The national transmission systems also include international connections.

In each of the Nordic countries there is one appointed system operator (TSO) for the national electricity transmission system. The TSO upholds the national responsibility to transport electricity and to ensure that production and consumption of electricity is in balance at all times.
The responsibilities of the TSOs include both ordinary network operations and system operations. This entails duties related to management, utilization and development of the physical network grid as well as the system security and balance responsibilities.

The Danish TSO is Energinet.dk which is a 100 percent state owned company through the Danish Ministry of Climate, Energy and Building. The transmission grid mainly consists of 400 kV lines with a total length of about 6000 km. From January 2012 Energinet.dk will also own and operate the Danish 132-150 kV lines with a total length of about 1000 km.

The TSO in Finland is Fingrid Oyj. Fingrid is a public limited company, majority owned by the Finnish state. Minority owners are Finnish pension insurance companies and institutional investors. The transmission grid consist of networks with voltages of 110 kV, 220 kV and 400 kV. The total length of transmission grid was 14622 km in 2011.

Statnett SF is licensed as the Norwegian transmission system operator (TSO). Statnett SF is a public enterprise, owned by the Norwegian state subordinate to the Ministry of Petroleum and Energy (MPE). Statnett SF owns most of the transmission grid. The grid is defined by decisions by NVE and includes some grid with voltage level of 132 kV, and all grids with higher voltage levels, where the most common levels are 300 kV and 420 kV. The total length of Statnett’s grid is 10 547 km.

The Swedish TSO, Svenska kraftnät (SvK), is a state owned utility that was established on 1st of January 1992. SvK operates the national transmission grid which in total consists of approximately 15 000 kilometres of 220 kV and 400 kV lines.

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1 In year 2011 the Finnish state owned 53%, Keskinäinen Eläkevakuutusyhtiö Ilmarinen 19,9 %, Keskinäinen työeläkevakuutusyhtiö Varma 12,2 % and institutional investors 15 %.
**Table 1: Comparison of some key figures of the TSOs in 2011**

<table>
<thead>
<tr>
<th>Element</th>
<th>Denmark</th>
<th>Finland</th>
<th>Norway</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ownership</strong></td>
<td>The Danish state through Ministry of Climate, Energy and Building</td>
<td>The Finnish State, pension insurance companies and institutional investors</td>
<td>The Norwegian state through Ministry of Petroleum and Energy (MPE)</td>
<td>The Swedish state. Svk is a state-owned public utility.</td>
</tr>
<tr>
<td><strong>Employees in total</strong>²</td>
<td>572</td>
<td>266</td>
<td>928</td>
<td>375</td>
</tr>
<tr>
<td><strong>Total km length of network</strong></td>
<td>6000 km</td>
<td>14622 km</td>
<td>10547 km</td>
<td>15650 km</td>
</tr>
<tr>
<td><strong>Share of cables</strong></td>
<td>Ca. 50 %</td>
<td>Sea-cables 200 km</td>
<td>705 km</td>
<td>550 km</td>
</tr>
<tr>
<td><strong>Voltage levels</strong></td>
<td>Mostly 400 and some 132-150</td>
<td>110 kV, 220 kV and 400kV</td>
<td>Mostly 300 and 420, and some 132kV</td>
<td>400 kV dominates (70 %) and 220 kV.</td>
</tr>
<tr>
<td><strong>Total capital</strong></td>
<td>5 669 million DKK</td>
<td>1 972,3 million EUR</td>
<td>23 881 million NOK</td>
<td>15 541 million SEK</td>
</tr>
<tr>
<td><strong>Annual result</strong></td>
<td>176 million DKK</td>
<td>32,998 million EUR</td>
<td>1000 million NOK</td>
<td>594 million SEK</td>
</tr>
</tbody>
</table>

² Employees in total for all the tasks of the company. The tasks of the TSOs vary between the countries.
2 Regulatory framework

The regulatory framework for the TSOs involves both network operations and system operations. The design of regulation is decided at several levels: Directives given at EU-level\(^3\), decisions by the parliaments in each country and interpretation and application of these rules by the regulator.

2.1 Denmark

The general provisions and objectives for regulation of the electricity network sectors in Denmark are laid down in the Electricity Supply Act together with other general overall frameworks for the electricity sector in Denmark.

The main objectives of the regulation are to promote and ensure security of supply, efficiency, consumer protection and reasonable consumer prices. The special provisions for Energinet.dk are established through law on Energinet.dk\(^4\) and executive order on economic regulation of Energinet.dk\(^5\).

Energinet.dk is regulated in accordance with a “non-profit” principle, whereby the company's tariffs may only cover the necessary costs incurred in efficient operation and an interest rate to ensure the real value of the company's capital base as at 1 January 2005. The regulation does not facilitate the determination of general efficiency requirements for Energinet.dk. However, DERA may determine that a specific cost - or the amount thereof - does not constitute a necessary cost at efficient operation and therefore may not be included (or only partially included) in the Energinet.dk tariffs.

2.2 Finland

The objectives for regulation of the electricity network operators in Finland are given in the Finnish Electricity Market Act\(^6\). The purpose of the Act, in force from 1995, is to ensure preconditions for an efficiently functioning electricity market so as to secure the sufficient supply of high-standard electricity at reasonable prices. By this Act, the Energy Market Authority has granted a license to Fingrid Oyj to function as the Finnish electricity transmission system operator responsible for the nation-wide transmission grid in Finland. System responsibility is defined in the electricity system license granted to Fingrid Oyj. The license defines the scope of system responsibility, as well as the duties, obligations and rights of the grid operator with system responsibility. The system responsibility in its present form has been in force since 1.1.1999 and shall remain in force until further notice.

The Electricity Market Act and EU legislation form the framework for the economic regulation of TSO.

\(^3\) Norway is not a member of EU, but the the directives are also relevant for Norway as a consequence of the EEA agreement,
\(^4\) Act nr. 1097 of 8 november 2011
\(^5\) executive order no 965 of 21 September 2006
According to EU legislation (Directive 2003/54/EC), national regulatory authorities are to ensure that transmission and distribution tariffs are non-discriminatory and cost-reflective. In addition, the directive further states, that the distribution system operator shall maintain a secure, reliable and efficient electricity distribution system in its area with due regard for the environment. And finally, distribution tariffs should be sufficient to allow the necessary investments in the networks to be carried out in a manner allowing these investments to ensure the viability of the networks.

According to Section 38 a § 1 of the Electricity Market Act, the Energy Market Authority shall confirm for every network operator separately the methods assessing the return on network services and transmission service charges during the regulatory period. The methods shall be confirmed before the implementation (confirmation decision).

According to Section 38 a § 2 of the Electricity Market Act, in the confirmation decision the Energy Market Authority can determine:

- The valuation principles of the capital invested to network operations
- The methods of measuring reasonable return for the capital invested to network operations
- Methods of determining the result of the system operations and the correction of the income statement and balance sheet required by them
- Target encouraging improvement of the efficiency of the system operations and the method of determining it, as well as the method to apply the target in pricing.

2.3 Norway

The main objectives for the regulation of the electricity sector are given in The Energy Act. According to the Act, the objectives of regulation are to ensure that the generation, conversion, transmission, trading, distribution and use of energy are conducted in a way that efficiently promotes the interests of society, including taking into consideration any public and private interests that will be affected.

The Energy Act and regulations laid down in accordance with the act constitute the framework for regulation of the network sector, including TSO. Through this framework, the TSO is regulated analogous with all network companies. For the TSO, the framework is extended by a particular regulation regarding system operations.

The framework for economic regulation of the network sector is defined in The Energy Act Regulation, where the key objectives are to secure a socially rational energy sector and network through enabling an effective energy market and an effective management, utilization and development of the electricity network. The regulation is designed in detail in the Regulation governing financial and technical reporting, revenue caps for network operations and tariffs.

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7 Act no. 50 of 29 June 1990: Act relating to the generation, conversion, transmission, trading, distribution and use of energy etc
8 Reg. No. 959 of 7 December 1990 Regulations concerning the generation, conversion, transmission, trading, distribution and use of energy etc
9 Reg. No. 302 of 11 March 1999
According to the Energy Act, the TSO is appointed by MPE. MPE has delegated the authority to appoint the TSO to NVE\textsuperscript{10}. NVE issue a license to Statnett to exercise the system responsibility. Through the Energy Act Regulation, NVE is delegated authority to issue a separate regulation on the system responsibility, and to supervise, follow-up and audit whether all provisions on system operation are complied with.

The scope, duties, rights and obligations for the grid operator that exercise the system responsibility is specified in the regulation concerning the system responsibility in the power system\textsuperscript{11}.

Regulation concerning energy planning\textsuperscript{12} includes provisions on power system planning. NVE has appointed Statnett as responsible for the power system planning process in the transmission grid (central grid).

Regulations concerning contingency planning in the power supply system\textsuperscript{13} sets requirement on Statnett as network owner and as the Norwegian TSO.

### 2.4 Sweden

The objectives for regulation of the electricity network operators in Sweden are given in the Swedish Electricity Act (1997:857). The purpose of the Act, in force from 1998 (preceded by the 1902 Energy Act), is to ensure preconditions for an efficiently functioning electricity market so as to secure the sufficient supply of high-standard electricity at reasonable prices. The Swedish Energy Act is the primary legal framework for regulation of transmission. Secondary legislation is Regulation on Network Concession (1994:1250) and Regulation on Measurement and Reporting (1999:716). Regulation on system responsibility (1994:1806) appoints Svenska Kraftnät (SvK) as the system operating authority. Ei has certified SvK.

The Energy Act include among other things the rules for concession, system operation, transmission grid tariffs and connection fees of new customers to the grid. It also includes rules on network losses and balancing. The Energy Act requires that the regulator approves the methods for establishing the conditions for balancing ex-ante. The Energy Act stipulates that each consumer (point of out take) should have a balance provider. The balance provider signs a balance responsibility contract with SvK. The balance provider must continuously plan for and achieve a balance between supply and consumption. Rules on congestion management are found in the EU congestion management guidelines.

SvK decides on the tariff methodology regarding the transmission grid. Ei has the possibility to object to the applied method ex ante. Ei is responsible for the regulation of the total revenue from transmission charges ex ante (Regulatory system for transmission). Ei determines the total revenues (cap). The data and methods used are enclosed in the decision.

\textsuperscript{10} Reg. no. 1043 of 24 October 2011

\textsuperscript{11} Reg. no. 448 of 7 May 2002. The regulation concerning the system responsibility has been modified several times, and the various public hearing documents are available at NVEs web pages (in Norwegian).

\textsuperscript{12} Reg. no. 1607 of 16 December 2002

\textsuperscript{13} Reg. no. 1606 of 16 December 2002
The Energy Act and a Governmental decree\textsuperscript{14} include the rules setting out the process for defining a revenue cap and also the rules that should be considered when calculating the cap. The regulation period is one calendar year\textsuperscript{15}.

