Influence of Regulation on Network Investments and Reliability

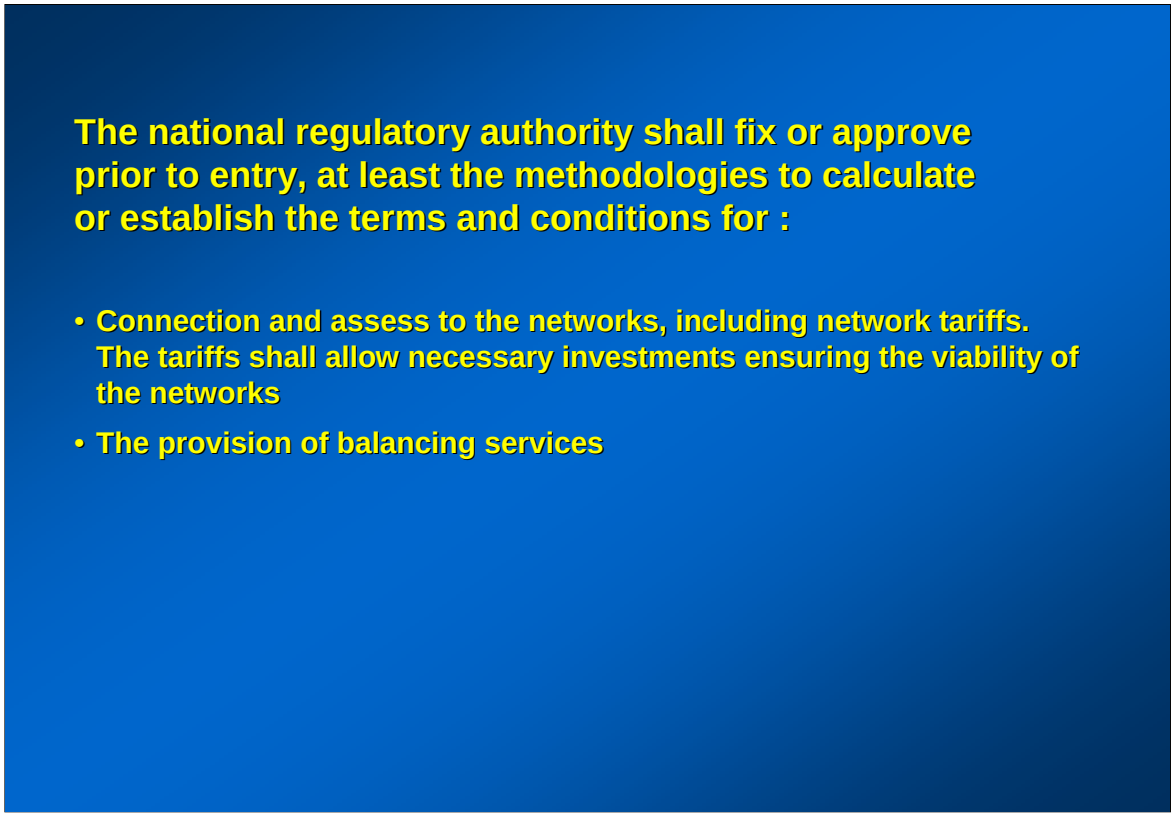
Prof. Roland Eriksson
Royal Institute of Technology (KTH)
Teknikringen 33
Se-100 44 Stockholm
roland.eriksson@ekc.kth.se

Ladies and gentlemen.

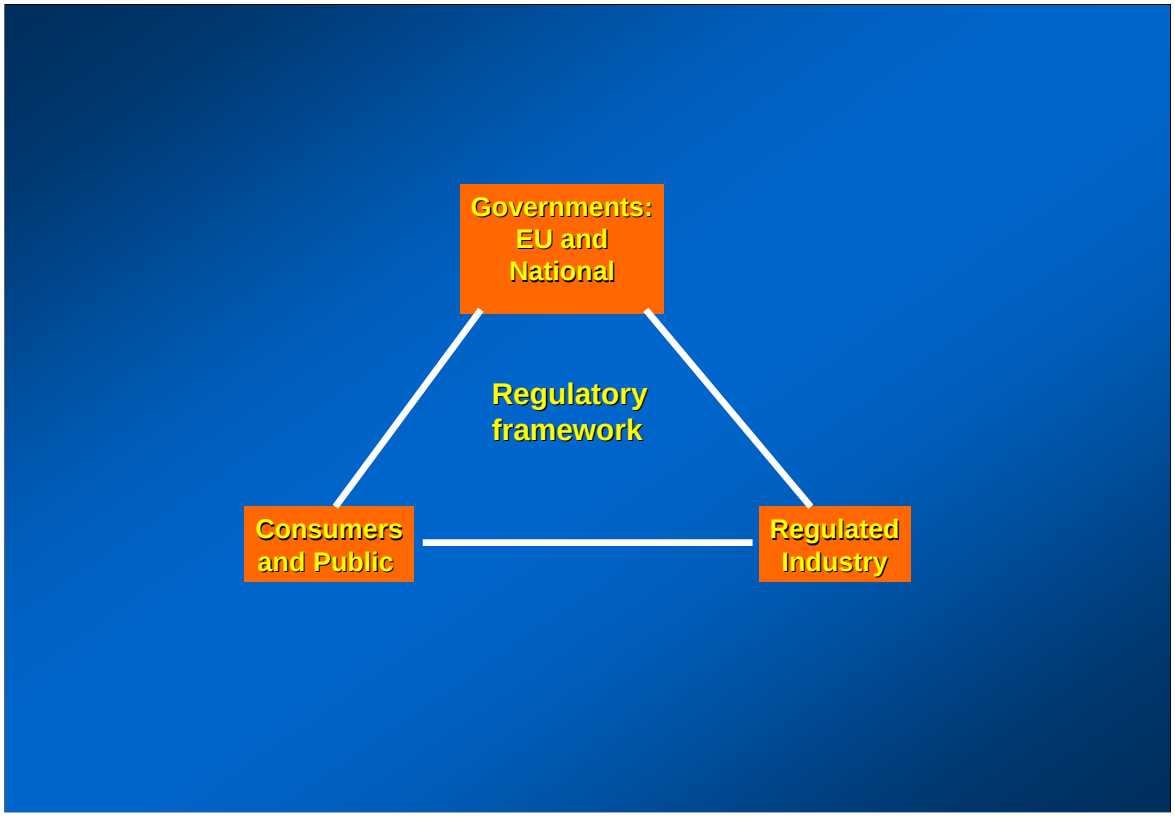
The title of my presentation is rather ambitious. I will give you some hints but it is up to you to make the analysis. You will also see that the situation in countries is rather different and conditions change. Mr. Manzoni's presentation concentrated on transmission, my presentation will concentrate on regulation related to distribution.

On a European level the EU Electricity Directive 2003/54/EC provides the general governing framework for regulators but you will see that national regulatory authorities have much to say and the details of regulation are set by them.

