

Research on the Demarcation of Provincial Initial Emission Quotas and the Emissions Trading

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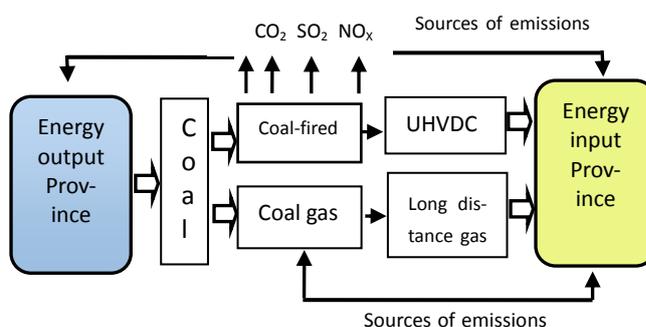
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Abstract: The distribution of China's energy resources and consumption is trending to reverse. Inter-provincial cooperation from of energy transforms form transporting coal to building coal-fired power, electricity transmission and natural gas transmission. That led to the increase in total emissions and environmental pressure in energy-rich province domain, which bring pressure to completion of regional emission reduction targets. This article propose to study and explore the "fair allocation of emission rights, effective exchange of emission rights" among provinces. It has not only the theoretical value, but also practical significance. On one hand, it is based on quantify emissions accounting standards and methods to research quantify emissions accounting standards and methods to provide a quantitative basis for project-based market. On the other hand, it is the goal of scientific rationality to configure the provincial domain initial emission rights. It is scientifically setting emissions baselines according to the provincial domain resource endowment, economic level, environmental capacity, capital and technology, population quality, development potential and space differentiation characteristics. So that it can provide a reasonable basis for allowance- based market. It promotes energy conservation and carbon reduction, in order to jointly cope with climate change while promoting the energy cooperation among provinces.

1 The phenomenon of the the energy and emission source reverse migration

It is not balanced between the resources owned and the economic development in China. 76% coal existed in the north and northwest, but the distribution of consumption is in reverse. Over 70% consumption is distributed in the developed southeast coastal area. Recently, because of the ecological requirements of the developed southeast coastal area and the limitation of the environment capability, the transformation of energy cooperation across provinces is promoted from transporting the coal to transporting the SNG in order to realize the power transmission to coal mine and coal-fired power plant. It formed the positive output of clean energy and the backward transfer of pollution sources. (see Picture 1)

In the "Thirteen Five" Plan, the government will designate the provinces total energy consumption "red line", especially the total coal consumption because of strengthening the haze pollution and climate change. It will put the three emissions targets of CO₂, SO₂, NO_x directly linked to regional development assessment. To this end, problems of quantify accounting, horizontal compensation, cross transactions of the emission rights cause national and energy output provinces' attention in the process of inter-provincial energy cooperation. Which includes science and rationality of provinces initial configuration of emission rights. And market exchange and trading emission rights issues have also been academic attention. Therefore, it is a new topic that fair allocation of emission rights and effective exchange of emission rights inter-provincial cooperation. It has not only the theoretical value, but also practical significance.



Picture1. The positive output of clean energy and the backward transfer of pollution sources.

2 Quantitative assessment and accounting of the Emission source reverse migration in the cooperation projects between two types of energies

It is well known that the traditional way of energy cooperation across provinces including the arrangement of thermal power plants in energy input province and the contract with the energy-rich province to ensure the energy(electricity) supply within this area.

2.1 The accounting of main emissions from the pithead coal-fired power plants project

Because the pithead coal-fired power plants are set up at the edge of the coal base, they can supply the electricity to coastal power grid point to point, in order to reduce the coal transportation and release the

Table 1:The estimated emissions of building million kilowatts coals and the impacts on the ecological environment

	Coal consumption (Ten thousand tons)	The emissions of CO ₂ (Ten thousand tons)	The emissions of SO ₂ (Tons)	The emissions of NO _x (Tons)
The project of million kilowatts coals	230	400	3000	1200
185 million kilowatts (Year 2015)	42550	74000	555000	222000

environment pressure. Based on ‘the Emission standard of air pollutants for thermal power plants (GB13223-2011)’ and ‘the Provincial greenhouse gas inventory guidelines (for Trial Implementation)’(2011), the emission can be accounted in a quantitative way. The main emissions during the process of coal-fired power generation, such as CO₂, SO₂, NO_x,TSP are measured. (see Table 1).