### 2.5 Schematic overview of main elements

<table>
<thead>
<tr>
<th>Framework for regulation of system operation and network operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element</strong></td>
</tr>
<tr>
<td>The legal basis</td>
</tr>
<tr>
<td>Who give licenses for building of network components?</td>
</tr>
<tr>
<td>Where is the system operation responsibility specified?</td>
</tr>
</tbody>
</table>

Table 2 Comparisons of framework for regulation of system and network regulation

\textsuperscript{14} Governmental decree (2010:304) 4-6 §§
\textsuperscript{15} Governmental decree (2010:304) 6 §
3 System operations

The TSO in each of the Nordic countries has the national responsibility of transmission of electricity and to make sure that production and consumption is in balance at all times. They have several tasks, inter alia, contributing to a high security of supply for end-users, while making sure that physical limits of the transmission grid are not violated. A TSO must always act in a neutral and non-discriminative manner towards various market participants.

The overall tasks for the TSOs are:

- Keeping the system in balance at all times
- Upholding the correct voltage level
- Maintaining security of supply
- Coordination towards neighboring countries
- Coordination of maintenance

The frequency is a measure for the balance between production and demand. In the Nordic countries, up until now, the frequency reserves have been consisting of automatic activated (primary) reserves and manually activated reserves. Automatic activated secondary reserves are under introduction. The manually activated reserves are made available through a common Nordic balancing market, known as “the Nordic regulating power market”. Both generators and large consumers can submit bids to meet the TSOs need for regulating power to balance the system. Each of the TSOs is responsible to perform the balance settlement in each country.

Each of the Nordic countries has extensive and detailed regulations for the exercise of the system operations responsibility. As the main focus of this report is economic regulation of the TSO, it will be too far-reaching to go into the details of these regulations in this report. In this chapter we therefore provide a brief overview of the main principles for regulation of the system operator in each Nordic country.

3.1 Denmark

3.1.1 System operation tasks

Beside efficient operation of the transmission grid, the objectives of Energinet.dk are:

- Maintain the overall short-term and long-term security of electricity supply
- Develop the main Danish electricity transmission infrastructure
- Create objective and transparent conditions for competition on the energy markets and monitor that competition works
- Carry out coherent and holistic planning, taking account of future transmission capacity requirements and long-term security of supply
- Support eco-friendly power generation and the development and demonstration of green energy production technologies
• Calculate the environmental impact of the energy system as a whole

These objectives include and emphasize responsibility for upholding security of supply, extending the overall Danish infrastructure in the electricity area, creating objective and transparent conditions for competition in energy markets and implementing cohesive and holistic planning including further needs for transmission capacity and the long term security of supply etc.

3.1.2 Costs related to system operations

The economic regulation of Energinet.dk does not facilitate explicit efficiency requirements for Energinet.dk. However, DERA may determine that a specific cost - or the amount thereof - does not constitute a necessary cost at efficient operation and therefore may not be included (or only partially included) in the Energinet.dk tariffs.

In the annual reports Energinet.dk account for that all cost does only constitute of necessary cost at efficient operation. And DERA will evaluate these reports in connection with the approval of the annual report.

3.2 Finland

3.2.1 System operation tasks

The grid operator with system responsibility (TSO) is responsible for the technical functioning and system security of the Finnish power system, takes care of the duties belonging to the national balance responsibility, and ensures the compatibility of the technical procedures related to system responsibility with the other Nordic power systems.

The duties and obligations of the grid operator with system responsibility are listed below. These tasks can be found, more detailed, in the electricity system license granted to Fingrid Oyj.

• Specify the system security level to be maintained in the Finnish high-voltage transmission system and maintain the relevant specifications for operational performance in accordance with Nordic and national design rules, and agree on procedures which secure the technical functioning of the system with parties operating in the electricity system.

• Maintain the frequency by reserving a volume of technical production reserves that is needed by virtue of an agreement between the Nordic TSOs, and ensure the continued sufficiency and activation of the reserves.

• Maintain the nation-wide power balance during each hour and maintain the balance power operations required by balance responsible parties.

• Settle the nation-wide power balance and the power balance of balance responsible parties.

• Responsibility for transmission management in the high-voltage transmission system and on interconnectors administered by it, for the normal state operation of the system and for the operational control of the system, and take care of the
clearing of serious disturbances and restoration of the power system to the normal state.

• Maintain and operate the Finnish power system in a technically purposeful manner so that sufficient technical system conditions are created for competition in the electricity market.

• Provide parties operating in the power system information on the transmission system needed in maintaining system security and information needed in balance settlement.

• Take care of duties pertaining to system responsibility in an equal and neutral manner with respect to all parties operating in the power system. Moreover, the TSO must ensure the economically prudent and efficient use of the balancing resources.

• Provide reports and accounts of the management of the duties belonging to system responsibility and deliver information to the Energy Market Authority.

3.2.2 Costs related to system operations
In the regulation model for the TSO, operational costs are divided into controllable and uncontrollable costs, where the controllable costs are subject to an efficiency target. All direct costs related to system operation are considered uncontrollable. In the annual financial statement, Fingrid reports the cost of managing balance operations.

3.3 Norway

3.3.1 System operation tasks
The regulation on the system responsibility in the power system sets out the following principles for the exercising of the system responsibility:

a. provide frequency regulation and ensure momentary balance in the power system at all times,

b. act in a neutral and non-discriminatory manner in relation to everyone covered by this regulation,

c. develop market solutions which will help to ensure the efficient development and utilization of the system,

d. to the greatest possible extent make use of instruments which are based on market principles,

e. coordinate and follow up the actions of licensees and end-users in order to achieve a satisfactory quality of electricity supply and efficient utilization of the power system, and

f. prepare and distribute information about power system-related matters that have a bearing on the power market, as well as matters of significance to the general quality of electricity supply.

The system responsibility is regulated through a number of paragraphs (20+) in the regulation on system responsibility. Compliance with the provisions stated in the regulation on system responsibility is supervised, followed up and audited by NVE.

The main elements in the tasks for Statnett as the Norwegian TSO are:
• Operate the transmission grid
• Responsible for the national power system planning of the transmission grid
• Manage congestions and establish bidding zones when necessary
• Set transmission capacity limits between and within bidding zones
• Ensure available sufficient frequency reserves (automatic and manually) at all times
• Point out who shall exercise the frequency control in temporary power system islands
• Determine use of automatic (system protection) or manual load-shedding to avoid larger blackouts
• Ensure making use of available power production when recovering the power supply after an interruption
• Set and approve system operation properties for installations to be connected to the transmission grid
• Coordinate operational shut-downs
• Coordinate statistics of operational disturbances at voltage levels above 1 kV.
• Develop and maintain measures for highly critical power situations

It is also Statnett who performs the balance settlement, and for this holds a license from NVE. Statnett’s activity related to balance settlement is a separate cost centre with separate books.

3.3.2 Costs related to system operations
The actual system operation costs, as reported in Statnett’s yearly financial statements, are specified in a separate note. This cost element comprise of the direct costs related to the exercise of Statnett’s system responsibility. The main elements are costs for buying reserve capacity from producers for primary regulation, special adjustments to correct for bottlenecks, costs related to buying tertiary reserves (balancing power options) and other system services such as purchase of reactive effect etc.

NVE regulates the system operation cost by the same main principles as the network costs, which means that 40% of Statnett’s actual total costs related to system operation are “pass-through” costs, while 60% are subject to a cost norm. The norm is calculated based on a combination of historical costs and assumptions about the cost development for future years. It shall be fixed for a five years period, but can be evaluated if special circumstances should occur.

3.4 Sweden
3.4.1 System operation tasks
The duties of the system operator include the responsibility for the electricity system being in a short-term state of balance and its installations working together in an operationally reliable way. SvK shall ensure that the Swedish electricity system functions reliably at the national level and that electricity production and import match consumption and exports throughout the country.

The system operator (SvK) is responsible for maintaining the balance between the production and consumption of electricity in Sweden.
The Electricity Act (1997:857) describes the overall task of the system operator.

The stipulations of the Electricity Act are supplemented by stipulations contained in the ordinance (1994:1806) on the system responsibility for electricity and the government’s annual appropriation directions\textsuperscript{16}.

Below lists the duties of the system operator (SvK):

- To have the overall system responsibility for power installations being coordinated in an operationally secure manner to ensure that balance between generation and consumption of electricity in the whole or parts of Sweden can be maintained in the short term.

- To the extent that it is necessary having regard to operational security of the national electrical power system, make regulations concerning the control, testing or inspection and other regulations relating to power installations, equipment intended to be connected to such installations, electrical material or electrical facilities.

- Shall establish targets for operational security under foreseeable conditions in the national grid and in interconnections to other countries. The targets shall be objective, transparent and non-discriminatory. Below lists the system operator’s targets:
  - Common technical requirements for secure system operation - Svk Ordinance Common planning, operation, connection and exchange procedures.
  - Operational security of the power system – operation planning timeframe - Up-to-date simulation model for Nordic power system, calculation of available transmission capacity, co-ordination of maintenance, operation across the borders.
  - Operational security of the power system – for day-ahead - Consistent and coordinated transmission capacity procedures, common procedures for congestion management.
  - Operational security of the power system during the operating hour - Utilisation of available resources within the power system, measurement and control systems.
  - Disturbance handling and remedial actions - System protection planning, active and reactive reserves, automatic load shedding, black start capability, restoration planning.
  - Maintain balance within operational hour - Automatic frequency control (primary control), regulation market, demand response.

\textsuperscript{16} Regleringsbrev för budgetåret 2012 avseende Affärsverket svenska krafntät inom utgiftsområde 21 Energi
http://svk.se/Global/01_Om_oss/Pdf/Var_verksamhet/111222_Regleringsbrev.pdf
Management of shortage situation - Up-to date plans and agreements, enforced disconnections, temporary capacity reserve

- Enhance efficient functioning of the market

- Ensure that the grid is being expanded to increase the reliability and availability of the transmission system

- Ensure that appropriate measures are taken to ensure that Sweden has a good power supply and the risk of power shortage can be reduced

- Assistance and support for technological research, development and demonstration in electricity transmission and distribution. The focus should be aimed at long-term improvement of reliability and availability of the transmission network and contribute to increased cost efficiency of operations

- Promote the integration and harmonization of the Nordic and Baltic electricity markets and electricity networks and for the further development of electricity cooperation in Europe to promote a single market for electricity. The starting point for this activity, in addition to the overall targets for electricity policy, as the agreements of the Nordic Energy meetings from 1995 to 2011

### 3.4.2 Costs related to system operations

The costs related to the system operations are reported in SvK’s annual report. There reports achievements in relation to set targets divided into areas network and systems operation. For these areas, SvK reports the costs, revenues, business volume, quality, and impact of the activities and achievements. Some items concern both the network and system operation. Costs that are not been possible to attribute to a single business area are allocated on a standard basis between the two segments.

