Smart community guideline: case study on the development process of smart communities in Japan

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Abstract. With the increasing demand for a sustainable society, smart community—a community that focuses on both environmental, social, and information technology efforts—become one of the answers to provide a more sustainable society. Despite the urgency to develop a smart community, the definition of what requirement should be included and the guideline on how to develop a smart community is not enough. In this paper, a case study on the Japanese smart community development measures is done, and the general development process of Japanese smart community is suggested based on the measures. The study was done on five representative cases and 14 measures were collected and classified into three categories based on the development process.

1. Introduction

Recently, more attention is given to environmental issues such as sustainable energy consumption and the greenhouse effect. The Paris Agreement agreed to limit the earth temperature increase below 2 degrees Celsius. In Japan, a more detailed target such as 26.0% greenhouse gases (GHG) emission reduction by the fiscal year 2030, 39% reduction in the residential sector by 2030, and GHG emission reduction of 80% by the fiscal year 2050 was set [1] [2]. Furthermore, in 2016 the United Nations suggested the Sustainable Development Goals (SDGs)—17 goals to end global urgent challenges in environment, politic, and economy which mentions ‘Sustainable Cities and Communities’ as one of its goals. Social, environmental, and energy needs in cities and communities are in the targets [3]. Thus, it is needed to develop a sustainable city or community that produce low greenhouse gases emission while aware of both social, environmental, and energy issues.

In Japan, an increase is seen in the development of smart community—a community that focuses on the practices on both environmental, social, and information technology aspects in its area such as: utilization of solar panel or other renewable energy as one of the community energy source, utilization of passive design, efforts in safety and security, and including educational or parenting facility. These efforts could answer the mentioned issues in the city and community which makes the smart community development important. However, the guideline on how to develop a smart community in Japan is not enough and need to be developed to promote smart community. Especially since the urban planning and energy planning processes are separated in the planning processes and the integration of energy planning in the urban planning process is needed to develop a smart community [4].

To develop the guideline, it is needed to understand the present smart community development and its measures. Therefore, the aims of this study are to understand the current smart community development measures in Japanese smart community by using case study and suggest ideas to promote the development from the measures.
2. Measures to implement energy strategies in community

2.1. Measures from Annex Research
A study by IEA-EBC Annex 63 on the implementation of energy strategies in communities [5] has been done in 11 countries including Austria, Canada, Denmark, France, Germany, Ireland, Japan, the Netherlands, Norway, Switzerland, and the United States of America. This study suggested nine common strategic measures to answer the issue. The measures are set vision and targets, develop renewable energy strategies, make full use of tools supporting the decision-making process, implement monitoring of energy consumption and GHG emissions, stakeholder engagement and involvement, include socio-economic criteria, and implement effective and efficient organizational processes. However, these measures are too broad and overlap with each other. Further, to make it easier to implement the strategies, community development process need to be considered. Therefore, to answer the issues mentioned, it is needed to suggest new measures. In this study, new measures are suggested from the case study on the cases used in the same case study with IEA-EBC Annex 63 study [5].

2.2. Measures suggestion
From the case study, collected development measures are shown in figure 1. The collected measures were classified into three categories by the community’s development stage which are decision making, planning, and operation.

![Figure 1. Smart community development stages and measures.](image)

Decision making categories indicate the measures that influence the decision making to develop smart community. Decision making includes master plan, labeling, and stakeholder interest measures. The master plan is when the government or municipality decided the use of the area as an environmentally friendly area or a smart community. The labeling measure proofs or promotes the area as a smart community. Stakeholder interest measure addresses the smart community development as a part of the stakeholder interest either to prove the stakeholder as an environmentally friendly company or to use the area as a research purpose.

The planning category indicates the measures that affect the planning process especially in deciding what technology or efforts need to be included in the smart community. The planning category includes set target, competition, use of supporting tools, and subsidies measures. Set target measure set a clear vision and targets for the development to reach. Competition measure conducts a competition between private or architect to obtain the best option in technology or efforts to be adopted. Use of supporting tools measure utilize technology or tool to support the planning on what type of technology or efforts need to be utilized in the smart community. Subsidies support the development of the smart community financially so that the community could include better technology or efforts.

