Possibilities for Commercialization of Business Models for Diffusion of Smart Homes--Can We Create a Business Environment that Promotes Behavior Change?

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ABSTRACT

Various programs have been developed to promote energy savings via behavior change, including feedback, demand response and smart home development. Business models for expansion of services offered in smart homes are needed, and have not received sufficient consideration. Business models need to be formulated, costs and revenues of expanding services investigated, and economic viability verified. In this paper, we investigate services that can be offered to promote behavior change, and the economic viability of the systems needed. We report on possibilities for implementation of business models for providing services.

We utilized communication and measurement instrumentation in smart homes and analyzed service models, both related and unrelated to energy efficiency: feedback, demand response, watching over elderly families, home security, healthcare, and data analysis services to third parties. We investigated configurations of systems for providing services and estimated investment and maintenance costs. We also surveyed consumers about their intentions of using such services and amounts they are willing to pay, and estimated revenue to be gained from providing these services. In all, we investigated 14 business models, calculating simple payback periods when smart homes diffuse to one million and ten million households.

Based on the results, while single services, such as feedback, are not economically viable, we confirm that compound services can be provided economically. Finally, we consider differences in the business environments of Japan and the US, and discuss strengthening of collaboration between players and policy changes necessary in order to spread smart homes in Japan.

Introduction

Full-scale installation of smart meters has begun by Kansai Electric Power Company (KEPCO), and the other electric utilities plan to begin this year or next year. Smart meter installation is expected to be complete by 2023 or later. Accordingly, with the installation of smart meters over the next ten years, we expect that feedback and demand-response services will spread (METI 2011).

Smart home is a dwelling incorporating a communications network that connects the key home appliances and services, and allows them to be remotely controlled, monitored or accessed. For example a smart home may control lighting, temperature, multi-media, security, window and door operations, as well as many other functions. Development of smart homes in Japan has focused mainly on emerging technologies. Besides carrying out some pilot projects funded by the government, housing manufacturers and others are implementing such programs on a trial basis as part of their client services. The spread of smart homes is expected, together with the societal merit of improved energy efficiency, to provide opportunities for various businesses.

But business models to further the spread of smart homes are not ready. Reasons for this are as follows. (i) The spread of smart homes requires large investments in infrastructure and in the systems inside the house, but it is difficult for individual businesses to bear such costs. (ii) Because the charges paid by those subscribing to feedback services are small, recovery of investment is difficult. (iii) There is no system in place to cover the investment costs to implement feedback and the decreased revenue due to energy efficiency, because in Japan there are no energy efficiency standards for electric utility companies, such as an Energy Efficiency Resource Standard or an Energy Company Obligation. Accordingly, while many businesses look forward to the spread of smart homes, they also expect that communication network infrastructure will be provided. For example, housing manufacturers expect that improvements in client services and advances in housing performance will be linked to increases in added value of their products. Appliance manufacturers expect awakening of demand for smart appliances used in smart homes. And consultants expect new opportunities to offer information and services.

There are many impediments, as mentioned above, to individual businesses developing smart home business models. To remove these barriers, various issues related to areas such as technology development, government support, and institutional planning to streamline information systems, must be solved (JIPDEC 2010). But first, the possibility of commercialization for the system as a whole must be investigated. In this paper, in order to investigate the possibility of commercialization related to smart homes including (i) services related to smart homes, (ii) systems needed in order to offer these services, and (iii) system investment and running costs. We then estimate (iv) the revenue from services offered, and (v) simple payback periods for each service. Our study assumed that smart homes have spread to 1 million or 10 million households in 2020 (Figure 1).

