H-2 A study on the process of transformation towards an industrial society with least environmental burden (Abstract of the Final Report)

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Total Budget for FY2000-FY2002 56,127,000Yen (**FY2002**; 16,682,000Yen)

Key Words ISO14001, eco-efficiency, Economical induction, CO_2 emission, Household Electric Appliances Recycling

1. Introduction

With efforts underway to decrease environmental burdens, there is increasing interest in environmental management systems like ISO 14001. It is often expected that adoption of an EMS will lead to beyond compliance business activities, which means that firm level environmental policy and actions are more stringent than regulations. The motivations behind voluntary environmental action and the effects of voluntarism have been a subject of recent research interest. Nevertheless, general application of new theoretical approaches to voluntary activity in Japan is limited; as is the academic investigation of firm level adoption of EMS' in Japan. Analyses on ISO14001 are described in part (1)-a) of each section.

Collaboration among various stakeholders such as citizens, government and industries with understanding each viewpoint is essential to realize sustainable society. Varieties in the views on environmental load reduction and improvement of the quality of society require compromise among these stakeholders. Industries that introduce environmental management are continuously increasing and they evaluate their own performance. However, their environmental management is rather limited to individual emission and such emission is managed independently from financial management. Environmental accounting takes into consideration of profit and cost of environmental countermeasures, but it does not include the benefit of customers or external stakeholders. Including the view of various stakeholders into the evaluation of performance of industries is important to maintain profit of all stakeholders in the society. An eco-efficiency is proposed as a communication tool in part (1)-b) of each section.

A bottleneck for the attempt to introduce unutilized energies to the commercial and residential sector or the industrial sector as energy supply source, is that it takes a large amount of money for construction of the infrastructure such as piping for their use. In order to prevail the use of unutilized energies, economical inducement strategies are necessary. The reason why the use of unutilized energies are not so much promoted today, is that the costs accompanied with use of unutilized energy are not clear and the benefits such as CO2

emission reduction to cost is uncertain compared with the present energy system. An economical induction scheme is discussed in part (2) of each section.

Recently, deficiency of waste disposal site has become a serious social issue in Japan. This situation should be resulted from massive consumption and disposal of materials in high-growth period. Therefore, reconstruction to the recycling-oriented society has been promoted at nationally and regionally levels with formulation of several recycling related laws, such as .the Electric Appliance Recycling Law. On our way to the recycling-oriented society, it is important to make incorporate recycling and waste management industries to a main stream, i.e. manufacture. This means an industrial transformation to balance arterial and venous function in our economical society. Legal systems are investigated in part (3) of each section.

2. Objective

(1) Voluntary management

a) ISO14001

This paper develops a theoretically based model to predict voluntary adoption behavior by Japanese firms of one EMS: International Standard's Organization (ISO) 14001. The model is applied to survey data to understand differences in adoption behavior among four industries – chemical, electronics, electric machinery and electric power and to show generalizable differences between first stage adopters, second stage adopters, and non-adopters. The paper compares the environmental behavior of first stage adopters, second stage adopters, and non-adopters across four types of environmental action to determine the extent to which greenness can be associated with EMS adoption.

b) Eco-efficiency

Environmental countermeasures and profit of industry as well as that of external stakeholders must be compromised and for the formation of sustainable society by industrial efforts. In order to evaluate such aspects, eco-efficiency is used because this index compares value and environmental loading coming from industrial activities. Value and environmental impact differ among stakeholders because of the difference of their views. This study proposes to utilize eco-efficiency that reflects the view of stakeholders for reaching the consensus among them. The purpose of this study is to demonstrate the possibility and usefulness of this index through two hypothetical case studies.

(2) Economical induction scheme

One objective of the study is to establish a simulation model which finds the combination of energy supply systems that meets a required CO2 emission limit with minimum cost, when unutilized energies are expected to introduce into the regional energy systems. To meet the objective, we conducted case studies for various regions that is different in characteristics such as types and total floor area of buildings. Another objective is to find the optimum operation scheme of co-generation systems in order to use its waste heat in most effective way to minimize CO2 emission. To meet the objective, CO2 emission from gas turbine co-generation system was compared for two cases, one case is for one type building and second is for two different type buildings capable mutual heat use.

