Verification Process of the Investment Option of Common Goods and the Social Suitability by a New City Management (Medi-Square) Model Based on Next-Generation Technology

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① Social agreement and technology selection by a new urban management model.
② Creation of a mechanism of re-investment in public area and service in the city, leading to substitution of administrative functions and incorporation of a multi-agency system into the public service sector.
③ Verification of the suitability of next-generation technology to social needs and the economic benefit.

1. Introduction

The infrastructural systems supporting various urban functions can be classified into two parts: tangible and intangible systems. The tangible system refers to networks consisting of railroad, road, communications, energy supply, waterworks, sewer, and others. The intangible system is defined as a control/management system, by which the tangible networks are steadily operated to meet a variety of highly specified demands such as environmental standard and better services for human care. Thus, the intangible system involves hybridization and sophisticated operation of high technologies, corresponding to the brain or intellectual property of a city.

Although emphasis was placed on the tangible network system in the 20th century, an alternative system that seems to become more effective for multiple management of complex social needs, as generated in the urban areas in the 21st century.

In particular, specification of the public demands should increase to higher level, as the environmental standards for air and water pollutions in the urban areas become more severe, according to recently increased needs for dealing with global warming. Moreover, in the countries typically like Japan that is currently facing an issue of unprecedented aging society; a new investment mechanism needs to be constructed that conforms to increasing demands for services of medical treatment and social welfare. However, unreasonably high dependence on the centralization system of administrative power apt to cause sometimes traffic congestion of the services on the public site because of short supply. Substituting for the conventional administrative framework, a multi-agency system providing integrated services and a new decision-making system responsible for investment are required for solving such a problem. In these alternative systems, the decision-making based on higher social needs, but not the usual

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administration and the reservation of technological specialty should be imposed.

The Medi-Square conception (abbreviated hereafter as MEDI) proposed herein is one of the urban management models, involving a mechanism by which a "social welfare" level can be elevated by understanding of the service demands growing potentially in the urban areas with a given specification of service. The term “Medi- “ implies the media that integrate a variety of agencies and sectors into a public body.

In this model, various services offered in the urban areas are characterized by a cell method, intelligence derived from whole public stream and terminal residents is linked and thereby integrated to understand the social demands, and then information is delivered to the residents. The MEDI is therefore a public structure that converts various urban needs into a highly public property and that multiplies integrated services, contributing to an investment process.

The investigation of investment size, is indispensable to the response effects of varying the total cost of provision of public good on willingness to pay (WTP) of crossed treatments: an informational treatment that varies the total cost of providing the public good to identify the absence or presence of possible *fair share* effects.

Developing a system or a program that can perform easily this integration work, we can establish a system of evaluating the next-generation technologies. In relation to this process, the experimental data of evaluating the technological specifications and the degree of impact on the environment and the human life is indispensable to design new city model that is responsible for the social needs. In order to utilize the new technology of environment and human care, the city space along with a certain degree of social agreement is useful for a joint experimental work with users. This process helps to verify economical and social valuation of technology. The process focuses on the making of agreement with time series, which will follow a certain algorithm. The procedure is explained below.

2. Setup of the Objective Function of Social Agreement-Making

A MEDI focuses on the reuse of existing common property of hard structures of cities. The public buildings that correspond to the environmental system or to medical care have been regarded as a closing system with space limitation in the conventional administrative system. This manner of thought is converted into an open social system, including a network of the flow of service and information.

The existing public services will be developed in two directions: an environmental system and a medical system. An environmental system includes an energy supply system, a waste disposal plant, and a water-and-sewage network. On the other hand, a medical system includes the type of open hospital that is characterized by remote inspection, a diagnostic system, and ground in the vicinity of the hospital. A city management company (special-purpose company; MEDI/SPC) grasps these information flows synthetically and acts as *aggregator*, which aggregates various public needs and is concerned with social agreement and collateralizing public responsibility.

In this system, the role of the user at a terminal is very significant. The user participates in the process of stratifying services composed by the MEDI/SPC and simultaneously functions as an evaluator and an investor, enjoying the sense of security and safety generated in that space.

MEDI/SPC guides a common service level in the higher direction based on measurement data, such as life cycle prediction of a structure and a rate of curtailment of greenhouse gas. It shapes the relations between a counter-value of common services and a user burden, charges it to service purchasers, and collects money from them.

The relation between this company and a user could lead to the development of an infrastructure of a next-generation city that can respond to fundamental needs with cheaper costs realized by the effects of spatial accumulation. This system is one of consensus agreement embodied in city space.

