2. Electrical Engineering

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Electrical engineering - tradition and expertise

Electrical engineering has a long tradition. The first electric light in Finland, and actually in the Nordic Countries, was introduced as early as in 1882, in the large textile factory of Finlayson in Tampere. Nevertheless, the pace of progress in this field is fast. Electricity usage has been on the increase for quite a while and the society is increasingly dependent on it. It is hard to imagine that society could ever be able to function even a single day without electricity.

While electricity has become a matter of course, the business environment has changed a lot over the years. The deregulation of the electricity market started in 1995. Ten years have past and people have generally grown used to the change. Most of the consumers know that they can request tenders from the electric companies, even if only fewer than 5 % of the customers do this.[1] People are now learning to live in a society that tries to reduce the emissions from the greenhouse effect and where emissions trading takes place.

Electricity, natural gas and emissions quota are bought and sold on the stock market

Deregulation opened up a common electricity market for Finland, Sweden, Norway, and Denmark. In this Nordic electricity market the price of electricity is formed on the electricity stock market. In the actual Nordic electricity stock market, called Nord Pool Spot AS, a market price for each hour of the following day is quoted based on bids. Approximately 45 % of all the electricity used in the Nordic electricity market is stock market electricity. The rest of the trade is bilateral. Some finance products use the electricity stock market price as their reference price.[2]

In addition, the natural gas market has now been deregulated. The 98/30/EU directive by the European Parliament and European Council, concerning the common rules for the internal market of natural gas, came into force. Finland was allowed a few exceptions as to the rules concerning opening the markets, for as long as Finland has mainly one natural gas supplier and as long as there is no connection to the gas network of another EU country. Only the so-called secondary natural gas markets have been opened. Even those are only for parties that fulfill certain criteria. Kaasupörssi Oy was established to take care of this trading on the secondary market.[1]

"Although the use of electricity increases all the time, its production is more environmentally friendly than before. Even the consumers can affect the production methods through their own choices."

The UN general assembly founded an inter-governmental negotiation committee in 1990. Its task was to prepare a framework convention with the aim of restraining climate change. In 1992 the United Nations Framework Convention on Climate Change was signed. As a follow up, the so-called The Kyoto Protocol was approved in 1997. The member states of the EU ratified the protocol in 2002. It defines the emissions quota for the industrial countries for 2008-2012.[1]

Emission Trading Act (683/2004) came into force in 2004. Internal emissions trading of the EU started in 2005. The system aims at creating an efficient way to reduce carbon dioxide emissions. Emission trading applies to any power plant with a capacity of 20 MW and power plants with a capacity that is less than 20 MW if they are connected to the same district heat network. It also applies to oil refineries, coking plants, and some other steel-, mineral-, and forestry plants. 600 Finnish plants are within the scope of emissions trading. It is possible to buy emissions quota in the stock market.[1]

At present the UN is starting negotiations on the plan for the time after the year 2012. At the meeting of the climate policymakers in Bali at the end of this year, the goal is to agree on the principles of how to continue the Kyoto Protocol after it expires in 2012.

Electricity saving is on the increase

As electricity has become a stock market product and the market has been deregulated, environmental issues have become even more important topics. Electricity production is getting more pro-environmental. The burning processes of the conventional power plants have been developed and the use of new pro-environmental energy production models has increased year after year.

Along with climate change, more attention is paid to how individual consumers can help. There are various guidebooks and lists available that deal with saving electricity and energy.

During the recent years people have become more and more interested in saving energy. Consumers can now pick the most energy efficient device from the ones available, and energy saving lamps can be easily found in almost any store.

On the other hand, despite this positive progress the number of electrical devices has gone up now. This for its part increases the use of electricity.

Assessing the environmental load from traffic is naturally also important when we are talking about saving our environment. People use more private cars. Although the air in Finland is normally quite good, there are foreign examples on what the air can get like due to excessive traffic.

