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The New Solutions for Energy Issues for Condominiums

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Abstract
Condominiums which satisfy the Japanese standards determined by laws have the seismic resistance to withstand an earthquake with an intensity of six to seven because the condominiums have to save the life of occupants. The condominiums also can contribute to the safety of cities as they provide one of the shelter for the neighboring people. However, the condominiums locate at the high-performance and high-density residential district. For that reason, in the emergency, all occupants experience the difficulty to maintain their daily lives without the supply of electricity, gas, water and other utilities. Additionally, the occupants who live in high-rise buildings feel greater inconvenience just like refugees because they are unable to use elevators. Shortly after the Great East Japan Earthquake, the metropolitan areas had an electric shortage; then these areas implemented the scheduled blackouts. This implementation affected the majority of condominium occupants. They reaffirmed the importance and convenience of electricity by the scheduled blackouts. Eventually, people have raised the awareness of power saving following the seismic disaster. This paper describes the community formation among the occupants by visualizing the electric power consumption, in real-time, with smart meters. In the emergency, it is very important to take care the elderly or physically-challenging peoples. Especially when they live alone, the visualization system for their household contributes to know their safety and welfare.

Key words: smart grid, distributed energy, power saving, smart mater, disaster, community, condominiums

1. Introduction

After the Great East Earthquake, the power went out at about 4.05 million households in the jurisdiction of Tokyo Electronic Power Company (TEPCO), and at about 4.4 million households in the jurisdiction of Tohoku Electronic Power Company. The multiple power plants stopped and power generation system was damaged by the Great East Japan Earthquake. This accident had a possibility of larger scale blackout due to lose a balance of supply and demand relationship after the electricity power restoration. TEPCO and Tohoku Electric Power Company announced and started the implementation for saving power in the jurisdiction of both companies on March 14th, 2011. This strategy is called the rolling blackouts or scheduled blackouts; it is sequentially stop and restart of power supply for each designated area or specified area to avoid the large-scale blackout due to the power demand exceeds the power supplying capability by electric companies. The first rolling blackouts implemented at 5 p.m. on Ibaraki, Shizuoka, Yamanashi, and Chiba Prefecture on the same day. It had been conducted since March 14th to 28th, 2011. The mostly specified areas for the implementation were the residential area to avoid the confusion of metropolitan economy by the rolling blackouts. However, Chiyoda-ku and Minato-ku in Tokyo, the disaster area, and the area in Gunma Prefecture where a hydroelectric power plant existed, were not included in the specified areas. The implementation created the confusion because the announcement was too hastily and the specific information such as schedule was not delivered to the residents in the implemented area from TEPCO. This event provided some motivation for the condominium occupants to re-realize the importance of electric power, and they have raised (increased) awareness of the way to use an energy and energy saving.

2. The Mansion Life Continuity Plan as Measures against Disasters

In the damage anticipation and measures of Nankai megathrust earthquakes and earthquakes occurring directly beneath the Metropolitan Area which are the Central Disaster Prevention Council published, it has no mention of the condominiums. Japanese earthquake measures are focused on the urban area where the wooden construction and low-rise building exist. Tokyo and Osaka has many built-up areas where have these building. When an earthquake occurs, these area are worried that get serious damage, but the condominiums not draw much attention for measures from Japanese government because there are less worries about collapse and fire.

Also, the government concentrates the rescue teams such as fire station, the police, the self-defense forces, etc. on the disaster area where the greatest damage occurs. We have to know the limits to dig out the trapped survivor of earthquake within 72 hours, and the condominium is less likely to get big damage, thus, this factor would result as the delay of rescue.

Although the condominium does not have big personnel and material damage by a disaster, the new issue beyond the normal limits of disaster prevention appears. Typical problem is high-rise living people; they will go to a lot of trouble if the electric blackout continues for a long time. The shakes of the earthquake become harder and increase the risk of fall such as furniture at high-rise households. Additionally, we have issue of the shelter shortage. When a disaster occurs, the evacuation area is set up by the administration; it is geared to people who lost their house due to a fire or a collapse. Therefore, there is a possibility that the evacuation area cannot be provided to the people who live in the condominium because there is less risk to get damaged by a disaster. Nankai megathrust earthquakes measures suggested “refugee triage” for this issue. It defines the priority people who have the serious house damage, and other people who cannot continue the life at their own house.