The "next-generation city management model" was developed to include the following functions.

① Grasping of potential requirement for environmental or medical service by the exchange of reciprocal information between a management body and a user

② Actualization of the fair burden system by fee collection models. As a result, the risk of national and local public finance coming from the conventional tax system is avoided.

③ Application of new environmental technology, which contributes to technology valuation through real estimation of marketability and social contribution at an early stage using feedback based on the verification data from MEDI. This function is similar to that of an application laboratory.

④ Increase in the possibility of investment recovery by the merit of the credit guarantee led by the city management company, as to avoid the political risk that stems from the instability of tax revenues

The feature of these city type experiments forms the fusion field of environmental management as applied economics and engineering (technology assessment). The financial part of investment recovery will contribute to experimental economics through financial analysis of project concerned while an engineering result will be utilized in back test of application of next-generation technology.

2. Outline of an Experimental Urban Management Body

MEDI is the on-site correspondence-type of system that increases the value added of services by the advanced information sharing system. In order to create the advanced city infrastructure (environmental value included), it utilizes next-generation technology as content of urban development by connecting it to a technical management system.

City infrastructure technology tends to be fixed once it has asset value over a long period of time. It becomes difficult to discern the timing of replacement investment. In order to eliminate this uncertainty, it is necessary to build a technical check into city management considering the added value both for a city company and for residents.

A city company would be in charge of this integration. This promotes investment and money flow based on advanced city management know-how. This model makes replacement possible, when the design of a construction stage becomes obsolete from the time of urban development.

As an administration body cannot process the needs of the entire administration area at the same time, a new SPC substitute management of the public zone with juridical personality is required. This enables the restriction of correspondence time and cost reduction through bulk processing by an energy contractor or a waste management agency (administration)., The capital flow to the investor in connection with the development area is managed and the cost of the entire range of public services is indicated to users in real time through this SPC.

A city management SPC collateralizes the intermediate agency role between administration and residents. Moreover, in the social system, it creates the desired relationship between a benefit and a burden between a user and a contractor.

The advantages of aggregating common services are long term. They include the cost reduction effect by accumulation of housing units and reservation of a maintenance level. It is customer-oriented in the sense that service specifications are flexible and changeable.

4. Experimental: Environment and Energy

4-1. Objective and Outline

A MEDI creates the measurement infrastructure that can grasp the actual condition of energy consumption of electricity, gas, water, and waste, and helps to set up combined space zone standards and regulations such as energy saving and greenhouse gas discharge curtailment, water reuse, etc. It furthers the design technology of systems by using time series management data.

Due to the above, the risk hedge portion to environmental regulation is verified according to a space zone by combined data and the route that raises city sustainability is clarified.

In valuation of the greenhouse gas curtailment technology, the measurement methods by single equipment or the combined system can be employed. The environmental control system in a city zone can positively examine the manner in which the environmental load falls through the complex system.

Excessive energy consumption and a heat island phenomenon are urban issues. In order to minimize energy consumption, it is necessary to measure the performance of an environmental load control device according to a city zone. This would reveal the extent to which a next-generation city contributes to "sustainable development."

Therefore, MEDI pays attention to:

① Synergistic effect by complex combination, such as multi-utility, i.e., energy consumption, and waste discharge, water use, etc.

② Practical use of the measurement infrastructure

③ Treatment of the environmental management group of buildings and of housing as one unit

④ Utilization of city infrastructure for evaluation of environmental conformity.

It becomes possible to set up environmental regulation by zone and to simultaneously set up the valuation basis of the city management capability. It puts utilizing as a candidate for dealings to a trade-in-international-permits market in the future.

A feasibility study (FS) is conducted as follows.

