Study on Production-based and Consumption-based CO_2 Emissions

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Research object

- Which sector is the largest CO2 emission sector based on input perspective, and which sector is the main sector contributing to it?
- Which sector is the largest CO2 emission sector based on demand perspective, and which sector is the main sector contributing to it?

introduction

- The widely used methodology for measuring CO_2 emissions in the IEA (2007a) and IPCC (2006) is production-based, that is, the CO_2 that is emitted within the nation is measured.
- The current studies are ***production-based—in effect domestic production including exports—and many critiques suggest the use of consumption-based methodology which subtract exports but include imports.***
- The two measurements reflect difference in the principle on emissions responsibilities: the consumption-based measurement corresponds to the "***beneficiary pays principle***," while the measurement of production-based emissions corresponds to the "***polluter pays principle***."
- consumption-based measurements offer the advantage of preventing carbon leakage, increasing the options available for mitigation, encouraging environmental comparative advantage, addressing competitiveness concerns. Moreover, they naturally encourage technology diffusion. The estimation based on the consumption-based methodology is important as basic information in terms of the equity.

Methods and data （1）

- The calculations are based on environmental input–output analysis (EIOA)
- the total output of an economy, x, can be expressed as the sum of intermediate consumption, Ax, and final consumption, y:

$$x = Ax + y \tag{1}$$

$$x = (I - A)^{-1}y \tag{2}$$

$$f = F(I - A)^{-1}y \tag{3}$$

- an environmental matrix, F, with *f* representing the sector-wise total supply-chain emissions to meet the final demand y.

Methods and data （2）

- This is the standard method for environmental IOA. However, this method is not sufficient for studies of trade as the direct requirements matrix A usually does not distinguish between domestically produced and imported products. Thus, it is common to derive new requirements matrices and final demand vectors in which only domestic goods are included, Ad and yd:

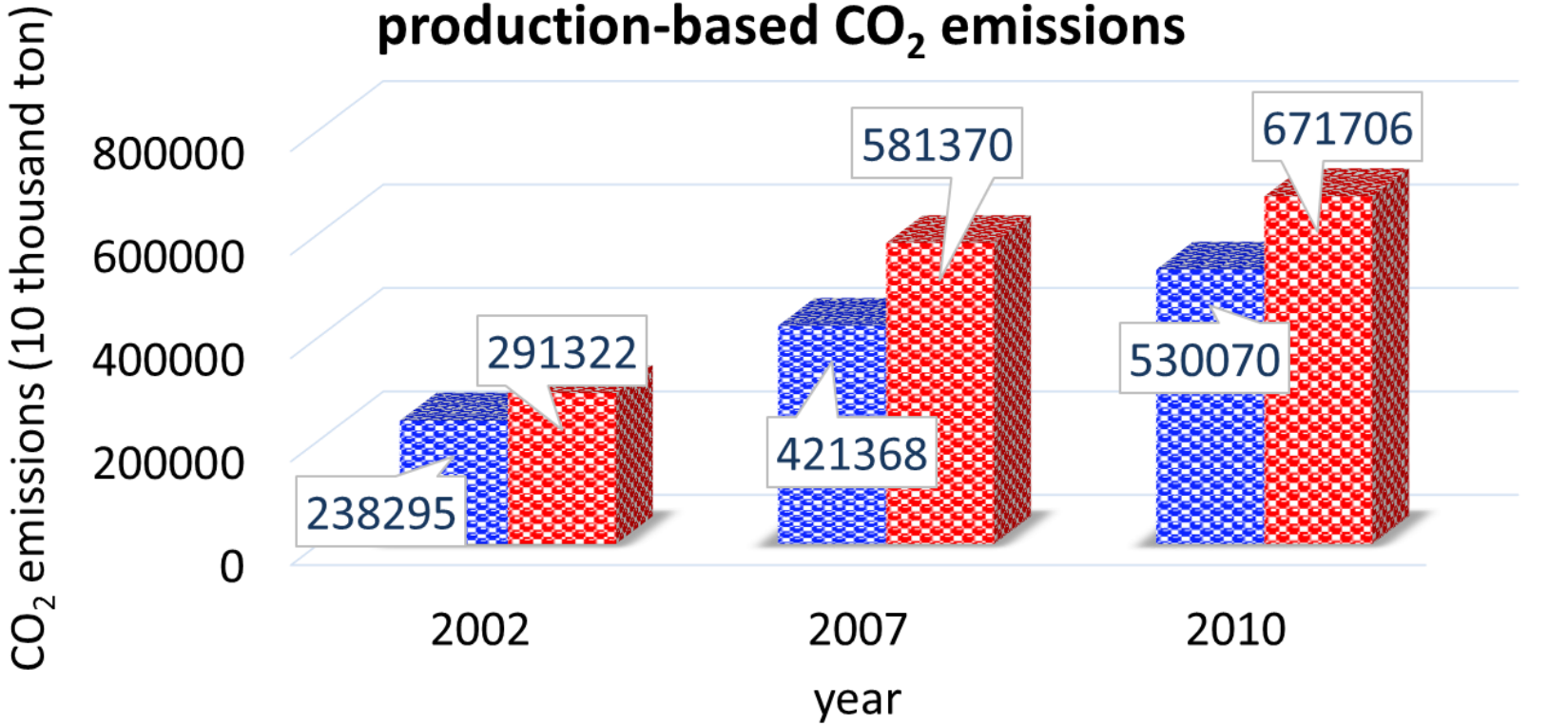
$$s_i = \frac{m_i}{x_i + m_i - e_i} \quad \text{for all } i$$
$$A_d = diag(s) * A$$
$$y_d = diag(s) * y \qquad (4)$$

