

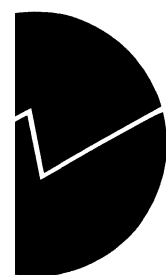
Statistics Norway
Research Department

Sigurd Holtskog

Documents

**Energy Use and Emissions to Air
in China**

A Comparative Literature Study



Preface

This document is a product of a Partnership Agreement between the State Statistical Bureau of China (SSB) and Statistics Norway (SN).

The project aims at:

- *Building capacity in the field of natural resource accounting*
- *Enhancing the capacity to prepare environmental statistics*
- *Developing analytical tools for linking natural resource use to economic activity and environmental impacts*
- *More comprehensive and widespread publications and improved methods of presentation*

During a four year period (1997-2001) SSB and SN will co-operate on an institution-to-institution basis for transfer of knowledge and sharing of experiences. The project is financed by the Norwegian Agency for Development Aid (NORAD). The National Environmental Protection Agency in China (NEPA) has the overall responsibility.

Contents

PREFACE	2
1. INTRODUCTION.....	5
2. SUMMARY	5
3. DEFINITIONS	6
4. ENERGY	7
4.1 COAL.....	9
4.2 OIL	15
4.3 GAS	24
4.4 ELECTRICITY	29
5. EMISSION TO AIR	34
REFERENCES.....	38
APPENDIX.....	40
1. NET CALORIFIC VALUE OF SELECTED ENERGIES FOR CHINA	40
2. LIST OF ABBREVIATIONS.....	41
3. SUMMARY OF THE DIFFERENT STATISTICS ON SUPPLY AND CONSUMPTION OF ENERGY.....	42
4. MAJOR ENERGY CONSUMING SECTORS	43

List of tables

TABLE 4.1 PRODUCTION OF COAL REGARDING OWNERSHIP OF MINE(TJ AND PERCENT). 1993	9
TABLE 4.2 COAL SUPPLY (TJ).....	10
TABLE 4.3 PRIMARY DATA SOURCES	12
TABLE 4.4 COAL CONSUMPTION, TOTAL AND BY SECTOR (TJ)	13
TABLE 4.5 CRUDE OIL SUPPLY (TJ)	15
TABLE 4.6 SUPPLY OF PETROLEUM PRODUCTS (TJ)	17
TABLE 4.7 OIL CONSUMPTION, TOTAL (TJ).....	19
TABLE 4.8 CRUDE OIL CONSUMPTION, BY SECTOR (TJ)	21
TABLE 4.9 GASOLINE CONSUMPTION, BY SECTOR (TJ)	21
TABLE 4.10 KEROSENE CONSUMPTION, BY SECTOR (TJ)	22
TABLE 4.11 DIESEL OIL CONSUMPTION, BY SECTOR (TJ)	23
TABLE 4.12 FUEL OIL CONSUMPTION, BY SECTOR (TJ)	24
TABLE 4.13 SUPPLY OF GAS (TJ)	25
TABLE 4.14 GAS CONSUMPTION, TOTAL (TJ)	26
TABLE 4.15 NATURAL GAS CONSUMPTION, BY SECTOR (TJ).....	27
TABLE 4.16 COKE-OVEN GAS CONSUMPTION (TJ)	29
TABLE 4.17 ELECTRICITY GENERATION(TJ)	30
TABLE 4.18 ELECTRICITY CONSUMPTION, TOTAL AND BY SECTOR (TJ).....	33
TABLE 5.1 EMISSION OF CO ₂ (MT).....	35
TABLE 5.2 EMISSION OF CH ₄ (MT).....	36
TABLE 5.3 EMISSION OF SO ₂ AND PM (MT)	37

List of figures

FIGURE 4.1 PRIMARY ENERGY PRODUCTION IN CHINA (TJ)	8
FIGURE 4.2 TOTAL ENERGY CONSUMPTION IN CHINA (TJ)	8
FIGURE 4.3 ANNUAL GROWTH IN GDP, CALCULATED AT COMPARABLE PRICES (PERCENT)	9
FIGURE 4.4 COAL CONSUMPTION BY END USE, ESTIMATED (MT AND PERCENT). 1990	12
FIGURE 4.5 IMPORT AND EXPORT OF CRUDE OIL AND NGL (MILLION TONNES)	16
FIGURE 4.6 IMPORT AND EXPORT OF OIL PRODUCTS (MILLION TONNES)	16
FIGURE 4.7 SUPPLY OF PETROLEUM PRODUCTS (TJ). 1995	19
FIGURE 4.8 ENERGY CONSUMPTION IN THE TRANSPORT-SECTOR (PERCENT). 1989	22
FIGURE 4.9 OIL CONSUMPTION BY END USE, ESTIMATED (MT AND PERCENT). 1990	23
FIGURE 4.10 TOTAL PRODUCTION AND CONSUMPTION OF NATURAL GAS (TJ)	25
FIGURE 4.11 ELECTRICITY GENERATION BY SOURCE 1995	30
FIGURE 4.12 POWER GENERATION CAPACITY (GW)	30
FIGURE 4.13 PRODUCTION AND CONSUMPTION OF ELECTRICITY (TJ)	31
FIGURE 4.14 ELECTRICITY CONSUMPTION BY END USE, ESTIMATED (MT AND PERCENT). 1990	32
FIGURE 5.1 EMISSION OF CO ₂ FROM CONSUMPTION AND FLARING OF FOSSIL FUELS (BILLION TONNES) AND PERCENTAGE INCREASE IN EMISSION PER YEAR	35

1. Introduction

This report is a literature study of emission to air and energy production and consumption in the People's Republic of China. The main goal of the study is to compare different data sources and find possible differences. This report is meant as a reference document in the ongoing work of developing the environment statistics in China.

The People's Republic of China (PRC) is a major energy consumer. It is ranked as the world's second largest energy consuming country behind USA, and accounts for more than a tenth of world carbon emissions (IEA 1994). Consequently inaccuracies in data for China have major effects on energy and emission assessments.

We originally planned to use 1995 as a base year, but the data published for this particular year was scarce and we therefore chose to study data from the 1990s instead. Due to our broad view the comparison is very rough, investigating the size of the figures rather than the exact number.

2. Summary

Through using different publications we have tried to present:

- the types and the amount of energy carriers produced, exported and imported;
- where - in what sectors - the different energy carriers are used;
- the amount of different components (CO₂, CH₄, SO₂ and PM) emitted to air, and to identify their major sources;
- and compare the different statistics regarding their reported energy use and emission to air.

ENERGY

Not surprisingly we found that most of the energy was consumed within the industry, see appendix 4 for more information. One third of the coal was solitary used for production of electricity and hot water/steam. The major consuming sectors of gasoline were manufacturing and transportation. About half of the kerosene was consumed by the transportation sector, while the biggest portion of diesel oil was used in farming, forestry, animal husbandry, fishery, water conservation, industry and transportation. A big share of the fuel oil was used for manufacturing, generation of electricity and the production of hot water/steam. Natural gas was mostly used for mining, quarrying and manufacturing, while the manufacturing sector was a major consumer of electricity.

The references we compared showed big differences concerning the supply of crude oil, gasoline, kerosene, fuel oil and electricity, while the references only differed for crude oil and electricity regarding the total consumption.

EMISSIONS

None of the statistics we used reported the emissions of CO₂, CH₄, SO₂, and PM as detailed as energy consumption. CO₂ was disaggregated according to combustion of the different energy carriers. The statistics on emission of CH₄ was reported from the major sources of this component, as rice cultivation, coalbed methane, biomass combustion, etc. Emissions of SO₂ and PM seems to be reported for industry only. We found one data source for the emission of NO_x, while no information on emission of N₂O was obtained.

The information we found on emission to air was very limited, and we only had data to compare the emission of CO₂, CH₄, SO₂ and particulate matter (PM). The references showed "little" difference in total emission data, but the emission from different sources varied a lot.

3. Definitions

Anthracite	Coal with high energy content, about 33 500 kJ per kg.
Biofuel	Renewable energy sources produced biologically (firewood, crop residue, animal dung, etc.).
BKB	Brown Coal Briquettes. Composition fuels manufactured from brown coal, produced by briquetting under high pressure.
Blast furnace gas	By-product in blast furnaces recovered on leaving the furnace.
Briquettes	Se BKB.
Brown coal coke	A solid product obtained from carbonization of brown coal briquettes.
Bunkers	Fuels supplied to ships and aircrafts engaged in international transportation, irrespective of the carrier's flag.
Coal	Hard coal (also referred to as bituminous coal), sub-bituminous coal, lignite (also referred to as brown coal), peat, products derived from coal (e.g., patent fuel, coke oven coke, gas coke, BKB). (OECD/IEA 1995b)
Coke from coal	The solid residue obtained from the distillation of hard coal or lignite in the total absence of air (carbonization). The three categories gas coke, coke oven coke and brown coal coke, are distinguished.
Coke-oven coke	All other coke produced from hard coal.
Coke-oven gas	By-product of the carbonization process in the production of coke at coke ovens.
Coking coal	Coal with a quality that allows the production of coke suitable to support a blast furnace charge. (OECD/IEA 1995b)
Distillate	An aggregate term for diesel oil, light fuel oil and gas oil.
Fossil fuels	Non-renewable fuels produced biologically (oil, coal and natural gas).
Gas coke	A by-product of coal used for the production of manufactured or town gas in gasworks.
Gasworks gas	Gas produced by carbonization or total gasification with or without enrichment with petroleum products.
Hard coal	Coal of gross calorific value greater than 23 865 kJ per kg on an ash-free but moist basis and with a mean random reflectance of vitrinite of at least 0.6. Hard coal comprises of coking coal and steam coal. (OECD/IEA 1995b)
International bunkers	Quantities of energy carriers delivered to sea-going ships of all flags and international air traffic.
Lignite	A non-agglomerating coal with a gross calorific value less than 17 435 kJ per kg and greater than 31 per cent volatile matter on a dry mineral matter free basis.
LPG	Liquified petroleum gas.
NGL	Natural gas liquids.
Oil products	Ethane, LPG, refinery gas, aviation gasoline, motor gasoline, jet fuels, kerosene, gas/diesel oil, heavy fuel oil, naphta, white spirit, lubricants, bitumene, paraffin waxes, petroleum coke and other petroleum products such as oils from coal liquefaction.
Patent fuel	Hard coal briquettes.
Primary electricity	Geothermal, hydro, nuclear, solar, tide, wind and wave.
Secondary electricity	Electricity produced by combustion engines and gas turbines.
Self producer (electricity)	Undertakings which, in addition to their main activities, themselves produce (individually or in combination) electric energy intended, in whole or in part, to meet their own needs.
Steam coal	Coal used to generate heat for use in steam raising, processing and space heating purposes and includes all Anthracite coals and Bituminous coals not included under Coking coal. (OECD/IEA 1995b)
Sub-bituminous coal	A non-agglomerating coal with a gross calorific value between 17 435 kJ per kg and 23 865 kJ per kg containing more than 31 per cent volatile