Large cities publish the disaster manual for the condominium occupants, but it assumes they continue the life in condominium after disaster. Shinagawa-ku published “the high-rise condominium disaster measure handbook”, the subtitle is “Advances of self-help and mutual assistance to realize ’Home Evacuation’”. Musashino-city put forward the suggestion for disaster measures of multiple dwelling houses in the regional disaster prevention plan edited in April 2013; it is called “Mansion Life Continuity Plan” (MLCP). This plan is different version of which the government and private company are engaged on Business Continuity Planning (BCP). MLCP is towards to the condominium where the people can live together, and the condominium association and the occupants who have to stay as much as possible after disaster. This shows a huge shift from the conventional disaster prevention and measures based on go outside to get out of the danger.

The idea of MLCP and home evacuation are not same mean that the people have no choice but to stay in their own house due to the shelter shortage. In a painful situation after the disaster, the people can use the advantages of condominium system. The condominium role is strong shelter to protect life. Otherwise, it has an advantage that the wide range of people live in the same building. When a big earthquake occur, various daily services will stop, and the people will be at a loss because they do not know what specialized knowledge and abilities needed. However, in the case of condominiums, the people who have the specialized knowledge and the abilities from various fields, lives in the same building. It means the advantage of condominiums have an opportunity to create a temporary project team easily.

Moreover, a fact that the evacuation area settled up at school such as primary, secondary, and more; we cannot say these area has good living condition. In the disaster area of Great East Japan, many people went back home caused by the living condition of evacuation area. A wise choice is the condominium occupants help each other if there is inconvenience.

3. Visualization System of Power Consumption

This research is toward for preventing the outage when the power supply has been stopped or significantly reduced. If the large-scale disaster occurs, every occupants check the power usage of entire condominium to cooperate and reduce the power usage in each household. Additionally, it accelerates the power-saving activity with an understanding of the big picture of power usage through the easy and real-time access to the electric demand. The visualization system of power consumption attempts to promote the energy saving action by understanding the real-time energy consumption with the smart meter.

The measurement used a wireless smart meter consisting of sensor unit and data acquisition unit as shown in Fig.1.

Collected data was transferred to another server, and then the system publishes data through the internet after processed with the special software developed by Linux or Windows. The collected data is displayed as shown in Fig. 1.

Currently, the power meter is widely used in the measurement of power usage in the HEMS(home energy management system), BEMS(building energy management system) and the power supplier side. The measured data can be monitored and checked only in the site. However, the present net power meter is possible to transmit the power consumption data to users and the network area through the communication function.

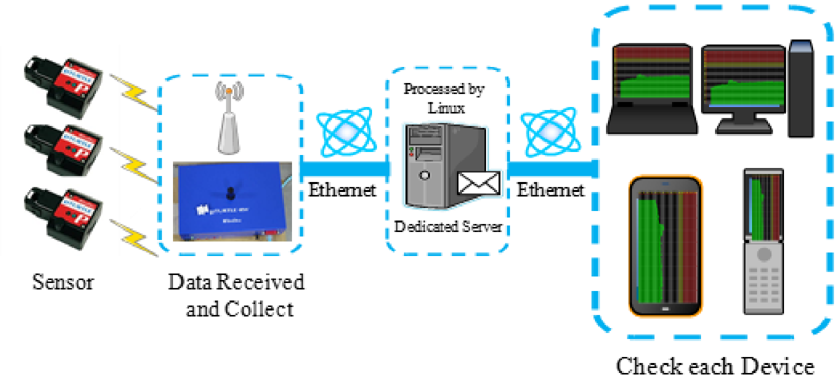

Fig. 1 Example of Visualization System

4. Experiment of power saving

The purpose is to investigate the effect of visualization system for power saving. The activities and response of inhabitants is important in the analysis of the mechanism.

On April 20 2014, the experiment to investigate the effect of visualization for power saving at the condominium which has 309 dwelling units in Yokosuka-city, Kanagawa prefecture, as shown in Fig.2 by the following steps.