$$f_r^{cons} = f_r^{prod} - f_r^{e} + f_r^{m} = f_r - f_r^{BEET}$$

Methods and data （3）

- We obtained the input–output tables from the Chinese National Bureau of Statistics (NBS) for 2002,2007 and 2010 with 42 sectors.
- The CO_2 by industry sector for 2002, 2007, and 2010 were constructed using official Chinese energy statistics and the IPCC reference approach (IPCC, 1996).
- The CO_2 emissions from the combustion of fuels = CO_2 emissions from total final consumption (except residential consumption) - CO_2 emissions from non-energy use + CO_2 emissions from thermal power + CO_2 emissions from heating supply.
- The CO_2 emissions of 42 sectors = CO_2 emission factor * output of 42 sectors .

Results-1



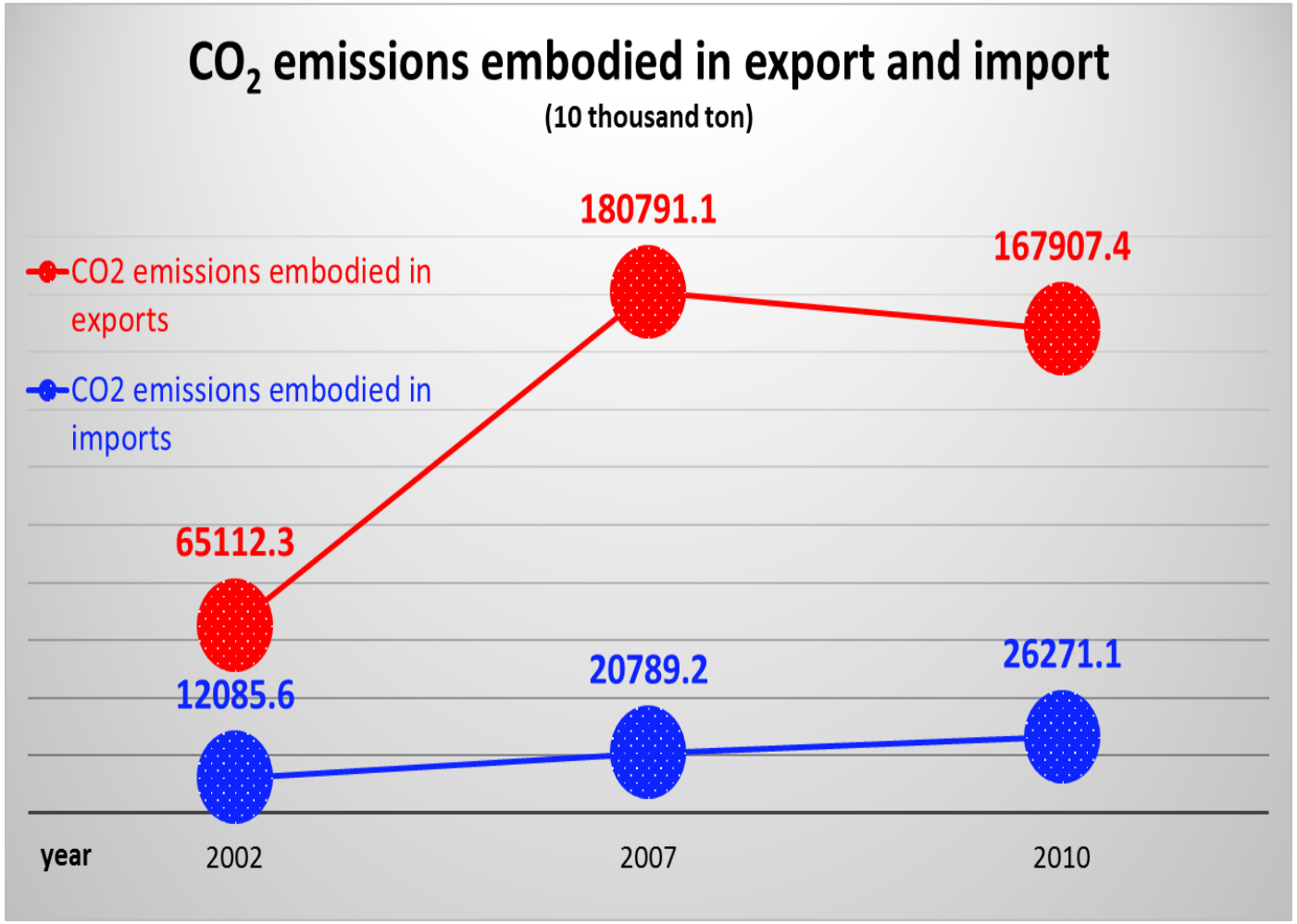
The Growth rate of consumption-based and production-based CO_2 emissions

