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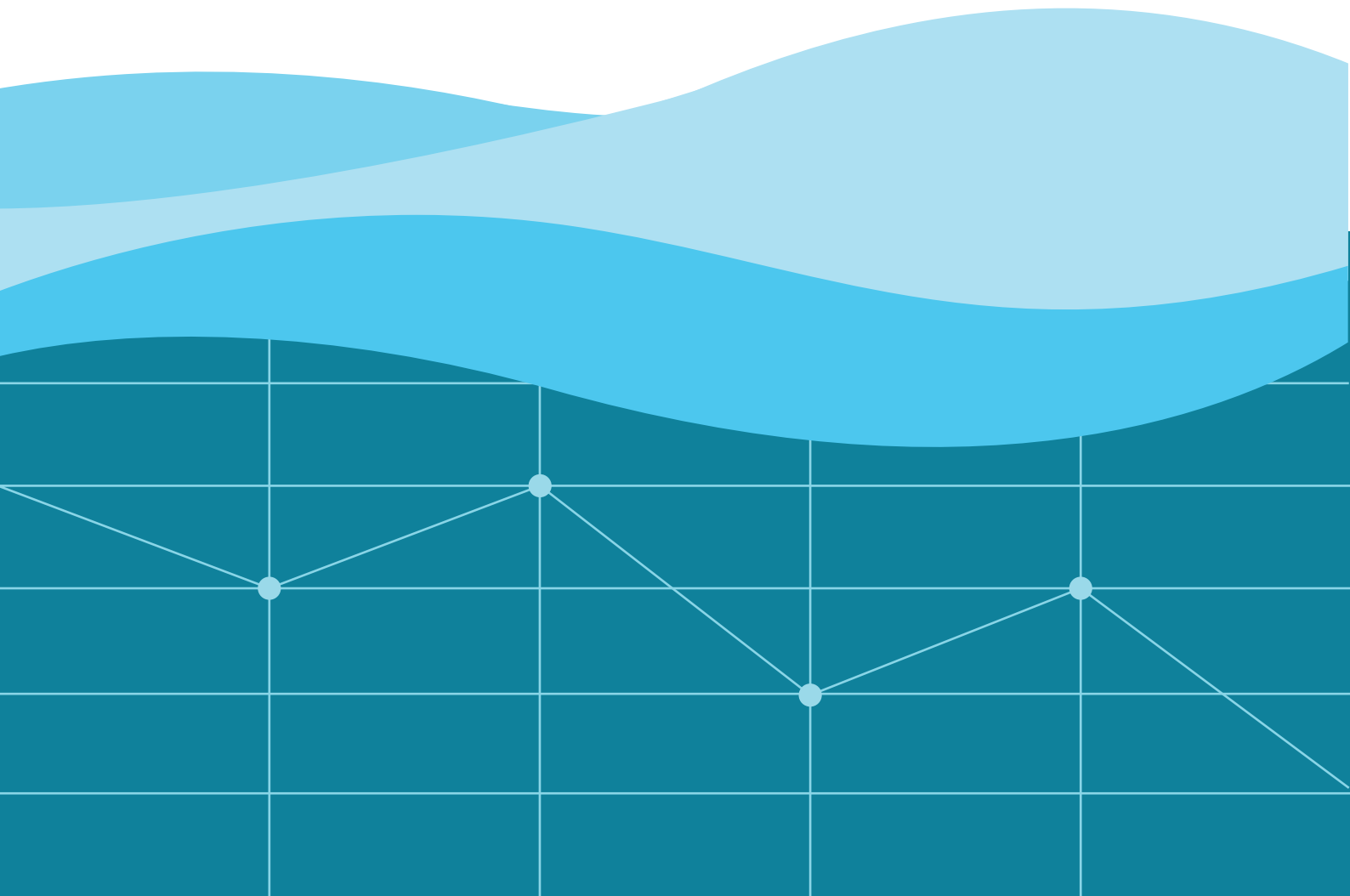
The External Environmental Cost of Coal



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Executive Summary

1.Background

China is the biggest coal producer and consumer in the world. Ever since the beginning of this century, China has witnessed an annual average growth rate in coal exploitation and utilization of 200 million tons. China's coal consumption in 2012 has reached 3.62 billion tons [1], which for the first time makes up more than half of total coal consumption in the world, namely 50.2%[2].

The current coal production and utilization methods in China have severe impact on the environment,including widespread destruction of land and vegetation, pollution to underground water resources, waste water, mining site subsidence, solid waste, and massive air pollution . A large proportion of $PM_{2.5}$ pollution , an air pollutant which has recently become something everyone is focusing on, comes from coal burning.

That the polluter should pay is the basic environmental economic principle, but China still has a long way to go to reach it. Though China currently has already implemented some tax policies that are advantageous to the environment, such as pollutant discharge fees, resources taxes and sustainable development funds, in the light of practical environmental destruction caused by coal, these policies are very much insufficient to make up for the real external environmental costs of coal production and utilization.