Fig. 2 Condominium in Yokosuka-city

1. The day of experiment, the occupants live their life as usual until 10 a.m. The electric demand of entire condominium could be displayed in every 1minute and can be noticed with each smart phones or personal computers.
2. From 10:00 to 10:30, turn off unnecessary lights and television, and turn down the air conditioner two or three

degrees to reduce use of power by 30% between this time range as a guide provided before the experiment.

3. From 10:30 to 11:00, turn off the air conditioner too, and stop using electric appliances that driven by a motor such as wash machine to reduce use of power by 60% between this time range as the guide.
4. After 11 a.m. the occupants back to the usual life.

Moreover, we took a questionnaires on the power-saving activity from the participants.

Beginning time of the power saving (10 a.m.), the power went down over 30kW quickly as shown in Fig3. The power of 30kW is for 75 houses in terms of average power use of general households. Figure 4 shows the number of views per day with smart phones or personal computers etc. On the experiment day, the number was increased to 750 times; the result suggests that the occupants were conscious of the power usage. Furthermore, the occupants who are unaccustomed to use computer, they did not observe total power usage. However, they have experienced with act in spontaneity that makes great effect on overall. Finally, the condominiums occupants succeeded to cut power usage by 60% except the standby power of facilities with their simultaneous power saving activities and knowing the real-time total power usage.