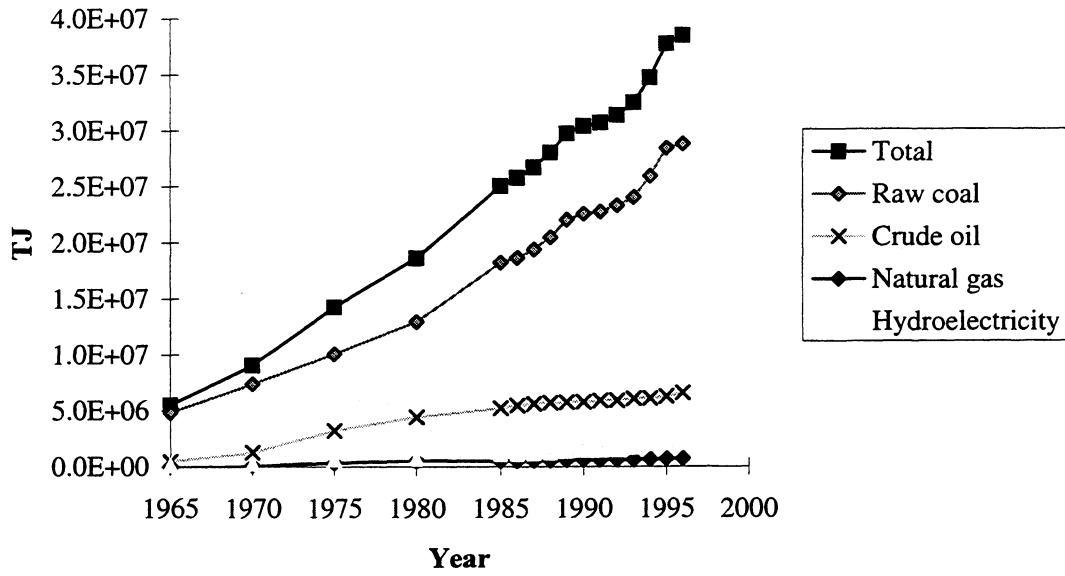
	matter on a dry mineral matter free basis. (OECD/IEA 1995b)
Thermal power generation	Generation of electricity and/or heat by combustion of fossile fuels or biofuels.
Total primary energy supply	Indigenous production + imports - exports - international marine bunkers +/- stock changes.
Washed coal	Coal where the ash- and sulphur-contents are reduced/washed out.
Bbl	Barrels (1 barrel = 0.159 m ³)
GW(h)	Gigawatt (hour)
Mbd	Million barrels per day
MT	Mega/million tonne
Mtce	Million tonnes coal equivalent
Mtoe	Million tonnes oil equivalent
t	Tonnes (metric ton)
TJ	Tera Joule
E+XX	10 ^{XX} . Ex. E+09 = 10 ⁹ , E-03 = 10 ⁻³ .
1 Gm ³ Natural gas	4.11*10 ⁴ TJ
1 GWh	3.6 TJ
1 MBbl crude oil	5.72*10 ³ TJ
1 Mtce	2.93*10 ⁴ TJ
1 Mtoe	4.19*10 ⁴ TJ

4. Energy¹

China's energy production and consumption has increased a lot during this decade (see Figure 4.1 and Figure 4.2). With an average annual GDP growth rate of ten percent the last decade (see Figure 4.3) and energy prices fixed at a level below world market price, China increases the pressure on resources and environment. Low energy prices also contributes to high energy intensity in industry and manufacturing, the intensity in China is about three times higher than in industrialised countries and twice as high as in many other developing countries (Haugland and Roland 1990).

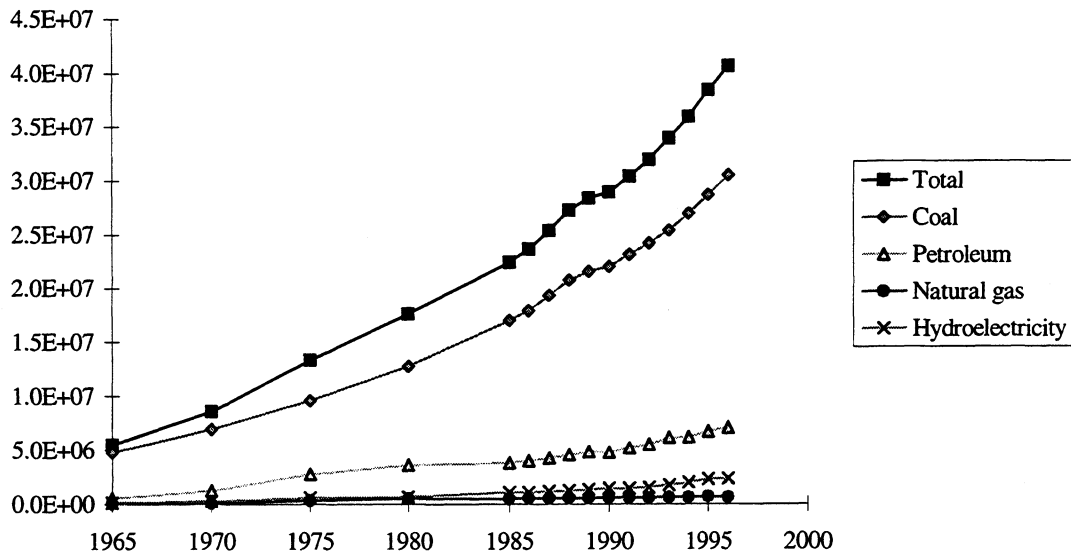
¹ For information on bioenergy see the report published at Statistics Norway (Holtskog 1998).

Figure 4.1 Primary energy production in China (TJ)



Source: SSB 1997.

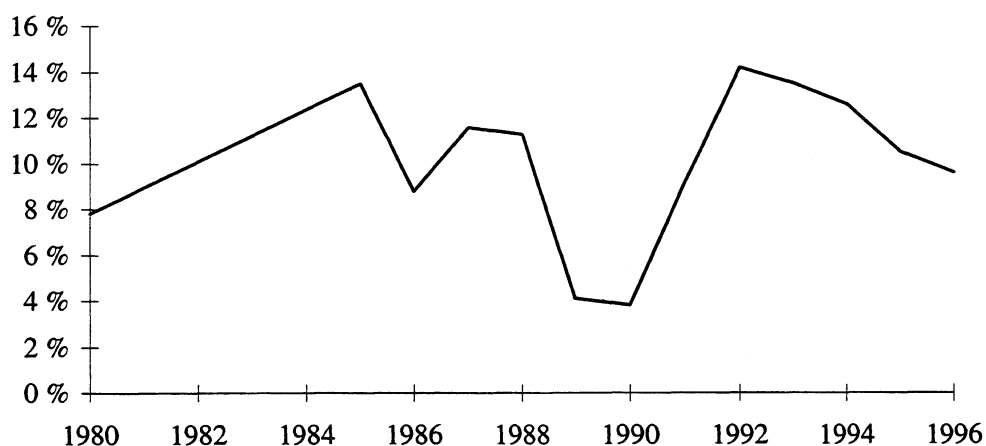
Figure 4.2 Total energy consumption in China (TJ)²



Source: SSB 1997.

² Included consumption in the energy sectors.

Figure 4.3 Annual growth in GDP, calculated at comparable prices (percent)



Source: SSB 1997.

4.1 Coal

“China is both the world’s largest producer and consumer of coal, which supplies about 75 percent of the country’s energy needs.” (EIA2) Most of the coal reserves are located in northern areas of the country, and the three provinces Shanxi, Shaanxi and Inner Mongolia accounts for two-thirds of the coal reserves. The coal is mostly extracted from underground-mines, these are either privately-owned, collectively-owned or owned by the state at national-, provincial-, prefectural- or county level. The production of coal regarding the ownership of the mines are illustrated in Table 4.1.

Table 4.1 Production of coal regarding ownership of mine (TJ and percent). 1993

Ownership	Output (TJ)	Share
State owned	9.40E+06	40 %
Local owned	1.42E+07	60 %
Provincial government owned	1.13E+06	5 %
Prefectural government owned	1.29E+06	5 %
County government owned	1.76E+06	7 %
Town/village owned	8.82E+06	37 %
Private owned	1.09E+06	5 %
Other ownership	1.01E+05	0 %

Source: FNI (1997).

There are several organisations keeping statistics on China’s coal supply. Table 4.2 gives a brief overview of these and their data material.

Table 4.2 Coal supply (TJ)

Reference	Haugland and Roland 1994	UN 1994	OECD/IEA 1995b	OECD/IEA 1995a	FNI 1997	LBL 1996
Year	1991	1992	1992	1993	1993	1993
Production - Total	2.23E+07	2.29E+07	2.33E+07	2.37E+07	2.41E+07	2.39E+07
<i>Hard coal</i>		2.29E+07	2.33E+07	2.37E+07		2.16E+07
Anthracite						
Bituminous						
Coking coal						
Other						
<i>Sub-Bituminous coal</i>						
<i>Lignite / brown coal</i>						1.93E+06
<i>Coke</i>		2.27E+06				2.65E+06
Import - Total						
<i>Hard coal</i>		2.52E+04	2.67E+04	2.52E+04		4.19E+04
Anthracite						
Bituminous						
Coking coal						
Other						
<i>Sub-Bituminous coal</i>						
<i>Lignite and brown coal</i>						
<i>Coke</i>						
Export - Total						
<i>Hard coal</i>		4.89E+05	4.12E+05	4.06E+05		5.80E+05
Anthracite						
Bituminous						
Coking coal						
Other						
<i>Sub-Bituminous coal</i>						
<i>Lignite and brown coal</i>						
<i>Coke</i>		3.84E+04				7.41E+04
Stock changes - Total				1.47E+05		
<i>Hard coal</i>		6.07E+04				
Anthracite						
Bituminous						
Coking coal						
Other						
<i>Sub-Bituminous coal</i>						
<i>Lignite and brown coal</i>						
<i>Coke</i>		-1.45E+04				

Table 4.2 Coal supply (TJ) (continued)

Reference	OECD/IEA 1996	EIA1	SSB 1997	BP 1996	Intervall
Year	1994	1995	1995	1995	
Production - Total	2.54E+07	2.92E+07	2.84E+07	2.74E+07	[2.23E+07, 2.92E+07]
<i>Hard coal</i>		2.82E+07		2.57E+07	[2.16E+07, 2.82E+07]
Anthracite		6.05E+06			
Bituminous		2.22E+07			
Coking coal					
Other					
<i>Sub-Bituminous coal</i>					
<i>Lignite / brown coal</i>		9.25E+05		9.15E+05	[9.15E+05, 1.93E+06]
<i>Coke</i>					[2.27E+06, 2.65E+06]
Import - Total	2.34E+04	4.00E+04	3.41E+04		[2.34E+04, 4E+04]
<i>Hard coal</i>		3.99E+04			[2.52E+04, 4.19E+04]
Anthracite					
Bituminous					
Coking coal					
Other					
<i>Sub-Bituminous coal</i>					
<i>Lignite and brown coal</i>					
<i>Coke</i>		1.06E+02			
Export - Total	6.12E+05	8.51E+05	5.96E+05		[5.96E+05, 8.51E+05]
<i>Hard coal</i>		5.99E+05			[4.06E+05, 5.99E+05]
Anthracite					
Bituminous					
Coking coal					
Other					
<i>Sub-Bituminous coal</i>					
<i>Lignite and brown coal</i>					
<i>Coke</i>		2.52E+05			[3.84E+04, 2.52E+05]
Stock changes - Total	2.96E+05	1.59E+05	1.81E+04		[1.81E+04, 2.96E+05]
<i>Hard coal</i>		1.36E+05			[6.07E+04, 1.36E+05]
Anthracite					
Bituminous					
Coking coal					
Other					
<i>Sub-Bituminous coal</i>					
<i>Lignite and brown coal</i>					
<i>Coke</i>		2.28E+04			[-0.14E+05, 2.28E+04]

We see from the table that it is mostly hard coal which is extracted and most of it consumed within the country (see Table 4.4). China is a net exporter of both coal and coke. The supply data is about the same magnitude, however the differences between some of the statistics are significant. Here are three major reasons for gaps in the statistics: Unaccurate conversion factors, the data is covering different years and different sources and