The cost of service as system operator which is related to the network business is regulated as part of the network tariff (that may include costs for primary control, energy compensation, countertrade, transit and disturbance reserve) And they are considered non-controllable.
## 3.5 Schematic overview of main elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Denmark</th>
<th>Finland</th>
<th>Norway</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economic regulation</strong></td>
<td>Regulator decides necessary cost at efficient level</td>
<td>Pass through actual costs – EMV verify the costs in annual negotiation method process</td>
<td>40% actual costs (pass through) and 60% cost norm. The norm is calculated based on a combination of historical costs and assumptions about the cost development for future years</td>
<td>Pass through actual costs. SvK report the costs to Ei annually for verification.</td>
</tr>
<tr>
<td><strong>Purchase of reserves</strong></td>
<td>Marked based, electricity act</td>
<td>Market based, Electricity Market Act</td>
<td>Market based, as far as possible</td>
<td>Market based, Electricity Act</td>
</tr>
<tr>
<td><strong>How are costs reported?</strong></td>
<td>In annual report</td>
<td>Fingrid delivers cost information to EMV in the annual negotiation method process</td>
<td>Annually submitted in NVEs database (eRapp). A detailed reporting of system operations costs is also carried out in a yearly report on system operations.</td>
<td>SvK annually reports the costs related to the system operations to Ei, together with SvK’s annual report.</td>
</tr>
<tr>
<td><strong>How are costs evaluated?</strong></td>
<td>Evaluation of reported costs and approval of annual report.</td>
<td>Evaluation is made annual in negotiation process on the basis of reported costs</td>
<td>Evaluation of costs is covered by the norm element in the economic regulation. As the economic regulation is 60% norm based, there is no further annual process.</td>
<td>Evaluation of annual reported cost</td>
</tr>
</tbody>
</table>

Table 3 Comparisons of main elements of system operation costs
4 Economic regulation of network operation

4.1 Regulatory model

In this chapter we describe the general principles for economic regulation related to network operations of the TSO in each of the Nordic countries. We also give a schematic overview of the main elements in the economic regulation. For a more detailed description, we refer to appendix 1 to 4.

4.1.1 Denmark

The economic regulation of Energinet.dk is a cost-plus regulation where only necessary cost at efficient operation can be included in the transmission tariffs. This applies to costs related to network operations (operating expenses and capital costs) as well as costs related to system operations. Any revenues generated from the operations will be subtracted from the amount allowed included in the transmission tariffs. On top of recovering necessary cost at efficient operation, the TSO is allowed to preserve the net value of its funding capital of 1st of January 2005. In practice, this is done by calculation of a small interest according to the price index representing price developments of labour and materials.

Each year Energinet.dk makes a separate account for congestion revenues. In this account it is possible to see the total income from congestion revenues and how these revenues are planned to be used. The use of congestion revenues will be done according to the EU-rules.

According the economic regulation of Energinet.dk there is no explicit regulation of the quality of supply.

Once a year, the tariffs are set ex ante by Energinet.dk according to budget. It is possible to change tariffs during the year, if Energinet.dk has strong indications that – for one reason or another – the budget figures won’t stand. Unbalances between costs and incomes for each tariff area are offset through tariffs in the following income year.

4.1.2 Finland

The Finnish regulatory model can be described as an ex-ante revenue cap model. The regulator use the model to decide the reasonable rate of return and the TSO set the tariffs based on the decision from the regulator. The regulatory period is four years. The Finnish regulation is now in its third regulatory period, in force for the years 2012 through 2015. During the regulatory period, the Finnish revenue cap (reasonable return) is calculated annually. The reasonable rate of return is calculated and subtracted from the TSO’s actual adjusted profit annually. The result from the calculation is surplus (+) or deficit (−). After the regulatory period, the four-year total surplus/deficit is calculated by adding up the annual surpluses/deficits. The TSO is obligated to compensate the surplus and allowed to compensate the deficit in their price setting in the following regulatory period.

The costs of TSO’s network operations also include system service costs, costs arising from countertrade, and compensation for cross-border electricity transmission paid by the
system operator, but these are not considered as controllable. For operating expenses considered as controllable, the TSO is subject to an efficiency target. The efficiency target is based on annual negotiation process where TSO’s actual controllable operating costs are benchmarked against TSO’s own historical or budgeted costs.

EMV confirms the starting level for reasonable controllable operating costs used in each year in the efficiency incentive. The starting level is determined using the controllable operating costs in accordance with the budget for the year in question, reported by the TSO, or the TSO’s actual controllable operating costs for the five previous financial years. The change in TSO’s network volume is taken into account when determining the starting level. After determining the starting level, the general efficiency target of 2.06 % is taken into account, after which the annual reference level can be determined. A range of ± five per cent, or an error margin, is set for the reference level of the determined efficiency incentive to reduce the uncertainty associated with the determination of the starting level.

The realized controllable operating costs are compared with the reference level annually. The value of the efficiency incentive may correspond to a maximum of three percent of the reasonable return calculated for the capital invested in network operations in the year in question.

Uncontrollable costs are treated as pass through costs. Other incentives are investment incentive, incentive to improve quality and innovation incentive. Controllable operating costs, uncontrollable operating costs and the incentives are discussed in more detail in Appendix 2.

Calculation of actual adjusted profit starts from the operating profit (see structure of the regulation model in Appendix 2). Operating profit depends on TSO’s turnover. The turnover includes tariff income from customers, bottleneck income (congestion revenues) and income from system operations. We get the actual adjusted profit after some adjustments are made and the effect of incentives is added in the operating profit.

The reasonable rate of return is subtracted from the actual adjusted profit each year. After the regulatory period, the 4-year total surplus/deficit is calculated by adding up the yearly deviations. The TSO is obligated to compensate the deficit in their tariffs in the following regulatory period.

4.1.3 Norway

The Norwegian regulatory model is an ex-ante revenue cap model. The regulator use the model to decide the total level of allowed revenues for the TSO, taking into account that the TSO should be able to obtain a reasonable rate of return on invested capital, given effective operation, utilization and development of the network. The TSO set the tariffs based on the decision on allowed revenue from the regulator.

The economic regulation for all network companies in Norway, including Statnett (TSO), is executed by annual determination of revenue caps for each company. The current revenue cap regulation entered into force 1st January 2007. According to the Energy Act Regulation, the main principles for calculation of revenue cap shall be re-evaluated

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17 for the calculation of this, see Appendix 2
periodically, but each period shall last a minimum of 5 years. Minor model adjustments can be executed during continuously.

The revenue cap for Statnett is based on a yardstick model, as for any other network company. 40 % of the costs included in the revenue cap are based on the Statnett’s actual costs (based on book values), while 60 % is based on a norm. This principle applies to costs related to network operations as well as system operations (described in chapter 3.3.2). The cost norm related to network operations is the result of a benchmark analyses. The benchmark of Statnetts’ transmission grid is based on the results of a European study on the TSOs, the e3GRID study. Statnett sets the tariffs based on their allowed revenue each year. The allowed revenue consists of the annual revenue cap decided by the regulator, property tax and tariff costs to other regulated grids. The deviation between actual collected revenues and the allowed revenue is subject to regulatory control. NVE set a yearly excess/deficit revenue balance. This balance is to be adjusted towards zero over time. Excess revenues must be reimbursed to the customers, while deficit revenues may be recovered.

The TSO is also subject to incentive regulation related to quality of supply. As for any other network company, this is executed through full integration of the CENS arrangement in the revenue cap. For the TSO, CENS is included in the revenue cap with a norm weighing 60 %, while 60 % of actual CENS costs are subtracted in the calculation of allowed revenue.

Actual collected revenues include tariff income from customers, bottleneck income (congestion revenues) and income from system operations. Any revenues generated from bottlenecks are considered to be a part of Statnett’s actual collected revenue, and thereby reduces the base for tariffs that can be collected from Norwegian customers. This way of handling bottleneck income implies that this income also indirectly is used to finance investments to eliminate bottlenecks

4.1.4 Sweden

The Swedish regulatory model is an ex-ante revenue cap model. A revenue cap is established in advance of each regulatory period and each regulatory period for the Swedish TSO is one calendar year.

The revenue cap is decided based on a process involving an application from the TSO with a proposed revenue cap and economic and technical data and budget. This application is submitted by the TSO and is evaluated by the regulator. The regulator assesses whether the revenue cap budgeted by the TSO is reasonable. The regulator is in this process taking into consideration the customer’s interests of low and stable tariffs and that the revenue cap should be sufficient to cover reasonable costs and give the TSO a reasonable rate of return on the capital required to operate the business.

When the regulator calculates the cap, the regulator uses the technical and economical information provided by the TSO. The regulator also uses methods to determine cost for capital, rate of return and operations.

18 Agrell, P. J. and P. Bogetoft e3GRID Final Results (2009)
Operation costs cover both network operations and grid related system operations. The operating costs are, in the calculating process, divided in controllable and non-controllable cost. The latter type of costs can the company pass through completely during the regulatory period. For calculating the controllable cost the regulator uses the information from earlier regulated periods. The regulator has decided an annual efficiency requirement of one percent, which forces the TSO to reduce the controllable operating cost if they will keep the rate-of-return at the same level. The capital costs are calculated from the RAB. The calculated operative costs and capital costs are then added together to get a total revenue cap. The cap is then compared to the information in the application and the TSO’s current revenue. From this information the regulator decide on a revenue cap for the regulatory period.

The allowed revenue is, after the regulatory period has ended adjusted taking the outcome of the non-controllable operational cost in consideration. The cap is also adjusted to the outcome of quality in the regulatory period.

The allowed revenue includes the incomes from the following activities:

- Grid fees (tariffs) – the tariff for consumers and feed-in tariff and connection.
- Capacity Charges
- Transit revenues
- Other network revenues

If there are any deviations from the decided revenue cap, e.g. if the grid operator’s actual revenue during the regulatory period deviates from the EI’s decided revenue cap, then the excess/deficit amount will decrease/ increase the subsequent regulatory period’s revenue cap19. If the actual revenue exceeds the cap with more than five percent, an overbilling addition will reduce the revenue cap for the subsequent regulatory period. The overbilling addition is a rate equal to the average reference rate according to § 9 Interest Act (1975:635), with an addition of fifteen percentage points20.

4.2 Schematic overview of main elements

In this chapter provides an overview of the main elements in the economic regulation for the Nordic TSOs. The tables below illustrate how the main cost elements are treated in the basis for calculation of revenue caps in each country, and the principles for calculation of capital costs. We also illustrated the main principles for incentive regulation related to quality of supply.

