Annex81: Data Driven Smart Buildings

Japan's Activities and Challenges

Yasunori AKASHI (Professor, The University of Tokyo)

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"Building Energy Efficiency and Indoor Air Quality"

9th November 2021, 12:00-15:00 UTC / GMT

Participation in Annex81

■Three main motivations for Japan's participation

- Urgent issue for decarbonization of buildings
- Importance of data driven operation in existing buildings
- Deeply related to the creation of new value and business in the field of building services

■Domestic committee for Annex 81

- 13 companies, 1 NPO, 2 universities (20 people)

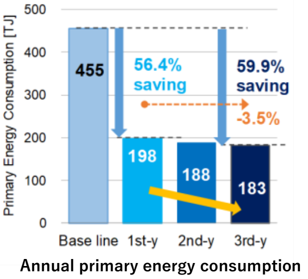
	Industry/Univ., NPO	Affiliation	Number of People
Chairperson & Secretaries	University	The University of Tokyo, Tokyo Denki University	3
	NPO	Building Services Commissioning Association	1
Members	Design	NIKKEN SEKKEI, NTT Facilities, P.T.Morimura & Associates	4
	Construction	Dai-Dan, Kyudenko, Shinryo, Takasago Thermal Engineering, TONETS	7
	HVAC Manufacturer	DAIKIN	1
	Automatic control	Azbil	1
	Energy	Kansai Electric Power, OSAKA GAS, Tokyo Electric Power	3

Example 1 from Japan #1

■In the meetings of Annex81, we provided two examples in Japan on data-driven operations in building systems.

■Example 1: Commissioning(Cx) of Kyoto Station Building

- A complex building (station, hotel, department store, theater, etc.) with the total floor of about 23,600m2 (built in 1997)
- Fully applied the Cx process to the large-scale water-side system retrofit project (2010-2019)
- First case of business-based Cx implementation with Cx fees in Japan
- The energy saving of 60% targetd in the OPR has been achieved
    - 8% reduction has been achieved using the measured data of EMS in the FPT and operational optimization during the first three years after the completion



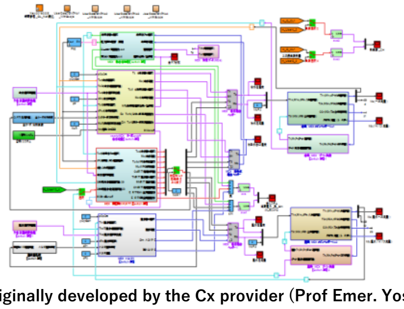
Annual primary energy consumption

Award
- The Energy Conservation Grand Prize, METI Minister Award (Grand prix) 2020
- ASHRAE Technology Award 2021, First Place

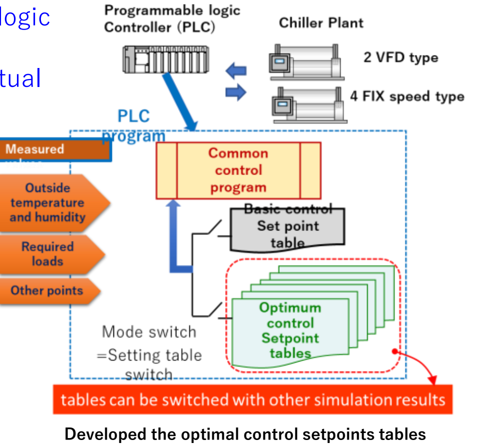
Example 1 from Japan #2

■For the aspects of simulation and data-driven operation in this example,

- Development of the detailed simulation with automatic controls
- Development of the applications for the optimal control logic of the chillers using the simulation
- These applications and the data of EMS optimize the actual operation, resulting in the additional 8% energy saving.



Simulation originally developed by the Cx provider (Prof Emer. Yoshida, Kyoto Univ.)

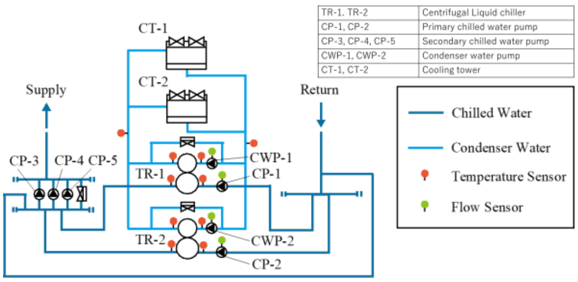


Developed the optimal control setpoints tables

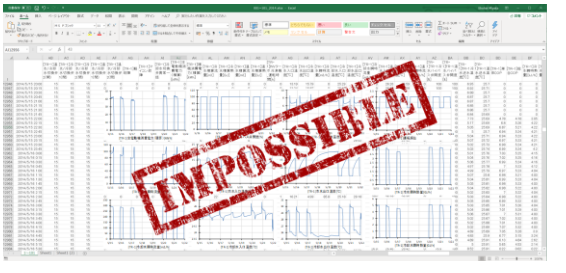
Example 2 from Japan #1

■Example 2: Automated Fault Detection and Diagnosis (AFDD) in a HVAC water-side system of a semiconductor plant