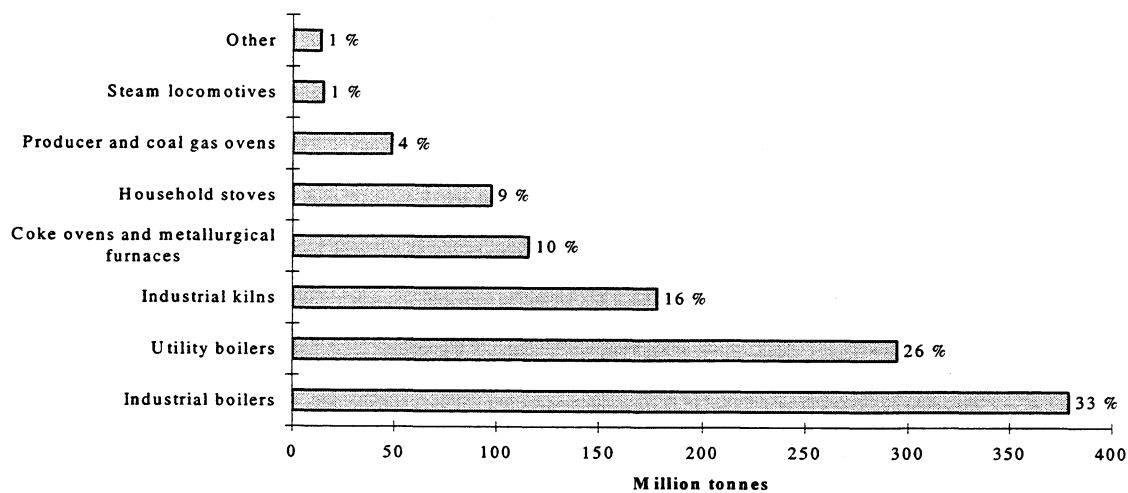
methods of calculating the production. The latter reason is what we are interested in. Although we are looking at several different statistics, the number of primary sources are limited, see Table 4.3.

Table 4.3 Primary data sources

Reference:	Primary source:
BP 1996	BP
EIA1	EIA
FNI 1997	China Annual Energy Review, China Energy and SSB (China Statistical yearbook)
Haugland and Roland 1994	BP and OECD/IEA
LBL	Ministry of Energy (Beijing), SSB, China Statistical Information and Consultancy Service Centre and University of Illinois at Chicago
OECD/IEA 1995b	OECD/IEA
OECD/IEA 1995a	OECD/IEA
OECD/IEA 1996	OECD/IEA
OPEC	Own estimations and various national and secondary sources
SSB 1996	SSB
UN 1994	UN

The reason for not strictly using the primary data sources throughout this paper is because some of the documents are hard to get and may even be in Chinese. The independent primary data sources outside China, that we found, were BP, EIA, OECD/IEA and UN.

Figure 4.4 Coal consumption by end use, estimated (MT and percent). 1990



Source: LBL 1997.

Table 4.4 Coal consumption, total and by sector (TJ)

Reference	Hauland and Roland 1994	OECD/IEA 1994	LBL 1996 1992	UN 1994	OECD/IEA 1995a 1993
Year	1990	1991	1992	1992	1993
Coal - Total consumption					
Total	2.50E+07	2.20E+07	2.39E+07		2.25E+07
<i>Hard coal</i>				2.24E+07	
Coke				2.24E+06	
Coal consumption by sector			2.39E+07		2.25E+07
-Farming, forestry, animal husbandry, fishery and water conservation			3.69E+05		
-Industry			1.94E+07		
-Mining and quarrying					
-Manufacturing					
-Electric power, gas and hot water production and supply			1.13E+07		7.02E+06
-Electric power, steam and hot water production and supply	5.84E+06		7.89E+06		6.92E+06
-Gas production and supply			3.37E+06		
-Tap water production and supply					
-Construction					
-Transport, post and tele- communications services			3.92E+05		
-Commerce, catering services, materials supply, marketing and storage			1.99E+05		
-Others			4.16E+05		
-Residential consumption			3.09E+06		3.43E+06
Coke consumption by sector					
-Farming, forestry, animal husbandry, fishery and water conservation					
-Industry			2.14E+06		
-Mining and quarrying			3.59E+04		
-Manufacturing			2.10E+06		
-Electric power, gas and hot water production and supply					
-Electric power, steam and hot water production and supply					
-Gas production and supply					
-Tap water production and supply					
-Construction					
-Transport, post and tele- communications services					
-Commerce, catering services, materials supply, marketing and storage					
-Others					
-Residential consumption					

Table 4.4 Coal consumption, total and by sector (TJ) (continued)

Reference Year	FNI 1997 1990	SSB 1997 1995	BP 1996 1995	Intervall
Coal - Total consumption				
Total	1.08E+07	2.87E+07	2.68E+07	[1.08E+07, 2.87E+07]
<i>Hard coal</i>				
Coke	1.93E+06	3.10E+06		[1.93E+06, 3.1E+06]
Coal consumption by sector	1.08E+07	2.87E+07		[1.08E+07, 2.87E+07]
-Farming, forestry, animal husbandry, fishery and water conservation	4.37E+05	3.87E+05		[3.69E+05, 4.37E+05]
-Industry	6.75E+06	2.45E+07		[6.75E+06, 2.45E+07]
-Mining and quarrying		2.06E+06		
-Manufacturing		1.32E+07		
-Electric power, gas and hot water production and supply		9.30E+06		[7.02E+06, 1.13E+07]
-Electric power, steam and hot water production and supply		9.13E+06		[5.84E+06, 9.13E+06]
-Gas production and supply		1.59E+05		[1.59E+05, 3.37E+06]
-Tap water production and supply		7.84E+03		
-Construction	9.96E+04	9.17E+04		[9.17E+04, 9.96E+04]
-Transport, post and tele- communications services	3.03E+05	2.74E+05		[2.74E+05, 3.92E+05]
-Commerce, catering services, materials supply, marketing and storage	6.55E+05	2.04E+05		[1.99E+05, 6.55E+05]
-Others		4.14E+05		[4.14E+05, 4.16E+05]
-Residential consumption	2.59E+06	2.82E+06		[2.59E+06, 3.43E+06]
Coke consumption by sector	1.93E+06	3.10E+06		[1.93E+06, 3.1E+06]
-Farming, forestry, animal husbandry, fishery and water conservation		3.71E+04		
-Industry	1.93E+06	3.01E+06		[1.93E+06, 3.01E+06]
-Mining and quarrying		4.37E+04		
-Manufacturing		2.96E+06		
-Electric power, gas and hot water production and supply		4.85E+03		
-Electric power, steam and hot water production and supply		1.10E+03		
-Gas production and supply		3.72E+03		
-Tap water production and supply		3.18E+01		
-Construction		3.11E+03		
-Transport, post and tele- communications services		2.92E+03		
-Commerce, catering services, materials supply, marketing and storage		7.42E+03		
-Others		1.86E+03		
-Residential consumption		3.80E+04		

Most of the coal is consumed by the industry, manufacturing (nonmetal mineral products and smelting and pressing of ferrous metals) and production of electricity, steam and hot water. Residential consumption of coal only counts for about ten percent of the total consumption. Consumption of coke is concentrated in the manufacturing industry, mostly smelting and pressing of ferrous metals. Less than two percent of the coke consumption are within the residential sector.

4.2 Oil

China's production of crude oil counted almost 3000 thousand barrels per day in 1995. The majority of oilfields in China are onshore, and the biggest ones are located in the provinces of Heilongjiang, Shandong and Liaoning. China's future as a oil producer lies, to a great extent, within the development of Tarim basin.

Table 4.5 Crude oil supply (TJ)

Reference	UN 1994	OECD/IEA 1995a	LBL 1996	OPEC 1995
Year	1992	1993	1994	1994
Crude oil/crude petroleum				
Production - Total	2.92E+06	6.19E+06	6.18E+06	6.21E+06
Import - Total	2.33E+05	6.67E+05	5.17E+05	
Export - Total	4.41E+05	8.28E+05	7.74E+05	7.83E+05
Stock changes	7.84E+03	-1.88E+05		

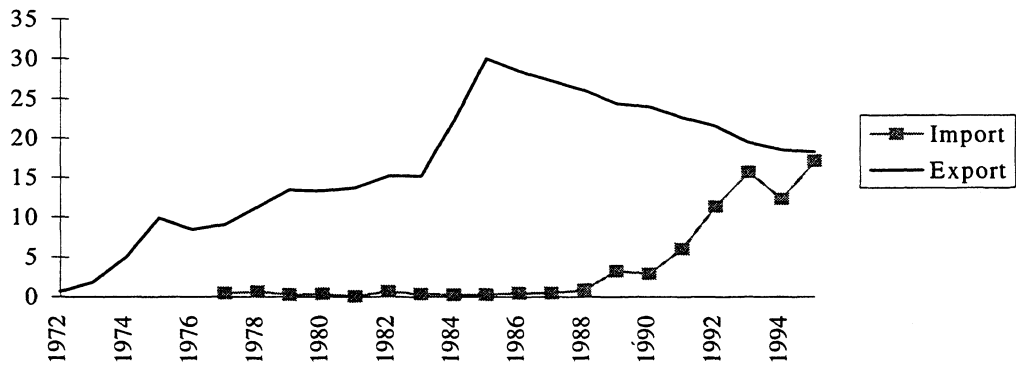
Table 4.5 Crude oil supply (TJ) (continued)

Reference	OECD/IEA 1995b	EIA1	SSB 1997	BP 1996	Intervall
Year	1995	1995	1995	1995	
Crude oil/crude petroleum					
Production - Total	6.26E+06	6.24E+06	6.27E+06	6.35E+06	[2.92E+06, 6.35E+06]
Import - Total		7.29E+05			[2.33E+05, 7.29E+05]
Export - Total		7.22E+05			[4.41E+05, 8.28E+05]
Stock changes					[-0.19E+06, 7.84E+03]

If we exclude statistics from UN (1994) we see that the production of crude oil has increased slightly, almost each year (about 2 percent), since 1993 (see Table 4.5). China has been a net exporter of crude oil and NGL until 1995 (see Figure 4.5), while it became a net importer of oil products³ in 1992 (see Figure 4.6) (OECD/IEA 1997).

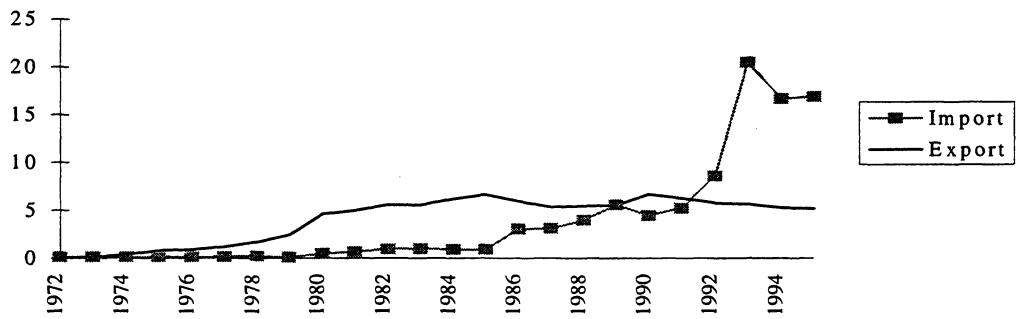
³ See chapter 3 for a definition of oil products.

Figure 4.5 Import and export of crude oil and NGL (Million tonnes)



Source: OECD/IEA 1997.

Figure 4.6 Import and export of oil products (Million tonnes)



Source: OECD/IEA 1997.

