Application of Horizontal Cooperation Platform in P2M to Smart Grid Project

Tatsuo SATO
Hideo KAMEYAMA

Smart Grid is a massive social Infrastructural improving project and its project consists of consortium in where many cross-industrial associations participate. Since the Smart Grid project needs to establish the optimal solutions for stakeholders such as each local community together with local government, industries, academic organizations, citizens, and how to manage the whole project is the key to success. P2M is one of the project management methods suitable for the projects whose individual functions are highly specialized and complexly interacts each other. The method is considered to be effective to the Smart Grid project.

Here we verify effectiveness of applying Horizontal Cooperation Platform in P2M to the Smart Grid project by a case study.

Keyword: P2M, Smart Grid, Platform, Logic Model, Balanced Scorecard

1. Summary of Smart Grid
In this chapter, we mention summary of the Smart Grid and define a scope of the Smart Grid project here we deal.

1.1 Smart Grid
The Smart Grid is "realization of power supply system which is highly efficient, quality, reliable, adding distributed power sources such as solar photovoltaics and user data to the current combination of centralized power source and grid through integration and utilization by ICT (Information and Communication Technology) [1]. The conventional power grids are one-way connection to the users and electric power companies always need to supply electricity equal to the total sum of actual consumption. Otherwise, disruption of supply-consumption balance could lead to accidental electric outage in the worst scenario. The balance is more important especially when high-rate introduction of Renewable Energy is concerned. The Smart Grid enables management of user electricity consumption and flexible power supply by ICT connecting supply source and consumers interactively. Moreover, the Smart Grid enables integration of electric supply infrastructure and ICT not only in centralized power grids but also at houses, factories, offices, commercial facility and in larger areas as towns and cities. The Smart Grid is a system to realize energy-saving and

1 Tokyo University of Agriculture and Technology
ecological societies also by bringing in renewable energy and electric vehicles. The Smart Grid consists of the conventional centralized power source system such as power plants utilizing heat, hydraulic and nuclear, the distributed power source system such as solar photovoltaics and wind plants, transforming stations, power grids, smart meters, accumulators, home electric appliances and electric vehicles. The Smart Grid manages overall electricity by connecting those with EMS (Energy Management System) and ICT network. [Fig.1]

![Fig.1 Overall Picture of the Smart Grid](image)

### 1.2 Background of Smart Grid

In U.S, too many electric power related companies were established associated with the deregulation of electric power in 1990, frequent massive blackouts became a major economic problem. Unstable power supply of the conventional power grids drove an approach of the Smart Grid. In Europe, renewable energy, taking a geographical advantage such as high winds, was introduced from early on and the energy management and control with the Smart Grid is required.

In Japan, an examination of the Smart Grid started being driven by the target of expanded introduction of renewable energy published in 2008 and various operation experiments are being implemented. The biggest of the Smart Grid projects is an operation experiment started in 2010 in four locations, that is Yokohama, Toyota, Keihanna in Kyoto and Kita-Kyushu. Not only an introduction of renewable energy to the locations, but also energy optimization in each location, examination of means of next-generation transportation such as electric vehicles, visual control of CO₂ emissions and other various experiments are being promoted[2][3].

Also, the Smart Grid became more conscious after the Great East Japan Earthquake
occurred on March 11, 2011 and power shortage and rising expectation for renewable energy is being rapidly closed up.

1.3 Development to Smart Cities
The Smart Grid is being developed to Smart City. Smart City does not only build electricity infrastructures but also improve social infrastructure such as overall energy, water and sewer system and public transportation system. Operation experiments to make cities “Smart” is being implemented globally in order to solve issues such as increase and aging of society and urbanization as well as environmental issues as energy supply. There are 400 smart city projects in 35 countries. By country and area wise, with China at the top of the list, the developing countries have 237 projects and the developed countries mainly U.S. 183 projects. This shows the developing countries are more active than the developed in Smart City project. Global Smart City market is said to reach US$31 trillions in cumulative total of 20 years from 2010 to 2030. It is anticipated the market will rapidly expand at the rate of 1.9% a year till 2020[4][5].