	2007	2010
Consumption-based CO2 emissions	**76.83%**	**25.80%**
Production-based CO2 emissions	**99.56%**	**15.54%**

Balance of Emissions Embodied in Trade (BEET) could be a main cause for the differences between consumption-based CO_2 emissions and production-based CO_2 emissions.

China is a net exporter.

Results-2

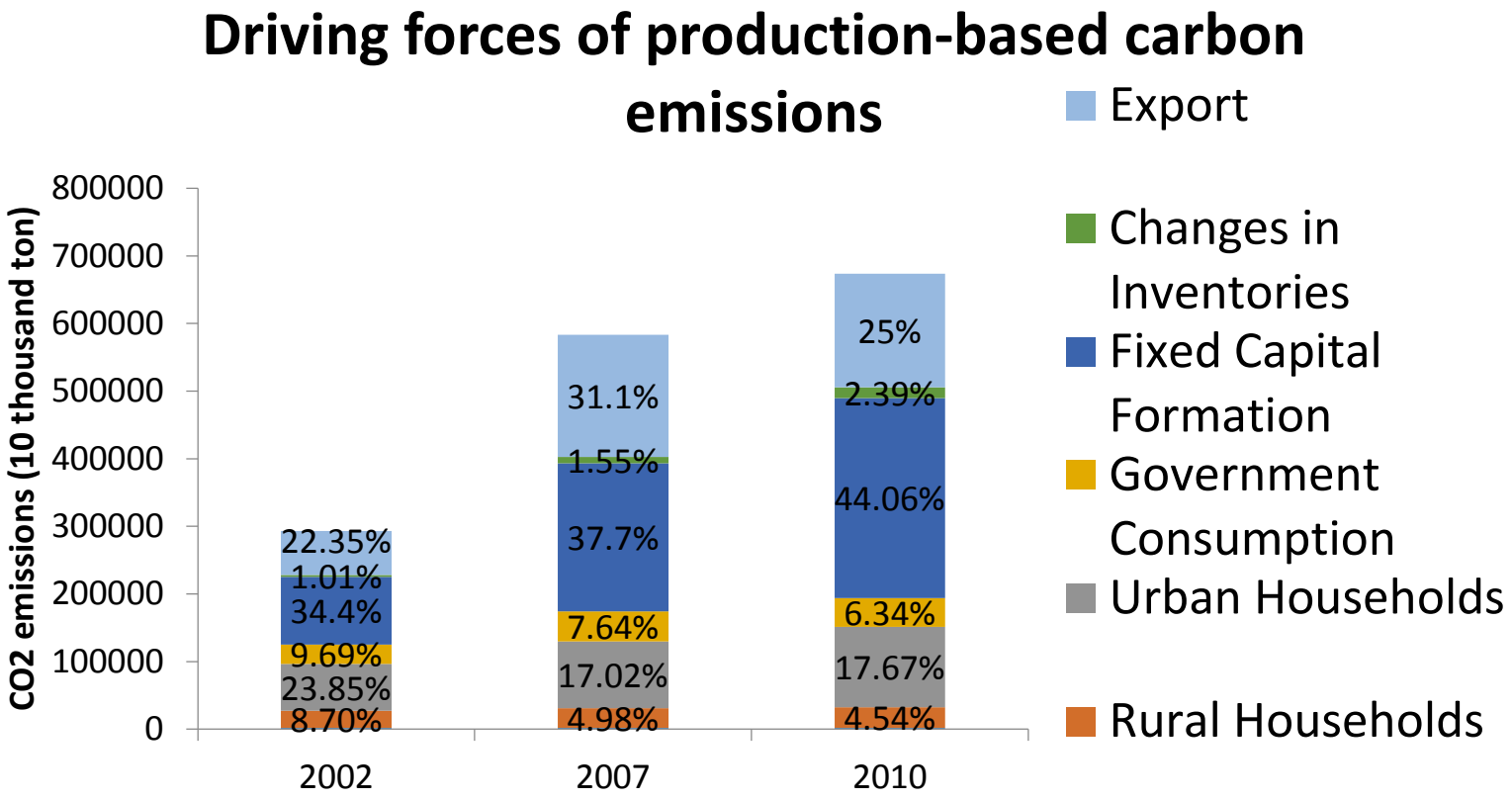


26% of China's domestic CO_2 emissions were in the production of exports from 2002 to 2010.