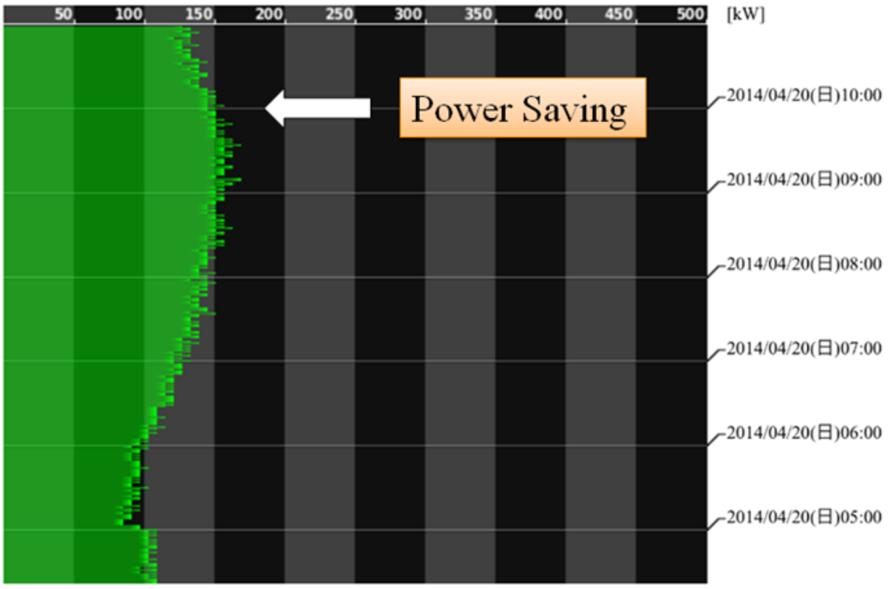

Fig. 3 Power Usage Graph on the Experiment Day

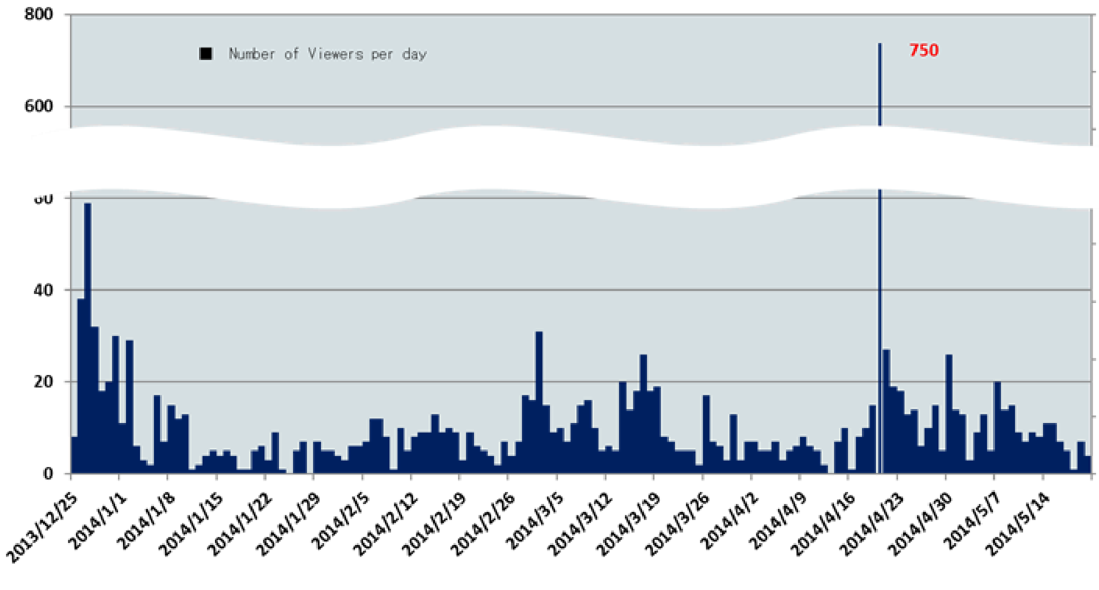

Fig. 4 Number of viewers per Day

The most important results from the questionnaires are shown below in Fig.5 to 7. Figure 5 indicates a lot of 40year-old generation lives with the primary school children in the condominium. The question asked what kind of action took to saving power during implementation. Most popular action for the power-saving is turning off the lightning as shown in Fig.6. The inhabitants who turn off the lights and television exceeded 60%. Figure 7 show that the inhabitants of 30% experienced the first checking of electricity demand of entire condominium. The experiment or training for emergency can contribute to aware the energy saving in each life.

