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Challenges and bottlenecks related to the cabling of the medium voltage network in rural areas: Key findings of the interviews and discovered development targets

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SGEM Large Scale Cabling
Short summary of the interviews

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Introduction

Traditionally, electricity has been distributed with overhead lines in the rural areas of Finland. A Large volume of them was built in 1960's and 1970's. The serviceable lifetime of these overhead lines is estimated to be about 50 years, thus several thousand kilometers of electric lines will be rebuilt annually in the near future.¹ In addition to rebuilding old lines, also new lines will be installed as the result of the growing energy requirements.

The reliability of power supply has become more and more important in modern society and it has direct effects on network business profitability through the business regulation. This is one factor driving towards the cabling of the distribution network. Different distribution companies have different cabling strategies. When rebuilding the old networks, the owners of distribution networks have had the possibility to rethink the structure of the electric network. One strategic question among others is, where to prefer underground cabling and where overhead lines. These alternatives have differences not only in the investment costs and esthetics, but also in reliability. Overhead lines are usually cheaper to construct, but for example storms and snow can cause problems, whereas underground cables have usually less reliability problems. However, if problems appear in the underground, they are often slower to fix.

There have been several studies about what could be a suitable strategy for replacing the old lines². Lassila et al.³ have reported about one company whose strategy was to favor underground cabling only in the urban environments. Some other companies have strategic decisions to use underground cabling as the primary network construction method even in the rural areas⁴.

Some decades ago Finnish power companies owned, designed and built all the electric lines in their market area. Furthermore, the same companies generated and sold energy. Later on power generation and sales businesses have been separated from each other by law. Also the distribution business is often separated.⁵ Distribution companies, who own the power lines, are utilizing more and more external service providers. Nowadays for example cabling work is usually outsourced to specialized companies.

When cabling strategy that prefers underground cables in the rural areas is implemented, several kinds of problems and challenges can appear. In order to get an overall picture about the current challenges and problems of underground cabling projects, six energy distribution companies, six cabling contractors and six external experts from Finland were interviewed in 2011. The challenges and problems were looked at the perspectives of energy network companies (who order the cabling) and contractors (who provide the cabling services). The interviews focused around underground cable network construction and its current practice, major challenges, development possibilities and quality assurance. The main findings of these interviews are introduced in this summary. There is also a more detailed report available which is written in Finnish.

¹ Haakana et al. 2009

² Bloom et al. 2006; Lassila et al. 2006; Schaffer et al. 2009,

³ Lassila et al. 2011, p. 19

⁴ Vattenfall 2009

⁵ Lassila et al. 2011, p. 3

Key findings and development targets

Several challenges were found. Those could be classified under the following main themes: preliminary design, content of the contracts, documentation, quality confirmation, joint construction and collaboration with authorities and other stakeholder groups.

Preliminary design

Until recent years the common division of duties has been that a network the company does the preliminary design, and the contractor's designing task is just to make the field planning for cabling. A recent trend in Finland has been an increased outsourcing of design work by some remarkable network companies.

The utmost form of outsourcing goes like this: network company orders piecework from a cabling contractor. The company tells that they want to have cabling with certain specifications from point A to point B and gives the contractor a free hand to realize it. All the detailed planning is left to the cabling contractor, who has to do all the planning either itself or by outsourcing these services to another company. This trend was not seen pleasant from the contractors' point of view in the interviews. Tender calculation is difficult to do when preliminary design information is not available and that's why contractors see a lot of risks in the costing of this kind of projects. In addition, the building costs differ a lot depending on the type of soil. Especially the smallest contractors don't have the ability to bear a lot of risk. Maybe that's why many of them told in the interview that they would prefer unit price contracts over design-build contracts.

Development targets: Examination of the significance of the preliminary design made by the network company

- The amplitude and the accuracy of the preliminary design made by the orderer
- Co-operation with the landowners

Content of the contracts

There were seen some problems also in the contents of the contracts. For example those contractors who were working for several network companies found it difficult that the same terms may carry various contents depending on the company. Even though uniform definitions have been created, all the companies don't utilize them. Therefore costing is sometimes a bit challenging and takes extra resources. The contracts were sometimes considered open to various interpretations. It was also mentioned that sometimes the agreements between the subcontractor and its subcontractors are only verbal, which is not advisable.

