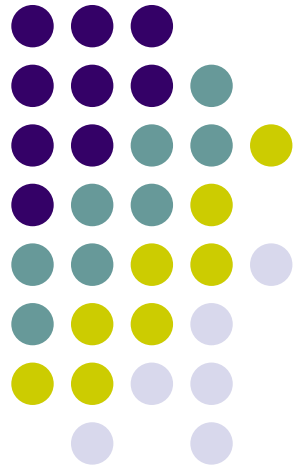
LCS Scenario Development on Household and Transport sectors in China



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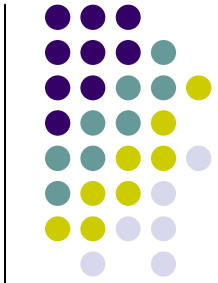
Narrative Description of China Scenario



- A harmonious and 'well-off' society
- Balancing human activities and natural resources
- The majority of the people living in cities, which are the hubs of industrial and social activities. Meanwhile, people living in rural areas also enjoy quality and convenient public services and clean environment.
- Two scenarios for 2050: reference scenario and countermeasure scenario
- Countermeasure scenario: a combination of the 'Doraemon' vision and the 'Satsuki & Mei' vision.
- Reference scenario: business as usual, few additional policy intervention for fuel mix cleaning and energy efficiency improvement

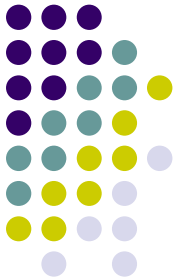
Quantification of China Scenario in 2050

Year	Unit	2005	2050
Population	Mil.	1307.56	1577
Household	Mil.	376.21	585.74
Average family members		2.96 Urban 4.08 Rural	2.5 Urban 3.5 Rural
Land use			
Urban Population rate	%	43	80
Forestry area	%	18.21	26
Access to Electricity	%	98	100
Share of detached house	%	50	20
Floor space of houses	m^2/person	28.69	30
Floor space of offices	m^2/person	6	7
Real GDP	bn US $	2299.45	17552
GDP Share of Industry			
Primary	%	12.6	5
Secondary	%	47.5	40
Tertiary	%	39.9	55

Grounds for Parameters

- Population: total population grows from 1307 mil. to 1557mil (official estimate)
- Household: size decrease, number of household increase
- Economic Growth: continue rapid growth, but the growth speed will gradually slow down (1998-2005: 9.2%; 2006-2020: 6.4%; 2021-2035: 4.5%; 2036-2050: 3%)
- Urbanisation: currently 43%, rising at around 1 percentage point per year, by 2050, urbanisation will complete, with 80% of the population living in cities
- Forest coverage: China has made significant efforts on afforestation and reforestation, forest coverage grew from 12% in 1980 to 18.2% in 2005. Government targets: 21% in 2020 and 26% in 2050
- Electricity supply access: By 2005, over 98% of the households have access to electricity supply. Due to urbanisation and income level increase, by 2050, all households will have electricity supply.
- Energy for cooking and heating: currently a large share of rural households rely on traditional biomass as the main fuel for cooking and heating, in urban areas, many households use coal for cooking and space heating. It is projected that by 2050, electricity, natural gas, as well as district heating will be available to all households.

Residential - Parameters



1 Energy service demand

	Unit	2005	2050					
			REF		CM		CM/REF	
			A	B	A	B	A	B
Space heating	Mtoe	52	64.24	64.24	24	64	38%	100%
Space cooling	Mtoe	5	6.45	6.45	3	6	40%	100%
Hot water heating	Mtoe	12	23.80	23.80	17	24	71%	100%
Cooking	Mtoe	39	65.58	65.58	52	66	80%	100%
Electrical appliances	Mtoe	13	39.67	39.67	36	40	90%	100%

Service Share

	Unit	2005									2050 A (CM)									2050(ref)								
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Space heating	-	24%	7%	9%	32%	0%	18%	0%	10%	100%		10%	10%	10%		50%		20%	100%		10%	10%	20%		50%		10%	100%
Space cooling	-	0%	0%	0%	0%	0%	0%	0%	100%	100%								100%	100%								100%	100%
Hot water heating	-	9%	21%	6%	52%	7%	0%	0%	5%	100%		5%	20%		15%	30%		30%	100%		5%	30%		5%	30%		30%	100%
Cooking	-	17%	9%	1%	72%	0%	0%	0%	2%	100%		5%	45%					50%	100%		10%	50%					40%	100%
Electrical appliances	-	0%	0%	0%	0%	0%	0%	0%	100%	100%								100%	100%								100%	100%
																			0%									
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Energy efficiency