Detailed descriptions of the respective elements can be found in Appendix 1-4.

19 Energy Act (1997:857) chap. 5 20
20 Energy Act (1997:857) chap. 5 21
## Operational costs

<table>
<thead>
<tr>
<th>Element</th>
<th>Denmark</th>
<th>Finland</th>
<th>Norway</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentive regulation</td>
<td>N.A.</td>
<td>Efficiency demand on costs that are considered controllable. Non-controllable costs are passed through.</td>
<td>All costs are subject to incentive regulation - the economic regulation does not differentiate between controllable and uncontrollable costs</td>
<td>Efficiency target on costs that are considered controllable. Non-controllable costs are passed through.</td>
</tr>
<tr>
<td>How is efficient level decided?</td>
<td>No efficiency level</td>
<td>Benchmarked against TSO’s own historical or budgeted costs in annual negotiation method process</td>
<td>Benchmark analyses (e3grid)</td>
<td>The efficiency target is the same as for the DSO and it is a result of analyses on productivity development of the DSO in Sweden and other countries.</td>
</tr>
</tbody>
</table>

Table 4 Comparison of treatment of operational costs
### Table 4 Comparison of treatment of quality of supply

<table>
<thead>
<tr>
<th>Element</th>
<th>Finland</th>
<th>Norway</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure of quality in the regulation</td>
<td>Calculated costs of interruptions for the customers.</td>
<td>Calculated costs of interruptions for the customers.</td>
<td>Calculated costs of interruptions for the customers.</td>
</tr>
<tr>
<td>Interruptions included</td>
<td>The number, time and power of outages for each connection point caused by unexpected outages and reconnections are taken into account, all durations</td>
<td>All interruption and all durations are included</td>
<td>Duration: Interruptions lasting for 1 minute and longer. Extraordinary interruption are excluded</td>
</tr>
<tr>
<td>Incentive regulation</td>
<td>Actual interruption costs are compared to reference level annually. The reference level is based on TSO’s historical interruption costs. The outcome (incentive to improve quality) affects the allowed revenue through the actual adjusted profit.</td>
<td>Quality element is integrated in the revenue cap as a norm for level of interruption costs. Norm is based on a historical average of costs. Actual interruption costs for the revenue cap year are subtracted from allowed revenue.</td>
<td>Actual interruption costs are compared to reference level annually. 50 % of positive or negative difference will be taken into account</td>
</tr>
<tr>
<td>Quality adjustment limit</td>
<td>± 2 % of annual reasonable return. Any quality sanction may not be higher than the possible quality bonus.</td>
<td>N.A.</td>
<td>Revenue cap is adjusted for deviations from quality reference level. ± 3 % of the decided revenue</td>
</tr>
</tbody>
</table>

### Table 5 Comparison of treatment of network losses

<table>
<thead>
<tr>
<th>Element</th>
<th>Denmark</th>
<th>Finland</th>
<th>Norway</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>How are costs of network losses treated?</td>
<td>Actual costs - marked based.</td>
<td>Actual costs. Following the Electricity Market Act, the network losses shall be purchased by following open, non-discriminatory and market-based procedures.</td>
<td>Regulator decides a reference price used to calculate costs. Calculated costs equal actual volume of losses multiplied with the reference price. Calculated costs are passed through.</td>
<td>Actual costs – marked based.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Network losses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Element</td>
<td>Denmark</td>
</tr>
<tr>
<td>How are costs of network losses treated?</td>
<td>Actual costs - marked based.</td>
</tr>
</tbody>
</table>
### Capital costs

<table>
<thead>
<tr>
<th>Element</th>
<th>Denmark</th>
<th>Finland</th>
<th>Norway</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the asset base based on?</td>
<td>The assets are based on 2005 net book values</td>
<td>Net present value, based on unit price for standard components. Regulator decides the unit price.</td>
<td>Net book values</td>
<td>Fixed asset replacement value, and acquisition values</td>
</tr>
<tr>
<td>How will investments affect the value of asset base?</td>
<td>The asset base will not be affected by investments</td>
<td>Investment increase the asset base by the standard component value when the investment is completed</td>
<td>Increase the asset base by actual capitalized costs</td>
<td>Investments increase the asset base by the actual investment costs when the investment is completed</td>
</tr>
<tr>
<td>Rate of return</td>
<td>Small interest calculated according to a price index</td>
<td>Real WACC</td>
<td>Nominal WACC</td>
<td>Real WACC</td>
</tr>
<tr>
<td>Depreciations</td>
<td>Linear</td>
<td>Linear. The depreciation is determined annually to correspond to the network replacement value at the beginning of each year.</td>
<td>Linear</td>
<td>Linear</td>
</tr>
</tbody>
</table>

Table 5 Comparison of treatment of capital costs
### WACC parameters for TSO (not relevant for Denmark)

<table>
<thead>
<tr>
<th>Element</th>
<th>Finland</th>
<th>Norway(^{21})</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk free rate</strong></td>
<td>Nominal: Yield of Finnish government bonds with 10 years maturity, previous year May average. Real: Nominal risk free rate – Inflation component 1%</td>
<td>Nominal: Annual risk free rate of government bonds with 5 years maturity</td>
<td>Nominal = 4 % Fixed rate.</td>
</tr>
<tr>
<td>Inflation</td>
<td>1,0%, subtracted from nominal risk free rate</td>
<td>-</td>
<td>1,99 %</td>
</tr>
<tr>
<td>Asset beta</td>
<td>0,4</td>
<td>0,35</td>
<td>0,38</td>
</tr>
<tr>
<td>Equity beta</td>
<td>0,844</td>
<td>0,875</td>
<td>0,66</td>
</tr>
<tr>
<td>Market risk premium</td>
<td>5,0%</td>
<td>4 %</td>
<td>4,74 %</td>
</tr>
<tr>
<td>Premium for lack of liquidity</td>
<td>0,5%</td>
<td>-</td>
<td>0,50 %</td>
</tr>
<tr>
<td>Capital structure (Debt / Equity)</td>
<td>60 / 40</td>
<td>60 / 40</td>
<td>50 / 50</td>
</tr>
<tr>
<td>Tax rate</td>
<td>24,5%</td>
<td>28 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Debt premium</td>
<td>1,0%</td>
<td>0,75 %</td>
<td>1,49 %</td>
</tr>
</tbody>
</table>

Table 6 Comparison of WACC parameters

\(^{21}\) Norway will apply a new WACC-model from 2013.
APPENDIX: Details of the models for economic regulation

1 Denmark

1.1 Economic regulation of network operations

The regulation of the Danish TSO is different from the TSO-regulation in the three other Nordic countries.

Energinet.dk is regulated in accordance with a “non-profit” principle, whereby the company's tariffs may only cover the necessary costs incurred in efficient operation and an interest rate to ensure the real value of the company's capital base as at 1 January 2005. The regulation does not facilitate the determination of general efficiency requirements for Energinet.dk.

In Denmark it is the owner (the Danish State through the Minister for Climate, Energy and Building) who will make the incentive regulation of the TSO. In exercising normal ownership control, the owner will also look at the company’s efficiency etc.

However, DERA may determine that a specific cost - or an amount thereof - does not constitute a necessary cost at efficient operation and may not be included (or only partially included) in the Energinet.dk tariffs. The ex post decision about whether there only is necessary cost at efficient operation is determined by DERA. There is no unambiguous way of these evaluations by DERA.

As part of the normal regulation of energy companies, DERA will however follow all international benchmarks of TSO’s efficiency. DERA will inform the owner of Energinet.dk if the results show any sign of problems with the efficiency of the Danish TSO.

Energinet.dk tariffs are set on the basis of forecasts of costs for the following year and the volume of electricity transported in the company’s grid etc., so revenues and expenses balance in accordance with the non-profit principle. However, the forecasts cannot always be 100 percent accurate, and the company will therefore either charge too much (over coverage) or not enough (under coverage). This over or under coverage is included in the tariffs for the subsequent year. Over coverage will mean lower tariffs in the following year, while under coverage leads to higher tariffs.
2 Finland

2.1.1 Structure of the regulation model

The Finnish electricity distribution regulatory model can be described as an ex-ante revenue cap model. EMV uses the regulatory model to set the reasonable rate of return and the TSO sets the tariffs themselves. The regulatory model is built of many components. Figure 1 illustrates the formation of reasonable return and actual adjusted profit. The reasonable rate of return is subtracted from the actual adjusted profit annually and the result is surplus (+) or deficit (-). After the regulatory period, the 4-year total surplus/deficit is calculated by adding up the yearly surpluses/deficits. The TSO is obligated to compensate the surplus and allowed to compensate the deficit by adjusting its price setting in the following regulatory period. EMV uses both building cost index and consumer price index for indexation in the regulatory model.

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**Figure 1** Structure of the regulation model of TSO in the third regulatory period (2012-2015)
2.1.2 Collected revenues

All the returns on network operations of TSO are included in turnover in the income statement. As we can see from figure 1, calculation of actual adjusted profit starts from the operating profit (operating loss). Operating profit (operating loss) is also taken from the income statement of the year in question. All the returns on network operations of TSO are this way taken into account in calculation of actual adjusted profit.

2.1.2.1 Return on network operations

When calculating actual adjusted profit, returns on network operations include network service fees, i.e. consumption, use of grid and connection point fees, as well as the sale of other services related to network operations and, for example, transferable connection charges.

Returns on network operations also include fees that are charged on the basis of the volume of electric energy imported into Finland through cross-border connections (such as the market border fee) excluding electricity imports from a reciprocal common electricity market area. Other returns on network operations include system service returns, returns on the sale of system administration services and the sale of balance power, and the income from congestion management as well as compensation for costs arising from cross-border electric energy transmitted in the system operator’s grid.

Moreover, the annual net change of the accrual of transferable and refundable connection charges and network rents entered in the system operator’s confirmed balance sheet, as well as the sales profit or loss from the sale of a network section and depreciation according to plan made on the goodwill are treated as items comparable to returns on network operations for the year in question.

When a customer connects to the transmission grid, the customer is responsible for the direct costs related to building the connecting line and the actual connection to the grid. The TSO pays indirect costs related to the new connection, i.e. required improvements in the transmission grid due the new connecting line.

2.1.3 Inflation

When calculating the actual adjusted profit, EMV uses consumer price index to adjust inflation in the quality incentive and in the efficiency incentive. Building cost index is used in the inflation adjustment made annually on the adjusted capital invested in the electricity network (unit prices). The adjustments will be done on the basis of consumer price index and building cost index (1995=100) so that the average index level for April–June 2011 will be used as the index level corresponding to the 2012 value of money, and the average for April–June of the previous year to the year in question will be used as the index level corresponding to the value of money in the other years of the regulatory period.