The things mentioned above reveal that people's attitudes to electricity have changed during recent years. Electricity is now often discussed in connection with environmental issues. Everybody would like to do their best to slow down climate change even if they were using electricity.

In Finland electricity is produced with various energy sources and by several production methods. In 2006 hydroelectric power constituted 12 per cent of the production.

New achievements with technology

Although home delivery of electricity has been available for a long time now, electrical engineering, like all technical fields, develops constantly.

Wireless services have increased considerably during the recent years. This was due to more efficient batteries making it possible for the wireless devices to function. Not only have they been able to make the new batteries smaller, but also the appliances using them are small. Technology must have taken huge steps to be able to pack all the components in such a small space.

Wireless devices and the services available have changed people's lives quite a lot. Especially the ways of communication and communication devices have undergone a transformation. A text message is now an everyday way to communicate. Email has taken the place of snail mail. People answer their phones almost anywhere now etc. We are so used to these services that it is hard to imagine life without them.

The development of individual devices tells us about the technological progress in general. However, to be able to use the devices and charge the batteries, we also need good quality electricity. Electricity production, transmission and distribution are under continuous development. The progress of automation and information technology offers us new possibilities while the environmental issues have also undergone some progress.

The ordinary citizens see this development merely in that there is always electricity available when they need it, and in that their appliances work without problems because the quality of electricity is good. If everything goes well, electricity becomes something to be taken for granted and we'll only realize its importance if there is a blackout.

The future of electrical engineering

The turnover of the Finnish electronics or electrical industry companies has gone up in recent years. In 2005 the companies' turnover in this branch rose by 7 % and totaled 20,5 billion euros. The turnover for electrical appliances and machines sales was 2200 million euro. 62 000 employees were working in electronics or electrical industries. This branch

will surely be a strong actor in Finland and in global export markets in the future as well.[3]

Electricity is likely to be productized more extensively in the future. Consumers want to know how the electricity they purchase was produced. They can have their say and demand that electricity will have to be increasingly produced with renewable energy forms. For example, the amount of wind generated electricity has increased in recent years as the demand for it has increased. In the future, more attention will be paid to how houses are heated, and there will also be a variety of decentralized forms for electricity production. Environmental values will get more emphasis in future.

It will be interesting to see how the UN will deal with the problem of the continuation of the Kyoto Protocol. Obviously, new conventions will be made but their form and scope is as yet totally unknown. Individual consumers, however, already seem to be active and willing to prevent the furthering of climate change, so at least we are progressing at some level.

The deregulation of electricity and natural gas markets will undoubtedly continue and develop in the entire EU area. For the market to function well, the electricity transmission networks will also have to be developed. The size of the European market areas remains to be seen, but surely they are developing as well. ■

References:

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Interview
Ulla Vehmasaho / Professor Leena Korpinen, M.D., D.Tech.

From transmission line supports to the stock exchange - Electric system is a showcase for engineering

When the Finns were green as electricity users the essential question was how everyone would be able to benefit from electricity, and how its usage could be increased in households. Now that we are experienced users of electricity, and as this sparking natural phenomenon is considered a must, the discussion topics have changed, too. Now electricity is green, and not its users. The hot topics now are environmentally friendly generation of power, cutting down consumption and emissions. The markets for electricity have changed totally. Households are now asking for competing tenders from their electric companies.

- The deregulation and renewal of the market started in 1995. Before that the major concern was in building the power plants and networks, and servicing them. Now electricity is a stock exchange product. It is purchased and sold on the stock exchange, explains Leena Korpinen, the head of the Laboratory of Electrical engineering and Health at Tampere University of Technology.

- Households will enjoy the benefits of this development in the form of lower prices.

There are 120 companies generating electric energy in Finland and approximately 400 power stations. Although there are so many companies in the electricity production, two groups do most operations. Fortum Oyj produces 40% and Pohjolan Voima Oy 20% of Finland's electric power. Industries that use a lot of energy are also significant producers of electric power.

