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Ownership relations and cooperation in the Norwegian power market

av

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PREFACE

The Norwegian Competition Authority (KT) under a grant from The Ministry for Government Administration and Reform (FAD) commissioned a study in December 2005 to outline the extent and nature of cooperation among the power production companies in the Norwegian Power market. The main objective of the study was to establish an updated data set that documents the status with respect to distribution of ownership of generation capacity, and to identify the main forms of cooperation and information exchange among the power generation companies in Norway.

Both secondary and primary sources have been used in the study. Data related to the distribution of generation capacity is mainly based on secondary sources and covers the total population consisting of 622 power plants and 183 companies in the Norwegian power market. In addition, requests for information were sent to a sample of power companies to collect primary information that could shed light on the status, trend, motivations, behavioural constraints, and exchange of information associated with different forms of cooperation between the power producers.

The complete data set and results are modelled in a spread sheet based database (OPS) that accompanies this report. This report summarises the main findings of the study. The primary data collected from the power companies during the sample survey is not included in this report. Only the main conclusions drawn on the basis of the analysis of the information provided by the respondents are presented in this report. It is important to emphasise that this publication reports data and information as collected from the primary and secondary sources in this project. The material presented in this publication reports a summary of the collected information and is not meant to draw any conclusions about the existence or otherwise of any form of collusion among the responding companies.

We would like to thank all those who have contributed with helpful comments and other inputs to the report. In particular, we are indebted to Lars Sørgard and Veronica Kvinge at KT and Elena Bråten at FAD for their detail comments and suggestions on the earlier versions of this report. The findings, interpretations, and conclusions expressed in this study are entirely those of the authors. They do not necessarily represent the view of the Norwegian Competition Authority or the Ministry of Government Administration and Reform.

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1 Introduction

Ownership in **P**ower **S**ector, the OPS, is a database for analysing ownership and control of production capacity in the Norwegian power market. This section provides an overview of the structure and data computations in the OPS. The material in this section is a practical guide and not an academic discourse on the metrics of ownership relations or industrial economics implications of these relations among corporate populations. Readers interested in a rigorous treatment of these topics may consult the recent literature[1].

The OPS consists of raw-data objects, the associations between these objects, and rules which govern operations on the objects. From the point of view of users, the OPS can be seen as a tree structure with some branches containing raw-data objects while other perform operations according to specified functions. Figure 1 provides a conceptual representation of the OPS.

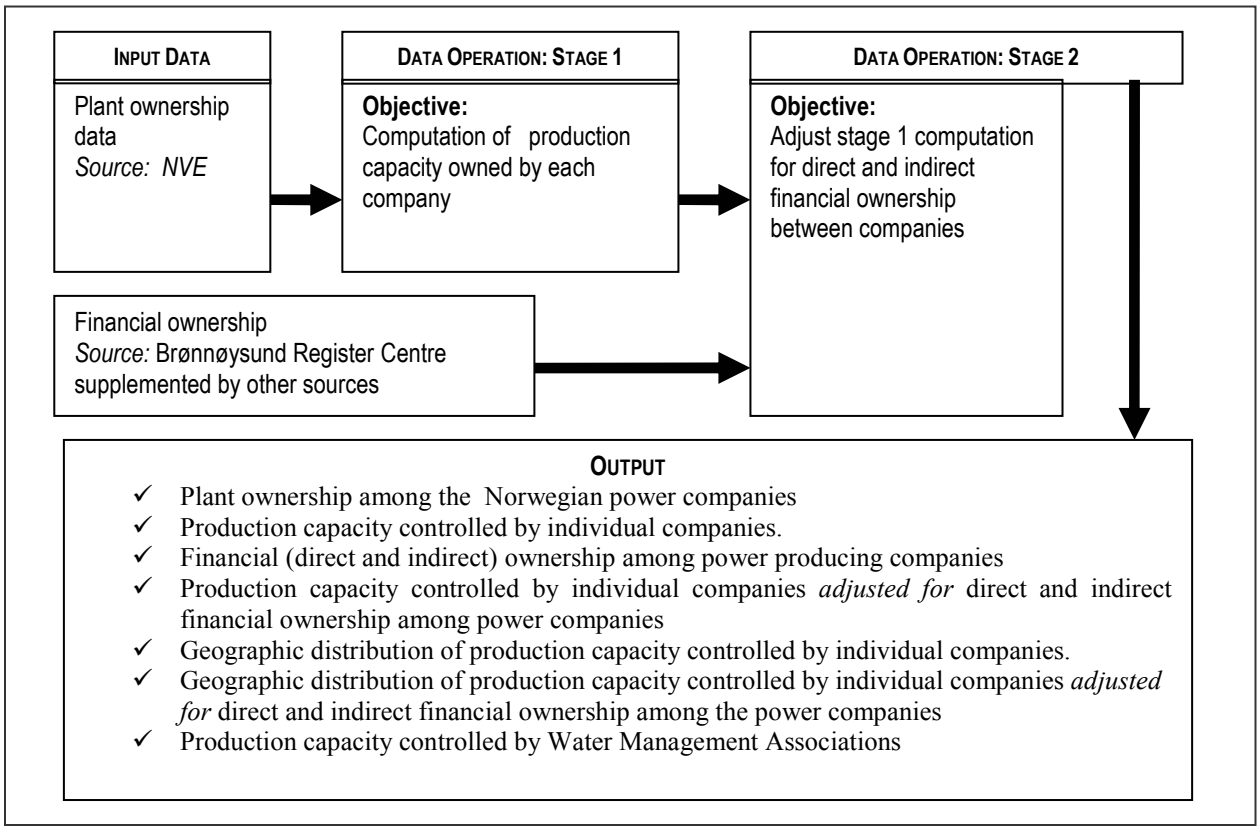


Figure 1. Conceptual structure of the OPS

[1] For a recent contribution with extensive bibliographic references on the subject see Chapelle, A., and A. Szafarz (2002) "Ownership and control: Dissecting the pyramid", Working Paper WP-CEB 03/002, Universite libre de Bruxelle, Bruxelle.

The OPS can be used as a tool to analyse the concentration in control of production capacity in the Norwegian power market. It establishes a baseline scenario for distribution of ownership and control of production capacity in the Norwegian power market for the year 2005. The users can enter actual changes in ownership relations into the raw data files and retrieve their impacts on control of production capacity with the help of routines included in the OPS. The database is organised in spread sheets and makes use of STATA™ to perform computations.

Input Data

Power plants in Norway are subject to various licensing provisions. The legislative framework for developing hydropower plants is quite elaborate and the number of licences and clearances that are required depends on the size and nature of the hydropower plant in question. The most important elements in the framework for development of hydropower plants are[2]:

- Management plan for Water Resources *(Verneplan og Samlet plan for vassdrag)*

  This is the recommendation from the government to the Parliament that sets priorities for considering individual hydropower projects. Potential hydropower developments have been divided into two categories; the first category, comprising of projects that are currently open for consideration for development, and the second category, that consists of projects that are not currently open for development.

- The Industrial Concessions Act *(Industrikonsesjonsloven)*

  To produce electricity, one needs access to a waterfall or a head to exploit energy. This Act governs the acquisition of user-rights or ownership-rights to waterfalls by all private developers of hydropower plants. It applies to all waterfalls with a technically and economically feasible production potential of more than 2944 KW. This Act was passed in 1917 and does not apply to plants that were developed before the passing of this Act.

- The Water Course Regulation Act *(Vassdragsreguleringsloven)*

  In cases where the power plant needs a regulation reservoir to store water to regulate output over the year, the plant needs an additional license under this Act.

- The Water Resources Act *(Vannressursloven)*

  Irrespective of whether or not a power plant requires licenses under the *Industrikonsesjonsloven* or the *Vassgdragsreguleringsloven,* it would normally still require a separate license under this Act. Some micro (< 0.1 MW) and mini (0.1-1MW) power plants that have insignificant impact on the water course may be exempted from this Act.

[2] For a detailed description of the legal framework for hydropower developments in Norway and motivations behind the different Acts see "Facts 2006: Energy and water resources in Norway", Ministry of Petroleum and Energy, Oslo, pp. 53-65.

- The Energy Act *(Energiloven)*
  This Act regulates through different procedures, the construction and operation of electrical installations, physical trade in power, system-coordination, network operations, quality of supply, energy planning, contingency planning etc.

- The Competition Act (*Konkurranseloven*)
  All Mergers and acquisitions of power plants need to be notified to the Norwegian Competition Authority NCA. The NCA shall intervene if the merger or acquisition in question will significantly reduce competition in the power market. Furthermore, abuse of a dominant position as well as agreements between undertakings that restrict competition are prohibited.

- In addition, the power plant may be affected by the provisions under the Compensation for the Expropriation of Real Property Act, and the Planning and Building Act and accordingly may require Environmental Impact Assessment for the plant.

Ownership relations: Some definitions

In this study, we analyse ownership and control of production capacity of all the power plants with capacity greater than 1 MW in the Norwegian power market. We assume that all these plants have the relevant permissions and licenses. Which licenses the individual power plant is subject to, or in whose name these licences have been issued is not examined in this study. It may be noted that relationship between license holdings and ownership varies across power plants depending on a number of factors and it is difficult to identify a general model in this context.

For example, consider a power plant under public ownership developed during the 1950-60s. The typical model for this development would have been that the local municipalities formed a Partnership *Sameie (SE*) that applied for a license under the *Vassdragsreguleringsloven* and the *Vannressursloven*. The relevant licenses were issued to the *SE*, which developed the power plant with the municipalities as its partners. For this project, licence under the *Industrikonsesjonslov* was not required as the partnership consisted of public owners. If the municipality held the property rights to the waterfall, the access to the waterfall was not an issue. On the other hand, if the waterfall was on private property, most probably, the property rights to the waterfall would have been acquired by the *SE* and the private owners would have been compensated under the *Compensation for the Expropriation of Real Property Act*.

If the same project had been developed during the 1990s, the municipalities concerned would have formed a legal entity, an *Interkommunalt selskap (IK*), and the *IK* would have applied

for the relevant licences. The licenses would have been issued in the name of the *IK* with municipalities as its shareholders. The IK may have developed this power plant on its own, or it may have developed the plant through a new company that it promoted together with other investors (for example the state owned power company Statkraft). In the latter case, Statkraft would today be a shareholder in the new company owning the power plant, without itself having the license in its name. A number of other variants of license holding and plant ownership have been structured during the past according to the priorities of the cooperating partners. In general, holding of a particular licence does not by itself imply ownership of the power plant and vice versa, and thus analyses of license-holdings is not a subject matter of this study.

To establish ownership and control of production capacity among producers in the Norwegian power market we distinguish between power plants and power generation companies. Power plants generate electricity and companies are legal entities that own power plants. Ownership implies control of generation in the concerned plant. A company may own a power plant individually or jointly with other companies. We refer to this as production capacity controlled by the company.

A Company X may have a direct shareholding in a company Y. We refer to this as direct financial ownership. Company X may also have indirect ownership in other companies. Indirect ownership occur when company Y holds equity in yet another company Z; thereby creating an indirect ownership interest of X in Z. We refer to this as indirect financial ownership. Financial ownership relations may take a form of one-way relationship such as in the case when X owns Y, or it may involve a two-way relationship such as where X and Y have equity participation in each other. The latter is also referred to as cross ownership in the literature.

Both, direct and indirect financial ownership implies reallocation of control of production capacity owned by a company. Production capacity owned by a company plus/minus the adjustments resulting as a consequence of direct and indirect financial ownership among the companies is referred to as the net production capacity controlled by the company.

Figure 2 illustrates the different financial ownership relations of one of the major companies in the Norwegian power market.