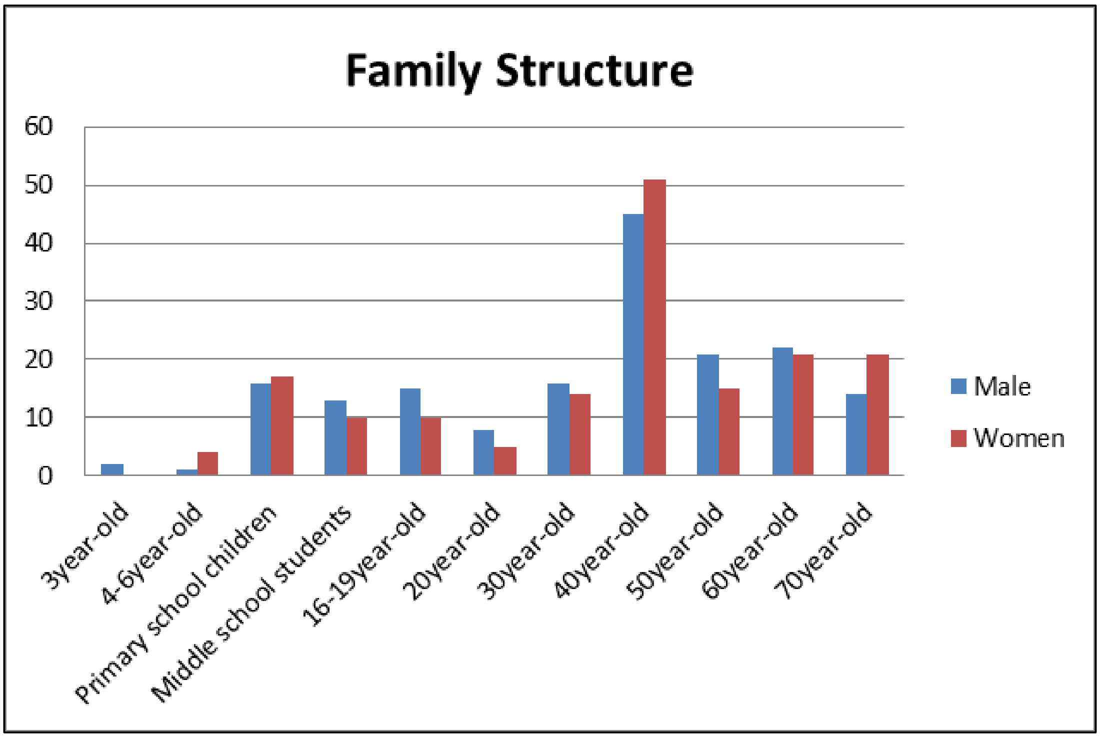

Fig. 5 Family Structure

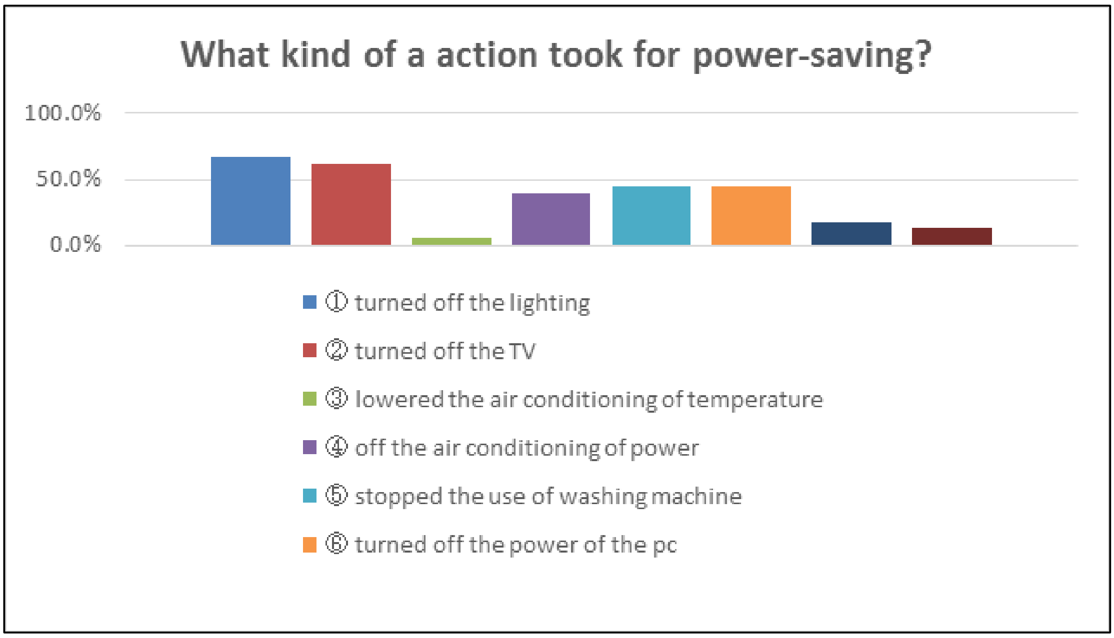

Fig. 6 Power Saving Action

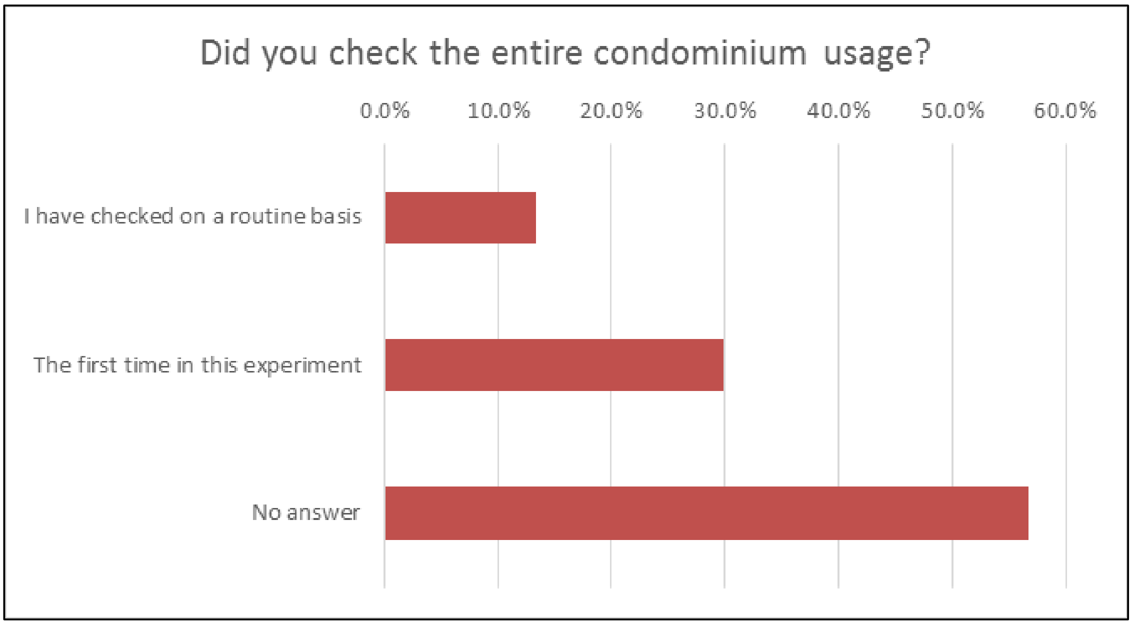

Fig. 7 Question

Another point to note, majority of occupants who experience the experiment commented "We took power-saving act in spontaneity, but we cannot believe it works for power-saving." They have realized that a little power saving actions make big power reduction.