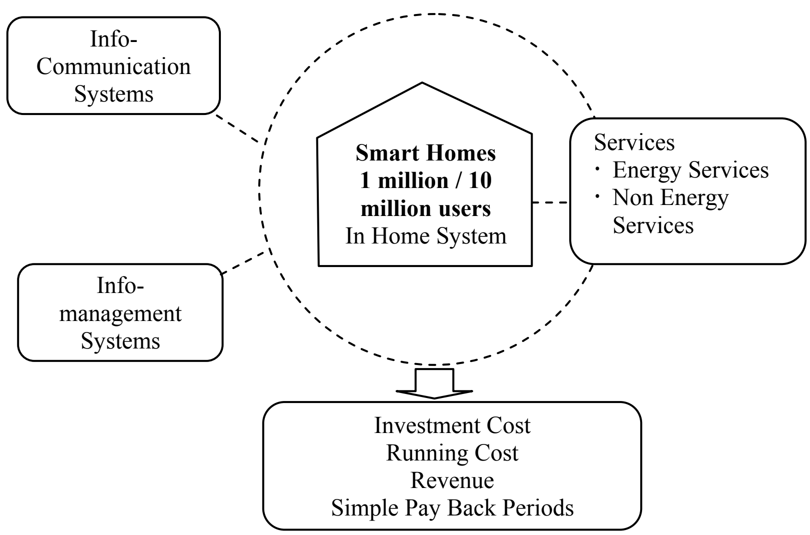

Figure 1. Diagram of survey.

Smart Home Systems

Figure 2 shows a conceptual diagram of smart home systems for collecting data and offering services. The system is divided into a data collection and control-related part and a data reference-related part.

Data Collection and Control System

The data collection and control system is composed of the following four elements.

In-home system. The smart meter and home gateway plus controller, are used to interface with the outside. Information from the smart meter is sent to the home gateway[1] plus controller.

Energy consumption inside the house is transmitted via the home network from the smart meter, as well as the power distribution board, electricity sensors installed at outlets, and smart appliances. Data for modes of use for appliances and water heaters is transmitted via the same route. In-home display and PC are also connected to the home network. The HEMS is not clearly shown, but it is composed of the home gateway plus controller, in-home display, electricity usage sensors, etc. The in-home display could use a special terminal, but it is possible to instead use an alternative, such as a tablet PC or a smart phone.

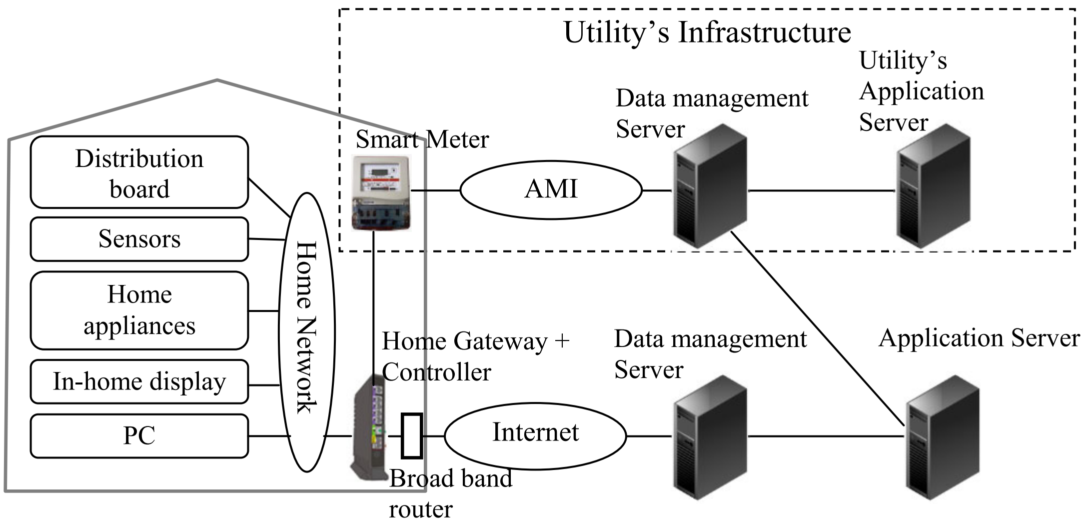

Figure 2. Diagram of system configuration of smart home and the network.

[1] Home gateway is a communication device which allows the connection of a local area network to wide area network.

Communications equipment. This is a network that connects the house internal apparatus and sensor system. It includes the Advanced Metering Infrastructure (AMI) built by utilities, for use by the smart meter, as well as internet connections installed by the customer and service businesses.

Data management server. This performs data collection, delivery, and control. It consists of an information processing server and a data management server, and has functions to allow various services to be offered.

Application server. This server is used to implement various types of services, such as feedback, failure diagnosis, and protection.

Data reference system

The data reference system is for viewing data from within the house. Of the above mentioned data collection and control systems, it consists of the smart meter, home gateway plus controller and in-home display or PC. However, if the services implemented only use information from the smart meter, a service business data management server is unnecessary.