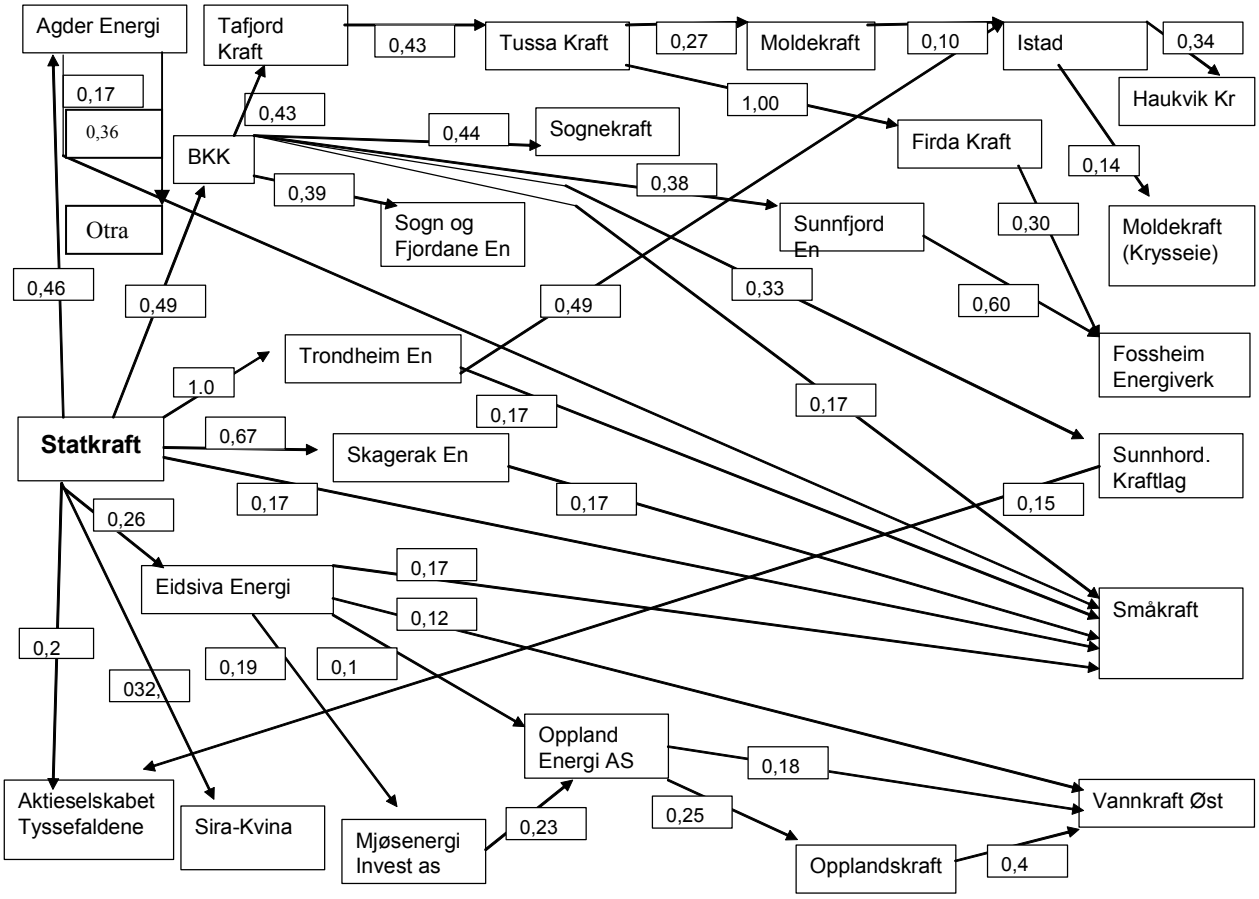


Figure 2 Direct and indirect financial ownership relations of Statkraft in the Norwegian power market

NVE Data set

Information about plant ownership in the Norwegian power market was obtained for this study from NVE. Information provided by NVE includes the following data at the plant level.

Ownership information

Power plants may be individually or jointly owned by companies. The information in the NVE dataset provides ownership structure for all the power plants with capacity greater than 1 MW in Norway. In addition, the main owner is also specified for each power plant

Information about the financial ownership of the Norwegian corporate population is available from the Brønnøysund Register Centre www.brreg.no. In addition, annual company reports and data from Amadeus database provides important information. The OPS primarily makes use of information from the Brønnøysund *Register of Business Enterprises* as updated daily by information service company Ravninfo www.ravninfo.com, to establish direct and indirect financial ownership among the Norwegian power companies[3]. Annual company reports and the Amadeus database were used as required to supplement the primary source of information.

Operations information

Power plants may be operated individually or jointly by plant owners. The information provided in the NVE dataset gives the share of the operation rights held by individual owners for all power plants with capacity greater than 1 MW in Norway.

Capacity information

Three capacity measures are given for each power plant; installed capacity in MW, annual energy production capacity in GWh and a measure of storage capacity.[4] Annual energy production capacity refers to a year with normal precipitation. The information used in the OPS covers 622 plants with total installed production capacity of 27888 MW representing a production potential of 118972 GWh which is close to 100% of total production capacity in Norway in a year with normal precipitation[5].

[3] Access to this service is available on subscription. For the list of companies and corporate groups included in the analysis see appendix 1.

[4] We are also thankful to NVE for providing a data set that gives an overview of the ownership of hydro storage capacity in the system.

[5] Data for the plants included in the OPS is available in the spread sheet based database that accompanies this report.

Supplementary Information
This includes information about the county in which the power plant is located and the year in which it was set into operation.

Information concerning geographic distribution of individual power plants across the most commonly used operations areas or "driftsområder" in the Norwegian power system was obtained from the national grid company Statnett.

Data collection and processing

Information presented in this report is collected at both the ***population*** and ***sample*** level. The OPS computations estimate the distribution of production capacity on the national and regional level. Information about cooperation and exchange of information among firms was collected through a questionnaire-based survey carried out among the Norwegian power companies.

Population Study

For the total population of power plants and power companies in Norway, the following computations were conducted:

- Plant ownership among the Norwegian power companies
- Production capacity controlled by individual companies.
- Financial (direct and indirect) ownership among power producing companies
- Production capacity controlled by individual companies *adjusted for* direct and indirect financial ownership among power companies
- Geographic distribution of production capacity controlled by individual companies.
- Geographic distribution of production capacity controlled by individual companies *adjusted for* direct and indirect financial ownership among the power companies
- Production capacity controlled by Water Management Associations

Population level computations are presented in section 3 of this report. Computations are conducted both in terms of *installed power capacity, MW,* and in terms of annual *energy production capacity, GWh,* for each company. In addition, information for distribution of

storage capacity mm^3 (million cubic metres) among power companies is also provided. In the above computations, **net production capacity** controlled by a company is given by the sum of production capacities owned by a company plus/minus the *adjustments* resulting as a consequence of direct and indirect financial ownership among the companies. The adjustments are made on the basis of specific assumptions that are commonly used in economic literature and do not necessarily reflect the practice followed by the Norwegian Competition Authority in concrete cases. In the *baseline scenarios* presented in this report, adjustments are made *assuming that capacity controlled by a company is in proportion to its actual direct and indirect financial ownership* in other companies. In other words, we assume equivalence between size of shareholding and control rights to production capacity.

Another alternative is to apply a rule based on ***empirical evidence.*** An empirical study (La Porta et al.1999)[6] estimates that a 20% financial ownership share may be sufficient to exercise full control over a company. In this case it must be emphasized that the control thresholds depend on the total ownership structure of a firm, in particular the ability and the willingness of the minority shareholders to exercise control. If ownership is dispersed amongst a large number of small shareholders, a share of even less than 20% may be sufficient to exercise control over a company.

Other alternatives for assessing control issues is to distinguish between the voting share of a owner as given by its financial ownership share and the owner's voting power. Various ***voting power*** indices can be used to analyse the voting power of a given shareholder. Two common indices that are often computed in this context are Shapley Shubik Index (SSI) and the Banzhaf Index (BI). The methodology underpinning can be explained in detail but we provide an intuitive explanation[7]. To understand the idea behind the *Shapley Shubik Index,* assume a voting game where all the players vote in a *particular order*. Whenever a winning coalition is formed for the first time in a given ordering of votes, the player who changed the coalition to a winning coalition is given a "pivot point". When computing SSI we consider all possible orderings of a given number of players in a voting game. If there are *n* players, there are *n!* orderings and for each of these orderings one pivot point is allocated to the player whose vote forms a winning coalition. The SSI can then be computed for each player as the

[6] La Porta R., F. Lopez-de-Silva, and A. Shleifer (1999) "Corporate Ownership around the World", Journal of Finance, 54,2 pp. 471-517.
[7] For computation details see section 3 of this report

total number of pivot points awarded to the player divided by all the possible orderings which is equal to *n!*

To understand the idea behind the *Banzhaf Index,* assume a voting game and consider a "proposal" that has been set before the players where each player votes yes or no. Now consider a particular yes/no voting pattern *P* which results in the proposal being passed. For each player *s* in this voting pattern who voted yes we determine what would have happened if *s* had voted no. If the result on this basis is that the proposal would have been rejected we allocate *s* a "pivot point". Note that for each pattern there may be several pivot points. This is in contrast to SSI where each voting ordering is associated with only one pivot point. The *BI* can then be computed for each player. First we calculate the total number of pivot points awarded to a player for all voting patterns *P* where the *proposal was passed* and the *player voted yes*, and where *had the player voted no*, the bill would have been *rejected*. The *BI* for the player is then the total of pivot points awarded to each player divided by the total of pivot points for all the players.

Which of these indices are better is not a trivial issue. Firstly, these are not the only power indices that have been proposed and there are other suggestions as well in the literature[8]. The main conclusion that can be drawn is that investigation of the concrete ownership constellation and voting situations must be undertaken and a decision made as to which of the indices is most relevant. In section 4, we provide some *alternative scenarios* for capacity controlled by each firm where the adjustments for direct and indirect financial ownership are made *assuming that capacity controlled by a company is in proportion to its voting power as reflected by SSI and BI* in other companies.

Sample Survey

In addition to the population-level information, data was also collected through a questionnaire-based survey covering a sample of 21 companies. Details about the structure of the survey are provided in section 5 of this report.

8 For free software for computation of different control indices see for example http://www.misojiro.t.u-tokyo.ac.jp/~tomomi/cgi-bin/vpower/index-e.cgi

2 Distribution of production capacity

Data in the population-study covers 622 plants and 183 power companies. Tables and discussion in this section refer to the 15 largest units in each category of information summarised in the tables.

The OPS computations to establish the distribution of net production capacity are undertaken in two stages. In stage 1, we compute the production capacity controlled by each company. Figure 3 illustrates the computations in stage 1.

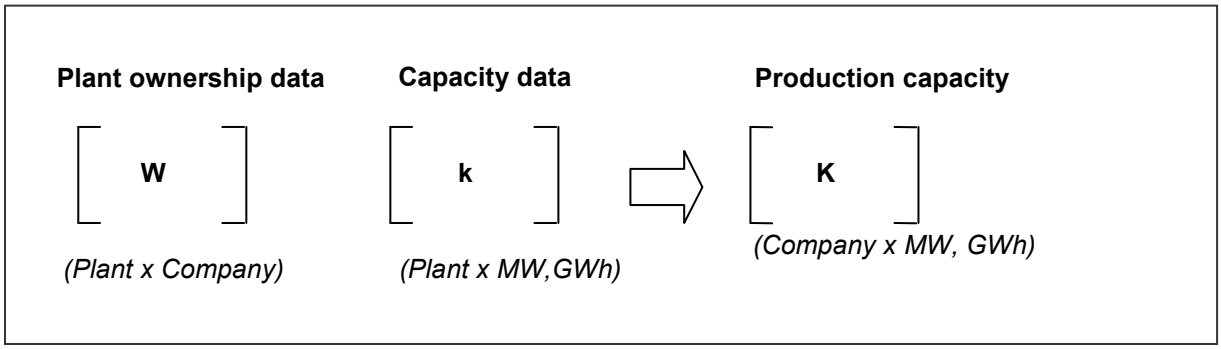


Figure 3 Schematic representation of computation in stage 1

More formally, let $\mathbf{W} = \left[w_{ig} \right] for\ i = (1,.....n),\ g = (1,.....m)$ be the plant ownership matrix where element w_{ig} is the share of the plant owned by firm (company) i in plant g. Define a vector $\mathbf{k}$, which gives the capacity of the set g, of power plants. Then production capacity $\mathbf{K}$ controlled by a firm i is given by

$$K_i = \sum_g w_{ig} k_g ,$$

Using matrix notation, the distribution of *production capacity* is given by the matrix

$$\mathbf{K = Wk'}$$

Example 1: Production capacity

Consider a case with 3 firms a, b and c, and four production plants, 1, 2, 3 and 4. Further assume that firm a owns 100% of production plants 1 and 2 and 50% of production plant 3. The remaining share of total production capacity is owned by firm b. There are no direct or indirect financial ownership relations among the firms and all the firms are owned by shareholders such as the state, counties, municipalities, who are external to the power industry. All production plants have a production capacity of 10 units. The plant ownership data is given in the table below.