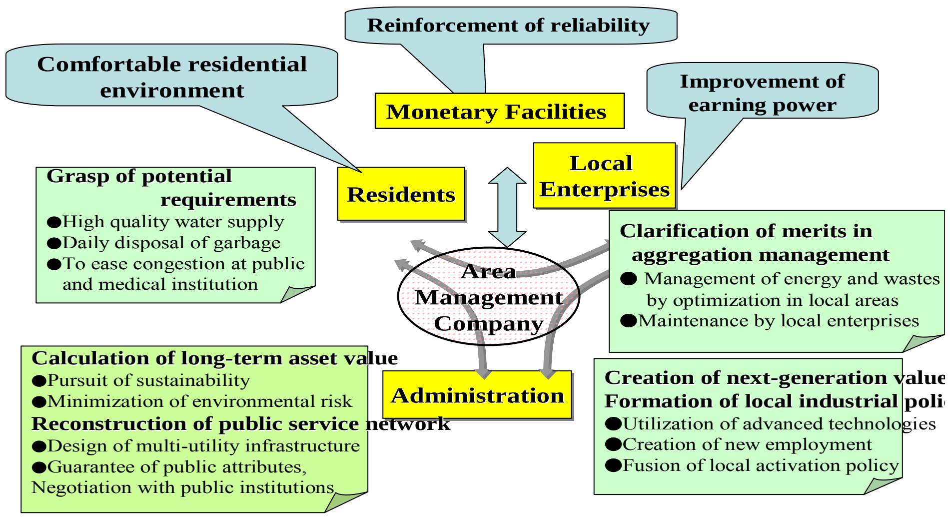

Fig. 1. Structure of the medic-square conception as a new urban management model.

4-2. Outline and Characteristics of a Model of Verifying **Curtailment of Greenhouse Gas in the field of** Environment and Energy

[procedure]

① Setup of the project areas: A newly developed zone is desirable with compact city space installed by a measurement information system. The Electric Power Company and a urban institute in the city collaborate to obtain the data from a targeted area.

② Introduction of energy consumption technology and the measurement infrastructure of the amount of consumption. Practical use of HEMS and BEMS.

③ Collection of the amount of energy consumption in a residential and in office floor space and the clarification of the energy control pattern for local optimization

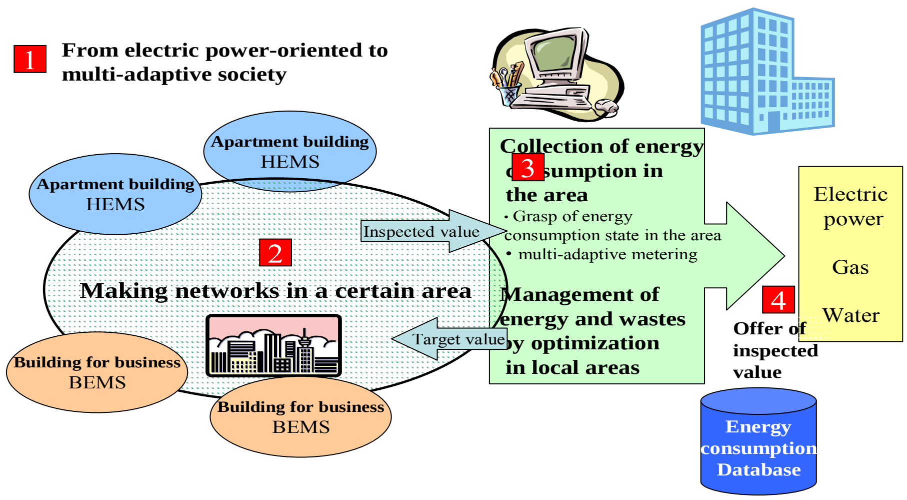

Fig. 2. Optimization of energy consumption.

A consumer database is created according to the minimum geographical unit of city space.

Energy management enables efficient management by a cross-supply of the energy among buildings, based on remote surveillance.

A representation of such a business model is provided in Fig. 3. A city management company contracts an energy supplier while each home and business enters into a contract with SPC. In this manner, the difference between business area and residential one is offset and the imbalance of planed demand and real one can be reduced.

