

Toward the Digital Transformation of Heat



SAITO, Kiyoshi*

Currently, the entire country is promoting the development of the “Society 5.0” as “a society that balances economic growth with the resolution of social issues with a system that effectively integrates physical space (real space) and cyberspace (virtual space).” One of the technologies required for realizing such a society is digital transformation (DX), which uses the Internet of Things (IoT) to transform products, services, and business models by connecting objects, as well as computers, to the Internet to transform business operations themselves and even corporate cultures and climates.

I have been conducting research specialized in the field of “thermal system dynamics and control.” Specifically, I have worked on system modeling, optimal design and control, and developing simulators development for heat pump-related technologies, including refrigeration and air-conditioning systems.

Heat utilization technology includes many analog elements, and in Japan, technological development has mainly focused on device technologies based on combustion and heat transfer, including rotating equipment such as compressors. As these technologies require long-term gradual basic research and development, Japan, which excels in this field, has strong technological capabilities and is expected to maintain high competitiveness in the global market.

Recently, studies on heat utilization technologies have been gradually advancing toward DX, with the introduction of increasingly sophisticated learning control, motion sensors, and automated driving. Energy management systems (EMSs), a key technology in DX, have been increasingly introduced in various applications, from residential to industrial. In addition, artificial intelligence (AI) has been used for predicting loads, weather, and even human behavior, and the results of related analyses are now being put to practical use.

In the future, for example, refrigerant charge management will become easier in the field of refrigeration and air-conditioning if early detection of refrigerant leakage becomes possible. As EMSs become more so-

phisticated, this will promote the consolidation of heat pump-related equipment, which is currently installed in multiple locations, and expand the use of renewable energy sources, enabling more efficient operation with lower CO₂ emissions. In the cold chain, adding evidence related to energy and refrigerants to digital information distribution will lead to reduced CO₂ emissions, lower global warming effect of refrigerants, and even reduced food losses throughout the supply chain.

On the other hand, I feel a sense of crisis when I look around the house and recognize DX hardly progressing. While the IoT is slowly moving forward, as an electronics-consumer enthusiast, I have as many as five remote controls around me, which I use to operate devices. In addition, I have been involved in many audits of energy management services, and, although energy saving and profitability are proclaimed, there are no means to verify the effectiveness of these services. Too often, energy management systems, if introduced, produce little effect. If nothing is changed, Japan will eventually fail to realize the energy management services that are truly needed and eventually lose its global competitiveness.

In the future, the key to realizing a sustainable decarbonized society will be the system integration technology, which Japan has not excelled in. If Japan, which leads the market in many fundamental technologies for heat utilization, can lead the world in heat DX, it will be possible to continue to make heat utilization technologies internationally competitive. One can only hope that Japan will not repeat the footsteps taken in the smartphone industry, which focused only on fundamental hardware technologies and found itself far behind the times.

Waseda University, together with more than 30 organizations including Fuji Electric, has launched a project entitled “Construction and Social Implementation of an Ambient Energy Platform” as a theme promoted by the Council on Competitiveness-Nippon (COCN). The project is investigating the creation of a common platform to quickly realize a thermal EMS by linking various heat utilization devices from various manufacturers with IoT.

The project is also scheduled to grow into a large-scale national project from fiscal 2023. I sincerely hope that the DX will continue to be a driving force for the

* Director, Sustainable Energy & Environmental Society Open Innovation Research Organization Professor, Department of Applied Mechanics and Aerospace Engineering, School of Fundamental Science and Engineering, Waseda University

heat utilization technology in Japan and push the development of a series of globally competitive technologies.





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