IWAFUNE LAB.

[Sustainable Energy Demand and Supply System]

Collaborative Research Center for Energy Engineering

http://www.iwafunelab.iis.u-tokyo.ac.jp/index.html

Department of Electrical Engineering

Sustainable Energy Demand and Supply System

Our research goal is exploring what kind of energy system has low environmental impact (in terms of carbon dioxide emissions or energy consumption) and how we can realize the system. The goal is simple, but we should consider wide-ranging constraints of the economy, the amount of resources, the international competition and political problems, the human preference, the uncertainty over the future, the rigidity of existing systems, etc.

Interdisciplinary research is needed in order to properly assess those factors, not only engineering, but economics, social sciences. The following three topics of recent research in our laboratory.

Fig. "COMMA House" for HEMS Operating Experiments

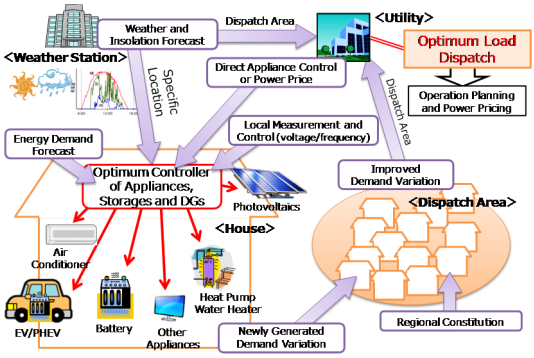

Fig. Autonomic Cooperative Energy Management System Including Renewable Energy Resources and Sophisticated Butteries

Autonomic Cooperative Energy Management System

We assumed the system for balancing supply and demand where centralized energy management treating a whole power system and decentralized energy management treating one building operate cooperatively.

Impact of Building Location to Energy System Selection in a City

"Compact City" is said to be an urban form leading energy conservation and low-carbon emission. Although some empirical evidence shows that, questions still remain regarding the generality of the results and the indication of compactness.

We focused on the energy supply side effect of the compactness. We developed an energy simulation model and compared preferable energy system for various building layouts with otherwise the same condition. Building layouts are quantified into some indices and analyzed their relationship with selected energy system.

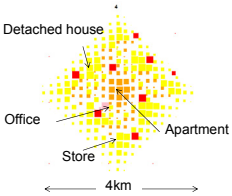

Fig. Example of generated building location

We generated 20 different building layouts of a town with the same population of 40,000 and calculated the favorable energy system for each. With carbon penalty of $100/tCO2, indices of clustering, mixed use, and concentration showed strong relationships with CO2 emission. This means that urban areas with high scores for these indices have greater potential to achieve low carbon dioxide emission at a relatively low cost.

Table Correlation Coefficients Between Building Layout Indices and Energy Cost / CO2 Emission with CO2 Penalty

Building Layout Index	Area energy facility cost	Area internal grid cost	Building equipment cost	CO_2 emission
Density	0.354	−0.427	−0.704	−0.585
Continuity	0.295	−0.537	−0.508	−0.433
Concentration	−0.403	0.273	0.734	0.692
Clustering	−0.393	0.123	0.668	0.762
Centrality	−0.531	−0.104	0.276	0.163
Nuclearity	0.083	−0.283	0.017	0.110
Mixed uses	0.212	−0.566	−0.729	−0.712
Proximity	−0.210	−0.533	0.151	0.183

Cells with a correlation coefficient >0.6 are shaded.
By definition, a large index value of concentration/clustering means less concentrated/less clustered.

Residential energy model with electric vehicle and photovoltaic system

To realize the low-carbon society massive introduction of photovoltaic power generation (PV) has been expected over the medium and long term in Japan.

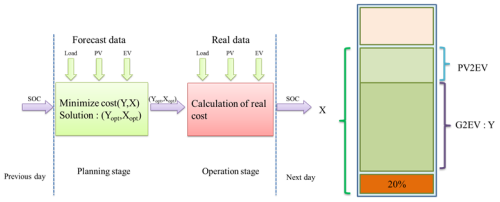

Fig. PV-EV battery operation model

However, the problem of reverse power flow by the mass introduction of PV has been an issue of concern in power network operation .

As a countermeasure for reverse power flow problem, the method of increasing the self-consumption by using EV battery.

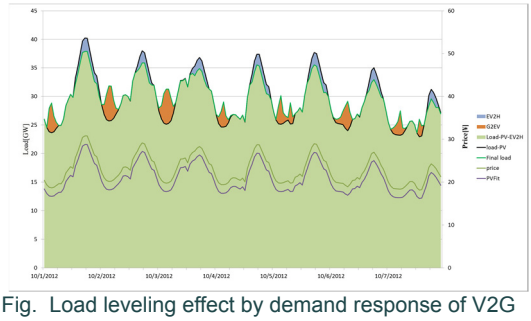

Fig. Load leveling effect by demand response of V2G

Assuming a household consisting of EV and PV System, we made a PV-EV linkage model to optimize the power supply and demand at the household, taking into account PV generation, EV usage patterns and electricity demand at the household. We studied the effect of contribution for supply and demand balance using V2G while maintaining users' comfort.