Services Offered

In the future a wide range of services targeting smart homes can be expected. One could even say that any household service will be possible. But, by including estimates of investment costs, and assuming the use of systems that are currently at the stage of becoming widely used, for this study of commercial feasibility, we find that energy efficiency services and home care services are the main focus. We have categorized the former as "energy services" and the later as "non energy services," as in the following overview.

- Energy services
  - Feedback service about energy consumption information
  - Demand response service
  - Services related to appliance maintenance
- Non-energy services
  - Watching over elderly family member services
  - Home security services
  - Health care services
  - Services providing data to third parties for use in market research

Energy Services

Energy services focus mainly on those intended for energy efficiency and peak cutting. For cases where data such as appliance operating conditions are collected, failure diagnosis is possible. It is possible to perform simple energy efficiency diagnostics from energy consumption data, but to perform a full-fledged energy audit a rater needs to visit the residents, so we do not envision that here. Energy efficiency advice, such as changes to temperature settings may be done via feedback.

Feedback service. Conventional energy consumption feedback (so-called "visualization") services include utilities showing previous year consumption for the each on the utility bill, or making it possible to view data for the past one to two years on their websites. But customer awareness of these services is low. The services enabled by the spread of smart meters and HEMS are not limited to viewing of data by time of use and by appliance in real time, and being able to see your history of household energy use. Other services envisioned include feedback to compare your results with those of similar households, energy efficiency diagnostic services that include replacement of appliances, and by accounting for the environmental value of energy efficiency services by obtaining J-Credit[2] (Ehrharbt Martinez et al 2010 and EPRI 2010).

In this paper we assume that feedback is offered to all customers, while the other services are optional add-ons. We refer to feedback based solely on data from a smart meter as "feedback service" and we refer to energy use data that can be obtained by appliance as "per-appliance data usage". In this case, in addition to enabling appliance maintenance services, addressed below, it is also possible to process and offer detailed energy usage data to third parties as market research results.

Demand response service. In Japan, demand response service for residential use has advanced to demonstration projects by utility companies and municipalities like Kitakyushu. There are many successful cases in which the midday electricity unit price is decided the previous day, based on the day's forecast high temperature, and publicized, using Critical Peak Pricing (CPP). Demand response includes both incentive-based programs and time-based programs, but due to the high equipment installation costs of direct load control programs, we envision time-based programs.

In this paper, we consider peak time rebates, real-time pricing, and CPP with control. Because utilities implement demand response in order to decrease their peak loads, besides estimating the needed investment costs, we assume that service providers will receive income via utilities. We also think that in order to carry out these services, a service offering price forecasting based on the customer's past electricity usage history will be offered, but we do not account for this kind of cost to the utility.

Services related to appliance maintenance. These are for cases with per-appliance data usage. Even now, when an AC or water heater breaks it is possible to analyze the causes of failure from data stored in the appliance. If technology for advance prediction of appliance failure could be established, then not only could the drawbacks of appliance failure be avoided, but replacement with higher efficiency appliances could be considered or proposed by the service provider. It may be difficult to predict appliance failure only using energy consumption data, but there could be a service to flag increased energy use from a certain point. Changes seen from normal energy usage patterns could indicate appliance failure, and urgent inspection could be recommended. It is important for manufacturers and retailers worried about coping with recalls to insure product traceability. Because appliance attribute data is managed in smart homes, information about recalls and product incidents can be communicated to the user with certainty. In the future, solar electric generation, fuel cells, and storage batteries are expected to become widely used in

[2] The J-Credit Scheme is a new scheme under which the Government of Japan certifies as credits the amount of greenhouse gas emissions reduced through efforts to introduce energy saving devices and utilize renewable energy as well as the amount of such emissions removed through appropriate forest management. And entities are able to trade the credit.

housing. Services that, for example, verify that solar electric system output is normal, are expected to spread.

Non-Energy Services

The energy consumption and other data collected for energy services can be utilized for non-energy services. With the introduction of internet-connected sensors related to security and bio-monitoring apparatus, such as body temperature and blood pressure meters, an even wider range of services can be offered. From the perspective of the providers of such services, because they can use the servers and internet environment furnished with the energy and appliance-related services, cost-effectiveness of these services is expected to improve. It is also expected that information about energy usage and operating conditions of appliances can be processed and sold to third parties as market research data.

Watching over an elderly relative service. These are services by which families can watch over elderly relatives and others living in distant locations. Such services are already offered by home security businesses, utilities, and appliance makers. But at present, points of sensing are limited (for example, sensing only electricity use by an electric pot), so these services have not reached the stage of making definitive judgments. In a smart home, a more precise confirmation of healthy living can be made from the energy usage data collected by the smart meter and the HEMS. Also, the incremental installation costs of such services are low.

