Unbundling of operation and network development activities in electricity distribution

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Abstract

Purpose – Based on literature and an empirical case, the purpose of this paper is to present a framework for decision-making in utilities where unbundling considerations are taking place. The paper analyses the implications of splitting long-term network planning activity from the organization responsible for short-term network operation activities.

Design/methodology/approach – The proposed framework includes an analysis of impacts of external forces, set-up of common targets and performance models, and alignment of responsibilities in the new organization. The empirical results and validation of the proposed framework is performed by an electric utility, where legal unbundling of activities has taken place; the study includes expert interviews and theoretical analysis.

Findings – Colliding interests in the new business model can be avoided if economic and technical targets are mainly set by the regulator for both network development and operation activities.

Research limitations/implications – The results are based on internal re-organization; a complementary study on re-organizing network business activities to an external service provider could give information about the generalizability of the findings.

Practical implications – Application of the proposed framework for decision-making and lessons learned can support electric utilities when planning for unbundling and strategic target-setting in the unbundled business model.

Originality/value – The study presents experiences of re-organized network business activities in a pioneering market area with a long experience of outsourcing. The detailed analysis of internal re-organization within one electric utility can facilitate further restructuring phases.

Keywords Electricity industry, Network operating systems, Long-term planning, Outsourcing, Performance measures

Paper type Research paper

1. Introduction

Electricity distribution business has faced significant challenges during the past few years. In industrialized countries, the network infrastructure is ageing, and there is a significant shortage of resources, both material and labour (Welch, 2001; Brown and Willis, 2006; Lave *et al.*, 2007). Climate change and environmental requirements have

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increased the penetration of distributed generation and placed new demand on distribution system development, and operation. The economic and technical regulation have put strict limits on investments, operational costs and quality of supply at the same time. Network companies are forced to analyse which business functions and activities will be managed inside the company and which ones will be outsourced based on the knowledge flow and cost saving targets. There are already several actual cases where for instance parts of network operation and construction are outsourced from the parent electricity distribution company. An example of a cross-section of the distribution business is presented in Figure 1.

Each of distribution business functions has to be organized efficiently. Typically the main functions are unbundled from each other, and each of them has economic indicators of their own. Unbundling has been referred to as separation between network business and production, trade, metering, and sales of energy (Künneke and Fens, 2006). However, in this study, the scope of unbundling covers explicitly the separation of activities within the network business; namely the network operation and development (including long-term planning). The traditional activities and activity groups of distribution companies are presented in Figure 2.

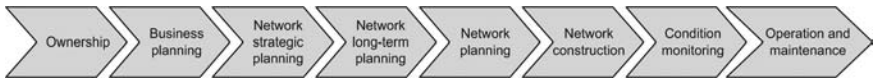


Figure 1.
Value chain of the distribution business

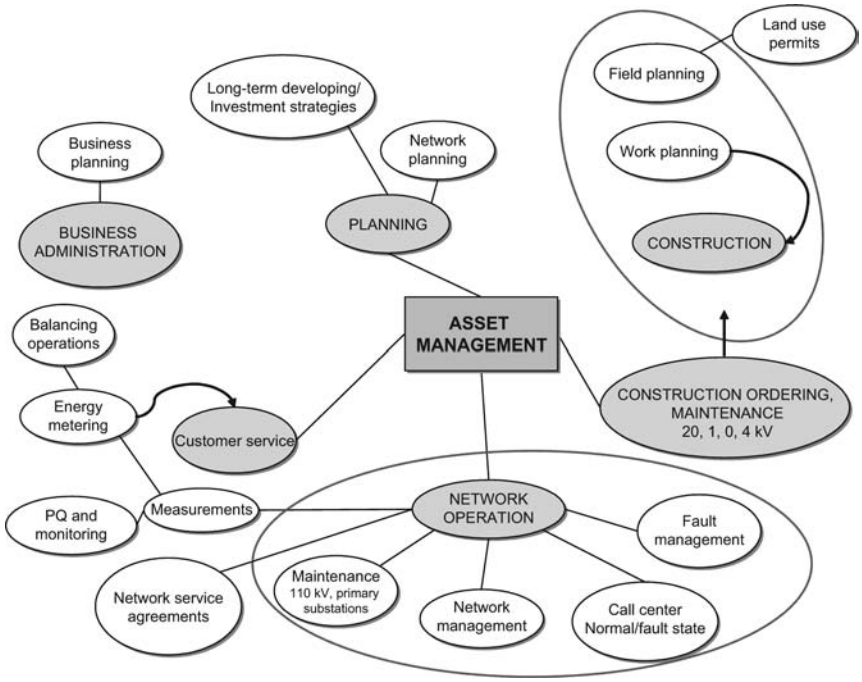


Figure 2.
Main activities of electricity distribution business highlighted by the case asset owner company SSS

Four different levels of unbundling have been identified; each of these levels depends on the market maturity. The unbundling levels include, in an increasing order of magnitude with respect to economic and legal separation, the following steps: administrative unbundling, management unbundling, legal unbundling, and ownership unbundling. First, administrative unbundling, also called account unbundling, covers separation of accounts between network business functions. The shared operational activities take place within one company. The second level of unbundling is referred to as management unbundling, where, in addition to administrative unbundling, the staff organization is divided into separate business units that function independently, but are managed from the same holding company (Künneke and Fens, 2006; Nillesen and Pollitt, 2008).

In the case of legal unbundling, the network activities are organized into separate legal units so that they can still belong to the same holding company. The fourth model is ownership unbundling (outsourcing), where the distribution business function is organized under different ownership than the main network company, and there is neither common holding nor any shared activities. In the European countries, the common models are legal unbundling and unbundling of accounts (Künneke and Fens, 2006). However, unbundling in the electricity distribution is not a phenomenon concerning Europe only; empirical results from ownership unbundling have been reported also from other markets, such as New Zealand (Nillesen and Pollitt, 2008). In its most advanced form (i.e. ownership unbundling), unbundling can be considered similar to outsourcing. Hence, outsourcing literature especially in the area of responsibility management is of use for utility decision-making and will be addressed later in section 3. Typical examples of outsourced business activities are network construction and condition monitoring.