Lastly, the operation group indicates the measures that keep the smart community as planned even after the construction of the smart community finishes. The operation category includes agreement and monitoring. Agreement measure set an agreement to reach the community goal between the stakeholders, especially to be followed by the residents. Monitoring measure monitor community condition such as electricity consumption or solar panel energy generation and collect its data so that the smart community can maintain its performance.
3. Measures and case study in Japanese smart community

The study by IEA-EBC Annex 63 and the measures mentioned in 2.2 include cases from 11 different countries but most of them are European cities or communities. However, each country has differences in climate condition, citizen needs, and especially the planning process. For instance, due to the long summer period in Japan, Japan has a higher temperature and lower heating demand compared to the European countries. Instead, the cooling demand is higher than the European countries. Also, the planning process is different for the landowner has a stronger influence than the municipality in area development. Due to these differences, the measures mentioned in 2.2 is insufficient for the Japanese community. Thus, it is needed to develop smart community development measures suitable for the Japanese community and includes them in the smart community development guidelines. This chapter will mention the measures of Japanese smart community from the case study done.

3.1. Target and limitation

The target case of this study is the Japanese smart community with the limitation of the smart community that mainly contain newly built detached housings.

3.2. Method

To establish smart community development guideline, it is needed to understand the present smart community development in Japan and the differences between smart community development with standard community development. Here, this study introduces the differences as smart community development measures, which is defined as any action, program, policy, or other activity that can demonstrate or influence change in the process that support the project to become a smart community.

The case study was done by the following approach. First, cases that satisfy the target and limitation were collected. Then, these cases were grouped by its leadership model [6] into three groups, which are government driven, private sector driven, and public-private partnership group. Two cases were chosen from each group as its representative, except for the public-private partnership where only one case is available. Next, a detailed analysis of the five cases’ development process measures was done. From these measures, the general smart community development in Japan is suggested. The representative cases and its grouping are shown in Table 1. Each case study characteristics and its measures is mention in this chapter. Also, the measure's summary is presented at the end of the chapter.

| Group                        | Name                                      | Location | Scalea |
|------------------------------|-------------------------------------------|----------|--------|
| Government driven            | Bonjono Kitakyushu Smart City Project     | Fukuoka  | 350    |
| Government driven            | M-Smart City Kumagaya                     | Saitama  | 73     |
| Private sector driven        | Osaka M Passive Town                      | Osaka    | 303    |
| Private sector driven        | Fujisawa Sustainable Smart Town           | Kanagawa | 600    |
| Public private partnership   | Ayameike Housing Development              | Nara     | 142    |

*a Number of detached housing in the area

3.3. Japanese smart community development measures

From the case study, development measures were collected and are shown in figure 2. Bolded measures are the measures that differ from the measures mentioned in 2.2 and the measures in black outline are the measures that included in all target cases. The collected measures were classified into three categories by the development stage—same with 2.2. Here, the measures that have not been mentioned in the previous section is discussed.

In the decision making category, town development project and council are the measures that differ from the measures in 2.2. Compared to the master plan mentioned in 2.2, the town development project able to decide the planning in a smaller area. This is due that in Japan, the smart community development...
scale is smaller and it is difficult to decide the planning for the whole city. Further, the council measure is different since some smart community development decided by a council.

Two measures in the planning category, guidelines and council, is added for the Japanese smart community measures. The guidelines set the target to be fulfilled by the other stakeholder related to the housing or area construction. Guidelines on the housing design and guideline on what kind of equipment need to be included in the housing or community are some of the guideline examples. Also, the establishment of the council supports the community development related to the decision making in the planning process.

Lastly, community management association development and management in environmental aspects are the two measures added to the development measure. The development of community management association is a measure where the community developed a community management association to manage the community especially in social aspects such as safety, security, community, landscape, and economy. On the other hand, the management in environmental aspects cover aspects such as energy consumption, energy saving advice, and alerts in energy and weather changes.