	Unit	2005									2050 A (CM)									2050(ref)								
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Space heating		0.45	0.68	0.68	0.23	0.00	0.76	0.00	2.76	-	0.75	0.90	0.90	0.90		1.00		6.00	-	0.65	0.80	0.80	0.80		1.00		5.00	-
Space cooling		0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	-								6.00	-								5.00	-
Hot water heating		0.45	0.56	0.56	0.23	1.00	1.00	0.00	0.47	-	0.75	0.95	0.95	0.95	0.95	1.00		5.00	-	0.65	0.85	0.85	0.85	0.85	1.00		5.00	-
Cooking		0.40	0.45	0.45	0.23	0.34	0.00	0.00	0.53	-	0.55	0.55	0.55	0.55	0.55			0.75	-	0.50	0.50	0.50	0.50	0.50			0.65	-
Electrical appliances		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	-								1.10	-								0.90	-
										-									-									-
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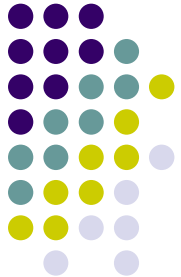
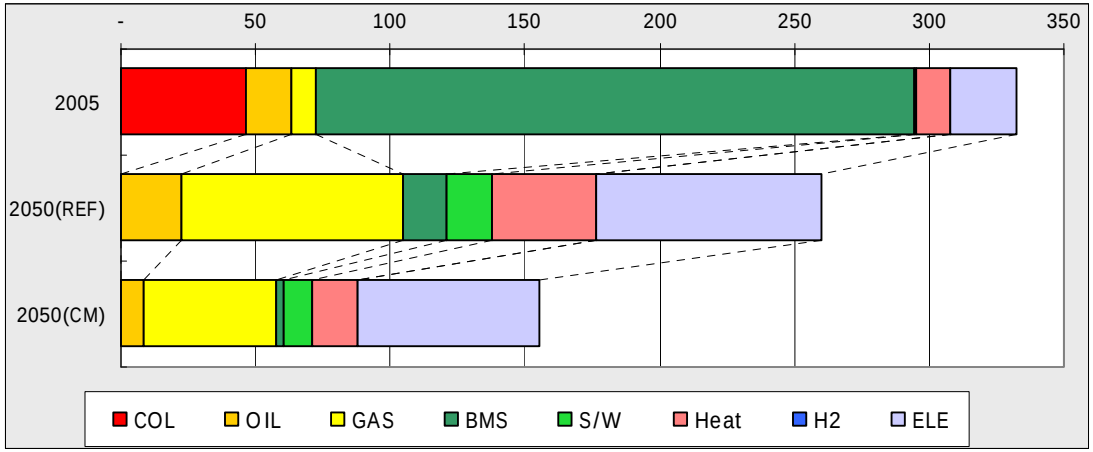
Residential – Ground for Parameters



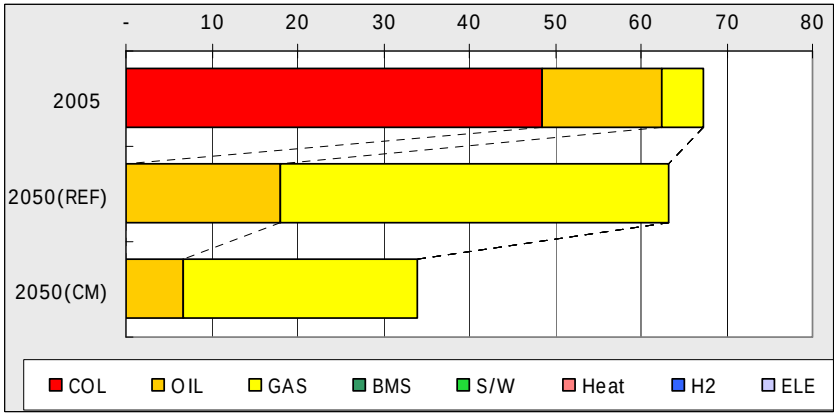
- Due to lack detailed data about the energy efficiency performance of different kind of electrical appliances, to simplify calculation, we combine lighting, TV, fridge, etc. under the sub category of electrical appliances. So only 5 items for household energy service demand: heating, cooling, hot water, cooking and electrical appliances
- The demand for energy service will see significant increase from the base year
- Under the countermeasure scenario, the demand of space heating and cooling will be much lower than the reference scenario, because of better insulation of housing
- In the base year, traditional use of biomass is major fuel for heating and cooking among a large share of the households, but by the target year, there will be little direct use of biomass among households

Residential – modeling results

Energy consumption in residential sector (Mtoe)



CO2 emission in residential sector without allocated emission from heat, H2, electricity (MtC)



The intervention measures not only include technology measures, but also include demand influencing measures, which mainly through influencing housing insulation.