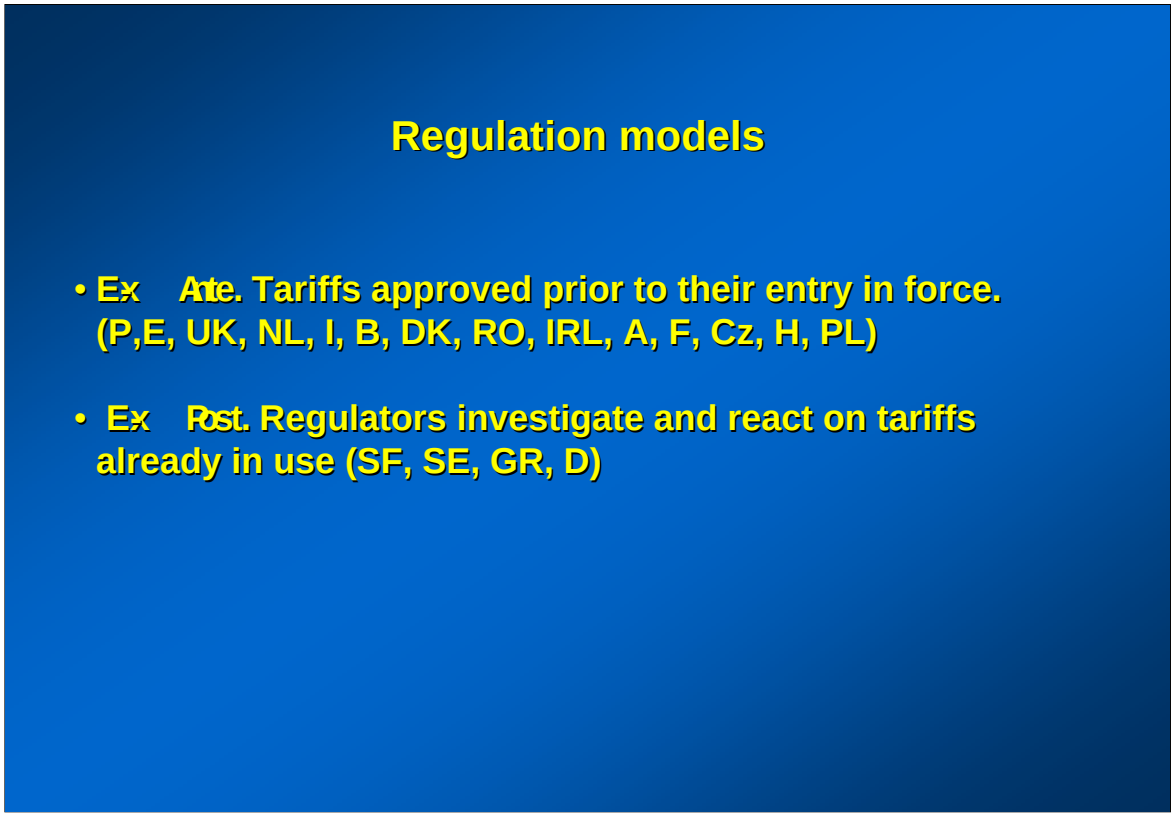
In the Directive it says that authority shall ensure non-discrimination, effective competition and efficient functioning of the market and you should take a number of steps: The rules of management, the way of handling congestion, the time you take for connection to be repaired, the network information to be published. A particularly important item is the unbundling of accounts to ensure that you have no cross-subsidization, because networks are a monopoly and many companies have both production and networks within their operations. Of course proper rules must exist for the connection of new producers, the performance of network operators and the levels of transparency and competition in markets.



It s important to note that prior to the entry the national regulatory authority shall fix or approve at least the methodologies to calculate or establish the terms and conditions, in particular the tariffs. The tariffs are important: If you don't have money you can't invest. If you have money at least you have the choice of giving it to the share holders or you can invest.



The regulation is trying to provide a fair balance between what is set as priorities of governments, the needs and demands of consumers and the public, the interest of industry in a regulated business and the legitimate interests of investors and network companies.



When you look at regulation you find 2 ways to regulate:

The first one is the so-called “ex-ante” regulation where tariffs are approved prior to their entry into force. This actually happens in most of the countries and is also foreseen in the directive. At least the methodology should be approved in advance. But you also have some countries where you have “ex-post” regulation which means that tariffs are set by the network companies and then the regulators investigate and take actions if the tariffs are not appropriate.

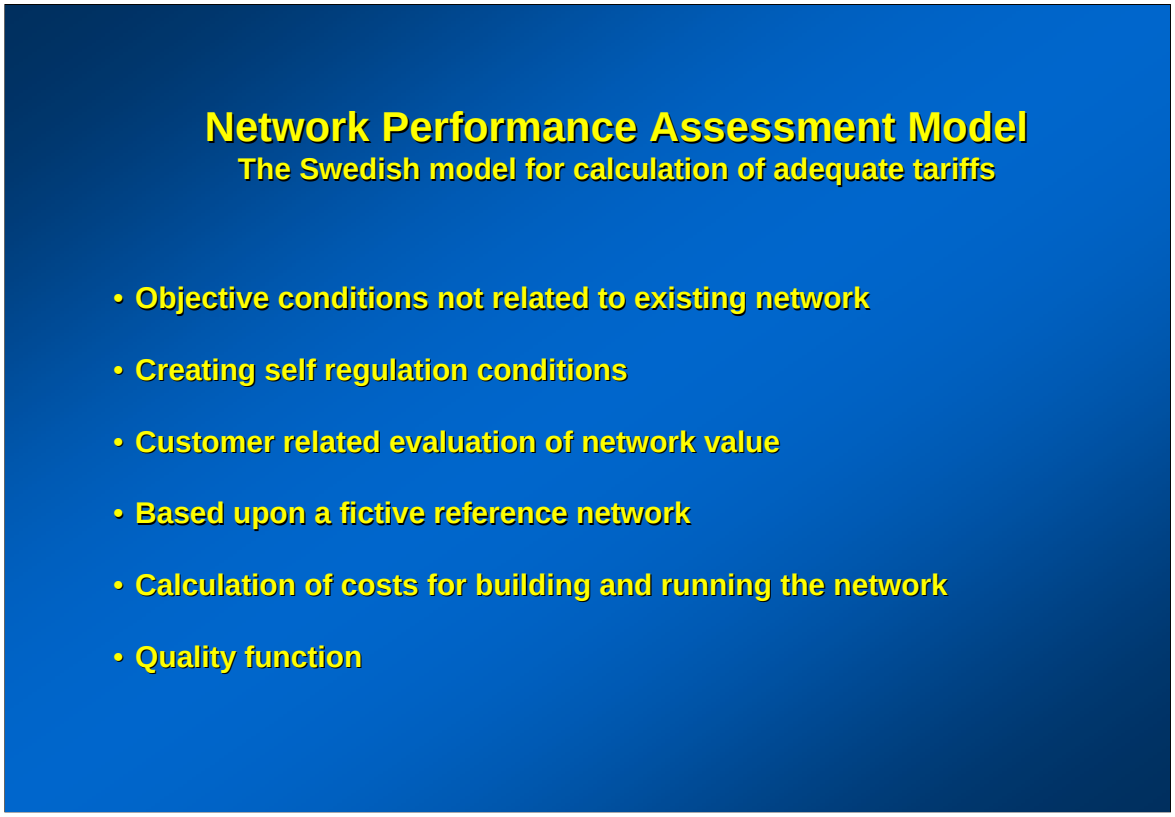
Regulation formulae

- **Price or revenue cap. (P,E, N, NL, I, SE, UK, Tr)**
- **Rate of return. (B, DK, SF, GR, D, IRL, P, RO)**
- **Combinations. (F, H, P, Cz)**
- **Benchmarking. (DK, SF, SE, IRL, P, NL)**

