WTR 2015;4:33-40 http://dx.doi.org/10.7165/wtr2015.4.1.33

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On Smartification of Kansai Science City†

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Keywords
Smartification, Smart community, Role of University

1. INTRODUCTION

From the beginning, an image of science city imprinted on our consciousness was different from usual image of industrial city we had known: a series of low, discreet buildings, usually displaying a certain air of quiet good taste, and set amidst impeccable landscaping in that standard real-estate cliché, a campus-like atmosphere (Castells and Hall 1994). In scenes like these, moreover, there are no smokestacks belching forth black smoke into the sky, and no drainage holes discharging factory effluent into the river. In other words, it was a fascinating, intellectual, eco-friendly, and promising image of future city distinguished from other common cities developed in the era of industrialization.

As a city model exactly as stated, therefore, a science city suggests a future-oriented or near-futuristic urban lifestyle. Additionally, it can be a stimulus for intellectual and creative class within and outside the city to innovate the existing lifestyle of common cities. In this sense, a science city is not only an incubator for new technology but also a test bed for new lifestyles. This is why the permanent dwelling condition was emphasized as much as the industrial and academic environment on the technopolis strategy of Japan in 1980s (Tatsuno 1986).

From this point of view, Kansai Science City, where the Smart Community Project has been promoted since 2010, is a good model. A smart community is a new lifestyle designed to provide sustainable growth and encourage healthy economic activities that reduce environmental burden while improving quality of life of residents. Furthermore, in the aftermath of the Great East Japan Earthquake that struck on March 11, 2011, and the subsequent nuclear power plant accident, there is even more demand for resilience in this day and age (http://jscp.nepc.or.jp, October 28, 2014). Kansai Science City is one of four locations in Japan for the Smart Community Project to identify an optimum form for smart grids and smart cities in Japan. In the project, a smartification of science city is not simply a question of changing physical appearance of urban areas; it is a quest to bring innovation to lifestyles of residents there. Kyoto University plays indispensable roles in smartification of Kansai Science City.

An overview of the Smart Community Project in Kansai Science City and the role of Kyoto University in it are explained below.

2. SMARTIFICATION OF PERMANENT DWELLING CONDITION IN KANSAI SCIENCE CITY

Kansai Science City, so called “Keihanna Science City”, was set up in 1978 as the second oldest science city after Tsukuba

† This is a revised version of the paper that was presented at the 2014 UNESCO-WTA International Training Workshop, November 11-13, 2014, Daedeok Innopolis Conference Hall, Daejeon City, Republic of Korea.

