

Modeling Energy Requirements for Basic Needs Satisfaction

the case of China: priorities, trends and the future

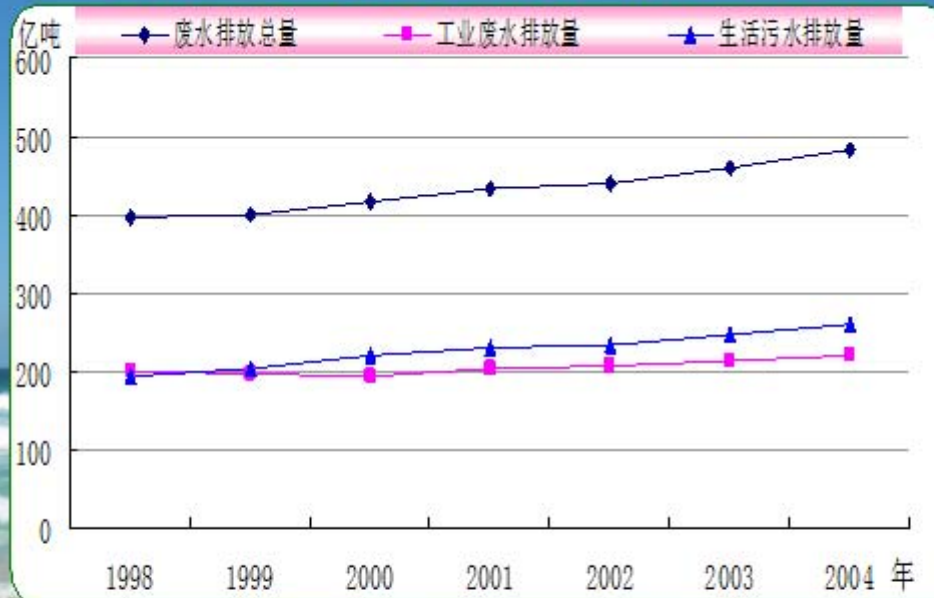
BASIC China Team

Beijing, Feb., the 17th, 2007

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Challenges and priorities: water



Urban waste water treatment in 2004:

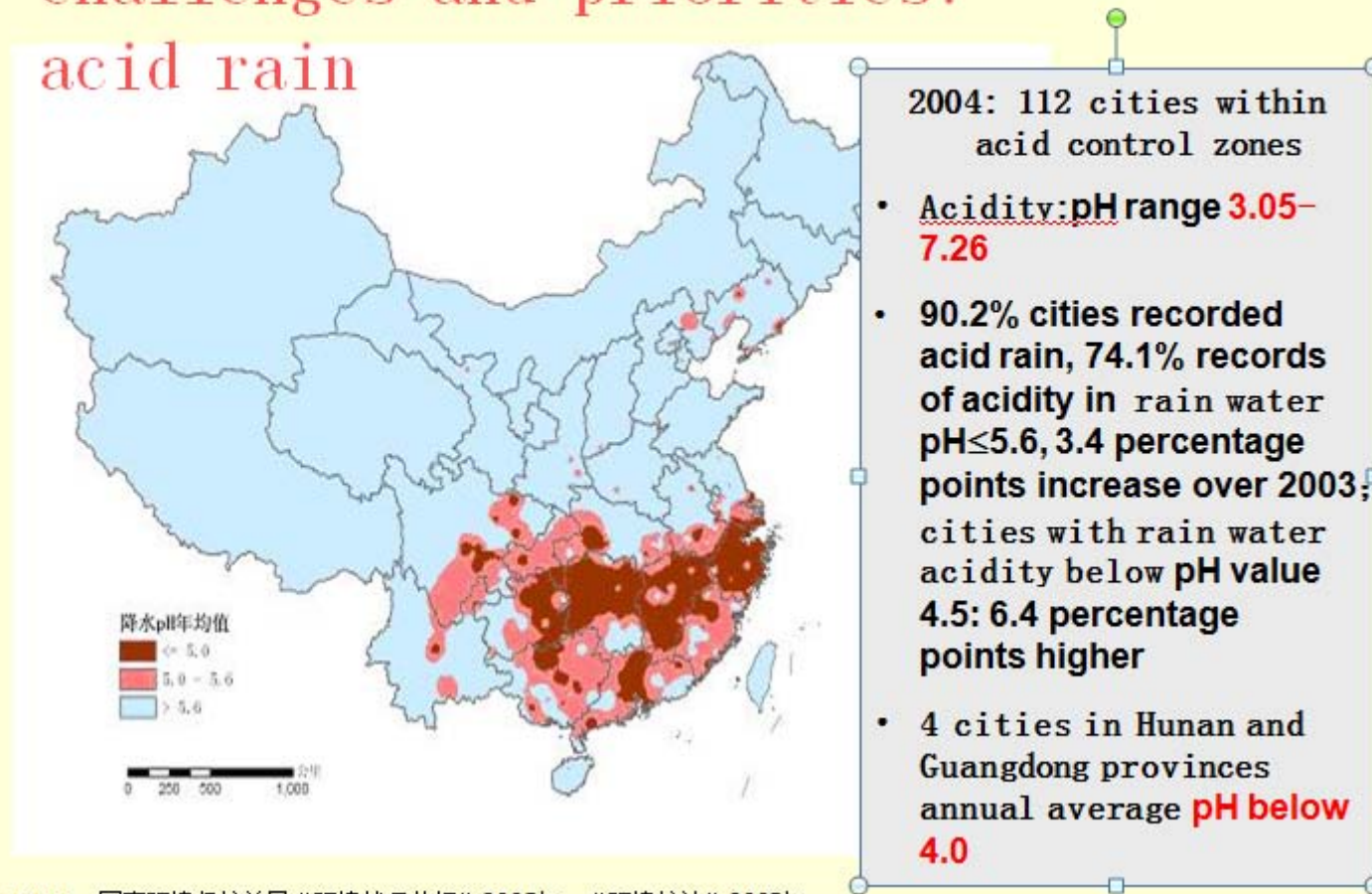
• **32.3%**.