	Company			Capacity
	a	b	c	MW
Plant 1	1	0	0	10
Plant 2	1	0	0	10
Plant 3	0,5	0,5	0	10
Plant 4	0	1	0	10

In the above case, in stage 1 we define matrix **W** that gives the plant ownership among the power companies, and plant capacity matrix **k** to compute the production capacity controlled by each company as follows:

$$\mathbf{W} = \begin{pmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 0,5 & 0,5 & 0 \\ 0 & 1 & 0 \end{pmatrix}, \quad \mathbf{k} = \begin{pmatrix} 10 \\ 10 \\ 10 \\ 10 \end{pmatrix}, \quad \mathbf{K} = (\mathbf{k'W})' = \begin{pmatrix} 25 \\ 15 \\ 0 \end{pmatrix}$$

Since all the firms are owned by external shareholders, we assume that each company controls its production capacity on behalf of its external shareholders.

Table 1 provides an overview of the structure of the distribution of plant ownership for the 15 largest plants in the Norwegian power industry

Table 1 Plant ownership among the Norwegian power companies

POWER PLANT	OWNER*	OWNER	COUNTY	GWh	MW
TONSTAD	STATKRAFT SF	0.321	VA	4169	960
	SKAGERAK ENERGI AS	0.146			
	SIRA KVINA KRAFTSELSKAP **(x)**	0.000			
	LYSE ENERGI AS	0.411			
	AGDER ENERGI AS	0.122			
KVILLDAL	STATKRAFT SF **(x)**	0.720	RO	3517	1240
	OTRA KRAFT DA	0.073			
	LYSE ENERGI AS	0.180			
	HAUGALAND KRAFT AS	0.025			
	AGDER ENERGI AS	0.002			
AURLAND I	STATKRAFT SF	0.070	SF	2407	675
	E-CO ENERGI AS **(x)**	0.930			
TOKKE	STATKRAFT SF **(x)**	1.000	TE	2221	430
RANA	STATKRAFT SF **(x)**	1.000	NO	2123	500
SY-SIMA	SUNNHORDLAND KRAFTLAG AS	0.088	HO	2075	620
	STATKRAFT SF **(x)**	0.650			
	BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	0.263			
SVARTISEN	STATKRAFT SF **(x)**	0.700	NO	1996	350
	AS NORDLANDSKRAFT	0.300			
AURA	STATKRAFT SF **(x)**	1.000	MR	1774	290
NEDRE RØSSÅGA	STATKRAFT SF **(x)**	1.000	NO	1708	250
NES	VARDAR AS	0.286	BU	1425	250
	E-CO ENERGI AS **(x)**	0.571			
	AKERSHUS ENERGI AS	0.143			
BROKKE	OTRA KRAFT DA **(x)**	1.000	AA	1407	330
NYE TYIN	NORSK HYDRO ASA **(x)**	0.000	SF	1398	374
	NORSK HYDRO ASA	1.000			
EVANGER	BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS **(x)**	1.000	HO	1380	330
SKAGEN	NORSK HYDRO ASA **(x)**	0.000	SF	1357	270
	NORSK HYDRO ASA	1.000			
LANG-SIMA	SUNNHORDLAND KRAFTLAG AS	0.088	HO	1329	500
	STATKRAFT SF **(x)**	0.650			
	BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	0.263			

Note: * *(x) refers to the company responsible for technical operations*.

Table 2 provides the distribution of production capacity among the 15 largest firms in Norway.

Table 2 Production capacity owned by individual companies

Company	**GWh**	**MW**	**MAG**
STATKRAFT SF	35888	8651	21659
E-CO ENERGI AS	7416	2022	2538
NORSK HYDRO ASA	6867	1521	1761
LYSE ENERGI AS	5871	1537	2733
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	6856	1556	1518
AGDER ENERGI AS	5571	1187	2114
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	3247	683	2340
AKERSHUS ENERGI AS	965	193	219
ELKEM AS	1413	279	794
ØSTFOLD ENERGI AS	1832	384	466
HAFSLUND ASA	2661	504	0
TRØNDERENERGI AS	1545	334	671
VARDAR AS	650	124	110
SKAGERAK ENERGI AS	4024	1056	2032
TROMS KRAFT AS	1107	239	585
SUM 15	85912	20270	39541
Total	**118973**	**27888**	**60253**

Note: Reservoir capacity is in mill m^3

Production capacity controlled by individual companies adjusted for direct and indirect financial ownership among the power companies

In stage 2 of the computations in the OPS, the production capacity controlled by each company is adjusted for direct and indirect financial ownership among the Norwegian power companies. A schematic overview of the computation routine to adjust for financial ownership relations in stage 2 is given in figure 4.

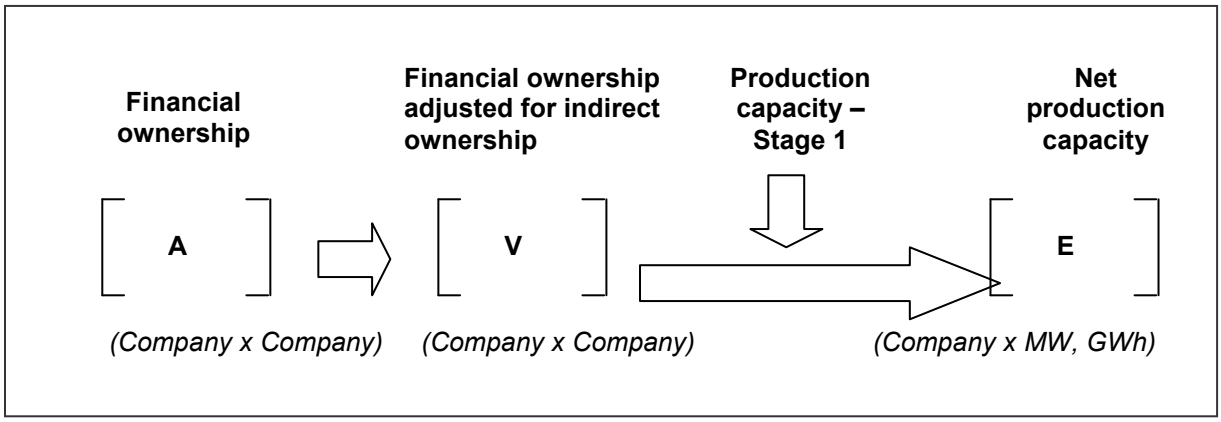


Figure 4 Schematic representation of computation in stage 2

More formally, to adjust for financial ownership relations between power companies; define a financial-ownership matrix $\mathbf{A} = \left[a_{ij} \right] for\ i,\ j = (1,.....n)$, where $0 \le a_{ij} \le 1$ is the share of equity directly held by firm i in firm j. *Indirect financial ownership* occurs when firm j has a shareholding in another firm, k. In this case, firm i's share in firm k is the product of firm i's shareholding in firm j and firm j's shareholding in firm k. A first step to compute a complete overview of the financial ownership involves computation of a matrix $\mathbf{B}$ that is obtained by multiplying all transitive share holdings:

$$\mathbf{B} = \sum_{\alpha=1}^{\infty} \mathbf{A}^{\alpha} = \mathbf{A(I - A)^{-1}},$$

where α^{th} term of the series $\mathbf{A}^{\alpha}$, represents all possible shareholding chains of length α. However a simple aggregation of shareholdings would result in double counting and the column sums of $\mathbf{B}$ may exceed 1. To correct for double-counting, we derive the adjusted financial ownership matrix $\mathbf{V}$ as follows:

$$\mathbf{V} = \left[diag(\mathbf{I - \bar{A}}) \right] \mathbf{B} = \left[diag(\mathbf{I - \bar{A}}) \right] \mathbf{A(I - A)^{-1}}$$

where $\bar{\mathbf{A}} = \left[a_j \right]$ *and* $a_j = \sum_i a_{ij}$ which is the sum equity shares held in firm j by the n-1 other firms and $diag(\mathbf{I} - \bar{\mathbf{A}})$ is a diagonal matrix where the elements on the main diagonal represent the shareholdings of the firms in the set by the external shareholders. Direct and indirect financial ownership implies reallocation of control of production capacity, $\mathbf{K}$, among the firms. The *net production capacity* for financial ownership is given by matrix $\mathbf{T}$ where

$$\mathbf{T} = \mathbf{X} + \mathbf{Y}$$

where matrices $\mathbf{X}$ and $\mathbf{Y}$ are given by:

$$\mathbf{X} = \mathbf{VK} = \left[\left[Diag(\mathbf{I} - \bar{\mathbf{A}}) \right] (\mathbf{I} - \mathbf{A})\mathbf{A} \right] \mathbf{K}$$

$$\mathbf{Y} = diag(\mathbf{I} - \bar{\mathbf{A}})\mathbf{K}$$

The matrix $\mathbf{X}$ is the capacity allocated to the firms from financial ownership relations, while the matrix $\mathbf{Y}$ gives the capacity controlled by the firm on behalf of its external shareholders such as the state, counties, municipalities who are not directly active in the power market.

Example 2: Direct financial ownership – One-way ownership relation

To understand the computations in stage 2, assume firm c owns 50% of firm b. The table below outlines the financial ownership structure in the industry.

Company	a	b	c
a	0	0	0
b	0	0	0
c	0	0,5	0

Assume further that plant ownership data is as in example 1. The impact of the single financial ownership relation is computed in stage 2, that consists of following computations. Define the $\mathbf{A}$-matrix that takes into account the company c's ownership in company b. Define matrix $diag(\mathbf{I} - \bar{\mathbf{A}})$ with only 1's along the main diagonal *except* for the cell where there is a positive ownership relation. The $\mathbf{V}$-matrix is then given by the relation $\mathbf{V} = diag(\mathbf{I} - \bar{\mathbf{A}})\mathbf{A}(\mathbf{I} - \mathbf{A})^{-1}$ as follows:

$$\mathbf{A}=\begin{pmatrix}0 & 0 & 0\\ 0 & 0 & 0\\ 0 & 0{,}5 & 0\end{pmatrix},\quad diag(\mathbf{I}-\bar{\mathbf{A}})=\begin{pmatrix}1 & 0 & 0\\ 0 & 0{,}5 & 0\\ 0 & 0 & 1\end{pmatrix},\quad \mathbf{V}=\begin{pmatrix}0 & 0 & 0\\ 0 & 0 & 0\\ 0 & 0{,}5 & 0\end{pmatrix}$$

To compute capacity controlled by firm c due to its ownership in *b*, we need to take into account that firm c now controls half of the production capacity controlled by *b* on behalf of its external shareholders. Capacity controlled by *c* is given by

$$\mathbf{X}=\mathbf{VK}=\begin{pmatrix}0 & 0 & 0\\ 0 & 0 & 0\\ 0 & 0{,}5 & 0\end{pmatrix}\begin{pmatrix}25\\ 15\\ 0\end{pmatrix},\quad \mathbf{X}=\begin{pmatrix}0\\ 0\\ 7{,}5\end{pmatrix}$$

The capacity now controlled by *b* on behalf of its external shareholders is given by the matrix $\mathbf{Y}=diag(\mathbf{I}-\bar{\mathbf{A}})\mathbf{K}$ that is computed as follows

$$\mathbf{Y}=diag(\mathbf{I}-\bar{\mathbf{A}})\mathbf{K}=\begin{pmatrix}1 & 0 & 0\\ 0 & 0{,}5 & 0\\ 0 & 0 & 1\end{pmatrix}\begin{pmatrix}25\\ 15\\ 0\end{pmatrix},\quad \mathbf{Y}=\begin{pmatrix}25\\ 7{,}5\\ 0\end{pmatrix}$$

The net production capacity controlled by each firm is then given by

$$\mathbf{T}=\mathbf{X}+\mathbf{Y}=\begin{pmatrix}25\\ 7{,}5\\ 7{,}5\end{pmatrix}$$

Example 3 Direct financial ownership – Two-way (cross) ownership relation

We take example 2 and extend the one-way financial relationship to a case of two-way or cross financial ownership relationship where we assume that now firm b owns a share of 50% in firm c. The table below outlines the ownership structure in the industry.