It is likely that consumption in the developed world is driving this trend.

Climate policies which would make the developed world responsible for China's export emissions have both benefits and costs, and must be carefully designed to achieve political consensus and equity. Whoever is responsible for these emissions, China's rapidly expanding infrastructure and inefficient coal-powered electricity system need urgent attention.

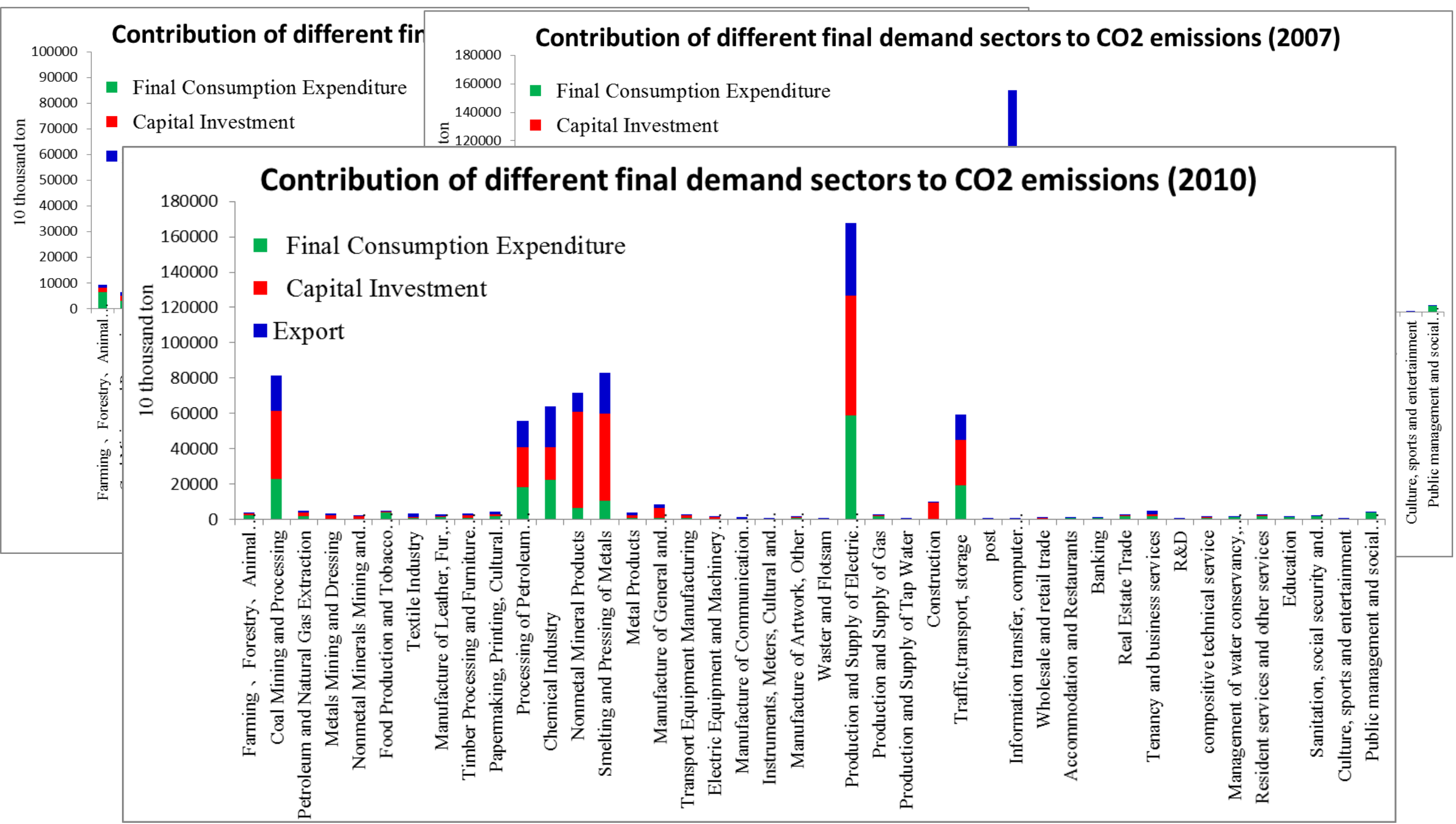
Results-3



	2002	2007	2010
Final Consumption expenditure	42. 24%	29. 65%	28. 55%
Capital Investment	35. 40%	39. 25%	46. 45%
Export	22. 35%	31. 10%	25. 00%

CO_2 emissions are mainly formed in the process of fixed capital formation in the production-based carbon emissions .