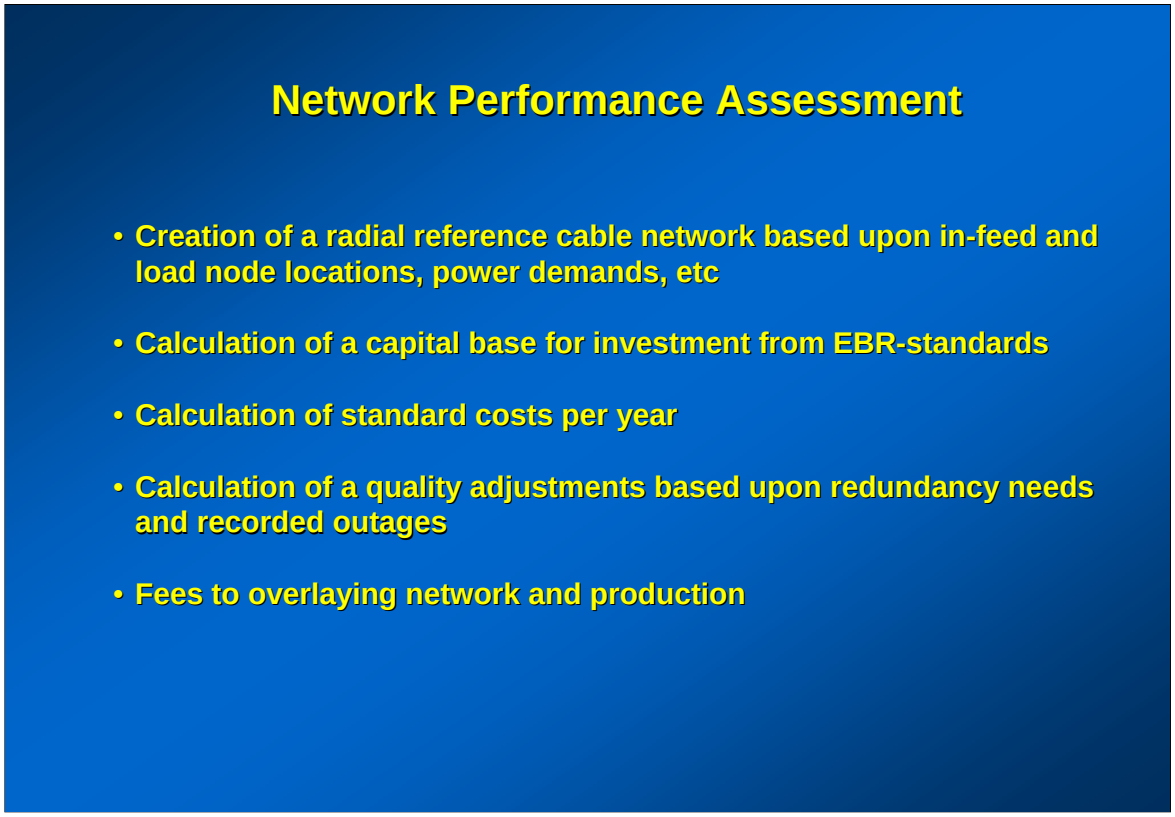
Now what does regulation look like and what are the measures the regulator can take?

There are some different modes which are also interrelated but you could probably structure them in the following way:

Very often you have a price or revenue cap which says that a network company should not be allowed to have revenues higher than a specific limit in other words the tariffs should not be higher than a specific limit. Of course the question of the incentive for an investment is raised if you have a fixed income. If you have a way of transferring the investment cost into tariffs you have a higher incentive for investment, so if you use a rate of return method where you can transfer the depreciation cost of your recent investment into tariffs it can be very positive for investments. You have combinations of methods of course and there is no clear cut between revenue cap and rate of return because you have to calculate the revenue cap and then you use depreciation and real cost. Also benchmarking is used by several countries in combination with the above methods. So much for the regulatory framework, I will now go into the situation of some particular countries and their regulations.



I will start with the Swedish regulation, not only because I know it very well but it is also describing some of the basic elements on how the cost structure is built up in a network company. It is also interesting because it is rather unique: the Swedish Regulator tries to set a goal of what a system should look like. They start from an “ideal” system which they construct, then look at the cost of that “ideal” system which then forms the basis for tariffs. In other words they disregard the cost of a real system and put up an “ideal” system which should be the target for network companies. This approach is called a Network Performance Assessment Model. The idea is to create objective conditions which are not related to existing networks. Of course the regulator does not want to interfere too much so they would like to see the creation of some self regulating conditions. The basic idea is that the customers should have a “say” in it, in other words a customer related evaluation of the network value. As I said before the model is based on a fictitious, radial reference network and for that network the cost of building and running is calculated. A particular function for quality and reliability is also included in this regulation model.



The procedure for assessing the performance (costs) are as follows:

The radial reference network, please note that it is a cable network, is created based on in-feed and node locations (the geographical conditions) and the power demand data. From that the capital base for investment from EBR standards is calculated and based on that you arrive at the standard cost per year. I will go into some more detail on that a little later. There is also a calculation of quality adjustments based upon redundancy because a radial network may be inappropriate to giving a good reliability so therefore adjustments are made for additional lines and transformers to achieve redundancy. And of course you have fees to overlaying networks and production.

Calculation of standard costs per year

- Calculation of capital costs as a real annuity using 40 years depreciation time and a real WACC rate of 4.8 %.
- Operation and maintenance costs in % of investment cost (1% for cables and 2% for transformers)
- Customer specific costs for metering etc.
- Costs for network losses as calculated for the reference network