(3) Legal systems

In this study, we attempted to analyze changes of regional industrial structure resulted from legally promoted recycling projects and these effects to indigenous industries from changes of material flows, environmental and economical effects. Especially, we chose the Eco-Town and the Household Electric Appliances Recycling projects as regional activity of recycling projects, and analyzed relationships between character of projects and the regional industrial transformation.

3. Results

(1)Voluntary management

a) ISO14001

Table 1 shows results from four logit regression runs. In the first column Certified Adoption for all facilities is regressed on the model. The second column compares ISO In Process Adopters with all facilities (Certified Adopters and Non-Adopters). The third column compares In Process Adopters with Non-Adopters, and the fourth compares In Process Adopters with Certified Adopters.

Compared with ISO and non-ISO facilities, In Process Adopters exist in more highly regulated areas, receive more administrative guidance, more negative citizen pressure, and more negative media pressure. In Process Adopters also consider competitiveness issues to be important reasons for environmental action. They are also more centralized and are more likely to have environmental representation in top-level decision making fora. There appears to be no association between rule boundedness and adoption. Size is also no longer an important distinguishing factor. Adoption of ISO appears to be associated with substantially different factors for Certified firms as for In Process firms.

When compared separately to Certified Adopter and Non Adopter groups, In Process Adopters are more likely to have received more administrative guidance and more negative media pressure. Interestingly In Process facilities report less citizen pressure than the non-ISO group. They are more likely to recognize competitive advantages for environmental action and are larger than Non-Adopters and smaller than Certified adopters. Their decision making structures are also less centralized than the other two groups, and they are more likely to have environmental representation in decision making contexts than Non-Adopters but not more likely than Certified Adopters. Social responsibility is also important for ISO In Process Adopters when compared to Non-adopters, but this effect disappears when electric power companies are removed (the significance pf all other relationships remain unchanged when electric power companies are removed).

These findings – especially those comparing In Process Adopters to Non-Adopters –indicate greater support for the hypothesized linkages between regulation, competitiveness, social responsibility, and organizational factors than was evident from the industry comparison. Facilities under stronger administrative and media pressure are more likely to volunteer; facilities producing public goods are more likely to consider environmental action to be a social responsibility of business; In process volunteers are more likely to perceive competitive advantages to environmental action, and decision making presence is important.

Nevertheless, firm conclusions about the implications of these findings are difficult. At least two general explanations exist. In the first scenario, high regulatory pressure is a

contributor to certification, however after certification regulatory pressure falls. In other words, voluntarism is a signal of investment that is recognized by the regulatory and other external communities (except citizens who seem to have little or confused effect). Similarly, competitiveness is a primary factor determining initial decision to adopt, but after adoption competitiveness advantages are not realized and the perception that ISO leads to competitiveness advantages disappears. This paper is not able make a direct linkage between adoption and regulatory pressure reduction, therefore a second explanation is equally or more likely.

According to the second explanation, early adopters (Certified Adopters) and In Process Adopters represent two fundamentally different groups of organizations. Certified adopters are large, complex organizations with significant slack resources and a general commitment to environmental management (as evidenced by their positive media treatment and lack of government and citizen group pressure). They are more likely to adopt early because they have the resources and structures to adopt early. The largest facilities are also more easily recognized either as polluters or as good examples and therefore receive greater benefits for being proactive volunteers. In Process Adopters represent a second stage of adoption of ISO 14001. These companies are smaller, more decentralized and less rule-bound. They are also under a greater degree of external pressure and are more likely to see environmental action as a competitive advantage. These firms may represent a second tier of adopters brought along as a result of business linkages with first adopters and because of high regulatory pressure.

Table 1 Logistic Results, Comparison of Adopters, In Process Adopters, & Non-Adopters

	ISO Certified (All Facilities)	ISO In Process (All facilities)	ISO In Process (w/ non-ISO only)	ISO In Process (w/ ISO)
Intercept	-5.72 ***	-7.99***	-13.01***	-5.33 **
Local Regulation	0.54*	1.32*	1.21	1.28
Administrative Guidance	-0.15	0.72**	0.98**	1.22 ***
Citizen Pressure	-0.43	-0.44	-1.06*	0.22
Media Pressure	0.33***	-0.26**	-0.01**	-0.42 ***
Social Responsibility	0.14***	0.07	0.25**	0.08
Competitive Advantage	0.05	0.29**	0.41***	0.30 **
Industry Guidelines	-0.08	-0.81*	-0.86	-1.60
Size	0.16***	0.04	0.23***	-0.15 **
Decentralization	-0.12*	-0.24*	-0.49***	-0.34**
Decision Making Presence	0.67**	1.10*	1.81**	0.52
Rule Boundedness	0.10***	-0.01	0.07	-0.03
Sample Size	529	529	236	321
Adopters (ISO firms)	295	29	29	26