We hereby define the Smart Grid project as a social infrastructure development focusing mainly on smart electricity infrastructure.

2. Subjects in Smart Grid project
Smart Grid is a massive social Infrastructural improvement project and its project consists of consortium in where many cross-industrial associations participate. Since the Smart Grid project needs to establish the optimal solutions for stakeholders such as each local community together with local government, industries, academic organizations, citizens, and how to manage the whole project is the key to success.

In this chapter, we summarize subjects to be solved from investigation reports concerning the Smart Grid [6][7][8][9][10].

(1) Total optimization as local infrastructure
Primary entity of the Smart Grid project is local community and its purpose is to improve local community people’s living. Since the current operation experiments, however, mainly focus on technical examination, individual functions of new technologies and multifunctionality, an aspect of total system with optimized combination of the technologies is missing.

The important thing for the local community who would introduce the Smart Grid is not technical capability of individual functions but grand design of the total community. The important is the concept of total optimization where stakeholders share the target based on clear vision and build a system meeting the community needs and solving the issues.
(2) Cooperation and integration of cross-industrial participants
In order for Smart Grip project to seek for total optimization, establishing a management system that enables stakeholders to share the project vision and to build consensus is required. There are not a few themes that are difficult to build consensus because of the difference in each purpose and way of thinking of each cross-industrial participants who may have different interests. Also everything could get messed up when each stakeholder would seek for their own profit. In the Smart Grid project, it is vital that all the stakeholders cooperate each other in a close cooperative relationship.

(3) Project management targeting short-term achievement and middle-term development
The Smart Grid project requires establishing a business model to continuously operate the system such as a primary owner of the Smart Grid after established and time frame for the Smart Grid to be profitable. After the Smart Grid is established, a certain level of achievement in improved local citizens living and convenience owing to stable operation as electric infrastructure is expected. Also in continuous operation, the system needs to be maintained and managed in a manner so that comments and requests from the citizens concerned can be incorporated for further modification and improvement.

In the mid-term outlook, it is important to operate the system in consideration of mid-long term road map and outcome based on future urban development concept such as cooperation with the Smart Grids of other cities and communities and integration of other infrastructures such as gas and water supply systems.

3. Application of Horizontal Cooperation Platform in P2M to Smart Grid project
P2M [11][12] is one of the project management methods suitable for the projects whose individual functions are highly specialized and complexly interacts each other. We hereby hypothecate the method is effective to the subjects in the Smart Grid project. Specifically, we apply Horizontal Cooperation Platform which we suggest to the P2M.

In this chapter, we describe a whole image when the Horizontal Cooperation Platform in P2M is applied to the Smart Grid project.

3.1 Application of P2M to Smart Grid project
P2M is intended to improve total values by organically linking multiple projects. The project Life cycle divided into three models, that is “Scheme Model”, “System Model” and “Service Model”, are called 3S models. Fig. 2 shows relation of the Smart Grid project and the 3S models of the P2M.
(1) Scheme Model
The important role is to clarify total concept of local infrastructure such as grand design and project plan of the Smart Grid to raise funds to make the project go smooth. The point is building a system enabling stakeholders to share the project vision.

(2) System Model
Based on the grand design of a system, it designs, procures, establishes and introduces individual systems. The important role is to manage the entire project such as consistency, information sharing, reconciliation of interests, cooperation and integration of individual functions.

(3) Service Model
The model aims to maintain the system for stable operation, improvement/modification and additional development after introduction of the system. The key role is to upgrade versions of the system in order to incorporate changes in needs of local citizens and society, and innovation of the system for monetization in a long-term viewpoint.

In Japan mainly in the ICT industry, U.S. PMBOK (Project Management Body of Knowledge) is widely spread. PMBOK is suitable for projects mainly developing systems on contracts but the Smart Grid project to cover the full range of concepts, construction and service of local infrastructure. P2M is better suited to such a project.

3.2 Horizontal Cooperation Platform in P2M
P2M positions Platform Management as an important function. The platform is defined as a shared infrastructure for the project members, which is important means of promoting human exchanges to lead to collaborative enhancement of knowledge production capability. Here the Horizontal Cooperation Platform which we propose application to the Smart Grid project is a community where stakeholders of the project such as local governments, industries, academic organizations and local citizens share the purpose based on clear vision,
cooperate each other as partners and work together at their individual strengths in specialized technologies and knowledge.