Most of the petroleum supply comes from domestic refineries. Although China was a net importer of petroleum products in 1995, the net import accounted for less than 10 percent of the total supply. Figure 4.7 illustrates differences in production, import and export for supply of the major petroleum products.

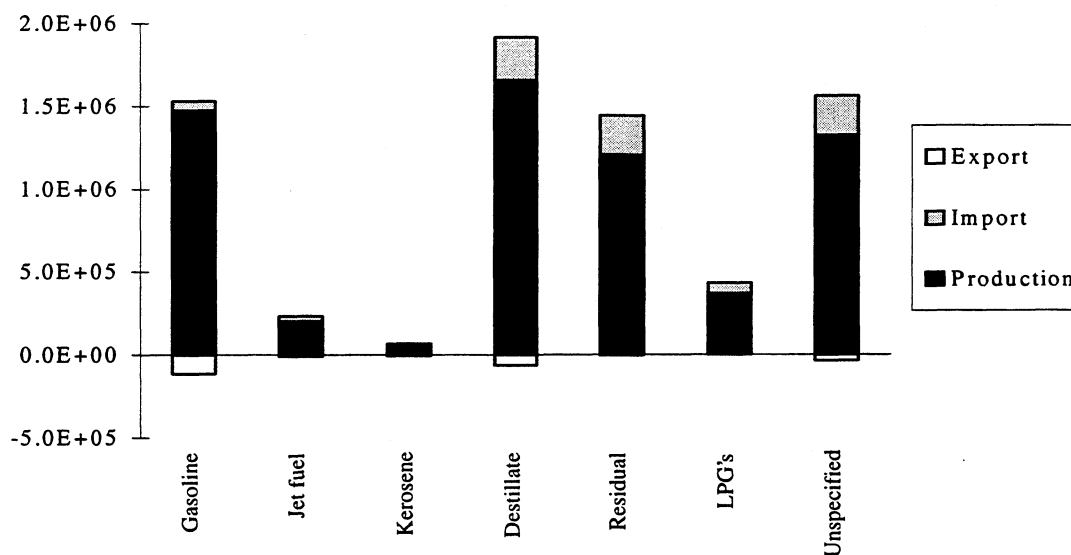
Table 4.6 Supply of petroleum products (TJ)

Reference	UN 1994	OECD/IEA 1995a	LBL 1996
Year	1992	1993	1994
Petroleum products			
Production - Total	4.21E+06		4.02E+06
<i>Gasoline</i>	1.20E+06		1.25E+06
<i>Aviation fuels</i>			
Aviation gasoline	3.94E+03		
Jet fuel			
<i>Kerosene</i>	1.70E+05		1.59E+05
<i>Destillate</i>			
Diesel oil	1.37E+06		1.48E+06
<i>Fuel oil</i>	1.31E+06		1.13E+06
<i>LPG's</i>	1.61E+05		
<i>Refinery gain</i>	1.59E+05		
Import - Total	4.20E+05	7.33E+05	5.46E+05
<i>Gasoline</i>	1.45E+04		
<i>Aviation fuels</i>			
Aviation gasoline			
Jet fuel			
<i>Kerosene</i>	2.44E+04		
<i>Destillate</i>			
Diesel oil	2.36E+05		
<i>Fuel oil</i>	1.44E+05		
<i>LPG's</i>	8.76E+02		
Export - Total		1.88E+05	1.63E+05
<i>Gasoline</i>	1.21E+05		
<i>Aviation fuels</i>			
Aviation gasoline			
Jet fuel			
<i>Kerosene</i>	1.35E+04		
<i>Destillate</i>			
Diesel oil	9.17E+04		
<i>Fuel oil</i>	4.95E+04		
<i>LPG's</i>	6.45E+02		
Stock changes - Total		-3.52E+05	
<i>Gasoline</i>	-4.00E+04		
<i>Kerosene</i>	-5.30E+03		
<i>Diesel oil</i>	-9.57E+03		
<i>Fuel oil</i>	3.82E+03		
<i>LPG's</i>	-9.22E+01		

Table 4.6 Supply of petroleum products (TJ) (continued)

Reference Year	EIA1 1995	Intervall
Petroleum products		
Production - Total	4.84E+06	[4.02E+06, 4.84E+06]
<i>Gasoline</i>	1.33E+06	[1.2E+06, 1.33E+06]
<i>Aviation fuels</i>		
Aviation gasoline		[3.94E+03, 3.94E+03]
Jet fuel	1.92E+05	
<i>Kerosene</i>	6.00E+04	[6E+04, 1.7E+05]
<i>Destillate</i>	1.68E+06	[1.68E+06, 1.68E+06]
Diesel oil		[1.37E+06, 1.48E+06]
<i>Fuel oil</i>	1.32E+06	[1.13E+06, 1.32E+06]
<i>LPG's</i>	2.55E+05	[1.61E+05, 2.55E+05]
<i>Refinery gain</i>	5.80E+04	[5.8E+04, 1.59E+05]
Import - Total	6.46E+05	[4.2E+05, 7.33E+05]
<i>Gasoline</i>	5.09E+04	[1.45E+04, 5.09E+04]
<i>Aviation fuels</i>		
Aviation gasoline		
Jet fuel	2.93E+04	
<i>Kerosene</i>	3.50E+03	[3.5E+03, 2.44E+04]
<i>Destillate</i>	2.58E+05	
Diesel oil		
<i>Fuel oil</i>	2.59E+05	[1.44E+05, 2.59E+05]
<i>LPG's</i>	4.61E+04	[8.76E+02, 4.61E+04]
Export - Total		[1.63E+05, 1.88E+05]
<i>Gasoline</i>	1.03E+05	[1.03E+05, 1.21E+05]
<i>Aviation fuels</i>		
Aviation gasoline		
Jet fuel	1.03E+04	
<i>Kerosene</i>	7.54E+03	[7.54E+03, 1.35E+04]
<i>Destillate</i>	6.30E+04	
Diesel oil		
<i>Fuel oil</i>	3.68E+03	[3.68E+03, 4.95E+04]
<i>LPG's</i>	6.38E+02	[6.38E+02, 6.45E+02]
Stock changes - Total		
<i>Gasoline</i>		
<i>Kerosene</i>		
<i>Diesel oil</i>		
<i>Fuel oil</i>		
<i>LPG's</i>		

Figure 4.7 Supply of petroleum products (TJ). 1995



Source: OECD/IEA 1997

Figure 4.7 illustrates the supply of petroleum products in China in 1995. The products which are unspecified includes white spirit, lubricants, parafin waxes, bitumen, etc.

The consumption of petroleum products in China in 1995 was 154.9 million tonnes (bunkers not included), which is 44 percent of Asia's total consumption (OECD/IEA 1997). Most of the crude oil (3/4) was refined or processed⁴ (see Table 4.8), less than 1 percent was used to generate electricity steam and hot water.

Table 4.7 Oil consumption, total (TJ)

Reference	OECD/IEA 1994	UN 1994	LBL 1996	OECD/IEA 1995a
Year	1991	1992	1992	1993
Oil - Total consumption				
Crude oil/crude petroleum	4.86E+06	5.61E+06	4.11E+05	5.84E+06
Petroleum products		4.39E+06	4.12E+06	6.06E+06
<i>Gasoline</i>		1.13E+06	1.10E+06	1.27E+06
<i>Aviation fuels</i>				
Aviation gasoline		3.94E+03		7.17E+04
Jet fuel				
<i>Kerosene</i>		1.86E+05	1.80E+05	1.16E+05
<i>Diesel oil</i>		1.52E+06	1.45E+06	1.55E+06
<i>Fuel oil</i>		1.40E+06	1.39E+06	1.31E+06
<i>LPG</i>		1.62E+05		1.45E+05
<i>Other products</i>				6.75E+05

⁴) The remaining 1/4 seems to have been consumed as crude oil.

Table 4.7 Total oil consumption, total (TJ) (continued)

Reference Year	SSB 1997 1995	BP 1996 1995	Intervall
Oil - Total consumption			
Crude oil/crude petroleum	6.45E+06	6.71E+06	[1.57E+05, 6.71E+06]
Petroleum products	5.03E+06		[4.12E+06, 6.06E+06]
<i>Gasoline</i>	1.30E+06		
<i>Aviation fuels</i>			
Aviation gasoline			[3.94E+03, 7.17E+04]
Jet fuel			
<i>Kerosene</i>	2.24E+05		[1.16E+05, 2.24E+05]
<i>Diesel oil</i>	1.89E+06		[1.45E+06, 1.89E+06]
<i>Fuel oil</i>	1.52E+06		[1.31E+06, 1.52E+06]
<i>LPG</i>			[1.45E+05, 1.62E+05]
<i>Other products</i>			[6.75E+05, 6.75E+05]

Most of the petroleum are consumed in the form of gasoline, diesel oil and fuel oil, and most if it is consumed by motor vehicles and in kilns. In accordance to SSB (1997) 36% and 29% of respectively the gasoline and diesel oil was consumed in the transportation sector and by residents in 1995. We assume, however, that this share is an underestimate because we suspect that more energy is used for transportation in the remaining sectors. This suspicion is confirmed by Sinton (LBL 1997) who consider the non-transportation consumption of gasoline to be insignificant, while the consumption of diesel oil in the agricultural-, industry- and other sectors used for transportation purposes to be respectively 20%, 10% and 12% of the reported consumption of diesel oil by the sectors (see Table 4.9 Table 4.11).

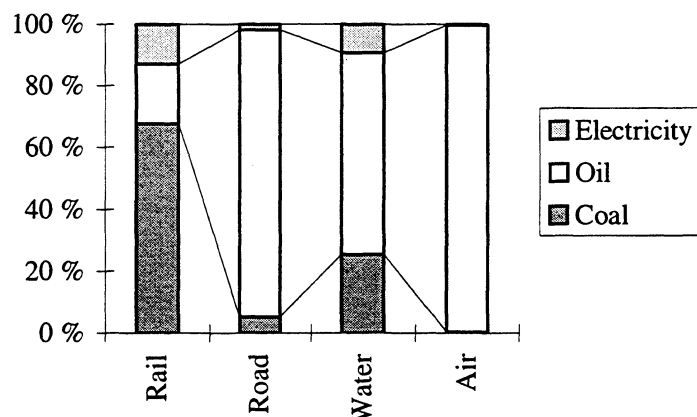
Table 4.8 Crude oil consumption, by sector (TJ)

Reference	FNI 1997	LBL 1996	SSB 1997	Intervall
Year	1990	1992	1995	
Crude oil consumption by sector	1.57E+05	4.11E+05	6.45E+06	[1.57E+05, 6.45E+06]
-Farming, forestry, animal husbandry, fishery and water conservation			4.38E+03	
-Industry	1.39E+05	3.87E+05	6.37E+06	[1.39E+05, 6.37E+06]
-Mining and quarrying		7.48E+04	7.30E+05	
-Manufacturing		1.30E+05	5.61E+06	[1.3E+05, 5.61E+06]
-Electric power, gas and hot water production and supply		4.65E+04	2.88E+04	[2.88E+04, 4.65E+04]
-Electric power, steam and hot water production and supply		4.65E+04	2.88E+04	[2.88E+04, 4.65E+04]
-Gas production and supply				
-Tap water production and supply				
-Construction	2.26E+04		1.17E+03	[1.17E+03, 2.26E+04]
-Transport, post and tele-communications services		2.39E+04	6.79E+04	[2.39E+04, 6.79E+04]
-Commerce, catering services, materials supply, marketing and storage			2.17E+02	
-Others				
-Residential consumption				

Table 4.9 Gasoline consumption, by sector (TJ)

Reference	LBL 1996	SSB 1997	Intervall
Year	1992	1995	
Gasolene consumption by sector	1.10E+06	1.30E+06	[1.1E+06, 1.3E+06]
-Farming, forestry, animal husbandry, fishery and water conservation		8.01E+04	
-Industry		3.62E+05	
-Mining and quarrying		6.06E+04	
-Manufacturing		2.84E+05	
-Electric power, gas and hot water production and supply		1.75E+04	
-Electric power, steam and hot water production and supply		1.51E+04	
-Gas production and supply		1.43E+03	
-Tap water production and supply		1.01E+03	
-Construction		4.62E+04	
-Transport, post and tele-communications services	1.08E+06	4.38E+05	[4.38E+05, 1.08E+06]
-Commerce, catering services, materials supply, marketing and storage		8.80E+04	
-Others		2.55E+05	
-Residential consumption		2.84E+04	

Figure 4.8 Energy consumption in the transport-sector (percent). 1989



Source: LBL 1996

Figure 4.8 illustrates the consumption of electricity, oil and coal. China had in 1995, 4607 steam-, 8411 diesel- and 2517 electric locomotives. Although the share of steam locomotives was only 30 percent, the consumed almost 70 percent of the energy used by railways. Road traffic are dominated by diesel and gasoline powered vehicles, consequently oil products account for more than 90 percent of the energy used for road traffic. The trolley buses are most likely to represent the consumption of electricity. It is not clear to us what vehicles accounts for the consumption of coal, and we suspect it to be related to other consumption by the transportation companies than the actual vehicles. The same goes for electricity consumption by water transportation and coal consumption by air traffic.