As shown in Table1, the response rate of questionnaire was over 60% from the target households (279 dwelling units), and the experiment participants were 45% except who away from home (absence). Thus, many occupants can take an active part in disaster-prevention activities regularly, and the community level in the condominium is high.

Table 1. Experiment participation and survey responses situation

Classification	Number of dwelling units	Remarks
Total units	309	
Number of target	279	Number excluding the foreign household
Number of responses	168	60% (recovery rate)
Power-saving experiment participation households that except for the absence, etc.	127	45% (participation rate)

The important point of "Visualization" of power is grasping (understood) not only one household usage but also "Power usage of the entire condominium". Some homes necessarily cannot be power-saving because the occupants have the different individual reasons. We understood the households that can control the power usage reasonably can act and cooperate, and the flexibility and freedom of each household is important. Based on the above, we suggest a disaster-proof smart grid with visualization system for the entire condominium. That includes,

1. The grasping of the power consumption for the entire condominium helps to introduce the renewable energy with the significant power variation into the electric grid, and the system can eventually contribute the power saving when the disaster occur.

2. The system contributes to achieve "Foster a new community through the energy". The condominium occupants realize the energy conservation (saving) of entire community from individual power saving

actions. It is expected to encourage a sense of solidarity by taking the power saving action all together. This approach helps to build and advance the disaster countermeasures of condominiums.

3. The condominium will get incentive by possible to control energy in diversification of lifestyle such as the exemption from the rolling blackouts, the reduction of electricity charge by peak cut, and the realization of safety and security in the condominium during disaster.

5. Experiment of watching over living alone

The "Visualization" of power also contribute to the watching over the living alone. Shown in Fig.8 is the electric demand of living alone when the air conditioner is off. The electric demand can be displayed in every 10 seconds and can be noticed with the allowed personal computers. The base usage of electricity is due to the refrigerator and the ventilation fan. The electric demand of refrigerator changes with an interval for the control of temperature. When he is in home, it is easy to notice the activity such as the light on in toilet and the usage of electric kettle. The time of going to bet and the wake up can also be known with increasing of the electric demand.

