ENERGY MANAGEMENT OF BUILDING POWER DISTRIBUTION SYSTEMS

EXECUTIVE SUMMARY

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CSA GROUP RESEARCH

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EXECUTIVE **SUMMARY**

Large commercial buildings are characterized by high annual energy consumption. Dry-type distribution transformers, along with other power distribution apparatus, remain a fundamental component in electrical distribution systems for commercial buildings. The distribution grid within commercial buildings is traditionally designed by connecting dry-type transformers in a "tree" configuration dedicated to specific floors. The sizing of the transformers has been determined for a static, peak load situation to which safety coefficients are applied. The traditional configuration has dry-type transformers energized 24/7 transferring electric power at low loading factors resulting in very low efficiencies. This project investigates energy efficiency gains from dynamically reconfiguring the dry-type transformers and building electrical network. This is achieved via a technique called Power Flow Optimization (PFO).

Currently three types of energy conservation measures are available for consideration for large commercial buildings.

1) Passive energy conservation measures where dry-type transformers are re-sized using CSA C802.4 *Guide for kVA sizing of dry-type transformers, 1.2 kV class, single-phase and three-phase*, to select the dry-type transformer kVA size relative to average load. Alternatively, existing dry-type transformers can be replaced with higher efficiency models.

2) Semi-active energy conservation measures by using a method of static power dispatch with scheduled electrical distribution grid reconfiguration. The energy efficiency is obtained by changing electrical distribution grid topology between two different distribution configurations in occupied hours (normal tree configuration) and unoccupied hours (switching off dry-type transformers supplying plugs or other power outlets).

3) Active energy conservation measures utilizing a dynamic power dispatch (DPD) model by using the PFO technique

The comparison of different approaches is summarized in Table 1.

TABLE 1. COMPARISON OF DIFFERENT PASSIVE AND ACTIVE ENERGY CONSERVATION MEASURES

	Dry-Type Transformer Re-sizing	Schedule-based Reconfiguration	Dynamic Power Dispatch
Advantages	• Minimum investment • Easy implementation	• Easy implementation • Moderate energy savings mainly no-load	• Optimized energy savings • Adaptive to new loads or load profiles, scenarios or building profiles • Can be applied to new building as well as retrofits by clustering DDT
Disadvantages	• Low energy savings • Unchanged load profile, building profile	• Requires re-work adaptive to changes of new loads or load profiles	• ROI > 3 years buildings retrofit • Less easy to implement on retrofit
Switching Dry-type Transformers	Non-existent	Two times per day	Multiple times per day

The DPD model can be further described as follows. When a load is concentrated at a single site with an internal network (such as within a large commercial building), demand response can be implemented via PFO. In these situations, an Active Energy Conservation Measure (AECM) is defined that includes dynamic adjustment of the internal electrical network within the building or load center. PFO is used to adjust the electrical distribution grid topology to the current load demand requirements by using the DPD concept. This is implemented as an optimization algorithm where the objective function is the minimization of power losses within the electrical distribution grid.

This research project developed a model for dynamically reconfiguring the electrical distribution grid within commercial buildings and dynamically dispatching power to commercial building loads. The model was verified on the network model using a second building. The results indicate that the DPD approach is an attractive method, if implementation details are ironed out. By using the DPD method, annual incremental savings for new and retrofit commercial buildings in Canada are estimated to be 83 GWh/year of energy savings and 14.1 MW/year of demand savings.

This project addressed the preliminary work and used simulation models to understand the dynamic power dispatch approach. Further work is needed to fully develop the concept and address implementation details. Next steps have been identified to further investigate the concept including potential impact on the Canadian Electrical and National Energy codes and other CSA standards as well as the design of the electrical distribution grid within commercial buildings. Once the method is further developed, it will be used to create a new CSA guide, C802.6 on energy estimation of dry-type distribution transformer configuration in commercial buildings.

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