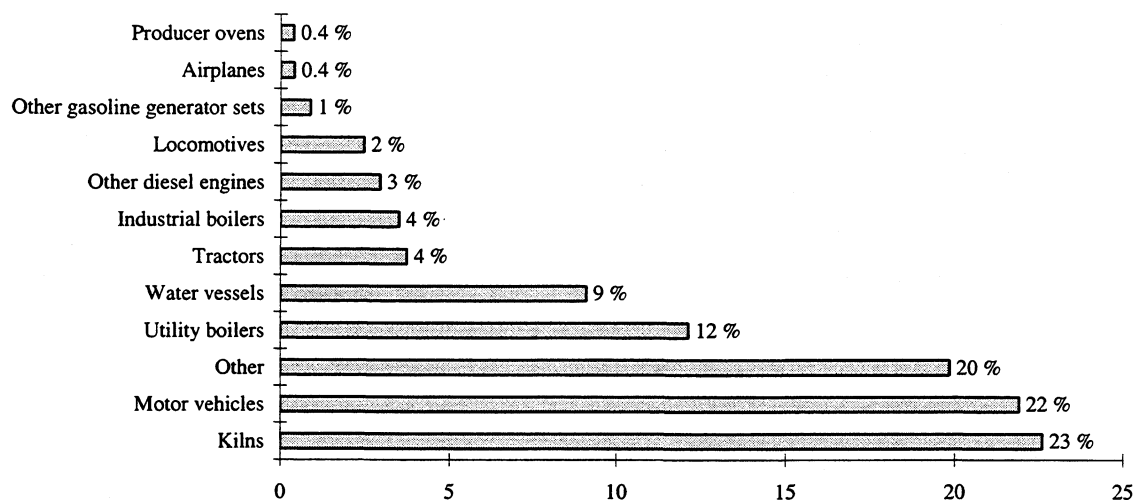
Table 4.10 Kerosene consumption, by sector (TJ)

Reference Year	LBL 1996 1992	SSB 1997 1995	Intervall
Kerosene consumption by sector	1.80E+05	2.24E+05	[1.8E+05, 2.24E+05]
-Farming, forestry, animal husbandry, fishery and water conservation		1.56E+03	
-Industry	1.07E+04	1.97E+04	[1.07E+04, 1.97E+04]
-Mining and quarrying	1.16E+03	1.28E+03	[1.16E+03, 1.28E+03]
-Manufacturing	9.53E+03	1.77E+04	[9.53E+03, 1.77E+04]
-Electric power, gas and hot water production and supply		7.05E+02	
-Electric power, steam and hot water production and supply		5.69E+02	
-Gas production and supply		4.82E+01	
-Tap water production and supply		8.76E+01	
-Construction		1.54E+03	
-Transport, post and telecommunications services		1.09E+05	
-Commerce, catering services, materials supply, marketing and storage		3.73E+03	
-Others		6.01E+04	
-Residential consumption	3.81E+04	2.81E+04	[2.81E+04, 3.81E+04]

Almost half of the kerosene are consumed in the transport sector. Most of the kerosene is probably used by airplanes, while some of it might also have been mixed with diesel oil to make diesel engines run at low, outdoor,

temperatures. The high consumption of kerosene in the residential sector may be caused by similar use for private vehicles or for heating and cooking.

Figure 4.9 Oil consumption by end use, estimated (MT and percent). 1990



Source: LBL 1997.

Table 4.11 Diesel oil consumption, by sector (TJ)

Reference Year	LBL 1996 1992	SSB 1997 1995	Intervall
Diesel oil consumption by sector	1.45E+06	1.89E+06	[1.45E+06, 1.89E+06]
-Farming, forestry, animal husbandry, fishery and water conservation	3.05E+05	4.39E+05	[3.05E+05, 4.39E+05]
-Industry	4.82E+05	5.21E+05	[4.82E+05, 5.21E+05]
-Mining and quarrying	6.08E+04	1.01E+05	[6.08E+04, 1.01E+05]
-Manufacturing	2.07E+05	3.16E+05	[2.07E+05, 3.16E+05]
-Electric power, gas and hot water production and supply	8.49E+04	1.04E+05	[8.49E+04, 1.04E+05]
-Electric power, steam and hot water production and supply	8.49E+04	1.03E+05	[8.49E+04, 1.03E+05]
-Gas production and supply		9.28E+02	
-Tap water production and supply		6.26E+02	
-Construction		5.18E+04	
-Transport, post and telecommunications services	4.96E+05	5.46E+05	[4.96E+05, 5.46E+05]
-Commerce, catering services, materials supply, marketing and storage		4.54E+04	
-Others	1.68E+05	2.83E+05	[1.68E+05, 2.83E+05]
-Residential consumption	8.62E+02	7.07E+03	[8.62E+02, 7.07E+03]

Most of the specified diesel oil is consumed within the transport sector (30%), the farming, forestry, animal husbandry, fishery and water conservation (20%) and manufacturing (15%).

Sinton (LBL 1996) estimated that the consumption of diesel oil by the transport sector was under-estimated by SSB, and he therefore calculated the consumption on the basis of the number of large vehicles (payload > 4 tonnes). SSB's corresponding figure for 1992 is 3.57E+05, about 30% less than Sinton's (Ibid.) estimation.

Table 4.12 Fuel oil consumption, by sector (TJ)

Reference Year	LBL 1996 1992	SSB 1997 1995	Intervall
Fuel oil consumption by sector	8.68E+05	1.52E+06	[8.68E+05, 1.52E+06]
-Farming, forestry, animal husbandry, fishery and water conservation		3.45E+03	
-Industry	7.59E+05	1.41E+06	[7.59E+05, 1.41E+06]
-Mining and quarrying	4.59E+04	1.02E+05	[4.59E+04, 1.02E+05]
-Manufacturing		9.02E+05	
-Electric power, gas and hot water production and supply	5.21E+05	4.01E+05	[4.01E+05, 5.21E+05]
-Electric power, steam and hot water production and supply		3.83E+05	
-Gas production and supply		1.87E+04	
-Tap water production and supply			
-Construction		5.87E+03	
-Transport, post and tele- communications services		9.38E+04	
-Commerce, catering services, materials supply, marketing and storage		2.73E+03	
-Others		1.27E+04	
-Residential consumption			

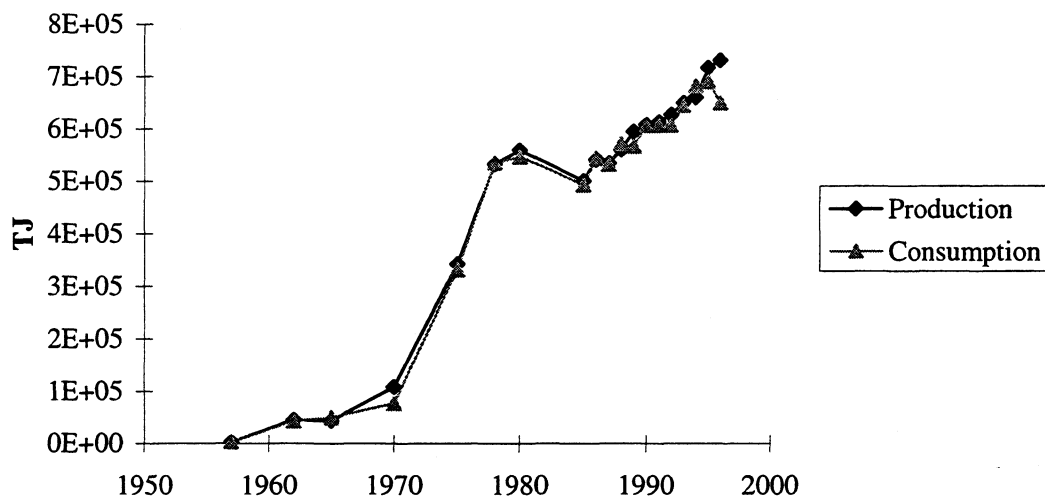
It is, as we see it, not separated between heavy and light fuel oil. We have therefore used the energy content and specific weight of heavy fuel oil to calculate the energy consumed and produced. According to SSB (1997), 25% of the (heavy) fuel oil was used to produce electricity, steam and hot water in 1995. The corresponding figure for petroleum processing and coking is 17%, while consumption smelting and pressing of ferrous metals accounted for 13% of the (heavy) fuel oil consumption (Ibid.).

4.3 Gas

China's production of natural gas are mostly located within the Sichuan province. Approximately half of the natural gas are consumed in oilfields for heating the crude oil for pipelines and for reinjection (OECD/IEA 1994).

The production of natural gas has grown, more or less, steadily the last decade (except for 1987). The average growth rate from 1988 to 1996 was about 3% (see Figure 4.1 and Figure 4.10).

Figure 4.10 Total production and consumption of natural gas (TJ)



Source: SSB 1997.

Table 4.13 Supply of gas (TJ)

Reference	UN 1994	OECD/IEA 1995a	LBL 1996	OPEC 1995
Year	1992	1993	1993	1994
Natural gas				
Production - Total	6.15E+05	5.95E+05	6.45E+05	6.85E+05
Import				
Export				
Other gases				
Production - Total	6.21E+05			
<i>LPG</i>	1.59E+05			
<i>Refinery gas</i>	1.37E+05			
<i>Gasworks</i>				
<i>Coke-oven gas</i>	3.25E+05		5.18E+05	
<i>Blast furnace gas</i>				
Import				
Export				

Figure 4.13 Supply of gas (TJ) (continued)

Reference Year	EIA1 1995	BP 1996 1995	SSB 1997 1995	Intervall
Natural gas				
Production - Total	7.38E+05	6.62E+05	7.18E+05	[5.95E+05, 7.38E+05]
Import				
Export				
Other gases				
Production - Total				
LPG				
Refinery gas				
Gasworks				
Coke-oven gas				[3.25E+05, 5.18E+05]
Blast furnace gas				
Import				
Export				

Comparing the production figures from the different publications with correspondig figures from SSB shows us that all of the statistics are within a 10% intervall.