The entire system is a showcase for engineering

Finland, Sweden and Norway have a common market for electricity. The market price for electric power is formed in the electricity stock market,

where the market price is quoted for each hour of the next day, based on bids.

The legislation on the market for electricity (386/1995) came into force in 1995 and opened up the market for competition. You are no longer forced to purchase your electricity from the local power company as all users of electricity are now allowed to buy their electricity from any vendor. Selling electric power is not regulated and a license is not required. Electricity network operations are still subject to license, and remain a kind of natural monopoly.

Korpinen says that both electricity itself and its present production and market situation are fascinating.

- This gradually built system is excellent: to maintain the market balance, to produce electricity in exactly the amount that is demanded, to maintain the frequency and voltage at the right level, continuous trading in the stock. This is a showcase for engineering, Korpinen praises.

Requesting bids for cheaper electricity

As said before, consumers can decide where they buy their electricity. The local network provider is responsible for the quality of the transmission of electricity, so it does not matter where the electricity comes from. Switching electric companies is free of charge.

This is why Korpinen recommends that we all request bids from our electricity vendor.

- Deregulation avails even the household consumer now. Finding out about the different electricity prices from various electric companies can reduce your electricity bill by tens or even hundreds of euros a year, depending on the type of housing you live in. You can get all the information you need for bidding the electric companies from your electricity bill. According to Korpinen, the web service by Energy Market Authority, at www.sahkonhinta.fi is a good place for comparing the electricity prices.

- The more the electric companies have to submit bids, the more pressure they feel to keep the prices down even in the future.

The household electricity bills comprise the price of the electric energy and the transmission service, i.e. the home delivery of electricity. It is not possible to bid for the transmission part. Hence switching over to

another power company does not affect the transmission fee. It is always the same no matter where you buy your electricity. For households, the actual electric energy forms about half of the electricity bill.

Emissions trading protects the environment

Environmental emissions are another object purchased and sold.

- Of course we can protect the environment even without the emissions conventions, but we have decided to handle it like this. For example, sulphur oxide and nitric oxide emissions as well as carbon dioxide emissions can be reduced with the new technology. We can also protect the environment by cutting down industrial and household energy consumption and rationalizing it, Korpinen reminds us.

- Power stations have their own quota for emissions coming from to the use of fossil fuels. However, it is possible to buy and sell these emission rights, which enables flexible and uninterrupted production.

Even if electricity itself does not leave any waste, the generation of electrical energy affects the environment. Energy generation with non-renewable fossil fuels is based on burning the fuel, which again frees carbon dioxide into the atmosphere. The released carbon dioxide contributes to climate change, i.e. strengthens the green house effect. International conventions, which Finland also belongs to, try to hold back the green house effect.

Climate change, the greenhouse effect, is being fought by international conventions limiting the use of fossil fuels. Consumers can have an impact by choosing electricity that has been produced pro-environmentally.

Finland uses several types of fuel for the generation of electric power. The imported fossil fuels are coal, oil and natural gas. Wood, other renewable bio fuels and peat are the domestic fuels. The proportion of renewable fuels of all the fuels in Finland is quite high compared to other industrialized countries. In addition to this, water, nuclear power and even wind force are used for the generation of electric power.

The idea of the internal emissions trading system of the European Union is

to reach the goals for emissions cuts in a way that is as cost efficient as possible. Finland must cut its emissions to the level of 1990. At the moment the emissions trading inside the EU applies only to carbon dioxide emissions. There are approximately 550 electric power stations in Finland that need the license.

The prices of emission rights are expected to rise significantly before the next contract period starts in 2012. Higher prices for the rights may affect the market prices and consequently the entire electricity consumption.

- Naturally, there is a limit to the rising price of electricity. Nevertheless, it has some positive effects like cutting electricity consumption and rationalizing it, states Korpinen.

"Heating constitutes over one third of the total electricity consumption of all households. Dropping the temperature by just a few degrees and some readjusting can bring significant savings."

Environmentally friendly, economical, recycled electricity

To sum up, power stations are not the only ones responsible for the environment. Each of us can make an impact on the amount of emissions by the choices we make.

