

WEEE Resource Ecological Compensation Mechanism Design

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Abstract—With the rising awareness of green sustainable development, waste electrical and electronic products (WEEE) resource processing has become a hot issue. Establishing an ecological compensation mechanism is of important to solve the current difficulties in constructing WEEE resource processing. WEEE resource ecological compensations beneficial to alleviate the pressure of WEEE on ecological environment and promote sustainable and coordinated development of WEEE supply chain. The paper aims to improve the ecological compensation system by systematically combing ecological compensation theory and practical experience of ecological compensation mechanism. Taking Shandong Province as an example, WEEE resource ecological compensation mechanism framework from the aspects of compensation subject, compensation object, compensation method and compensation standard is constructed. The guarantee measures for constructing WEEE resource ecological compensation mechanism in Shandong Province are also proposed.

Keywords— WEEE resource, ecological compensation, mechanism design, guarantee measures.

I. INTRODUCTION

Green and low-carbon sustainable development is a brand-new development concept, which has theoretical and practical significance for promoting economic and social development (Gillian and Jerry 2011, Kindler and Siemens 2011). Since the 21st century, human survival has been greatly threatened by resource scarcity, solid waste pollution and environmental degradation. In the context of rapid economic development, many governments have

issued necessary laws and regulations to control environment pollution (Mahanty et al 2013, Leimona et al 2015). How to realize an eco-friendly and environmentally-friendly society in the process of industrialization becomes an important development issue in the new normal of economic development (Muradian et al 2010, Muradian et al 2013). The harmless treatment and comprehensive utilization of waste electrical and electronic products (WEEE) is the development direction of waste recycling and has been valued by all countries in the world.

Ecological compensation mechanism of WEEE resource is an important part of ecological compensation system and ecological civilization construction. In recent years, with the substantial increase of WEEE, the number of group events that occurred during the site selection and operation of WEEE treatment facilities and social attention has increased (Tacconi 2012, Wegner 2015, Koeger 2013). The lack of ecological protection incentives and ecological compensation mechanisms are important factors in this problem. Therefore, it is urgent to establish and improve the ecological compensation mechanism of WEEE resource to alleviate social contradictions and accelerate the construction of ecological civilization (Wunder 2015, Kemkes et al 2010, Wunder 2013).

According to the mature experience of developed countries and explorations already carried out in some areas of China, it is of great significance to establish an ecological compensation mechanism for WEEE resource. The ecological compensation mechanism based on “pay for ecological services” can effectively balance the location of WEEE facilities. Ecological compensation can repair and

rebuild the ecological environment, it can also promote WEEE processing enterprises to actively improve the process and management and reduce the cost of ecological compensation.

II. THEORY AND PRACTICE OF WEEE

RESOURCE ECOLOGICAL COMPENSATION

2.1 Theory of WEEE resource ecological compensation

The theory of WEEE resource ecological compensation mainly involves externality theory, public product theory and environmental equity theory. Externality theory holds that there is an external non-economic effect, it should be taxed to the enterprise. When there is an external economic effect, the enterprise should be subsidized and the externalization effect can be realized through taxation or subsidy. Public product theory believes that public product is prone to two problems in the process of use: "tragedy of the commons" and "free-riding problem", which needs to solve the "free-riding" phenomenon in public product consumption and the footwork of public goods through institutional design. Environmental equity theory requires that the rights and obligations of different countries, regions and groups must be treated fairly when dealing with environmental issues in the process of using and protecting the environment.

2.2 Practice of WEEE resource ecological compensation

In Germany, nearly 98% of WEEE is treated safely and harmlessly every year, 70% of WEEE products are recycled by the government and about 30% are handled by enterprises. In order to standardize the recovery operation of WEEE, the government has introduced perfect laws and regulations of WEEE recovery. The rights and obligations of the relevant responsible persons are clear, also the incentive and supervision mechanism are in place to ensure the efficiency and coordination of WEEE resource utilization. In Netherlands, 90% of WEEE products are handled by government, 10% are responsible for company

and WEEE recycling rate is close to 100%. Japan has perfect WEEE recycling laws and regulations. The main bodies of recycling are WEEE recycling enterprises with mature technology and perfect management. The recycling rate is above 97% and the secondary pollution is basically zero.

Through the research on WEEE resource ecological compensation of the developed countries such as Germany, Netherlands, Japan and South Korea, the lessons that can be used for reference are summarized as follows.