Company	A	b	c
a	0	0	0
b	0	0	0,5
c	0	0,5	0

The plant ownership data is still as in example 1. Redefine the $\mathbf{A}$-matrix with a positive entry that takes into account company c's ownership in company b and vice versa. Similarly,

redefine matrix $diag(\mathbf{I} - \bar{\mathbf{A}})$ with only 1's along the main diagonal *except* for the cells where there is a positive ownership relation. The $\mathbf{V}$-matrix is now more complex. When only finding the solution to the chain of financial ownership, the capacity allocated to each firm will be larger than the total capacity of the plants (double counting).[9] By pre-multiplying the matrix $\mathbf{A(I - A)}^{-1}$ with $diag(\mathbf{I} - \bar{\mathbf{A}})$ the resulting $\mathbf{V}$-matrix will not overstate the capacity:

$$\mathbf{A} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0,5 \\ 0 & 0,5 & 0 \end{pmatrix}, \quad diag(\mathbf{I} - \bar{\mathbf{A}}) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0,5 & 0 \\ 0 & 0 & 0,5 \end{pmatrix}, \quad \mathbf{V} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0,17 & 0,33 \\ 0 & 0,33 & 0,17 \end{pmatrix}$$

The capacity controlled by each firm due to cross-ownership relations are now:

$$\mathbf{X} = \mathbf{VK} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0,17 & 0,33 \\ 0 & 0,33 & 0,17 \end{pmatrix} \begin{pmatrix} 25 \\ 15 \\ 0 \end{pmatrix}, \quad \mathbf{X} = \begin{pmatrix} 0 \\ 2,5 \\ 5 \end{pmatrix}$$

The capacity controlled by *b* on behalf of its external owners remains as in example 2 where $\mathbf{Y} = diag(\mathbf{I} - \bar{\mathbf{A}})\mathbf{K}$ is given by:

$$\mathbf{Y} = diag(\mathbf{I} - \bar{\mathbf{A}})\mathbf{K} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0,5 & 0 \\ 0 & 0 & 0,5 \end{pmatrix} \begin{pmatrix} 25 \\ 15 \\ 0 \end{pmatrix}, \quad Y = \begin{pmatrix} 25 \\ 7,5 \\ 0 \end{pmatrix}$$

The net production capacity controlled by each firm is then given by

$$\mathbf{T} = \mathbf{X} + \mathbf{Y} = \begin{pmatrix} 25 \\ 10 \\ 5 \end{pmatrix}$$

[9] $\mathbf{A(I - A)}^{-1} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0,33 & 0,67 \\ 0 & 0,67 & 0,33 \end{pmatrix}, \quad \mathbf{A(I - A)}^{-1}\mathbf{K} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0,33 & 0,67 \\ 0 & 0,67 & 0,33 \end{pmatrix} \begin{pmatrix} 25 \\ 15 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 4,95 \\ 10,05 \end{pmatrix}$

Example 4: Direct and indirect financial ownership

Take example 3 and assume now that firm a owns the remaining shares in firm b; that is, firm b is now 100% owned by other firms in the industry (50% by a and 50% by c). Ownership structure in the industry is given in the table below

Company	A	b	c
a	0	0,5	0
b	0	0	0,5
c	0	0,5	0

Rewrite the $\mathbf{A}$-matrix and the matrix $diag(\mathbf{I} - \bar{\mathbf{A}})$ to account for the change in direct and indirect ownership relations. Since firm b is fully owned by other firms in the industry, $diag(\mathbf{I} - \bar{\mathbf{A}})$ has a zero value for firm b. The $\mathbf{V}$-matrix is now:

$$\mathbf{A} = \begin{pmatrix} 0 & 0,5 & 0 \\ 0 & 0 & 0,5 \\ 0 & 0,5 & 0 \end{pmatrix}, \quad diag(\mathbf{I} - \bar{\mathbf{A}}) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0,5 \end{pmatrix}, \quad \mathbf{V} = \begin{pmatrix} 0 & 0,67 & 0,33 \\ 0 & 0 & 0 \\ 0 & 0,33 & 0,17 \end{pmatrix}$$

The capacity controlled by each firm due to indirect ownership is now given by:

$$\mathbf{X} = \mathbf{VK} = \begin{pmatrix} 0 & 0,67 & 0,33 \\ 0 & 0 & 0 \\ 0 & 0,33 & 0,17 \end{pmatrix} \begin{pmatrix} 25 \\ 15 \\ 0 \end{pmatrix}, \quad \mathbf{X} = \begin{pmatrix} 10 \\ 0 \\ 5 \end{pmatrix}$$

Note that no capacity is controlled by b as it is 100% owned by firm a and firm b. There is a transfer of capacity from firm b to a. Further, note that firm c's capacity is unaltered since its ownership share in firm b is unaltered. The matrix $\mathbf{Y} = diag(\mathbf{I} - \bar{\mathbf{A}})\mathbf{K}$ is:

$$\mathbf{Y} = diag(\mathbf{I} - \bar{\mathbf{A}})\mathbf{K} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0,5 \end{pmatrix} \begin{pmatrix} 25 \\ 15 \\ 0 \end{pmatrix}, \quad \mathbf{Y} = \begin{pmatrix} 25 \\ 0 \\ 0 \end{pmatrix}$$

The net production capacity controlled by each firm is then given by:

$$\mathbf{T} = \mathbf{X} + \mathbf{Y} = \begin{pmatrix} 35 \\ 0 \\ 5 \end{pmatrix}$$

Table 3 provides the distribution of capacity controlled by individual companies adjusted for direct and indirect financial ownership among the 15 largest firms in Norway.

Table 3 Net Production Capacity: Production Capacity controlled by individual companies adjusted for direct and indirect financial ownership among the power companies

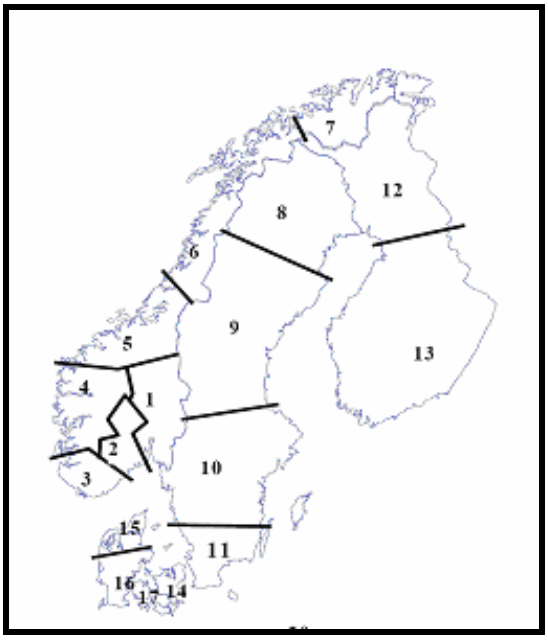
Company	GWh	MW	MAG (mm3)
STATKRAFT SF	50386	12104	27625
E-CO ENERGI AS	9822	2655	3238
NORSK HYDRO ASA	8808	1892	2439
LYSE ENERGI AS	5898	1540	2749
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	4318	989	1062
AGDER ENERGI AS	4021	972	1934
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	3247	683	2340
AKERSHUS ENERGI AS	2248	427	1698
ELKEM AS	1883	356	926
ØSTFOLD ENERGI AS	1849	387	475
HAFSLUND ASA	1754	332	0
TRØNDERENERGI AS	1637	362	689
VARDAR AS	1388	275	255
SKAGERAK ENERGI AS	1344	353	678
TROMS KRAFT AS	1223	269	585
Sum 15	99827	23597	46693
Total	**118973**	**27888**	**60253**

To illustrate the adjustment made to production capacity to arrive at net production capacity, take for example the GWh figure for Agder Energi AS given in row 6 in table 3. From table 2, we know that Agder Energi AS controls 5571 GWh of production capacity (the aggregate of Agder Energi's ownership in power plants as given in matrix **K** explained earlier). Furthermore, from financial ownership data we know Statkraft SF owns 45,52 % of Agder Energi AS. Consequently we allocate control over 2536 GWh of Agder's production capacity to Statkraft SF (the **Y** -matrix explained earlier). From financial ownership data we also know that Agder Energi AS has financial ownership in both Otra Kraft AS (68.6% of 2633 GWh) and Småkraft AS (16.67 % of 17 GWh). Consequently, we need to reallocate control of production capacity of Otra Kraft and Småkraft to Agder. This reallocation amounts to 1809.2 GWh. However, given that Agder is partly owned by Statkraft, the control to be reallocated from Otra and Småkraft is divided between Agder and Statkraft such that only 54.48 % or 986 GWh (the relevant cell is the **X** -matrix explained earlier) is allocated to Agder Energi AS and the rest to Statkraft SF. The net production capacity controlled by Agder Energi AS is then 4021 GWh (5571 - 2536 + 986) which is given by relevant cell of the **T** -matrix explained earlier in this section.

Geographic distribution of production capacity owned by Norwegian companies

In addition to the distribution of production capacity at the national level, the OPS-computations can be carried for specified geographic partitions of the Norwegian power market. There are various alternatives for creating geographic partitions of the Norwegian power system. In this report we chose to partition the Norwegian system as shown in figure 5. The partitions in the figure correspond to the most commonly used *operation-areas* or "driftsområder" defined by the national grid company Statnett.

Figure 5: Operations areas in the Norwegian and Nordic power market



It is important to emphasise that operation-areas are not necessarily the same as the *price-areas* "prisområder" defined by Nordpool; the power exchange for the Nordic market. The price-areas are typically an aggregation of the operations areas; the pattern of aggregation being determined by the actual demand, supply, and transmission capacity conditions prevailing on hourly basis in the Nordic power market. Most frequently, the Norwegian power system is divided into two price areas- South Norway (SN) comprising of operational areas 1-4, and North Norway (NN) covering operations areas 5-7. Tables 4, 5 and 6 provides information about production capacity controlled by individual companies for the most frequently used price areas SN and NN in the Norwegian power system.

Table 4 Geographic distribution of production capacity owned by Norwegian companies (MW)

COMPANY	TOTAL	SN	NN
STATKRAFT SF	8651	5759	2892
E-CO ENERGI AS	2022	2022	0
NORSK HYDRO ASA	1521	1519	2
LYSE ENERGI AS	1537	1537	0
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	1556	1556	0
AGDER ENERGI AS	1187	1187	0
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	683	0	683
AKERSHUS ENERGI AS	193	193	0
ELKEM AS	279	79	200
ØSTFOLD ENERGI AS	384	384	0
HAFSLUND ASA	504	504	0
TRØNDERENERGI AS	334	0	334
VARDAR AS	124	124	0
SKAGERAK ENERGI AS	1056	1056	0
TROMS KRAFT AS	239	0	239
SUM 15	20270	15920	4350
TOTAL	**27888**	**20867**	**7021**

Table 5 Geographic distribution of production capacity owned by Norwegian companies (GWh)

COMPANY	TOTAL	SN	NN
STATKRAFT SF	35888	21842	14046
E-CO ENERGI AS	7416	7416	0
NORSK HYDRO ASA	6867	6855	12
LYSE ENERGI AS	5871	5871	0
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	6856	6856	0
AGDER ENERGI AS	5571	5571	0
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	3247	0	3247
AKERSHUS ENERGI AS	965	965	0
ELKEM AS	1413	409	1004
ØSTFOLD ENERGI AS	1832	1832	0
HAFSLUND ASA	2661	2661	0
TRØNDERENERGI AS	1545	0	1545
VARDAR AS	650	650	0
SKAGERAK ENERGI AS	4024	4024	0
TROMS KRAFT AS	1107	0	1107
SUM 15	85912	64950	20961
TOTAL	**118973**	**86456**	**32517**

Table 6 Geographic distribution of reservoir capacity owned by Norwegian companies (mill. M^3)

Company	Total	SN	NN
STATKRAFT SF	21659	9655	12004
E-CO ENERGI AS	2538	2538	0
NORSK HYDRO ASA	1761	1738	23
LYSE ENERGI AS	2733	2733	0
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	1518	1518	0
AGDER ENERGI AS	2114	2114	0
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	2340	0	2340
AKERSHUS ENERGI AS	219	219	0
ELKEM AS	794	222	572
ØSTFOLD ENERGI AS	466	466	0
HAFSLUND ASA	0	0	0
TRØNDERENERGI AS	671	0	671
VARDAR AS	110	110	0
SKAGERAK ENERGI AS	2032	2032	0
TROMS KRAFT AS	585	0	585
Sum 15	39541	23347	16194
Total	**60253**	**33764**	**26489**

Geographic distribution of production capacity owned by Norwegian companies *adjusted* for direct and indirect financial ownership among the power companies

Tables 7 to 9 below provide information about production capacity controlled by individual companies *adjusted* for direct and indirect financial ownership among the power companies for the two different geographic regions Northern Norway and Southern Norway.