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World Technopolis Review

WTR 2015;4:33-40 http://dx.doi.org/10.7165/wtr2015.4.1.33

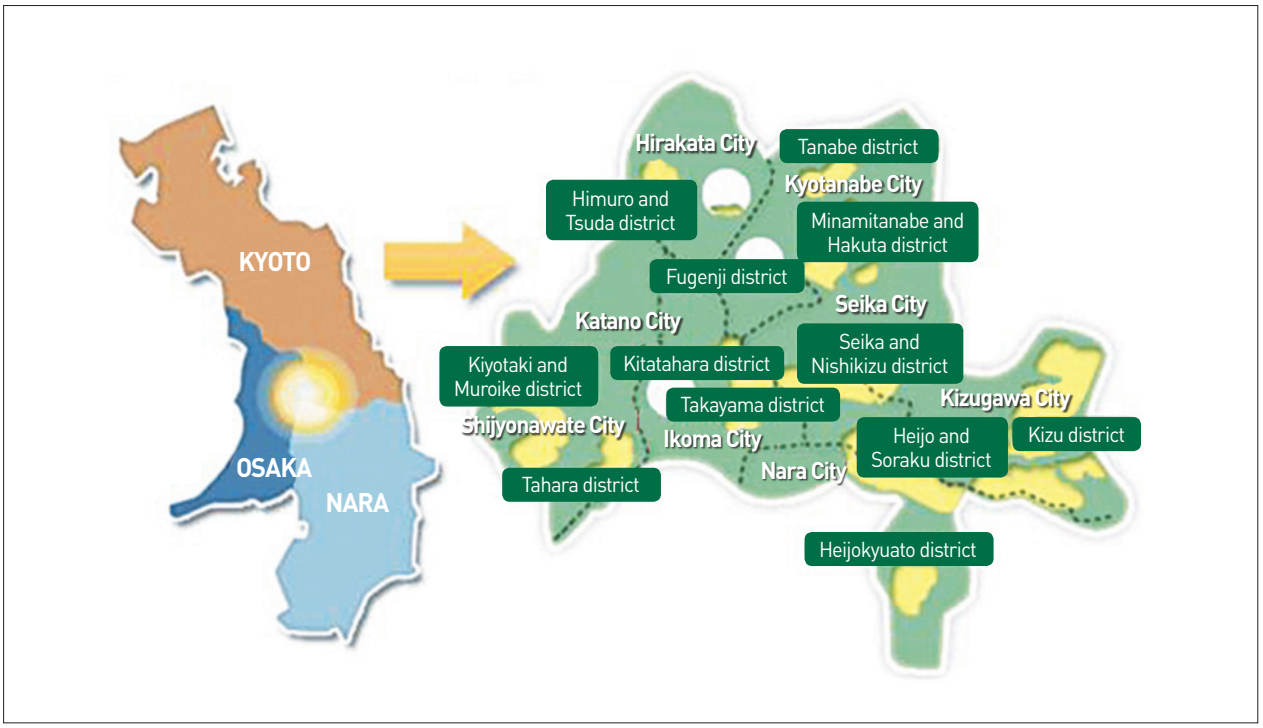

Fig. 2. 1. Gamut of Kansai Science City

Source: http://keihanna.biz (October 28, 2014)

Science City in Japan. As soon as the construction promotion law for Kansai Science City was brought into force in 1987, the city construction started substantially as a national project in the area of the Kansai hills extending to the three prefectures, Kyoto, Osaka and Nara in the Kinki region where old capitals of Japan are located <Fig. 2.1>.

The city consists of Science zones (Tanabe, Minamitanabe and Hakuta, Kizu, Seika and Nishikizu, Heijo and Soraku, Himuro and Tsuda, Kiyotaki and Himuro, Tahara, Heijoato, Takayama) and surrounding zones. The Science zones have public beneficial facilities, habitats and other facilities in addition to the facilities for researchers and those exchanges. The surrounding zones, on the other hand, have necessary facilities to enhance the Science zones and conserves natural environments. These two kinds of zones and all districts in the zones share functions and all districts are organically connected with transportation and information network.

The construction of Kansai Science City in 15,000ha of the area was undertaken to create a base for activities focusing on the three philosophies as follows (http://keihanna.biz, October 28, 2014):

(1) Creating a base for new development in culture, science, and research
(2) Contributing to the development of culture, science, and research in Japan and throughout the world, and to the development of the national economy
(3) Foundation of the intellectual and creative city that opens doors for the future

As we can see above, the construction of Kansai Science City aims to build a future-oriented model city based on intellect and creativity of humanity not only in science and research but also in culture which includes ways of living. To realize these philosophies, the development direction of the facilities in Kansai Science City was set as follows: facilities for cultural and academic pursuits, promotion of industries, habitats, city functions, extensive transportations and fundamental facilities for information and communications. It reveals that it is important to develop the facilities for permanent dwelling including habitats as much as for academic pursuits or promotion of industries in Kansai Science City as an ordinary city.