(1) Laws and regulations should be used to ensure the goal of ecological compensation. For establishing WEEE resource compensation mechanism, one of the important tasks is to construct a policy and regulation system framework for ecological compensation. The conflicts of existing policies and revising some impacts on ecological compensation must be paid more attention when formulating corresponding laws and regulations. Implementing the principles of ecological compensation through legislative procedures into the framework of policy and legal system can be legally enforced to protect the smooth implementation of ecological environmental protection.

(2) Establishing a multi-subject financing mechanism for ecological compensation should be emphasized. Although the main source of ecological compensation funds is financial funds and supporting funds cannot be put in place, the effect of ecological compensation is greatly limited. Since ecological compensation is mostly caused by different stakeholders, regional economic development is unbalanced and the inter-regional horizontal financing mechanism will also affect the sustainability of ecological construction to some extent. The fiscal policy and the increase of inter-regional horizontal transfer payments have become an important reform direction.

(3) Monitoring and evaluation of ecological compensation should be given more attention. There is a certain inevitable connection between the amount of compensation and the effect of compensation. If the

compensation object is not considered to exert environmental and use a unified standard, the compensation effect will be difficult to achieve. Therefore, the ecological compensation mechanism should be routinely monitored and evaluated to understand its contribution to environmental improvement, and different levels of compensation should be given according to the size of the contribution. The establishment of a dynamic adjustment mechanism through the assessment and monitoring of ecological compensation content will help to develop reasonable ecological compensation standards.

(4) Establishing a social participation and negotiation mechanism should be emphasized. The formulation of ecological compensation policy is to effectively coordinate the economic interests of the injured, beneficiaries and other stakeholders. The compensation objects can be identified by combining regional differences. In the formulation of compensation standards, the ecological environment differences and the formulation process of ecological compensation policies should be considered.

III. STATUS OF WEEE RESOURCE ECOLOGICAL COMPENSATION IN SHANDONG PROVINCE

The fundamental significance of ecological compensation lies in the realization of environmental friendly between WEEE resource enterprises and the surrounding public environment through ecological compensation. Through ecological compensation, the implementation of environmental protection standards for WEEE resource enterprises is improved and environmental quality is improved. However, there are still limitations of WEEE resource ecological compensation in Shandong Province.

Ecological compensation mechanism has not been established is the first status of WEEE resource in Shandong Province. In recent years, with the improvement of public safety awareness and shortage of land resources, the resistance encountered in the construction of WEEE resource facilities has increased greatly. But the ecological

compensation mechanism of WEEE resource in Shandong Province has not yet been established and the compulsory of WEEE resource ecological compensation fees are not clear. The location of WEEE resource facilities in Shandong Province is generally dominated by suburban rural areas, which is relatively remote and sparsely populated. Moreover, the WEEE resource industry has not formed a consensus on ecological compensation. During the operation, the ecological compensation cost was not included, which caused the contradiction among the residents around the WEEE resource facilities.

Insufficient theoretical research and the amount of compensation difficult to determine is the second status of WEEE resource ecological compensation in Shandong Province. Foreign WEEE resource ecological compensation has generally experienced decades of development and established a mature evaluation and measurement model. China only has a few cities such as Guangzhou and Beijing to carry out WEEE resources ecological compensation currently. But compensation standards and compensation forms are still insufficient. In particular, the compensation measurement model and evaluation system for WEEE resources in China is still in its infancy, which involves the ecological benefits and externalities of the whole compensation scope. There is a lack of research on the form of compensation. At present, WEEE resource industry in Shandong Province has not considered the ecological compensation from the facility planning to the designing stage of the project, which makes it difficult to implement compensation funds. The ecological compensation model of developed countries is mainly in the form of indirect compensation such as public services and public facilities. The form of direct compensation such as compensation is supplemented. However, China has not yet established a compensation model combining indirect compensation and direct compensation.

Insufficient third-party participation is the third status of WEEE resource ecological compensation. In recent years,

the contradiction between WEEE resource enterprises and surrounding people has become increasingly prominent in Shandong Province so WEEE resource enterprises have to face the public's appeal for ecological compensation. Some enterprises have developed various types of trials to improve and improve the surrounding areas. According to the experience of developed countries, the negotiation and compensation process of ecological compensation require third-party intervention for supervision. However, the openness of WEEE resource enterprises in Shandong Province is relatively low likely to introduce third-party participation, which makes it difficult to achieve ecological compensation.

IV. WEEE RESOURCE ECOLOGICAL COMPENSATION MECHANISM DESIGN IN SHANDONG PROVINCE

4.1 Basic principles

The overall idea of WEEE resource ecological compensation mechanism design is to reduce the negative impact of WEEE resource utilization and follow the principles of "who benefits, who compensates". The aim of WEEE resource ecological compensation mechanism design in Shandong Province is to construct a scientific and effective ecological compensation mechanism to promote the comprehensive, coordinated and sustainable development of economy and society through innovation of institutional and mechanisms. The basic principles are as follows.