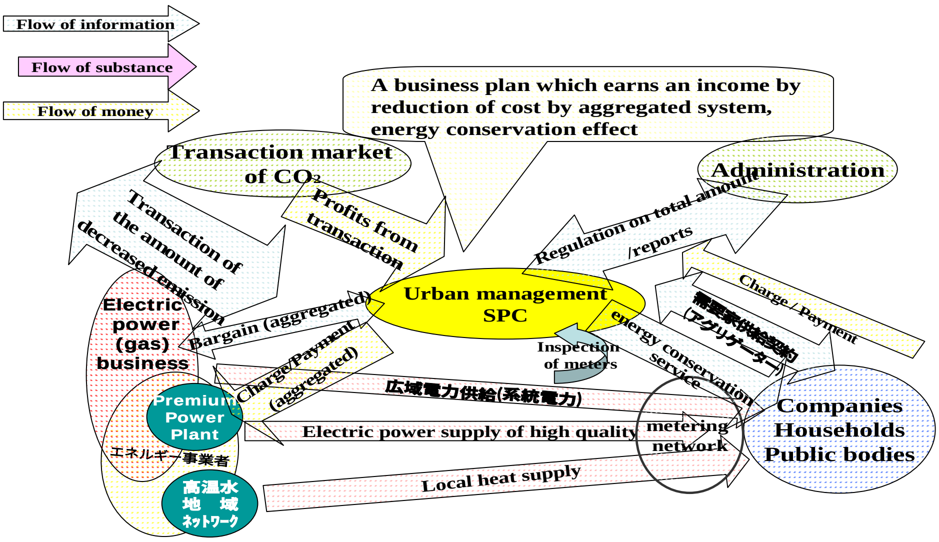

Fig. 3. A business model of energy management.

4-3. Outcome of collective Waste Management and of Additional Treatment of Water Supply

The introduction of kitchen garbage composting of daily basis and of high-quality water supply on-site is needed:

A) Loss-in-quantity scale of the garbage by kitchen garbage separation by the introduction of a collective processing system; assessment of curtailment of greenhouse gas emission related to the collection conveyance truck line of garbage and of the decrease of incineration energy consumption in the waste plants is taken into account.

B) Introduction of a collective water-purifying system: A nano filtration film (NF film) removes impurities and various germs. Reducing the dependence on the purchase of individual bottles called PET bottles, thereby heightening the loss-in-quantity effect of PET bottle garbage.

4-4. Methods of Evaluation of Outcome (**cost-benefit analysis**)

The combination of improvement in service by reproduction of environmental conformity at a local community and of a reciprocal information system linked with fee collection system will facilitates to asses the rate of curtailment of the administration cost of a city zone. Although the initial cost naturally increases when raising environmental conformity, but if minimization of an environmental risk occurs simultaneously, the target value of future urban management model and asset value in this target zone will be increased. This outcome can be calculated by cost-benefit analysis (“with” or “without” project scenarios) (see ANNEX 1-1, 1-2).

① Reduction of consumption of electricity
② Curtailment of greenhouse gas
③ Others :increase in market value of developed land, lesser fiscal burden of local government, higher asset value of existing infrastructure network, acceleration of application of new environmental technology etc

5. A Model of Verifying New Medical Service System

5-1. Traffic Congestion in the Medical Area

The problem of a medical service has frequently been argued from the perspective of the improvement of national medical management. However, a MEDI approaches the improvement of hospital service from the viewpoint of the kind of urban support system.

The first social problem is that of medical traffic congestion. The phenomenon occurring as a result of fiscal constraints of medical finances is curtailment of the hospitalization period, increase in the number of outpatients, and increase in the duration of the waiting period in a large hospital.

The MEDI’s method of solving these issues is to separate the inspection system from a hospital and to introduce a remote inspection system.

5-2. Diagnosis System in the 21st Century

A MEDI increases the value added of an area by setting up consultation outside a hospital and introducing a remote inspection system into service of city space. The introduction of a microchip under development in the Kitamori laboratory of the University of Tokyo is being considered.

This epoch-making technology enables the diagnosis of diseases even in extremely small quantities of blood. The primary features of this technology are the diagnosis of diseases in small quantities of blood, the reduction of inspection time, and a high-sensitivity diagnosis. In cancer diagnosis, the required amount of blood is 100 nanoliters. The time required for diagnostic in this method is shortened to tens of minutes in comparison to the conventional method, and the experimental result of detection sensitivity is 100 times that of the conventional method.

By utilizing such a feature, health checks and diagnoses can be conducted on-site, at a workplace and at home, at any time. Furthermore, by connecting the terminal machine for diagnosis by network, the data of each diagnosis can be managed, transmitted to, and accumulated at the clinic of a given area.

This involves an expense of approximately 5000 yen per month and an approximate burden of 120,000 yen per year. It is equivalent to the expense for one thorough physical check up. Actual proof data is required with regard to the manner in which an inspection system is established as part of social infrastructure from a preventive medicine standpoint.

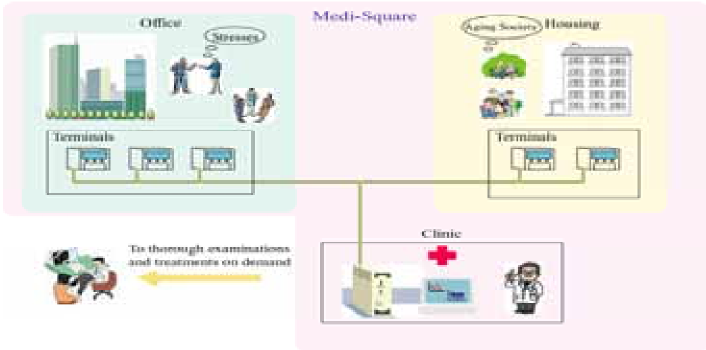

Fig. 4. Remote diagnosis system using microchip.

