Management of network losses

Per Norberg on behalf of Study Committee C1

Electricity as an energy carrier has amazing properties and in comparison to many other forms of energy transfer, is highly efficient. However, there are a few percentage losses at each voltage level in the power system and, generally, the percentage increases with proximity to the end user.

This is well known within the energy supply business. What has historically been an industry internal issue has, over the past few years, gained increasing attention from society as a way to reduce CO2 emissions by minimizing the network losses in the power system. Various initiatives to improve energy efficiency on the demand side have been ongoing for many years and the replacement of old equipment has often been efficient in reducing the losses as energy-efficiency has improved for modern products.

The European Union, (EU), has introduced the ECO-design criteria that define requirements on efficiency limits for different products on the market.

Several years ago, various interest groups advocated that the power system should be seen as a combination of products that should be covered by the ECO-design directive. Power transformers were at the vanguard and became subject to efficiency requirements introduced in the summer of 2015.

After the criteria for transformers were introduced, the ambition was to proceed with criteria for cables and other electrical equipment but the decisions taken so far have not dealt with the power system as a whole.

Eco-design is considered by CIGRE to be an important issue and improved efficiency is, of course, a laudable objective.

Obviously, it is in everyone's interest that technology advances so that improved efficiency can be obtained for all individual components that are present in the power system – on an individual component basis this is managed and operated within the different Study Committees of CIGRE. However, a large number of components are then combined into a power system which must be environmentally sustainable and economically optimal and, in particular, the latter is the responsibility of Study Committee C1. It is worth noting that economic optimization must be taken from a customer / community perspective.

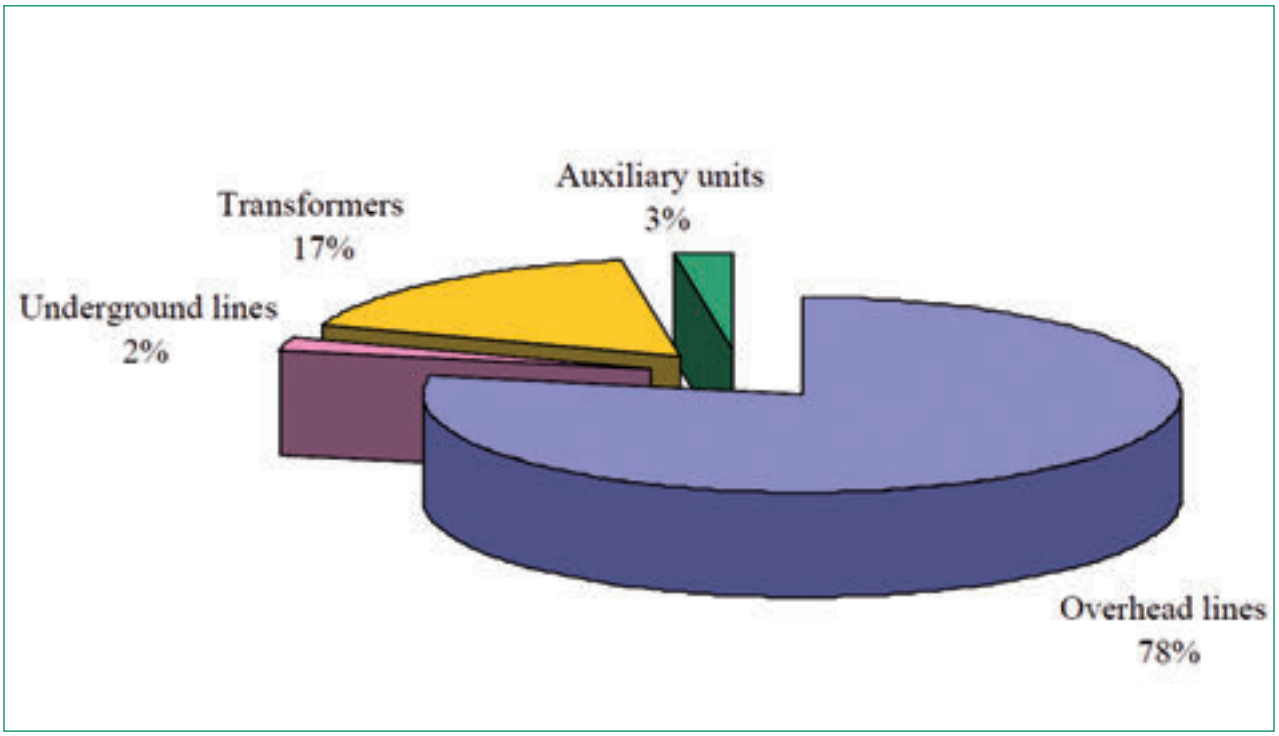
Transformers are components with very high efficiency in comparison with, for example, generation resources or inverters. In large transmission systems, the losses in power lines are generally much larger than those in the transformers. Hence, to exclusively focus on the transformer loss optimization (i.e., install more expensive transformers with lower losses) may not always result in the cost optimal solution with respect to lowering the system losses for the entire power system.