In order to calculate the environmental costs of developing and utilizing coal and also to search for policies to deal with them, the China Academy for Environmental Planning (CAEP), funded by Energy Foundation China(EFC), has carried out this study .

[1] Data source: Statistical Bulletin of National Bureau of Statistics

[2] Data source: 2013 BP Statistical Review of World Energy

2.Accounting Framework and approaches

This study developed an accounting framework and approaches for environmental cost across the whole supply chain of coal from a life cycle perspective. (see Figure 2-1).

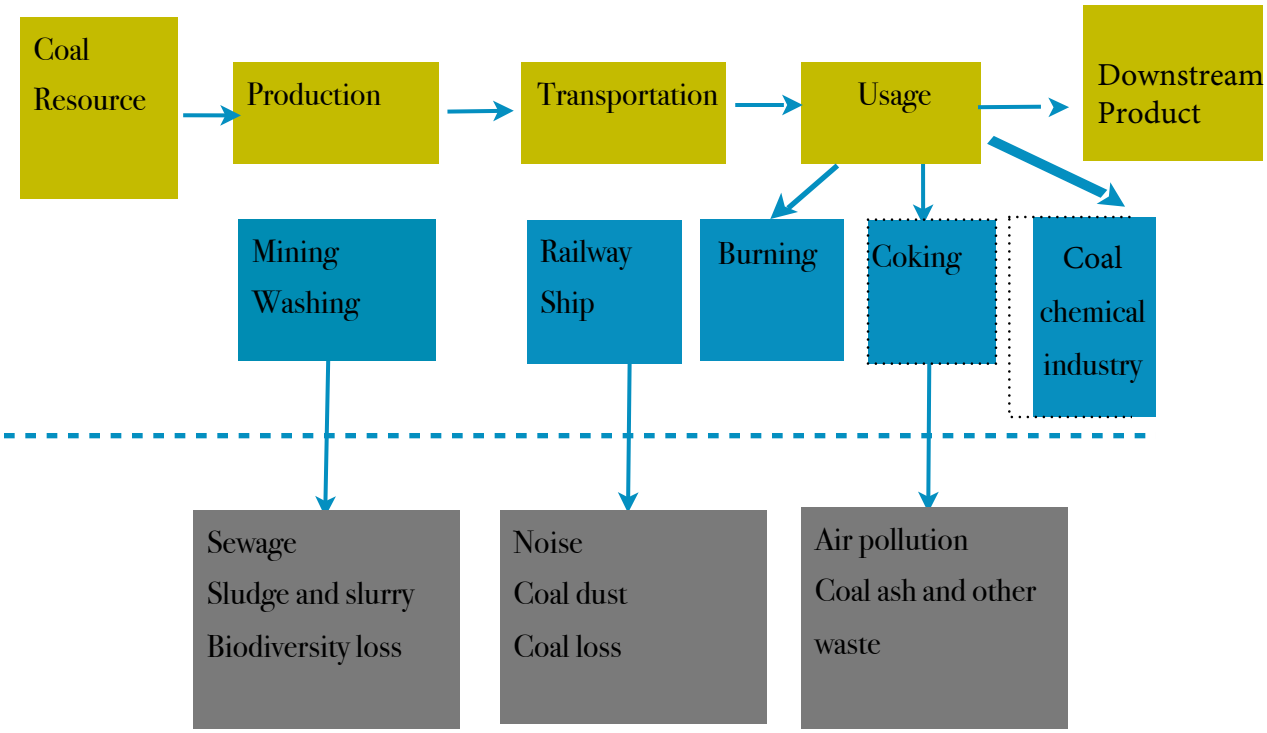

Figure 2-1 Life cycle of coal

Integrating the coal life cycle environmental cost theory, we define the external environmental costs of coal as the economic losses of environmental damages and ecosystem destruction caused by coal mining, transportation and utilization processes, which the benefited enterprise fails to pay.

2.1Accounting framework

Based on the product life cycle theory, by analyzing the objects and scope of environmental impact of the whole supply chain, we determined the environmental pollution inventory of coal, then defined specific accounting items. Finally, we monetized the environmental loss based on the accounting framework of the external environmental cost of coal. (see Table 2-1).