Table 7 Geographic distribution of production capacity owned by Norwegian companies; adjusted for direct and indirect financial ownership among the power companies. (MW)

COMPANY	TOTAL	SN	NN
STATKRAFT SF	12104	8376	3728
E-CO ENERGI AS	2655	2654	1
NORSK HYDRO ASA	1892	1812	80
LYSE ENERGI AS	1540	1540	0
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	989	926	64
AGDER ENERGI AS	972	972	0
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	683	0	683
AKERSHUS ENERGI AS	427	427	1
ELKEM AS	356	156	200
ØSTFOLD ENERGI AS	387	386	1
HAFSLUND ASA	332	332	0
TRØNDERENERGI AS	362	0	362
VARDAR AS	275	275	0
SKAGERAK ENERGI AS	353	353	0
TROMS KRAFT AS	269	0	269
Sum 15	23597	18208	5389
Total	**27888**	**20867**	**7021**

Table 8 Geographic distribution of production capacity owned by Norwegian companies; adjusted for direct and indirect financial ownership among the power companies. (GWh)

COMPANY	TOTAL	SN	NN
STATKRAFT SF	50386	32791	17595
E-CO ENERGI AS	9822	9816	6
NORSK HYDRO ASA	8808	8452	356
LYSE ENERGI AS	5898	5898	0
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	4318	4074	244
AGDER ENERGI AS	4021	4021	0
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	3247	0	3247
AKERSHUS ENERGI AS	2248	2244	5
ELKEM AS	1883	879	1004
ØSTFOLD ENERGI AS	1849	1845	5
HAFSLUND ASA	1754	1754	0
TRØNDERENERGI AS	1637	0	1637
VARDAR AS	1388	1386	2
SKAGERAK ENERGI AS	1344	1344	0
TROMS KRAFT AS	1223	0	1223
SUM 15	99827	74503	25324
TOTAL	**118973**	**86456**	**32517**

Table 9 Geographic distribution of reservoir capacity owned by Norwegian companies; adjusted for direct and indirect financial ownership among the power companies. (mill. M^3)

Company	Total	SN	NN
STATKRAFT SF	27625	13958	13667
E-CO ENERGI AS	3238	3230	8
NORSK HYDRO ASA	2439	2168	271
LYSE ENERGI AS	2749	2749	0
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	1062	980	82
AGDER ENERGI AS	1934	1934	0
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	2340	0	2340
AKERSHUS ENERGI AS	1698	1692	7
ELKEM AS	926	355	572
ØSTFOLD ENERGI AS	475	468	7
HAFSLUND ASA	0	0	0
TRØNDERENERGI AS	689	0	689
VARDAR AS	255	253	2
SKAGERAK ENERGI AS	678	678	0
TROMS KRAFT AS	585	0	585
Sum 15	46693	28464	18229
Total	**60253**	**33764**	**26489**

Distribution of production capacity among the Water Management Associations in Norway

Hydro resources in the Norwegian power system are located in geographically separated catchment areas in Norway. Within each catchment area, ownership of storage and generation facilities may be dispersed among a large number of power companies. A number of these companies cooperate through WMAs to attain optimal storage and utilisation of their hydro generation capacity. Participation in the Water Management Associations (WMAs) may be legally mandated and organised as associations established under the *Vassdragsregulerings Law 1917,* corporate entities under the company law or informal producer networks and producer interest groups in a catchment area. In addition, the scope, objectives, size, and modus operandi may also vary across these associations. An examination of the licenses granted by the Norwegian Water Resources and Energy Directorate NVE reveals that there are at least 22 licensed WMAs spread out over 11 catchment areas in the Norwegian power system.

Table 10 Registered Water Management Associations in the Norwegian Power System

CATCHMENT AREA	WATER MANAGEMENT ASSOCIATION
HALDENVASSDRAGET OG TISTA	TISTAS BRUKSEIERFORENING
	HALDENVASSDRAGETS (X)
GLOMMA	HUNNSELVENS
	GLOMMENS OG LAAGENS (X)
	LEKUMVASSDRAGET
	MESNAVASSDRAGETS
MOSSE	MOSS
NORDMARK	AKERSELVENS
SIMOA	FORENINGEN TIL TYRIFJORDS REGULERING
	FORENINGEN TIL BÆGNAVASSDRAGEST REGULERING (X)
	FORENINGEN TIL RANDFJORDS REGULERING
	ÅNGERMANSELVENS VATTENREGULERINGSFORETAK
NUMEDALSLÅGEN	FORENINGEN TIL HALLINGDALSVASSDRAGETS REGULERING
	FORENINGEN TIL YLJAVASSDRAGETS REGULERING
	NUMEDALS-LAUGENS (X)
VEST	SKIENS BRUGSEIER (X)
	ØST TELEMARKENS (X)
	NEDREVEST-TELEMARKS
KRAGERØ	KRAGERØVASSDRAGETS
ARENDALS	ARENDALSVASSDRAGETS (X)
OTRA	OTTERAAENS (X)
KVINA	KVINA

Source: NVE, http://www.nve.no/admin/FileArchive/100/kdbv001-015.pdf, http://www.nve.no/admin/FileArchive/100/kdbv016-050.pdf

The NVE information in the public domain only lists the names of the WMAs, however there is no information about the reservoir or generation capacity managed through these WMAs,

or the companies that participate in these organisations. It may be mentioned that not all of these WMAs are large organisations with significant resources. Comparison of the NVE license data base with the Brønnøysund Register BR revealed that of the 22 WMAs identified in the NVE database, only 8 of these were registered in the Brønnøysund register. Information provided in BR is quite limited and it does not provide any information about the reservoirs or power plants managed by the registered WMAs or the power companies participating in the concerned WMA.

On the basis of data search and a telephone survey among the registered WMAs and examination of their annual reports and websites, production capacity information could be compiled for 3 WMAs. All of the three WMAs are located in the South Norway price area of the Norwegian power system. It may be mentioned that one of these WMAs was also contacted in the sample survey reported in section 5 of this report, however the WMA concerned did not respond directly to the survey questionnaire and instead referred the matter to its member power companies. Table 11 provides a summary of the capacity managed by a sample of 3 WMAs in South Norway.

Table 11 Production capacity managed by WMA in Norway. (MAG in mill. M^3)

CATCHMENT AREA	WATER MANAGEMENT ASSOCIATION	GWH	MW	MAG.
GLOMMA	GLOMMENS OG LAAGENS MEMBERS: 21 POWER STATIONS: 45 SEE WWW.GLB.NO FOR DETAILS	10071	2073	3522
SIMOA	FORENINGEN TIL BÆGNAVASSDRAGEST REGULERING MEMBERS:7 POWER STATIONS: 18 SEE WWW.BEGNA.NO FOR DETAILS	2263	509	1038
NUMEDALSLÅGEN	NUMEDALS-LAUGENS MEMBERS:6 POWER STATIONS: 13 SEE WWW.NLBVASSDRAG.NO FOR DETAILS	1942	553	936

Source: WMA websites. Estimates for installed capacity (MW) for Begna and Numedals-Laugens are based on OPS computations

3 Ownership, control and market concentration: An illustration

The computations presented in sections 2 provided a *base-line scenario* where adjustments due to financial ownership relations were made *assuming that capacity controlled by a company is in proportion to its actual direct and indirect financial ownership* in other companies. Table 12 and 13 provides estimates of Herfindahl-Hirschman index (HHI)[10]. Computations are made both for the base-line scenario data (Column 1 entitled "Financial), and for scenarios where the adjustments due to financial ownership are made *assuming that capacity controlled by a company is in proportion to its voting power as reflected by SSI and BI* in other companies. To reduce computations for the calculation of power indices we have restricted the analysis to compute voting power of 7 shareholders which include the six largest shareholders plus a seventh shareholder that is assumed to collectively represent the remaining small shareholders in a company. Indices are calculated both for installed capacity and the energy production potential of different companies in a normal year.

Table 12 Market concentration in the Norwegian Power Market- (Capacity in GWh)

COMPANY	FINANCIAL		SHAPLEY		BANZHAF	
	CAP	HHI	CAP	HHI	CAP	HHI
STATKRAFT SF	50386	1794	55273	2158	56392	2247
E-CO ENERGI AS	9822	68	11617	95	11619	95
NORSK HYDRO ASA	8808	55	8747	54	8747	54
LYSE ENERGI AS	5898	25	5481	21	5481	21
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	4318	13	1884	3	1070	1
AGDER ENERGI AS	4021	11	3497	9	3192	7
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	3247	7	3247	7	3247	7
AKERSHUS ENERGI AS	2248	4	1935	3	1930	3
ELKEM AS	1883	3	1892	3	1892	3
ØSTFOLD ENERGI AS	1849	2	1849	2	1849	2
HAFSLUND ASA	1754	2	2661	5	2661	5
TRØNDERENERGI AS	1637	2	1574	2	1602	2
VARDAR AS	1388	1	1081	1	1081	1
SKAGERAK ENERGI AS	1344	1	0	0	0	0
TROMS KRAFT AS	1223	1	1274	1	1284	1
Sum 15	99827	1989	102011	2364	102048	2449
Total	**118973**	**1997**	**118973**	**2371**	**118973**	**2457**

[10] The HHI is given by, $HHI = 10000\sum(s_i)^2$ where s_i is the market share of firm i.

Table 13 Market concentration in the Norwegian Power Market- (Capacity in MW)

COMPANY	FINANCIAL		SHAPLEY		BANZHAF	
	CAP	HHI	CAP	HHI	CAP	HHI
STATKRAFT SF	12104	1884	13498	2343	13747	2430
E-CO ENERGI AS	2655	91	3128	126	3129	126
NORSK HYDRO ASA	1892	46	1871	45	1871	45
LYSE ENERGI AS	1540	31	1331	23	1331	23
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	989	13	402	2	228	1
AGDER ENERGI AS	972	12	858	9	783	8
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	683	6	683	6	683	6
AKERSHUS ENERGI AS	427	2	368	2	367	2
ELKEM AS	356	2	357	2	357	2
ØSTFOLD ENERGI AS	387	2	387	2	387	2
HAFSLUND ASA	332	1	504	3	504	3
TRØNDERENERGI AS	362	2	351	2	359	2
VARDAR AS	275	1	221	1	221	1
SKAGERAK ENERGI AS	353	2	0	0	0	0
TROMS KRAFT AS	269	1	282	1	285	1
Sum 15	23597	2094	24241	2565	24253	2650
Total	**27888**	**2101**	**27888**	**2572**	**27888**	**2657**

As indicated in tables 12 and 13, there is a high degree of concentration in control of production capacity in the Norwegian power market. The data indicates that concentration is higher when we calculate the indices on the basis of the share of installed capacity (MW) as compared to the computations based on the share of energy production (GWh) in a normal year. Indices based on data corrected for control as reflected by SSI and BI for the concerned companies further supports the conclusion. The results in table 12 with respect to Financial HHI are similar to results obtained in an earlier study however the same cannot be said for the results related to Banzhaf HHI which are higher in the earlier study. [11]

Table 14 provides an overview of the degree of market concentration on a regional basis. In the recent years, there has been a growing debate that calls for an increase in the number of price areas for congestion management in the Norwegian power market. Most of this debate has abstracted from the issues of market concentration. Results in table 14 indicate the concentration levels in the regional markets.

[11] See for example "A powerful competition policy", Report form the Nordic competition authorities, No. 1/2003. In this study, State, Counties and Municipalities are explicitly included as owners and given the high share of public ownership in the Norwegian power market this may explain the higher values for voting power indices.

Table 14 Market concentration in geographic regions in the Norwegian Power Market- (HHI for capacity in GWh)

COMPANY	TOTAL	SN	NN
STATKRAFT SF	1794	1439	2928
E-CO ENERGI AS	68	129	0
NORSK HYDRO ASA	55	96	1
LYSE ENERGI AS	25	47	0
BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	13	22	1
AGDER ENERGI AS	11	22	0
NORD-TRØNDELAG ELEKTRISITETSVERK FKF	7	0	100
AKERSHUS ENERGI AS	4	7	0
ELKEM AS	3	1	10
ØSTFOLD ENERGI AS	2	5	0
HAFSLUND ASA	2	4	0
TRØNDERENERGI AS	2	0	25
VARDAR AS	1	3	0
SKAGERAK ENERGI AS	1	2	0
TROMS KRAFT AS	1	0	14
SUM 15	1989	1775	3078
TOTAL	1997	1783	3116

Needless to say, the figures in the table would be sensitive to the geographic boundaries demarcated in a concrete situation. Computations for alternative scenarios for regional markets can be made using the OPS.

4 Cooperation and exchange of information: Sample survey

The purpose of this section is to outline:

- Why the survey was conducted and the coverage of the survey.
- The status and recent trend in types of cooperation in which the companies surveyed participate.
- The motivations behind the current forms of cooperation disclosed by the companies surveyed.
- The constraints on commercial behaviour associated with different forms of cooperation.
- The main channels for information exchange associated with different forms of cooperation.