Horizontal Cooperation Platform is a base for communication and consensus making in the Smart Grid project. In projects as the Smart Grid project where stakeholders from cross-industries and various sources participate in, purpose of the project, roles and responsibilities of each stakeholder, each project tasks and subjects easily get unclear. Horizontal Cooperation Platform enables such stakeholders to cooperate each as partners by common language, codes, scales and interpretation when visualizing the unclearness mentioned. And this platform can be applied to integrate each project results. [Fig. 3]

As tools for realizing the concept of Horizontal Cooperation Platform, Logic Model [14] and Balanced Scorecard [15] are used. Previous studies where the Logic Model and Balanced Scorecard are applied in P2M include community development [16], research and development [17] and intellectual property management [18]. Also there is another study which we applied the Logic Model and Balanced Scorecard into the ICT project [13]. Here we examine application of the tools to Smart Grid project which has few studies yet in P2M. Logic Model is such a suitable tool that stakeholders of the Smart Grid project can know a whole image of the project. Balanced scorecard is to be prepared as a tool to describe target and action plan for individual projects broken down from the major project, which enables the stakeholders of each project can review other projects. Advantage of the two tools is that the total project overview can be reviewed on one piece of paper. It make the project management in total optimization viewpoint possible by encouraging communication among the individual projects across the entire smart Grid project not to fail in specific optimization of each individual project. [Fig.4]
Fig.4 Relationship P2M, Logic Model & Balanced Scorecard

(1) Consensus making by Logic Model

Logic Model is a method to determine an action plan of a project from outcomes. It describes an effective procedure for the project for logically leading an action plan to the goal with the existing resources available.

<table>
<thead>
<tr>
<th>Resources</th>
<th>Activities</th>
<th>Outputs</th>
<th>Outcomes</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local government</td>
<td>Project management of the entire optimum focus on the relationship within the consortium.</td>
<td>The energy-saving and energy creation achieved by the use of ICT.</td>
<td>Improved convenience of local residents.</td>
<td>[After 1-3 years] Integration with other social infrastructure.</td>
</tr>
<tr>
<td>Large company</td>
<td>Clarification of roles and responsibilities in the consortium.</td>
<td>The social trust by the system failure zero.</td>
<td></td>
<td>Expand introduction results to other regions.</td>
</tr>
<tr>
<td>Vencore company</td>
<td>Matching and technology needs of local Consultation with various stakeholders</td>
<td></td>
<td></td>
<td>[After 4-6 years] Expansion of Smart Community in collaboration with other regions.</td>
</tr>
<tr>
<td>Local company</td>
<td>Risk management and quality in accordance with the degree of difficulty of the complex function</td>
<td></td>
<td></td>
<td>Long tail of the smart grid business.</td>
</tr>
<tr>
<td>Research Institute</td>
<td></td>
<td></td>
<td></td>
<td>Establishment of a consortium standard.</td>
</tr>
<tr>
<td>University</td>
<td></td>
<td></td>
<td></td>
<td>Standard model of Smart Grid.</td>
</tr>
<tr>
<td>Consultant(Management)</td>
<td></td>
<td></td>
<td></td>
<td>Global reputation as an environmental city.</td>
</tr>
<tr>
<td>Consultant(Pre-Technology)</td>
<td></td>
<td></td>
<td></td>
<td>World standard from Japan.</td>
</tr>
<tr>
<td>Local citizens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig.5 Example of Logic Model (For the Smart Grid Project)

For applying the model to the Smart Grid project, based on the effects obtainable by utilizing “Strategies” and “Assumptions” of the Smart Grid to be established in the area, and the effects obtainable by utilizing the current internal and external environment as “Resources”, describe the image of the area after 10 years as “Impact”. Road map of the Smart Grid project should be described in this manner. First, assume middle-long term “Outcomes”
which the area should target such effects, then assume the Project short-term "Output" targeting the middle-long term outcomes and then determine "Activities" to obtain the output. [Fig.5]

Projects based on contract agreement mainly concern Resources, Activities, Output. The Smart Grid projects, however, cannot build user-friendly systems unless the projects are planned based on the total concepts including "Strategies", Assumptions, Outcomes and Impacts. Logic Model is an effective tool to make the whole image of the Smart Grid project clear and to share it among the stakeholders concerned.