As unbundling separates the business activities from each other, several new questions have to be considered: which will be the right unbundling level for our specific needs, can we then better respond to the external drivers in the long run, how can we set common business targets and performance indicators without suboptimization, and finally, how can we be certain that all the information flows are guaranteed between the activities after unbundling? These questions will be addressed in the following sections. The issues behind unbundling processes include diversity of information flows, external market requirements, and interconnections between network operations and network planning (Figure 3).

Figure 3 illustrates the strong dependencies between network operation and planning. In many distribution companies, this has not been actively taken into consideration so far, because network operation and network planning are located in the same company, and in many cases, they are managed by the same persons. As a result, for example the amount and importance of information passing daily from the operation personnel to the planning personnel or vice versa is not observed.

This study presents a framework for utility decision-making considering different types of unbundling of long-term electricity distribution network planning and short-term network operation. The purpose of the paper is to evaluate the effects on the utility and its organization when two highly interconnected network business functions are unbundled in different ways from each other. The key elements in the framework include an analysis of the impacts of external forces, set-up of common targets and performance models, and adjustment of responsibilities in the new organization, which will be presented in the following sections. The suggested

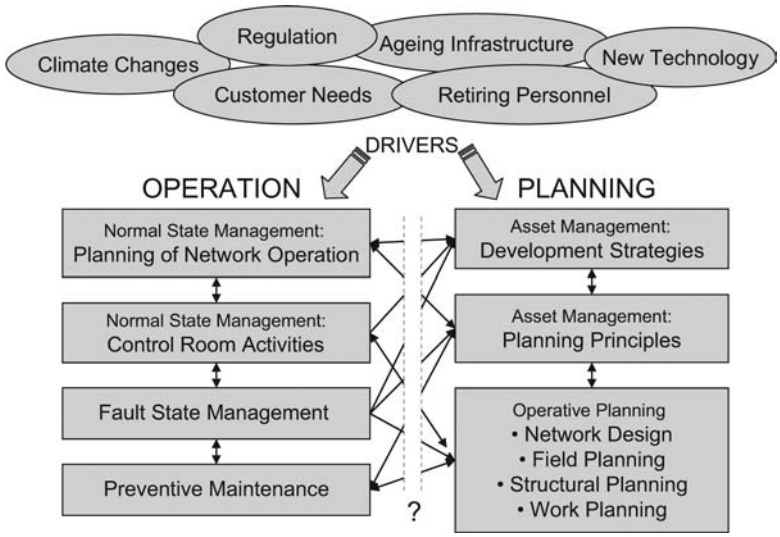


Figure 3.
Interconnections between network operation, network planning, and electricity distribution business environment

framework is finally verified by a Nordic electricity utility, where legal unbundling has taken place.

1.1 Specialization behind the unbundling

As network business functions are becoming more specialized, there is a capability gap arising, which has to be taken into consideration. Economic and technical regulation make the interactions of business processes more complicated. For instance, evaluation of outage costs interconnects the short term operation of distribution network with long-term investment strategies. This sets special requirements for agreements in cases where the unbundling is based on either legal or ownership unbundling. It is also important to have a good understanding of the directing signals of regulation. When performance meters that benchmark the quality of supply, such as the outage cost experienced by a customer, are included in the economic regulation, they will also be incorporated in the financial management of the electric utility. Consequently, electric utilities are incentivized to take the outage costs into consideration in network planning and operation target setting (Honkapuro, 2008).

A key question for utilities is where the resources can be obtained from and how they can be developed. Make-or-buy decisions are based on governance structure choices related to markets, partnerships, and hierarchies. The underlying dynamic and static costs and benefits for make-or-buy decisions in network operation functions have been analysed in (Tanskanen *et al.*, 2007), the roots of which are in the extended transaction costs economics (TCE) theory. When extending the scope of the TCE analysis to cover critical interconnections with the long-term network development function, new (biased) perspectives have to be considered. For example, the increasing use of network automation can from the network operation perspective be viewed as action-developing capabilities (internal or external), whereas from the network development perspective, the increased automation can be seen to improve network

reliability and to decrease outage costs. Nevertheless, automation costs and benefits should be considered only once without suboptimization.

Strategic capability development of electric utilities within operations management, control room, and field work activities has previously been analysed in (Tanskanen *et al.*, 2007). The study presents benefits of the use of market option for field work activities and partial control room activities. Challenges are identified for the use of markets in the case of core operations management activities. The reasons behind the challenges are based on the close relationship and dependencies between network operation, planning, and asset management. Further analysis is thus required on core network operation and planning dependencies.

2. External forces affecting the network development and network operation unbundling model

Nowadays, several external factors have to be taken into account when planning new electricity distribution business models. In particular, the economic regulation has developed rapidly in the past ten years. Regulatory directing signals (Honkapuro, 2008) and advanced network control systems constitute both market initiatives/opportunities and limitations for arising business models. Economic regulation gives several incentives to outsource network planning and operation activities. Incentives are coming from common requirements to improve cost efficiency and personnel knowledge in the distribution company. A higher competence level is needed for instance because of the increasing amount of intelligent automation, AMR, distributed generation in distribution networks, and regulation of the quality of supply. Companies are also forced to reserve increasing resources from outside to be prepared for large-scale interruptions. These requirements have an impact both on long-term and short-term network development.

Successful business management requires understanding of the regulation model. This is a challenge because the model includes several economic interactions between different cost components such as investment cost, operational costs, and outage costs. The requirement is emphasized because of the considerable need for coming renovation investments. The regulation model and the need for investments will significantly affect the way how distribution networks will be planned and operated in the near future.

Previously, external forces affecting the development of network operation have been analysed in (Brådd *et al.*, 2006a,b) where also a methodology for evaluation of the impacts of external forces is presented. External forces that strongly affect the selection of the long-term business model for network operation and planning include economic supervision, ageing infrastructure, labour and material resources, and climate changes. These forces will be presented in the following sections.

2.1 Economic supervision through regulation

Economic supervision plays a significant role in the modern electricity distribution business. There are more and more economical incentives to track the best practices to operate and develop distribution networks. Economic regulation strongly affects both the network operation and the development practices. Interconnections between network operation and long-term planning have always been strong, yet economic regulation emphasizes these connections even further. If regulation did not exist, interconnections between the functions would evidently be weaker. As the case utility is located in Finland, we will take a short look at the local regulatory framework.

