System Engineering Research Laboratory

Brief Overview

The System Engineering Research Laboratory (SERL) conducts research on planning, operation, control and analysis methods for electric power transmission, distribution systems as well as information and communication systems to facilitate secure supply of electricity generated by large-scale and distributed power sources. The laboratory also pursues researches on development, test and assessment of customer service technologies to achieve efficient use of electricity.

Achievements by Research Theme

Electric Power Systems

【Objectives】

We aim to develop new electric power system monitoring/stabilization control technologies and protective relay setting support tools (SSSC: Support System for Setting and Coordination), in order to work out a solution responding to increase of uncertainty and stability deterioration on power system operations caused by large-scale integration of renewable energy resources in the near future.

【Principal Results】

- Solar PVs (photovoltaics) were newly equipped with CRIEPI's power system simulator to examine impacts of high penetration of PVs on power system stability following disturbances. Test results of the simulator showed that dynamic behavior of PVs following disturbances could lead to complicated power swing due to frequent stop and restart of PV power conditioners.
- To prevent miss-coordination among protection relays caused by massive interconnection of distributed generators and subsequent fluctuation of power-flow, we added a checking function of protection coordination to SSSC. The method consists of the following steps: 1) discriminating a protective zone of the relays to be coordinated, 2) finding overlap of the protective zones, 3) checking consistency of operation time over the overlapped zones [R10007].

Customer Systems

【Objectives】

In order to promote energy conservation, we aim to develop tools and element technology for supporting energy-saving. We also aim to develop methods to infer operational status of customer-owned distributed generation systems (DGs) from distribution line.

【Principal Results】

- We developed a support tool that enables us to determine the priority of energy-saving activities convincingly when reducing energy demand in office buildings. In the tool, we consider not only amounts of energy saved, cost merits/demerits for a building owner and a tenant, but also workers' benefits such as convenience and comfort (Fig. 1) [R10013].
- We developed a heat source characteristic model describing cooling and heating performance of an air conditioner for residential use based solely on public technical data. It enables us to infer power consumption of the air conditioner accurately under various conditions in room temperature, ambient temperature, and heat demand [R09017] and [R10009].
- We developed methods to infer operational status of DGs from a distribution line. It enables us to take countermeasures beforehand against, for example, overload of a distribution line just after a fault restoration accompanied by shutoff of DGs [R10017] and [R10041].

Communication Systems

【Objectives】

As fundamental technologies of future communication network for power utilities, we aim to develop disaster countermeasure technologies, communication media technologies for facility maintenance work, security technologies for SCADA system and others.

【Principal Results】

・We developed a novel technique for suppressing signal interference when optically modulated radio (radio-on-fiber) signals used, for example, for smart metering and wireless access were added to an existing digitized optical fiber network such as FTTH (fiber to the home) [R10015].

Mathematical Informatics

【Objectives】

To realize accurate diagnosis of electric power equipment, we aim to develop their diagnosis methods based on high performance pattern classification techniques. We will also pursue application of image processing techniques to monitoring electric equipment such as snowpack around transmission lines.

【Principal Results】

・We developed an accurate diagnosis method for fault modes of transformers based on high performance pattern classification techniques. The diagnosis method uses principal gas concentration as input data, and maps them to 9 dimensional spaces (Fig. 2) [R10030].

・We developed a new tracking method of LED targets that are attached to transmission lines for monitoring the movement (galloping). Introducing transition probability of targets, the method can track the movement even in heavy snow [R10021].

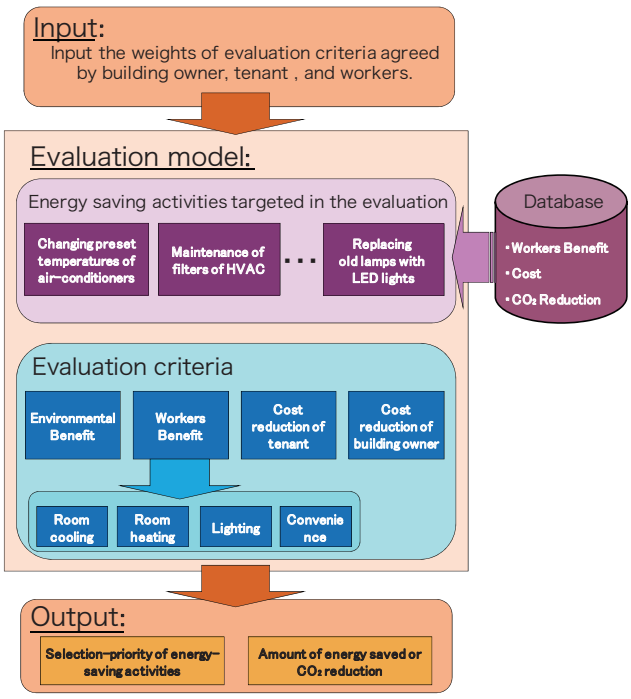

Fig. 1 Support Tool for Ranking Energy-Saving Activities for Office Buildings

By using analytic hierarchy process (AHP), decision-making for energy-saving can be facilitated while exchanging views among a building owner, tenants, and office workers.

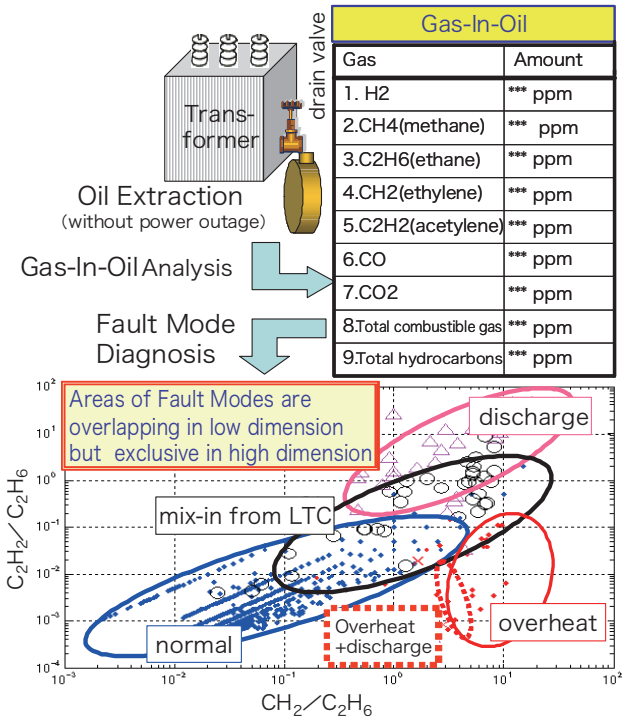

Fig. 2 Diagnosis of Fault Modes of Transformers

Conventional methods using composition ratio among CH_2, $C2H_2$, C_2H_6 cannot diagnose correctly. Out method tries to discriminate the modes in the 9 dimensional space. Its precision for given data is 100% and the estimated precision for unknown data is about 98%.