4.1.1 Clear object

The adjustment of ecological compensation is the relationship of stakeholders. The premise of achieving the balance of interests is that the beneficiaries should be paid and the injured should be compensated. This is the first principle of ecological compensation compliance. The compensation subject and the compensation object are two basic stakeholders in the ecological compensation mechanism, which leads to a series of problems such as compensation standards and compensation methods. The

effective ecological compensation mechanism should emphasize the clarification of the compensation subject and the compensation object. If the positioning of the two is ambiguous and the ecological compensation mechanism constructed is unstable, it is difficult to achieve the purpose of ecological compensation and realize the benefits of ecological compensation. In the WEEE resource processing process, when the WEEE resource generation area transports the recyclable materials to the location of the WEEE resource treatment facility for landfill or incineration, it should be responsible for the direct and derivative losses caused by WEEE waste disposal and should receive corresponding compensation.

4.1.2 Government-led and social participation

WEEE resource ecological compensation mechanism was constructed mainly through the innovation of institutional mechanisms, so government in law, economy and necessary administrative means played an important role in improving the control measures for WEEE resource processing. At the same time, all parties involved in society will be actively guided through introducing the ecological compensation mechanism to explore the path of ecological compensation socialization.

4.1.3 Full compensation and feasible

WEEE resource ecological compensation should be compensated for various costs or losses caused by WEEE resource treatment. In fact, the impact of WEEE resource processing is multifaceted so it is necessary to quantitatively analyze the ecological environment cost, social cost and economic cost. Effective ecological compensation for WEEE resource should be based on accurate pricing. If the compensation pricing is too low, it will not be motivating difficult to achieve the desired compensation effect. However, if the compensation pricing is too high, it will generate an unnecessary financial burden. Based on this, accurate pricing is one of the basic principles for constructing an ecological compensation mechanism. When determining the compensation standards and other indicators, it should be combined with

the actual situation of economic and social development of region.

4.1.4 Dynamic mechanism

In the construction of WEEE resource ecological compensation mechanism, it is necessary to consider that the arrangement of the system should be different in different time horizons. The same institutional arrangement has different effects in different time frames. Different institutional arrangements are required in different time frames to maintain the efficiency of the operation of the mechanism. Therefore, when constructing an ecological compensation mechanism, it should be

forward-looking.

4.2 Compensation mechanism framework design

The mechanism is a dynamic system composed of different elements. In this system, various elements are interacted with each other and move regularly to form the endogenous operation of the system. According to the general idea of establishing ecological compensation mechanism, the compensation mechanism framework includes four aspects: compensation subject, compensation object, compensation method and compensation standard, as is shown in Fig.1.

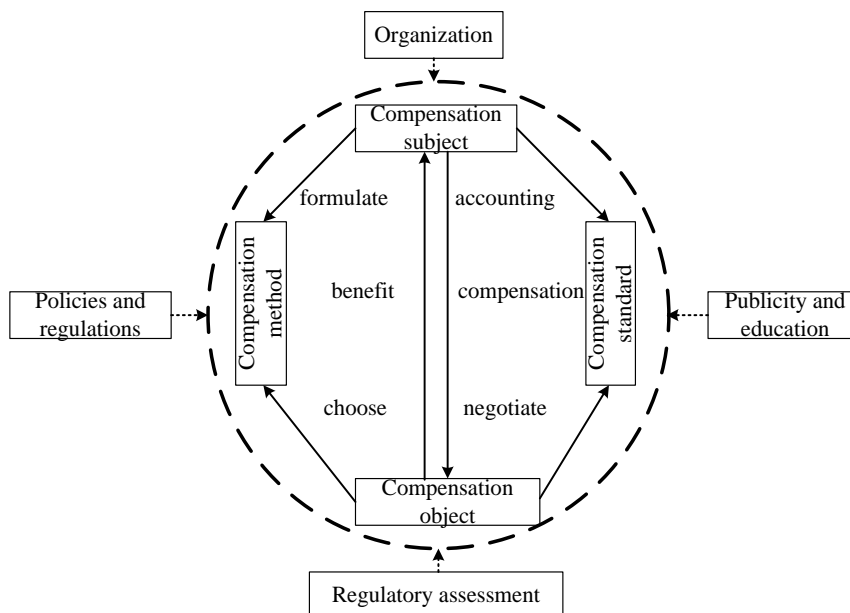


Fig.1 WEEE resource ecological compensation mechanism framework

4.2.1 Compensation subject

Compensation subject is the issuer of the ecological compensation activity. According to the externality theory and the beneficiary compensation principle, the ecological compensation subject should be the enjoyer of the positive externality of the ecological service or the producer of the ecological service. For the beneficiary object, the benefited area and individual shall bear the corresponding ecological compensation fee. If the beneficiary object is not clear, the beneficiary representative shall be responsible for the corresponding ecological compensation responsibility.