If the statistics (UN 1994 and LBL 1996) are correct, the production of other gases is significant, especially coke-oven gas. China Statistical Yearbook has, however, no explicit overview of the production or consumption of other gases than natural gas. Other gases may however be underreported in the statistics.

Table 4.14 Gas consumption, total (TJ)

Reference Year	FNI 1997 1990	OECD/IEA 1994 1991	LBL 1996 1992	UN 1994 1992
Gas - Total consumption				
Total		5.44E+05		1.24E+06
Natural gas	5.81E+05		8.63E+05	6.15E+05
Other gases	2.52E+05 ⁵		3.81E+05 ⁶	6.21E+05 ⁷

Table 4.14 Gas consumption, total (TJ) (continued)

Reference Year	OECD/IEA 1995a 1993	BP 1996 1995	SSB 1997 1995	Intervall
Gas - Total consumption				
Total				[5.44E+05, 1.24E+06]
Natural gas	5.85E+05	6.62E+05	7.29E+05	[5.81E+05, 8.63E+05]
Other gases				[2.52E+05, 6.21E+05]

Figure 4.10 illustrates that consumption and production of natural gas follows, especially from 1989 to 1995, in 1996, however, consumption was 10% lower than production.

⁵ Coke-oven gas.

⁶ Coke-oven gas.

⁷ Coke-oven and refinery gas and LPG.

Table 4.15 Natural gas consumption, by sector (TJ)

Reference	FNI 1997	Haugland and Roland 1994	LBL 1996
Year	1990	1990	1992
Natural gas consumption by sector	5.81E+05		6.15E+05
-Farming, forestry, animal husbandry, fishery and water conservation			
-Industry	4.75E+05		5.27E+05
-Mining and quarrying			
-Manufacturing			
-Electric power, gas and hot water production and supply			
-Electric power, steam and hot water production and supply		5.61E+05	
-Gas production and supply			
-Tap water production and supply			
-Construction	3.52E+04		
-Transport, post and tele- communications services			4.39E+03
-Commerce, catering services, materials supply, marketing and storage			3.52E+03
-Others			1.25E+05
-Residential consumption	7.06E+04		8.49E+04

Table 4.15 Natural gas consumption, by sector (TJ) (continued)

Reference	OECD/IEA 1995a	SSB 1997	Intervall
Year	1993	1995	
Natural gas consumption by sector	5.85E+05	7.29E+05	[5.81E+05, 7.29E+05]
-Farming, forestry, animal husbandry, fishery and water conservation		8.22E+01	
-Industry		6.35E+05	[4.75E+05, 6.35E+05]
-Mining and quarrying		2.13E+05	
-Manufacturing		4.14E+05	
-Electric power, gas and hot water production and supply		7.07E+03	
-Electric power, steam and hot water production and supply	8.03E+04	4.69E+03	[4.69E+03, 5.61E+05]
-Gas production and supply		2.38E+03	
-Tap water production and supply			
-Construction		1.15E+03	[1.15E+03, 3.52E+04]
-Transport, post and tele- communications services		6.45E+03	[4.39E+03, 6.45E+03]
-Commerce, catering services, materials supply, marketing and storage		2.26E+03	[2.26E+03, 3.52E+03]
-Others		4.89E+03	[4.89E+03, 1.25E+05]
-Residential consumption	7.51E+04	7.98E+04	[7.06E+04, 8.49E+04]

Some of the differences in the sector consumption are probably due to the definition of the sectors. According to SSB statistics (SSB 1997), 35% of the natural gas consumption was used by the manufacturing of raw chemical materials and chemical products. Extraction of petroleum and natural gas accounted for 30% of the consumption, while residential consumption counted 10%. The natural gas are distributed to residents both by pipelines and containers.

Table 4.16 Coke-oven gas consumption (TJ)

Reference Year	FNI 1997 1990	LBL 1996 1992	Intervall
Coke-oven consumption by sector	2.52E+05	3.81E+05	[2.52E+05, 3.81E+05]
-Farming, forestry, animal husbandry, fishery and water conservation			
-Industry	2.17E+05		
-Mining and quarrying			
-Manufacturing			
-Electric power, gas and hot water production and supply			
-Electric power, steam and hot water production and supply			
-Gas production and supply			
-Tap water production and supply			
-Construction			
-Transport, post and tele- communications services			
-Commerce, catering services, materials supply, marketing and storage			
-Others			
-Residential consumption	3.49E+04	9.37E+04	[3.49E+04, 9.37E+04]

The little statistics we found on use of coke-oven gas showed that 15%-25% of the coke-oven gas are consumed by residents. This gas is distributed solely by pipelines to residents. We did not find any statistics on the use of blast furnace gas.

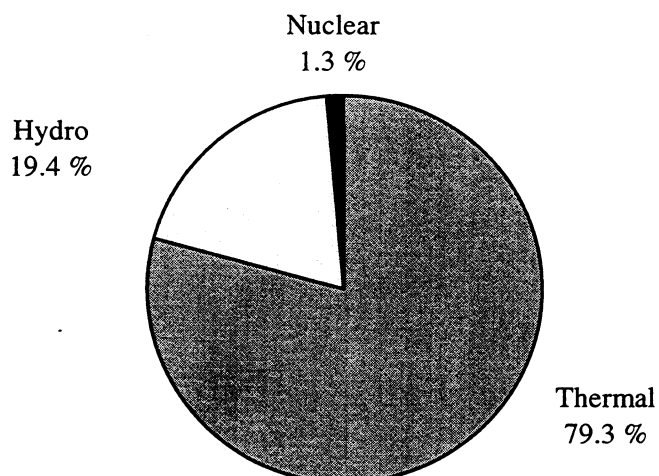
4.4 Electricity

Most of the electricity in China is generated by coal fired plants. Thermal plants have, so far, the highest capacity to produce electricity. In 1991 three quarters of the generating capacity was represented by thermal power plants, these plants produced 82 percent of the electricity (OECD/IEA 1994 and 1995a).

It has been estimated that China's hydropower potential amounts 676 GW, with 379 GW suitable for exploitation (OECD/IEA 1994). In 1994, only 40 GW was developed, consisting mostly of small scale plants (Ibid.). The official projections are 80 GW by the year 2000 (Ibid.). The Three Gorges project will solely account a capacity of 17 GW.

Nuclear power is not a major energy source in China. About one percent of the electricity generated in 1995 came from nuclear plants (see Figure 4.11). The capacity of nuclear plants were 0.3 GW in 1993, but plans are that by 2000 the capacity is to be 6 GW, with a further increase of 1.2 GW per year after 2000. The reactors are located in the provinces of Guangdong and Zhejiang.

Figure 4.11 Electricity generation by source. 1995



Source: OECD/IEA 1995a

Figure 4.11 illustrates the energy sources. Almost 4/5 of the electricity generated in 1995 came from thermal power plants. The electricity generated this way has increased by almost 90% from 1985 to 1991, while the corresponding growth of hydro-power was nearly 45% (see Figure 4.12 and Figure 4.13).

Figure 4.12 Power generation capacity (GW)



Source: OECD/IEA 1994.

Table 4.17 Electricity generation (TJ)

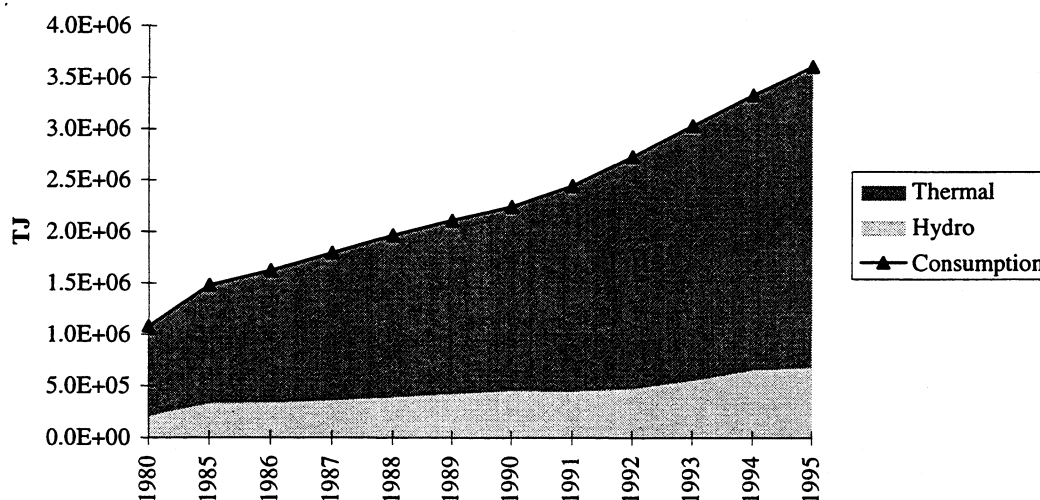
Reference	UNED 1993	Haugland and Roland 1994	OECD/IEA 1994	UN 1994	OECD/IEA 1995a
Year	1990	1991	1991	1992	1993
Electricity					
Generation	3.98E+05	2.44E+06	2.72E+06	2.71E+06	3.02E+06
Nuclear			7.20E+03		5.83E+03
Hydroelectric		4.50E+05	4.50E+05	4.77E+05	5.46E+05
Thermal			1.98E+06	2.24E+06	2.47E+06
Import				1.79E+04	1.87E+04
Export					
Losses					

Table 4.17 Electricity generation (TJ) (continued)

Reference Year	LBL 1996 1993	SSB 1997 1995	EIA1 1995	Intervall
Electricity				
Generation	3.02E+06	3.63E+06	3.43E+06	[3.98E+05, 3.63E+06]
<i>Nuclear</i>	5.76E+03	4.62E+04	4.46E+04	[5.76E+03, 4.62E+04]
<i>Hydroelectric</i>	5.47E+05	6.86E+05	6.66E+05	[4.5E+05, 6.86E+05]
<i>Thermal</i>	2.47E+06	2.90E+06	2.72E+06	[1.98E+06, 2.9E+06]
Import	5.33E+04	2.30E+03	2.72E+03	[2.3E+03, 5.33E+04]
Export	1.38E+03	2.17E+04	2.17E+04	[1.38E+03, 2.17E+04]
Losses	2.39E+05	2.68E+05	2.40E+05	[2.39E+05, 2.68E+05]

We see from both Table 4.17 and Figure 4.13 that China was a net exporter of electricity in 1995. Both Sinton (LBL 1996), SSB (1997) and EIA (EIA1) reported that transmission and distribution losses⁸ accounted for 7%-8% of the gross consumption. Figure 4.13 illustrates the generation and consumption of electricity, we see that import and export has not played an important role in the electricity balance. Losses in transmission and distribution are included in the consumption.