The **main purpose** of the survey was to obtain primary information that could not be retrieved from the secondary data used in the population study. Hydropower companies may engage in different forms of cooperation that may range from direct or indirect financial ownerships to complicated forms of joint ownership and operation of hydro facilities. Some of these forms of cooperation may be legally mandated by the licensing authorities to assure optimal usage of precipitation in a catchment area as in the case of WMAs who may or may not be covered by the secondary datasets used in the population survey. Similarly, motivations, constraints, and information exchange associated with different forms of cooperation are often firm-specific information that is only available to the companies engaged in such cooperation.

An important consideration in any survey is related to the choice of the **sample** for the survey. The sampling strategy in the survey was focused on selecting companies that represented wide variations both with respect to their size and participation in different forms of cooperation among the companies. In other words, a maximum-variation purposeful sample consisting of 21 companies was constructed for the survey.

Primary **data collection** was carried out using a questionnaire-based postal survey that was supplemented by telephone and personal interviews as required to gather information. Data collected in the survey distinguished between the following six forms of cooperation

Financial ownership relations between companies. The corporate ownership structure in the Norwegian power market is such that there are very few companies that are listed on the stock exchange and most of the companies are under public ownership; represented through the Central, County or municipal owners.

Jointly owned power plants. Most of the current installed capacity in Norway was built during the years 1970-1985 and there have only been marginal additions in capacity during the last 15 years. Historically power plant licences have been allocated to owner consortiums (mainly state, counties and municipalities). The existing structure of plant ownership is a consequence of the past licensing practices and priorities and currently joint ownership of plants is quite common.

Participation in Water Management Associations (WMAs)
All hydro storage and regulation systems in Norway require a licence from the Norwegian Water Resources and Energy Directorate NVE. WMAs often hold these licences on behalf of its member hydro power companies. The main objective of WMA is to develop and operate storage reservoirs and regulation systems to assure optimal utilisation of natural flow of water in the rivers, keeping in view the production plans of its member hydropower companies. Member companies are represented on the board of directors of WMA and provide financial resources for the running of the WMA. At the operational level, regular contact is maintained between the WMA and its member power companies to realise the overall objectives of the WMA.

Plant operation contracts. Jointly owned plants are often operated by one of the owners. In most cases the majority owner takes on the role of plant operator on behalf of the other co-owners. Large producers may also enter into contracts for operation of plants where they may not have any ownership interests.

Joint sales organisations if any established by a corporate group.

Other activities. Additional forms of cooperation including activities such as joint maintenance of facilities, training of personnel, etc.

The **questionnaire** used in the survey consisted of following five sections:

A. *General information* about current cooperation activities of the respondents. Included herein was information related to the *status* in 2005 and the *trend* during the period 2000-2005.
B. *Motivations* for current cooperation activities. The respondents were asked to reflect on the necessity and likely alternatives to current forms of cooperation. In particular, information about three likely motivations- reliability of supply, optimal use of hydro resources and optimal use of storage facilities were specifically investigated.
C. *Constraints* on the commercial decisions of the cooperating partners. Constraints on five commercial decisions- hydro storage, use of hydro flows, use of generation capacity, sales activities, and investment decisions were investigated.
D. *Information exchange* in cooperation. Information exchange through seven main channels of cooperation – participation in company boards, exchange of employees, exchange of generation plans, and exchange of information related to precipitation and hydro inflows, exchange of information related to network conditions, exchange of information related to demand conditions and exchange of investment plans were investigated.
E. *Comments.* Given the complex nature of the issues under examination, participants were encouraged to use this section to comment or qualify the responses to the closed and open questions in sections A-D.

Choices regarding the companies to be included in the sample, questionnaire design and information to be collected in the survey were made in consultation with the Norwegian Competition Authority. The questionnaire used in the survey and the companies included in the sample is provided in appendix 2.

Sample survey: Initial Findings

This sub section summarises the preliminary findings based on the analysis of the responses received from the companies included in the survey. The survey was conducted during March

–May 2005. The response rate in the survey is quite satisfactory and well above 70%. Of a sample consisting of 21 companies, 16 companies responded to the questionnaire. One of the respondents was a WMA who chose to refer the questionnaire to their member power companies and did not respond directly to the questionnaire. Individual question-response rates vary across the firms. For some firms with limited participation in cooperation activities, answering the questionnaire required limited resources. For major players with a mesh of ownership relations and participation in different forms of cooperation agreements, responding to the questionnaire required more effort. All the firms made extensive use of section E to comment and qualify the answers in the questionnaire.

Status and recent trend in types of cooperation

The table below summarises the distribution of the respondents across different forms of cooperation

Table 15 Distribution of the respondents across different forms of cooperation

	Ownership in other companies	Jointly owned plants	Participation in WMA and plant operation entities	Plant operations contracts	Joint sales organisations	Others
N	6	10	5	6	0	4

Note: Data in the table refer to the number of respondents who confirmed participation in the respective form of cooperation

The data indicates that respondent companies displayed a wide variation with respect to their participation in different forms of cooperation identified in the survey. The only exception is joint sales organisations, where none of the companies report any participation. However, detailed examination of comments submitted by respondents reveals that this may not be the case. For example, one respondent, a jointly owned plant operating company participates in the *balancing market* on behalf of its owners. In this company, joint owners take deliveries of the rest of the production in proportion to their ownership shares and bid it directly in the *spot and/or bilateral* market. In another case, the majority owner with operational responsibility for a plant also sold the production on behalf of its co-partners and a weekly financial settlement was made on the basis of the value of production in the spot market. The respondent emphasized that the sales mechanism was motivated by a need to achieve cost effectiveness in production and sales activities of the joint owners.

The trend in new establishment of different forms of cooperation during the period 2000-2005 is summarised in the table below.

Table 16 The trend in new establishment of different forms of cooperation during the period 2000-2005

	Ownership in other companies	Jointly owned plants	Participation in WMA and plant operation entities	Plant operations contracts	Joint sales organisations	Others
Relations established during 2000-05	4	3	1	1	0	1

Note: Data in the table refer to the number of respondents who confirmed recent establishment of the respective form of cooperation

During the period 2000-2005, the data provided by respondents indicates a growing trend towards different forms of cooperation among producers. During this period, a number of respondents reported new cooperation agreements. The most popular forms of cooperation reported are new financial ownership relations and jointly owned plants. Only two respondents reported discontinuation of an existing cooperation with partner companies during this period.

Detailed examination of the comments submitted by respondents also reveals some information about the trend to be expected in the future. A respondent reported an ongoing shift in the corporate strategy where in future the company will focus on converting its financial ownership interests in other companies (having independent sales activities), into rights to a share in physical production of the respective company. The company reported that it is focusing on separation of activities in its portfolio, where generation and sales are seen as two separate core activities and where the generation facilities are expected to supply to the sales company that specialises in trading of electricity. Financial ownership relationships that granted physical rights to production were also reported by another respondent in the survey. The respondent in this case interpreted its financial ownership as a physical contract to take deliveries from the company in which it had financial participation.

Motivations behind the current forms of cooperation

Questions investigating motivations behind the current forms of cooperation were in the open form. Various sub-issues were investigated in this section of the questionnaire.

Motivation. Two main motivations can be identified from the explanations submitted by the respondents. Firstly, the current structure and forms of cooperation, particularly with respect to the presence of joint ownership of plants, joint operations of power plants or participation in WMAs is explained as a matter of *inheritance* by the respondent companies. Another justification quoted by the respondents to explain current cooperation highlights the positive *efficiency impacts of cooperation* on the operations of the cooperating parties. A respondent participating in a number of different forms of cooperation indicated that some of the current joint ownership relations are due to the fact that the parties holding fall-rights to hydro facilities have often preferred to retain an ownership interest in the development of the resource rather than outright sale to the developers. The same respondent also emphasises the *risk-sharing* role of joint ownerships for development of capital intensive projects in the power industry.

Necessity. Seven respondents specifically answered this question, all of these, except one, emphasised the necessity for cooperation. Almost all emphasise the need for joint operations to assure optimal utilisation of hydro-resources. This was particularly true in case of cooperation through the WMAs.

Alternatives. A major player identified the lack of new plant licenses as one of the main drivers motivating the increased trend towards direct and indirect financial ownership in the industry. The same respondent suggested that the current owners could exchange ownership shares in a manner that results in consolidation and general reduction in joint ownership of plants in the industry. The respondent illustrated his suggestion by referring to a concrete example that involved two jointly owned power plants and where the respondent company could consider surrendering its share in favour of its co-owner in one of these plants provided the co-owner did the same in the favour of the respondent in the other plant. This would result in two individually owned plants instead of the current joint ownership.

Reliability and optimality. Maintenance of reliability in production is not seen as an important motivation for cooperation by the respondents. On the other hand optimal use of hydro-resources is seen as the most important rationale for different forms of cooperation between the companies. Of the 10 respondents who addressed the optimality issue, 9 of the respondents emphasised optimal use of hydro resources as an objective for cooperation. However, none of the respondents reported having undertaken a systematic investigation of

the performance of plants that were subject to cooperation versus plants that were independent of any form of cooperation. A respondent that participated in 3 WMAs further reported that optimal use of water across the seasons was the most important role of the WMAs. Optimal storage across shorter time periods was seen as the responsibility of the plant operator, who most often was the majority share holder of the plant.

Constraints on commercial behaviour

Goal effectiveness of cooperative efforts implies constraints on the behaviour of cooperating partners. Constraints on five commercial decisions- hydro storage, use of hydro flows, use of generation capacity, sales activities, and investment decisions were investigated in this section. The table below summarises the responses received in the survey.

Table 17 Constraints on commercial behaviour

Constraints	Ownership in other companies	Jointly owned plants	Participation in WMA and plant operation entities	Plant operations contracts	Joint sales organisations	Others
Hydro storage	1	1	3	1	0	1
Use of hydro flows	1	3	4	2	0	1
Use of generation plants	1	4	3	0	0	1
Sales activities	1	1	0	0	0	1
Investments	4	7	2	1	0	1

Note: Data in the table refer to the number of respondents who associated individual constraints with the respective form of cooperation

WMA together with *jointly owned plants* are the forms of cooperation that are most frequently reported to constrain the commercial decisions of the cooperating partners. This applies especially to decisions related to investments, but also use of hydro flows generation plants are reported as constraining commercial behaviour. Use of hydro storage capacities are less restricted, while sales activities are not regarded as restraining commercial decisions. One respondent elaborates that operational strategies may have been *different* in the absence of joint ownership however whether this meant that these strategies would have been more economically efficient from the point of view of the market is not elaborated by the respondent.

Two of the respondents associated *plant operations contracts* with constraints on use of hydro flows. Closer examination of the comments submitted by the respondents indicates that there is varying practice with respect to how storage, flows, and generation capacity is divided between the plant operating company and the other minority owners. In one case a respondent who is also a major plant operator reports that the plant operator could impose maximum or minimum *limits on the generation* that could be taken out by owners, for example during the following day/period. Another respondent that had majority position and operational responsibility in a number of plants reported that it had developed administrative routines that offered its co-partners an option to require implementation of their individual production plans. However, its experience was that this option had not been used by any of its co-partners. The respondent reports that partners who require implementation of individual plans "will have to bear the risk of marginal losses associated with these plans and also the risk of spillage of water caused by these plans in the future" and this could explain the lack of interest in requiring implementation of individual plans. Why such individual production plans involve increase in risk for marginal losses or spillage of water and what is the mechanics of these consequences is not elaborated by the respondent in question.

Although almost all forms of cooperation are reported to be associated with constraints on *investment* decisions, the two most frequent forms of cooperation in this context are financial ownership relations and joint licensing of plants. Nearly 50% percent of the respondents reported joint licensing as constraining investment decisions, which is not surprising given the nature of this form of cooperation.

Exchange of information

Effective exchange of information between cooperating partners is a prerequisite for meaningful cooperation. Information exchange between the cooperating partners can take place through a number of channels. In the survey, status with respect to seven main channels and activities for exchange of communication between the cooperating partners were investigated. The table below summarises the responses received in the survey.

Table 18 Exchange of information

Activities	Ownership in other companies	Jointly owned plants	Participation in WMA and plant operation entities	Plant operations contracts	Joint sales organisations	Others
Company board participation	6	5	4	2	0	1
Exchange of personnel	1	3	1	2	0	1
Exchange of production plans	1	4	2	1	0	0
Exchange of hydro inflow information	1	5	3	1	0	0
Exchange of network conditions	1	1	0	0	0	0
Exchange of demand information	1	0	0	0	0	0
Exchange of investment plans	3	8	1	2	0	2

Note: Data in the table refer to the number of respondents who associated individual information activities with the respective form of cooperation

Jointly owned plants, ownership in other companies and participation in WMA, are the three forms of cooperation that are most frequently reported to involve information exchange through a number of channels. The most frequently reported main form of information exchanges under financial *ownership* relations among the companies is participation in the board of directors. Only in one of the cases is this form of cooperation reported to involve exchange of operational information. Cooperation through *jointly owned plants* is frequently reported to be associated with participation on the board of a company, exchange of operational information (production plans, hydro inflow information, exchange of employees) and exchange of investment plans between the cooperating partners.