Kansai Science City, actually, has been proceeding with a

large-scale housing development, making it an ideal location for testing and verifying the outcomes of research on advanced technologies and new social systems in cooperation with residents. From this point of view, the Keihanna Eco City Next-generation Energy and Social Systems Demonstration Project (hereinafter referred to as the Keihanna Smart Community Project) is a model case of it. The Keihanna Smart Community Project is an activity that demonstrates a smart community in actual fields, including not only the transportation sector, but also the residential sector and commercial sector. It features the introduction of a community energy management system (CEMS) for supervision of sectors and optimization of energy utilization in the community (Yano et al. 2013). Making full use of environment of the city, the Keihanna Smart Community Project seeks to develop the CEMS that minimizes CO2 emissions without affecting quality of life or convenience for residents, who look forward to the construction of a next-generation energy society <Fig. 2.2>.

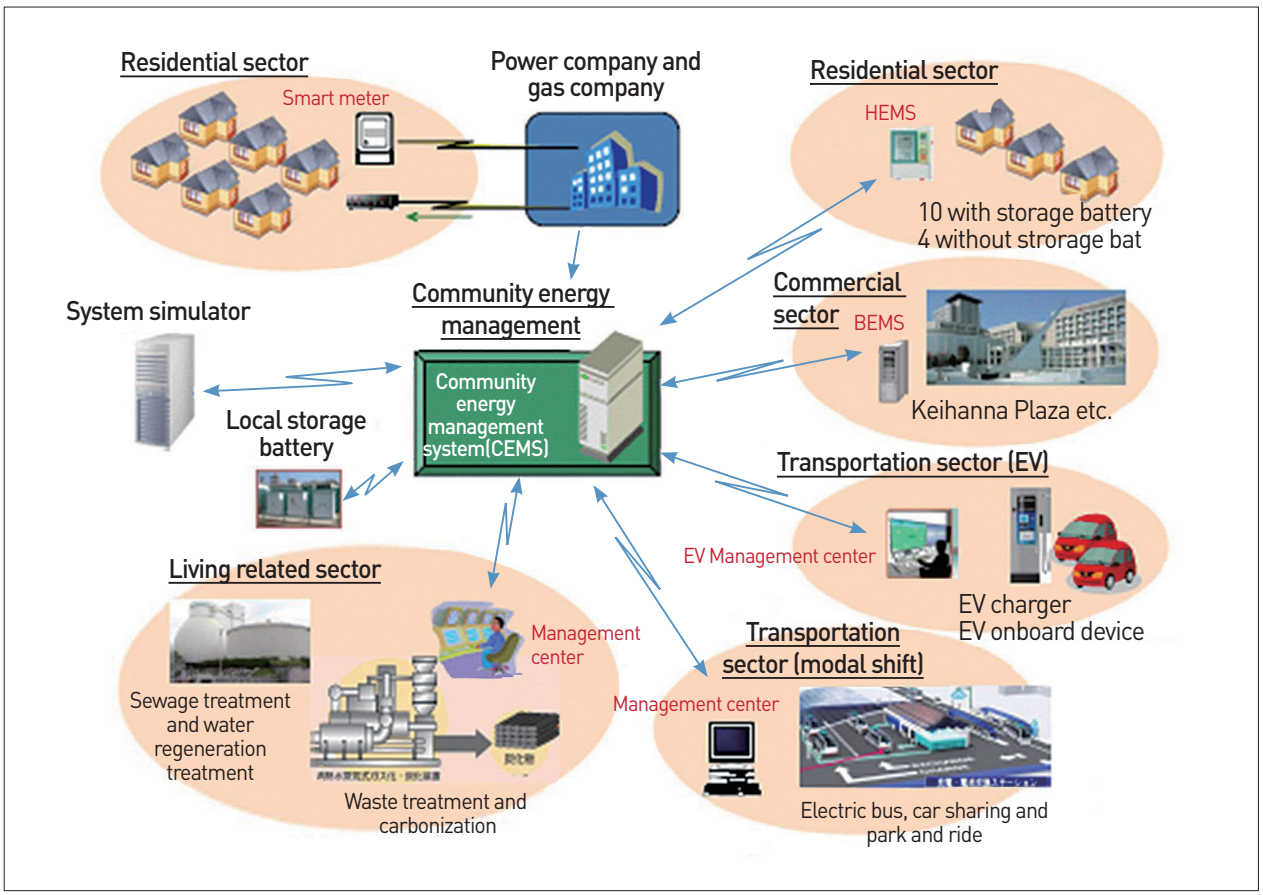

Fig. 2. 2. Keihanna Smart Community Project

Source: Yano et al. (2013):p.5.

The area for operational experiments of the Keihanna Smart Community Project is located in Seika and Nishikizu district of the Science zone. This district is positioned as the central district of the city and plays centric roles in the various fields such as information communications and environments utilizing location of those facilities. Especially, it is promoted to develop green parks utilizing habitats, urban service facilities and natural environments in this district.

The goal of the Keihanna Smart Community Project is the optimization of energy supply and demand on a global scale. Realization of this goal involves the development of systems including the CEMS for comprehensive management of energy in

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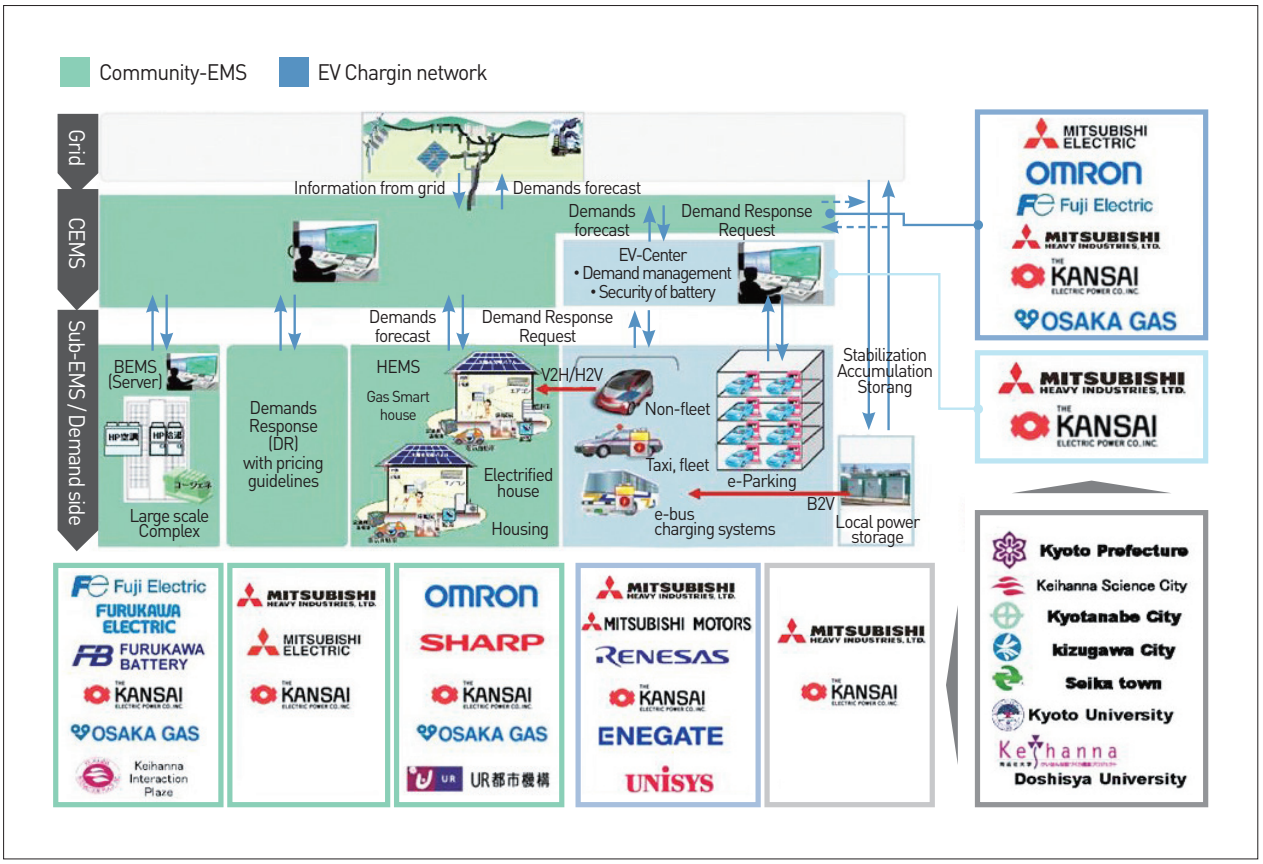