Water quality in 7 biggest rivers in China: worsening trend (412 monitoring sections)

2000: Class I - III: 57.7%; IV - V: 28.5%; > V: 13.8%。

2004: Class I - III: 41.8%; IV - V: 30.3%; > V: 27.9%

Challenges and priorities: acid rain



source: 国家环境保护总局《环境状况公报》2005年,《环境统计》2005年

Challenges and priorities: urban environment

Among 500 cities with data available

- **Solid waste materials: hazardous waste** 60.44% properly treated (hospital waste);
municipal solid waste: 57.7% properly treated;
urban waste water: 32.3%
- **No environmental facilities:** 155 cities with no hazardous waste treatment facilities; 193 cities with no waste water treatment plants; 160 cities with no municipal solid waste treatment facilities

Challenges and priorities: resource consumption – world steel production in 2005

		Raw steel			iron
1	China	349.4	1	China	330.4
2	US	127.0	2	Japan	83.1
3	Japan	112.5	3	Russia	48.4
4	Russia	66.2	4	US	36.4
5	S. Korea	47.7	5	Brazil	34.0
6	Germany	44.5	6	Ukraine	30.8
7	Ukraine	38.6	7	Germany	28.8
8	India	38.1	8	S. Korea	27.3
9	Brazil	31.6	9	India	26.1
10	Italy	29.1	10	France	12.7

Raw steel: world total in 2005: 1.13 bt, , growth by 5.9%. China: **349.4mt**, 24.6%. EU186.5mt, **-3.6%**; N. America 127.0mt, **-5.3%**; S. America 45.3mt, **-1.2%**