Home security services. Home security services are estimated to have spread to about 2% of households. Initial costs of several thousand dollars and monthly service charges of several tens of dollars have prevented widespread use. Security companies also offer optional services of guards responding to disturbances, but have plans without guards that keep service charges low. In smart homes, systems with sensors for detection of forced entry are needed, just as with conventional home security systems, but the frequency of dispatching guards can be reduced, or there can be simple services without response by guards. We consider the following cases. (1) For systems with only invasion detection sensors, there will be false positives and negatives. By offering smart home data to security companies these false signals can be reduced and the frequency of sending guards can also be decreased. For this case, we assume that invasion detection sensors have already been installed. (2) Invasion detection sensors are installed, but forced entry is foiled by burglar alarms, and at the same time, prevented by control of lighting and other appliances to simulate occupancy. This case does not include response by guards. (3) Full service includes installation of invasion sensors and response by guards.

Health care services. Health care related services include the forwarding of biometric information (weight, body fat percentage, etc.) for viewing by smart phone and PC. Some of these are free services and are already offered. Also, electronic medical records and prescription records are more prevalent and home pharmaceutical delivery services are expanding. In smart homes, basic services include feedback about benchmark health information by age and sex and simple health advice. Health care services can include rational management of electronic prescription drug, medical care and test records of clinical and nursing services, and comprehensive services such as remote clinic visits done from home.

Services providing market research data to third parties. We envision services providing market research data to third parties by analyzing the large amounts of data collected in smart homes. The failure diagnosis service and per-appliance energy consumption data mentioned above would meet the needs of appliance manufacturers and retailers. Safety confirmation services would not only be useful for families, but could also meet needs of local authorities and nursing service businesses. Health care service data could be useful for medical organizations, nursing service businesses, pharmaceutical companies, drug stores and others.

Service Model Configurations

Table 1 shows the various service models used to study the commercialization possibilities for smart homes. We assume that feedback service is provided with all models and that the targets for non-energy services are residents with contracts for energy services. Also, by bundling various services, there is the advantage of being able to use the internal house equipment for common purposes. We assume that at this time 10% of customers will participate in security services, but that once smart homes spread to 10 million households, 4% will participate in home security services.

Table 1. Service model configurations

Symbol	Service name	Income source
Energy service		
1A	Feedback (utility offers the service)	Customer
1B	Feedback (service business offers the service)	Utilities
1C	Demand response (Peak time rebate)	Utilities
1D	Demand response (Real-time pricing)	Utilities
1E	Demand response (Critical peak pricing with control)	Utilities
1F(1)	Appliance data usage (failure diagnosis)	Customer, Repair business
1F(2)	Appliance data usage (marketing information)	Customer, Third party
Non-energy service		
2A	Safety confirmation	Contracted party
2B	Home security (offering per-appliance data)	Security company
2C	Home security (Simple service: no response by guards)	Security company
2D	Home security (Full service: including response by guards)	Security company
2E(1)	Health care (Feedback and advice)	Contracted party
2E(2)	Health care (medical care and prescription support)	Contracted party
2E(3)	Health care (marketing information)	Contracted party, Third party

Note) All models are assumed to include feedback service.

Acceptability of Services

In order to understand customer's intentions regarding use of each kind of smart home service, as well as service fees and initial system installation costs that could be paid, we conducted an internet survey. Of respondents sample of 2,000, effective answers were received from 1,994 samples. Respondents were evenly distributed by gender and age, from their 20s to their 60s.

Intentions to Use Services

Respondents' intentions to use the various services are shown in Figure 3. For feedback, the mainstay energy service, about 50% said they would be very likely or a little likely to use it, indicating intention to participate. We asked about differences in the methods for viewing feedback and the information offered for the feedback services (1A) and (1B), but we did not see a major difference in intentions of use. Among the demand response services (1C), (1D), and (1E), (1C), peak-time rebate, was high at 60%, but 1E, critical peak pricing with control was rather low. About half, or 49%, intend to use appliance failure diagnosis service, (1F(1)).

Among non-energy services, watch over elderly family member, (2A), had 45% acceptance, or about the same intentions to use as energy services. Intentions to use security services and health care service were rather low. It seems that needs for security and health care vary with a household's circumstances, but we can see that there are great expectations of internet services, with simple security, (2C), at around 40% and health care at around 20% acceptance.