5-3. Open Neighboring Hospital

A hospital is not only intended for the medical staff and patients but also serves as a point of social exchange among the following types of people and services.

① Medical-related: medicine manufacturing, medical apparatus, clinical inspection, medical waste processing company, university medical departments, nursing schools, etc.

② Patient-related: family, relatives, friends, superiors, etc.

③ Staff: supply of food, cleaning, printing, advertisement, etc.

④ Finance-related: bank, life insurance, damage insurance, consulting, accountant, lawyer, medical consultant, etc.

⑤ Miscellaneous: administration of a district, a hospital, functional evaluators, a ranking company, construction companies, a communication software development company, etc.

In order to interconnect these networks, hospital space can be expanded and managed as a socially integrated unit in a city, instead of conducting all dealings within the premises of the hospital.

6. Conclusion

The scale of the supply of public goods used to be determined by the general equilibrium theory in economic theory: the variables that determine a price system of common goods is insufficient unlike in the case of market goods. A price mechanism does not take into account service level since it is especially premised on a tax system. As a result, an individual willingness to pay level is not reflected. Besides, the argument on technical progress will fall out... Consequently, a supply scale will be solely determined by the administration system, without considering willingness to pay of individuals and environmental issues.

In the MEDI, a price determining mechanism is introduced between city management body and users. All charges to users are calculated in terms of money based upon regional social cost which intends to realize social objectives setup by higher social demand. The scale of public goods is determined at the point that makes a social cost at the margin (a tax or user burden) in agreement with each one of demand curves. This classical thinking is further developed in the MEDI model. The technical evaluation theory also is used to evaluate asset values of urban infrastructure. The value driver to increase a share of common goods and the cost factors which raises the degree of social cognition should be included in valuation of new social demand.

The agreement formation by systematization (program) is another feature of a MEDI model. The merit of transformation from the fragmented agreement formation process to one integrated opinion as a system should be visible to create the group unit with different opinions. Then, the probable partial majority model which finds out a rational solution by phasing is proposed. The length of the time for agreeing and the group structure for every city utility should be analyzed and applied to a city system design.

This process will bring the freshness to the formation of share value and to technical evaluation into a city planning theory. A possibility of substituting the conventional governing body by a new city management formation process is high. Public responsibility and a consensus system will make use of new generation technology to support a new system which reflects the more extensive opinion of society, thus to realize higher level of social welfare.

References

1）Robert P. Barrens and others, “Further Investigation of Voluntary Contribution Contingent Valuation: Fair Share, Time of Contribution, and Respondent Uncertainty”, Journal of Environmental Economics and Management 44, 144–168 (2002).

2）Peter C. Boxall, Jeffrey Englin, and Wiktor L. Adamowicz, “Valuing aboriginal artifacts: a combined revealed-stated preference approach” Journal of Environmental Economics and Management 45 (2003) 213–230.

3) Peter C. Boxall and Wiktor L. Adamowicz, “Understanding Heterogeneous Preferences in Random Utility Models: A Latent Class Approach”, Environmental and Resource Economics 23: 421–446 (2002).

4) Wiktor Adamowicz, “Perceptions versus Objective Measures of Environmental Quality in Combined Revealed and Stated Preference Models of Environmental Valuation” Journal of Environmental Economics and Management 32 (1997).

ANNEX 1 [The Scale of the Target Area : 500 Households-1000 People]

Proposal 1-1: Management of Energy in Each Area

(1) Specifications without the Scheme; consumption of electricity per a household is 720 kWh /month.

(2) Specifications with the Scheme
Reduction of consumption of electricity by 5%, according to the result of empirical research on HEMS. The amount of electricity consumed per a household become (720*0.95 =) 684 kWh /month.

(3) Effect of the Scheme ;
based on a conversion rate from electricity into crude oil, 0.254 //kWh, the consumption of crude oil will be reduced by ((720 - 684)*0.254 =) 9.144 //month.

(4) Costs of Facilities;
a communicating terminal for collecting information per household: 20,000 yen
system cost in a controlling center: 5,000,000 yen.