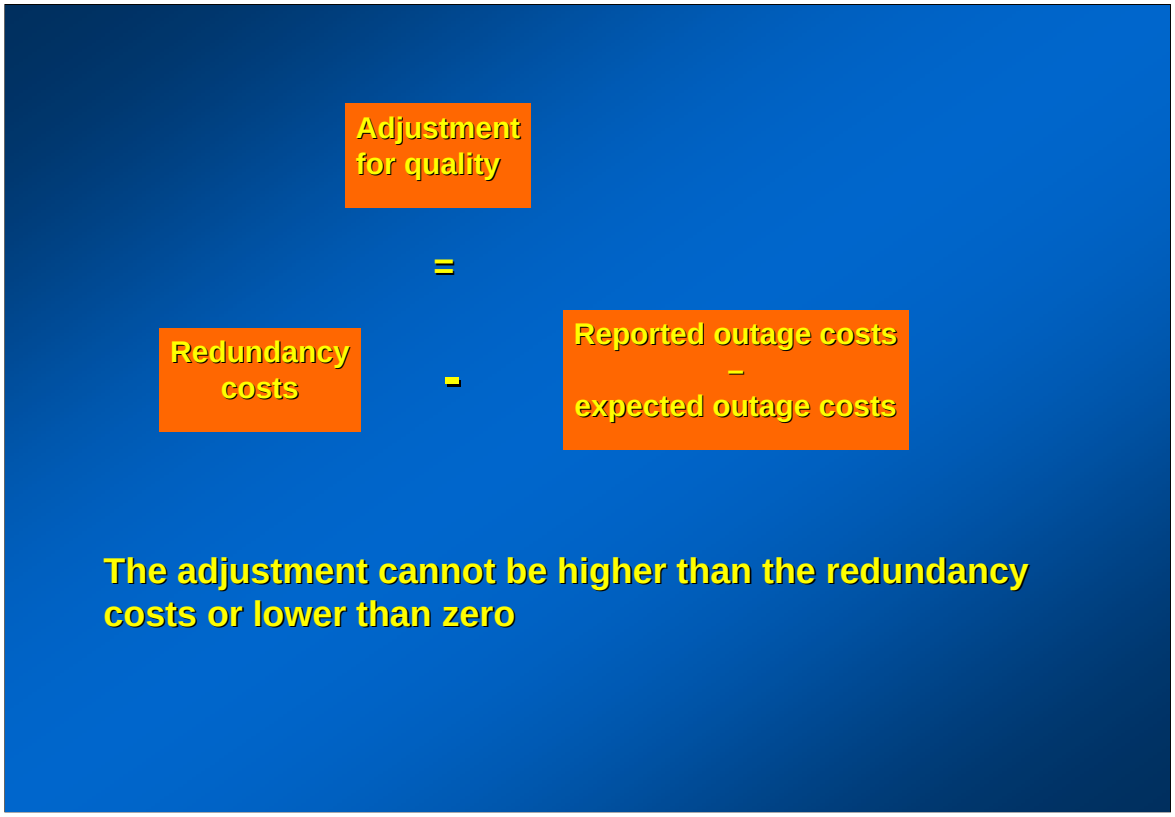
What about the standard cost now?

The capital cost is calculated as a real annuity using 40 years depreciation time and a real weighted average capital cost of 4.8%. The operation and maintenance cost is calculated at 1% of the investment cost for cables and 2% for transformers. Then you have customer-specific cost for metering, handling of the customers, invoicing etc. and of course the losses of networks

Calculation of the quality adjustment

- **Evaluation of the customers costs for outages. (Swedish average for unplanned outages: (1,9 - 2,4) EUR/kW + (7,5 - 12,4) EUR/kWh**
- **Including redundancy in the reference network to balance the customer outage costs**
- **The calculations have resulted in the following redundancy costs in % of the investment cost of the reference network:**
  - **reserve transformers except for connection to low voltage**
  - **0-7% increase of low voltage lines**
  - **15-20 % increase of 6-20 kV lines**
  - **50% increase of 20-50 kV lines**
  - **100% increase of 70-130 kV lines**

The particular calculation for quality adjustment is based upon what is outage cost for the customers. A survey done by the Swedish utilities for unplanned outages shows the following cost: Close to €2 per kW and around €10 per kWh interrupted load which is at least about 100 times the price of electricity. Then the adjustment for quality is done by including redundancy in the reference network to balance the customer outage cost. It includes as much redundancy as to have an incrementally improved outage cost equal to the incremental cost of additional network components. The additional network components for redundancy are: addition of a reserve transformer, 0-7 % increase of low voltage lines depending upon load density, 15-20 % increase of 6-20 kV voltage lines depending upon load density, 50 % increase of lines for higher voltages, 100 % increase of lines in regional transmission and distribution.



And the adjustments for quality in tariffs is shown on this slide.

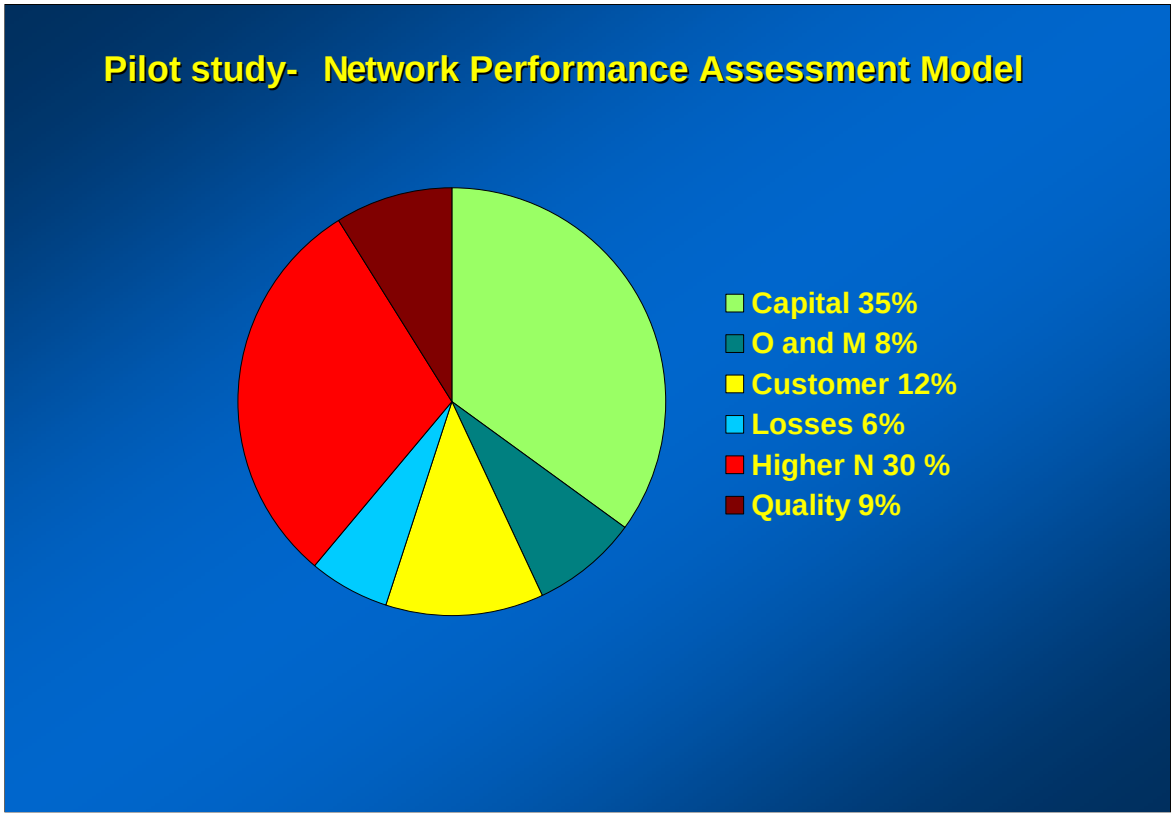
You estimate the redundancy cost of the network you have, you report the outage cost and compare it to the expected outage cost. This redundancy cost which is allowed in the tariffs is than subtracted depending on the outcome. If you have more outages than expected you have a reduction in tariffs.