Development targets: Examination of the content of the contracts

- The optimization and standardization of the content of the building units

- Reduction of content which is open to various interpretations

Documentation

The cable routes are documented after the cables have been installed. It varies, how documentation is done, and who is responsible for the documentation: sometimes it's the contractor and sometimes someone else. Usually, the documentation includes information about the cable route, the location of the cable joints, cable type, -length and -cross section area and some times the installation depth. Some information that might be valuable in the future is not documented this includes the installation method (plowing, trenching or boring), the installation configuration (direct buried, in conduit or some other special protection) and the ground level.

When someone intends to install a new cable, information about the old ones is needed. However, the basic problem is that the information about the location of the old cables is gathered in different sources and is not always easily available. Defense forces, energy, telecommunication and water companies know themselves where their own cables lie. Also municipalities have information about the cable locations. Even though some nationwide cable location databases exist, all underground infrastructure is not included in these systems. Especially information about the oldest cables is missing. According to the interviewees, old cables have sometimes been accidentally cut because there hasn't been information about the existence of the old underground cables. It can require a lot of work and time to find out what cables there are under the ground, who is the present owner and how to get the required information.

One problem is that the information about the old cables may be in paper form and too broad by scale. In the worst cases the information of different companies' cables are in different charts and documented in different scale. The situation is going to be better and the location information of new cables is nowadays usually saved in nationwide digital databases. However, defense forces and several cooperatives and companies don't deliver information in these databases. A shared interface, where all the country's underground infrastructure can be accessed has been set as a target for the near future.

The use of GPS location information as a documentation tool is slowly becoming more and more common these days. With GPS it is easier to get the accurate location information into digital form. However, many contractors still see these equipments as too expensive and are thus slowing down the development. Some interviewees hoped that not only the latitude and the longitude, but also the realized depth and ground level information would be documented. At the moment depth information is not often stored.

Development targets: The development of the electronic documentation

- The liability distribution in documentation
- The documentation of the cable installation configuration (direct buried, in conduit, protected with a cement plate, etc.), the material of the cable duct, the type and the installer of the cable joints and terminations
- The documentation of the cable route, the installation method (plowing, trenching, boring, etc.), the installation depth and the z-coordinate (ground level)
- A shared interface where the location of all underground infrastructure can be accessed to help the design and excavation work

- Utilizing of the use of GPS

Quality confirmation

Installation methods that before have been used only with low voltage cables are now used also with medium voltage cables. Cable plowing is one method that is now used also with medium voltage cables. The main reason to install cables with a plow is its relatively low-price in comparison to traditional trenching-based underground cable installation methods. However, a common impression within many interviewees was that cables installed with blowing method can later on cause somewhat more reliability problems. There is a need for further research related to the question, how the installation methods in fact affect on the reliability and lifetime of the cable in Finnish conditions.

Required technical measurements are done before the commissioning of the cable, but all potential quality problems don't show in these measurements because of the limits of the measuring methods. Failures can appear months or years after the installation. The amount of faults encountered during the first years of operation has generally been very low. However, it was also mentioned that there had been a problem with one type of terminations that were prone to early faults.

Quality is not just a technical issue. Also worker's motivation, knowledge and many other things have an effect on it. Even though some supervision is done by the orderer, quality control is often widely based on operator's own control, and is reliant on workers' expertise and motivation. The contractors also argued that network companies don't value enough quality things when choosing the contractor.

In the earthwork there seems to be many workers without formal education about digging or cabling work in the excavating sites. It was also seen as a challenge.

Development targets: The development of the quality assurance

- Definition of the quality criteria
- Emphasizing of the quality points in competitive tendering
- The clearance of rules in monitoring, operator control and measurements
- The development of "cable installation card" for excavation workers and electricians
- The auditing of the subcontractors

Joint construction

In the case of underground cabling, joint construction means that those organizations who have needs for underground infrastructure are working together. Excavation causes remarkable part of the costs when building infrastructure networks. Therefore it is preferable to tend to install not just the power cable but also the other infrastructure simultaneously. Potential collaboration partners in joint construction can be the owners or the builders of energy networks, roads, streetlights, telecommunication networks and pipes.

Joint construction can also mean joint tendering, joint selection of the contractors and joint applications for licenses. For instance in the case of fiber cables, excavation costs can be even 80 % of all the construction costs.⁶ That's why aspiration to do joint construction could be thought to be strong. However, according to our interviewees, the joint construction is too rare in practice.