The following formula illustrates the change of building cost index for year $t$

$$
\Delta BCI_t = \frac{BCI_{t-1}}{BCI_{t-2}} - 1
$$

where
\[ \Delta BCI_t = \text{change of the building cost index for year } t \]

\[ BCI_{t-1} = \text{The average of the building cost index (1995=100) figures for April – June in year } t-1. \]

\[ BCI_{t-2} = \text{The average of the building cost index (1995=100) figures for April – June in year } t-2. \]

The change of consumer price index for year \( t \) is calculated in the same way.

### 2.1.4 Capital costs

The Reasonable rate of return is calculated by multiplying regulatory asset base (RAB) with WACC - %. RAB consist of equity and interest bearing debts.

#### 2.1.4.1 Asset base

When determining the value of capital invested in network operations in the calculation methods concerning the return on the electricity network operator’s network operations, EMV will not apply the book value of the electricity network because the book value of the network will not necessarily reflect the actual market value of the capital invested in the network due to its previous tax practices. The value of the electricity network will be adjusted in calculation methods concerning the return on network operations to better meet its market value by using its net present value (NPV) instead of its book value. The NPV of the electricity network is determined each year, January first. When determining the capital invested in network operations, the electricity network administrated by the network operator is treated in the same way regardless of whether it is owned or leased by the network operator. In the event that the network operator has leased a network that it administrates in whole or part, the leasing arrangement is dissolved in calculations of the return on network operations, whereupon the leased network components are included in the network assets of the network operator and also in the capital invested in network operations.

When calculating the replacement value of the transmission network, the Energy Market Authority assesses the validity of the unit price data declared by the TSO on the basis of the costs of network construction projects and changes in the construction costs. Based on the assessment, the Energy Market Authority decides the unit prices of standard components it uses in the calculation of replacement value of the transmission network. Standard values are defined also for the buildings, sites, computer systems etc. invested in network operations.

For the other years of the third regulatory period (2013-2015), unit prices are adjusted with inflation.

NPV is calculated from RV using component-specific unit price and average age data. In order to calculate the average age the TSO is required to find out the true age of the network components. The RV of the whole network is calculated by multiplying all the components with their respective unit prices.

In an acquisition, the network acquired is added into the NPV and RV of new owner based on the information on the number of network components and average age data. Correspondingly, the network is deducted from the NPV and RV of the seller.
Calculating the NPV of a network component from the RV, using the average age and lifetime data will be calculated as follows:

\[
NPV_{it} = \left(1 - \frac{\text{average-age}_{it}}{\text{lifetime}_{i}}\right) \times RV_{it}
\]

\[NPV_{it} = \text{ Net present value of all components } i \text{ included in network component } i \text{ in year } t, \text{ in the 2012 value of money}\]

\[RV_{it} = \text{ The combined replacement value of all components included in component } i \text{ in year } t, \text{ in the 2012 value of money}\]

\[\text{lifetime}_{i} = \text{ Lifetime of network component } i. \text{ The lifetime denotes the period for which a network component is in actual operation before it is replaced (technical financial lifetime).}\]

\[\text{average-age} = \text{ The age information of network component } i \text{ weighted by its volume information in the beginning of year } t\]

The difference between depreciation according to the plan (in income statement) and the straight-line depreciation calculated from the replacement value of network, is taken into account in the calculation of adjusted profit. (incentive to invest – part of the regulatory model, see Figure 1). The difference is considered as an allowance for replacement investments of transmission network.

Straight-line deprecinations calculated from the electricity network replacement value. For the entire network, the straight-line depreciation will be calculated as a sum of straight-line deprecinations determined for individual components, see the formula below:

\[
JHATP_{it} = \sum_{i=1}^{n} \left(\frac{JHA_{i}}{\text{lifetime}_{i}}\right)
\]

The depreciation is determined annually to correspond to the network replacement value at the beginning of each year. The determination is carried out at the same time with the determination of the network replacement value.

Inventories and account receivables (part that is committed to network operations) are appreciated on their book value in RAB. Short and Long-Term Receivables, Financial Instruments and Cash and Bank Receivables are eliminated from the capital committed to network operations.

2.1.4.2 Rate of return

Based on several expert opinions, EMV has selected the Weighted Average Cost of Capital model (WACC) as the basis for determining a reasonable return on capital invested in electricity network operations. EMV has applied the WACC model in assessing the reasonableness of pricing of electricity network operations since 1999. The only difference between WACC-parameters for DSOs’ and TSO is in the capital structure (Debt/Equity). WACC – parameters are shown in table 1.
## WACC parameters for the third regulatory period

<table>
<thead>
<tr>
<th>WACC parameter</th>
<th>DSO</th>
<th>TSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk free rate (real value)</td>
<td>10 year Finnish</td>
<td>10 year Finnish</td>
</tr>
<tr>
<td></td>
<td>government bond yield</td>
<td>government bond yield</td>
</tr>
<tr>
<td></td>
<td>(average of previous</td>
<td>(average of previous</td>
</tr>
<tr>
<td></td>
<td>year May) - inflation</td>
<td>year May) - inflation</td>
</tr>
<tr>
<td></td>
<td>component</td>
<td>component</td>
</tr>
<tr>
<td>Inflation component (subtracted from nominal risk free rate)</td>
<td>1,0 %</td>
<td>1,0 %</td>
</tr>
<tr>
<td>Asset beta</td>
<td>0,4</td>
<td>0,4</td>
</tr>
<tr>
<td>Equity beta</td>
<td>0,527</td>
<td>0,844</td>
</tr>
<tr>
<td>Market risk premium</td>
<td>5 %</td>
<td>5 %</td>
</tr>
<tr>
<td>Premium for lack of liquidity</td>
<td>0,5 %</td>
<td>0,5 %</td>
</tr>
<tr>
<td>Capital structure (Debt / Equity)</td>
<td>30 / 70</td>
<td>60 / 40</td>
</tr>
<tr>
<td>Tax level</td>
<td>24,5 %</td>
<td>24,5 %</td>
</tr>
<tr>
<td>Debt premium</td>
<td>1,0 %</td>
<td>1,0 %</td>
</tr>
</tbody>
</table>

Table 1 WACC parameters for the third regulatory period

### 2.1.5 Operating costs

#### 2.1.5.1 Overview

In the Finnish regulation model part of the operating costs are considered controllable and they are subject to the efficiency target. Controllable operating costs (KOPEX) are defined before start of the regulatory period.

The key figures describing the cost effectiveness of operations must include all essential items of expenditure, on which the TSO may have an impact on its operational activities. In the assessment, the Energy Market Authority will apply the KOPEX based on the financial statement of TSO.

KOPEX will cover the following expenses in accordance with the financial statements: 1) materials, accessories and energy purchases, 2) increase or decrease in stocks, 3) staff costs, 4) rents, 5) other external services, and 6) other costs. Production for own use is also deducted from these costs.

When measuring the cost effectiveness of operations, items considered as uncontrollable operating costs are eliminated from KOPEX. The costs considered as uncontrollable include also the direct costs related to the system responsibility of Fingrid and purchasing costs of lost electricity.
The costs for maintaining European marketplace are considered as uncontrollable when they are related to the operation of ENTSO-E\textsuperscript{22}.

The equation illustrates the calculation of KOPEX. The items of calculation are listed below:

\[
KOPEX_t = ATE_t + VM_t + HK_t + VU_t + VP_t + MK_t - VOK_t - HEH - RK_t - TP_t - EMY_t - VKO_t - VST_t - RO_t
\]

where

\[
KOPEX_t = \text{the system operator’s controllable operational costs in year } t, \text{ euros}
\]

\[
ATE_t = \text{materials, accessories and energy purchases in year } t, \text{ euros}
\]

\[
VM_t = \text{change in stocks (decrease/increase) in year } t, \text{ euros}
\]

\[
HK_t = \text{personnel costs in year } t, \text{ euros}
\]

\[
VU_t = \text{rent, not including network rents in year } t, \text{ euros}
\]

\[
VP_t = \text{other external services, not including network service fees to other system operators in year } t, \text{ euros}
\]

\[
MK_t = \text{other costs in year } t, \text{ euros}
\]

\[
VOK_t = \text{production for own use in year } t, \text{ euros}
\]

\[
HEH = \text{acquisition cost of lost energy}
\]

\[
RK_t = \text{costs of maintaining reserve capacity in year } t, \text{ euros}
\]

\[
TP_t = \text{balance service costs in year } t, \text{ euros}
\]

\[
EMY_t = \text{maintenance costs of the European marketplace (ENTSO-E) in year } t, \text{ euros}
\]

\[
VKO_t = \text{countertrade purchases in year } t, \text{ euros}
\]

\[
VST_t = \text{balance management costs related to Russian transmission connection in year } t, \text{ euros}
\]

\[
RO_t = \text{scrapping costs in year } t, \text{ euros}
\]

---

\textsuperscript{22}European Network of Transmission System Operators for Electricity
2.1.5.2 Efficiency incentive

TSO has an efficiency target only on its controllable operative cost (KOPEX). EMV confirms every year of the third regulatory period the starting level of KOPEX. When measuring the starting level EMV uses KOPEX budgeted by TSO in the year in question or the realized KOPEX of five previous years. The network volume is also taken into account.

The following equation illustrates the calculation of KOPEX reference level.

$$KOPEX_{ref, t} = [KOPEX_{ref, t} \times (1 - 2,06\%)] \pm 5\%$$

where

$$KOPEX_{ref, t} = \text{TSO’s KOPEX reference level in year } t$$

$$KOPEX_{ref, t} = \text{TSO’s KOPEX starting level in year } t$$

$$2,06\% = \text{The general yearly efficiency target for the third regulatory period}$$

$$\pm 5\% = \text{The error margin of the reference level (This will diminish uncertainty related to the definition of the reference level)}$$

Every year the realized KOPEX is subtracted from the KOPEX reference level. The following equation illustrates the calculation of TSO’s efficiency incentive:

$$TKAN_t = kk \times (KOPEX_{ref, t} - KOPEX_{real, t})$$

where

$$TKAN_t = \text{TSO’s efficiency incentive in year } t$$

$$kk = \text{Incentive coefficient } 0,5 \text{ (benefit or loss caused by over-performing or underperforming related to reference level is divided between TSO and customers)}$$

$$KOPEX_{ref, t} = \text{TSOs KOPEX reference level in year } t$$

$$KOPEX_{real, t} = \text{TSOs realized KOPEX in year } t$$

Before confirming the starting levels of KOPEX in the efficiency incentive, to be applied in each year of the regulatory period, EMV reserves the right for the TSO to express its views on the confirmed starting levels in a so-called negotiation procedure. The negotiation procedure between EMV and the TSO will take place by 15th of March every year. In the procedure, the actual KOPEX for the previous five years and the budget compiled by the TSO for the KOPEX for the year in question will be discussed.
EMV considers that when assessing the reasonableness of pricing of the TSO’s network operations, the efficiency incentive in euro to be taken into account in the calculation of the adjusted profit in each year of the third regulatory period may correspond to a maximum of three percent of the reasonable return calculated for the capital invested in network operations in the year in question.