Table2-1 The framework of accounting external environmental cost of coal

		Amount	Evaluation
Coal Production			
Pollution	Water pollution	Sewage Discharge	Sewage discharge cost
	Air pollution	1.Number of mine workers who suffer from black lung	1Mine worker and family economic lost
		2.Water to clean the mine site	2.Clean cost
		3.Polluted agriculture area	3.griculture loss
	Solid waste	1.Gangue land use	1.Land cost
		2.Gangue storage	2.Soil pollution
			3.Gangue loss
Ecology damage	Aquatic Ecosystem	1.Polluted water	1.Water resource loss
		2.Runoff and land damage	2.Runoff and land loss
		3.Water shortage	3.Regional economic loss from water scarcity
		4.Drought	4.Loss from drought
	Land Ecosystem	Land subsidence area	1.Land loss from subsidence
			2.Emigration cost
			3.Transportation facility damage
	Forest Ecosystem	1.Wood consumption	1.Biodiversity loss
		2.Deforestation area	2.Planting cost
			3.Deforestation loss
			4.Ecological loss
	Grassland Ecosystem	Grassland damage area	Grassland ecological value loss

		Amount	Evaluation
	Agriculture Ecosystem	Arable land damage area	Arable land loss value
	Wetland Ecosystem	Wetland damage area	Wetland ecological value
Coal transportation			
	Railway transportation	1.Coal loss 2.Average distance	1.Coal loss value 2.Pollution during transportation
	Waterway transportation	Coal loss and coal dust during unloading and uploading	1.Coal loss value 2.Pollution damage value
	Road transportation	1.Coal loss on the road 2.Coal dust during unloading and uploading	1.Coal loss value 2.Pollution damage value
	Storage	Coal dust	Coal dust pollution damage
Coal Usage			
		Increased mortality and morbidity due to combustion pollution	Public health loss
		Agriculture productivity reduction	Agriculture economic loss
		Population affected by pollution	Clean cost
		CO_2 Emission	Economic loss caused by CO_2 emission
		Sledge and coal ash amount	Solid waste storage damage

2.2 Accounting approaches

The existing approaches of assessing the value of environmental pollution include four categories: the direct market evaluation approach, the surrogate market evaluation approach, the willingness-to-pay approach, and the achievement reference approach. Approaches to material damage monetization adopted in this report include the market value approach, defensive cost approach, restoration or replacement cost approach, shadow project approach, opportunity cost approach and human capital approach. Based on these approaches, the accounting methodology of determining the environmental external costs of coal are identified as follows:

Table 2-2 The accounting methodology of external environmental cost of coal

Phase	Pollution type	Value	Accounting approach
Coal exploitation	Water pollution	Loss of waste mine water	Restoration or replacement cost approach
	Air pollution	Loss of mining workers having pneumoconiosis disease	Human capital approach
	Solid waste pollution	Opportunity cost of gangue stockpiling area	Opportunity cost approach
		Natural gangue pollution	Restoration or replacement cost approach
		Loss of land covered by gangue	Restoration or replacement cost approach
	Water environment	Soil and water loss	Restoration or replacement cost approach
		Damage to water resource	Shadow pricing approach
	Land	Land resources loss caused by surface subsidence	Restoration or replacement cost approach

Phase	Pollution type	Value	Accounting approach
		Immigration due to subsidence	Shadow pricing approach
	Forest	Diversity loss of timber consumption	Market value approach
		Timber loss of forest land occupied	Market value approach
		Eco-function loss of forest land	Shadow pricing approach & Market price approach
		Additional expense of planned forestation	Market value approach
	Grassland	Loss of grassland service value	Shadow pricing approach
	Farmland	Loss of farmland service value	Shadow pricing approach
Coal Transportation	Railway transportation	Coal loss during railway transportation	Market value approach
		Environment pollution during railway transportation	Opportunity cost approach
	Port handling	Coal loss during waterway transportation	Market value approach
		Coal dust pollution during handling	Market value approach
	Coal stockpiling	Coal dust pollution caused by year-end stock of coal	Market value approach
Coal utilization	Loss caused by air pollution	Health loss	Human capital approach
		Added cleaning fee	Human capital approach
		Agriculture loss	Market value approach

2.3 Accounting result

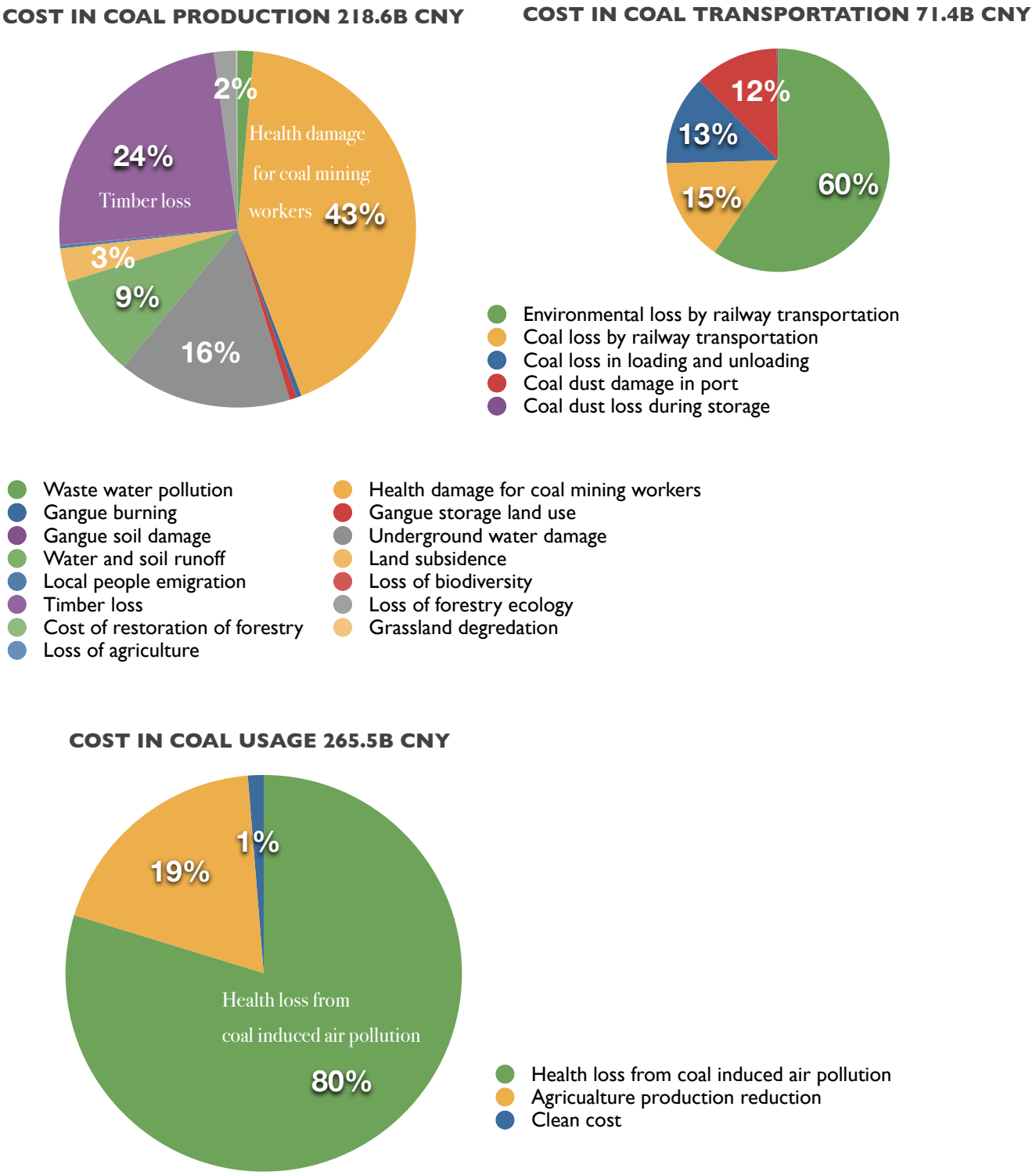

Figure2-2 Life cycle external environmental cost of coal

The external environmental cost of coal in 2010 has reached CNY 555.544 billion , of which 218.595 billion, 71. 413 billion and 265.537 billion yuan were from production, transport and utilization of coal respectively, and accounting for 39%, 13% and 48% of the total cost. The total environmental cost of coal per ton in 2010 was CNY 204.76 yuan , coal production, transportation and utilization share a burden of 67.68, 52.04 and 85.04 yuan per ton respectively. Please see Figure 2-2 for specific accounting percentage.

We rank the different items of loss, (Figure 2-3), among all of the external environmental cost accounting items, damage to health caused by air pollution and health loss of the mine workers made up the largest proportion, totaling 305.1 billion yuan, which accounts for 55% of total external environmental costs. Next in importance are timber loss, reduction of crops, environmental pollution caused by railway transportation, damage to underground water resources as well as soil and water damage.

The above-mentioned calculations were carried out in a relatively conservative way. For example, this study mainly adopted human capital approach to calculate health damage. This is a comparatively conservative estimation method, if we calculated the same health loss based on the willingness-to-pay approach, the estimated loss might be about three times. [3]

With respect to the environmental pollution that occurs during coal production, the loss of social productivity owning to pneumoconiosis of mine workers is 14.81 yuan per ton, which accounts for 48% of environment pollution cost. The economic cost of timber loss is 16.04 yuan per ton which accounts for the biggest percentage of ecological destruction cost. With regard to transportation costs, the environmental pollution caused by rail transportation is 27.28 yuan per ton, which makes up 52%. In terms of utilization costs, damage to health caused by air pollution from coal burning is 67.81 yuan per ton, which makes up for the biggest percentage.

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[3] World Bank,China environmental cost of pollution: Economic estimates of physical damages [EB/OL]. 2007:67-74.(2006-12-31)[2013-07-01]http://siteresources.worldbank.org/INTEAPREGTOPENVIRONMENT/Resources/China_Cost_of_Pollution.pdf

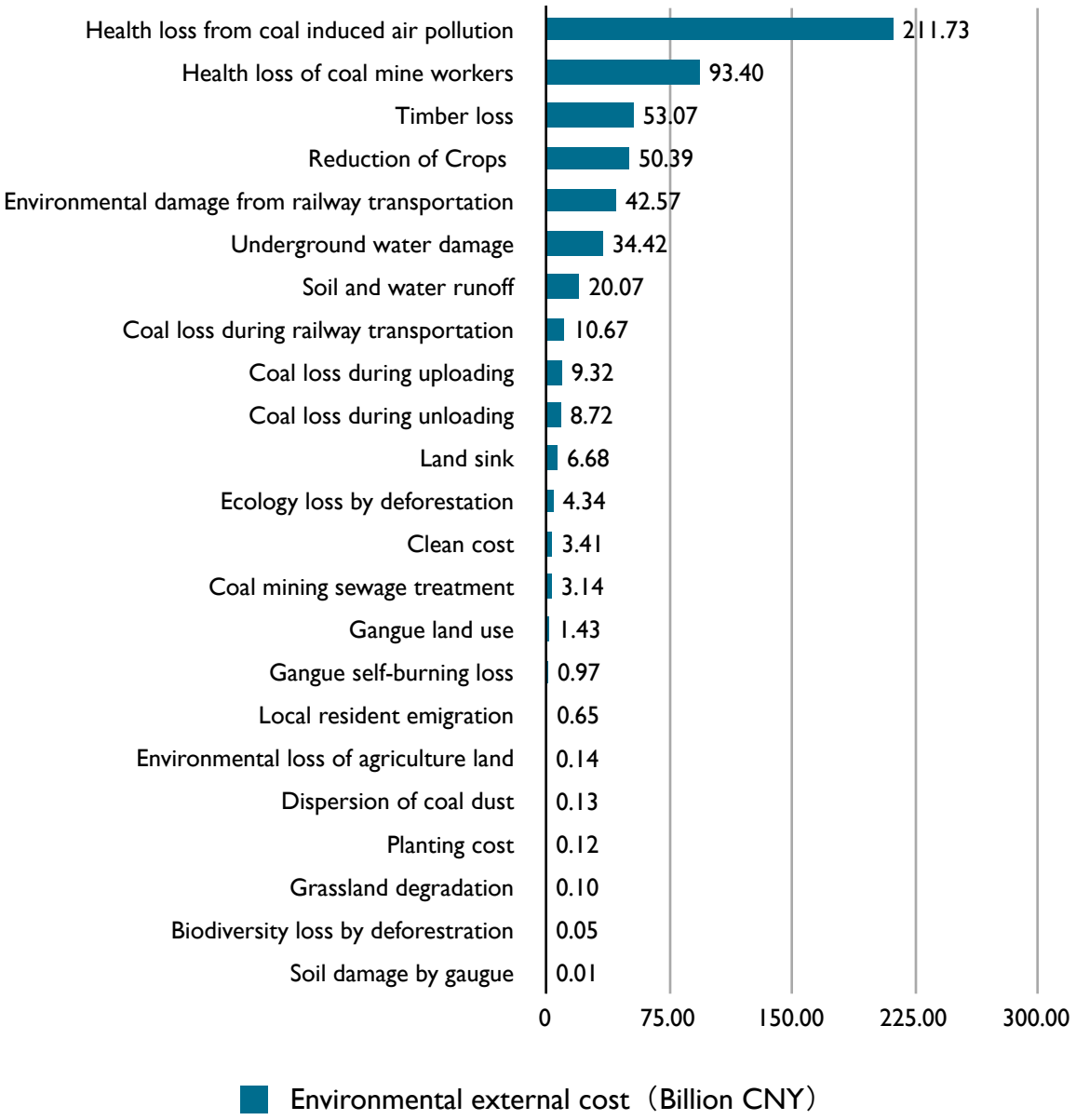

Figure 2-3 Ranking the environmental external cost items

2.4 Comparison with other studies

In 2008, with the support from Energy Foundation, Greenpeace and WWF, the Unirule Institute of Economics, together with experts and scholars in various fields, completed *The Cost of Coal research (TCOC)*.The research gave calculation on various external cost of coal utilization in China, including air pollution, water pollution, ecosystem degradation, health loss and cost and price distortion caused by government regulation. We have made a comparison of the external environmental costs especially:

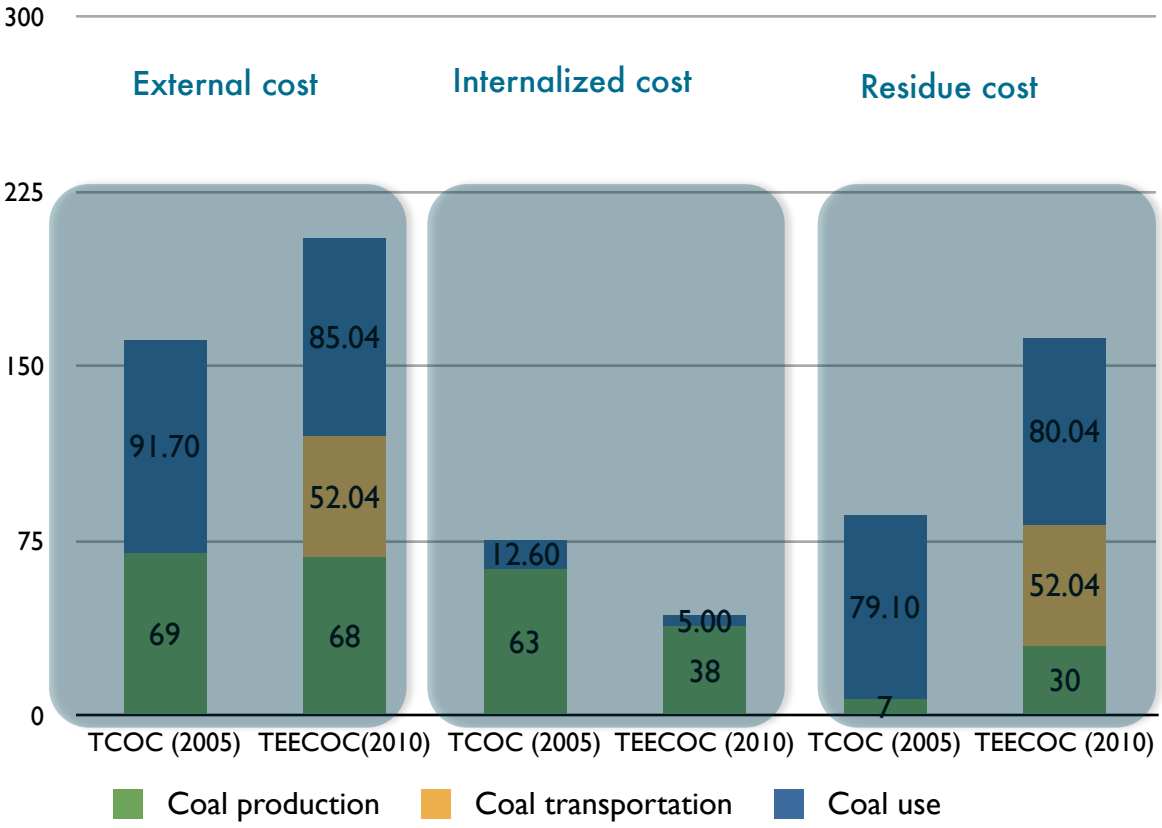

Figure 2 – 4 Comparison with TCOC report

3.Coal supply chain evaluation:Environmental tax and fee policy in China

3.1 Categories of existing environmental taxes and fees on coal

China currently has more than 100 of taxes and fees on coal, including 21 items of taxes such as value-added tax, resource tax and corporate income tax, etc. Besides tax, there are 92 fees that coal enterprises need to pay to get various approvals from different authorities, including 40 administrative undertaking fees, six operating fees and 46 railway & port freight and other miscellaneous fees. Various taxes and fees on coal account for 25% to 35% of enterprise revenue.

There are currently over ten different types of taxes and fees are relating to resources and the environment (see Figure 3-1). In the coal mining process, charges include fees for exploration

and mining rights, deposits for mineral resource compensation, pollutant discharge fees, deposit s for mine environment governance and restoration, funds for the sustainable development of coal, emission trading, compensation fees for soil erosion and funds for forestry restoration. With respect to the processing phase, it mainly includes pollutant discharge fee and emission trading. Fuel tax is mainly imposed on transportation. Pollutant discharge fees and emission trading are mainly included for burning. These policies have not been implemented national wide.