Fig. 2. 3. Implementation Framework of the Keihanna Smart Community Project

Source: http://www.nedo.go.jp (October 28, 2014)

community, a Home EMS (HEMS) to manage energy supply and demand in home, power demand response (DR) for energy management including large-scale DR, a Building EMS (BEMS) to manage energy in buildings, an electric vehicle (EV) charging management system, and V2X (Vehicle to X) <Fig. 2.3>.

Specifically, in homes and buildings of the operational experiments area, the Demand Response linking CEMS to HEMS, BEMS, and EV charging management centers is being conducted in order to verify the effect in saving energy and reducing CO2 emissions. In the EV charging management system, the peak shift effect is being verified to be obtained from deriving the charging location and time from the location of the EV and the remaining power in the storage batteries. In the area of V2X, the use of EV storage batteries is being verified in relation to the supply and demand of power to factories. Based on the outcomes, it is expected that a new business around the Keihanna Model for smart community and eco city will be created, and it will extend to the reconstruction of cities in the Tohoku area from the Great East Japan Earthquake and promote its application in the rest of the world[1].

3. THE ROLE OF KYOTO UNIVERSITY

For the promotion of low carbonization and energy conservation in cities, it is important to introduce effective equipment to improve efficiency in each phase of the "generation, transmission and consumption" of energy. In addition, the establishment of a system that can monitor states of energy supply and demand, and balance them through ICT manage-

[1] http://jscp.nepc.or.jp, accessed October 28, 2014

ment (smart community concept), has been attracting attention of late (Yano et al. 2013).

The Keihanna Smart Community Project is a social demonstration project as a step toward a total management system for optimizing whole-city energy consumption of Kansai Science City. Especially, this project places particular focus on smart technologies in the ICT management sector, which is now seeing innovation due to the progress of Internet of Things (IoT) and big data processing. From this point of view, it can be said that the smartification of the Keihanna Smart Community Project means to informatize energy based on ICT management system for home, building, transportation, and community.

The promotion organization of the project includes Kyoto prefecture and involves twenty-four companies, local governments and universities. There are 7 working groups taking charge of each part in an energy management system and its verification such as CEMS, HEMS, Demand Response, BEMS, EV Charging Management System, EV Charging Network, and Leading Verification. Among them, Kyoto University is involved in the Leading Verification WG, so called 'i-Energy WG', as the managing organization leading the verification <Fig. 3.1>.