In Finland, the regulating authority is the Energy Market Authority subordinate to the Ministry of Trade and Industry. The supervision includes both economic and technical control. It focuses above all on the profit of distribution business and the efficiency of network business operations. Supervision includes control of the quality of electricity, which focuses primarily on reliability of supply. This interconnection with reliability and profit creates real financial value for interruptions (actual outage costs). For instance, if a utility has an one-hour interruption on an average 20 kV medium-voltage feeder, the outage cost will be more than 20,000 €/h. In some countries, the utilities also have to pay compensation for customers, if the duration of interruption is more than 12 or 24 h. In Finland, the compensation is 10 per cent of the annual distribution fee when the interruption exceeds 12 h. Interconnections of this kind create incentives to develop the distribution system so that outage costs are reduced in the long run. A simplified model of regulation principles is presented in Figure 4.

The regulating authority sets obligations for the distribution companies to improve the economic efficiency of their operations. Simultaneously, the company owners expect the business to make good profit. Now there is a risk that investments and operations related to the quality of electricity receive less attention, unless special attention is paid to these matters through supervision. From the distribution company perspective, a risk is uncertainty caused by regulation. The intensified regulation requiring more and more detailed information from the companies increasingly binds company resources. Further, the more complicated regulation model also makes the detection of various cost effects of the investments more difficult.

From the viewpoint of unbundling network development from network operation, the incentives and sanctions set by the regulating authority affect especially the new business model through the following:

- The defined short-term incentives set the basis for business targets of the network operation function.
- The urge to minimize the operative costs will affect the cost structure of network development and operation in different ways.

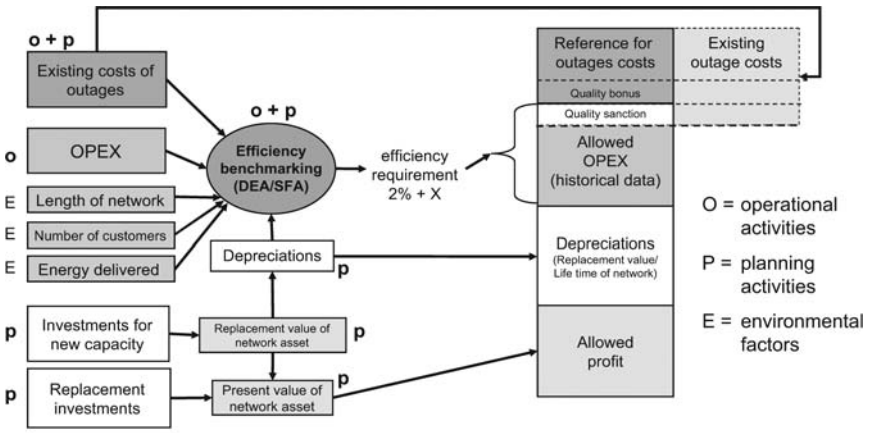


Figure 4.
Interconnections between power quality, outage costs, and allowed rate of return in the Finnish regulatory model (Honkapuro, 2008)

Source: Honkapuro (2008)

- The principles of allocation and usage of money for network development and operation. If the asset owner assigns for instance 1 M€ for network development purposes, which company will decide on the investment objects, such as an investment in a substation or an increase in field mechanics? How will the decision making process be structured between the parties involved? Further, some party should take the overall responsibility for the network development.

All these regulatory aspects create incentives to carry on the unbundling process in the distribution network business.

2.2 Ageing infrastructure, labour and material resources

In the coming few years, the large-scale ageing of electricity distribution networks will be among the major challenges in the electricity distribution business. From the viewpoint of labour and material resources, this and many other trends indirectly affect the network development function. Utilities and service providers have often faced a situation in which not enough material can be provided for repair or maintenance purposes. In the near future, plenty of expertise and tacit knowledge will inevitably be lost when key people retire from the companies. The electricity distribution business has for a long time been characterized by a high average age of the personnel (Lave *et al.*, 2007). The field has not managed to invite new experts similarly as for instance the electronics industry. On the other hand, the distribution companies have searched for cost efficiency by reducing their personnel costs, thus decreasing the number of young employees, both electricians and designers, in the past few years.

The consideration of the age structure in the distribution network companies together with the ageing network infrastructure raises a justified concern: how to respond to the massive renovation challenges, when the personnel designing and building these networks will be remarkably reduced as a result of retirement. Infrastructural and resource aspects create incentives to carry on the unbundling process in the distribution network business. Ensuring acquisition of labour and materials for replacement construction may prove a real challenge when the need for replacement investments will be at highest.

2.3 Climate changes and reliability

The on-going climate change has already had and will have a significant influence on the electricity distribution; both network planning and operation activities. All the effects of the climate change are not yet clear; however, the increased windiness and severe storms are probably the most notable effects of this change (European Commission, 2005). The growing risk of major storms forces companies to reserve the needed resources The amount of network outages will also increase if the distribution network is not planned to better endure climate changes (winds, storms, snow loads). From the business point of view, it is a question of focusing mainly on operative activities (fault repair, network automation, proactive forestry work) or on long-term planning (weather-proof network constructions). Different approaches lead to a different business outcome. Climate change and environmental requirements speed up the penetration of distributed generation in networks. This is a challenge for network planning and operation. When the required knowledge may not be found from the local distribution company, outside services are needed.

3. Set-up of common targets and performance measurement in the unbundled business model

Management of overall network performance can become very complex in cases where highly interconnected unbundled long- and short-term activities with independent techno-economical targets are to be managed by different parties (Figure 3). Harmonization of network management in advanced unbundled models is firstly achieved through identification and specification of common target setting and performance measurement. Secondly, implementation is executed through solid agreements and information systems in place. This section introduces harmonized targets and performance meters for network development and operation followed by responsibility management take-aways for successful implementation.

Regardless of the operations model of the distribution company, the aim of network development is to ensure cost-efficient network sustainability in the long run. The requirement is anything but simple and defined in the modern multifaceted business environment. While strategic network planning sets long-term targets up to 10, 20, or even 40 years, network operation activities deal with short-term challenges focusing on the next day, week, or month. The question remains how to find the correct incentives to both network planning and network operation, which result in a minimum cost and yield a maximum profit from asset management point of view.