**Figure 2.** Smart community development process and measures.

4. **Case study of Japanese smart community representative cases**
Below the details of Japanese smart community representative cases mentioned in Table 1 and its measures used in each case is mentioned.

4.1. **Bonjono Kitakyushu Smart City Project (Government driven)**
Located in ex-self-defense force base in Fukuoka, Bonjono Kitakyushu Smart City Project is a smart city development project planned by Kitakyushu government as an effort to Kitakyushu’s Environmental Model City project. The measures in the Bonjono Kitakyushu Smart City Project are shown in Table 2. The development of this project was planned in the ‘Kitakyushu City urban planning master plan on Kokurakita-ku’ and labeled as a zero carbon leading area. A planning council with Ministry of Finance (MOF), Fukuoka Prefecture, Urban Renaissance Agency (UR), and Kitakyushu city as its member was established. A detailed target was decided and includes zero carbon, sustainable town planning, and so on. Guidelines were made to be followed by the developer and subsidies were given for Zero Energy Housing (ZEH) and energy management system construction. Community energy management system (CEMS) and housing energy management system (HEMS) was brought in the area to collect energy consumption data and provide information to the residents. The information provided includes comfortability and energy saving advice as a part of the management in the environmental aspect. Green management in landscape and town security management are some example of the management done by the community management association.
| Measures                  | Stakeholder                  | Details                                                                 |
|--------------------------|------------------------------|-------------------------------------------------------------------------|
| Town Development Project | Kitakyushu City              | Kitakyushu City urban planning master plan on Kokurakita-ku.            |
| Labeling                 | Kitakyushu City              | Labeled as Zero Carbon Leading Area.                                    |
| Stakeholder Interest     | Kitakyushu City              | An effort to Kitakyushu's Environmental Model City.                     |
| Set Target               | Jono-buntonchi Atochi Shori  | Detailed target on zero carbon, support for parenting and elderly,      |
|                          | Planning Council             | sustainable town planning, townscape and scenery.                       |
| Guidelines               | Jono-buntonchi Atochi Shori  | Jono Zero Carbon Leading Area Town Planning Guideline (contains the    |
|                          | Planning Council             | definition of Zero Energy, its effort and detailed target).             |
| Subsidies                | Kitakyushu City              | Subsidies for Zero Energy Housing and Energy Management System          |
|                          | Council                      | construction.                                                           |
|                          | MOF, Fukuoka Prefecture, UR | Establishment of Jono-buntonchi Atochi Shori Planning Council.          |
| Monitoring               | Jono Hito-machi Net          | Usage of CEMS/HEMS to collect energy consumption data, and to provide  |
|                          |                              | information to the residents.                                           |
| Community Management     | Jono Hito-machi Net          | Development and requirement to join Jono Hito-machi Net that manages    |
| Association              |                              | security, greenery, and energy.                                         |
| Management (Environment) | Jono Hito-machi Net          | Energy Management (provide information about comfortability and         |
|                          |                              | energy saving advice to residents).                                    |

4.2. M-Smart City Kumagaya (Government driven)

M-Smart City Kumagaya is a smart community development of 73 detached housing developed in a 1.8 ha ex-elementary school land. Since the land was owned by the municipality, the municipality has the right to control the usage of the area. The municipality created Kumagaya Smart Town Development Project in the area and promoted a competition to decide the best development option for the area. The measures in M-Smart City Kumagaya are shown in Table 3. This development received labeling as the Leading Project for Promoting CO2 Reduction in Housing and Building from the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) and received subsidies from the same ministry. Thermal environment simulation of the housing area was done and the guideline to regulate the housing design was also made by the developer. After the construction finished, the management in the social aspect as in the community hall management and event management is done by the municipality, but monitoring by the weather observation equipment, questionnaire, and HEMS are done by the developer.