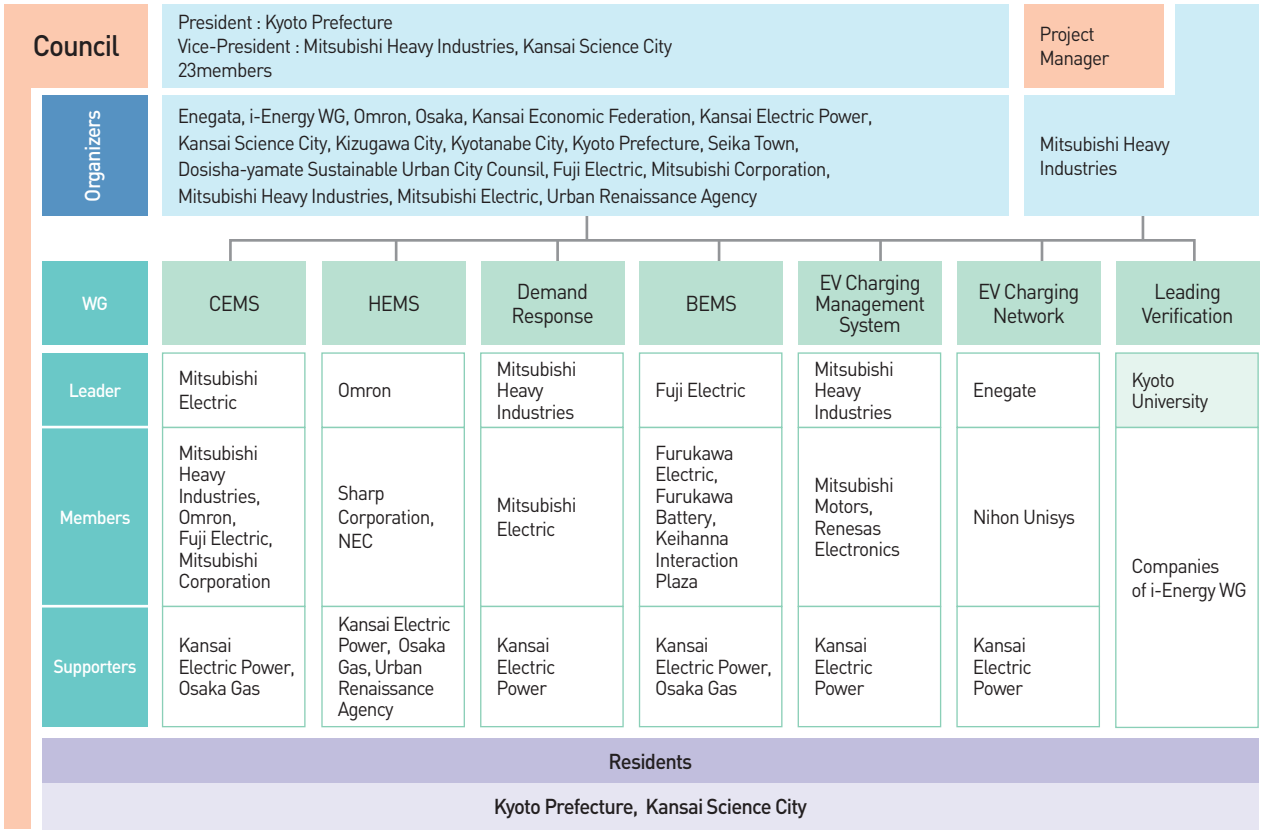

Fig. 3. 1. Promotion Organization of the Keihanna Smart Community Project

Source: http://jscp.nepc.or.jp (October 28, 2014)

The i-Energy WG, originally, was inaugurated at May 2009 for R&D, human resource cultivation, creation of new businesses or industries, and international cooperation through industry-university collaboration on energy management system appropriate to the coming new era. In April 2010, it was positioned as the part for leading verification of the Keihanna Smart Community Project and became a big group including 60 general members for parties, 33 special members for individuals from universities and government agencies, or municipalities including Kyoto Prefecture, and 5 companies as observers at April 2014 <Fig. 3.2>.