In network planning, the target is to find such a technically feasible solution, the long-term total costs of which can be minimized. These costs include costs of investments (material and labour), operational costs (losses, maintenance and repair), and outage costs (economic harm of interruptions experienced by electricity end-users). All these cost components are actual money for the distribution companies because of the regulation model and the economic supervision performed by the local authority. The target of the economic supervision is to give incentives to companies to find such methods for asset management and network development that will produce minimum cost in the long-run, taking into account all the necessary technical issues such as maximum voltage drops, protection settings, maximum length of interruptions, customer connections, and distributed generation demands. If long-term cost minimization is carried out successfully in the distribution company, it will also benefit the end-customer by the paid distribution tariffs. Although distributed generation is a current topic in the modern distribution business, it has no significant role in this study, because outsourcing as a process and a challenge for information flows does not depend on the generation structure, even though distributed generation may create new opportunities for service providers.

Successful distribution business management requires understanding of different technologies and their economic effects. Distribution networks are characterized by a long time span and a strong mutual dependence of the investments. In general, a planning assignment can be characterized as a minimization task of the present value of the investment, loss, outage, and maintenance costs occurring during the planning period as presented in equation 1 (Lakervi and Holmes, 1995). The representation characterizes the practical calculation methodology, in which the costs are expressed as a sum of the present values of the annual costs during the planning period. The methodology is widely applied in electricity system planning. Outage costs in particular play an increasing role in the distribution business as presented in subsection 2.1. The techno-economic lifetime of network components is long, typically several decades. Long lifetimes emphasize the importance of long-term network design.

$$C_{\text{tot}} = \int_0^T \left(C_{\text{capex}}(t) + C_{opex}(t) + C_{\text{outage}}(t)\right) dt \quad (1)$$

where

C_{tot} = Total costs

C_{capex} = Capital costs

C_{opex} = Operational costs

C_{outage} = Outage costs

T = Lifetime of network

Minimization of costs has to be made within the boundary conditions of the planning assignment. Typical boundary conditions are voltage drop, load current capacity and fault current withstand capability of the conductors, regulations concerning the performance of the protection devices and electrical safety regulations (Lakervi and Partanen, 2008).

To achieve the previous minimum cost requirement, there have to be reasonable targets and performance indicators for each network activity, both network planning and operation, even if the activities are not inside the same company.

3.1 Activity-specific targets

The network development planning produces actions for both the network planners and the network operators, by which the state of the network, taking into account the development factors, can be made to meet the set objectives as cost-efficiently as possible. Network design and planning are closely connected to other core operations of the distribution company, such as construction, network operation, and financial management (Figure 5).

Network operation on the other hand can be defined as the function responsible for securing the availability of the network. The objective of network operation is to minimize the total costs subject to technical constraints such as voltage level, thermal limits, and operation of protection. Today, additional external market demands are putting pressure on solutions aiming at improved network reliability and end-customer satisfaction. The following sections present quantifiable indicators to follow up network quality, reductions in operation and maintenance costs, and improvements in customer satisfaction.

3.2 Common targets and indicators for network operation and long-term planning

In the long-term development planning, the target is to define the guidelines for the development of the network during the planning period, that is, what large and far-reaching investments are required in different years in order for the network to comply with the set requirements with minimum total cost during the entire planning period. Central factors that influence the network design are temporal and regional changes in the load level as well as changes for instance in the cost ratios between work, equipment, and losses. Well-planned anticipatory planning plays a focal role in the network development processes.

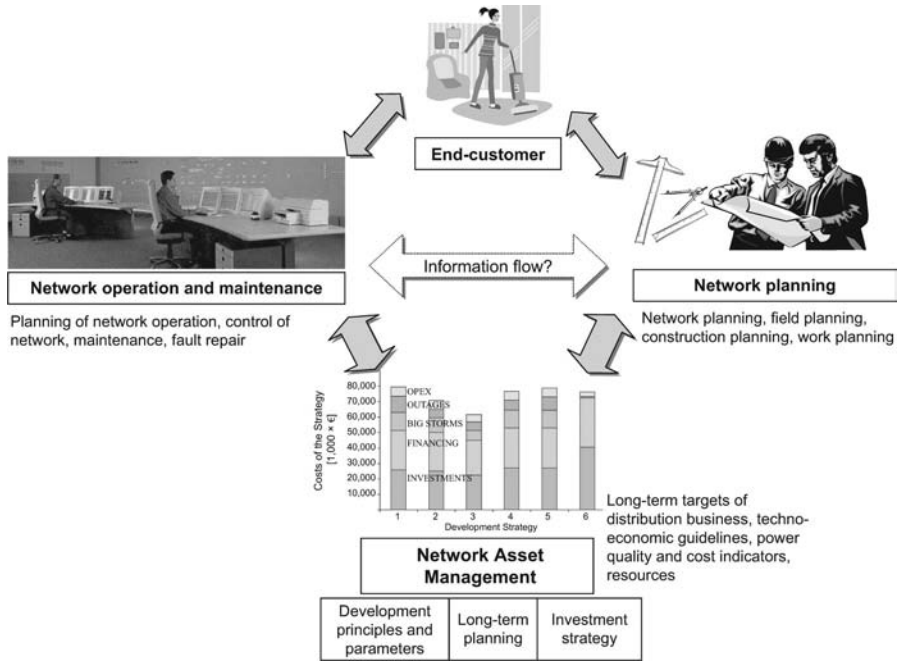


Figure 5.
Network operation, network planning, and asset management

Common targets and indicators have to be chosen so that they are not inconsistent with each other and that they support the general goals of asset management. Depending on the chosen time span of the performance period to be assessed, the indicators can be prioritised in different ways. Without common asset management guidelines for separate partners working with network planning and network operation, conflicts in interests may occur in definition of target levels.

An example of common targets and indicators for long-term planning and operational activities is presented in Table I. Some of the targets are more abstract and more difficult to measure than others. As one can see, power quality and outage costs play a significant role in both activities. Because of the strong role of economic supervision in distribution business discussed in section 2.1, there are incentives to decrease outage costs by both technological solutions (underground cabling, new primary substations etc.) and operative actions (faster reconnections and fault repair, network automation). From an asset management point of view, a balance and incentives between long-term planning and short-term operation activities for network reliability have to be defined so that long-term total costs can be minimized.