2.2 The major emissions accounting of Synthetic Natural Gas project

Coal Based Synthetic Natural Gas is an energy that through coal gasification produces synthesis gas, and then after methanation process produces Synthetic Natural Gas (SNG). Synthetic Natural Gas (SNG) is a clean energy with high energy conversion rate (up to about 50%), which after combustion , particulate matter ,SO₂ , CO of its release accounts for only 1/ 660 , 1/120 , 1/ 132 comparing to coal combustion,coastal provinces are happy to develop.According to Environmental impact report of 1200M3/d Synthetic Natural Gas(SNG) project and relevant analysis and research, plus relevant accounting methods and standards , it can be quantified accounting. We estimates CO₂, SO₂, waste and wastewater which coal-fired power generation mainly discharges preliminarily(as shown in Table 2).

Table 2. The emissions and environmental impact estimates of building 2 billion M³ / year Synthetic Natural Gas (SNG)

	Coal consumption (10 ⁴ tons)	Emission of CO ₂ (10 ⁴ tons)	Emission of SO ₂ (tons)	Ash(10 ⁴ tons)	Waste water(10 ⁴ tons)
2 billion M ³ / year SNG	580	1580	4500	60	130
18 billion M ³ (2015)	5220	14220	40500	540	1170

Data source: WANG Xiaowu, HUA Ben, Comparison between liquefied natural gas, pipe natural gas and substitute natural gas, CIESC Journal, Vol1 60(2009),35-38

3 Initial emission right has been the scarce environmental resources property right to each province

On the premise of esurience that the implementation of this right wouldn't damage other public environmental rights and interests, the right of emission right refers to the right of discharging pollutants into the environment in accordance with the law, which is within the quota allocated by environmental protection administration. Like water resources and mineral resources, emission right also belongs to the public resources. The configuration of all provinces' traditional emission right has two characteristics: firstly, emission quotas is configured free of charge under the guidance of the state; secondly, emission quota is based on regional historical emissions, with the configuration method of "base + decline rate".

Table 3:The energy input of the southeast coastal economically developed provinces:

Province	Percent of energy self-sufficiency(%)	Inputting power (10 ⁴ KW h)	Inputting coal gas (108 M ³)	Emission reduction of CO ₂	Emission reduction of SO ₂	Emission reduction of NO _x	Emission right E-CSN
A ₁ (Shanghai)	0.65	X ₁	Y ₁	E-T ₁	E-L ₁	E-D ₁	E-CSN ₁
A ₂ (Zhejiang)	3.9	X ₂	Y ₂	E-T ₂	E-L ₂	E-D ₂	E-CSN ₂
A ₃ (Jiangsu)	12.7	X ₃	Y ₃	E-T ₃	E-L ₃	E-D ₃	E-CSN ₃
A ₄ (Guangdong)	22.2	X ₄	Y ₄	E-T ₄	E-L ₄	E-D ₄	E-CSN ₄
A ₅ (Fujian)	33.2	X ₅	Y ₅	E-T ₅	E-L ₅	E-D ₅	E-CSN ₅
A ₆ (Shandong)	46.8	X ₆	Y ₆	E-T ₆	E-L ₆	E-D ₆	E-CSN ₆
A _i		X _i	Y _i	E-T _i	E-L _i	E-D _i	E-CSN _i

Remarks: CSN_i represents the overall amount emission of CO₂ ,SO₂NO_x of the special energy inputting provinces. All of CSN_i are national binding emission reductions except CO₂.