The i-Energy WG endeavors to realize a smart community as

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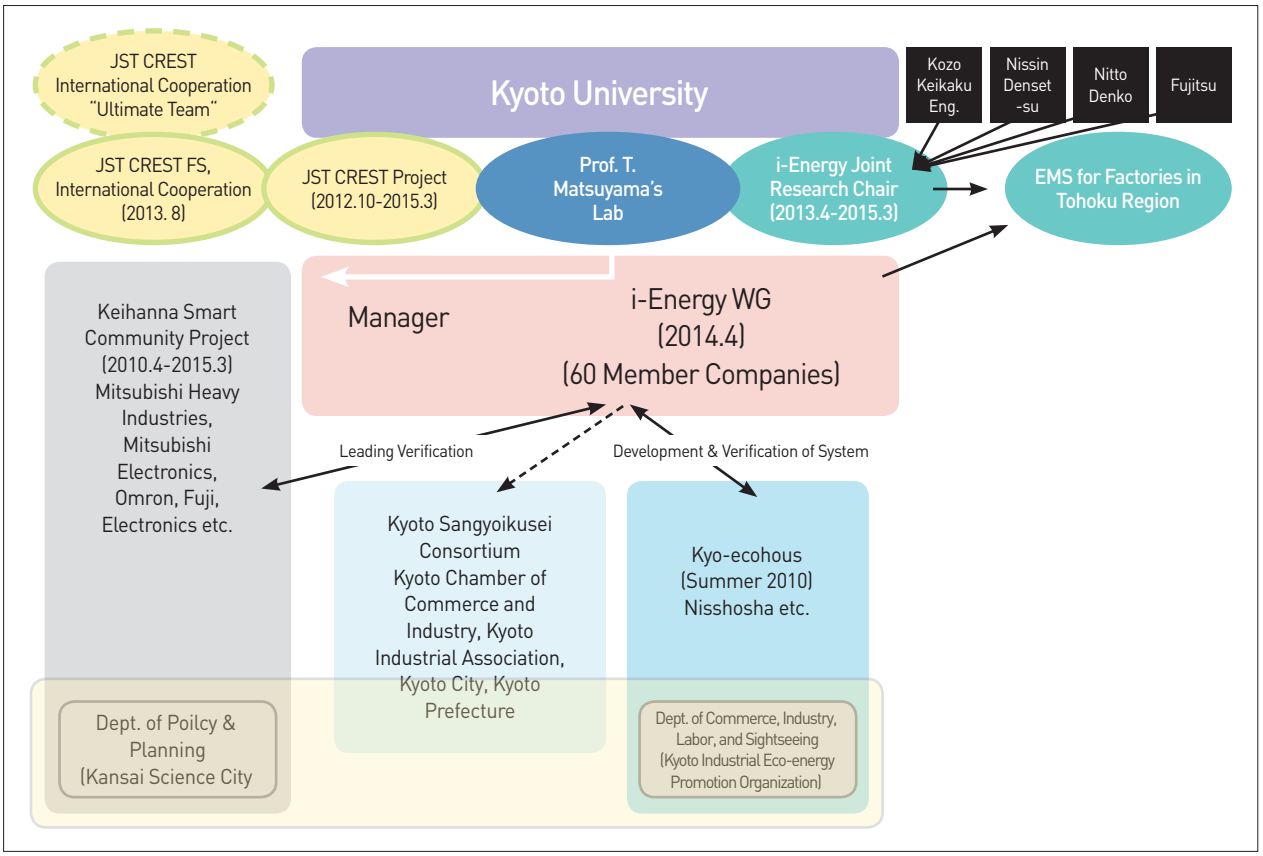

Fig. 3. 2. i-Energy Working Group and Its Cooperative Relationship

Source: http://www.i-energy.jp (October 28, 2014)

a prosumer group, who carries out electricity management autonomously by introducing dispersed power sources such as photovoltaics, fuel cell, storage battery (EV) etc., through R&D and demonstration based on industry-university collaboration by 4 steps as follows:

(1) **Step 1**: Visualizing energy consumption of every household appliance by the Smart Tab Network and learning and watching human behavior by the electricity consumption pattern analysis of household appliance
(2) **Step 2**: Realizing energy saving system with the reduction rate guarantee (Wh) & peak cut (W) system by the Energy on Demand (EoD)
(3) **Step 3**: Building a home nano-grid that has the function to control according to power supply by the electricity coloring
(4) **Step 4**: Creating energy market by community nano-grid (smart community system) networking with local prosumers