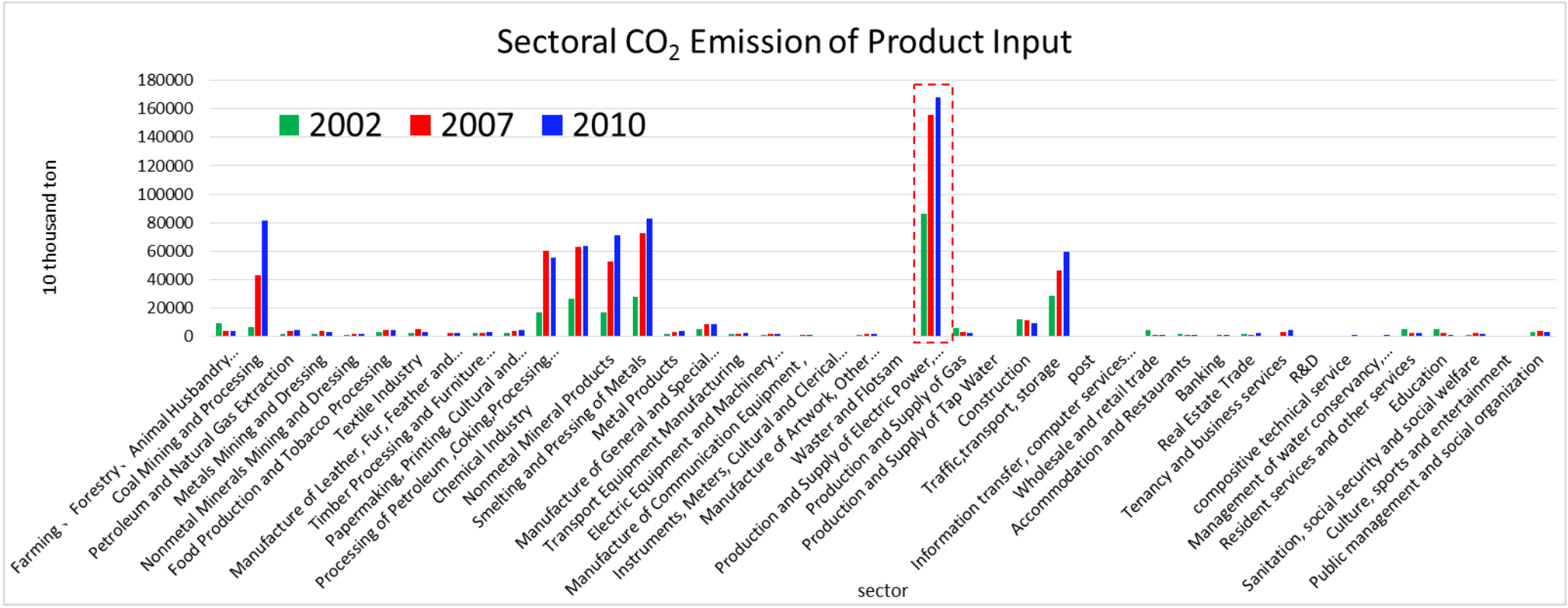
Although the CO_2 emissions of the process of final consumption increased year by year, the proportion is decreased.


Contribution of different fin
Final Consumption Expenditure
Capital Investment
10 thousand ton
Contribution of different final demand sectors to CO2 emissions (2007)
Final Consumption Expenditure
Capital Investment
ton
Contribution of different final demand sectors to CO2 emissions (2010)
Final Consumption Expenditure
Capital Investment
Export
10 thousand ton
Farming 、Forestry、Animal...
Coal Mining and Processing
Petroleum and Natural Gas Extraction
Metals Mining and Dressing
Nonmetal Minerals Mining and...
Food Production and Tobacco...
Textile Industry
Manufacture of Leather, Fur,...
Timber Processing and Furniture...
Papermaking, Printing, Cultural...
Processing of Petroleum...
Chemical Industry
Nonmetal Mineral Products
Smelting and Pressing of Metals
Metal Products
Manufacture of General and...
Transport Equipment Manufacturing
Electric Equipment and Machinery...
Manufacture of Communication...
Instruments, Meters, Cultural and...
Manufacture of Artwork, Other...
Waster and Flotsam
Production and Supply of Electric...
Production and Supply of Gas
Production and Supply of Tap Water
Construction
Traffic,transport, storage
post
Information transfer, computer...
Wholesale and retail trade
Accommodation and Restaurants
Banking
Real Estate Trade
Tenancy and business services
R&D
compositive technical service
Management of water conservancy,...
Resident services and other services
Education
Sanitation, social security and...
Culture, sports and entertainment
Public management and social...

Results-4

Sectoral CO_2 emission matrix provides a better understanding of the relationship between CO_2 emissions from product input and product demand.