Suppose, energy inputting province is A_i , energy outputting province is B_i , during the provincial energy cooperation, regarding Coal power generation and coal gasification as the research object (as shown in table three, table 4), the output power of province B_i is X_i ; gas transmission volume is Y_i ; according to the related emissions accounting standards and methods:

(A) by simplifying and quantifying to the total emission of province B_i 's energy output of X_i and Y_i :

$$E_{B_i} = \sum (x_i * EF_{i,k} + y_i * EF_{i,k}) = \sum (E_{Ti} + E_{Li} + E_{Di})$$

(B) Thereinto, EB_i stands for the reverse emissions of province B_i 's output power and gas volume;

EF: emission factor (kg/KWh);

X_i : the output power of B_i (KWh);

I: the type of fuel;

K: the type of power generation technology.

(C) With the same emission accounting standards and methods of province B_i , convert province A_i 's clean energy input "to reduce emissions":

$$E_{A_i} = \sum (X_i * EF_{i,k} + Y_i * EF_{i,k}) = \sum (E_{Ti} + E_{Li} + E_{Di})$$

(D) The nationally initial emission quota of energy outputting province B_i is $E\text{-csni}$; when changing the energy cooperation mode, it turns to be $+EB_i$

The nationally initial emission quota of energy inputting province A_i is $E\text{-CSNi}$; when changing the energy cooperation mode, it turns to be $-EA_i$

(E) The emission reducing task of province B_i is large: $E(B) = E\text{-csni} * (1 - \beta B_i) + EB_i$ βB_i : the emission reducing rate (national requirements)

Province A_i takes a new path of emission reduction: $E(A) = E\text{-CSNi} * (1 - \beta A_i) - EA_i$ βA_i : the emission reducing rate (national requirements)

In order to construct an emissions trading market system of the provincial inter domain, the rationality and fairness of the baseline of each provincial initial emission quota turns out to be the basic scientific problem. Whether it is reasonable of the initial emission quota of energy inputting province B_i ($E\text{-csni}$) and the initial emission quota of energy inputting province A_i ($E\text{-CSN}$), it may needs further and deeper research to figure out the scientific basis (resource endowment (α), economic level (δ), environmental capacity (ETA), financial capital (f), science and Technology Foundation (μ), the quality of the population (P), the development potential of (λ) and regional (θ) etc.). At the same time, we also need to create a fair market environment for the development of the provincial emission rights trading, to provide a public platform to solve the structural contradiction of the "energy and emissions reverse migration" during the provincial energy cooperation. From the national perspective, Western energy bases shifting from coal to gas transmission, brought the problem of "emission source reverse migration", but is good to relief Eastern environmental pressure and coal pressure. By the mode and mechanism of marketing emission trading, the state can guide the economic developed province to change from the energy corporation to industry corporation and environmental protection corporation, to bring capital, technology, talent for energy output provinces, in order to promote the development of low carbon green circulation.

4 Developing country's two types and three kinds of Emissions-trading market

Taking international responsibility of climate change is GOC's promise. So developing allowance-based and project-based emissions trading market. While developing this two kinds of trading mode, system and mechanism are very important. First, developing two types of emissions-trading market which called allowance-based and project-based. Second, developing three kinds of emissions-trading market which contain CO_2 , SO_2 , NO_x . These are called country's two types and three kinds of Emissions-trading market. The later belongs to the national binding's emission. Processing separately CO_2 , SO_2 , NO_x trading's issue through researching three kinds of emission's type pattern, quantity, accounting method, verify method, inspect method.

4.1 Allowance-based emission trading market mode

Allowance-based emission trading market mode is similar to Joint Implemented in Kyoto Protocol, energy input province A_i helps output province B_i to build emission project, and sell the emission reduction unit to deduct the assigned amount units or charge against the parts of units that clean energy forward output which is part of pollution source reverse remove's unit. According to emissions trading markets, certifying emission reduction units and getting China's approval. At present, the energy input province A_i have reduce the energy conservation and emission reduction's marginal efficiency, but the emission reduction's cost rise. Trans-provincial emission reduction's allowance-based market and project-based market can reduce emission reduction's cost and increase efficiency so it can bring about country's emission reduction's goal.