| Measures                  | Stakeholder                  | Details                                                                 |
|--------------------------|------------------------------|-------------------------------------------------------------------------|
| Town Development Project | Kumagaya city                | Kumagaya Smart Town Development Project                                |
| Labeling                 | MLIT                         | Labeled as The Leading Project for Promoting CO2 Reduction in Housing and Building |
| Competition              | Kumagaya city                | Kumagaya Smart Town Development Project                                |
| Set Target               | Developer (House maker)      | Create a city with zero energy and zero disasters, comfortable for long-time living, connect people and history |
| Use of Supporting Tools  | Developer (House maker)      | Thermal environment simulation of the housing area                      |
| Guidelines               | Developer (House maker)      | Machi-ie-tsuuki Guideline (regulate the housing design, environment, and efficiency) |
| Subsidies                | MLIT                         | The Leading Project for Promoting CO2 Reduction in Housing and Building |
| Management (Environment) | (HEMS)                       | Energy overuse alert                                                   |
| Monitoring               | Developer (House maker)      | Monitoring by the weather observatory, questionnaire (once a year), HEMS (real-time monitoring, visualization of electricity consumption and production) |
4.3. Osaka M Passive Town (Private driven)
Osaka M Passive Town is a development of a smart community located in Osaka, with the total housing area of 7.8 ha with 300 houses planned. The measures in the Osaka M Passive Town are shown in Table 4. It is labeled as the Leading Project on Sustainable Building by MLIT and was given subsidies by the same ministry. The developer interested to develop the area to answer the increasing needs of environmentally friendly housing and to evaluate the housing technologies it has. Further, the developer collaborates with other housing companies and university to decide the planning details of the area. The university performed housing simulation model to analyze the energy consumption of the community. Also, a guideline on the structure and design of the housing and community area and to decide the device need to be used in housing and community area such as the usage of PV, fuel cell, water sprinkle device, and automatic windows. After the construction finishes, the developer will collect the housing energy consumption data.

### Table 4. Measures in Osaka M Passive Town.

| Measures         | Stakeholder       | Details                                                                 |
|------------------|-------------------|-------------------------------------------------------------------------|
| Labeling         | MLIT              | The Leading Project on Sustainable Building                              |
| Stakeholder Interest | Developer       | To answer the needs of environmentally friendly housing and to evaluate its technology |
| Use of Supporting Tools | University   | Use of housing simulation model to analyze the energy consumption and simulation to decide the housing and road position |
| Set Target       | University        | Create a community with a passive design based on the area climate and community that encourages the CO₂ reduction |
| Guidelines       | Developer         | Guideline on structure and design of the housing and community area and guideline to use a specific device in housing and community area. |
| Subsidies        | MLIT              | Labeled as the Leading Project on Sustainable Building                  |
| Council          | Developer         | Council of three private company and university to decide the planning details |
| Monitoring       | Developer         | Collection of energy consumption data                                   |
| Management (Environment) | (HEMS)         | Provide energy saving advice                                            |

4.4. Fujisawa Sustainable Smart Town (Private driven)

### Table 5. Measures in Fujisawa Sustainable Smart Town.

| Measures         | Stakeholder       | Details                                                                 |
|------------------|-------------------|-------------------------------------------------------------------------|
| Labeling         | MLIT              | Labeled as the Leading Project for Promoting CO₂ Reduction in Housing and Building |
| Stakeholder Interest | Developer       | Usage of home appliance manufacturer ex-factory site and to promote usage of its products. |
| Set Target       | Fujisawa SST Council | Environmental Target: 70% reduction of CO₂ emission, 30% reduction of water consumption. Energy Target: 30% increase in renewable energy. Safety Target: CCP: 3 days |
| Use of Supporting Tools | Developer       | Simulation of utility cost and environmental performance of the utilities. |
| Guidelines       | Fujisawa SST Council | Project Design Guidelines: guideline on processes related to the project development, Town Design Guidelines: guideline on town development, a guideline on environment design |
| Subsidies        | MLIT              | The Leading Project for Promoting CO₂ Reduction in Housing and Building |
| Council          | 16 Companies *    | Fujisawa SST Council |
| Monitoring       | Fujisawa SST Management Company | HEMS (visualization), energy consumption survey by the internet, questionnaire, interview, measurement (until 3 years after moving in) |
| Community Management Association (Environment) | Fujisawa SST Management Company | Development of Fujisawa SST Management Company to manage related to community safety, event management, building management, and energy management. |
| Management (Environment) | Fujisawa SST Management Company | Use of HEMS, energy advice to each housing |

* Including electronic company, utility company, housing company, and town management company.