(2) Target sharing using Balanced Scorecard

Logic Model is an effective tool to simply describe the whole image of a project. It, however, does not describe detailed action plans. In order to describe the action plans for individual projects broken down from the whole image of the Smart Grid project, Balanced Scorecard should be used.

<table>
<thead>
<tr>
<th>Strategic Map</th>
<th>Strategic Goal</th>
<th>CSF</th>
<th>Measure</th>
<th>Action Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Finance</strong></td>
<td></td>
<td>Energy-saving &amp; creation effect</td>
<td>CO₂ reduction</td>
<td>Set the validation phase of the feasibility CO₂ reduction, power generation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved convenience of local</td>
<td>Power self-sufficiency rate</td>
<td>amount, revenue from electricity sales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>residents</td>
<td>Electricity sales</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost reduction through electricity sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Customer</strong></td>
<td></td>
<td>Cooperation vendors &amp; users</td>
<td>Residents satisfaction</td>
<td>Create a grand design of the system in cooperation with local residents.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Satisfaction of local residents</td>
<td>System requirements</td>
<td>Quality assurance by performing full performance test and operational test of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reliability of the system</td>
<td>achievement rate</td>
<td>the system.</td>
</tr>
<tr>
<td><strong>Internal Business Process</strong></td>
<td></td>
<td>Establishment of a management</td>
<td>Problem solving</td>
<td>Consortium leaders understood the progress and challenges of each player.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>process</td>
<td>(Number)</td>
<td>Challenge early resolution to participate the experts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Realization of high quality</td>
<td>Quality reference</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elimination of risk</td>
<td>values achievement rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collaboration of stakeholders</td>
<td>Risk extraction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Number)</td>
<td></td>
</tr>
<tr>
<td><strong>Learning and Growth</strong></td>
<td></td>
<td>Integration of diverse view</td>
<td>Concern with various stakeholders</td>
<td>Focus on user interaction in the concept phase.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cooperation of a variety of</td>
<td>Information sharing by use of ICT</td>
<td>Clarification of roles and responsibilities of each player in the project.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>techniques</td>
<td></td>
<td>Making mechanism of information sharing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interface standardization</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>transparency of information</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig.6 Example of Balanced Scorecard (For Management Company of the Smart Grid Project)

Balanced Scorecard determines “Strategic Objectives” and “CSF(Critical Success Factor)” based on four aspects including “Finance”, “Customer”, “Internal Business Process” and “Learning and Growth”, then those determines “Measures”, and then individual action plans to achieve the targets. Example of a management company of a Smart Grid project is shown in Fig.6.

In the Smart Grid projects, Balanced Scorecard is effective as a tool to visualize targets of
individual project and corresponding action plans so that stakeholders concerned can share them to confirm consistency between the whole image of the Smart Grid project and the individual projects and between each of the individual projects.

4. Case Studies
In this chapter, we examine effectiveness of applying Horizontal Cooperation Platform to the Smart Grid projects by case studies. Since Smart Grid is globally still under operation experiments, there are a few cases only. We here support the effectiveness picking up an overseas case.

4.1 Summary of the Case
We pick up SmartGridCity in Boulder, Colorado, U.S. as a case of a Smart Grid project. This project started in March, 2008 as establishment of a Smart Grid project on the whole city scale as the first attempt in the world. The budget of the project summed up to about hundred million dollars. The project was on the consortium system where many cross-industrial companies including Accenture participate, administered by Xcel Energy, the 15th biggest electricity company in U.S [19][20][21]. Though the project received remarkable attentions from the world because it was one of the earliest attempts as an operation experiment of Smart Grid, the project failed due to the issues such as significant budget overruns.

At the time of the project started, necessary investment estimated 15.3 million dollars but some other unexpected costs incurred. For example, there incurred costs not estimated in installation of optical fibers under the ground and also other issues swelled establishment costs. The project budget was corrected to 17.9 million dollars in 2009 and then to 44.8 million dollars in 2010.