Acceptable Monthly Service Charge Amount

Table 2 shows the monthly service charges respondents said they would be willing to pay for each service. Fifty percent of people said they would pay nothing for feedback service, while just under 40% would pay nothing for security, and just over 20% nothing for health care. When these responses are included, the overall monthly service charge customers are willing to pay for energy services is less than one dollar. People were willing to pay more for security: $5.20 for simple security, (2C), and $10 for full security, (2D). People were willing to pay $2.30 for simple health care, (2E(1)), and $4 for health care with medical care, but at those rates it would be difficult to cover service costs.

On the other hand, if all the people who said they would pay nothing for a service are excluded, feedback services, (1A) and (1B), are valued at between $2.60 and $3.60, appliance failure diagnosis, (1F(1)), at $2.70, and watching over an elderly relative at $5, providing a certain income stream. Other non-energy services exceed energy services in value, with security services, (2C) and (2D), at $10 to $18 per month, and health care, (2E), at $7 to $11 per month.

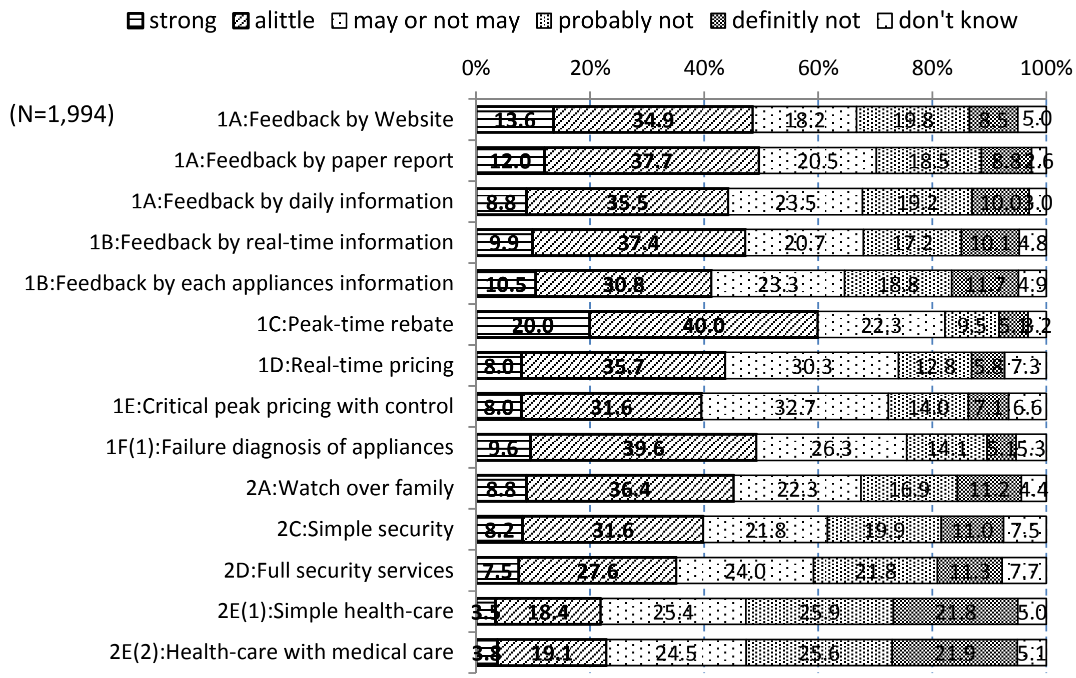

Figure 3. Intentions to use various services.Note: Throughout the figure, the numbers such as (1A) and (1B) refer to the same cases shown in Table 1.

Table 2. Monthly amount willing to pay for service (USD/month)

Service type	Overall		Limited to strongly and a little likely to use	
	Including "free"	Excluding "free"	Including "free"	Excluding "free"
1A: Paper report	$0.65	$2.75	$0.87	$2.83
1A: Daily information	$0.58	$2.56	$0.77	$2.45
1B: Real time information	$0.93	$3.60	$1.12	$3.38
1F(1): Appliance failure diagnosis	$0.75	$2.66	$0.96	$2.58
2A: Watch over elderly relative	$2.09	$4.99	$3.16	$5.09
2C: Simple security	$5.20	$9.96	$7.75	$10.52
2D: Full security services	$10.13	$18.16	$15.10	$19.53
2E(1): Simple health care	$2.27	$6.89	$4.55	$7.97
2E(2): Health care with medical care	$4.09	$10.74	$7.47	$11.55

Acceptable Costs for In-Home System Investment

Initial investments respondents said they would be willing to make to enable each service are shown in Table 3. When we consider only people who are interested in using the services, and exclude people who just want free service, we see that people are willing to pay $18 for the feedback system, and $12 for in-home display, very low amounts. For non-energy services, people are willing to pay $650 for a security system and $61 for health care devices. These are also small amounts, considering current cost levels.