One way to obtain an optimal solution is to assign a price to the losses and then build the system to ensure the overall lowest capitalized cost.

One argument for including transformers in the Eco-design criteria is that the valuation of losses when purchasing transformers differed significantly between different countries. This diversity led to the possibility that companies could prioritize low transformer purchase prices over transformer whole life cycle costs. Eco-design criteria aim to counter-act such tendencies with minimum limits.

The electric power industry is facing major challenges and the rate of changes increases. In many countries, local thermal electricity production will be replaced by wind power in remote areas and solar panels (that could be local and decentralized). Local solar panels will reduce losses if they are not too large, however, we can expect that network losses will increase overall in the power system especially in transmission systems, given a higher distance of transport due to the remote generation areas and the intermittency of solar panels. This will likely lead to increased societal pressure to reduce network losses despite the fact that the increase is often due to the replacement of old generation plants which have high CO2 emissions.

To obtain a view on how losses are managed among network operators around the world, Study Committee C1 recently conducted a survey among its members. From the responses received some learnings can be derived:



Example of breakdown of energy losses in the electricity transmission system

- The relative distance between production and consumption is an important factor in how losses are treated. If the distance is high, losses will generally constitute an important cost factor, both in daily operation and in system planning. Moreover, at the planning stage, losses are usually capitalized over the lifetime of the investment;
- Companies / systems with short transfer distances pay, therefore, little attention to losses in system planning and operation. Losses are treated as a cost that cannot be influenced and is recovered in the network tariff;
- Most answers showed that losses are considered when buying equipment like cables, overhead lines and transformers;
- Most answers confirmed that regulators are increasingly interested in losses but no answers indicated any defined limits set by a regulator.

We believe that the industry should take the management of losses more seriously. Otherwise, there is a significant risk that society will enforce limits that are not optimal for the system which, in turn, will incur costs that, ultimately, will be charged back to customers. At the same time, our industry's success is based on the competitive price of electricity and sustainability of its production.

So what can be done?

One way forward is that all parties involved in system development evaluate losses as the cost of CO2 free generation in the actual system. If losses are still high and are challenged by society, it is reasonable to answer, for example, that it is more optimal to invest in wind-farms (that produce the loss energy) than to put in more copper or aluminum into the system.

In Sweden, with nearly all hydro in the north and the load in the south, it's very simple to obtain large savings in lost energy by starting-up thermal power plants in the south thereby reducing the power flows. But is it good for the society and the environment? Of course not – it's better to operate the hydro plants and accept greater network losses!

We need to remind ourselves and inform society that the important thing is not to reduce network losses at any cost since this would create sub optimizations. The important thing is that we move towards an electrical system that is CO2 free and deliver electricity to customers at prices that are as competitive as possible whilst the losses that are inevitable are treated as seriously as possible. ■