Work assignments directly affecting the level of availability of the distribution network are of the kind that typically require continuous local presence, 24/7 surveillance, and rapid intervention. The tasks can be grouped under the operation function, the common performance characteristic being the short-term evaluation time span. Indicators describing the quality performance include:

Target	Indicator
Planning perspective	
Strategic planning and asset management	
Minimum cost in the long-run	Investment costs, OPEX, outage costs
Positive development of network value	Present value of the network
Growing the business	Replacement value of the network, distributed electricity
Improving power quality	PQ indices, outage costs
Decreasing compensation fees	Long-lasting interruptions
Company-wide strategy known	Recognized and congruent planning principles for whole personnel
Resource management	Enough labour and material resources to develop network
Technical goals	
Reliability	Number and duration of interruptions, amount of customer compensation fees
Voltage quality	Customer complaints
Planning process	
Faster planning process	Number of planning tasks per day
Better quality planning process	Need for re-examination of planning targets, customer satisfaction
More economic planning solutions	Total costs of targets, less expensive network connection fees for end-users
Suitable planning solutions for each environment	Costs, reliability indices, easier solutions for network operation Easier solution to next planning phase (e.g. to field planning) No need for renovation or reinforcement before lifetime is in the end (e.g. planning of low-voltage network), customer satisfaction
Operational perspective	
Resources (cost-effective use of network, labour and IT)	Organization costs, outage costs and loss costs
Management of connection and load state	Response time in fault situation
Maintenance, inspections (replacement of older components)	Number of component failures
Fault management (outage cost minimization)	Duration of faults

Table I.
Targets and indicators for long-term planning and operational activities

- Outage management: cost of outages, cost of losses [€].
- Normal-state network management (observation of possible upcoming faults): reaction time in a fault state [h].
- Fault diagnostics: network component failures [pcs].
- Fault management: minimization of outage costs [€], duration of fault/interruption [h].

In pace with investments in increased network automation, savings in personnel costs are typically derived from reduction in substation operating levels and fewer inspection visits (Northcote-Green and Wilson, 2007). Operation and maintenance costs can further

be decreased by proper long-term network planning. On the other hand, inadequate network planning may result in higher operation and maintenance costs. As such, the company responsible for delivering savings in operation and maintenance costs depends on the quality and performance of the network planning function (= the other party). It follows that the partner responsible for operation and maintenance should have an opportunity to influence the target-setting of long-term network planning. The interconnection between network planning and network operation is especially strong regarding the target-setting and measuring of operation and maintenance cost savings. Indicators describing savings in operation and maintenance include:

- Cost of field personnel [€].
- Cost of developing capability/competence of personnel [€].
- Cost of annual preventive and corrective maintenance [€].
- Maintenance service level: Percentage of completed work.

Quantifiable indicators that describe the performance of fault state management from the customer's perspective include:

- Number and duration of faults: SAIFI and SAIDI indices.
- Trouble call management: Answered end-customer calls in major interruptions [%].
- New customers: New subscriber connections [pcs/a].

3.3 Managing responsibilities in the unbundled model

Responsibility management is implemented through appropriate agreements for the level of unbundling in question and further enabled through network information systems. As both network development and operation activities are highly dependent on the common information systems, it becomes important to consider how and with which tools the vital information processes will be managed and secured in the new business model.

3.3.1 Agreements. Agreements form the basis for responsibility management in unbundling of long-term and short-term activities such as network development and operation. The role of agreements is emphasized in the legal and ownership unbundling models. Implementation of common targets and performance meters presented in the previous subsection 3.2 is carried out in the agreements. In the case of network operation and development, an example of implemented meters in an agreement may include definition of a certain performance reference point. The reference point represents a determined value for efficient network operation, and thereby it becomes possible to implement sanctions/bonuses among parties. However, the key is to commonly determine factors behind the investment decisions, as the investment decisions must be in agreement with those of outage costs. Otherwise, bonuses may be granted to a wrong party, who actually had nothing to do with the expected positive outcome.

Managers working at the interface of outsourcing can be said to promote a certain shift in the mindset: instead of managing workers and contractors, managers must learn to manage agreements. (Allen and Chandrashekar, 2000) In general, outsourcing agreements are competitively defined as short-term, price-based, and discrete transactions. Such agreements are nevertheless not suitable for managing high risks associated with outsourcing key or protective competences. Close collaboration between parties is necessary if the scale of benefits needed to justify a decision to

outsource is to be obtained (Wester *et al.*, 2001), (Marshalla *et al.*, 2007). Thus, it follows that agreements should be long-term ones (Wester *et al.*, 2001). In an internal legally unbundled model, however, the role of the agreement is not as definite as in an ownership unbundling model. Nevertheless, the same points have to be identified and planned for.

A common feature in many outsourcing cases is that the characteristics of IT service quality are not specified clearly enough in the agreement (Chen and Fu, 2007). Nevertheless, detailed Service Level Agreements (SLA) are required in cases where the core business activities are directly dependent on the outsourced IT services (Paschke and Bichler, 2005). In the unbundled model of network operation and network planning, both activities directly depend on the availability of information systems.

3.3.2 Information systems. Network control systems today form the basis for efficient and economical network operation and planning. Long-term network planning applies primarily the network database system FM/AM/GIS interface, whereas network operation functions (including operational planning) are dependent on the distribution management system (DMS) (Moore *et al.*, 2000). Network operation functions enable control and supervision of the distribution network and include control, monitoring, fault management, and operating statistics. Operational planning functions include activities to define, prepare, and optimise the sequence of operations required for carrying out maintenance work on the network, and they also include network simulation and switch action scheduling (Roberts *et al.*, 2001). In an unbundled model, problems may arise when the level of control system integration is not high, and separate companies have to ground actions and decisions on information available.

It has been argued that one common factor in successful outsourced programs has been an ability to maintain transparent and direct communication with everyone involved in the activities across the organization and with the contractor (Allen and Chandrashekar, 2000). A clear management structure with defined roles, responsibilities, decision structures, and processes between the parties enables further transparency and can be referred to as an internal governance model (Gewald and Helbig, 2006). Information shortages between parties in an unbundled model where both activities are highly dependent on information systems can lead to fatal network situations.

In the most advanced level of information system outsourcing, new risks arise related to the content of information and loss of control over the performance of activities. Information that permits estimation of the outsourced business value can be considered highly risky (Kweku-Muata and Ojelanki, 2006). However, in an internal unbundled model, risks related to loss of control over the performance of activities are minimal as both companies belong to the same corporation.