Tariffs

The assessment of the economic value of the network performance as now calculated is compared with the actual tariffs

Higher tariffs than calculated indicates that the tariffs can be inadequate

If the assessed economic value of the network is higher than the tariffs they may be inadequate. There is a debate in Sweden on whether the network performance assessment model will correctly describe the network costs. It is also not yet clear how tough the regulator will be towards companies with higher costs than the model will show. The network companies can appeal to court and I believe that there will be such cases.



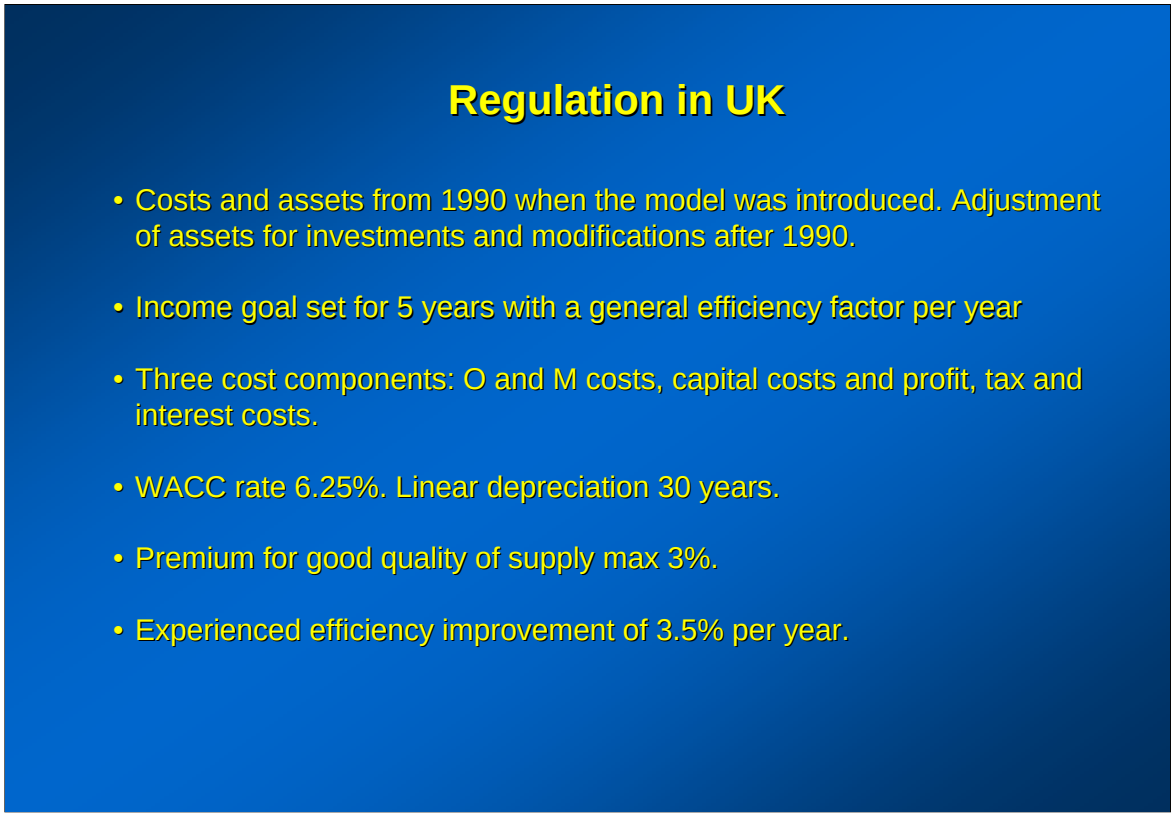
Finally, this is a pilot study where you can compare the cost for a network and you see that the capital cost or the majority is 35%, operation and maintenance 8%, customer specific cost 12%, which sounds to me a bit high, it is related to metering and so on, losses 6%, the fees to the higher network 30% and the quality and reliability is 9%.

So that was the Swedish Network Performance Assessment Model. I think it is interesting because it really sets a target. You should be better and better, it is a performance target for the network company. How does it look now in some other countries ?

Regulation in Finland

- **Tariffs are set by the Network Companies**
- **The regulator make checks on own initiative or after complaints**
- **Actual operation and maintenance costs**
- **Standardised capital costs. 50 % replacement value. Re-calculated (increased) equity. WACC rate 4.4%. Depreciation costs equal to the highest of 1) average of last three years or 2) last year.**

Finland is an example of a rather light-handed regulation where the network companies are setting the tariffs. It is also an example of a rate of return regulation. The regulator makes checks on his own initiative or after complaints and you base it on the actual operation and maintenance cost. The capital cost is based on 50% of the replacement value and you make some additions to the equity in the calculation and you have a rate of 4.4%. In this regulation you are allowed to include the depreciation cost which could be equal to the highest average of the last 3 years or the last year. So there is an example where you have a rather good investment incentive, because you can take your investments and transfer them into the tariffs.



In the UK, I think it is one of the countries with the longest experience in regulation. They use the cost and assets from 1990 when the model was introduced and they set up a goal or a cap which is set up for 5 successive years in advance. And I think they calculate the cost components in a similar way: Operation and maintenance, capital but also profit and tax. They have a 6.25% rate and a linear depreciation of 30 years and the quality adjustment is not so high as the 10% in Sweden but it is up to 3% maximum. Since 1990 they have experienced an efficiency improvement of 3.5% per year.

Regulation in Norway

- Income goal set for 5 years with an efficiency factor 1.5% per year.
- Capital from third year before the regulation period and a yearly adjusted interest rate (around 8.4%).
- Historic O and M costs adjusted for inflation.
- Actual depreciation costs from third year before the regulation period (average depreciation time 20 years).
- Adjustment parameter for new investment.
- Adjustment for supply quality.

Norway is another example of price or revenue cap where the goal is set for 5 years and they also require that the companies should increase their efficiency by 1.5% per year, so that means that tariffs should be reduced by 1.5% a year, of course added to the inflation. In Norway it is a bit more difficult to make investments if you just look into the tariffs because the capital is taken from the 3rd year before the regulation and that is also true for the cost of depreciation, so you can always ask yourself how can I invest if I only get covered by the investments I did 3 years ago. They have an adjustment parameter for new investments but it's not related to what you do, it is more sort of a standard figure which you add to your calculation procedures to come up to the tariffs. In Norway, however, they have quite an interesting adjustment for supply quality. It has some similarities to the Swedish system, but it gives both premium and punishment, the Swedish is only punishment.