Base in country layer's emission rights' exchange and trading's top layer design and institutional arrangement, it can solve government and market's fairness and efficiency's problem radically. For example, giving up selling the emission rights B_i or making sure the buyer A_i subject, trading format, pricing institution, settlement bargain, and also including emission allowance's granting, emission units' certificating, emission online monitor. These can boost trans-provincial emission rights' trading scientization, rationalization and standardization.

4.2 Base in trans-provincial energy cooperation project's emission rights trading mode.

Energy project certified emission amount units can be exchanged and traded separate in two parts. One is emission rights trading, Energy output province B_i can sell all or parts of emission units in country emission rights trading market. And energy input province A_i can buy all or parts of emission units. They can negotiate the price or use the market mechanism. After the trade, energy output province B_i admit and except emission source remove reverse, and energy input province A_i get

the Emission Reduction Units because of buying the emission rights. The other is emission rights exchange. Energy input province A_i exchange the Certified Emission Amount Units with energy output province B_i that is the energy cooperation partner. Those units are reckoned in province A_i 's emission gross. According to development situation, emission reduction's tendency, market changing, overall trend each province will make policy choice and market judge in emission rights dealing or exchange trading market.

Developing trans-provincial emission rights trading market's micro foundation is country need formulate the accounting standard and method in emission reduction project or something about energy project. And certificating the project's Certified Emission Amount Units for certificating, measuring, computing the emission units in trans-provincial's emission rights trading or exchanging.

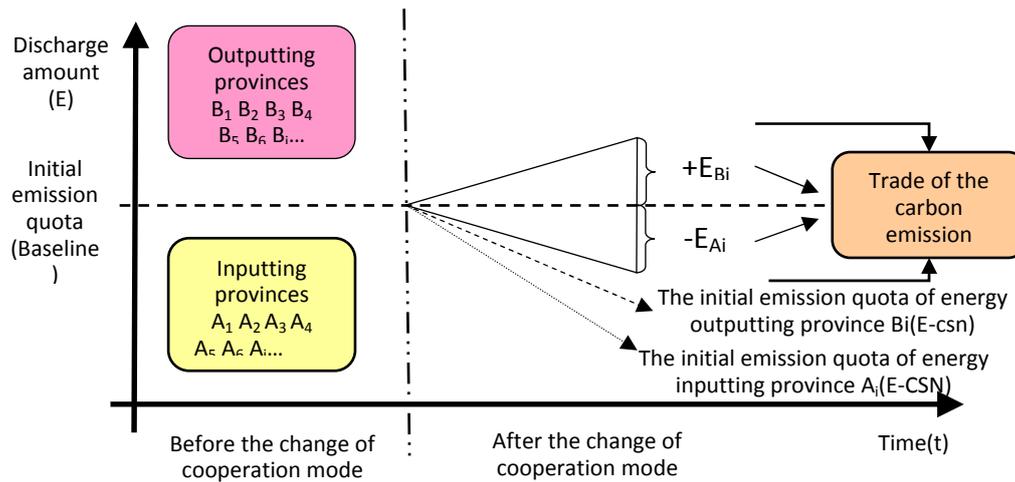
Each province's emission rights deal with the emission source remove problem through the government policy administration and market trading institution. Each province's policy administration's is emission initial configuration, trans-provincial's emission rights trading or exchanging is market mechanism, the goal is to control emission gross ,optimize emission rights' configuration and increase the emission efficiency. Trans-provincial energy cooperation corresponding to two types and three kinds(two types are allowance-based and project-based emissions trading market, three emission mode contains

CO_2 , SO_2 , NO_x)emission trading market. New mode include two types and three kinds emission rights market management institution, running system and the third party certification, which containing emission certification's granted, certified emission amount units, trading law system. Also including emission trade rights' trade program, trade mode, pricing institution, clearance and settlement, emission online monitor's setting between each province. So that giving the new thought in the innovation of the trans-provincial in emission trading market system.