Input perspective

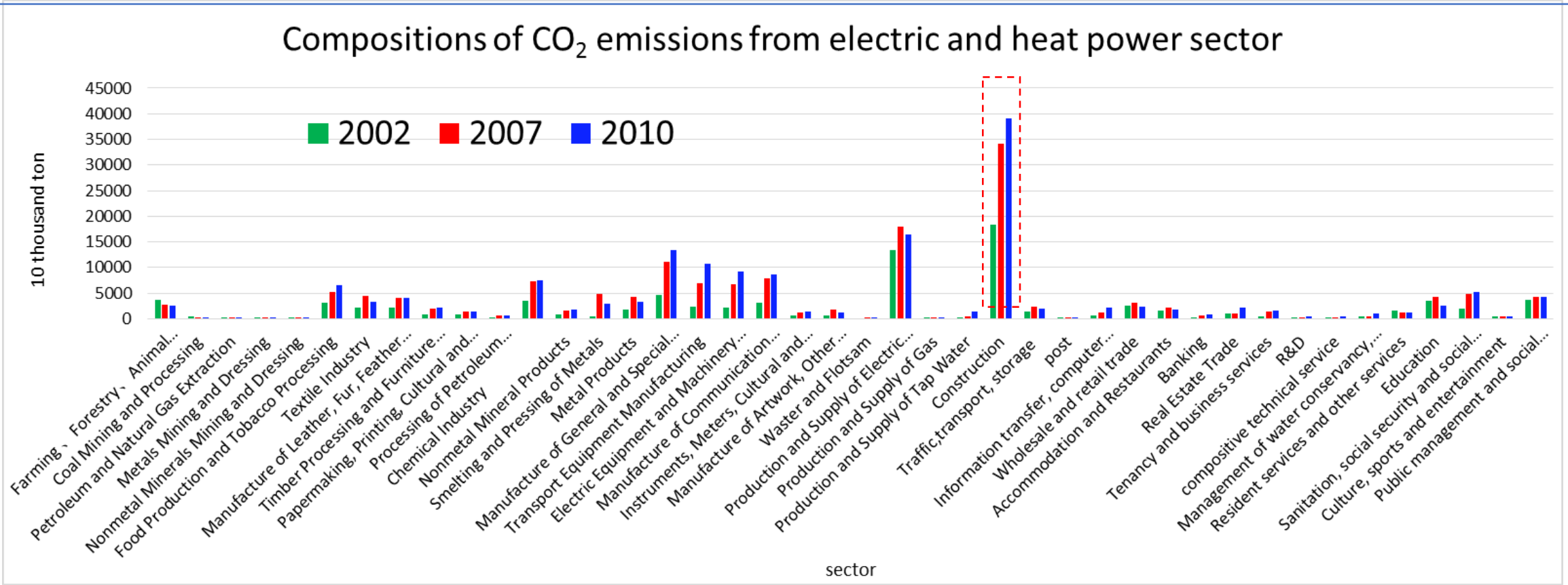


The sector of Production and Supply of Electric Power, Steam and Hot Water is the largest sector of CO_2 emissions on product input perspective, 27.2% of China's domestic CO_2 emissions during 2002 to 2010, which must be taken urgent policies.

Top sectors of CO_2 emissions by input perspective

2002			2007			2010		
sector	CO_2 emissions (10^4 ton)	Proportion (%)	sector	CO_2 emissions (10^4 ton)	Proportion (%)	sector	CO_2 emissions (10^4 ton)	Proportion (%)
Production and Supply of Electric Power,Steam and Hot Water	86592.42	29.72	Production and Supply of Electric Power, Steam and Hot Water	155558.3	26.76	Production and Supply of Electric Power, Steam and Hot Water	167947.7	25.00
Traffic,transport, storage	28398.05	9.75	Smelting and Pressing of Metals Smelting	72730.07	12.51	Smelting and Pressing of Metals	83221.16	12.39
Smelting and Pressing of Metals	27773.57	9.53	Chemical Industry	62973.99	10.83	Coal Mining and Processing	81407.01	12.12
Chemical Industry	26575.25	9.12	Processing of Petroleum ,Coking,Processing of Nucleus Fuel	60570.7	10.42	Nonmetal Mineral Products	71575.66	10.66
Processing of Petroleum ,Coking,Processing of Nucleus Fuel	17012.41	5.84	Nonmetal Mineral Products	52983.43	9.11	Chemical Industry	63944.89	9.52
Nonmetal Mineral Products	16829.37	5.78	Traffic,transport, storage	46403.29	7.98	Traffic,transport, storage	59550.4	8.87
Construction	12318.57	4.23	Coal Mining and Processing	43416.55	7.47	Processing of Petroleum ,Coking,Processing of Nucleus Fuel	55734.79	8.30
Total	215499.6	73.97	Total	494636.3	85.08	Total	583381.6	86.85