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

b) Eco-efficiency

The first case study was about the application of eco-efficiency to compare the judgments of various stakeholders. Eco-efficiency of seven air-conditioners sold in Japan was calculated and compared among industry, investor, consumer and green consumer. The definition of eco-efficiency is different among them. Market share weighted with external evaluation of environmental soundness, market share, surplus value, and surplus value weighted with environmentally friendly design were value for company, investor, ordinary consumer, and green consumer, respectively. This comparison of eco-efficiency enabled the overall evaluation of the product from the viewpoints of various stakeholders. Such application of eco-efficiency can be done by industries in the stage of planning new products to reduce the environmental loading.

The second case study was about the strategy of operation of a factory in the context of the relationship between that factory and neighborhood citizens. The values and environmental loading each stakeholder concern about is different as shown in Table 1.

Table 2 Evaluation of value and environmental loading in strategy of factory operation

Index of value	
stakeholder	calculation method
company and investor	profit
neighborhood citizens and local government	Tax revenue and job opportunities
Environmental NGO	social contribution of company
Index of environmental loading	
stakeholder	calculation method
company, investor and Environmental NGO	Integration by ecopoint of air & water pollution, solid waste and energy consumption
neighborhood citizens	Integration by ecopoint of air & water pollution
local government	Integration by ecopoint of air & water pollution and solid waste

(2) Economical induction scheme

a) Optimization model for introducing energy

In the energy supply and demand system of regional area, the most economical way of primary energy use is determined by best combination of unutilized energy and the prevalent energy systems.

For an region characterized by 100% of office buildings, the case study of energy supply combination when CO2 emission reduction constraint vary from 1-30% was proceeded. The result for the Daiba in Koto Ward is shown in Fig. 1. The trash incineration waste heat is introduced when CO2 reduction is over 16%. Its share and the supply cost

increases with the increase of CO2 emission reduction and share reaches constant 18 MW over 24% in CO2 reduction. On the other hand, the sewage heat is not used in this region. The case study for the Toneri in Adachi Ward dominant with residential buildings shows that the trash incineration waste heat and sewage water heat are not both used in allowable cost range. As this region has no equipment such as conduits for transport of warm/cool water as heat carrier, it takes huge cost for such equipment for delivering warm/cool water. This could be an obstacle to introduce unutilized energies. If some subsidy is put into these area, use of unutilized energies is expected to be effectively promoted.

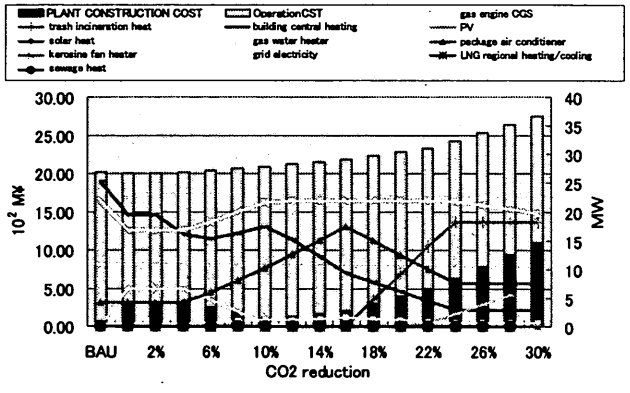

Fig.1 Energy supply share and cost when CO2 reduction increases

b) Use of waste heat from gas turbine

In above section a), the objects of the study were comparatively broad regional area and optimum combination of various energy systems in it. In this section, one energy source such as gas turbine co-generation system is targeted for analysis. And analysis was proceeded using seasonal and hourly electricity/heat demands data.