Unit: million tons; source: IISI

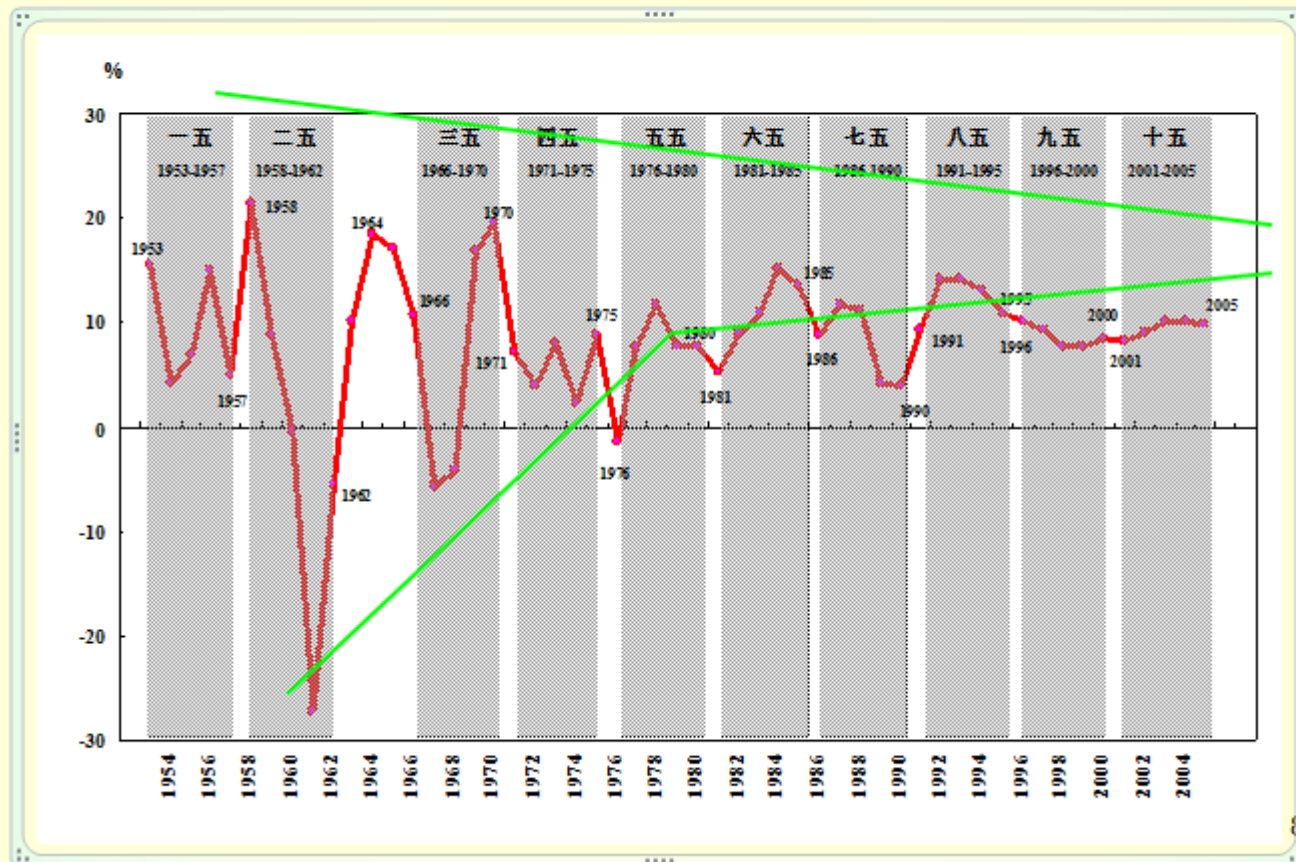
Challenges and priorities: resource consumption

- Cement: production in 2005: 1022.58mt, +5.42%,
- Electricity: newly added capacity in 2005: 70GW, total capacity: 510GW; total production of electricity: 2.4trillion kWh

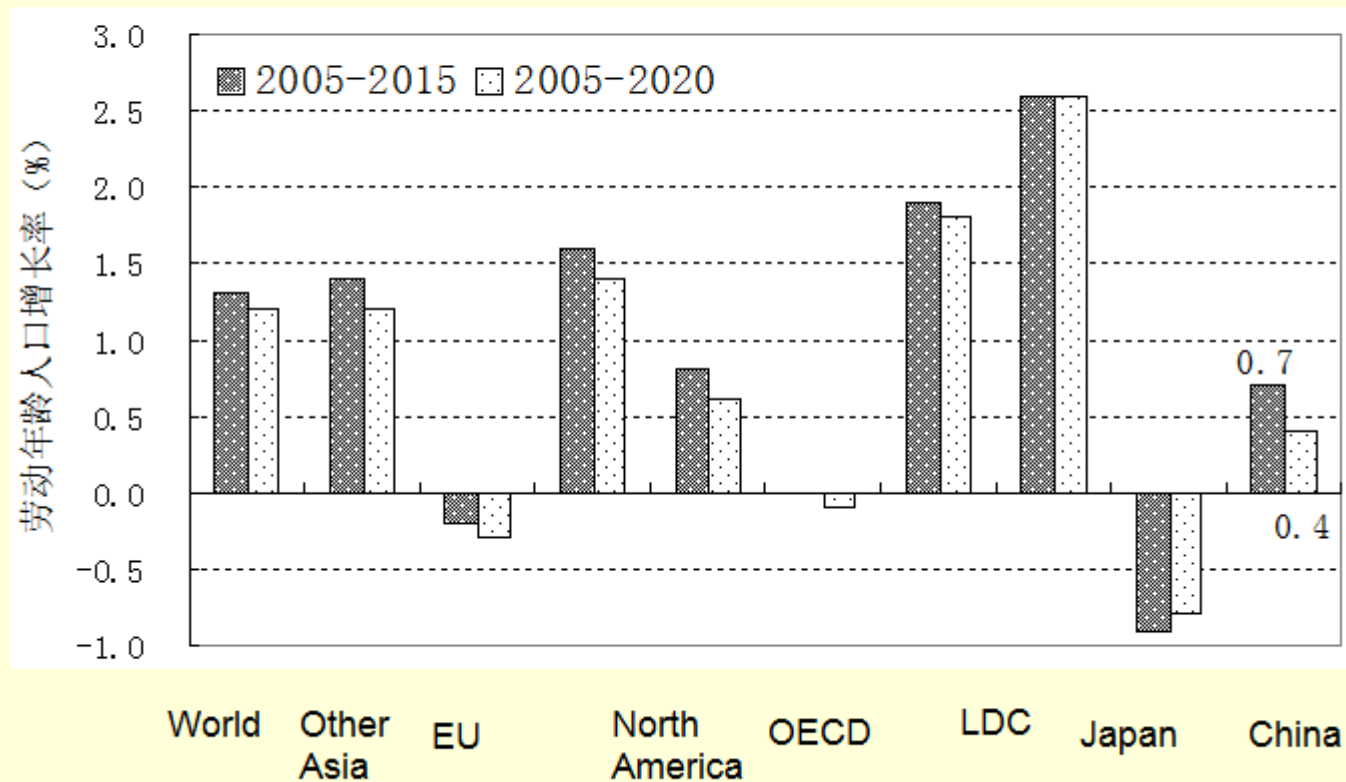
Will this trend continue and sustain?