### 2.1.6 Innovation incentive system

TSO is able to cover some of the investment costs through the Innovation incentive system. The expenditure caused by research and development activities (maximum 0.5 % of annual turnover) is considered as pass-through cost. This is similar to the innovation incentive system of DSOs’ regulatory model.

### 2.2 Quality regulation

Disadvantage caused by outage (DCO) is calculated annually. The method used to calculate DCO is based on connection points of transmission network. In order to calculate the connection point specific DCO, a consumption type specific for each connection point has been defined. Unit prices have been defined for consumption types of different customers in order to calculate the DCO.

The incentive to improve quality takes into account connection point specific number of outages, duration of outages and wattage of outages caused by unexpected outages and autoreclosers. The prices that are used in valuation of connection point-specific outages are based on studies commissioned by EMV and Fingrid Oyj. The formula of DCO calculation is shown below.

#### 2.2.1 Calculation of Disadvantage Caused by Outage for TSO

TSO conducts annually the calculations about the disadvantage caused by connection point-specific outages. The following formula is used in the calculation.

\[
DCO_{t,k} = \sum_{i=1}^{n} \left[ A_i + B_i \times T_i \right] \times P_i \times K_{i,va} \times K_{i,op} \times \left( \frac{CPI_{k-1}}{CPI_{2009}} \right)
\]

where

- \( DCO_{t,k} \) = Actual disadvantage caused by electricity supply outages to the customers of the network operator in year \( t \) in the value of money of year \( k \).
- \( n \) = The number of unexpected outages in year \( t \).
- \( A_i \) = A wattage-coefficient of unexpected outage \( i \) which depends on the consumption type.

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23 Pöyry Forest Consulting Oy (2009), Keskeytyksestä aiheutuneen haitan arviointi kemiallisessa metsätöollisuudessa, julkinen raportti, 26.10.2009
24 Pöyry Forest Consulting Oy (2009), Keskeytyksestä aiheutuneen haitan arviointi metalli- ja kemiantoollisuudessa, julkinen raportti, 20.11.2009
$B_i = \text{An energy-coefficient of unexpected outage } i \text{ which depends on the consumption type.}$

$T_i = \text{duration of unexpected outage } i, \text{ hours.}$

$P_i = \text{The wattage of connection point when the unexpected outage } i \text{ starts, kW.}$

$K_{va} = \text{A season-coefficient of the starting time of unexpected outage } i.$

$K_{vp} = \text{A “time of the day”-coefficient of the starting time of unexpected outage } i.$

$CPI_{k-1} = \text{Consumer price index in year } k-1$

$CPI_{2009} = \text{Consumer price index in year 2009}$

The change in the building cost index in the above formula for calculating outage costs for the year $k$ will be calculated with the following formula:

$$\Delta CPI_k = \frac{CPI_{k-1}}{CPI_{2004}} - 1$$

where

$\Delta CPI_k = \text{Change in the consumer price index for the year } k.$

$CPI_k = \text{The average of the consumer price index (1995=100) index figures for April–June in the year } k.$

The reference value (DCOref,$k$) of the disadvantage caused by the network operator’s outage costs for the year $k$ during the regulatory period of 2012–2015 will be calculated using the formula below. The method is similar to the method used to calculate the reference level of DSOs quality incentive:

$$DCO_{ref,k} = \frac{\sum_{t=2005}^{2010} DCO_{t,k} \times \left(\frac{W_k}{W_r}\right)}{6}$$

where

$DCO_{ref,k} = \text{The reference value of disadvantage caused by outages in the network operator’s electricity supply (outage costs) for the year } k.$
\[ DCO_{t,k} = \text{Actual disadvantage caused by electricity supply outages to the customers of the network operator in the year } t \text{ in the value of money of the year } k. \]

\[ W_k = \text{The amount of energy transferred to the users from the network operator’s network with a voltage of 0.4 kV and 1–70 kV in the year } k, \text{ kWh.} \]

\[ W_t = \text{The amount of energy transferred to the users from the network operator’s network with a voltage of 0.4 kV and 1–70 kV in the year } t, \text{ kWh.} \]

EMV considers that the difference between actual disadvantage caused by outages in electricity supply and the reference level of outage costs, which is taken into account in the calculation of actual return on network operations, may correspond with a maximum of two percent of the reasonable return calculated for capital invested in the year in question. This applies to both floor and ceiling levels.
3 Norway

3.1 Joint revenue cap

The revenue cap regulation is specified in detail in the Regulation governing financial and technical reporting, revenue caps for network operations and transmission tariffs (Reg. No. 302 of 11 March 1999). According to Section 11, the company appointed as system operator is regulated by a joint revenue cap; including costs related to the TSO’s own network components and costs related to the exercise of the role as system operator. Further, it is stated that the sections defining the principles for the calculation of the revenue cap for the network sector shall apply to the revenue cap for the TSO as far as possible.

NVE decides a yearly revenue cap for all companies, including the TSO. The revenue cap for Statnett is illustrated by the following formula:

\[
RC_t = 0.4C_t + 0.6C^*_t + 0.6CENS^* + 0.4SO_t + 0.6SO^*_t
\]

- \(RC_t\) = Revenue cap
- \(C_t\) = Cost base for actual costs related to network components
- \(C^*_t\) = Cost norm for costs related to network components
- \(CENS^*\) = Expected level of CENS cost (CENS – cost of energy not supplied)
- \(SO_t\) = Costs related to system operations
- \(SO^*_t\) = Cost norm for costs related to system operations
- Degree of norm cost/yardstick competition is set to 0.6

NVE notifies the expected revenue cap for all companies before the start of the year, based on estimates for WACC, CPI, the reference price on power related to power losses and system operations costs. These parameters are not known until the revenue cap year ends. When the parameters are known, NVE decides the final revenue cap for the year based on the actual values. The main intention of notification of the revenue cap is to give the companies an approximate figure to base their tariff decisions on for the revenue cap year.

3.2 Costs related to network operations

The revenue cap for the TSO’s network operations is calculated by the same principles, and including the same cost elements, as the revenue cap for any other network company.
There is a difference in the treatment of the quality element, due to the lack of comparable companies. For other network companies, the quality element (CENS) in the revenue cap is calculated yearly and included in the ordinary cost base and in the benchmarking analysis. For the TSO, the CENS element is only included in the revenue cap as a norm, (CENS*), calculated as the CPI adjusted average of Statnett’s CENS costs for 2001-2005.

All economic, and some technical, data are collected annually through NVEs report system (eRapp). Total costs that enter into the regulation consist of operation and maintenance costs, capital costs, costs related to network losses and CENS. To be able to notify the revenue cap before the beginning of the year, the revenue cap is based on data from two years earlier, i.e. the revenue cap for 2012 is based on costs in 2012.

The cost base is calculated according to the formula:

\[ C_t = OM_{t-2} \times \frac{CPI_{t-2}}{CPI_{t-2}} + PL_{t-2} \times P_t + DEP_{t-2} + RAB_{t-2} \times WACC_t \]

- OM = operation and maintenance costs
- CPI = consumer price index
- PL = power loss volume
- P = reference price of power
- DEP = depreciations
- RAB = regulatory asset base
- WACC = weighted average cost of capital

Some costs related to system operations are also included in the network operations cost base. This applies to personnel costs and capital costs (e.g. related to the system control center) ordinary included in the ordinary cost base.

The cost norm, C*, is a result of benchmarking analyses. The benchmarking of Statnetts’ transmission grid is based on the results of the international studies on the TSOs, the e3GRID study\(^{25}\). Statnett also owns part of the regional grid, which is benchmarked by Data Envelopment Analyses (DEA)\(^{26}\), comparing Statnett’s data to data for the other regional grid companies. The results from each analysis are weighed together to calculate the cost norm. The weights attached to the results are calculated as the respective shares of the total cost base. The cost norm is then found by multiplying the weighted result with the total cost base.

### 3.2.1 Operation and maintenance costs

The operation and maintenance costs mainly comprise of personnel- and material costs related to own production of services and purchase of external services. The following

\(^{25}\) Agrell, P. J. and P. Bogetoft e3GRID Final Results (2009)

\(^{26}\) The model used in the regulation is described in NordREG report 7/2011 Economic regulation of electricity grids in Nordic countries
cost units are included: purchases of transmission and system services, purchases of goods and material, salaries and other personnel costs incl. pension costs, other operating costs, bad debts and internally priced services. These costs also include costs related to the system operations responsibility.

3.2.1.1 Inflation
NVE use the annual average Consumer Price Index (CPI) to inflate the O&M costs and CENS from two years back to reflect the price level in the revenue cap year $t$. The CPI is collected from Statistics Norway (http://www.ssb.no/kpi_en/).

3.2.2 Capital costs
The capital costs that enter into the regulated cost base are annual depreciations and return on the regulatory asset base (RAB). The RAB is based on historical book values for networks and other fixed assets. All accumulated depreciations and write-downs are subtracted from the historical cost.

Networks under construction are not included in the RAB. When calculating the RAB, NVE use net book values per 31.12.

3.2.2.1 RAB
The RAB for the TSO consists of the following fixed assets: central and regional network components, sites, buildings, customer-specific equipment, means of transport, fixtures, tools and computer equipment, and other fixed assets used in the network business. Components, buildings etc. utilized for the system operations responsibility are also included in the RAB.

Leased assets are not included in the RAB. However, the leasing costs of network assets (lines, cables, transformers, switches) which is leased from another regulated network company is allowed to include in the tariffs costs related to other regulated grids (TC). Hence, it will be included into the allowed revenue (AR).

To reflect the working capital, NVE add 1 % of the total book value per 31.12. to the RAB. The RAB is then multiplied with the WACC to calculate a reasonable return on the regulatory asset base.