Fujisawa Sustainable Smart Town or Fujisawa SST is a project located in ex-factory site of a home appliances manufacturer in Kanagawa. Other than 600 detached housing, apartments, shops, health and
welfare facility, educational facility, and park are also located in the 19-hectare area. The developer which is also a home appliances manufacturer and the landowner has the interest to develop the area to promote the use of their product and to utilize the factory site. The measures in the Fujisawa SST are shown in Table 5. The area received CASBEE-UD Rank S and selected as ‘the Leading Project for Promoting CO₂ Reduction in Housing and Building’. Detailed target on environmental, energy and safety is set in the area and three guidelines related to the project development, environment design, living continuity plan, etc. is made by the Fujisawa SST Council. On the operation phase, the monitoring is done by HEMS, survey, questionnaire, interview, and measurement. Further, management in community safety, event management, and energy advice are done.

4.5. Ayameike Housing Development (Public-Private Partnership)

Similar to Fujisawa SST, Ayameike housing development is a community development that includes not only a housing development, but also facilities development in the area including kindergarten, station, shops, and parks. The development is located near Ayameike lake in Nara prefecture and was done in 2010. A railway company was interested to develop the area to increase the value of the area since the area is along its railway line. The measures in the Ayameike Housing Development are shown in Table 6. To decide the development, Ayameike Amusement Park Land use investigation group is established with the member of the municipality, academic experts, local representative, and a railway company and targeted to create a “multipurpose complex town” which include fine housing, educational facilities, and other convenient facilities. The development was labeled as ‘The Leading Project for Promoting CO₂ Reduction in Housing and Building’ and received an A-Rank CASBEE-UD certification. Supporting tools was used to simulate the housing passive design and two guidelines were created. Monitoring was done on the area energy consumption and shown in the community monitor and as the height of the fountain water located at the community. Eco-activities is promoted in the area, and LETS (Local Exchange and Trading System), where each eco activities will award citizen with eco-points that can be exchanged with a shopping voucher.

| Measures          | Stakeholder                          | Details                                                                 |
|-------------------|--------------------------------------|------------------------------------------------------------------------|
| Stakeholder Interest | Railway Company                      | Plan to increase the value of living environment along the railway line |
| Council           | Nara City, Academic experts, local representative, Railway Company | Establishment of Ayameike Amusement Park Land use investigation group to discuss area land use |
| Set Target        | Ayameike Amusement Park Land-use investigation group | Increase the value of the land while creating harmony with nature and propose a new lifestyle. Create a new city with living facilities within walking distance. Create a sustainable city |
| Labeling          | MLIT                                 | The Leading Project for Promoting CO₂ Reduction in Housing and Building |
| Use of Supporting Tools | Developer                         | Housing passive design simulation                                      |
| Guidelines        | Ayameike Amusement Park Land-use investigation group | Detached housing guideline (to create balance with the environment, including outer structure, plants, etc.), scenery and environment guideline |
| Subsidies         | MLIT                                 | The Leading Project for Promoting CO₂ Reduction in Housing and Building |
| Monitoring        | Management Association               | CO₂ emission visualization                                               |
| Community Management Association | Management Association | Development of management association to manage safety, security, scenery, and environment, etc. |
| Environment       | Management Association               | Management of community energy-saving equipment, management of residents eco-activities and LETS |

5. Discussion

5.1. Measures summary and its trend

The summary of the Japanese smart community measures is shown in Table 7. From the cases, it is suggested that each measure include the following aspects. The town development includes two kinds
of development project, town development project where it requires the area to be developed as a smart community by creating targets that need to be fulfilled and the town development project that organize a competition with a certain target and choose the best plan for the area. The former is shown in Bonjono Kitakyushu Smart City project, and the latter is shown in M-Smart City Kumagaya. More responsibility and more effort by the government is needed in the former project since the development is based on the target and guidelines made by the government. In the latter, the government can only initiate a broader goal in the town development project competition and let the private sector decide the details. Still, the decision to create a smart community depends on the town development project planned by the government or municipality.