- The answer is NO. Reason
 - No need once stock is there
 - Not Possible, physical constraints

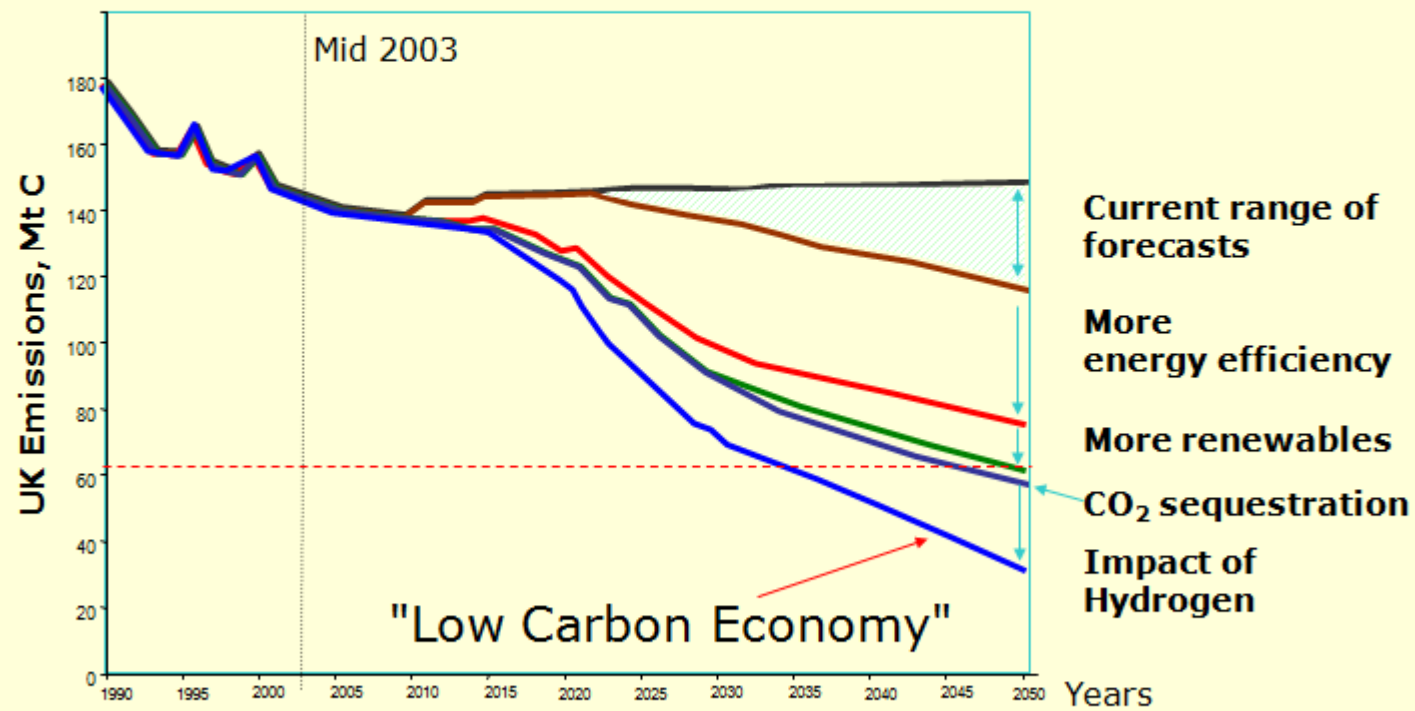
Fluctuations of Growth rate in China 1954 to 2005: unstable to stable, reduced rate of growth



Projections of growth in labour supply (%)



UK Emissions paths and projections: no need to emit more



Transitional stages from high to low energy requirement

➤ Industrialization process

- urbanization
- infrastructure: physical infrastructure and institutional infrastructure
- Industrial process: labor intensive (energy intensity low) ==» capital intensive (energy intensity high) ==» knowledge intensive (energy intensity low)