Table 3. Acceptable costs for in-home system investment (USD)

System or component	Overall		Limited to strongly and a little likely to use	
	Including those that answered "free"	Excluding those that answered "free"	Including those that answered "free"	Excluding those that answered "free"
Feedback system	$4.06	$17.31	$5.53	$18.21
Measurement devices for appliances	$1.37	$6.25	$1.77	$5.80
In-home display	$2.36	$10.93	$3.26	$12.30
Security system	$380.91	$592.48	$528.46	$651.27
Health care devices	$27.97	$51.48	$47.81	$61.27

Estimates of System Cost and Simple Payback Period

Table 4 shows the categories to be considered for cost estimates.

Table 4. Categories for cost estimates

Expense category classification		Equipment system or business expense
Equipment investment cost	In-home system	Smart meter, home gateway + controller, in-home display, PC, sensors, security system, bio-monitoring apparatus
	Business system	Communications management server, data management server, communications equipment, visualization server, server for demand response, advertising server, server for watching over family, printer
Running costs	Personnel/Labor costs	Salespeople, call center, back-office
	Marketing & publicity	Sales promotion to customers, PR activates
	Communications	Postage
	Subcontracting costs	Use of external data, security service, medical service

We calculate both the equipment investment costs of the smart home system and the running costs. We expect the spread of smart homes to accelerate so we estimated the costs for mass production. For the central system, the main costs are the investment costs of servers and communications equipment, but because the server cost is proportional to the quantity of data it handles, even for the case of 10 million users, we do not expect economies of scale. Results of the initial equipment investment costs estimates are shown in Table 5. Indeed, costs for the 1 million and 10 million smart home cases differ by essentially a factor of 10, with the cost per smart home staying roughly constant. This scalability is also reflected in the SPP, since both costs and revenue are largely proportional to the size of the customer base.

Table 5. Results of initial equipment investment cost estimates

Equipment type and purpose		Cost: 1 million user case	Cost: 10 million user case	Payer
Central server, Communication equipment	1A, 1B: Feedback	$11.3 million	$113 million	Utilities or service business
	1C, 1D: Demand response	$12.2 million	$122 million	Service business
	1E: Demand response	$13.1 million	$131 million	Service business
	1F, 2A, 2B, 2E: Failure diagnosis, watching over family, health care	$1.1 million	$11 million	Service business
	2C, 2D: Security	$2.2 million	$22 million	Service business
Application server	Visualization server	$2 million	$20 million	Service business
	Demand response server	$0.1 million	$1 million	Service business
	Advertising system	$1 million	$10 million	Service business
	server for watching over family	$10 million	$100 million	Service business
In-home equipment	Smart meter	$100/unit (METI 2012)		Utilities
	Home Gateway + Controller	$300/unit		Service business
	In-home display	$100/unit		Service business
	Appliance energy use sensors	$200/set		Service business
	Sensors for watching over family	$200/set		Service business
	Security system	$2,000/set		Service business
	Simple health-care	$50/set		Service business
	Health-care with medical care	$200/set		Service business
	PC	$500/unit		Users
Network	Internet	$40/month		Users

System operation and maintenance costs were calculated assuming that replacement of worn out equipment would cost 0.5% of the in-home equipment, and 3% of the server investment costs annually (by empirical value of Hitachi, Ltd). In addition, personnel costs, communication costs, and subcontracting costs were estimated. Revenue was estimated based on the amounts customers were willing to pay for services (Table 2: Revenue = Cost willing to pay * Number of customers), and revenue from sales of data to third parties was set based on market research industry revenues (JMRA 2013). Demand response revenues were calculated based on unit cost for electric generation considering the peak cut effect. Operation and maintenance costs are subtracted from these annual revenues, to yield annual profit. The initial investment amount is then divided by annual profit to yield simple payback period (SPP).