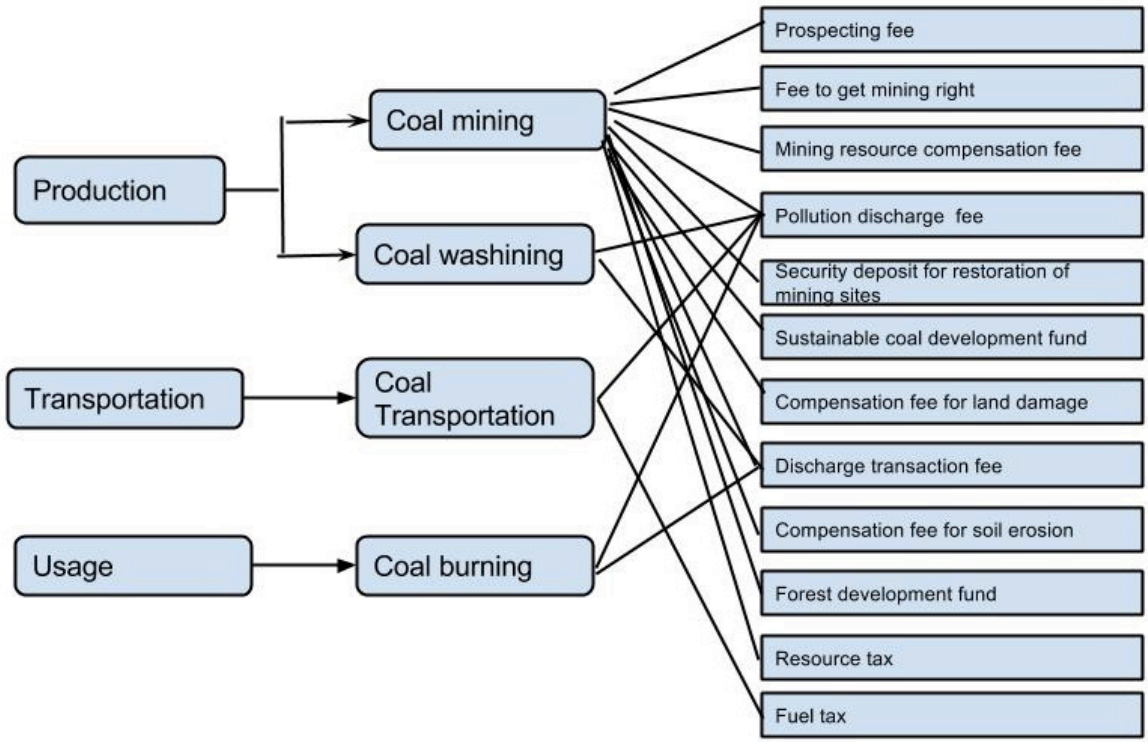

Figure 3-1 Tax&Fee in coal supply chain

3.2 Environment tax and fee burdens in the supply chain

Big differences exist in tax and fee policies in different areas, and different types of coal pay different level taxes & fees. All of the environment taxes and fees charged in the whole supply chain of coal ranged from 30 to 55 yuan per ton, which only accounts for 15%~27% of external environmental cost.

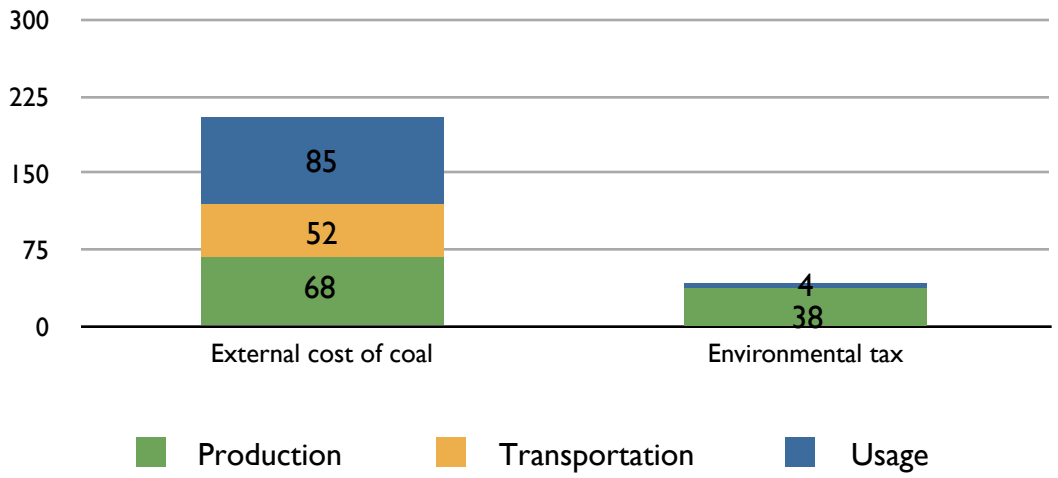

Figure3－2 Comparison on environmental tax–fee burden with external cost

Further analysis shows that most of the environmental taxes and fees are set for the mining of coal. Barely any environmental taxes and fees are charged for coal transportation , execpt the pollutant discharge fee is imposed on road dust only in limited areas. Pollutant discharge fees are mainly regarded as environment taxes and fees for coal burning and utilization, which is only five yuan per ton and is far lower than its external environmental cost. Figure 3-2 shows a comparison between the environment taxes and fees burden across the whole chain and the external environmental costs per ton of coal.Please see Table 3-1 for detailed information regarding the environment taxes and fees burden across the whole chain.

3.3 Problems with the existing environment taxes and fees for coal

Although coal pricing is already market-based, unreasonableness still exists in the pricing scheme and basically fails to reflect the cost of environmental damage. Currently, more attention has begun to be paid to environmental taxes and fees, and there are already certain institutional foundations imposing taxes on coal production and utilization: the existing environmental tax policies for coal have enhanced the awareness of environmental protection for the coal mining and consuming enterprises, and a certain amount of funds has been raised for pollution treatment and ecological restoration. Nevertheless, there are still a few problems.