➤ Industrial status

- De-industrializing countries (decoupling energy)
- Industrialized (stable and high level of energy consumption)
- newly industrialized (slow growth of energy consumption)
- rapidly industrializing (rapidly increasing consumption of energy)

Stocks vs flows

- **Stocks:** all the build-up infrastructure, buildings and durables stock carbons
 - physical infrastructure
 - buildings (public & private)
 - durable consumption goods (cars, electric appliances)
- **Flows:** daily/regular need for carbon
 - depreciation
 - maintenance
 - household/service

A decent living standard would require

The following basics



Shelter



education



necessary calories for survival

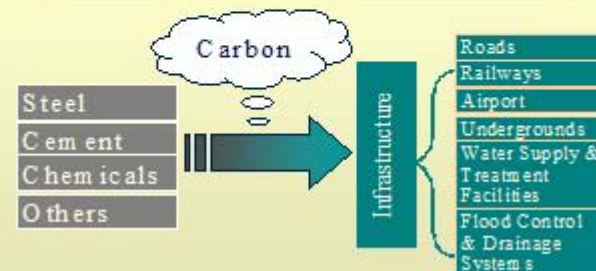


basic health care



access to clean water

Carbon emission: Infrastructure



Concepts of Basic Needs

- Sustainable consumption

Sustainable consumption is the use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations (UN-CSD 1995).

- “Human development is the end – economic growth a means.”

----Human Development Report 1996, UNDP

- Basic needs

- Biologically limited and measures should be taken to guarantee their satisfaction;
- Luxury, wasteful, competitive, and status identification needs are unlimited and should be discouraged;

- two levels of basic needs

- basic needs for survival: the eradication of absolute poverty and deprivation
- Basic needs for a decent standard of life: a society in which the majority of people can enjoy a life of adequacy, associated with the completion of industrialization of urbanization.

Basic Needs for Survival

--UN Millennium Development Goals

In the UN Millennium Declaration made in September 2000, 189 UN member countries committed themselves to making the right to development a reality for everyone and to freeing the entire human race from want. They acknowledged that progress is based on sustainable economic growth, which must focus on the poor.

The Declaration calls for halving by the year 2015, the number of people who live on less than one dollar a day. This effort also involves finding solutions to hunger, malnutrition and disease, promoting gender equality and the empowerment of women, environmental sustainability, and global development partnership.

Goal 1. Eradicate extreme poverty and hunger

Goal 2. Achieve universal primary education

Goal 3. Promote gender equality and empower women

Goal 4. Reduce child mortality

Goal 6. Combat HIV/AIDS, malaria and other diseases

Goal 7. Ensure environmental sustainability

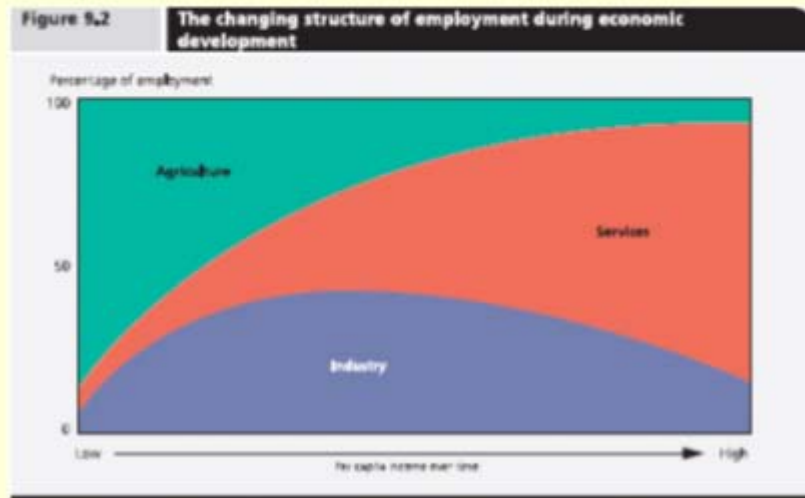
Goal 8. Develop a global partnership for development