Joint construction was seen as a thing, which should be done more often, but which is however too rarely done. Joint construction requires cooperation between many organizations. It can also require some compromises in the routing, the timing of the cable installation and the costs. However, it can provide remarkable saving possibilities. The costs of joint construction are usually clearly lower-priced than what would be the sum of the costs, if all the operators were digging just for themselves. However, the division of costs has turned out to be quite challenging. No clear rules exist how the costs should be divided. Successful joint construction projects seem to require early design work and early collaboration⁷. One key reason for rarity of joint construction seems to be the limited and not easily available information about the external organizations' plans.

Development targets: The development of joint construction and informing process

- Informing about upcoming installations
- Responsibility to somehow inform about upcoming projects and responsibility to find out if someone else is planning to operate at the same area
- The principles of the division of costs

Permissions

Society has changed a lot from 1960's and 1970's when a large amount of overhead lines was built. According to a few interviewees, landowners are not as eager to give permissions to install power lines into their land as before, at least without good compensation. Currently there is no general agreement for land use compensation. Some interviewees supposed that one key reason behind this kind of an attitude is that the landowners in the rural areas don't see cabling just as a public good thing anymore. It is seen as a business. It is partly a consequence of urbanization and heritages, that nowadays many landowners live somewhere else than where their lands are located.

Nowadays it is preferred to build cables near the road instead of installing them into forests. It was also mentioned in the interviews that installing the cables near the public roads is still made too difficult by the rules of Finnish Centre for Economic Development, Transport and the Environment, even though some facilitate development has happened during the last years. Also the required time for getting the permissions was seen to be too long by both the owners of the networks and the contractors.

Development targets: Co-operation with road administration and with other interest groups

- Processing times of permissions

⁶ Niemelä 2010

⁷ Niemelä 2010

- Co-operation with the Centre for Economic Development, Transport and the Environment
- General contractual terms/model agreements for land use compensation

Conclusions and discussion

Several problems and challenges related to cabling processes were found. These foregoing issues are potential targets for future development. This case study was carried out in the Finnish environment, but many of these challenges are probably of general validity. They must be taken into account both when planning and implementing cabling strategies. But what are the possibilities for improvements?

It can be very difficult for single companies to change the common practices in the field. For example the need for joint construction has been seen for decades, but it is still too rare. Many problems related to the energy strategy may need both national and company level solutions.

One root of the current problems is linked to the insufficient sharing of information. A partial solution to the problem could possibly be a regulation that one should inform the others about one's future underground cabling plans. The regulation could also include an obligation to check out, whether other companies have plans in the same area, before starting a project. This kind of a regulation already exists when operating in the urban areas, but it could be extended to concern also the rural areas.

Better knowledge and more easily available information about the cable locations and the future plans of other organizations would be useful for designers who are evaluating the new cable route possibilities. Better and more easily available documentation could be worthwhile also for other operators, like contractors. These improvements could reduce the underground cabling costs and broken downs, and thus also have some positive impacts on the reliability of energy distribution.

The central themes in development of the processes are:

1. Examination of the significance of the preliminary design made by the network company
 - The amplitude and the accuracy of the preliminary design made by the orderer
 - Co-operation with the landowners
2. Examination of the content of the contracts
 - The optimization and standardization of the content of the building units
 - Reduction of content which is open to various interpretations
3. The development of the electronic documentation
 - The liability distribution in documentation

- The documentation of the cable installation configuration (direct buried, in conduit, protected with a cement plate, etc.), the material of the cable duct, the type and the installer of the cable joints and terminations
- The documentation of the cable route, the installation method (plowing, trenching, boring, etc.), the installation depth and the z-coordinate (ground level)
- A shared interface where the location of all underground infrastructure can be accessed to help the design and excavation work
- Utilizing of the use of GPS

4. The development of the quality assurance

- Definition of the quality criteria
- Emphasizing of the quality points in competitive tendering
- The clearance of rules in monitoring, operator control and measurements
- The development of “cable installation card” for excavation workers and electricians
- The auditing of the subcontractors

5. The development of joint construction and informing process

- Informing about upcoming installations
- Responsibility to somehow inform about upcoming projects and responsibility to find out if someone else is planning to operate at the same area
- The principles of the division of costs

6. Co-operation with road administration and with other interest groups

- Processing times of licenses
- Co-operation with the Centre for Economic Development, Transport and the Environment
- General contractual terms/model agreements for land use compensation

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