In this WG in particular, Kyoto University is in charge of the verification for informatizing energy with the member companies. In the verification, informatizing energy means to integrate a power grid as a social infrastructure in a physical real world with an information grid as a social infrastructure in a cyber network society for building a new super-distributed energy social infrastructure. It is similar with an idea of smart grid to upgrade power grids by ICT technologies. However, unlike smart grid—its energy management is beyond the control by each private person or company because it targets countrywide and public power grids managed by power companies—energy informatization targets independent grids in homes, facilities, and localities managed by private persons and companies. For this reason, a need to build an advanced energy management

system may be realized by this completely new idea of energy informatization. Furthermore, it can also be said that the concept of energy informatization aims to reduce CO2 emission from homes and office buildings instead of the industrial facilities that faced the limit of further carbon emission reduction.

To realize energy informatization, it is necessary not only to develop smart technologies that function validly in a physical real world but also to pioneer a new discipline based on informatics, communication engineering, control engineering, and electrical engineering because laws or rules that hold and explain human behaviors or activities in a physical real world are different with it in a cyber network society. In other words, it is a critical factor to build a new theoretical foundation and train researchers for energy informatization heading towards integration between a physical real world and a cyber network society in the field of community energy management. Kyoto University, for this reason, established the i-Energy Joint Research Chair in the Department of Intelligence Science and Technology, Graduate School of Informatics in April 1, 2013.

The i-Energy Joint Research Chair, as a chair specialized in the research based on a joint research contract, is to promote R&D activities in anticipation of new market development and international expansion. Because three full-time teachers who participate in the joint research, a program-specific researcher, and four joint researchers dispatched from each member company belong to the chair securing an occupied space for itself, it is expected that the joint research can be implemented steadily and speedily with a clear vision of the final applications. In addition, it is possible for the joint researchers from member companies to be employed as docents in the joint research chair. In this way, researchers from companies can be trained in the chair.

4. CONCLUSION

Similarly to the spread of urbanization to common cities, it is expected that smartification of cities will rapidly spread within a few years in Japan due to the current energy crisis, global warming and climate change, and the Fukushima Daiichi Nuclear Disaster. Because of this, it is thought that innovation needs for smartification based on smart technologies will rise.

However, smartification of city is not just a technological matter. As urbanization in the era of industrialization does so, it suggests and requires a new lifestyle based on changing infrastructure and superstructure in the era of an informatized world. In other words, it means a deconstruction of the socio-economic systems of industrial society. Smartification of city, therefore, is a matter of social/societal innovation as well.

Synchronization between technological innovation and social innovation in a city is a long-cherished desire in the field of science city/technopolis development. And, as described above, such innovative challenges of the Keihanna Smart Community Project have been proceeded. As a result, the building of the infrastructure including CEMS, HEMS, BEMS, DR, EV, and V2X etc. has been completed in Kansai Science City as a test bed for city smartification of Japan in the near future. More than that, large quantities of data and high quality experience have been accumulated in the members of the promotion organization including Kyoto University.

For Kyoto University to bring the initiative for smartification of city into view, it is important to analyze and utilize the data and experience for creating discipline and building a theoretical foundation about smartification to appeal operator companies and residents as local users. On that account, Kyoto University, assuming research, development, training areas in the verification field, established the i-Energy Joint Research Chair mentioned above. It is anticipated that the Chair can be a stimulus for intellectual and creative class who feel warm interest in smartification to be attracted into the city.

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Received November 05, 2014
Revised February 02, 2015
Accepted March 11, 2015

Acknowledgements

This is a part of research results funded by the President's Grand for Education and Research, the University of Nagasaki in FY 2014.