4. Case study: restructuring network operation and network planning in a distribution company

The case study presents actual experiences from a Finnish utility active in a pioneering market area with a long experience of outsourcing behaviour. In addition, the case study represents an implementation of the third-level legal unbundled model. In the 1970s and 1980s, it was common that all operations from network construction to network planning and fault repair were handled by the same company. After that, activities such as network building, fault repair, customer service, and meter reading have been partly or fully outsourced.

Suur-Savon Sähkö Oy (SSS) is a distribution company, where an internal supplier-buyer business model for two companies belonging to the same corporation has been set up. The corporation was founded in 1946, and it is situated in the lake area in south-eastern Finland with a turnover of 110 M€. The utility is responsible for production and purchasing of energy, and electricity distribution. The length of the electricity distribution network is 25 400 km with 97,000 electricity end-users and a total 1200 GWh consumption. The distribution network of SSS has chiefly been built between the 1950s and 1970s; the situation is the same in most rural distribution companies (Figure 6).

4.1 Background of the organizational change

In 1995, in pace with the new electricity legislation, organizational rearrangements were made in the SSS electricity utility. The structure of the electricity utility (with a personnel of 260) finally reached the form presented in Figure 7.

Figure 6.
Electricity distribution network area of Suur-Savon Sähkö Oy in south-eastern Finland

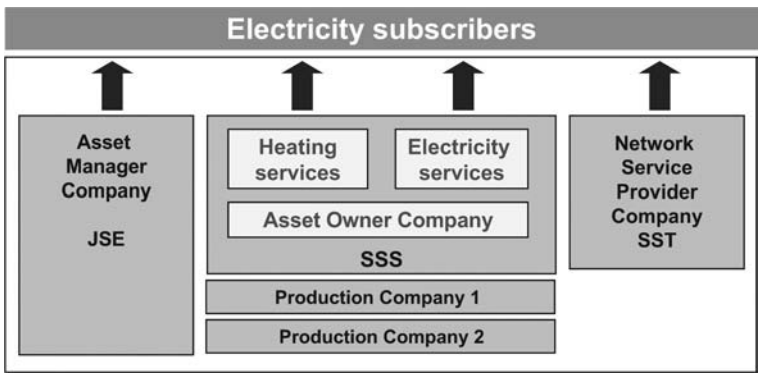


Figure 7.
Company structure of Suur-Savon Sähkö Oy (SSS)

During the recent years, the electricity regulatory authority has continued to place more requirements on the network manager company (JSE) to specify its role and responsibilities against the SSS network owner company from a regulatory viewpoint. Specified work instructions have been made to clarify common working practices and roles for the parties concerned.

Cost-efficient asset management and long-term planning are core activities in SSS. Other activities are more or less supporting by their nature. In the company, works related to small-scale building, stand-by engagement, inspections, and service as well as fault repair are considered to be part of network operation. Usually, long term planning of electricity distribution takes place almost without exception within the distribution company, and is to a large extent independent of the other more detailed network design. This seems to be the practice irrespective of the company form, that is, whether the company is a joint-stock company or a municipally owned one. Today, SSS and JSE have over 14 years of experience of working in an environment where long-term network planning and network operation are placed in separate organizations, even though both within the same mother corporation. The development trend at SSS has been and will be an increasing use of service providers.

4.2 Evaluation of external forces affecting the business model

As in many other Nordic distribution companies, also SSS has considered the challenges coming from a changing business environment. SSS used the methodology presented in (Brådd *et al.*, 2006a,b) to evaluate the magnitude of impacts where results are based on a questionnaire study conducted in the utility. The discussions with the company further showed that the main concerns in the business are the ageing network infrastructure, climate changes, and growing needs of the end-customers. The utility was asked to determine those environmental factors and driving forces that most strongly affect the network planning and operation activities. In Table II, main network planning functions are reflected against the driving force. The method is discussed in more detail in (Brådd *et al.*, 2006a,b). The impacts of the presented driving forces were evaluated on a scale from one to five. The score describes the overall importance of the driving force in network planning.

The scores show that in particular, the ageing distribution networks and customer needs have to be taken more carefully into account both in asset management and operative planning in the distribution company in the future. Correspondingly, the impacts of business environmental challenges on the network operation functions are presented in (Brådd *et al.*, 2006a,b). Hence, the empirical scores imply that the same environmental challenges affect strongly both long-term network planning and operational functions. This emphasizes the importance to ensure successful information flow through all business activities as illustrated in Figure 2.

4.3 Set-up of business model targets and performance indicators (meters)

A major part of the asset management targets defined in SSS come indirectly from the regulatory background. These economic and technical requirements are mostly implemented in the company's operations model. This way, it is ensured that individual functions support the business goals of the parent company. The targets of network planning and operation activities are observed monthly by the parent

Table II.
Network planning functions and impact of driving forces

Functions (planning)	A	B	C	D	E	F	G	H	I	J	K	L	M
Asset management													
Planning principles	5	4	4	4	4	4	4	4	4	4	4	3	4
Long term development	5	4	4	4	4	4	4	4	4	4	4	3	4
Investment strategies	5	5	3	4	4	4	4	4	4	4	4	5	4
Operative planning													
Network design	5	5	3	4	3	3	3	3	4	3	4	4	4
Field planning	4	5	4	2	3	4	4	3	3	2	2	2	4
Structural planning	4	5	4	2	3	4	4	3	3	4	3	2	4
Substation planning	2	5	3	4	3	4	4	2	2	3	4	3	2

Note: A = Ageing distribution networks; B = Customer needs; C = Climate changes; D = Regulation; E = Ageing resources within utility; F = Internal competence changes, when services bought from outside; G = Underground cabling; H = Transferring lines to roadsides; I = Use of 1,000 V technology; J = Network component automation; K = Network data system automation; L = AMR (automatic meter reading); M = Development of network construction techniques

company. For instance, development of large investment projects and network reliability development issues are discussed in the meetings.

The annual grade of the service level achieved by the network operation (SSS) is evaluated for instance by the number and duration of interruptions experienced by the end-customers. The network maintenance service level on the other hand is measured through the percentage of completed work and generated costs. The scope of maintenance works is agreed on in an annual action plan, which is then evaluated by both parties in the follow-up meetings.