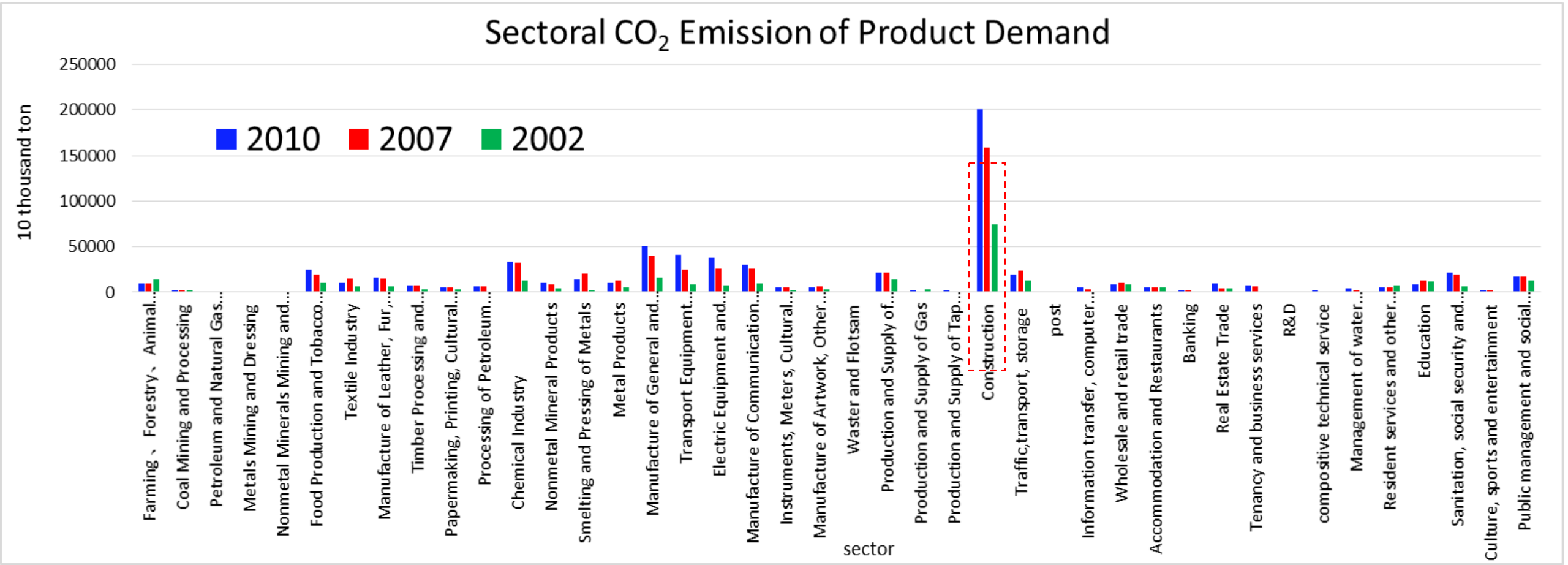
88.7% of the CO_2 emissions are generated for other sectors to supply electricity and heat. Construction sector is the largest sector using electricity and heat, resulting in **22.1%** of CO_2 emissions in the electric and heat power sector.



First, the power industry to improve power generation efficiency, control power generation process of CO_2 emissions.

Second, other sectors to improve the utilization efficiency of electricity , control electricity consumption, especially in the construction sector.