Urbanization & Structure of the Economy

Economic and GDP structure in the 12 most populous Countries and Regions-2005

	Population (million)	Per capita GDP (PPP\$)	Urbaniza tionrate in 2003	GDP Composition			Employment by Occupation		
				Agriculture	Industry	Service	Agriculture	Industry	Service
China	1,306	\$5,600	39%	13.8%	52.9%	33.3%	49%	22%	29%
India	1,080	\$3,100	28%	23.6%	28.4%	4.8%	60%	17%	23%
EU-25	457	\$26,900	78%	2.2%	28.3%	56.3%	8%	19%	69.4%
USA	296	\$40,100	78%	0.9%	19.7%	79.4%	0.7%	22.7%	76.6
Indonesia	242	\$3,500	44%	14.6%	45%	40.4%	45%	16%	39%
Brazil	186	\$8,100	83%	10.1%	38.6%	51.3%	20%	14%	66%
Pakistan	162	\$2,200	34%	22.6%	24.1%	53.3%	42%	20%	38%
Bangladesh	144	\$2,000	27%	21.2%	27.1%	51.7%	63%	11%	26%
Russia	143	\$9,800	73%	4.9%	33.9%	61.2%	12.3%	22.7%	65%
Nigeria	129	\$1,000	47%	36.3%	30.5%	33.3%	70%	10%	20%
Japan	127	\$29,400	79%	1.3%	24.7%	74.1%	5%	2.5%	70%
Mexico	106	\$9,600	75%	4%	27.2%	68.9%	18%	24%	58%

Industrialization and Post-industrialization



Income Level and Economic Structure-2003

	Per Capita GNI (PPP \$)	Agriculture	Industry	Manufacturing	Service
World Average	8190	4	28	18	68
Low Income	2110	24	27	14	49
Middle Income	6000	10	36	22	54
Lower Middle Income	5500	11	37	25	52
Upper Middle Income	9990	6	35	18	59
Low and Middle Income	4300	12	35	21	53
High-income	29580	2	27	18	71
Europe EMU	26350	2	28	20	70

- As **income per capita** rises, agriculture loses its primacy, giving way first to a rise in the industrial sector, then to a rise in the service sector.
- As industry generally has a higher energy intensity than agriculture and service, the catching up process is accompanied by increasing requirement for energy.

Methodological consideration: Production and Consumption

In systems of national accounting:

- Production = household consumption + public consumption + investment

In the Basic Needs Calculation:

- All production is ultimately for some form of personal consumption.
- Public consumption is taken as a form of collective consumption, paid by the consumers with taxes;
- Investment is for future consumption, as each year consumes something from previous year and accumulate some investment for the future, in a time range of a few years, generally difference between total consumption and production is negligible.

Basic Needs Calculation

Step 1: Define overall national development level

As countries take the main responsibility of securing the satisfaction of their people's basic needs and peoples living standards are to great extent influenced by the economic development level of their country, in basic needs satisfaction, the first step is defining the overall national development level: basic needs for survival equivalent to the transition from low income countries to lower middle income countries; the basic needs for a decent life corresponding to the development level of finishing urbanization and industrialization.

Indicators	Basic Needs for Survival	Basic Needs for a Decent Life
Human development index	>0.75	>0.85
% of population living below international poverty line (1\$)	<10%	< 3%
% of population living below international poverty line (2\$)	<20%	<10%
Per capita GDP (PPP\$)	3500	8000
Urbanization Rate	>40%	75%

Fix the value specific Basic Needs indicators

Step 2: Define basic needs for different goods and services

Food

Clothing and Footwear

Housing

--Indoor Heating and Cooling

--Furniture and durables

Infrastructure Services – electricity, water, and sanitary

Passenger transportation

-- per capita annual traveling distance

-- transportation modes (share by train, car, bus, air etc.)

-- transportation density (paved road, railway, airport)

Public and commercial services

-- education

-- medical care

--public administration and defense

-- restaurant and hotels\

-- other social services

Step 3: Calculate the total basic needs of a country

Based on the basic needs definition, a country's total basic needs satisfaction can be calculated based on:

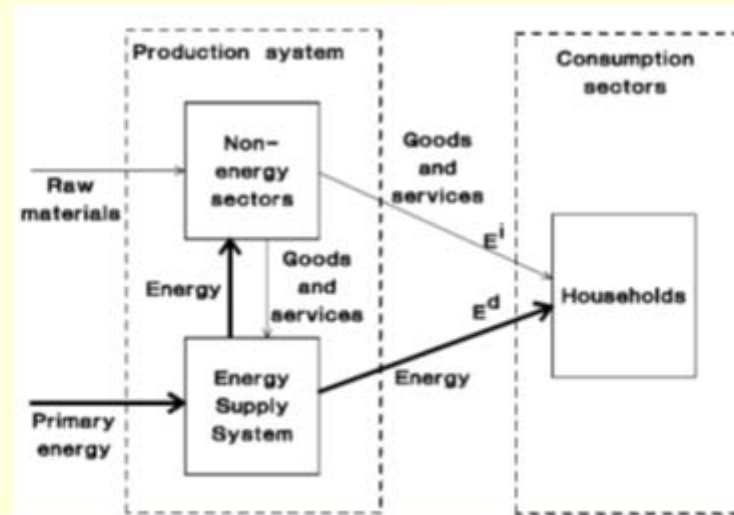
- 1) For basic needs for survival or basic needs for a decent life;
- 2) The population structure and distribution;
- 3) Climate conditions;
- 4) Surface area.