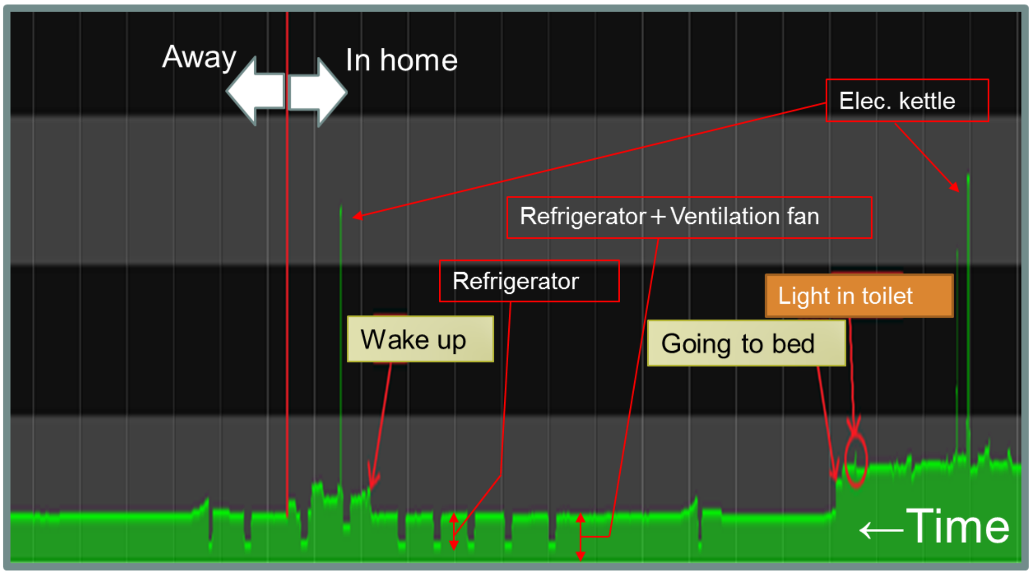

Fig. 8 Electric demand for living alone without air conditioner

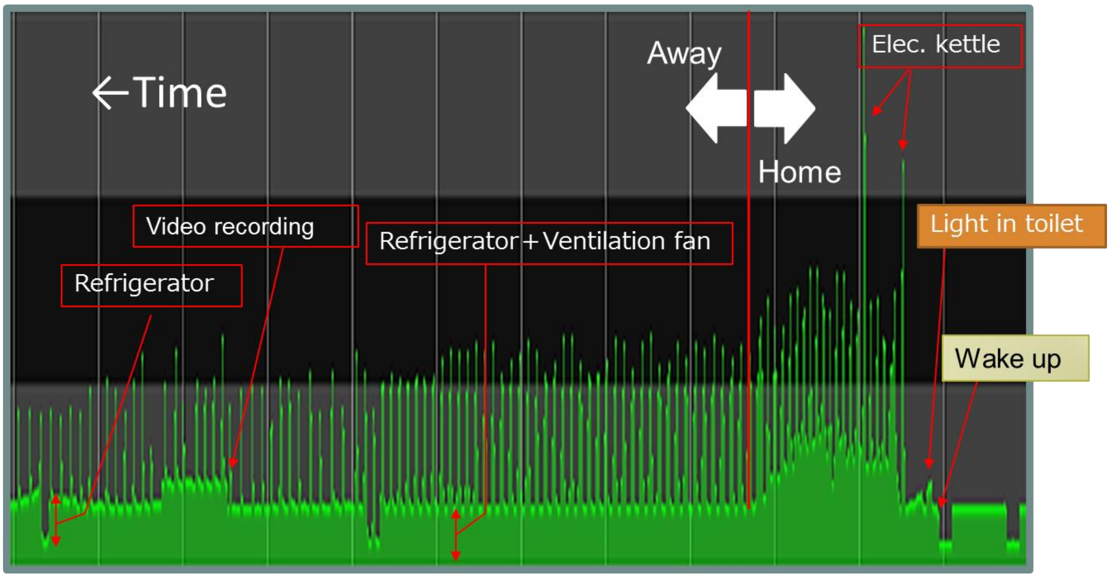

Fig. 9 Electric demand for living alone with air conditioner

Shown in Fig.9 is the electric demand of living alone when the air conditioner is on. The air conditioner makes the spikes of electric demand due to the on-off operation to control the room temperature. The figure indicates the operation of air conditioner soon after the wakes up. When he is in home, it is easy to notice the activity such as the light on in toilet and the usage of electric kettle. The time of going to bet and the wake up can also be known with increasing of the electric demand.

In the emergency, it is very important to take care the elderly or physically-challenging peoples. Especially when they live alone, the visualization system for their household contributes to know their safety and welfare.

6. Conclusion

The occupants have worried that the relationship reducing the intimacy in urban area when they need to be together and cooperate such as disaster. The condominiums locate at the high-performance and high-density residential district. In order to continue at home evacuation life after the disaster, occupants need the specific strategies to compensate with the mutual support when elevators and water supply facilities are stopped caused by the power outage. However, if the occupants lives in the same condominium, they do not have chance to communicate because lifestyles become more diversified in majority downtown condominiums. Humio Tanaka (2014) pointed out that the most important thing for the disaster countermeasure is stockpile and communication with the occupants in condominium. In this research we implemented the power visualization system of entire condominium. It is expected to encourage a sense of solidarity by taking the power saving action all together. This approach helps to build and advance the disaster countermeasures of condominiums. The power saving action on daily life contributes to maintain the communication with someone who lives in the same condominium, it will become a network that can exchange the information and result as the reasonable decision-making and the action at the disaster. In the emergency, it is very important to take care the elderly or physically-challenging peoples. Especially when they live alone, the visualization system for their household contributes to know their safety and welfare.

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