3.2.2.2 WACC
The Weighted Average Cost of Capital (WACC) is given by the following formula:

$$ WACC_{net} = 0.4[Rf(1-t) + \beta_e \times MP] + 0.6(Rf + Pd) \times (1-t) $$

Where the variables are as follows:

- **Nominal risk free rate** ($Rf$):
  
  Annual average yield of government bond with 5 years maturity

- **Tax rate** ($t$): 28%

- **Market premium** ($MP$): 4%

- **Asset beta**: 0.35 (equity beta $\beta_e$: 0.875)

- **Debt/equity share**: 60/40
• **Debt premium (Pd): 0.75 %**

The WACC-model applied to the TSO is the same as for the DSOs. A CAPM-model was used to assess the cost of the companies’ equity. The gearing ratio is 60 %. An average 5-years maturity government bond is used as a measure of the risk free interest rate. The asset beta is set to 0.35 and the market premium is 4 %. On the debt-side, a debt premium equal to 0.75 % is used. The WACC formula is post tax, but NVE operate with a pre-tax rate of return. The WACC-formula is rewritten to an easier formula for pre-tax calculation of the rate of return:

\[ NVE_{rate} = 1.14R_f + 2.39\% \]

The formula is determined in the Regulation on economic regulation of power networks. All parameters in the WACC formula except for the risk-free rate are fixed. Any amendments in the parameters require an amendment in the regulation. The risk-free rate on the other hand is updated annually when setting the revenue cap.

3.2.2.3 **Depreciations**

The depreciation of capital is linear. The TSO decides the economic life of components based on the conditions in the area they are operated in, and then calculate the depreciation according to the expected economic lifetime of the specific network component.

3.2.2.4 **Time-lag and treatment of capital costs related to investments**

Asset additions in the last and current year (year t and t-1) are not included in the RAB as a result of the time-lag in the cost base. However, the TSO can calculate the capital costs related to investments into their allowed revenue the year they are commissioned, as given in formula 3) for *allowed revenue*. This implies that investments are also included in the tariff base as of the commissioning year.

3.2.3 **Network losses**

Network losses are measured as the difference between metered input and metered output (MWh). The costs related to the network losses are included in the cost base. To calculate the costs, NVE uses yearly reference prices of power.

The prices are calculated based on volume weighted monthly area spot prices. In Norway there are currently five price areas. The monthly area spot prices are collected from Nord Pool Spot AS and the weight is based on monthly national consumption volumes collected from statistics published by NVE.

The TSO operate in all price areas, as opposed to other network companies, which normally operate in one (or occasionally two) price area(s). To calculate the cost of network losses for the TSO, the reference prices for the areas are summarized and multiplied by the total volume of losses. The summarizing of area prices is done by assigning a weight to each reference price. This weight is calculated as the relative portion of loss volume in the respective areas (i.e. volume of losses in price area1/total volume of losses = weight assigned to the reference price for area1). A mark-up of 11 NOK/MWh is added to the final volume weighted spot price.
3.2.4 Quality dependent revenues

The revenue cap is quality dependent, by inclusion of the element CENS, which internalize the customers’ interruption costs. The net effect of the inclusion of the CENS element in the revenue cap and allowed revenue is that the customers indirectly are compensated for 60% the socio-economic costs related to poor quality of supply through lower tariffs in the future. For the TSO, this implies an economic gain or loss depending on whether outage level in a given year is better or worse than the average included in the norm.

The CENS arrangement is equal for all network companies, including the TSO. Normalized cost data (based on a customer survey conducted in 2001-2003) are used to establish continuous cost functions for the customers, which are divided in six groups: industry, commercial, large industry, public, agriculture, residential. Calculation of interruption costs is based on the mandatory reporting of interruptions. The arrangement includes both notified and non-notified interruptions.

The cost of an interruption of duration $r$ at reference time, $C_{ref}$, is calculated as follows:

$$1) \quad C_{ref} = c_{ref}(r) \cdot P_{ref}$$

where:

$C_{ref} =$ Interruption cost for an interruption at reference time

$c_{ref}(r) =$ Cost rate in NOK/kW for interruptions of duration $r$

$P_{ref} =$ Interrupted power in kW at reference time

The reference time is a working day in January. The interrupted power is defined as the estimated power in kW that would have been supplied at the time of interruption if the interruption did not occur.

Interruption costs are found to vary by season, weekdays, time of day and whether the interruption is notified. Correction factors are therefore established to adjust the calculated cost of interruption, taking these facts into account.

3.3 Costs related to system operations

$SO_t$ is the actual system operation cost in year $t$, as reported in Statnett’s yearly financial statements, where these costs are specified in a separate note. This cost element comprise of the direct costs related to the exercise of Statnett’s system responsibility. The main elements are costs for buying reserve capacity from producers for primary regulation, special adjustments to correct for bottlenecks, costs related to buying tertiary reserves (balancing power options) and other system services such as purchase of reactive effect etc.

$SO^*$ is the system operation cost norm, calculated based on a combination of historical costs and assumptions about the cost development for future years. The $SO^*$ was fixed for a five year period as of 2008, but can be evaluated if special circumstances should occur.
3.4 Allowed revenue – tariff base

The TSO set the tariffs based on their allowed revenue. The allowed revenue (AR) for each year is calculated according to the formula:

\[
AR_t = RC_t + PT_t + TC_t - 0.6CENS_t + [(DEP_{t-2} - DEP_{t-3}) + (RAB_t - RAB_{t-3}) \times WACC_t]
\]

PT is the property tax. TC is tariff costs to other regulated grids. These costs are not included in the revenue cap itself, but added to the allowed revenue. The CENS costs subtracted in the AR-formula are actual CENS costs, without time lag – e.g. in the AR for 2011, the subtracted CENS cost are related to outages that took place in 2011. The expression in [ ] is included to remove the two year time lag on capital costs related to any changes in these. The implication of this element is that the companies can calculate the capital costs related to investments into their allowed revenue in the actual year the investments are made.

The allowed revenue constitutes a basis for the calculation of tariffs, and the revenue compliance is subject to regulatory control. Excess or deficit revenue for a given year is calculated as the difference between actual collected revenues (CR) in a year \( t \) and allowed revenue for year \( t \):

\[
Excess/deficit = CR_t - AR_t
\]

Every year, when all relevant data regarding revenue cap, allowed revenues and actual collected revenues are known, NVE decides an excess/deficit revenue balance. This decision is made approximately one year after the revenue cap is set, when the companies have reported their actual costs in the revenue cap-year. The excess/deficit revenue balance is to be adjusted towards zero over time, through tariff changes. Excess revenues must be reimbursed to the customers, while deficit revenues may be recovered.

3.4.1 Actual collected revenues

Actual collected revenues include tariff income from customers, bottleneck income (congestion revenues) and income from system operations.

Any revenue generated from bottlenecks is considered to be a part of Statnett’s actual collected revenue, and thereby reduces the base for tariffs that can be collected from Norwegian customers. However, costs related to removing bottlenecks are also part of the tariff base, which implies that the bottleneck income is also used to finance investments to eliminate bottlenecks.

3.4.2 Connection charges

The transmission grid in Norway is regarded as a mesh-type network. For meshed networks, the network owner must carry the costs related to reinforcements or capacity expansions, irrespective of what factors that trigger the need. As a consequence, when a customer connects to the transmission grid, the customer is responsible for the costs related to building a connecting line, and the costs related to the actual connection to the

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27 According to Reg. No. 302 of 11 March 1999, Part V Tariffs
grid is carried by the transmission grid owner. The costs carried by the transmission grid owner are included in the cost base as any other network costs, and thus included in the tariff base.
4 Sweden

The TSO in Sweden is regulated by an ex-ante regulation. A revenue cap is established in advance of each regulatory period and each regulatory period for the Swedish transmission grid (SvK) is one calendar year\(^{28}\).

The revenue cap ensures that the grid company can maintain a high degree of reliability and that they can make the necessary investments to maintain its capacity and if necessary expand the existing network. The regulation aims to ensure that the customer has to pay a fair price for network service. Furthermore, the regulation help to give customers a long term of security supply and safeguard the Swedish electricity supply. The network companies will also receive stable and long-term conditions for its grid operations. Another important goal of regulation is that it will support the development of a well functioning electricity market\(^{29}\).

The Ex Ante regulation process starts off with the TSO submits a proposal on a revenue cap for a period of one year to the regulator\(^{30}\). The revenue cap should cover revenues from tariffs (transmission and connections) and congestion management\(^{31}\).

The application is examined by Ei which decides on a revenue cap for the actual period. When deciding on a revenue cap Ei uses methods (described in this chapter) and regards the the customers interests of low and stable tariffs.

For the TSO the capital costs constitutes a significant proportion of the total costs due to large investments in infrastructure. Ei has decided to calculate capital costs based on the principle of operating capital maintenance (OCM).\(^{32}\) This means that the cost of capital reflects the asset's capacity to generate services rather than its age. The basis is fixed assets replacement value and a reasonable capital cost is calculated with a real annuity method. As long as the TSO is using a network grid component it receives capital cost for the component.

The cap shall cover reasonable cost to conduct network activities taking into account also the quality of the supply and delivery of services\(^{33}\). The cap should provide SvK with sufficient resources to maintain its responsibility for system and security of supply and to operate the national grid in an efficient way. The operating cost of the Swedish TSO consists of costs for purchase of network losses, maintenance, operation, administration, etc. These costs are, in the calculation process, divided into controllable and non-controllable cost. The latter type of costs can the company pass through completely. For the controllable cost an annual efficiency requirement has been set. The efficiency requirement is one percent (1 %), which in real terms forces the TSO to reduce the controllable operating cost if they will keep the rate-of-return at the same level. The operative and capital cost are then added together to calculate a total revenue cap.

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\(^{28}\) Electricity Act, 5 chapter, 4 §.
\(^{29}\) Prop. 2008/09:141 p. 58
\(^{30}\) Electricity Act 5 chapter, 4 §.
\(^{31}\) Ei examines how congestion revenues are used in a specific order, by special resolution.
\(^{32}\) The other principle is financial capital maintenance (FCM).
\(^{33}\) Electricity Act 5 chapter 8 §.
When assessing if the claimed revenue cap is reasonable\textsuperscript{34}, EI has to consider the interest of customers of low and stable tariffs\textsuperscript{35} and the fact that the revenue cap should be sufficient to cover the grid company reasonable costs and earn a reasonable return on the capital required to operate the business\textsuperscript{36}. The calculated cap is therefor compared to the TSO’s current revenues. This assessment should guarantee that the customers should not get unjustifiably large changes in the tariff from one year to another.

After the regulatory period, Ei compare the cost deemed non-controllable with the TSO’s actual costs during the period. The cap can be adjusted accordingly. The cap can also be adjusted if the outcome of quality in the regulatory period is higher or lower than expected. The Fel! Hittar inte referenskälla. below shows schematically how the revenue cap is determined.