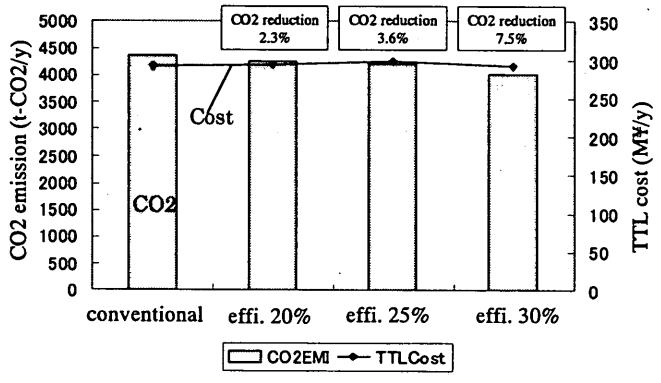

Fig. 2 Reduction in CO2 emission minimization

CO2 emission and operation cost of gas turbine co-generation system are compared with those of conventional central warm/cool heat supply system. Fig.2 shows the simulation results in the CO2 emission minimization case. CO2 emission reduction increases with increase of the gas turbine thermal efficiencies. The maximum CO2 reduction could be 7.5% for the gas turbine of 30% thermal efficiency at almost same cost as conventional system. The

case of cost minimization showed cost reduction of 2% and CO2 reduction of 6.1% were expected for the turbine efficiency of 30%. In this case the cost pay back time of the system was 11 years. The pay back time can be expected to decrease by taking into account the monetary evaluation of CO2 reduction. One of that evaluation is the carbon emission tax.

In urban region, there are many kind of buildings of which electricity/heat demand patterns are very much different each other. In this case, if heat can be used more flexibly among buildings from the buildings of less demand to those more demand, discarded heat can be reduced. To prove this quantitatively, primary energy use and accompanied operation cost was evaluated for an apartment house and a super market, when micro gas turbine cogeneration system was introduced to those buildings respectively or in common. In the winter season the apartment house requires more warm heat than the supermarket, and in the summer season super market requires more cold heat than the apartment house. Result of simulation is shown in Fig. 3. In case of in common installation 12.2% primary energy reduction was expected compared with the conventional system, instead of 5.7% for respectively installation. It was clarified that in the case of in common installation the auxiliary fuel supply in the day time in winter or in night time in summer was very much decreased.

The initial cost of the system is 58.9 millions yen and annual benefit yielded by substitution this system for conventional system is 9.6 million yen. Fig. 4 shows the one result of the cash flow analysis. When the operating period is set 15 years, the net present value (NPV) is zero at discount rate 14%. This discount rate is particularly called the internal rate of return (IRR), because even if the revenue is discounted at this rate, initial cost can be paid back in 15 years. Today, as the capital cost (return to investors, interest etc.) is about 7-8%, the return of 14% is fully beneficial. The investment to this system should be subsidized by the government as ESCO (energy service company).

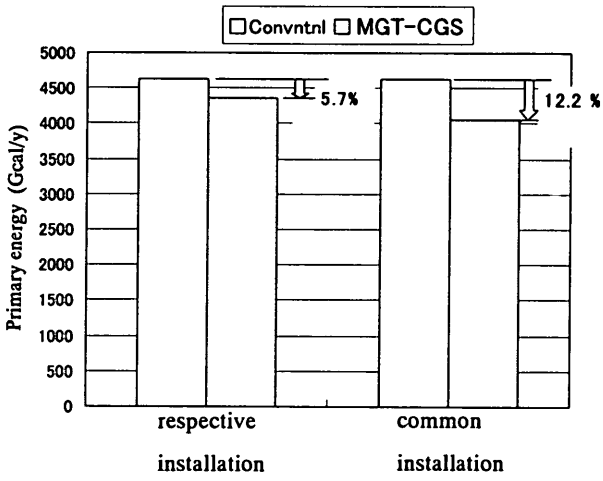

Fig. 3 Reduction energy consumption by mutual heat use among buildings

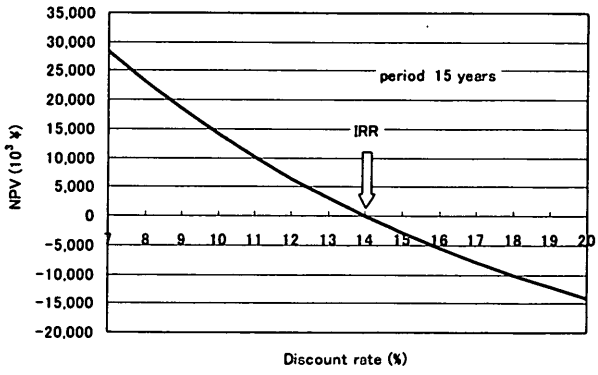

Fig. 4 Economic evaluation of micro gas turbine installed two buildings in common