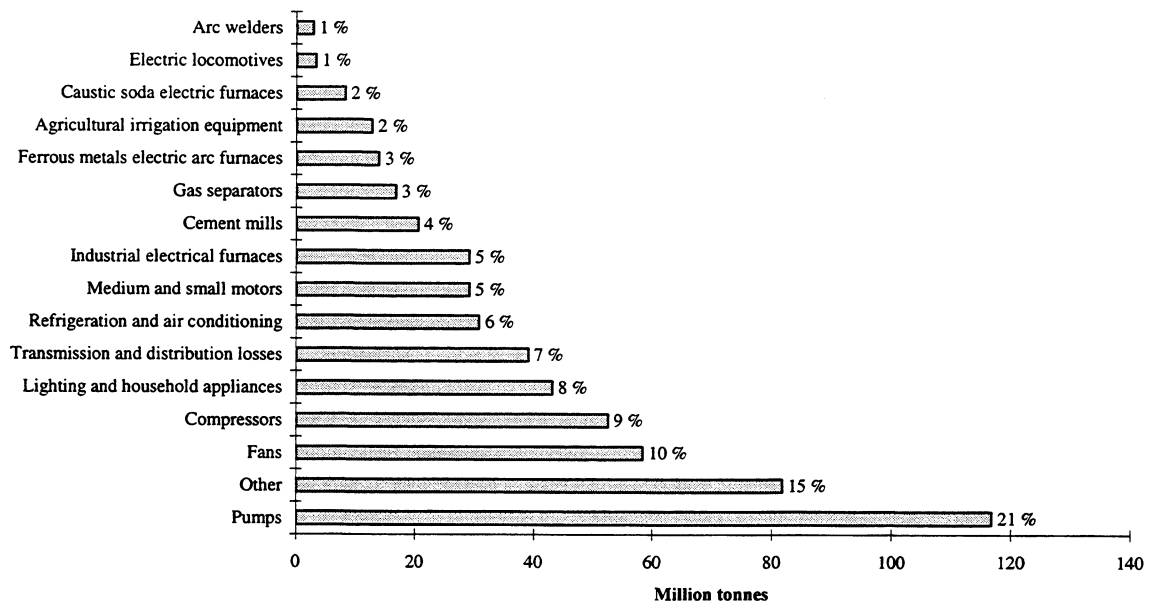
Figure 4.13 Production and consumption of electricity (TJ)



Source: SSB 1991, 1992, 1993, 1994, 1995, 1996 and 1997.

⁸ We assume this includes losses in distribution losses as well.

Figure 4.14 Electricity consumption by end use, estimated (MT and percent). 1990



Source: LBL 1997

Figure 4.14 illustrates the end use of electricity in 1995. Most of the electricity supplied was used by pumps and fans. Lighting and household appliances accounted for 8 percent of the consumption, while electric locomotives accounted for less than 1 percent.

Table 4.18 Electricity consumption, total and by sector (TJ)

Reference	Haugland and Roland 1994	OECD/IEA 1994	LBL 1996 1992	UN 1994 1992
Year	1990	1991	1992	1992
Electricity - Total consumption				
Total	1.97E+06	2.72E+06	2.35E+06	2.73E+06
Hydroelectric	3.34E+05	4.61E+05		4.95E+05
Nuclear		4.19E+04		
Thermal	1.47E+06	2.22E+06		2.24E+06
Electricity consumption by sector			2.35E+06	
-Farming, forestry, animal husbandry, fishery and water conservation			1.88E+05	
-Industry			1.74E+06	
-Mining and quarrying			2.88E+05	
-Manufacturing			1.61E+06	
-Electric power, gas and hot water production and supply				
-Electric power, steam and hot water production and supply				
-Gas production and supply				
-Tap water production and supply				
-Construction				
-Transport, post and tele- communications services			4.90E+04	
-Commerce, catering services, materials supply, marketing and storage			1.36E+05	
-Others				
-Residential consumption			1.73E+05	2.30E+05

Table 4.18 Electricity consumption, total and by sector (TJ) (continued)

Reference	OECD/IEA 1995a	SSB 1997	BP 1996	Intervall
Year	1993	1995	1995	
Electricity - Total consumption				
Total	2.82E+06	3.61E+06		[1.97E+06, 3.61E+06]
Hydroelectric			6.78E+05	[3.34E+05, 6.78E+05]
Nuclear			1.38E+05	[4.19E+04, 1.38E+05]
Thermal				[1.47E+06, 2.24E+06]
Electricity consumption by sector				
-Farming, forestry, animal husbandry, fishery and water conservation	2.82E+06	3.61E+06		[2.35E+06, 3.61E+06]
-Industry	2.17E+06	2.76E+06		[1.74E+06, 2.76E+06]
-Mining and quarrying		3.02E+05		[2.88E+05, 3.02E+05]
-Manufacturing		1.86E+06		[1.61E+06, 1.86E+06]
-Electric power, gas and hot water production and supply		6.00E+05		
-Electric power, steam and hot water production and supply		5.54E+05		
-Gas production and supply		3.90E+03		
-Tap water production and supply		4.16E+04		
-Construction		5.75E+04		
-Transport, post and tele- communications services		6.56E+04		[4.9E+04, 6.56E+04]
-Commerce, catering services, materials supply, marketing and storage		7.18E+04		[7.18E+04, 1.36E+05]
-Others		8.43E+04		
-Residential consumption	2.52E+05	3.62E+05		[1.73E+05, 3.62E+05]

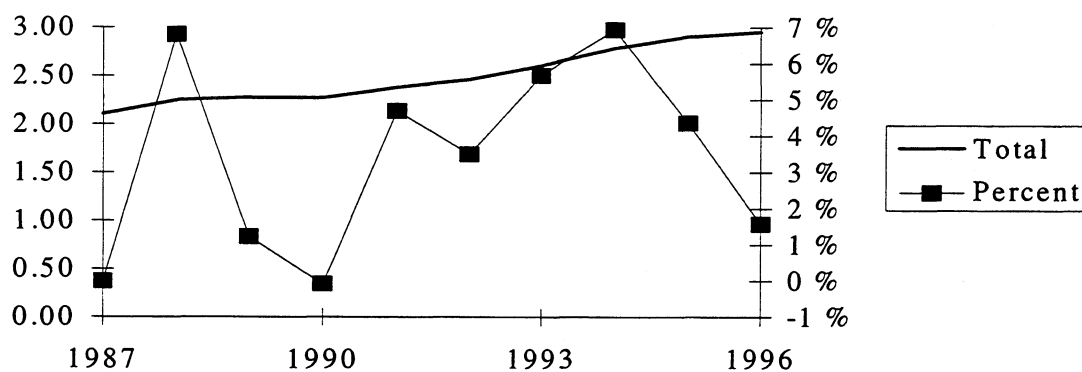
In 1995 15 percent of the electricity was consumed within the sector of electric power, steam and hot water production and supply. Manufacturing of raw chemical materials and chemical products accounted for 10 percent of the electricity consumption, about the same as the consumption by residents, while the corresponding figure for smelting and pressing of ferrous metals was 9 percent.

5. Emission to air

The information we found on emission to air was very limited. Statistics on emissions of the components CO₂, CH₄, SO₂ and PM were found in more than one reference, while information about emission of NO_x was only found in one reference (UNEP 1993).

Figure 5.1 illustrates the emission level of CO₂ and the annual percentage increase in the emission. The total emission of CO₂ increased by 40% from 1987-1996 according to OECD/EIA (EIA3).

Figure 5.1 Emission of CO₂ from consumption and flaring of fossil fuels (billion tonnes) and percentage increase in emission per year



Source: EIA3

Table 5.1 Emission of CO₂ (MT)

Reference	FNI 1997, ADB-project	FNI 1997, GEF-project	UNEP 1993	IEA 1995
Year	1990	1990	1990	1990
CO₂	2.26E+03	2.43E+03	2.49E+03	2.40E+03
<i>Combustion of fossil fuels</i>				
<i>Liquid</i>				
Oil	1.06E+03	3.24E+02		
<i>Crude oil</i>		1.66E+01		
<i>Gasoline</i>		5.62E+01		
<i>Diesel</i>		8.43E+01		
<i>Kerosene</i>		1.06E+01		
<i>Fuel oil</i>		1.08E+02		
<i>LPG</i>		7.96E+00		
<i>Refinery gas</i>		9.32E+00		
<i>Other oil</i>		3.15E+01		
<i>Solid</i>				
Coal	1.94E+03	2.07E+03		
<i>Gas</i>				
Natural gas	2.86E+01	3.30E+01		
<i>Processes</i>				
<i>Cement</i>				

Most of the CO₂ was emitted from coal burning, between 80-85% of total emission. The statistics on total emission of CO₂ are of the same magnitude, this is also mostly the case for the emission from each energy carrier.

Table 5.1 Emission of CO₂ (MT) (continued)

Reference	LBL 1996	OECD/IEA 1994	EIA3	Intervall
Year	1991	1991	1995	
CO₂	2.55E+03	2.42E+03	2.91E+03	[2.26E+03, 2.91E+03]
Combustion of fossil fuels	2.42E+03		2.91E+03	
<i>Liquid</i>	3.66E+02			
Oil				[3.24E+02, 1.06E+03]
<i>Crude oil</i>				
<i>Gasoline</i>			3.90E+02	[5.62E+01, 3.9E+02]
<i>Diesel</i>				
<i>Kerosene</i>				
<i>Fuel oil</i>				
<i>LPG</i>				
<i>Refinery gas</i>				
<i>Other oil</i>				
<i>Solid</i>	2.03E+03			
Coal			2.48E+03	[1.94E+03, 2.48E+03]
<i>Gas</i>	3.08E+01			
Natural gas			3.31E+01	[2.86E+01, 3.31E+01]
Processes				
<i>Cement</i>	1.24E+02			

Table 5.2 Emission of CH₄ (MT)

Reference	FNI 1997, ADB-project	FNI 1997, GEF-project	UNEP 1993	Intervall
Year	1990	1990	1990	
CH₄	6.15E+00	1.45E+01	5.24E+01	[6.15E+00, 5.24E+01]
Energy consumption and use	5.00E-02	6.00E-02	1.79E+01	[0.05E+00, 1.79E+01]
Leakage in oil and natural gas production	4.00E-01	1.80E-01		[0.18E+00, 0.4E+00]
Coalbed methane	5.30E+00	1.07E+01		[5.3E+00, 1.07E+01]
Biomass combustion	4.00E-01	3.62E+00		[0.4E+00, 3.62E+00]
Landfills			2.09E+00	
Livestock			7.37E+00	
Rice cultivation			2.50E+01	

Statistics on the emission of CH₄ is not of the same magnitude. Estimated emissions done by the Asian Development Bank (ADB) - project is about one tenth of the emission reported by UNEP (1993). Coalbed⁹ methane seems to be the biggest source of CH₄ emission, followed by biomass combustion, leakage from oil and natural gas production, rice cultivation and energy consumption and use.

⁹ Coalbed methane is methane emitted from coal mines.

Table 5.3 Emission of SO₂ and PM (MT)

Reference	SSB/NEPA	LBL 1996	LBL 1996	Edmonds 1994	SSB/NEPA
Year	1991	1991	1992	1992	1992
SO₂	1.62E+01	1.62E+01	1.69E+01	1.69E+01	1.69E+01
Industry	1.17E+01	1.17E+01	1.32E+01		1.32E+01
Non-combustion			1.98E+00		
PM		1.31E+01	1.41E+01	1.99E+01	
Industry	1.42E+01	8.45E+00	8.70E+00		1.45E+01
Processes		5.79E+00	5.76E+00		

Table 5.3 Emission of SO₂ and PM (MT) (continued)

Reference	SSB/NEPA	Lin, G 1997	CEY 1996	Intervall
Year	1993	1994	1995	
SO₂	1.30E+01	1.83E+01	1.89E+01	[1.3E+01, 1.89E+01]
Industry	1.29E+01			[1.17E+01, 1.32E+01]
Non-combustion				[1.98E+00, 2.18E+00]
PM			1.48E+01	[1.31E+01, 2.03E+01]
Industry	1.50E+01			[8.45E+00, 1.5E+01]
Processes				[5.76E+00, 6.17E+00]

Both data on SO₂ and PM are not too different for the four different references found on emission of these components. We assume that the statistics referred to in Table 5.3 include emission from industry only.

Emission data on NO_x was only found in the report from UNEP (1993), which reports the the total emission of NO_x in 1987 was 7.37 MT.