- ➢ Conventional manual FDD and optimization are extremely inefficient, so they are rarely implemented, including in general building systems.
  - Since it is not possible to know in advance which faults are occurring, it is necessary to check all data in the end.
- ➢ However, some reports indicate that the FDD and operational optimization can reduce building energy consumption of 10-30%.



Schematic of HVAC water-side system

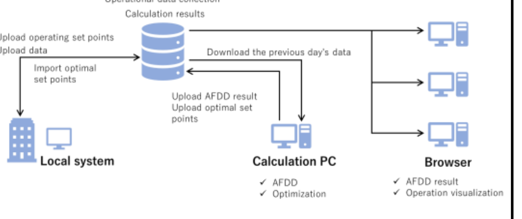


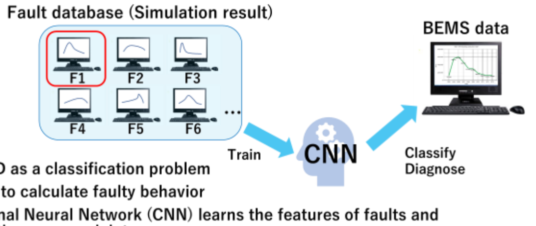
Conventional manual FDD and optimization

Example 2 from Japan #2

■For the aspects of simulation and data-driven operation in this example,

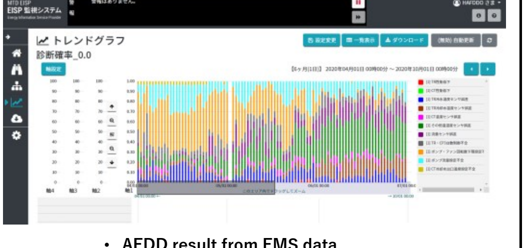
- ➢ Development of the detailed simulation with automatic controls
- ➢ Development of the applications for AFDD using the simulation and machine learning
- ➢ Now, these applications are being demonstrated in the actual system to verify the effectiveness of the AFDD method.





Regard AFDD as a classification problem

- Simulation to calculate faulty behavior
- Convolutional Neural Network (CNN) learns the features of faults and diagnoses the measured data.
- AFDD results was verified by manual data analysis.

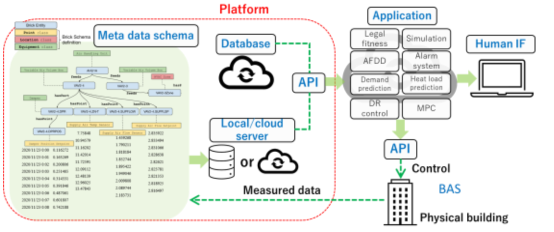


- AFDD result from EMS data
- Demonstration system is running everyday

Shohei Miyata, Jongyeon Lim, Yasunori Akashi, Yasuhiro Kuwahara & Katsuhiko Tanaka (2020) Fault detection and diagnosis for heat source system using convolutional neural network with imaged faulty behavior data, Science and Technology for the Built Environment, 26:1, 52-60, DOI: 10.1080/23744731.2019.1651619

What we learned from the examples/Annex81 for Japan

- ■ Data and applications can improve building energy performance in the operation.
- ■ Various data and applications need to be utilized in buildings on a plug-and-play basis. It will upgrade building energy performance according to the building usage.
- ■ In Japan, there is very little use of such data and applications. The construction industry in Japan is just at the tipping point.
  - ➢ An open platform is still not used in most buildings.
  - ➢ A Cloud EMS is used in each example, but it does not have mechanism to efficiently manage large amounts of data such as a Graph DB.
- ■ Important points for promoting decarbonization of existing buildings
  - ➢ Developing data-driven system that can be installed relatively easily during retrofit or normal time,
  - ➢ Making building owners and occupants understand the value of installing the technologies with the value of data-driven smartification,
  - ➢ Human resources for system integration and application development



Data platform, meta data schema, applications for data-driven operation