c) Constraint by regulation

When one company plans to supply warm/cool heat to the buildings in a district area, it should be regulated by the governmental regulations and the regional standards. Existing heat supply system in the district area is limited to supply only in own area and can not supply heat next door region beyond their system boundary. This could be obstacle for supplying heat from the area near the unutilized energy source to another area and for mutual use of heat between two areas.

(3) Legal systems

The Eco-Town projects, which promoted by the Ministry of Economy, Trade and Industry and the Ministry of Environment and subsided to construction of waste treatment and reclaim facilities as a core of the industrial town, were categorized by their relations to indigenous industries. The type of "transformation of indigenous industries" typically appears in the old mine area, and this type of Eco-Town would be utilized the domestic refining technologies and idled facilities and land for the metal recycling. The second type of "collaboration of indigenous industries" includes the agricultural, pulp and paper and cement industries as collaborator to the waste management and recycling sector. Organic wastes from the agricultural sector can be recycled to the high grade feeding stuff and compost, the particleboard, and some chemical argents, and pulp and paper and cement industries can use these organic waste, especially wood waste, and plastic waste as material and heat source for their production. The "establishment of core facility" type usually constructs the waste and its incinerated ash melting facilities for domestic waste reduction and detoxification.

The recycling project for electric appliance waste in Akita prefecture was chosen as a case study of recycling project promoted by legal systems (the Electric Appliance Recycling Law). The main system of this project is

Table 3 Ton-km of First and Second Transportation of Electric Appliance Waste

	Hokkaido B	Kita-Tohoku A	Kita-Tohoku B	Kanagawa&Tama A
First Trans.	152,119	104,723	95,157	106,477
Second Trans.	1,313,931	1,199,209	707,095	425,299
Sum.	1,466,049	1,303,932	802,252	531,776

Table 4 Enegy Consumption, CO2 Emission and Cost from Collection to Disposal and Recycling of Electric Appliance Waste

Energy Consumption (Mcal/apparatus)

		Hokkaido B	Kita-Tohoku A	Kita-Tohoku B	Kanagawa&Tama A
First Trans.		0.7	0.7	0.7	0.3
Second Trans.		6.0	8.1	5.2	1.2
Plant Process	Initial	3.5	3.9	2.8	3.0
	Running	11.4	10.5	10.7	10.3
Third Trans.		8.4	7.0	2.5	2.3
Sum.		30.0	30.2	21.9	17.1

CO2 Emission (Mcal/apparatus)

		Hokkaido B	Kita-Tohoku A	Kita-Tohoku B	Kanagawa&Tama A
First Trans.		0.2	0.2	0.2	0.1
Second Trans.		1.8	2.4	1.5	0.4
Plant Process	Initial	1.6	1.0	1.1	0.8
	Running	3.2	2.9	3.0	2.9
Third Trans.		2.5	2.0	0.7	0.7
Sum.		9.2	8.5	6.5	4.8

Cost (Mcal/apparatus)

		Hokkaido B	Kita-Tohoku A	Kita-Tohoku B	Kanagawa&Tama A
First Trans.		3,465	3,463	3,464	3,426
Second Trans.		1,942	1,909	1,940	1,927
Plant Process	Initial	745	453	510	367
	Running	1,062	1,098	1,120	1,100
Third Trans.		451	309	68	105
Disposal and Recycling		-49	129	-272	1
Sum.		7,616	7,362	6,830	6,927

nonferrous metals from electric appliance wastes recycling by refining industry. We analyzed the structure and the material flow of electric appliance waste recycling and estimated the substitution effect of recycling metals in existing market. Factors for construction of metal recycling system in this area are; (1) development of the broad collection system of electric appliance waste under the law for securing material supplies, ; (2) subsidization of construction and running cost for the recycling facility as a initial investment; (3) utilization of existing infrastructures and market for nonferrous metals. Quantitative shares of recycling metals (iron, aluminum, and capper) in the local scrap market were estimated at a few - over ten percent.