Adjustment for quality of supply in Norway

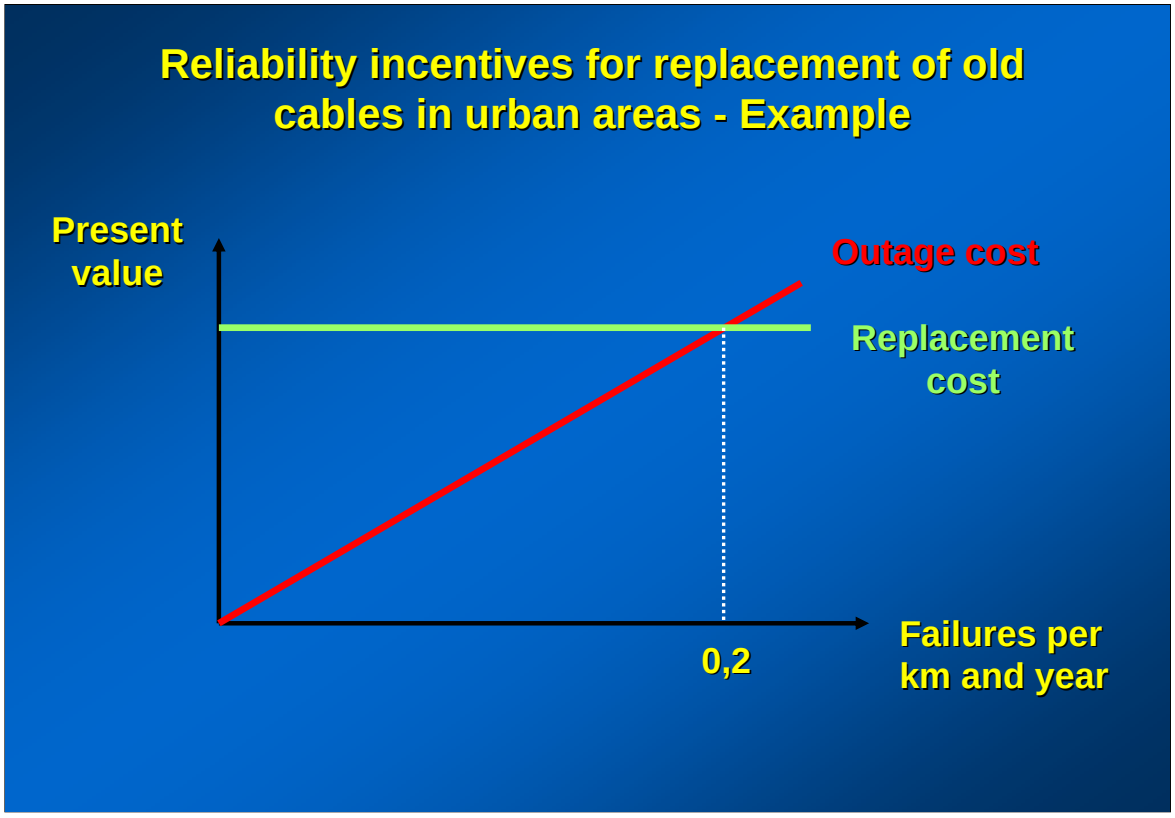
- **Recording of all outages longer than 3 minutes.**
- **Outage costs for different categories in the range 1-12 EUR/kWh.**
- **Calculation of the difference between experienced and expected costs of not supplied energy.**
- **The difference is added to the income goal for next year. Positive for better and negative for worse quality then expected .**

The adjustment for quality in the Norwegian system is based upon record and report all of their outages which are longer than 3 minutes and they have an evaluation of the outage cost which is in the range of €1 to €12 per kWh depending on the categories and they calculate the difference between experienced and expected cost of not-supplied energy. This difference is added to the income goal for the coming year. If it is a positive one you are allowed to increase the tariffs, if it is negative you have to reduce them. So you have a punishment and a premium which is equal to the actual difference in experienced outages.

Changes in total tariff income 1998 to 2001

- **Sweden +3%.**
- **Norway +3%.**
- **Finland +2%**

You can see, this is a record of the changes in tariffs for the last years and you will see they are fairly small changes.

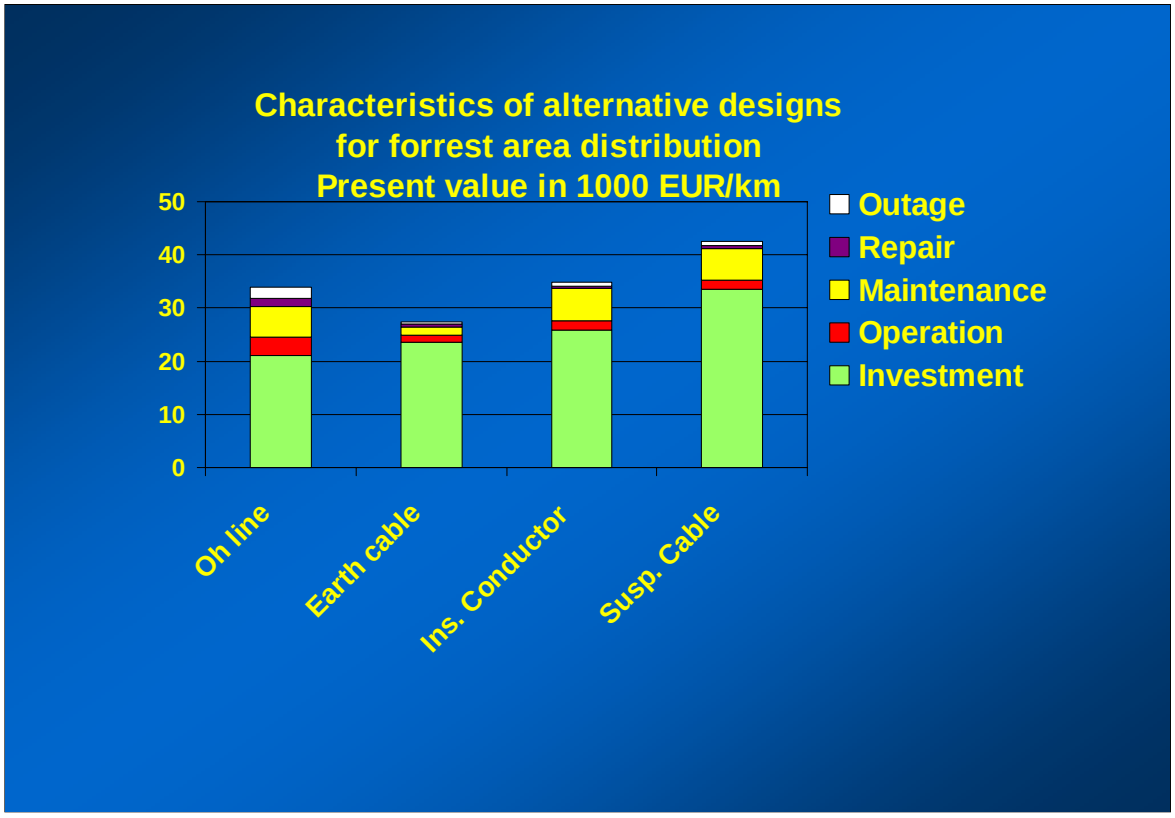


These were some comparisons and some details of the regulations and you can see there is a spread. I mean you have interest rates between 4.4 and 8.4%, you have a depreciation time between 20 and 40 years, so there are a number of parameters in these regulations which are very specific for a country and the specific conditions in a country. So it is a bit difficult to see what the actual incentives for investments are. You saw that there were some examples, at least in Norway and Sweden, on reliability incentives. I will say a few words about reliability incentives seen from a rather general point of view and I made a calculation first for an urban area and my question was then: when do I replace a cable which is unreliable? Then I will give an example on overhead lines in forests and that is a case where may be not a regulation had an impact but political pressure. So let me first show you the urban cable. I have taken an area outside Stockholm. The y-axis gives the present value and you can see that there is a breakeven for a failure rate of 0,2 faults per km and year which is about 20 times higher than the normal failure rate. I think before you come up to this point you will get into trouble with the public and therefore I think pressure from public can be higher in terms of reliability than purely calculating the cost related to what the regulator has said in the tariffs.