Table 4:The energy output of the five largest energy bases

	Province	Outputting power 10^4 KWh	Outputting coal gas 10^8 M ₃	Emission reduction of CO ₂	Emission reduction of SO ₂	Emission reduction of NO _x	Emission right E-csn _i
Shanxi energy base	B1(Shanxi)	x_1	y_1	$E-t_1$	$E-l_1$	$E-d_1$	$E-csn_1$
Region of Inner Mongolia energy base	B2(Inner Mongolia)	x_2	y_2	$E-t_2$	$E-l_2$	$E-d_{12}$	$E-csn_2$
Xinjiang energy base	B3(Xinjiang)	x_3	y_3	$E-t_3$	$E-l_3$	$E-d_3$	$E-csn_3$
Erdos basin	B4(Shannxi)	x_4	y_4	$E-t_4$	$E-l_4$	$E-d_4$	$E-csn_4$
	B ₅ (Ningxia)	x_5	y_5	$E-t_5$	$E-l_5$	$E-d_5$	$E-csn_5$
	B ₆ (Gansu)	x_6	y_6	$E-t_6$	$E-l_6$	$E-d_6$	$E-csn_6$
The southwest energy base	B ₇ (Guizhou)	x_7	y_7	$E-t_7$	$E-l_7$	$E-d_7$	$E-csn_7$
	B ₈ (Yunnan)	x_8	y_8	$E-t_8$	$E-l_8$	$E-d_8$	$E-csn_8$
	B ₉ (Sichuan)	x_9	y_9	$E-t_9$	$E-l_9$	$E-d_9$	$E-csn_9$
	B _i	x_i	y_i	$E-t_i$	$E-l_i$	$E-d_i$	$E-csn_i$

Remarks: CSN_i represents the overall amount emission of CO₂, SO₂ NO_x of the special energy inputting provinces. All of CSN_i are national binding emission reductions except CO₂.



Picture 2:Diagram of the provincial emission rights trading

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References

- [1] Schennach S M. The economics of pollution permit banking in the context of title IV of the 1990 clean air act amendments [J]. *Journal of Environmental Economics and Management*, 2000, 40(3):189-210.
- [2] IPCC. *Kyoto Protocol*, UK: Cambridge University Press, 2006
- [3] IPCC (Intergovernmental Panel on Climate Change). *Climate Change 2007—The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC*[R]. Cambridge: Cambridge University Press, 2007.
- [4] Goeree, J. et al (2010), "An experimental study of auctions versus grandfathering to assign pollution permits", *Journal of European Economic Association* 8 (2 - 3) :514 - 525.
- [5] Sovacool, B. K. (2010), "Building umbrellas or Arks? Three alternatives to carbon credits and offsets", *The Electricity Journal* 23 (2) :29 - 40.
- [6] Betz, R. et al (2010), "Auctioning greenhouse gas emissions permits in Australia", *Australian Journal of Agricultural and Resource Economics* 54 (2) :219 - 238.
- [7] ZHANG Sifeng, ZHANG Yan, TANG Min. Construction and application of evaluation model for restoration compensation for ecological damage in the exploitive zone of coal mines[J]. *Research of Environmental Sciences*, 2012, 25(1) : 116-124.
- [8] WANG Xiaowu, HUA Ben, Comparison between liquefied natural gas, pipe natural gas and substitute natural gas, *CIESC Journal*, Vol1 60(2009),35-38
- [9] Babiker M.H, Climate change policy, market structure, and carbon leakage, *Journal of International Economics* 65, 2005(2),126-131
- [10] Costanza R, D'Arge R, Groot R, et al. The value of the world's ecosystem services and natural Capital[J], *Nature*, 1997, 387: 233 -240. 386: 253-260.
- [11] EU. *Integrated pollution prevention and control (IPPC) reference document on best available techniques in the large combustion plants*[R]. Brussels: European Union, 2006.