As all production chains end in people's consumption, all energy consumption of a society can be traced as direct and indirect energy requirements of households:

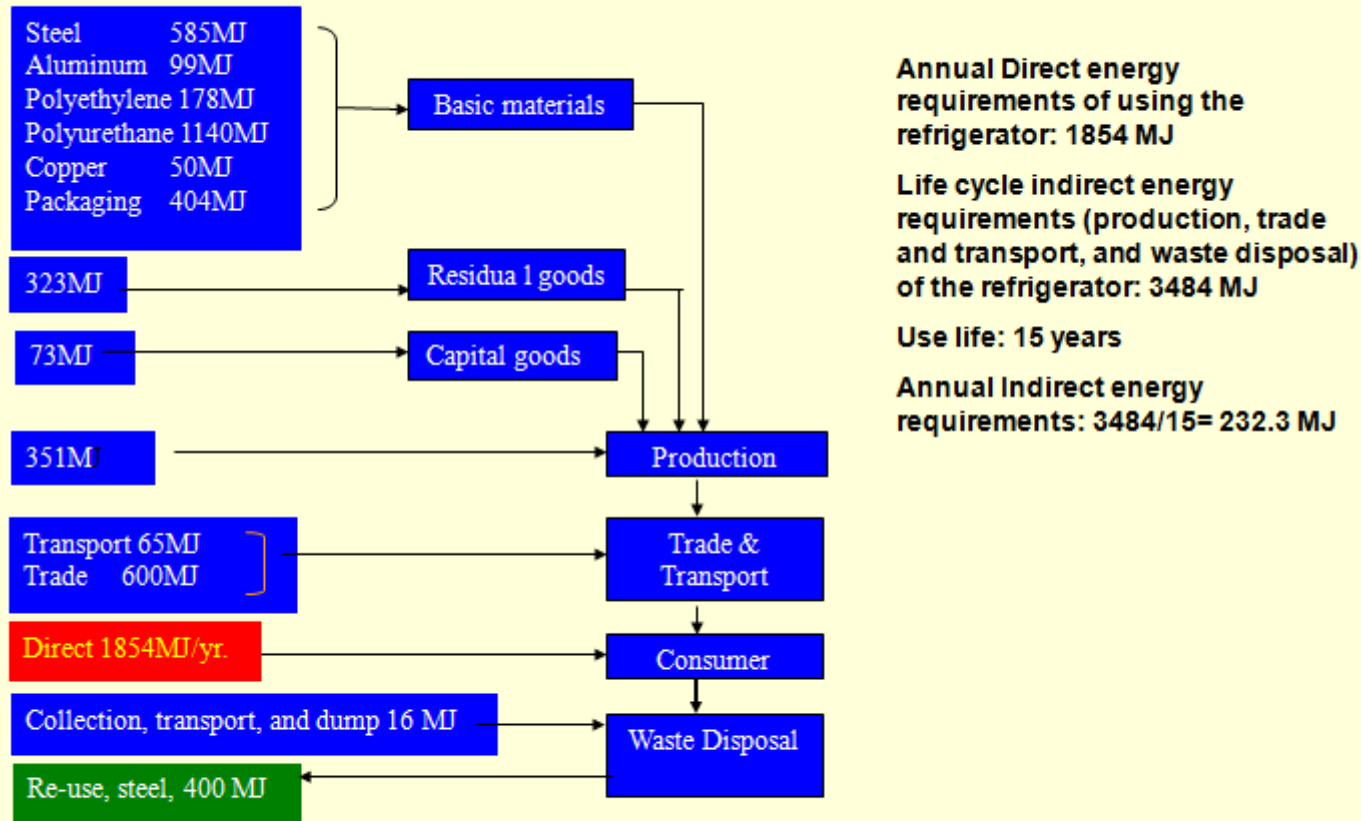
Tracing energy use of products and services over life cycle: using life circle analysis

As all products and services are ultimately for people's consumption, the energy use during their whole life cycle can be attributed to some consumption and needs satisfaction.

Figure 1 Direct and Indirect Energy Requirement of Households



Example, Life Cycle of a Refrigerator



Note: the energy requirements of each step is given.

Source: Kees Vringer, 2005

Case Study on China

Major assumptions and parameters:

Population: 1.3 billion

Service share of GDP: 60%;

Surface area: 9,596,960 sq km

Service share of employment: 56%

Urbanization rate: 75%

Climate: extremely diverse (in heating and cooling energy requirement fixation, the monthly average temperature in 1971-2000 of the provincial capitals are used to calculate the HDD and CDD of each province).

Results:

Using the existing LCA and energy intensity data in Europe and other OECD countries, the total energy requirements of 1.3 billion people's basic needs satisfaction is estimated at 2498.29 Mtoe per year, or 1.92 toe per capita per year.