The follow-up of outsourced functions is critical to achieve cost-savings without lowering the level of quality in distribution operations. The significance is emphasized when an affiliated company simultaneously operates with many service providers. In that case, different kinds of production control systems are needed. In SSS, the development work of company resource planning is currently in progress.

Based on over ten years' experience of unbundling activities in SSS, the company has established common guidelines and targets for network planning and operation functions. The goals do not collide with each other, and they support the overall asset management. The foundation for this is that the personnels in both organizations work closely and continuously with each other, and they have a good mutual understanding. The leader of asset management is responsible for and ensures that the targets in network planning and operation support the targets of the parent company.

Responsibilities of parties

4.4.1 Agreement structures and agreed procedures. In the SSS case company (Figure 7), the final responsibility for the customers and the electricity distribution regulator for long-term network development and operating belongs to JSE as the asset manager company. For the time being, however, the agreements between the parent company SSS and the affiliated company JSE are quite open. The personnel have worked a long time together in the same SSS company before restructuring, and therefore the personnel have shared understanding of the aims of network operation and long-term development. The special skills and qualifications of every staff member were taken into account when the organization change was made. Unfortunately, this kind of open agreement is not possible in an ownership unbundling model.

JSE and SSS have regular (monthly) foreman and manager meetings, where current network and personnel policy issues are discussed. In those meetings, coming network development targets and the results of completed targets (for instance a new remote-controlled disconnector, a primary substation) are presented. If a consensus considering the coming network investments between JSE and SSS can be found, SSS is allowed to put the next investment targets into action.

In the agreements with external partners, there are no restrictions between the affiliated company JSE and the service providers, which would restrict the service providers to work also for other distribution companies at the same time. For instance, the network operator JSE is basically allowed to operate also other distribution networks, not only the networks owned by SSS.

4.4.2 Information systems and flows. The importance of the functioning information flow becomes evident when organizational changes take place in a company. Even if an operation or a planning unit is only moved to another premise, the question of workable information flows has to be discussed. The question becomes even more

relevant if some of the units are to be outsourced. Failure in information flow may lead to situation where new innovations and investment decisions are delayed inside the organization. In addition to the delay, investment decisions can be based on unrealistic assumptions if long-term planning does not get feedback from the field. This may lead to unproductive network investments.

In SSS, a total of roughly 60 data systems have proved to be a challenging lot to manage and use. Further, future does not seem to bring any more easily manageable solutions. The main information systems are presented in Figure 8.

Each information system has its basic data and is responsible for updating its own data; if other systems use the same data, the data can be copied and transferred to them. The most important data transferred to other systems are:

- from the customer information system: delivery point, customer, and consumption data;
- from SCADA (System Control and Data Acquisition): state changes of switches and measurements;
- from the material information system: equipment data;
- to the material information system: equipment and accessories reservation data;
- to the economy and cost information system: basic job information, cost estimates.

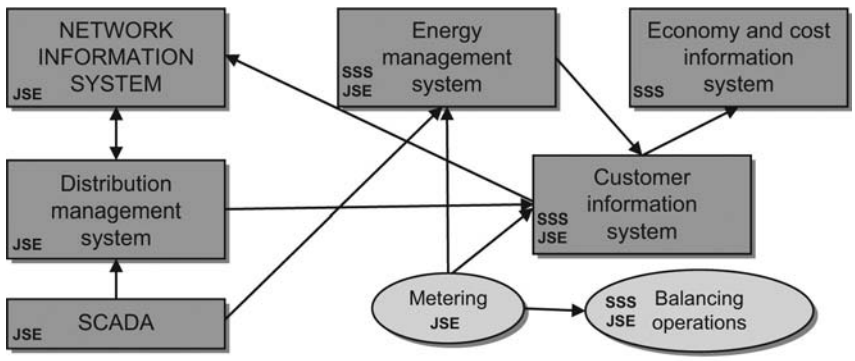
During a period of a couple of weeks, both companies were actively analysing their daily interfaces, occurring problems, and information flows. Because of the relatively large size of the company and numerous data systems, the working information flows constitute a challenge for efficient development processes. In the next section, the key findings of shared information that turned up from the follow-up study are presented in the order of incidence.

Daily:

- No need for daily information interchange.

Weekly:

- New end-customers and network construction works.



Note: JSE = owned and operated by JSE; SSS = owned and operated by SSS

Figure 8.
Main data systems and interconnections in a distribution company (JSE = owned and operated by JSE, SSS = owned and operated by SSS)

- Updating information of completed network construction works for the network operation personnel.
- Interruption information and power quality feedback from the operation personnel to network planners.
- Suggestions for new remote-controlled disconnectors from the network operation to long-term network planners.

Monthly or rarely:

- Interruption statistics (number and duration of faults, reasons for interruptions etc).
- Revision of annual strategy.
- Major construction sites; progression and scheduling (primary substations, construction of new feeders).
- Maintenance and inspections (investments and scheduling).

Regardless of various numbers of data systems and the size of the SSS, it was shown that no information-related problems between the two companies occurred during the relatively short follow-up period. Again, even though working in separate companies, the staffs that know each other well and trust each other can solve many information shortages that could prove fatal in some other circumstances. At a weekly and monthly level, however, it can be anticipated that information-related problems will occur as the amount of shared information grows. As with the informal internal agreements supported by the agreed policies, also common policies for information sharing between the companies could be beneficial to avoid information shortages and possible unintended misuse.

5. Results and discussion

A framework for decision-making in utilities considering network activity-based unbundling models has been presented. Key points in the framework include an analysis of impacts of external drivers, set-up of common targets and performance models, and adjustment of responsibilities in the new organization. Special considerations are proposed for the agreement structure and modelling and management of information flows. The appropriate level of unbundledness for each utility is further dependent of the ownership vision, market conditions, and regulatory restrictions and recommendations.

External drivers should especially be taken into consideration in long-term network development, as network operation activities can faster adapt to changes in the business environment. External factors such as ageing of distribution networks and regulatory changes can be considered quite slow and of slight practical importance within network operation activities. Moreover, from the perspective of long-term network development, the existing investment decisions have a significant effect on network operation activities.

