Waseda University

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Top -level research and data

Design research for next-generation power systems that utilize distributed energy resources
(Representative papers)

- Multipurpose Charging Schedule Optimization Method for Electric Buses: Evaluation Using Real City Data, Y. Tomizawa, Y. Hayashi, et al., IEEE Access (2022.5).
- Versatile Modeling Platform for Cooperative Energy Management Systems in Smart Cities, Y. Hayashi, K. Tomsovic, H. A. Jacobsen et al., Proceedings of the IEEE (2018.4).
- Evaluation of Annual Energy Loss Reduction Based on Reconfiguration Scheduling, Y. Takenobu, Y. Hayashi et al., IEEE transactions on Smart Grid (2018.3).

Keyword

- Power system control
- Energy management system (EMS)
- Distributed energy resources (solar, storage batteries, and EV)
- Smart cities
- Sector coupling
- Virtual power plants
- Digital twins
- Electricity demand forecasting
- Optimization

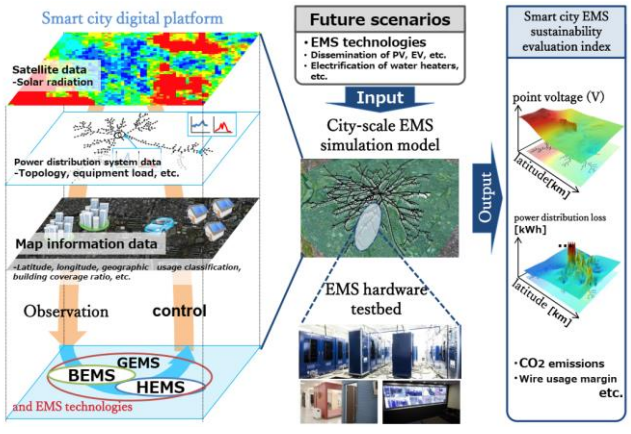
Deployment targets (sites, materials, etc.)

Collaboration with 61 member companies such as infrastructure and manufacturers at the Advanced Collaborative Research Organization for Smart Society
【commissioner】Next Generation Distributed Power System Study Group, Chairman (2022–); Next Generation Smart Meter System Study Group, Member (2020–); Energy Conservation Subcommittee, Member (2020–); Institute of Electrical Engineers of Japan, Tokyo Branch Chief (2020–2021); Electricity and Gas Market Surveillance Commission, Member (2015–2021); and Ministry of Education, Culture, Sports, Science and Technology PEP Program, Program Coordinator (2018–)

Features (implementation means, etc.)

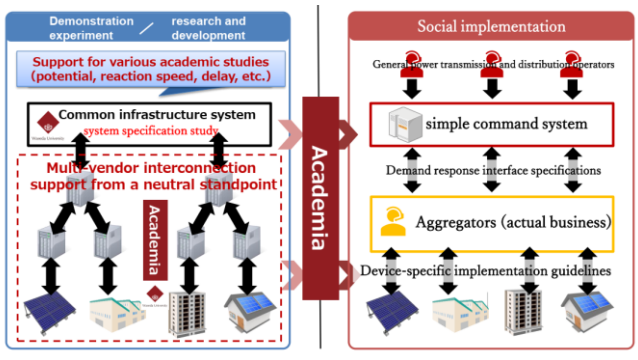
Smart city EMS simulation platform

EMS simulation platform was developed that integrates geographic information, power grid data, traffic data, and meteorological satellite data in order to evaluate and study EMS methods needed to realize next-generation power systems that support smart cities in various future scenarios. Furthermore, EMS hardware testbed was built that simulates both the power grid (smart grid) and consumers (smart houses) and can implement the methods developed through simulation. Using this evaluation environment, the impact of the new EMS method on power quality and the effect of reducing CO_2 emissions are quantitatively evaluated.



Research and prototype demonstration of renewable energy / negawatt two-way standard communication system → Social implementation

The Waseda University EMS Shinjuku Demonstration Center has been developing multi-vendor standard communication systems such as demand response (DR) and virtual power plants (VPP) for the utilization of distributed energy resources on the consumer side. By supporting the interconnection of the systems, research and development, demonstration, and international standardization efforts were promoted, and the system was implemented in society. It also contributes to the reform of the electricity trading market by making recommendations and collecting opinions based on empirical results.



Associated proprietary technologies

- EMS hardware testbed: A power distribution system control simulator is available that can simulate any power distribution system and implement measurement, monitoring, and control schemes, as well as smart houses equipped with communication-controllable storage batteries and HEMS. This facility enables the demonstration experiments on various technologies that are needed to achieve next-generation power systems.
- Distribution loss minimization technology: The power flow within the distribution network is determined by controlling the opening / closing state of switches in the distribution line (system configuration) , and there are countless candidates (e.g., 〖6×10〗^23) for the possible configurations. This technology can quickly determine a configuration that minimizes power distribution loss, and the result has been applied to TEPCO PG's distribution network.
- Management method for electric bus charging that maximizes the use of surplus generation from local PVs: While bus electrification is progressing, it is important to note that bus service in urban areas peaks in the morning and evening, with many vehicles parked in business offices and garages during the day. By utilizing large-scale real-time data such as RT, excess solar power generated during the day can be used to charge electric buses, achieving local production for local consumption.

Expected outcome/ applications

・Ensuring power quality when introducing large amounts of renewable energy
・Construction of a distributed cooperative energy management system
・Effective use of solar power generation using EVs (local production and local consumption of energy)

Associated SDGs