Per capita Primary Energy Supply in Selected Countries and Regions-2003, toe

Africa	Latin America	Asia	India	China (mainland)	Non-OECD Europe
0.64	1.07	0.61	0.52	1.09	1.89
Former USSR	Middle East	Non-OECD total	EU-25	OECD total	World
3.36	2.52	1.01	3.80	4.67	1.69

Source: Energy Balances of Non-OECD Countries 2002-2003, IEA, 2005

Preliminary Results of the Case Study

Direct and Indirect energy requirements for a Decent Standard of Life for 1.3 billion Chinese People (Mtoe)

Item	Direct Energy Requirements	Indirect Energy Requirements	Total
Food	74.31	535.35	562.47
Clothing	44.85 ¹	149.71	149.71
Housing			81.26
Space heating	469.85		469.85
Space cooling	12.76 ¹		
Electricity Use	279.45		279.45
Water heating	61.90		61.90
Newsprint, writing and printing paper		213.33	213.33
Furniture, appliances		83.82	83.82
Passenger transportation	167.65	179.29	346.94
Fuel	167.65		
-Buses, coaches, light rails	62.60		
-Private cars	69.63		
-Rail	25.81		
-Air	9.60		
Vehicles		58.75	
Buses, coaches, light rails		25.04	
Private cars		31.33	
Rail		2.38	
Transportation infrastructure			
Road		48.89	
Railway		12.91	
Services	112.85	39.84	152.69
Public administration and defense	29.30		
Hotels and Restaurants	28.86		
Hospitals/health	3.99		
Education and other social workers	50.70		
Buildings		15.06	
Internal fittings		24.78	
Total			2498.29

Note¹: Included in total electricity use.

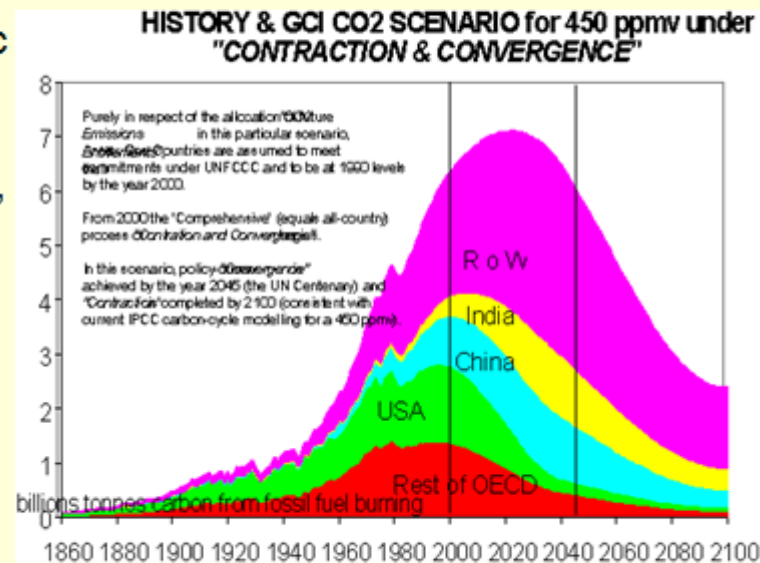
Per capita Annual Direct and Indirect Energy Requirements

Item	Energy Requirements (GJ)	% in total
Total	80.11	100.0%
Direct	34.10	42.6%
cooking	2.38	3.0%
space heating	15.07	18.8%
electricity use	8.96	11.2%
water heating	5.46	6.8%
car fuel	2.23	2.8%
Indirect	46.01	57.4%
food	17.17	21.4%
clothing	4.80	6.0%
housing	2.61	3.3%
newsprint	6.84	8.5%
furniture, appliances	2.69	3.4%
public passenger transport		
fuel	3.14	3.9%
vehicle	1.88	2.4%
transport infrastructure	1.98	2.5%
services	4.90	6.1%

Compared with the results of some existing studies on direct and indirect energy requirements of households in different countries, the results of this analysis seem reasonable.

Future Work

- The emissions can be calculated based on the results of energy requirements modelling.
- The per capita energy and emission requirements for basic needs satisfaction can be combined with some existing future commitment frameworks, such as Contraction and Convergence, Graduation and Deepening, as well as the approach of empowerment.
- More case study can be performed to compare the results with different countries, including the developed ones.



Source: GCI, 2005

Conclusions

- Development is a transitional process, at different stages of development, priority areas are different
- High growth of energy consumption is required for the capital intensive industrialization period, but will be reduced at post-industrialization stages.
- Although people's needs change over time, the basic part and non-basic part can still be measured and the energy requirements can be modelled with LCA.
- For basic needs satisfaction, the amount of energy and emissions required is somewhat limited. The focus of emissions reductions should be put on wasteful and luxurious parts.