5) Buildings for business are also managed in terms of energy by next-generation management system. For these buildings, a decrease in the consumption of electricity per square meter by 15.72 kWh/month is expected, once air conditioning system with highly efficient heat pumps and hot-water supply system with heat pump are introduced.

Proposal 1-2: Composting Kitchen Garbage

(1) Specifications without the Scheme;
consumption of energy for burning garbage is 615 kWh/day, on the conditions that the emission of kitchen garbage per person is 300g/day, that the consumption of energy for burning garbage is 1762 Mcal/t , and that we deal 500 households (1000 people) collectively.

(2) Specifications with the Scheme;
consumption of energy for composting garbage is 104 kWh/day if we install two composting machines whose ability is to composting 150kg garbage a day and consume 52 kWh a day.

(3) Effect of the Scheme;
based on a conversion rate from electricity into crude oil, 0.254 //kWh, the consumption of crude oil will be reduced by ((615 - 104)*0.254 =) 129.8 //month.

(4) Costs of Facilities;
Cost of composting machines whose ability is composting 150kg garbage a day: 10,000,000 yen.

(5) Notes;
a cut in carbon dioxide by reducing the trucks serving as gathering garbage.The weight and the volume of garbage decrease into 1/5 and 1/6 each..

Proposal 1-3: Water-purifying System (Saving Water)

(1) Specifications without the Scheme;
the consumption of energy for processing water and treating sewage is 270 kWh/day, on the conditions that the consumption of water per person is 300 //day, that the consumption of electricity for processing water and treating sewage is 0.9 Wh// (0.5 Wh for processing water, 0.4 Wh for treating sewage). Deal 500 households (1000 people) collectively.

(2) Specifications with the Scheme;
if the costs of depreciation and maintenance are added to a normal water charges, the total charge will be duplicated, so we set the highest objective on decreasing the consumption of water by 50 %. The consumption of energy will be (270*0.5*1.2 =) 162 kWh/day (20 % of concentrated sewage of supplied water).

(3) Effect of the Scheme;
based on a conversion rate from electricity into crude oil, 0.254 //kWh, the consumption of crude oil will be reduced by ((270 - 162)*0.254 =) 27.4 //month.
Curtailment of greenhouse gas emission related to the collection conveyance

truck line of garbage

(4) Costs of Facilities;

No special facilities are required for saving water if the facilities mentioned in 1-1 is installed. (A set of systems for highly purifying water cost about 54 million yen.)

(5) Notes;

Decrease in sewage can be expected by using concentrated sewage with water for amenity or making good use of sewage.

ANNE2

【The Scale of the Target；500 Households-1000 People】

Proposal 1－1

Proposal	Item Examined	Specification before the Scheme	Specification after the Scheme	Improvement	the Number of Target	Effect(1)	Effect(2)	the Number of Target	Total Effect	Unit Price of Ene	Economic Effect	Cost of Facilit	the Number of Years for Collecting the Investment
		kWh／month	kWh／month	kWh／month	household	l／month	l／year	household／area	kl／year・area	yen／l	yen	yen	
Management of Energy in Each Area	Electricity	720	684	36	1	9.144	109.86	500	54.93	24	1,318,320	15,000,000	11.4

Proposal 1－2

Proposal	Item Examined	Specification before the Scheme	Specification after the Scheme	Improvement	the Number of Target	Effect(1)	Effect(2)	the Number of Target	Total Effect	Unit Price of Ene	Economic Effect	Cost of Facilit	the Number of Years for Collecting the Investment
		kWh／day (Converted into Electricity)	kWh／day	kWh／day	people (household)	l／day	l／year	system／area	kl／year・area	yen／l	yen	yen	
Composting Kitchen	Electricity	615	104	511	1000 (500)	129.8	47,380	1	47.38	24	1,137,120	20,000,000	17.6

Proposal 1－3

Proposal	Item Examined	Specification before the Scheme	Specification after the Scheme	Improvement	the Number of Target	Effect(1)	Effect(2)	the Number of Target	Total Effect	Unit Price of Ene	Economic Effect	Cost of Facilit	the Number of Years for Collecting the Investment
		kWh／day	kWh／day	kWh／day	people (household)	l／day	l／year	system／area	kl／year・area	yen／l	yen	yen	
Highly Water-purifying System (Saving Water)	Electricity	270	162	108	1000 (500)	27.4	10,000	1	10	24	240,000	現状、総額54百万円から当該部分の切り出し不明	