The nature of the public goods in the ecological environment determines that its supply is mainly the responsibility of the government. In WEEE resource ecological compensation mechanism, government is the supervisor of ecological compensation mechanism and promotes ecological compensation as compensation subject. Among them, central government is a leading position in ecological compensation mechanism, while local government assumes the role of implementation and is responsible for implementation of ecological compensation work. The central government and local

governments together constitute the main body of compensation in ecological compensation mechanism.

4.2.2 Compensation object

The compensation object is the object that the rights and obligations of the compensation subject pointed to. According to the externality theory, the ecological compensation object should be the recipient of the negative externality of the ecological service or the producer of the externality of ecological service.

4.2.3 Compensation method

The compensation method is the specific compensation method provided by compensation subject to compensation object in a predetermined form under certain social and economic conditions. According to the principle of "development priority, ecological priority", compensation subject should give priority to the coordinated development of economic and social development of the affected area to restore the ecological environment when determining the compensation method. At the same time, it is necessary to set up various compensation forms in combination with the actual situation to meet the willingness of compensation for the diversification of objects. The main compensation methods are as follows.

(1) Financial compensation

Financial compensation should be based on major ecological projects and strive for the use of ecological compensation financial resources for the recycling of WEEE resources. When obtaining the central government special transfer payment through ecological engineering project, local government should also undertake certain compensation obligations such as providing financial support for ecological compensation and assisting the central government in ecological compensation. In addition, construction of the ecological compensation mechanism must take into account the horizontal transfer of financial funds from different regional governments in order to achieve a relatively balanced ecological compensation state between regions.

(2) Policy compensation

Related laws and regulations should be made to support the development of WEEE resource recycling enterprises. And specific layout design, management methods and emission standards should be formulated to various aspects of specific implementation process.

(3) Technical compensation

Technical compensation should be used to support for WEEE resource recycling enterprises. On the one hand, WEEE resource utilization involves more specific supporting technologies, and most of them have great space for improvement in practical applications. On the other hand, the development of WEEE resource enterprises not only requires improvement of existing technologies, but also requires newly integrated technologies. Therefore, technical compensation is one of the important compensation methods in ecological compensation mechanism.

(4) Intellectual compensation

In the process of WEEE resources, the main body of production and management will be deepening the cognition of ecological compensation mechanism through training, lectures and publicity. This can improve the ability and technical level of the production and management to carry out WEEE resources.

4.2.4 Compensation standard

The compensation standard is the specific compensation amount paid by compensation subject to compensation object according to the predetermined basis under certain social and economic conditions. It solves the problem of "how much to make up." According to the principle of "sufficient compensation and practical feasibility", the compensation entity should first account the various impacts or losses caused by WEEE resource disposal. Then the total loss value and determine the specific amount according to the social development level and the compensation object agreed upon will be calculate.

V. WEEE RESOURCE ECOLOGICAL COMPENSATION GUARANTEE MECHANISM

Compensation guarantee mechanism is a series of supporting measures to ensure the smooth operation of WEEE resource ecological compensation mechanism, which solves the problem of how to ensure compensation. WEEE resource ecological compensation guarantee mechanism is mainly constructed from the following four aspects.

5.1 Organizations guarantee mechanism

WEEE resource ecological compensation mechanism is a complex system involving the relationship between environmental protection and economic development. Strong organizational leadership, unified deployment of major issues and comprehensive decision-making should be guaranteed to resolve possible conflicts between different stakeholders and strengthens close coordination between departments and regions.

5.2 Policies and regulations

Policies and regulations are the guarantee for smooth operation of WEEE resource ecological compensation mechanism. Through the establishment and improvement of relevant policies and regulations, WEEE resource ecological compensation should be incorporated into the regional development plan. The compensation object, compensation method and compensation standard should be clearly defined to avoid short-term and disordered ecological compensation mechanism. At the same time, the supporting policy system of ecological compensation information disclosure and interest expression negotiation including the standardized track should be clearly defined.