Replacement of forest area OH lines in Sweden

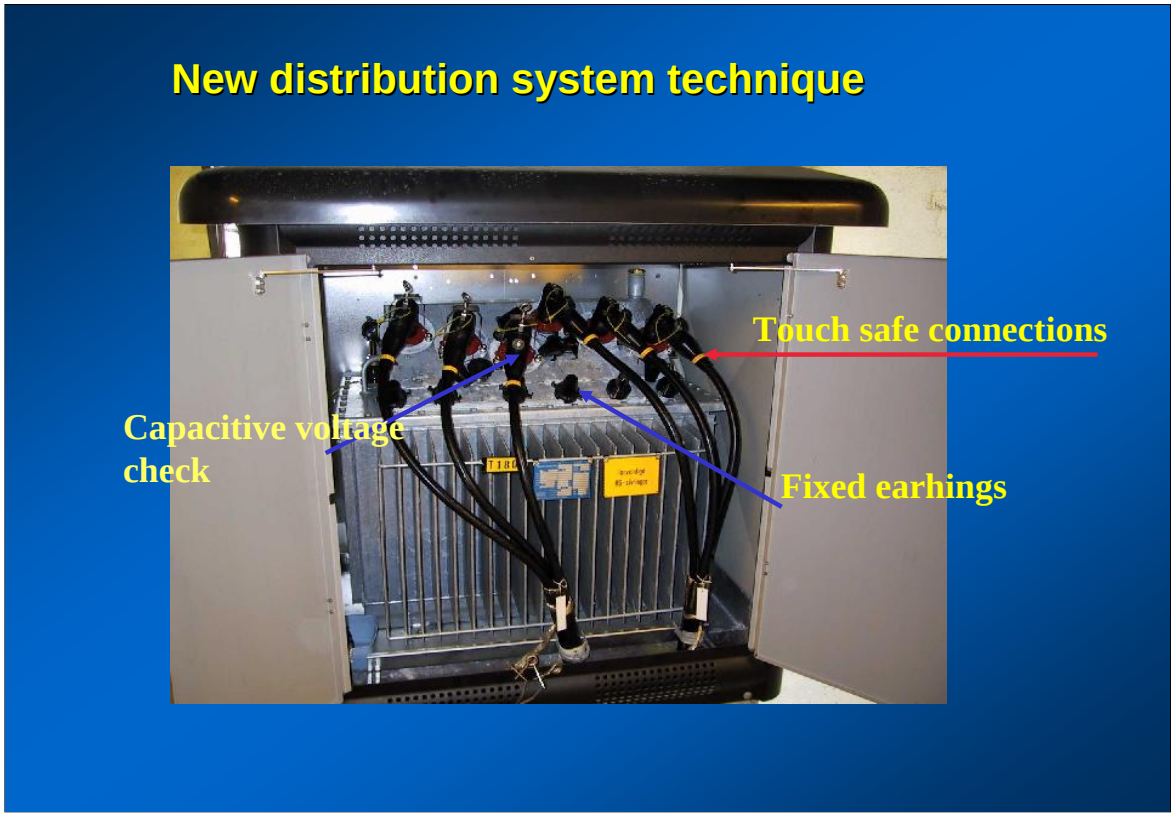
- **Political driven replacements to increase reliability**
- **Replacement of 57 000 km overhead lines in forest areas**
- **Replacement investment: 2 000 MEUR**
- **Replacement period: 10 years**

The next case is related to overhead lines in forests. There were quite a number of storms in the last couple of years, with snowfalls and trees falling over the overhead lines. The public was upset, the politicians were upset and there was some discussion between the government and the Swedish utilities and they made an agreement to replace 57.000 km of overhead-lines in forest areas. That was correspondent to a replacement investment of €2 billion and the replacement period should be over after 10 years. This had nothing to do with regulation, it was pressure from the public.



I will just show you a few examples of the calculations done by Swedish utilities in terms of finding what could be the alternative solutions. You have the standard bare conductors, you have a buried earth cable, you have insulated conductors and you have suspension cables. You can see that the earth cable comes out very favourable, even if the investment cost is a bit higher you can see that the maintenance is considerably lower, you don't have to clear the routes and you have less outage cost and less operation and repair cost. So this was what was done by the Swedish utilities and of course it requires some technique development on equipment, laying, etc.

They would like to go for a robust solution: High voltage cable, plugged into a transformer and then you have the low voltage distribution.To make it robust you have to simplify system and components…..