Because smart meters are the utilities' responsibility, they are only included in the equipment investment costs for the case of (1A) in Figure 4. Because components inside the home, such as the in-home display and electricity usage sensors except security system, and the servers provided by the service business are all included in the initial investment cost estimate, we calculated the SPP for investment and profits for both the customer and the service business. In reality, there are cases where the customer does bear the initial investment costs, but to simplify the calculation we used the case in which the service providers bears all those costs. However, we assumed that the customer would cover both initial investment and running costs for PC and internet service.

Furthermore, all households participate in feedback service, but we assumed that 10% of these customers participate in other services. But when smart homes spread to 10 million households, 4% (by diffusion rate of home security services) of these households are assumed to participate in security services.

Currently, initial equipment investment is needed for the in-home display and for devices that measure appliance electricity use. In the future, the in-home display could be replaced by a tablet PC, and the need to install appliance electricity usage sensors could be eliminated by the spread of smart appliances. We calculated results for two cases: (1) basic case, in which in-home display and appliance electricity usage monitoring devices need to be installed, and (2) low cost case, in which, in the future, in-home display and appliance electricity usage monitoring devices need not be installed.

Results for investment costs, annual running costs, annual revenue, and SPP for the 10 million household case are shown in Figure 4.

For feedback done only by the utility, (1A), the $5.1 billion investment costs are nearly all for in-home equipment. For feedback done by a service provider, (1B), investment costs for in-home equipment are reduced by smart meter costs, which are borne by the utility, so the investment costs come to $4.1 billion. The following cases are those for which failure diagnosis, security, health care, and other services are added to case (1B). For all of them, in-home investment costs of about $6 billion are needed, with total investment costs amounting to $6.1 to $6.3 billion. In-home costs for security systems for the full security service vary from $2000 to $4000. However, because the full security service includes on-site response by guards, we assumed here that the service business would cooperate with an existing security business, that in-house security equipment has already been installed, and that the additional equipment needed, such as electricity use sensors, would be included in the investment costs. We also assumed that the service business would manage information, and would request the on-site response by guards from the security company, when needed. At the same time, the security company would receive the security service charge. Accordingly, even for the full security service case, note that we consider the in-home equipment investment costs to be identical to the simple security service case. Comparing with the simple security service case, the service business running costs increase, but the revenue also increases. The $136 to $146 million cost of servers provided by service businesses is minor when compared to the in-home investment cost, hardly impacting the overall investment costs. However, the annual running costs are all incurred by the service business, starting at a small $48 million for (1A), but rising to between $223 and $254 million for other services. On the other hand, annual revenue exceeds running costs for all cases, so if expenses needed to recover equipment investments are excluded, all services should be profitable. SPP for equipment investment cost recovery exceed 10 years for feedback and demand response services when done alone, but by combining these with other services the SPP shortens. In particular, for the low cost case they are less than 5 years. The reason for the shorter SPP is the provision of data analyses from failure diagnosis, watching over elderly, full security and simple health care services to third parties, with basic case SPP of 5.5 years and low cost case SPP of 2.8 years.

For smart homes to spread, combinations of viable services need to be offered. Offering only whole-house energy consumption data from a smart meter is a limited service without profitable prospects. In contrast, by measuring appliance energy usage, services for appliance failure diagnosis and for watching over an elderly relative become possible. By offering these and other non-energy services (for example, security and health care) appropriately, commercial viability can be improved.