By splitting up an integrated organizational structure, it is possible to obtain more transparent cost information of different activities. This helps to direct effort to the activities with the best opportunities for cost savings. As the ageing networks will require large-scale renovations in the future, there will be shortage of workforce. It is not economical to keep a staff large enough for the highest periods and then have the workers underemployed when the demand is lower. In an outsourced organization structure, adjustment of resources is easier in dynamic conditions. In small distribution

companies, it can be uneconomic to maintain all the business-specific special knowledge inside the company personnel. Rarely needed knowledge can be easily lost. Also the risks and consequences of losing a key person in a small organization operating in a special-knowledge area are more serious.

The majority of the economic and technical targets in the asset owner company SSS are coming indirectly from the regulator, which guarantees a common basis for targets for long-term planning carried out by SSS and for network operation performed by asset manager company JSE. The theoretical business performance indicators are acknowledged by SSS and JSE (Table I); however, these indicators are not yet all in active use. However, similar indicators are applied within the network operation company towards external subcontractors. Service performance indicators (subsection 3.2) should always be determined before the agreement is signed (Allen and Chandrashekar, 2000). Based on the experiences of SSS, the targets and business performance indicators presented in Table I can support utilities in similar situations.

Common target setting especially in the areas of a) matching long-term network development actions with those of short-term planning and b) suboptimization both in network development and operation should in these both areas aim at minimum overall costs in the distribution company in the long run.

Currently, agreements between the parent company SSS and the affiliated company JSE are quite open. However, contract terms specified for subcontractors could further be developed to be used by the companies in the unbundled model. The agreed framework for the common work of both companies could be specified as agreed policies or written agreements.

Close collaboration is taking place as the personnel in both activities know each other well and have shared understanding of the aims of network operation and long-term development. If the current level of legal unbundling were to evolve into ownership unbundling in the future, it would be essential to focus on developing agreement management including set-up of long-term agreements, defined SLAs, and agreeing on the performance indicators prior to signing of the agreement.

An intensive analysis period in the case utility was taken to model and react to challenges present in the current information processes between the parties. Serious information system challenges manifest in the beginning of the unbundled model have been tackled along the years. According to SSS, many of the challenges can be avoided when information flows and common proceedings within network data system interfaces (GIS, SCADA, and DMS) and towards other operating functions such as network construction and maintenance are specified prior to set-up of an unbundled model. Moreover, information shortages between parties can lead to situations where new innovations and investment decisions are delayed within the organization. Unproductive network investments may also result if long-term planning makes investment decisions without feedback from the operations activity and the field. Successful distribution network management is thus possible only if the feedback of network reliability is arranged from network operation for the long-term planners. Various data (number and duration of faults, disconnection times) have to be collected to understand the demands of the distribution environment.

Further, network planners have to take into account the opinions and needs of the network operator when for instance new feeders and disconnectors are planned. The network operator has to be informed if there are changes in investment scheduling.

This information is needed in particular to guarantee successful fault repair and customer services. If the legally unbundled model used in SSS were to further develop into ownership unbundling, it would become important to identify and evaluate the risks involved in confidentiality aspects, since sharing of information processing activities can mean loss of control over the performance of activities.

Special outcomes highlighted by SSS include the role of strategic planning, quality standards, and effective usage of network reliability data in development activities. An annual development strategy has to be drawn up together with the network operator and the long-term planners. All partners have to know the coming investments in advance in such a way that heavy and expensive maintenance operations are not focused on the areas where network is fully renovated anyway in the next few years. Also, various quality standards have to be defined and agreed upon to follow up the development of electricity distribution.

6. Conclusion

Based on supporting literature and key findings from the empirical case, the paper presents a framework for decision-making in utilities where unbundling considerations are taking place. Different levels of unbundling (administrative, management, legal, and ownership unbundling) in the electricity distribution business are presented as part of the literature review.

The two elementary levels of unbundling (administrative, management) represent largely the current state of utilities for example in the Nordic countries with no existing techno-economical restraints on market and regulative behaviour. Typical features for administrative and management unbundling-levels include: account-based separation of network functions, minor changes in operations and agreements based on mutual trust (one holding company). The administrative unbundling model is an alternative to developing electricity distribution business, whereas the foundation for cost management and regulative reporting is defined. Obtainable benefits through a shift from the administrative unbundling to management unbundling are slight and include possible competence development as part of more specialized organizations.

The third level of unbundling represents legal unbundling, whereas network activities are legally separated. Benefits from the legal unbundling model include; an opportunity to improve network performance through set-up of a controlled supplier-buyer model and prepare the organization for future outsourcing alternatives. The case study presents a legal unbundling model, whereas empirical conclusions suggest that the expected benefits have been obtained and special caution should be given when modelling of information flows and set-up of common performance targets prior to cut-over. A further change in ownership unbundling may in general include benefits related to outsourcing to an external partner with expectations of higher and specialized competence and smaller operative costs (OPEX).

Factors strongly impacting the unbundling of distribution network activities are regulation, tightening customer demands, business owner policy, ageing networks, and climate change. In the empirical part, the study applies a methodology for evaluation of the impacts of external forces, previously presented by Brådd *et al.* (2006a,b). The case utility SSS has made large-scale rearrangements to meet these challenges.

The unbundling of network operation and long-term network development is an alternative in the cases where common business targets are agreed on and cost

efficiency can be measured. Long- and short-term target differences can be harmonized through strong common regulatory requirements set by the asset owner company. In the case study of SSS, the internal legally unbundled model had acknowledged theoretical targets and indicators, but they were not actively in use. Benefits recognized from the legally unbundled model by the two companies include an increase in knowledge of the service cost levels and information of know-how of each subcontractor. This helps to set long-term targets and develop the business.

The authors believe that the SSS utility represents a pro-active and market-conscious case of utility reorganization, the empirical results and experiences of which can be widely exploited, because the unbundling process with its challenges is similar inside the distribution business regardless of the country in which the outsourcing is carried out. Nevertheless, experiences from utilities active outside the North European market area can bring different and complementary results.

Finally, the main steps in the above-presented framework for utility decision-making considering different types of unbundling include identification, specification, and implementation of the appropriate unbundling model. Identification of the proper unbundling level is based on the long-term strategy to manage external drivers combined with owner interest and a need to meet requirements of specialization. Specification of the chosen unbundled model requires harmonization of target setting and performance measurement. Implementation of common targets and performance meters is carried out through agreements and enabled by proper information systems.

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