In order to cope with the additional costs incurred, Xcel Energy applied for rise of electricity cost by 6.5% against PUC (Public Utilities Commission). PUC, however, pointed out the companies participating in the consortium were to share the total cost of hundred million dollars at the time of the project start-up but the reality was burden of expense to be shared among the companies were not clear and then required to make the cost sharing clear and estimation of the proper costs which citizens needed to bear before the electricity cost rise. In order to satisfy the requirements, Xcel Energy was to submit CPCN (Certificate of Public Convenience and Necessity) to prove what the business investment would be profitable for the users concerned [22][23]. Since then the project has been developed to the lawsuit against the electricity cost rise to be unreasonable doubtfully to compensate the costs for the Smart Grid project by Xcel Energy [24].
4.2 Consideration
We analyze the reason of the abortion of the project and examine effectiveness of the application of Horizontal Cooperation Platform to the Smart Grid project by evaluating the effectiveness of the platform as means of avoiding the abortion. We get subjects in the project straight as below.

(1) Planning of appropriate initial plan
At first, each stakeholder did not perform cost and benefit analysis before the project started. Xcel Energy did not submit CPCN to be prepared normally before decision of the investment required for building facility as power plants [22][23]. Xcel Energy determined they would not need the CPCN because the project was just for research. In case the document had been submitted, PUC had been able to check the project action plan in advance and it is highly possible the project was able to avoid the significant over budget of the project.

(2) Information sharing and consensus making among the stakeholders.
Secondary, cooperation of Xcel Energy and important stakeholders such as the local government and the citizens were not sufficient. Boulder City examined the cause of the failure included the wrong consensus making process in decision making and that Xcel Energy promoted the project without consulting with such important stakeholders [24]. The important requirement for success of the Smart Grid project is to give clear explanations to the stakeholders and continuously make consensus with them.

(3) Project management system integrating cross-industrial association
Thirdly, the failure case of the smart Grid project shows high communication capability, which cannot be solved by the electric company’s know-how, is required there. We need a system to manage the entire project by integrating the know-hows of the individuals.

The first subject shows we can avoid critical mistakes impacting the progress of the project by knowing the whole image at the initial stage of the project. The second subject also shows information cooperation and consensus making process become easier by giving the whole image of the project for the stakeholders. Those subjects can be managed by visualization of the whole image of the project by Logic Model used in Horizontal Cooperation Platform. For the third subject, the project can be more successful by making the entire project plan clear and promoting the project while confirming the consistency with individual action plans drawn up by each participants. That is, consistency between the entire project and the...
individual projects can be confirmed by making Balanced Scorecards of the individual projects broken down from the Logic Model.

In order to solve the subjects of the Smart Grid projects made clear in the case study, we assume application of Horizontal Cooperation Platform is effective. However, it is necessary to continuously examine other cases to confirm the application as the best approach. We continue examination as our future subjects.

5. Conclusion
Operation experiments of Smart Grids are being performed both domestically and internationally. And in a parallel way, technology specifications and interfaces are standardized and it is anticipated the business market will be rapidly growing in future. Domestically the experiments are being currently performed in the combination of major local community and big corporations and in a practical use phase, combination of small and minor local communities and tiny companies are expected, and it is anticipated a grand design of urban development bringing in views of “local production for local consumption”, local business development and local revitalization will become more multifaceted. Establishment of the project management systems accommodating these situations is an important proposal concerning entire progress of energy issues and environmental business, and the study result will contribute to establishment of a new social infrastructure.

References
[5] METI; “Welcome to Smart Community” (Smart Community he youkoso), METI Journal October/November 2011
[7] Nomura Research Institute; “Trends in Smart City in Japan and Overseas” (Kokunaigai ni okeru Smart City no doukou), Knowledge Creation Integration May, 2011 p6-p19, 2011
[8] The Japan Research Institute; “Challenges and Future Efforts to Realize Smart City” (Smart City Jitugen ni muketa torikumi to kongo no kadai), Research Focus, April 30, 2013,


