Outlook of Employment and Competition

Losses of electricity distribution network

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Role of **losses** in designing electricity distribution networks

The role and economics of future distribution network design are fundamentally changing. One of the key elements of network design that is yet to be fully incorporated in the design guideline is the life-cycle consideration of network losses, particularly on determining the optimal cable rating in distribution system.

In 2012, the total Transmission and Distribution (T&D) system losses recorded by Tenaga Nasional Berhad (TNB), Malaysia power utility, was 8.25% [1]. This translates into an estimated annual financial cost of between RM2.0 to RM2.5 billion to TNB. It means a 1% reduction in T&D losses could result in annual saving of between RM250 to RM300 million to TNB. In addition, it should be noted that the proportion of distribution system losses is significantly higher than the losses in a transmission system. Figure 1 shows the proportion of TNB’s T&D losses in 2012.

It can be observed that the distribution losses is contributing to approximately 80% of the total T&D losses, with only 20% from the transmission system. Figure 2 gives a better insight into the breakdown of transmission and distribution losses in Malaysia electricity network. The high proportion of distribution losses is driven by the lower network voltage used and the extensive distribution networks which connect millions of consumers across the wide geographical area. As a result, the effort to reduce system losses should be emphasizing more on the distribution level.

In Malaysia, the distribution system consists of network at voltage levels of 33kV, 22kV, 11kV, 6.6kV and 400/230V.

In 2002, TNB’s T&D losses level is in the range of 12%. This includes both technical and non-technical losses. The high level of T&D losses has gained serious attention from TNB and special team has been formed to tackling this issue in a more effective way.

Figure 3 shows the historic T&D losses for Malaysia electricity network. As can be seen from the figure, the T&D losses in Malaysia is consistently over 10% before 2007.

Figure 1: Proportion of TNB’s (T&D) system losses in 2012.

Figure 2: Breakdown of T&D losses in Malaysia.
However, the performance of total system losses has improved significantly from 10% in 2007 to 8.25% in 2012. Driven by the previous success in losses reduction initiative, TNB is committed to further reduce system losses, with a target of 5% at the distribution level. The specific T&D losses target set by TNB is 6-7% by 2015. However, a comparison between the level of T&D losses in Malaysia with Japan and Germany [2], which are two of the highest T&D losses performance countries in the world, indicates that Malaysia still has greater room for improvement, as illustrated in Figure 3.

Given the crucial role of losses in distribution network design and TNB’s commitment to achieve the 5% distribution losses target, it is therefore important to develop procedures and methodologies that can achieve optimal level of losses.

A recent study in the UK investigated the optimal level of losses by trading off the investment cost against the cost of circuit losses over the technical life-span of the cable [3].

The study suggested that the optimal utilization of the 11kV cable should be quite low and in the range of 20-40%. This means the utility should install cables with rating of approximately 2.5 to 5 times of the peak demand. A preliminary study was conducted by the researcher at Universiti Teknikal Malaysia Melaka (UTeM) by utilizing the similar methodology [4].

This suggests that a higher cable rating should be selected in designing the Malaysia distribution network (11kV in this case), apart from satisfying relevant safety and quality standards. Further investigation on the optimal utilization of cables and lines for 132kV, 33kV and 0.4kV in Malaysia is currently being carried out at UTeM.

Figure 4 shows the overall cost breakdown of 11kV cable in Malaysia. In this example, the 95mm² cable has the minimum rating to meet the peak demand. As expected, it has the lowest capital cost, but with the highest total cost, driven by the highest proportion of the cost of losses. In this respect, if the cost of losses is taken into consideration, the higher cable rating should be selected in designing the Malaysia distribution network apart from satisfying relevant safety and quality standards.

300mm² cable has the overall minimum cost. Therefore, the design should select the 300mm² cable in order to achieve optimal level of losses, which leads to a minimum overall total cost. To conclude, this highlights the paramount importance of establishing procedures and methodologies that consider the role of losses in determining the optimal utilization of cables in Malaysia.

References: