

Quantitative Analysis of Carbon Emission Demand and Fulfillment of Human Development

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Yao Yufang Jiang Jinhe

Institute of Quantitative and Technical Economics, Chinese Academy of Social Sciences

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The meaning of fulfillment of human development potential and indicators analysis

- **Meaning:** To meet human fundamental demands, and guarantee the decent living standards. The fundamental demand means meeting the survival demand of human life, including nutrition, housing, environment, medical treatment, and compulsory education, and living standard includes income, life-span and so on.
- **Indicator Analysis**
 - Economic indicators: GDP per capita, consuming level and consuming structure, industry structure, living standard.
 - Social indicators

- **By analyzing many countries' development, we assume the GDP per capita US\$10,000(US price in 2000) is the index of fulfillment human developing potentials.**

When the GDP per capita is about US\$10,000(2000 US price), China industry structure ratio is that , namely, the first industry : the second industry: the third industry = 6.7:37:56.3

Table 1 consuming structure at development potential(%)

consuming	food	medical	Traffic and communication	Education and amusement	housing
US\$5500	20	6	9	16	16

Table 2 living quality at development potential

	GDP per capita US\$ 10,000
Per capita housing area(m ²)	28
urban	26
rural	32
Per capita protein daily(g)	90
Engel coefficient(%)	20
Private cars per 100 person	12
Culture, education, amusement expenditure (%)	16
Information fee expenditure percentage(%)	10
Per capita public greenbelt area(m)	20
Per capita life consuming electricity(kwh)	1600 or so

Economic-energy model and simulation result

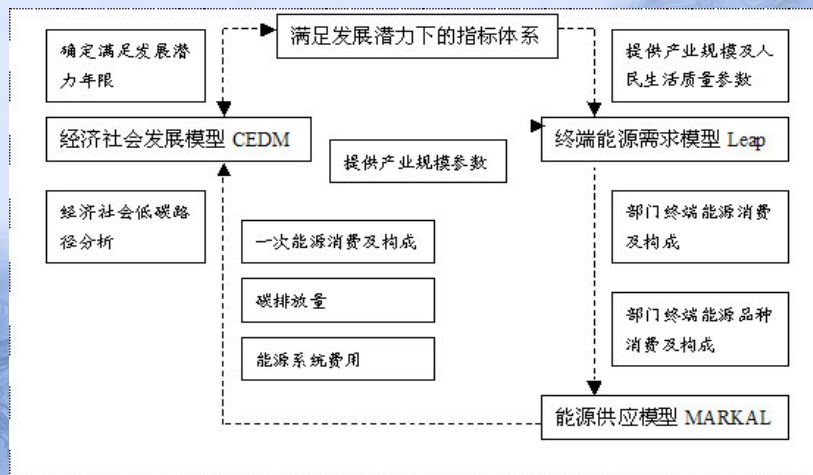


Figure 1 integration model frame sketch

Table 3 terminal variety, sector terminal consuming and structure at meeting development potential(base case)

	coal	power	oil	Natural gas	others	total	%
agriculture	54	47.3	15	0	28.5	144.8	3.9
Construction	22.4	25.2	8	12.8	8.8	77.2	2.1
life	204.7	590	156.3	77.4	1.09	1029.5	27.8
industry	599.79	251.2	35.2	81.8	55.4	1023.4	27.6
service	114	195	68.4	131.1	39.9	548.4	14.8
transport	0	68	815.9	0	0	883.9	23.8
total	994.89	1176	1098.8	303.1	133.67	3707.2	100
%	26.8	31.7	29.6	8.3	3.6	100	

note: unit is one million standard coal.

Table 4 Primary energy supplying and structure in 2000-2050 (base case)

	2000	2010	2020	2030	2040	2050
Primary energy total (Mtee)	1506.3	2309.5	3662.4	4430.6	5219.7	5767.8
coal	860.0	1400.6	2252.9	2587.6	3018.0	3227.0
oil	322.0	494.3	774.6	963.0	1100.3	1177.2
natural gas	33.8	94.1	245.8	397.6	530.8	679.8
hydroelectric	83.3	115.6	144.7	159.8	171.2	195.8
nuclear power	4.7	38.4	88.2	150.5	195.8	216.3
new energy	2.6	6.6	16.2	32.2	63.7	132.2
traditional biology energy	200.0	160.0	140.0	140.0	140.0	140.0
CO ₂ emission (Mt C)	772.6	1257.9	2051.0	2442.6	2864.0	3109.0

Scenarios set:

- **Base case:** In about 2050, when per capita GDP amounts to US\$10,000, the paper suggests social economy development and energy supply-demand.
- **Consumption Case of natural gas replacing petroleum:** Both petroleum and natural gas are high quality resources. In order to ensure the petroleum safety, the paper suggests reducing import of petroleum and making energy structure more.
- **Increase energy utility efficiency case:** Increase energy efficiency and saving resources are the necessary option of realizing sustainable development.
- **Optimize energy structure case:** To increase hydroelectricity equipped capacity, which will amount to 320GW in 2050 from the 240GW; the development of geothermal power and solar electrical energy generation will be 1.5 times the reference case; to accelerate developing the nuclear power, which will reach 210GW in 2050 from 125GW.
- **Coal liquidation case**