Table 3-1 Environmental taxes and fees in the coal supply chain

Phase	Tax type	Value(CNY/ton)	
Production	Resource tax	2-4	Steam coal
	Compensation fee of mineral resource	5	Based on sale price, 500 CNY/ton
	Fee of exploration right application	Neglected	
	Fee of mining right application		
	Cost of exploration right and mining right	2-4	
	Pollutant discharge fee	1	Literature
	Fund for sustainable development of coal	5-23	Minimum threshold and maximum threshold are taken.
	Deposit for mine environment governance and restoration	10	Shanxi province
	Land reclamation fee	0.6-2	Shanxi province and Henan province
	Fee for the prevention and control of soil and water loss	0.7	Shanxi province
	Forestry development fund	0.05-0.1	Shanxi province
Transportation	Pollutant discharge fee	Neglected	
Utilization	Pollutant discharge fee	5	Estimated value
In total	31—55		

Firstly, distortion in mining resource taxes exists in China. In general, the tax burden rate is excessive, and the rate for cross-generational resource loss compensation and environmental compensation for exploitation is relatively low. Secondly, the environmental tax policies of coal are chaotic and there are no national standards or regulations. Moreover, there are some obvious defects in some major environmental tax policies. Current pollutant discharge standards are far lower than pollution treatment costs, which makes the cost of violation of the laws much lower

than the cost of complying with the laws, so that the system cannot assume the role it is supposed to.

Therefore, adjustment of the structure of categories of coal taxes and fees needs to be done in order to add environmental tax policies that reasonably reflect the environmental cost of coal. Price transmission mechanism needs to be carried out to fulfill the task of regulating the energy consumption structure and compensating the environment pollution losses and intergenerational resource compensation.

4. Internalization the environmental cost of coal

Since policy plans vary in terms of orientation, charging intention and targets for regulation (see Table 4-1), policies shall be proposed with the basic principle of internalizing the environmental costs of coal development. It should have combine the opportunities conditions, planning & coordination and system considerations of each policy.

There are some methods that can internalize the external environmental costs of coal: the level of internalization can be raised via strict enforcement of the laws, and enhance the effectiveness of execution of current policies. Revising and improving the existing laws and regulation can also achieve this goal, and inducing new policies is yet another way. Tax is a basic measure for internalizing environmental external costs, we can introduce different specific items under the environmental tax scheme to internalize different environmental damage. This research carried out step by step combination and grading operation on the three aforementioned policy schemes for internalizing the environmental costs of coal.

Policy scenario	Function	Intention	Implementation recommendations
Pollutant discharge tax	Pollutant discharge during the whole process of coal exploitation	Aims for pollution treatment and environmental protection so as to internalize environment pollution loss	Reform the pollution discharge to tax

Policy scenario	Function	Intention	Implementation recommendations
Ecological protection tax	Compensating ecological destruction caused by coal exploitation	Compensate ecological destruction caused by mining exploitation activities, correct negative ecological externality caused by mining activities	It shall be promoted step by step and finally reach a tax which reveals the external cost of ecological compensation.
Resource tax	Cost of coal resource depletion and environment, ecosystem damage	It embodies the state's right to coal resources and aims to restore ecosystem damage and environment pollution caused by coal	Promote resource tax reform and solve ecological and environmental issues during coal exploitation.

Table 4-1 Comprehensive analysis of policy schemes for internalizing the environmental costs of coal

5. Estimations of the effects and impacts of internalizing the external environmental cost of coal

Coal prices will inevitably increase with the progress of internalizing the environmental costs of coal, which will bring impacts on the economy, household consumption and international competitiveness. Those impacts must be fully taken into consideration during the internalizing process, and thus a reasonable policy roadmap should be set out.

This study used the GREAT-E model to analyze how internalization measures influences the macro economy, income level, industrial structure, trade structure, and demand factors. The findings are shown as follows:

(1) Internalizing the environmental cost of coal would have a certain impact on China's GDP growth; internalizing all external costs of mining, transportation and use of coal separately would have a limited impact on China's GDP , which is still within a bearable range. However, if there were a full internalization of the environmental costs of the whole life cycle

of coal, there would be a negative impact on GDP, where there would be a reduction of more than 0.15% .

(2) Internalizing the environmental cost of coal would have an obvious effect on income distribution, and would bring negative impacts on the welfare improvement of residents. Measures such as increasing subsidies to the impacted population need to be carried out to neutralize the policy's negative impact on income distribution.

(3) Internalizing the environmental cost of coal can optimize industrial structure. It will have a restraining effect on heavy industry, and foster industry upgrade.

(4) The policy of internalization of the environmental costs of coal would be beneficial for optimizing the structure of import and export trade. It will help to correct China's "trade surplus and energy deficit" distortion in its international trade structure.