References

- The British Petroleum Company (BP) (1996): *BP Statistics of World Energy 1996*. England
- China Environmental Yearbook (CEY) (1996)
- Fridtjof Nansen Institute (FNI) (1997): *Energy Structures as Determinants of Response to Climate Change: Case Studies of Brazil, China, India and Mexico*. ed. J. Estrada and H.O. Bergesen.
- Haugland, T. and K. Roland (1990): *Energy, Environment and Development in China*. Report 1990/17. The Fridtjof Nansen Institute, Norway.
- Haugland, T. and K. Roland (1994): *Energy Consumption in China, India, Indonesia and South Korea*. Report 303/94. ECON, Oslo.
- Lawrence Berkeley Laboratory (LBL) (1992): *China Energy Databook*. ed. J.E. Sinton. Ernest Orlando Lawrence Berkeley National Laboratory, Berkeley, CA.
- Lawrence Berkeley Laboratory (LBL) (1996): *China Energy Databook*. ed. J.E. Sinton. Ernest Orlando Lawrence Berkeley National Laboratory, Berkeley, CA.
- Organisation for Economic Co-operation and Development (OECD)/International Energy Agency (IEA) (1994): *World Energy Outlook, 1994 edition*. Paris.
- Organisation for Economic Co-operation and Development (OECD)/International Energy Agency (IEA) (1995a): *Energy Statistics and Balances of Non-OECD countries, 1992-1993*. Paris
- Organisation for Economic Co-operation and Development (OECD)/International Energy Agency (IEA) (1995b): *Oil, Gas and Coal Supply Outlook*. Paris.
- Organisation for Economic Co-operation and Development (OECD)/International Energy Agency (IEA) (1996): *Coal Information 1995*. Paris.
- Organisation for Economic Co-operation and Development (OECD)/International Energy Agency (IEA) (1997): *Energy Statistics and Balances of Non-OECD countries, 1992-1993*. Paris
- Holtskog, S (1998): *Residential Consumption of Bioenergy in China: A Literature Study*. Documents 98/3. Statistics Norway.
- The State Statistical Bureau of China (SSB) (1991): *China Statistical Yearbook*. China.
- The State Statistical Bureau of China (SSB) (1992): *China Statistical Yearbook*. China.
- The State Statistical Bureau of China (SSB) (1993): *China Statistical Yearbook*. China.
- The State Statistical Bureau of China (SSB) (1994): *China Statistical Yearbook*. China.
- The State Statistical Bureau of China (SSB) (1995): *China Statistical Yearbook*. China.
- The State Statistical Bureau of China (SSB) (1996): *China Statistical Yearbook*. China.
- The State Statistical Bureau of China (SSB) (1997): *China Statistical Yearbook*. China.
- United Nations (UN), Department for Economic and Social Information and Policy Analysis, Statistical Division (1994): *1992 Energy Statistics Yearbook*. New York.

United Nations Environment Programme (UNEP) (1993): *Environmental Data Report: 1993-1994*. UK.

Internet

Reference	Internet-address
EIA1	http://www.eia.doe.gov/emeu/world/country/cntry_CH.html
EIA2	http://www.eia.doe.gov/emeu/cabs/china.html
EIA3	http://www.eia.doe.gov/emeu/iea/tableh1.html
Sinton, J.E. (1995)	http://eande.lbl.gov/EAP/AR/ieei/ieei15.html

Appendix

1. Net calorific value of selected energies for China

	TJ/t	toe/t	tce/t
Oil			
Crude oil	0.04	1.02	1.46
Petroleum products			
Refinery gain/gas	0.05	1.15	1.64
LPG	0.05	1.13	1.62
Gasoline	0.04	1.05	1.50
Kerosene	0.04	1.03	1.47
Diesel oil	0.04	1.03	1.47
Aviation gasoline	0.04	1.05	1.50
Jet fuel	0.04	1.05	1.50
Heavy fuel oil	0.04	0.97	1.39
Coal			
Hard Coal			
Production	0.02	0.49	0.70
Imports	0.02	0.49	0.70
Exports	0.02	0.49	0.70
Washed coal	0.03	0.72	1.02
Coke	0.03	0.68	0.97
Crop residual	0.014	0.33432	0.47794
	TJ/Mm³	toe/Mm³	tce/Mm³
Gas			
Natural gas	39	931.32	1331.42

2. List of Abbreviations

ADB	Asian Development Bank
EIA	Energy Information Administration (United States)
FNI	The Fridtjof Nansen Institute
GEF	Global Environment Facility
IEA	International Energy Agency
IEEI	The Industrial Energy Efficiency Initiative
LBL	Lawrence Berkeley Laboratory
NEPA	National Environmental Protection Agency
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PM	Particular matter
PRC	The People's Republic of China
SSB	State Statistical bureau of China
TFC	Total Final Consumption
TPES	Total Primary Energy Supply
UN	United Nations

3. Summary of the different statistics on supply and consumption of energy

The table below illustrates where the reports differed significantly (by at least a factor of 2, with correction for annual increment according to Statistical Yearbook)

	Coal	Oil					Gas			Electricity
		Crude oil	Gasoline	Kerosene	Diesel oil	Fuel oil	Natural gas	Coke-oven gas		
Production	-	*	-	*	-	-	-	-	*	
Import	-	*	*	*	-	-	-	-	*	
Export	-	-	-	-	*	-	-	-	*	
Consumption	-	*	-	-	-	-	-	-	-	

*: The reports differs significantly.

-: The reports are fearly unanimous.

:: Only one report has data for this.

4. Major energy consuming sectors

The following table illustrates where most of each energy carrier are used.

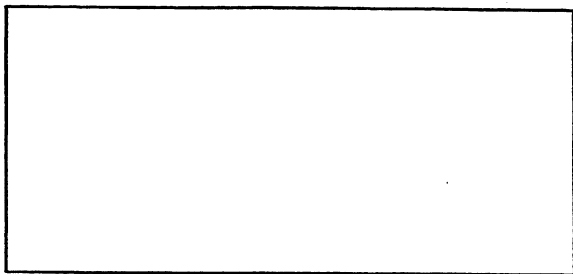
Sector	Oil							Gas		
	Coal	Crude oil	Gasoline	Kerosene	Diesel oil	Fuel oil	Natural gas	Coke-oven gas	Electricity	
-Farming, forestry, animal husbandry, fishery and water conservation					*					
-Industry	*	*	*		*	*	*	*	*	
-Mining and quarrying						*	*		*	
-Manufacturing		*	*			*	*		*	
-Electric power, gas and hot water production and supply	*					*	*			
-Electric power, steam and hot water production and supply	*					*	*			
-Gas production and supply										
-Tap water production and supply										
-Construction										
-Transport, post and telecommunications services										
-Commerce, catering services, materials supply, marketing and storage			*	*	*					
-Others										
-Residential consumption										

*: Major energy consuming sector

Recent publications in the series Documents

- 96/24 Å. Kaurin, E. Vinju and L. Solheim: Statistics on Waste and Recycling from Parts of the Public Sector
- 96/25 T. Bye and S. Kverndokk: Nordic Negotiations on CO₂ Emissions Reduction. The Norwegian Negotiation Team's Considerations
- 96/26 L. Rogstad and M. Dysterud: Land Use Statistics for Urban Agglomerations. Development of a Method Based on the Use of Geographical Information Systems (GIS) and Administrative Records
- 96/27 K. Rypdal: NOSE – Nomenclature for Sources of Emissions
- 97/1 T.C. Mykkelbost and K. Rypdal: Material Flow Analysis of Cadmium and Di-2-ethylhexylphthalate (DEHP) in Norway
- 97/2 S. Grepperud: The Impact of Policy on Farm Conservation Incentives in Developing countries: What can be Learned from Theory
- 97/3 M. Rolland: Military Expenditure in Norway's Main Partner Countries for Development Assistance. Revised and Expanded Version
- 97/4 N. Keilman: The Accuracy of the United Nation's World Population Projections
- 97/5 H.V. Sæbø: Managerial Issues of Information Technology in Statistics Norway
- 97/6 E.J. Fløttum, F. Foyn, T.J. Klette, P.Ø. Kolbjørnsen, S. Longva and J.E. Lystad: What Do the Statisticians Know about the Information Society and the Emerging User Needs for New Statistics?
- 97/7 A. Bråten: Technical Assistance on the Jordanian Consumer Price Index
- 97/8 H. Brunborg and E. Aurbakken: Evaluation of Systems for Registration and Identification of Persons in Mozambique
- 97/9 H. Berby and Y. Bergstrøm: Development of a Demonstration Data Base for Business Register Management. An Example of a Statistical Business Register According to the Regulation and Recommendations of the European Union
- 97/10 E. Holmøy: Is there Something Rotten in this State of Benchmark? A Note on the Ability of Numerical Models to Capture Welfare Effects due to Existing Tax Wedges
- 97/11 S. Blom: Residential Concentration among Immigrants in Oslo
- 97/12 Ø. Hagen and H.K. Østereng: Inter-Baltic Working Group Meeting in Bodø 3-6 August 1997 Foreign Trade Statistics
- 97/13 B. Bye and E. Holmøy: Household Behaviour in the MSG-6 Model
- 97/14 E. Berg, E. Canon and Y. Smeers: Modelling Strategic Investment in the European Natural Gas Market
- 97/15 A. Bråten: Data Editing with Artificial Neural Networks
- 98/1 A. Laihonen, I. Thomsen, E. Vassenden and B. Laberg: Final Report from the Development Project in the EEA: Reducing Costs of Censuses through use of Administrative Registers
- 98/2 F. Brunvoll: A Review of the Report "Environment Statistics in China"
- 98/3: S. Holtskog: Residential Consumption of Bioenergy in China. A Literature Study
- 98/4 B.K. Wold: Supply Response in a Gender-Perspective, The Case of Structural Adjustments in Zambia. Technical Appendices
- 98/5 J. Epland: Towards a register-based income statistics. The construction of the Norwegian Income Register
- 98/6 R. Chodhury: The Selection Model of Saudi Arabia. Revised Version 1998
- 98/7 A.B. Dahle, J. Thomasen and H.K. Østereng (eds.): The Mirror Statistics Exercise between the Nordic Countries 1995
- 98/8 H. Berby: A Demonstration Data Base for Business Register Management. A data base covering Statistical Units according to the Regulation of the European Union and Units of Administrative Registers
- 98/9 R. Kjeldstad: Single Parents in the Norwegian Labour Market. A changing Scene?
- 98/10 H. Brüngger and S. Longva: International Principles Governing Official Statistics at the National Level: are they Relevant for the Statistical Work of International Organisations as well?
- 98/11 H.V. Sæbø and S. Longva: Guidelines for Statistical Metadata on the Internet
- 98/12 M. Rønsen: Fertility and Public Policies - Evidence from Norway and Finland
- 98/13 A. Bråten and T. L. Andersen: The Consumer Price Index of Mozambique. An analysis of current methodology – proposals for a new one. A short-term mission 16 April - 7 May 1998
- 98/14 Sigurd Holtskog: Energy Use and Emmissions to Air in China: A Comparative Literature Study

Documents



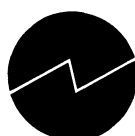
Tillatelse nr.
159 000/502

B *Returadresse:*
Statistisk sentralbyrå
Postboks 8131 Dep.
N-0033 Oslo

Statistics Norway
P.O.B. 8131 Dep.
N-0033 Oslo

Tel: +47-22 86 45 00
Fax: +47-22 86 49 73

ISSN 0805-9411



Statistisk sentralbyrå
Statistics Norway