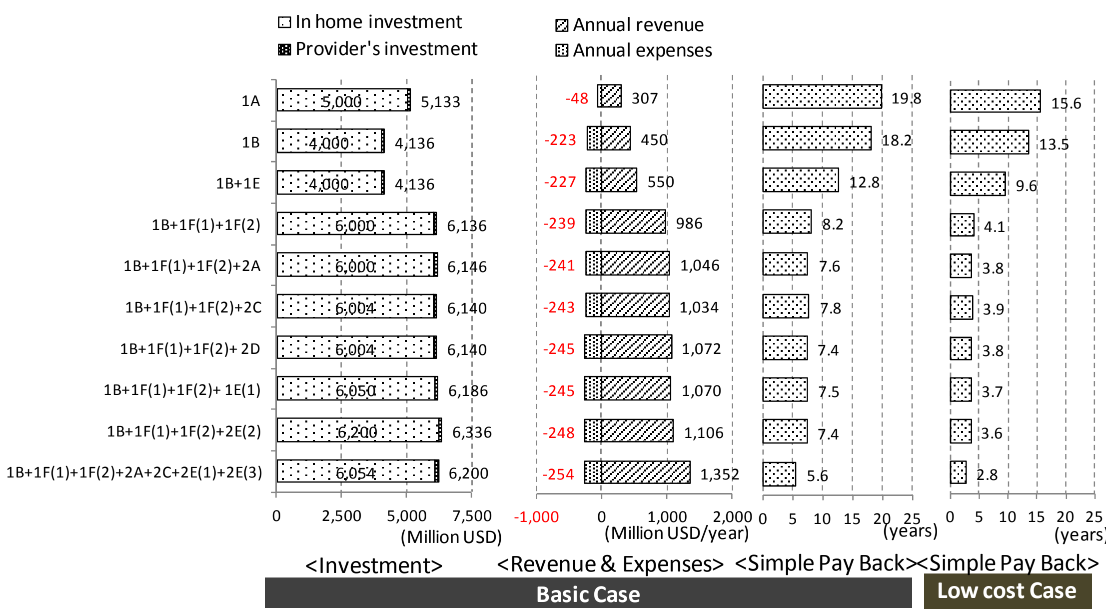

Figure 4. Equipment investment, annual expenses, annual revenue, SPP (in years), for the 10 million household case.

Note: 1A: Feedback (utility offers service)/ 1B: Feedback (provider offers service)/ 1E: Critical peak pricing with control /1F(1): Failure diagnosis of appliances /1F(2): Marketing information / 2A: Watch over family / 2C: Simple security / 2D: Full security / 2E(1): Simple health care / 2E(2): Health care with medical care / 2E(3):Simple health care with market information

Conclusion

It is effective to provide services such as feedback and demand response in order to encourage behavior change, but for utilities to do so, they must install communication equipment like the home gateway, and sensors. If utilities bear all of these costs then they would be saddled with payback periods longer than 10 years while experiencing decreased revenue due to energy efficiency. There is concern that this would worsen the business fundamentals of utilities. Because there is no system for recovering debt obligations by imposing surcharges on energy, the economic foundation for providing feedback service has not been established. However, once smart homes have widely diffused, by offering various services other than feedback, in-home equipment can be shared and revenue can increase, thereby improving profitability.

In this research we investigated services that become possible with the spread of smart homes, estimated the equipment and systems needed, and calculated initial investment costs, running costs, and revenue. We conducted a survey to find out how customers would accept these services, and what they would be willing to pay for them. In order to provide a wide range of services, in-home equipment including electricity usage sensors, crime prevention sensors, and bio-monitoring sensors for use in health care, are all needed, as is communications infrastructure, such as an internet connection and a PC. Further, the service provider furnishes equipment, such as servers, and also covers operating costs, including personnel, management, and communications costs. The great bulk of equipment investment cost is to furnish in-home equipment, and is estimated at between $400 and $600 per household. Among these, the PC or in-home display could be replaced by a tablet PC, thus decreasing costs, or further, the PC could be considered as an essential item for the family and purchased by the customer. Also, if electricity usage sensors are included in electrical appliances, costs to offer services can be reduced. These assumptions underlie the estimate for the low cost case, in which the cost to furnish in-home equipment is estimated at between $300 and $400 per household, a reduction of $100 to $200 per household. But even for the low cost case, if only feedback is provided, the SPP exceeds 10 years, which is not economically advantageous. But when other services, such as appliance failure diagnosis, watching over an elderly relative, security, and health care, are also offered, the SPP falls to below 5 years, and when, in addition to those services being provided the data collected can be analyzed and market research results sold to third parties, it is possible to shrink the SPP to 2.8 years, confirming economic viability.

To spread energy services such as feedback and encourage behavior change, it would be effective to strengthen energy efficiency regulations and introduce Energy Efficiency Resource Standard (EERS), which have been implemented in the USA. However, in Japan at present, regulatory reform to liberalize electricity and gas is being considered, and the likelihood of implementing regulations such as EERS is low. But even in these circumstances, it is possible to develop economically viable business through improving services. Next steps are to decrease costs for in-home equipment investment, to secure a replacement for the certain decrease in utility revenues, and to collaborate with other business types to establish business models. Through government and service providers investigating business modes, it is possible to encourage the spread of smart homes and make behavior change a part of one's lifestyle.

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