Table 7. Summary of the measures from the case study in the Japanese community.

| Leadership model | Bonjono Kitakyushu Smart City Project | M-Smart City Kumagaya | Osaka M Passive Town | Fujisawa Sustainable Smart Town | Ayameike Public Housing Development |
|------------------|--------------------------------------|-----------------------|----------------------|----------------------------------|-----------------------------------|
| Scale            | 350                                  | 73                    | 303                  | 600                              | 142                               |
| Decision Making  |                                      |                       |                      |                                  |                                   |
| Town Development Project | ○                                | ○                     | ○                    | ○                                | ○                                 |
| Labeling         | ○                                    | ○                     | ○                    | ○                                | ○                                 |
| Stakeholder Interest | ○                                | ○                     | ○                    | ○                                | ○                                 |
| Council          |                                      |                       |                      |                                  |                                   |
| Set Target *     | ○                                    | ○                     | ○                    | ●                                | ○                                 |
| Competition      | ○                                    |                       |                      |                                  |                                   |
| Use of Supporting Tools | ○                                | ○                     | ○                    | ○                                | ○                                 |
| Guidelines       | ○                                    | ○                     | ○                    | ○                                | ○                                 |
| Subsidies        | ○                                    | ○                     | ○                    | ○                                | ○                                 |
| Council          | ○                                    | ○                     | ○                    | ○                                | ○                                 |
| Monitoring       | ○                                    | ○                     | ○                    | ○                                | ○                                 |
| Operation        |                                      |                       |                      |                                  |                                   |
| Community Management Association | ○                                |                       | ○                    | ○                                | ○                                 |
| Management (Environment) | ○                                | ○                     | ○                    | ○                                | ○                                 |

*Cases where a detailed target is decided are marked by ●.

The labeling measure includes labeling from municipality and labeling from the ministry’s program. Stakeholder interest measures are different in each case. In this case study, four interest was found, which are as a part of an environmental program the stakeholder is currently doing, to answer the needs of environmentally friendly housing, to evaluate and promote the stakeholder or developer technology, and to increase the area land value. The council measures are used in the decision making phase and/or the planning phase. The council member differs for each case. Council of government organizations, private sectors, and both sectors are shown in the case study. Set target measures in the target cases include environmental targets such as zero carbon and CO₂ emission reduction, social targets such as support for parenting and elderly, comfortable living and safety, and energy targets such as to increase of renewable energy usage. The competition in the target case includes the competition made by the government to the private sector as a part of the town development project. The supporting tools in the target cases are classified by its contribution to energy consumption to direct supporting tool and indirect supporting tool. The direct supporting tool includes housing energy consumption simulation, where indirect supporting tool includes the passive design and thermal environment simulation. Further, in the target cases, the guidelines contents include some or all of the three main contents: housing and community energy efficiency standards, environment and landscape design, and usage of a particular technology or device. The monitoring in the target cases uses some or all of these content: CEMS or HEMS, questionnaire, interview, direct measurement, and visualization. The development community management organization measure plays a big part of the social aspect in the community since the community management organization manage social aspects of the community such as the security,
safety, greenery, scenery, and environment. On the other hand, the management (environment) aspect plays a big part in the environmental and energy aspects. The environmental management includes the use of energy overuse alert, energy saving advice, and management of eco-activities.