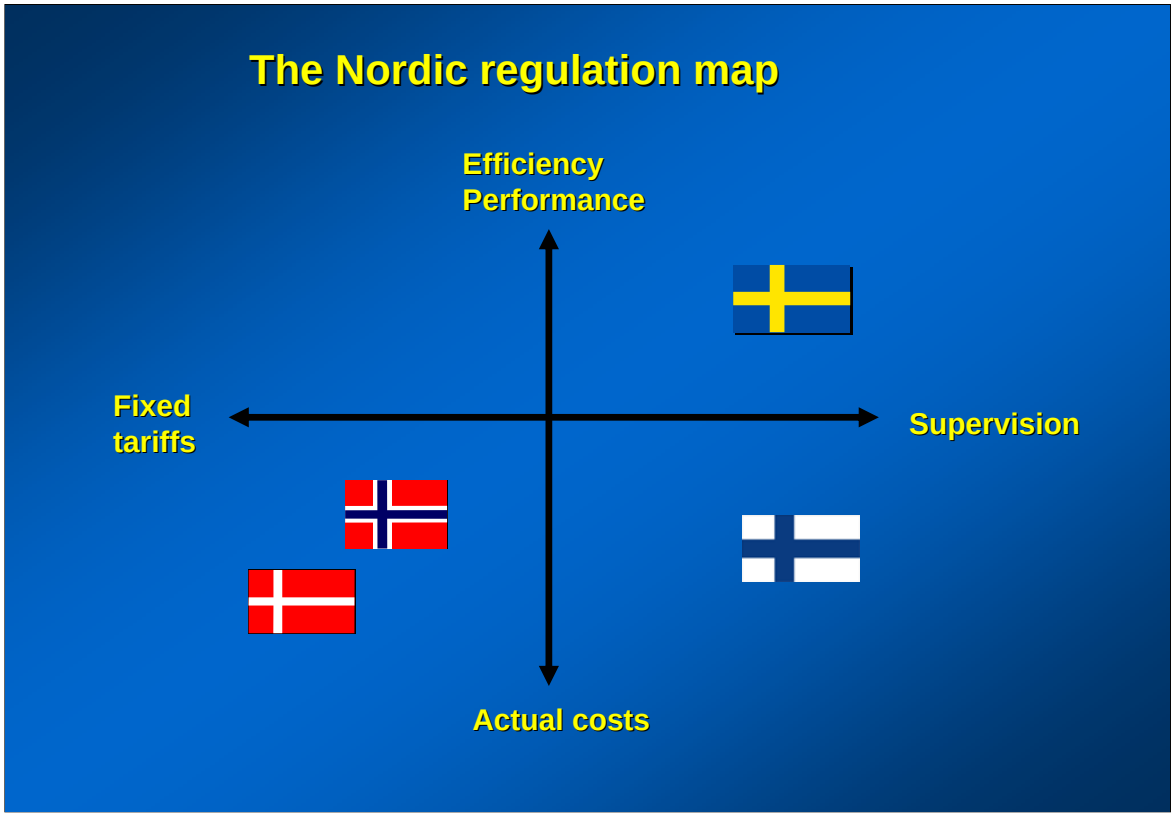


… no switching devices, a simple plug-in system, where you plug the cable into the transformer. In case you have fault you can roll out a reserve cable and you can repair the cable when it is most suitable for the power company.

Potential investment incentives for reliability in Sweden

- **Total energy sales in Sweden: 135 TWh**
- **Total network replacement value: 20 000 MEUR**
- **Estimated mean customer outage cost per year: 0.0017 EUR/kWh**
- **Total outage costs in Sweden: 230 MEUR (≈ 1%)**

Finally regarding the reliability: What could be the total possible maximum level of investment in reliability. The sales in Sweden are about 135 TWh, the network value is about €20 billion. You have an estimated customer outage cost per year which is €0.0017 per kWh and the total outage cost is about €230 million, so even if you would completely eliminate all faults you cannot motivate higher investments than this value.



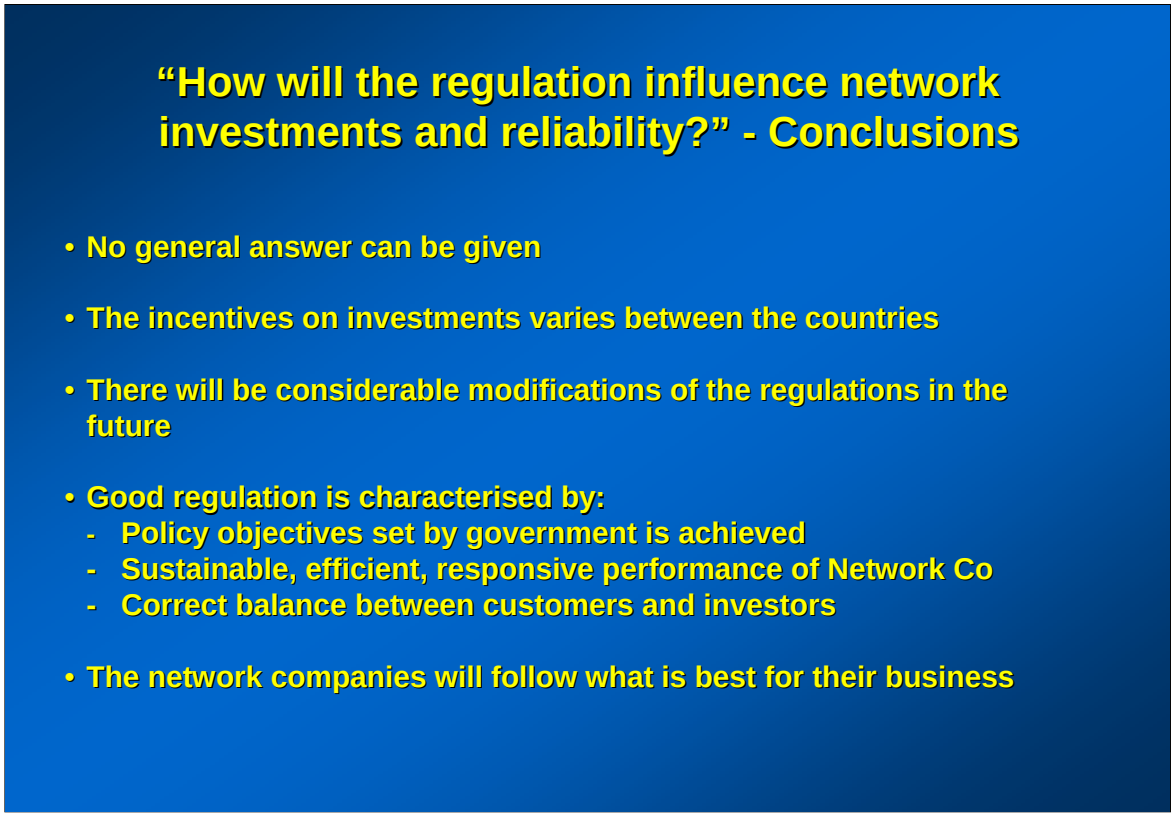
So now a few words about future regulation. I talked already about the Nordic map and you could add to this map other countries, you can go from fixed tariffs to supervision and you can go from actual cost to performance.

I think in the survey made between Nordic countries it was recently concluded that there will be considerable modifications in the Nordic regulations in the near future and the driving forces will be objectives to meet goals on cost efficiency and investments. Also they believe that direct regulation on quality and standards to meet customer needs will increase. National regulation will certainly remain, countries are different, but some harmonization will take place. Of course, the credibility and predictability of regulation is very important, it is very important for investment.

Development of the regulation

- CEER, Council of European Energy regulators
- ERRA, Energy Regulators Regional Association
- Europeans Regulators' group (Commission decision 11 Nov 2003)
  - consultation, coordination and cooperation
  - consolidating internal market
  - ensuring consistent application in all Member States

On the European scene you have the Council of European Energy Regulators which is a contact organization between the European Commission and the Regulators, you have the Energy Regulators Regional Association, which is a voluntary organization for the candidate countries and the Commission has put up quite some effort to set up a European Regulators Group for further development of the market for consultation, coordination and cooperation and of course to ensure that you have consistent application in all member states.



Now to my conclusions. It is not so easy to give a general answer. I have given some hints in different directions but it is up to you to think what might be the future, because the incentives vary between countries. I think there will be considerable modifications of the regulations in the future and some harmonization between the countries.

What is a good regulation? That you achieve a policy objective set by government, that you have sustainable and viable network companies and that you also have a correct balance between customers and the investor's interests.

And of course the network companies will follow what is best for their business. Below I list some references for my presentation. Thank you for your attention.

References:

Electricity Directive 2003/54/EC

Eurelectric report on regulatory models, January 2004

The Swedish Energy Agency. Documentation on the Network Performance Model, 2004

Dreber Lundkvist. Economic parameters in network regulation, 2004

Review of Scandinavian regulatory models, EBL 170a-2004

Swedenergy – Future distribution network