**Table 5 Five scenarios of energy system cost during 2000 and 2050
(thousand million RMB yuan)**

	2000	2010	2020	2030	2040	2050
Optimization of energy structure	6325	16308	32091	44240	60517	80434
Base case	6324	16140	31832	43450	59751	79218
Natural gas replacing petroleum	6324	16608	31853	43990	59864	79499
Coal liquidation	6324	16140	36806	44909	60101	82877
Increasing energy efficiency	6324	18223	32497	44786	62276	83133

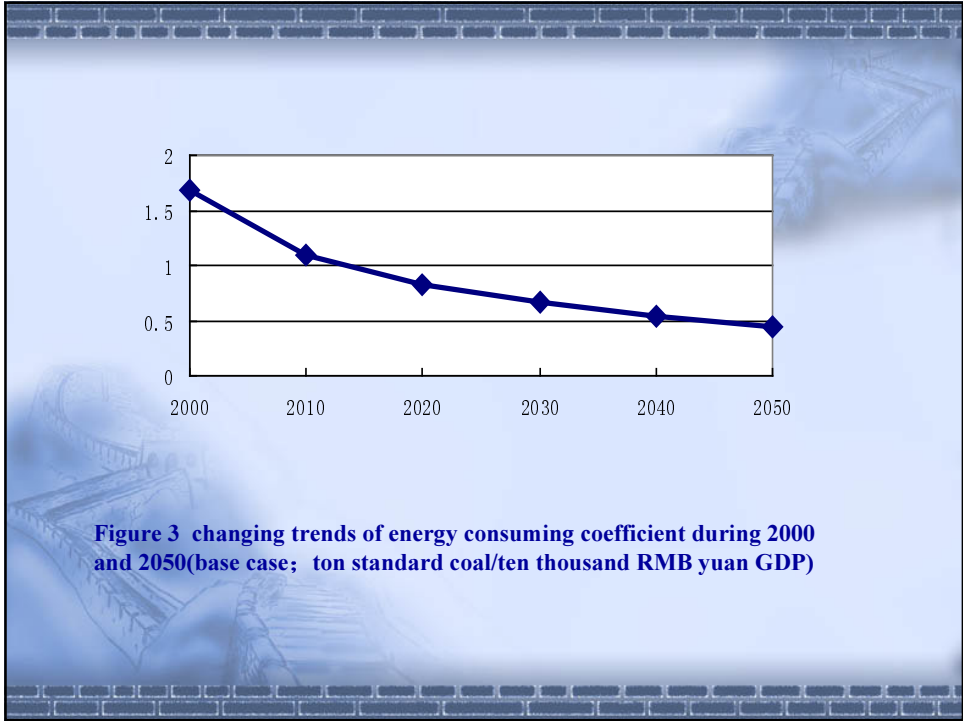


Table 6 Carbon dioxide emission and per capita emission of world and part countries in 1998 (unit: carbon)

	Carbon dioxide emission (hundred million tons carbon)	Per capita carbon dioxide (ton carbon/person)
US	15.21	5.63
China	8.45	0.682
Russia	4.05	2.76
Japan	3.14	2.49
India	2.48	0.253
German	2.37	2.89
UK	1.54	2.6
Canada	1.35	4.46
Italy	1.17	2.03
Korea	1.01	2.18
Total	61.94	1.05

The calculating results of base case indicate that in order to fulfill the human development potential, per capita gross domestic product reaches US\$10,000 in 2050, energy consumption per capita is 3700kg standard coal/person, below the level of developed countries in the 1990s; per capita carbon emission is about 2 tons; the energy consumption coefficient is from 1.68 kg standard coal/ten thousand yuan(RMB) in 2000 to 0.45 kg standard coal/ten thousand yuan(RMB) in 2050, down about 2.6% annually, energy elastic coefficient is about 0.5 during 50 years.

About energy structure of generation power, coal accounting for 56.4%, nuclear power occupying 4.4%, natural gas at 25.6%, new energy at 5.2%, and hydroelectric at 8.4%. And per capita equipped capacity is about 1.82 kw/person; per capita generation power is about 6948 kwhr, reaching the level of developed countries at the 1990s.

China carbon dioxide emission in 2000 is about 800 million tons carbon. At fulfillment development potential demands, it will amount to 3,110 million tons carbon, 4 times that of 2000, annually increasing 2.8%.

Conclusion:

- China will realize the human development potential, when per capita GDP is about US\$10,000 in 2050. The calculating results of base case indicate that CO₂ emission is 2051 million tons carbon in 2020; 3,110 million tons carbon in 2050, primary energy demands is about 5770 million tons standard coal, among which petroleum consumption is 1177 million tons standard coal, natural gas is 680 million tons standard coal. Meanwhile both environment and carbon dioxide emission is severe. The saving efficiency of base case is 2.6% annually during 50 years.
- In order to fulfill human development potential, we must analyze people consuming mode, pursuing low consuming energy, and will live a comfortable and high quality living style.
- We should strengthen the exploring and mining of energy, and make study the renewable energy and new energy. From the visible technology prospect, it will be a bit difficult to realize the human development and low carbon at the same time. We expect the future energy realize the essential breakthrough in utilizing technology and developing new energy, meanwhile we hope can get the support from foreign countries.