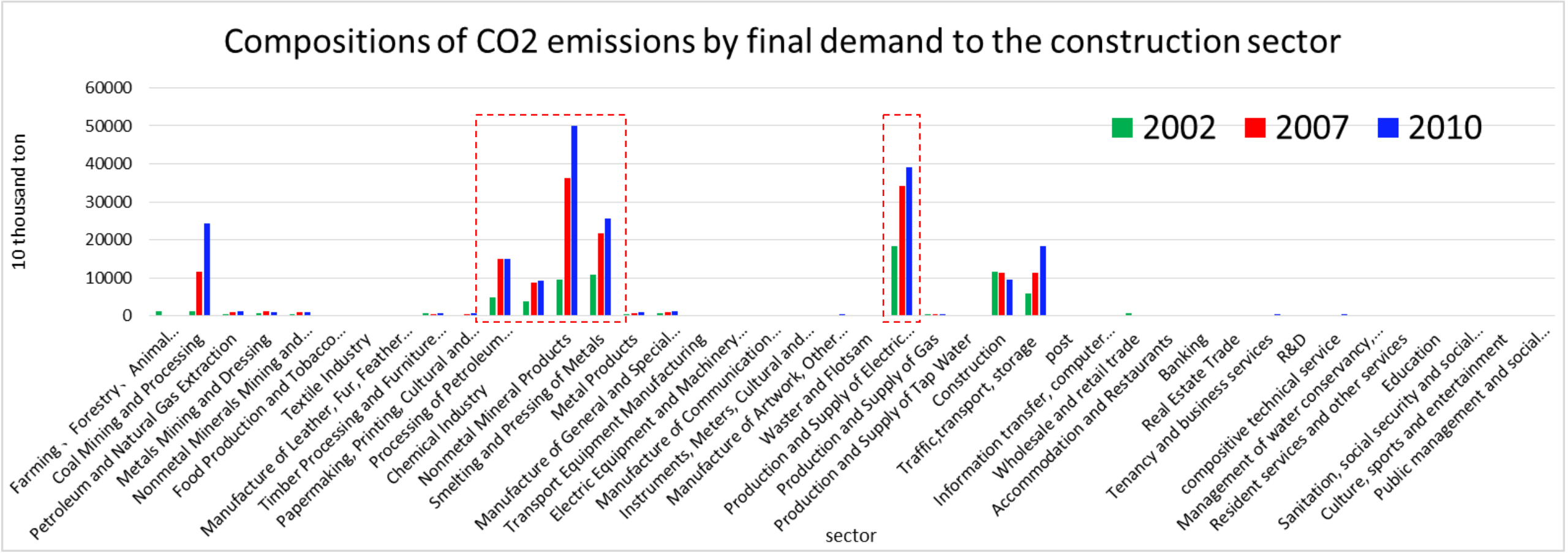
Demand-based Perspective



Construction is the largest sector of CO_2 emissions on final demand, 27.55% of China's domestic CO_2 emissions during 2002 to 2010, which must be taken urgent policies.

Top sectors of CO_2 emissions by demand-based perspectiv

2002			2007			2010		
sector	CO_2 emissions (10^4 ton)	Proportion (%)	sector	CO_2 emissions (10^4 ton)	Proportion (%)	sector	CO_2 emissions (10^4 ton)	Proportion (%)
Construction	74098.63	25.44	Construction	158383.5	27.24	Construction	201245.1	29.96
Manufacture of General and Special Purpose Machinery	16070.11	5.52	Manufacture of General and Special Purpose Machinery	40000.25	6.88	Manufacture of General and Special Purpose Machinery	51143.94	7.61
Production and Supply of Electric Power, Steam and Hot Water	14531.98	4.99	Chemical Industry	32537.71	5.60	Transport Equipment Manufacturing	41171.15	6.13
Farming 、Forestry、Animal Husbandry and Fishery	14471.2	4.97	Electric Equipment and Machinery Manufacturing	26305.28	4.52	Electric Equipment and Machinery Manufacturing	37553.74	5.59
Chemical Industry	13228.93	4.54	Manufacture of Communication Equipment ,	25983.58	4.47	Chemical Industry	33553.14	5.00
Public management and social organization	12832.42	4.40	Transport Equipment Manufacturing	24938.22	4.29	Manufacture of Communication Equipment ,	30612.28	4.56
Traffic,transport, storage	12572.98	4.32	Traffic,transport, storage	23237.64	4.00	Food Production and Tobacco Processing	24597.11	3.66
Education	11890.08	4.08	Production and Supply of Electric Power, Steam and Hot Water	21412.36	3.68	Sanitation, social security and social welfare	21834.25	3.25
Food Production and Tobacco Processing	11000.8	3.78	Smelting and Pressing of Metals	20463.43	3.52	Production and Supply of Electric Power, Steam and Hot Water	21060.28	3.14
Manufacture of Communication Equipment ,	9693.782	3.33	Sanitation, social security and social welfare	19206.18	3.30	Traffic,transport, storage	19422.72	2.8
Total	190390.9	65.35	Total	392468.2	67.51	Total	482193.7	71.79

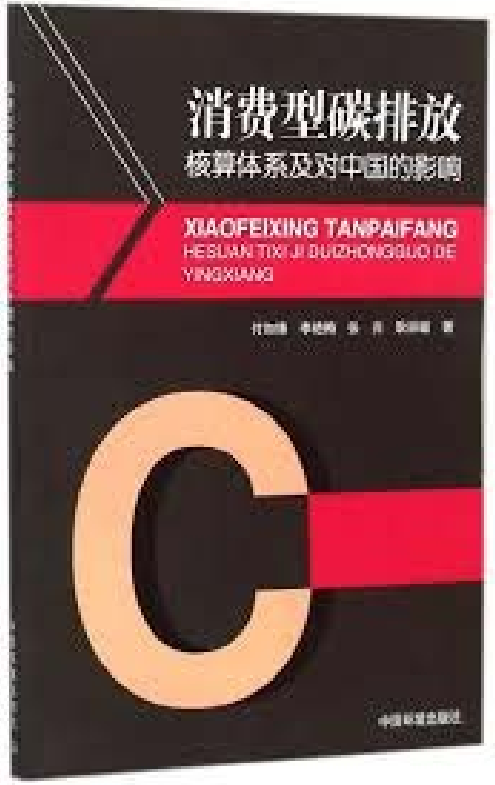


In order to meet final demand of construction sector, CO_2 emissions of nonmetal mineral products, production and supply of electric Power, Steam and Hot Water, *et al.*, were more higher than other sectors. 55.82% CO_2 emissions of construction sector in top three sectors.

First is to improve the utilization efficiency of raw materials in construction sector and reduce the usage of main raw material. ***Second*** is to upgrade the main relative industries and control their CO_2 emissions.

By now

- We have finished assessment report on country level and province level by using the data in 2010,2007,2002.



Next step

- Co-control analysis between CO_2 and air pollutants
- Policy management on Low carbon and environmental protection
- ……

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