The structure of information exchange through the *WMA* is quite similar to that of jointly owned plants except for the exchange of investment plans which seem to be less important in cooperation through WMAs. Participation in WMA is frequently associated with participation in the board of the WMA and with exchange of operational information. As mentioned earlier, the WMA contacted in this survey did not respond to the questionnaire and instead referred the matter to its participating members. Analysis of the information available on the website of the WMA however confirms that the exchange of operational information, in particular dispersal of hydrological information to its members is one of the most important activities carried out by this association. The detailed mechanics and expanse of operational information-flow within the WMA however, could not be identified from the information collected in the survey. In the context of exchange of generation plans, under *plant operations contracts*, one respondent company clarified that exchange of this information was sequential and bilateral in the sense that individual owners communicated their *generation requests* to the operating company, which in the next instance determined the *final plans* keeping in view resource availability and requests of all the co-owners. The final plans applicable to each owner (requested plan or its revision) were then communicated to the individual owners by the operating company.

The above observations and conclusions are drawn on the basis of responses of the companies covered in this survey. Some respondents were brief in their replies while the major players in the industry responded with detailed notes. It is important to emphasise that the above material reports a summary of the information received in the survey and is not meant to draw any conclusions about existence or otherwise of any form of collusion among the responding companies.

Appendix 1 Companies and corporate groups included in the analysis

COMPANY	CORPORATE GROUP	COMMENTS
Agder Energi Produksjon As	AGDER ENERGI AS	Ingen endring
Akershus Kraft As	AKERSHUS ENERGI AS	Ingen endring
Aktieselskabet Saudefaldene	AKTIESELSKABET SAUDEFALDENE	Ingen endring
Aktieselskabet Tyssefaldene	AKTIESELSKABET TYSSEFALDENE	Ingen endring
Nord-Østerdal Kraftlag Andelsverk AS	AL NORD-ØSTERDAL KRAFTLAG	Ingen endring
Albert Collett	ALBERT COLLETT	Ingen endring
Alta Kraftlag Al	ALTA KRAFTLAG AL	Ingen endring
Andøy Energi As	ANDØY ENERGI AS	Ingen endring
Arendals Fossekompani Asa	ARENDALS FOSSEKOMPANI ASA	Ingen endring
Arna Kraftselskap As	ARNA KRAFTSELSKAP AS	Ingen endring
As Eidefoss	AS EIDEFOSS	Ingen endring
A/S Helge-Rein-By Brug	AS HELGE-REIN-BY BRUG	Ingen endring
As Forseth Brug	AS FORSETH BRUG	Ingen endring
As Nordlandskraft	AS NORDLANDSKRAFT	Ingen endring
Randsfjord Tremasse & Papirfabrikk A/S	AS RANDSFJORD TREMASSE- OG PAPIRFABRIKK	Ingen endring
As Vadheim Elektrochemiske Fabriker	AS VADHEIM ELEKTROCHEMISKE FABRIKER	Ingen endring
As Vigelands Brug	AS VIGELANDS BRUG	Ingen endring
Austdøla Kraft AS	AUSTDØLA KRAFT AS	Ingen endring
Ballangen Energi As	BALLANGEN ENERGI AS	Ingen endring
Befring Kraft As	BEFRING KRAFT AS	Ingen endring
Bkk Produksjon As	BERGENSHALVØENS KOMMUNALE KRAFTSELSKAP AS	Ingen endring
Bodø Energi As	BODØ ENERGI AS	Ingen endring
Borregaard Industries Ltd Ltd	BORREGAARD INDUSTRIES LTD	Ingen endring
Borregaard Trælandsfoss As	BORREGAARD INDUSTRIES LTD	Lagt under BORREGAARD INDUSTRIES LTD
Brekkestøl Kraftverk AS	BREKKESTØL KRAFTVERK AS	Ingen endring
Buskerud Kraftproduksjon As	EB KRAFTPRODUKSJON AS	Gammelt navn
Cato Aall	CATO AALL	Ingen endring
Chr Salvesen & Chr Thams'S Communication As	CHR SALVESEN & CHR THAMS'S COMMUNICATION AS	Ingen endring
Dalane Energi Iks	DALANE ENERGI IKS	Ingen endring
Dalane Kraft As	DALANE ENERGI IKS	Ingen endring
As Dragefossen Kraftanlegg	DRAGEFOSSEN KRAFTANLEGG AS	Ingen endring
Drangedal Everk KF	DRANGEDAL EVERK KF	Ingen endring
E-Co Energi As	E-CO ENERGI AS	Ingen endring
E-Co Vannkraft As	E-CO ENERGI AS	E-CO ENERGI AS eier E-Co vannkraft 100%
Oslo Lysverker As	E-CO ENERGI AS	E-CO ENERGI AS eier Oslo Lysverker AS 100%
Eidsiva Energi Vannkraft AS	EIDSIVA ENERGI HOLDING AS	Ingen endring
Elkem Energi Bremanger As	ELKEM AS	ELKEM AS eier 100%
Elkem Energi Salten Lakshola Kraftverk AS	ELKEM AS	ELKEM AS eier 100%
Elkem Energi Salten Siso Kraftverk AS	ELKEM AS	ELKEM AS eier 100%
Finnmark Energiverk As	STATKRAFT SF	STATKRAFT ENERGI AS eier 100%
Fosenkraft AS	FOSENKRAFT AS	Ingen endring
Fossheim Kraftverk A/S	FOSSHEIM ENERGIVERK AS	Ingen endring
Fritzøe Skoger M M Treschow	FRITZØE SKOGER; M M TRESCHOW	Ingen endring

Fura Kraft AS	FURA KRAFT AS	Ingen endring
Gauldal Energi As	GAULDAL ENERGI AS	Ingen endring
Gilja Kraftverk AS	GILJA KRAFTVERK AS	Ingen endring
Glomma Kraftproduksjon AS	GLOMMA KRAFTPRODUKSJON AS	NB kommune
Gloppen kommune	GLOPPEN KOMMUNE	Ingen endring
Gudbrandsdal Energi As	GUDBRANDSDAL ENERGI AS	Ingen endring
Hadeland Kraftproduksjon As	HADELAND KRAFTPRODUKSJON AS	Ingen endring
Hafslund Asa	HAFSLUND ASA	Ingen endring
Hafslund Produksjon As	HAFSLUND ASA	HAFSLUND ASA eier 100%
Halden Kraftproduksjon AS	HALDEN KRAFTPRODUKSJON AS	Ingen endring
Hallingdal Kraftnett As	HALLINGDAL KRAFTNETT AS	Ingen endring
Hammerfest Energi As	HAMMERFEST ENERGI AS	Ingen endring
Haugaland Kraft As	HAUGALAND KRAFT AS	Ingen endring
Haukvik Kraft AS	HAUKVIK KRAFT AS	Ingen endring
Hedmark Energi AS	HEDMARK FYLKESKRAFT AS	Ingen endring
Helganes Kraftverk	HELGANES KRAFTVERK	Ingen endring
Helgelandskraft As	HELGELANDSKRAFT AS	Ingen endring
Hol kommune	HOL KOMMUNE	NB kommune
Horpedal Kraft AS	HORPEDAL KRAFT AS	Ingen endring
Hålogaland Kraft As	HÅLOGALAND KRAFT AS	Ingen endring
Indre Hardanger Kraftlag As	INDRE HARDANGER KRAFTLAG AS	Ingen endring
Istad As	ISTAD AS	Ingen endring
Istad Kraft As	ISTAD AS	ISTAD AS eier 100%
Jernbaneverket	JERNBANEVERKET	Ingen endring
Jondal Energiverk	JONDAL ENERGIVERK KF	Ingen endring
Jørpeland Kraft AS	JØRPELAND KRAFT AS	Ingen endring
Kiær Mykleby	KIÆR MYKLEBY ANDERS KIÆR	Ingen endring
Kjetland Kraft AS	KJETLAND KRAFT AS	Ingen endring
Kongsberg Energi Eiendom AS	KONGSBERG ENERGI EIENDOM AS	Ingen endring
Kraftverkene I Orkla	KRAFTVERKENE I ORKLA	Ingen endring
Kraftverkene I Øvre Namsen	KRAFTVERKENE I ØVRE NAMSEN	Ingen endring
Kragerø Energiverk A/S	KRAGERØ ENERGI AS	Gammelt navn
Kvam Kraftverk As	KVAM KRAFTVERK AS	Ingen endring
Kvinnherad Energi As	KVINNHERAD ENERGI AS	Ingen endring
Kvænangen Kraftverk As	KVÆNANGEN KRAFTVERK AS	Ingen endring
Lillehammer Og Gausdal Energiverk As	LILLEHAMMER OG GAUSDAL ENERGIVERK HOLDING AS	Gammelt navn
Lofotkraft Produksjon As	LOFOTKRAFT HOLDING AS	Gammelt navn
Luostejok Kraftlag Al	LUOSTEJOK KRAFTLAG AL	Ingen endring
Luster Energiverk AS	LUSTER ENERGIVERK AS	Ingen endring
Lyse Produksjon As	LYSE ENERGI AS	Lyse Produksjon AS er 100% eid av Lyse Energi AS
Løvenskiold-Fossum	LØVENSKIOLD-FOSSUM	Ingen endring
M Peterson & Søn As	M PETERSON & SØN AS	Ingen endring
Meløy Energi As	MELØY ENERGI AS	Ingen endring
Mesna Kraftselskap Da	MESNA KRAFTSELSKAP DA	Ingen endring
Midt Nett Buskerud AS	MIDT NETT BUSKERUD AS	Ingen endring
Midt-Telemark Energi AS	MIDT-TELEMARK ENERGI AS	Ingen endring
Mo Industripark As	MO INDUSTRIPARK AS	Ingen endring
Modalen Kraftlag Ba	MODALEN KRAFTLAG BA	Ingen endring
Modum Kraftproduksjon Kf	MODUM KRAFTPRODUKSJON KF	Ingen endring
Mossefossen Kraftverk Ans	MOSSEFOSSEN KRAFTVERK ANS	Ingen endring

Namdal Kraftproduksjon As	NAMDAL KRAFTPRODUKSJON AS	Ingen endring
Narvik Energi As	NARVIK ENERGI HOLDING AS	Narvik energi er 100% eid av Narvik energi holding as
Nesset Kraft AS	NESSET KRAFT AS	Ingen endring
Niingen Kraftlag AS	NIINGEN KRAFTLAG AS	Ingen endring
Nord Troms Kraftlag As	NORD TROMS KRAFTLAG AS	Ingen endring
Nordkraft As	NORDKRAFT AS	Ingen endring
Nordkyn Kraftlag Al	NORDKYN KRAFTLAG AL	Ingen endring
Nordmøre Energiverk AS	NORDMØRE ENERGIVERK AS	Ingen endring
Nord-Salten Kraftlag Al	NORD-SALTEN KRAFTLAG AL	Ingen endring
Nord-Trøndelag Elektrisitetsverk FKF	NORD-TRØNDELAG ELEKTRISITETSVERK FKF	Ingen endring
Norsk Grønnkraft AS	NORSK GRØNNKRAFT AS	Ingen endring
Norsk Hydro ASA - Hydro Energi	NORSK HYDRO ASA	Alle Hydroselskaper legges inn under NORSK HYDRO ASA
Norsk Hydro Asa	NORSK HYDRO ASA	Alle Hydroselskaper legges inn under NORSK HYDRO ASA
Norsk Hydro Produksjon AS	NORSK HYDRO ASA	Alle Hydroselskaper legges inn under NORSK HYDRO ASA
Notodden Energi As	NOTODDEN ENERGI AS	Ingen endring
Oppland Energi Produksjon As	OPPLAND ENERGI AS	Oppland Energi Produksjon 100% eid av Oppland Energi AS
Opplandskraft DA	OPPLANDSKRAFT DA	Ingen endring
Otra Kraft DA	OTRA KRAFT DA	Ingen endring
Otteraaens Brugseierforening	OTTERAAENS BRUGSEIERFORENING	Ingen endring
Pasvik Kraft Da	PASVIK KRAFT AS	Ingen endring
Ramfoss Kraftlag	RAMFOSS KRAFTLAG	Ingen endring
Rauma Energi As	RAUMA ENERGI AS	Ingen endring
Repvåg Kraftlag A/L	REPVÅG KRAFTLAG AL	Ingen endring
Ringeriks-Kraft As	RINGERIKS KRAFT AS	Ingen endring
Rissa Kraftlag BA	RISSA KRAFTLAG BA	Ingen endring
Rivedal Kraftverk AS	RIVEDAL KRAFTVERK AS	Ingen endring
Ryssdal Kraft AS	RYSSDAL KRAFT AS	Ingen endring
Rødøy-Lurøy Kraftverk AS	RØDØY LURØY KRAFTVERK AS	Ingen endring
Røldal-Suldal Kraft As	RØLDAL-SULDAL KRAFT AS	Ingen endring
Røros Elektrisitetsverk As	RØROS ELEKTRISITETSVERK AS	Ingen endring
S D Cappelen Ans	S D CAPPELEN ANS	Ingen endring
Sagevikelv Kraft AS	SAGEVIKELV KRAFT AS	Ingen endring
Sandal & Fossheim Kraft AS	SANDAL & FOSSHEIM KRAFT AS	Ingen endring
Selbu Energiverk	SELBU ENERGIVERK AS	Ingen endring
SFE Produksjon AS	SOGN OG FJORDANE ENERGI AS	SFE Produksjon AS er eid av Sogn og Fjordane Energi 100%
Sigdal kommune	SIGDAL KOMMUNE	Ingen endring
Sira Kvina Kraftselskap	SIRA KVINA KRAFTSELSKAP	Ingen endring
Sjøfossen Energi As	SJØFOSSEN ENERGI AS	Ingen endring
Skafså Kraftverk Ans	SKAFSÅ KRAFTVERK ANS	Ingen endring
Skagerak Kraft As	SKAGERAK ENERGI AS	Ingen endring
Skien Kraftproduksjon AS	SKIEN KRAFTPRODUKSJON AS	Ingen endring
Skjåk Energi	SKJÅK ENERGI	Ingen endring
Sks Produksjon As	SKS PRODUKSJON AS	Ingen endring
Småkraft A/S	SMÅKRAFT AS	Ingen endring
Sognekraft As	SOGNEKRAFT AS	Ingen endring
Statkraft Energi As	STATKRAFT SF	Alle Statkraftselskaper er samlet i STATKRAFT SF