From the case study, though each case uses different measures, both labeling, set target, subsidies, monitoring, guidelines, and management (environment) measures are used in all cases. Labeling and subsidies are received from the same organization and at the same time, which makes both of the measures used together. This includes labeling from the municipality and from Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) as ‘the Leading Project for Promoting CO\textsubscript{2} Reduction in Housing and Building’ or as ‘the Leading Project on Sustainable Building’. 4 out of 5 representative cases used the labeling and subsidies from MLIT. Thus, the programs run by MLIT highly contributes to the smart community development in Japan. Labeling is an important measure to increase the area value as a smart community or an environmentally friendly community. On the other hand, subsidies are important since smart community development costs more, especially to create a high-efficiency house and install a high-efficiency device or appliance such as PV, battery, or fuel cell. Further, most subsidies require the case to monitor energy usage and to evaluate its success. Therefore, cases that apply labeling measure also apply subsidies and monitoring measures. Set target measure was used in all cases and it is important to use the measure to decide the goal and vision to be reached by the community. However, only 2 of 5 representative cases decided a detailed target such as 100% CO\textsubscript{2} emission reduction or 30% water consumption reduction. Guidelines measure is also applied in all cases but with different contents in each case. The guideline is important to assure the housing development fulfill the community target since the stakeholder that initiate the development and the house builder differ in some of the development. Also, all target cases used environmental management measures, but with a different type of management in each case. Most of the cases are using the energy-saving advice from the HEMS data, others provide an alert of energy overuse, and the other use eco-currency to promote eco-activity.

The stakeholder and leadership model are strongly related to the measures applied in the case, especially measures in the decision making and planning category. In government driven cases, the town development project is strongly related since the development was initiated by the government and on government’s land. The government either decide the target in the guideline or created a competition and set criteria that need to be fulfilled. Therefore, the town development project always used in the government driven cases and either competition or guideline measures are used in the planning phase.

On the development driven by the private sector, the stakeholder interest plays a big role in the development. The measures used and the result depends on the stakeholder interest. For example, since the developer of Fujisawa SST is a home appliances manufacturer company that interested to promote their products, supporting tools was used to provide utilities cost and environmental performance. Instead, the Osaka M Passive Town where the developer is a real estate and housemaker company, it used supporting tools to simulate the energy consumption and to decide the housing and road position.

Further, the measures used also related to the scale of the development. The council measure in the planning process is done by large-scaled cases with more than 300 houses. Ayameike Housing Development consists of 142 detached housing, but 269 apartment rooms are also in the area, thus considered as large-scaled cases. It is reasonable since in bigger development more stakeholder is involved so that the development council is needed.

5.2. Suggestion to promote Japanese smart community development

It is understood that in government driven cases, the government plays a big role in the development, wherein private driven case it is the private interest and in the partnership is the council. However, it is difficult to propose a suggestion to the private sector, therefore, this section proposes the suggestion on what the government, especially what Japanese government needs to do to increase the number of smart community and its quality.

To increase the number of smart community, it is needed to promote the measures that used by all the cases, especially the labeling and the subsidies measures since the labeling and subsidies measures
are mostly initiated the government and is an approach to provide an incentive to smart community development. The labeling measure is important to increase the value of the area and the subsidies measure is important to increase the community capability to include high-efficiency devices or to include better practices in the community. The labeling and subsidies are also important measures to increase the private sector’s interest to develop a smart community.

Also, the government, especially municipality, needs to include the smart community aspects in not only competition requirements but also in the general housing or community development requirements to motivate the smart community development.

Further, in some cases, the monitoring and management in the environment in the community are done only for the first years after the construction finishes. It is needed to require the management to be done for not only the first years, so the community can keep its quality. It is also possible to increase the quality of the smart community by increasing the requirement of the competition and guideline.

6. Conclusion
14 measures of Japanese smart community development are proposed in this study. The measures are town development project, labeling, stakeholder interest, and council in the decision making phase, set target, competition, use of supporting tools, guidelines, subsidies, and council in the planning phase, monitoring, community management association, and management in the environmental aspect in the operation phase. The usage of the measures differs in each case, especially the measures in decision making and planning phase are strongly related to the development’s leadership model and some other measures related to the development scale. Also, since it is difficult to directly increase the private sector’s interest to develop smart community, the government needs to determine stricter regulations and standards to be fulfilled by the developer to increase smart community number and quality. Further, from this study the essential measures in the planning and development phase are suggested, but, the cases studied in this study are new cases developed within 10 years. Therefore, further investigation is needed on the effectiveness of the measures, especially the measures on the operation phase. Also, to promote and maintain the long-term environmental performance of the smart community, further study is needed on the measures that possible to maintain smart community’s environmental performance, especially to develop community brand and to provide co-benefits to the residents.

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