5.3 Regulatory assessment

In order to protect the rights and interests of stakeholders such as compensation subjects and compensation objects, supervision and joint law enforcement mechanisms should be introduced to ensure the transparent operation of ecological compensation activities using administrative supervision, media supervision and public supervision in

the process of implementing ecological compensation. At the same time, a technical advisory committee for evaluating compensation mechanism will be established to regularly evaluate the operation status and implementation effects, which can provide reference for further improving the compensation mechanism and provide a basis for dynamic adjustment of relevant compensation indicators.

5.4 Publicity and education

In the process of implementing ecological compensation, public participation should be actively promoted and fully implemented through various meetings, document books and news media and festival activities. Environmental protection and legal awareness of public should be enhanced and participation in WEEE resource ecological compensation of public should be strengthened to jointly promote WEEE resources and improve the ecological compensation mechanism continuous.

VI. POLICY RECOMMENDATIONS FOR WEEE RESOURCE ECOLOGICAL COMPENSATION MECHANISM

6.1 Establishing WEEE resource ecological compensation decision-making coordination organization

WEEE resource ecological compensation mechanism is an institutional arrangement for adjusting the relationship of stakeholders in WEEE production and achieving regional coordinated development, which involves urban government, government departments, WEEE disposal units and production areas. In order to standardize the process of ecological compensation, WEEE resource ecological compensation management system should be established, and corresponding mechanisms to exercise the relevant functions of decision-making, coordination, supervision of ecological compensation should be set up.

6.2 Improving relevant policies and regulations on WEEE resource ecological compensation

WEEE resource compensation mechanism involves many stakeholders. The operation of compensation activities is

very complicated. It must not only cooperate with WEEE generation, WEEE charging and WEEE processing, but also requires the support and protection of relevant policies and regulations. Reasonable policies and regulations are the prerequisites for ensuring the implementation of WEEE resource ecological compensation mechanism.

6.3 Increasing the investment in WEEE resources ecological compensation

The current WEEE resource ecological compensation funds can be invested by relevant levels of government and be used for separate accounting and special funds. The ecological compensation funds can be combined with the actual situation of WEEE production area and treatment area applying economic means and legal means such as product feedback (electricity, steam, heat, etc.), WEEE treatment fee reduction, WEEE incineration power generation fee reduction, municipal infrastructure allocation and other compensation methods.

Government can guide WEEE production areas and processing areas to establish horizontal compensation relationships through voluntary negotiations, support counterpart cooperation, industry transfer and personnel training using a negotiation platform. Besides, implementing inter-regional horizontal ecological compensation in the form of co-construction of parks, combined with national policies and mechanisms for ecological compensation can expand ecological compensation methods such as land replacement, resettlement, construction project substitution, ecological trading, personnel training and technical support.

6.4 Strengthening the supervision of WEEE resource ecological compensation

The effective operation of ecological compensation mechanism is inseparable from the supervision and management of compensation activities. The supervisory agency can clarify the rights and obligations of the compensation subject and object. Also it can constrain the behavior of the relevant stakeholders during ecological compensation through conjunction with the

decision-making, coordination and organization to supervise the corresponding duties of the compensation entity. Besides, a performance appraisal system for funds use and corresponding reward and punishment mechanisms should be set up to regularly assess the allocation of funds in the process of ecological compensation and monitor the use of ecological compensation funds throughout the whole process through understand the various demands of compensation objects. In this system, the funds for ecological compensation should be regularly audited and the information disclosure should be improved among media supervision and public supervision.

6.5 Raising awareness of ecological compensation for public

WEEE resource ecological compensation cannot be separated from the active participation of public. This is the social foundation for establishment the compensation mechanism when public participation in the principles of openness, equality, breadth and convenience. Taking into account factors such as geography, occupation, professional knowledge background and degree of influence, reasonable choice of legal persons or other organizations should be solicited. Through the extensive participation of public, negative impact of WEEE resource utilization will jointly be coped with, involving the overall harmonious development of various interest groups.

VII. CONCLUSIONS

The improvement of economic level and the acceleration of urbanization have brought about changes in the number and structure of WEEE. Traditional WEEE management model based on end processing is innovating and WEEE resource approach with sustainable development and circular economy is becoming more and more important. However, environmental protection has a strong external effect, which leads to the WEEE resource relatively slow. In addition, WEEE process itself has technical, personnel and financial difficulties, so it is difficult to carry out

related activities consciously. This paper analyzes and summarizes the status and existing problems of WEEE resource utilization. Then WEEE resource ecological compensation mechanism framework from the aspects of compensation subject, compensation object, compensation method and compensation standard in Shandong is built. It is worth noting that the paper constructs WEEE resource ecological compensation mechanism, but there is no systematic dynamics simulation of compensation mechanism, which is the direction for further research.

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