### 4.1 Description of the method to calculate a revenue cap

![Components in the economic regulation Revenue frame](image)

**Figure 1 Components in the economic regulation Revenue frame**

#### 4.1.1 Operational cost

The operational cost can in turn be divided in two parts: controllable and non-controllable. The latter part is cost which the company in short term has no or little control over in terms of possibility to reduce over time. The first part is costs which the company has the possibility to reduce for given services (output). In a special report Ei analysed how the division between different cost items should be done.\textsuperscript{37}

\textsuperscript{34} Electricity Act 5 chapter, 6 §.
\textsuperscript{35} Prop. 2008/09:141 p. 22
\textsuperscript{36} Prop. 2008/09:141 p. 58
\textsuperscript{37} Energimarknadsinspektionen, ”Löpande kostnader i förhandsregleringen”, EI R2010:06, april 2010.
4.1.1.1 Non-controllable operational cost

The TSO forecasts the expected non-controllable cost for the regulatory period. After the end of the regulatory period the non-controllable costs are compared and adjusted if necessary.

Cost that is defined as non-controllable is possible to pass through to the customers and it does not have any efficiency requirement. EI has identified below as non-controllable:

- Purchase of loss power
- Cost for transit
- Costs for counter-trade
- Energy compensation
- Cost of system operation, primary regulation and disturbance reserve

The grid losses are controllable in the long run, but for the first periods/years it will be regarded and treated as non-controllable cost. The Electricity Act states that the electricity for covering network losses shall be tendered in a competitive way. The grid company must tender the grid losses in an open, non-discriminatory and market orientated way. This cost is possible to examine in an auditing external from the economic orientated way.

Because of the SvK is also the system operator for electricity in Sweden which involves ensuring that the Swedish electricity system functions reliably at the national level and that electricity production and import match consumption and exports throughout the country, the cost related to this business are treating as non-controllable. It means that the cost regarded as primary control, energy compensation, counter trade, transit and disturbance reserve are non-controllable.

Note that only a part of the cost for primary control and disturbance reserve are treated as a non-controllable operational cost, the remainder belong to other activities that are not grid-related and thus they are not included in the regulation of the Swedish TSO.

4.1.1.2 Controllable operational costs

The starting point is the reports from the TSO – its historical costs taken from audited data from bookkeeping. The starting value is set to average of the two latest years, two years before the regulating period start (e.g. the non-controllable operational cost for 2012 was set on the averages of the non-controllable cost 2008 and 2009 inflated to the price level of 2010).

The concept of controllable costs is necessary because those costs will have an efficiency target. The TSO should be able to reduce these costs over time. EI has analysed and defined the cost items in controllable and non-controllable. A typical controllable cost is the cost for the staff and services. 

EI has decided that a general requirement shall be applied on current controllable costs. The efficiency target has been set to 1 %.

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38 Electricity Act, 3 chapter, 16 §.
To determine the size of the efficiency requirement, several analyses have been made. Productivity developments have been studied by calculations for the Swedish electricity grid companies, through comparisons with other sectors and by international comparisons.  

### 4.1.2 Capital Cost

The capital cost is a product of a decided rate of return on assets, the calculated capital base and chosen depreciation times. The main principle to calculate the regulatory asset base is to use replacement values with real annuities. This valuation principle is supplemented by some other methods when explicit values of replacement are not known.

#### 4.1.2.1 Asset base

The basis for calculating capital cost is fixed assets replacement value. Fixed asset is the physical equipment that the grid company uses to operate the grid.

To determine the regulatory asset base there are four methods which may be used to value assets within electricity networks. Those methods are decided in a Government Decree and also described by Ei in various reports (EI R2010: 07 on valuation of electricity grid real assets set four methods (see also Ei's PM 2010: 11, 2010:12 and 2010: 13) and EIFS2010: 6 (Regulation on the transmission of data) chapter 5 set out the accounting of capital base.) The four methods for valuation listed below shall be used in descending order. The standard values are the default mode, then acquisition values, then bookkeeping values and at last other valuation methods.

During the regulatory period the asset base is adjusted for inflation. Ei uses the development of production cost for buildings’ index for this purpose.

*Valuation according to standard values*

Fixed asset included in the capital base shall as a first alternative be set to a replacement value that corresponds to a standard value. A standard value on each equipment to be calculated on the basis of the investment expenditure a grid company would have to acquire or produce in a cost-effective manner with due regard to conditions which grid company cannot affect. Ei has decided on standard values for network components with voltage up to 220 kV. As SvK operates on the level 220 kV - 400 kV, Ei has not standard values for assets on those levels. Instead SvK has to use the method “acquisition values”.

*Valuation according to acquisition value*

When there are no standard value for a component, the rules states that the replacement value should be calculated on the basis of the expenditure for the acquisition or the manufacturing of the fixed asset when it originally came into operation in the network.

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40 Energimarknadsinspektionen, ”Förhandsregleringen krav på effektiviseringar – intäktsramen för löpande kostnader, EI R2010:11.
42 Energimarknadsinspektionen, ”Värdering av elnätsföretagens kapitalbas i förhandsregleringen”, EI R2010:07, juni 2010.
43 [http://www.energimarknadsinspektionen.se/For-Energiforetag/EI/Forhandsprovning-av- elnatstariffer/Viktiga-dokument-forhandsreglering/](http://www.energimarknadsinspektionen.se/For-Energiforetag/EI/Forhandsprovning-av- elnatstariffer/Viktiga-dokument-forhandsreglering/)
To take into account the change in price mode from the acquisition to present the Development of production cost for buildings’s index is used. The company must be able to verify that the acquisition value is the original.

*Valuation according to book value*

If there are no prerequisites to compute a replacement value based on the standard value or acquisition value, cost is calculated on basis of the asset's book value.

*Valuation by other way*

If none of the above methods are applicable, then the value of the facility has to be determined by a reasonable method\(^4\). An example could be a rented facility that is not in the list of standard values.

**4.1.2.2 Return-on-capital (cost of capital)**

Ei have decided to use the Weighted Average Cost of Capital (WACC) method. The WACC method is an established method for determining the rates of return. WACC is used by several regulators for deciding on the norm value of rate of return. When the rate-of-return is calculated Ei aim to estimate the level of return that is necessary for attracting capital to the industry.

Ei has for the period of 2012-2015 commissioned an estimation of the WACC from two independent financial consultancies. On the basis of those reports Ei set the real WACC before tax to 5,2 % for the regulatory periods up to 2015 without any change during those years\(^5\). Table 1 presents an overview of the parameters for the WACC.

**Table 1 Rate of return parameters for the first regulatory period**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk free rate nominal</td>
<td>4,0%</td>
</tr>
<tr>
<td>Market risk premium</td>
<td>4,74%</td>
</tr>
<tr>
<td>Tax rate</td>
<td>20,0%</td>
</tr>
<tr>
<td>Asset beta</td>
<td>0,38</td>
</tr>
<tr>
<td>Equity beta</td>
<td>0,66</td>
</tr>
<tr>
<td>Illiquidity premium</td>
<td>0,50%</td>
</tr>
<tr>
<td>Debt share</td>
<td>0,50</td>
</tr>
<tr>
<td>Debt/equity share</td>
<td>1,00</td>
</tr>
<tr>
<td>Expectation on inflation</td>
<td>1,99%</td>
</tr>
<tr>
<td>Debt premium</td>
<td>1,49%</td>
</tr>
</tbody>
</table>

\(^4\) 11 § of the decree (2010:304)

\(^5\) Energimarknadsinspektionen, ”Kalkylränta i elnätsverksamheten”, PM 2011:07, september 2011.
4.2 Quality regulation

The Swedish Electricity Act includes general rules on quality of supply. The TSO’s quality of supply should also be considered when determining the revenue cap. In Chapter 5, 7 § of the Electricity Act can be read that the quality of supply should increase or decrease the revenue cap. The decrease should however be limited to the rate of the return. None the less for the time being, Ei has decided a “ceiling” and a “floor” for the quality adjustment to 3 % of the revenue cap.\(^{46}\)

When deciding the quality of supply, Ei uses data from the TSO on power interruptions and information about customers’ costs for interruptions. The interruption costs are calculated on the basis of a study commissioned by the Swedish Energy (the industry association for DSOs) in 1994. This study has been updated in 2003 by inflating the values by changes in consumer price indices (CPIs).\(^{47}\) The costs are therefore adjusted to the price level for respective regulatory period.

4.2.1 The measurement of quality

The quality is measured by the indicators for unplanned interruptions, annual non delivered energy (ILE) and annual non delivered power (ILEffekt) calculated per withdrawal point for unplanned interruptions. The quality norm is based on the average of the indicators for the last ten years two years before the regulatory period starts, e.g. the quality norm for 2013 is based on the interruptions for the years 2001-2010.

SvK register number of interruptions, but for interruptions up to one minutes SvK has not registered the reconnection time. Therefore, Ei has decided to exclude interruptions up to one minute in the calculation of non-delivered energy and non-delivered power.

Exceptional interruptions are defined as interruption of type N-2. The Swedish grid is sized and operated, so that a so-called design error (N-1) of a line or other item will not put at risk the stability of the network. If the error is persistent, the operating activities are adjusted within 15 minutes so the grid can hold out N-1 fault. Interruption of type N-2 takes place when two interruptions occur within 15 minutes. It may lead to larger parts of the grid can be disconnected. There have been two interruptions of this type since 2000, one in 2002 and another in 2003. Since these exceptional interruptions are rare, Ei has decided to exclude these interruptions in the calculation of ILE and ILEffekt.

4.2.2 Impact on the revenue cap

Ei estimates that the economic benefit/deficit of the changed quality of supply should be divided between the TSO and its customers. The financial outcome of the regulatory period is thus the difference between the normal interruption cost and the actual interruption cost divided by two.

4.3 Allowed revenue

The allowed revenue includes the incomes from the following activities:

- Grid fees (tariffs) – the tariff for consumers and feed-in tariff and connection.

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\(^{46}\) Energimarknadsinspektionen, ”Kvalitetsbedömning av elnät vid förhandsregleringen”, EI R2010:08, maj 2010.

\(^{47}\) Swedish Energy is the industry association for the DSO in Sweden.
• Capacity Charges (congestions/bottleneck revenues) – it occurs when the Nordic electricity market has been divided into different price areas. They are used to counter trade and investment to increase capacity and reduce the restrictions on the grid.

• Transit revenues – it consists of reimbursement of power flows through the grid from other countries.

• Other network revenues – it contains a variety of revenue e.g. settlement of congestions charges and investment grants, sales of services within and outside the group, fees for common facilities where SvK is the principal owner.

The allowed revenue is impacted by the performance quality of the grid.

4.3.1 Connection charges

SvK has the system responsibility to ensure that facilities should be connected in such a way that the power system high reliability can be maintained and therefore SvK needs to build the network structure in a way that is sustainable, technically appropriate and economically viable.

SvK has developed “Guidance for connection to the Swedish national grid”

The general rule for deciding the size of the connection charges is that the customer should pay the customer-specific costs (the components used to connect a customer) for the connection. However if a component is of benefit to other existing customer the cost for those components should be paid by all the customers connected to the grid.