We compared the local differences of the amount of material supply, costs, and environmental load among the three local areas (Hokkaido, Kita-Tohoku, Kanagawa & Tama) including four electric appliance waste recycling systems. Differences of ton-km of the first transportation (form residence to assigned acceptance sites) are not large between areas, but ton-km of the second transportation (form assigned acceptance sites to recycling facilities) differ between recycling systems as their population density (Table 3). The third transportation (from recycling facilities to recovered material users) shows the extent of the linkage of recycling and indigenous industries. Although processes with high rate of energy consumption and CO2 emission are construction and running of recycling facilities, their difference between recycling systems would be small. The second and third transportation processes are next contributor. The first transportation would be most expensive in all processes (Table 4).

4. Discussion

(1)Voluntary management

a) ISO14001

This paper provides the most detailed analysis to date on the adoption and effectiveness of ISO 14001 in Japan. Results indicate some support for regulatory, competitiveness, social responsibility, and organizational hypotheses. Specifically, second tier adopters are more likely to be under regulatory pressure than either first tier adopters or non-adopters. Similarly, first tier adopters, second tier adopters and non-adopters show different levels of environmental activity. Whether these results indicate effects of ISO 14001 adoption, or whether this finding simply identifies two separate types of facilities should be a subject of more detailed future research.

Nevertheless, results tend to support the conclusion that different stages of voluntary adoption exist. If these stages belie an adoption-diffusion model, then second tier adopters may simply be following first tier adopters as a result of direct business linkages or indirect changes in industrial norms and expectations. If these stages specify a regulatory effect, then evidence probably indicates self selection of secondary adopters based on size, environmental pressure and expectations that adoption results in reductions in regulatory pressure. Regardless the true nature of the mechanism observed here, evidence shown here has two broad implications.

First, ISO 14001 clearly appears to have gained a strong foothold in Japan and is growing significantly. Although the extent that adoption of ISO leads to increased greenness

of business is unclear, there is a high probability that, over time, it does and that Japanese companies are becoming greener as a result of adoption (at least to some extent). Identification of two stages of ISO adoption is the second finding with broad implications. Prior research has continually hypothesized that propensity to volunteer is a function of regulatory demands. However, it may be that different factors affect the propensity to volunteer at different stages in the diffusion process. At the beginning, voluntary activity can be expected from large, complex, green organizations regardless their regulatory pressure or competitive expectations. As time goes on, other organizational, economic, social and regulatory factors become more important. However, the diffusion model is disjointed such that until a certain level of industry acceptance is reached, self-selection to volunteer based on other identified theoretical reasons is not forthcoming.

b) Eco-efficiency

Effectiveness of using eco-efficiency to express the viewpoint of various stakeholders was demonstrated on new product development and strategy of factory operation. More reliable and convincing method and participation of each stakeholder in index development are necessary for practical use.

(2) Economical induction scheme

We developed the optimization model which finds the combination of energy supply systems that meets a required CO2 emission limit with minimum cost. This model can predict the share of unutilized energies when CO2 emission should be reduced in the municipal energy supply system. Analysis showed that unutilized energies is introduced when CO2 reduction would be high, but cost increases with CO2 reduction ratio. Consequently some economical strategies such as subsidy, carbon tax and investment can be considered very much effective on promoting use of unutilized energy .

In case of introduction of unutilized energy, it was also cleared that the different characteristics of area from region to region and the constraint by rule and standard should be considered.

(3) Legal systems

Categorization the Eco-Town into three types indicates several conditions for the regional industrial transformation, including linkages to indigenous industries, siting, degree of location, holding technology, scale of operation. Preparing collection system of waste for recycling in a broad area and making the market of recyclables should be important for establishment and maintaining regional recycling industries. Small share of scrap metals from electric appliance wastes in the market indicate that industries have reserve capacity for more recycling metals. Transportation can mainly cause differences of scale, cost and environmental effect of recycling operation between local areas. Transportation should also be defined by the population density, the location and capacity of the recycling facility and market of recyclables. To extend the industrial and social capacity of recycling, more preparation of transportation system of materials from recycle facilities to distant market and clarification of the share of the cost of this process should be needed by law.