		(100% eierskap)
Statkraft Sf	STATKRAFT SF	Alle Statkraftselskaper er samlet i STATKRAFT SF (100% eierskap)
Storbrofoss Kraftanlegg Da	STORBROFOSS KRAFTANLEGG DA	Ingen endring
Stranda Energiverk AS	STRANDA ENERGIVERK AS	Ingen endring
Stølskraft AS	STØLSKRAFT AS	Ingen endring
Suldal Elverk	SULDAL ELVERK KF	Ingen endring
Sunnfjord Energi As	SUNNFJORD ENERGI AS	Ingen endring
Sunnhordland Kraftlag As	SUNNHORDLAND KRAFTLAG AS	Ingen endring
Sunnmøre Energi AS	TUSSA KRAFT AS	Sunnmøre Energi AS er eid av Tussa Kraft As 100%
Svorka Energi As	SVORKA ENERGI AS	Ingen endring
Sykkylven Energi AS	SYKKYLVEN ENERGI AS	Ingen endring
Sørfold Kraftlag A/L	SØRFOLD KRAFTLAG AL	Ingen endring
Tafjord Kraftproduksjon As	TAFJORD KRAFT AS	Morselskap (100%)
Tinfos AS	TINFOS AS	Ingen endring
Tinn Energi AS	TINN ENERGI AS	Ingen endring
Titania AS	TITANIA AS	Ingen endring
Tou Mølle As	TOU MØLLE AS	Ingen endring
Trollfjord Kraft As	TROLLFJORD KRAFT AS	Ingen endring
Troms Kraft Produksjon As	TROMS KRAFT AS	Morselskap (100%)
Trondheim Energiverk Kraft As	TRONDHEIM ENERGIVERK AS	Statkraft eier 100% i Trondheim Energiverk Kraft AS
Trønderenergi Kraft As	TRØNDERENERGI AS	Morselskap (100%)
Tussa Energi As	TUSSA KRAFT AS	Morselskap (100%)
Tysseland Kraftlag As	TYSSELAND KRAFTLAG AS	Ingen endring
Ulefoss Kraftverk Carl Diderik Cappelen	ULEFOSS KRAFTVERK	Ingen endring
Ustekveikja Energi As	USTEKVEIKJA ENERGI AS	Ingen endring
Vaksdal Industrier AS	VAKSDAL INDUSTRIER AS	Ingen endring
Valen Kraftverk AS	VALEN KRAFTVERK AS	Ingen endring
Valsøyfjord Kraftverk As	SVORKA ENERGI AS	Gammelt navn, heter nå Svorka Energi AS
Vang Energiverk	VANG ENERGIVERK KF	Ingen endring
Vannkraft Øst As	VANNKRAFT ØST AS	Ingen endring
Vardar As	VARDAR AS	Ingen endring
Veiteberg Kraft AS	VEITEBERG KRAFT AS	Ingen endring
Vesterålskraft As	VESTERÅLSKRAFT NETT AS	Morselskap (100%)
Vest-Telemark Kraftlag AS	VEST-TELEMARK KRAFTLAG AS	Ingen endring
Vikeså Kraftverk AS	VIKESÅ KRAFTVERK AS	Ingen endring
Vinstra Kraftselskap Da	VINSTRA KRAFTSELSKAP DA	Ingen endring
Vokks Kraft As	VOKKS KRAFT AS	Ingen endring
Voss Energi As	VOSS ENERGI AS	Ingen endring
Ytre Kandal Kraft AS	YTRE KANDAL KRAFT AS	Ingen endring
Østerdalen Kraftproduksjon As	ØSTERDALEN KRAFTPRODUKSJON AS	Ingen endring
Østfold Energi As	ØSTFOLD ENERGI AS	Ingen endring
Øvre Eiker Energi As	ØVRE EIKER ENERGI AS	Ingen endring
Ågjølet Kraftverk AS	AAGJØLET KRAFTVERK AS	Ingen endring
Ål kommune	AAL KOMMUNE	NB Kommune
Åsedøla Kraft As	AASEDØLA KRAFT AS	Ingen endring

Appendix 2 Questionnaire and companies included in the survey

……..AS

A. GENERELT OM SAMARBEID INNEN PRODUKSJON AV ELEKTRISITET

I det norske elektrisitetsmarkedet eksisterer en rekke typer samarbeid mellom ulike produsenter. For eksempel eierskap i andre selskaper, felleseide produksjonsanlegg, deltagelse i brukseierforeninger og driftsselskaper og andre typer samarbeid. Spørsmålene under søker å kartlegge ulike former for samarbeid innen elektrisitetsproduksjon i det Norske kraftmarkedet.

Dersom de har kommentarer eller tilføyelser til enkelte spørsmål, eller undersøkelsen som helhet ber vi dem gjerne skrive disse i del E.

1. For året 2005, hvor mange og hvilke type samarbeidsrelasjoner med andre produksjonsselskaper har selskapet tatt del i? Med MW, GWh i tabellen under, mener vi kapasitet som motparten disponerer.

	Eierskap i andre selskaper	Felleseide produksjons anlegg	Deltagelse i brukseierforening / driftsselskaper	Driftsansvar	Felleseid salgsorganisasjon	Andre*
Antall	S11v1	S11v2	S11v3	S11v4	S11v5	S11v6
MW	S12v1	S12v2	S12v3	S12v4	S12v5	S12v6
GWh	S13v1	S13v2	S13v3	S13v4	S13v5	S13v6

* Andre: vennligst spesifiser type samarbeidsrelasjon. Leie = S14v1,

2. For årene 2000 – 2005, *hvor mange nye* samarbeidsrelasjoner med andre energiselskaper innen elektrisitetsproduksjon er etablert og *hvor mange har blitt avsluttet*?

	Eierskap i andre selskaper	Felleseid produksjons anlegg	Deltagelse i brukseierforening / driftsselskaper	Driftsansvar	Felleseid salgsorganisasjon	Andre*
Antall nye	S21v1	S21v2	S21v3	S21v4	S21v5	S21v6
Antall avsluttet	S22v1	S22v2	S22v3	S22v4	S22v5	S22v6

* Andre: vennligst spesifiser type samarbeidsrelasjon. S23v1

B. FORMÅLET MED SAMARBEIDET

3. Om De har svart bekreftende på spørsmålet 1

a) Vennligst beskriv hovedformålet med samarbeidet? Vennligst spesifiser dersom det er avvik i formål med ulike former for samarbeid.

S31v1 = Øke produksjon
S31v2 = Utnytte eksisterende kompetanse / ressurser
S31v3 = Risikospredning

b) I hvilken grad er samarbeidet nødvendig for måloppnåelse?

S32v1

c) Finnes det andre alternative måter for å oppnå målet?

S33v1

d) Er ønske om å opprettholde *driftssikkerhet* i produksjon av elektrisitet et viktig formål med samarbeidet?

S34v1

e) Er det gjort noen undersøkelser om systematisk variasjon i driftssikkerhet mellom produksjonsanlegg som tar del i produksjonssamarbeider, og anlegg som er uavhengig av samarbeidet? Hvis ja, hva er deres erfaring?

S35v1

f) Er ønske om mer *effektiv bruk av vannressurser* et viktig formål med samarbeidet?

S36v1

g) Er det gjort noen undersøkelser om systematisk variasjon i effektivitet i bruk av vann mellom produksjonsanlegg som tar del i produksjonssamarbeider, og anlegg som er uavhengig av samarbeidet? Hvis ja, hva er deres erfaring?

S37v1

h) Er ønske om mer *effektiv bruk av lagringskapasitet* et viktig formål med samarbeidet? Hvis Ja, vennligst angi hva er hovedkilde til økt effektivitet?
Forbedringer i lagring over sesong
Forbedringer i lagring over et døgn

S38v1

C. FØRINGER KNYTTET SAMARBEIDET

Måloppnåelse i samarbeidsrelasjoner kan innebære føringer på selskapenes individuelle beslutninger.

4. Vennligst kryss av hvilke føringer Deres selskap har opplevd i de aktuelle formene for samarbeid. For kategorien "Andre" vennligst spesifiser i del E.

	Eierskap i andre selskaper	Felleseid produksjons anlegg	Deltagelse i brukseierforening / driftsselskaper	Driftsansvar	Felleseid salgs organisasjon	Andre
Føringer på beslutninger knyttet til *lagring av vann*	S41v1	S41v2	S41v3	S41v4	S41v5	S41v6
Føringer på beslutninger knyttet til *bruk av vann*	S42v1	S42v2	S42v3	S42v4	S42v5	S42v6
Føringer på beslutninger knyttet til *bruk av produksjonsanlegg*	S43v1	S43v2	S43v3	S43v4	S43v5	S43v6
Føringer på beslutninger knyttet til *salgsaktiviteter*	S44v1	S44v2	S44v3	S44v4	S44v5	S44v6
Føringer på beslutninger knyttet til *investeringer*	S45v1	S45v2	S45v3	S45v4	S45v5	S45v6

D. INFORMASJONSFLYT I SAMARBEIDET

Samarbeid krever ofte informasjonsflyt mellom samarbeidende parter. Nedenfor er det angitt mulige kanaler for informasjonsflyt mellom samarbeidende parter.

5. Om Deres selskap er med i et samarbeid, vennligst kryss av hovedkanaler for informasjonsflyt knyttet ulike former for samarbeid. For kategorien "Andre" vennligst spesifiser i del E.

	Eierskap i andre selskaper	Felleseid produksjons anlegg	Deltagelse i brukseierforening / driftsselskaper	Driftsansvar	Felleseid salgsorganisasjon	Andre
Styredeltakelse	S51v1	S51v2	S51v3	S51v4	S51v5	S51v6
Utveksling av ansatte	S52v1	S52v2	S52v3	S52v4	S52v5	S52v6
Utveksling av produksjonsplaner	S53v1	S53v2	S53v3	S53v4	S53v5	S53v6
Utveksling av informasjon om tilsigsinformasjon	S54v1	S54v2	S54v3	S54v4	S54v5	S54v6
Utveksling av informasjon om nettforhold	S55v1	S55v2	S55v3	S55v4	S55v5	S55v6
Utveksling av informasjon om etterspørsel	S56v1	S56v2	S56v3	S56v4	S56v5	S56v6
Utveksling av investeringsplaner	S57v1	S57v2	S57v3	S57v4	S57v5	S57v6

E. **KOMMENTARER ELLER TILFØYELSER**

S61v1

VI TAKKER FOR DERES SAMARBEID