In practice all electricity gets mixed in the electric network, no matter how it was produced. Consequently and according to the laws of physics, the electricity that we get from our plugs is the same for all consumers.

But the consumers can have their say in what proportion of the total amount of electricity is produced with renewable energy sources. The kind of electricity that is produced in a sustainable way and with renewable energy sources, risk-free and in ways that minimize environmental harm, is green electricity. Production of green electricity does not increase carbon dioxide emissions like production with fossil fuels does, and is therefore a responsible alternative from the global climate change view.

- The demand for more environmentally friendly electricity has had an impact; companies have increased the use of wind force.

- Nowadays many companies also use wind force, even if on a smaller scale. In 2006 wind force was used only for 0.2 % of the Finnish elec-

tric power generation but the EU demands its wider use. Households can choose to buy only electricity that is generated by wind force. It is just a little more expensive than normal electricity.

It is possible to increase the production of wind electricity, but increasing solar electricity is more challenging because of the distance from Finland to the equator where sunny days are more frequent.

- For example, you can install appliances that use solar energy in houses. One of the problems with solar energy is how to store the energy collected in summertime.

Recycled electricity is also a very environmental and cost-aware choice. The fuel gets used almost totally in this kind of co-production and much less fuel is needed than when heat and electricity are produced separately. According to Helsingin Energia, the same amount of energy that is used by 270,000 houses in a year is saved in Helsinki because of this co-production. Furthermore, the emissions of the production are reduced by half. Finland is a leading country in co-production: almost 80 % of district heating is produced as co-production.

Alternatives exist but like Korpinen says, the consumers have not woken up to them yet.

- The more obvious the signs in the environment, the more we take note of the risks to the environment and start looking for alternatives for reducing energy consumption, and for safer and more pollution-free production.

Could we give up something?

The electrification of the Finnish households started in the 1930s. The idea was to make it possible for all the citizens to enjoy the improvements that electricity could bring to the homes and working conditions.

The aim was to preserve electricity consumption at a ‘sensible’ level. Electricity was to be used only when necessary and only for purposes that brought technical or financial advantages. No more but no less either. Electricity had to be used in a way that fully exploited its unique characteristics but caused as little harm as possible.

Rationalization is still needed, perhaps even more than in 1930s. In 2006 Finland used approximately 90 terawatt-hours of electricity. The

growth compared to the previous year was 6.5 %. The growth has been greater than ever. What can we easily go short of?

- As regards the purity of environment, traffic is a major element, Korpinen reminds us and continues to express an opinion as a doctor of medicine:

- Development and promotion of public transportation also protects the people themselves. Sitting in a bus or a train, you will get to see beautiful things that you'll never even notice when driving a car. This is important for people's well-being.

- But there are obvious electricity saving targets. 35 % of all household energy goes for heating. Checking the settings and dropping the temperature by a few degrees is of great significance.

"We must not forget traffic emissions when talking about unpolluted environment. Public transportation saves the environment - and people."

What are the things Korpinen would be ready to give up herself?

- Those appliances that belong closest to my normal life would certainly be the hardest to give up, say, the fridge and other devices used for cooking and perhaps the washing machine. I think I could do without the television as it is possible to watch the news elsewhere.

New devices have been designed with saving energy in mind already in the design phase. Nevertheless, there is still a lot of development work to do.

- For example televisions are high technology. Still we are obliged to go to the store to buy an extension cord in order to be able to turn off the power in them, Korpinen says laughing.

Electricity is a natural force. Is it possible for a man to totally tame it? Can it be that the greatest risk is that after everything has been made electrical someone comes and pulls out the plug?

To Korpinen the availability of electricity is not a risk. Getting it even when you do not want it is more of a risk.

- The greatest obvious risk is an electric shock. Electricity is everywhere today. It is so self evident that we do not even think about it. Especially the combination of water and electricity, which is known to be so wonderfully sparkling, is also life-threatening. ■