Passenger transportation – parameters

1 Energy service demand

	Unit	2005	2030 REF A	2030 REF B	2030 CM A	2030 CM B	2030 CM/REF A	2030 CM/REF B
Motorbike	B pkm	31	537		510		30%	
car	B pkm	516	905		652		70%	
bus	B pkm	365	5,255		5,071		95%	
railway	B pkm	606	4,049		3,319		120%	
aviation	B pkm	204	1,047		35.3		30%	
Maritime	B pkm	7	32		26		70%	

REF = Reference case
CM = Countermeasure case

4-6 Energy consumption / CO2 Emission

		Unit	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
4 Energy Consumption	2005	Mtoe	0	22	0	0	0	0	0	2	24
	2030 A (CM)		0	20	0	9	0	0	6	7	42
	2030 B (CM)		0	0	0	0	0	0	0	0	0
5 Emission Factor	2005	MtC/Mtoe	1.05	0.80	0.55	0.00	0.00	0.00	0.00	#REF!	-
	2030 A (CM)		1.05	0.80	0.55	0.00	0.00	0.00		1.19	-
	2030 B (CM)		1.05	0.80	0.55	0.00	0.00	0.00	0.00	1.19	-
6 CO2 Emission	2005	MtC	0	18	0	0	0	0	0	#REF!	#REF!
	2030 A (CM)		0	16	0	0	0	0	0	9	24
	2030 B (CM)		0	0	0	0	0	0	0	0	0

2 Service Share

2005

	Unit	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike	-	0%	100%	0%	0%	0%	0%	0%	0%	100%
car	-	0%	100%	0%	0%	0%	0%	0%	0%	100%
bus	-	0%	100%	0%	0%	0%	0%	0%	0%	100%
railway	-	0%	0%	0%	0%	0%	0%	0%	100%	100%
aviation	-	0%	100%	0%	0%	0%	0%	0%	0%	100%
Maritime	-	0%	100%	0%	0%	0%	0%	0%	0%	100%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%

2030 A scenario

	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike		30%		20%				50%	100%
car		30%		20%			50%		100%
bus		30%		20%			50%		100%
railway				20%			20%	60%	100%
aviation		100%							100%
Maritime		80%		20%					100%
									0%
									0%
									0%
									0%
									0%

2030 B scenario

	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike				100%					100%
car				100%					100%
bus				100%					100%
railway				100%					100%
aviation				100%					100%
Maritime								100%	100%
				100%					100%
		100%							100%
									0%
									0%
									0%

3 Energy efficiency

2005

	Unit	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike	'05=1.0		1.00		1.00			5.00	5.00	-
car	'05=1.0		1.00		1.00			5.00	5.00	-
bus	'05=1.0		1.00		1.00			5.00	5.00	-
railway	'05=1.0		1.00		1.00			5.00	5.00	-
aviation	'05=1.0		1.00		1.00			5.00	5.00	-
Maritime	'05=1.0								1.00	-
										-
										-

2030 A scenario

	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike		2.30		2.30			4.00	5.00	-
car		2.30		2.30			4.00	5.00	-
bus		2.30		2.30			4.00	5.00	-
railway		2.30		2.30			4.00	5.00	-
aviation		2.30		2.30			4.00	5.00	-
Maritime								2.00	-
									-
									-

2030 B scenario

	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike		5.00		5.00			4.00	5.00	-
car		5.00		5.00			4.00	5.00	-
bus		5.00		5.00			4.00	5.00	-
railway		5.00		5.00			4.00	5.00	-
aviation		5.00		5.00			4.00	5.00	-
Maritime							1.00	2.00	-
							1.55		-
							1.30		-
									-
									-
									-

2005: oil fuel locomotive: 0.0246 toe/10000 t-km, electricity locomotive: 111.3 kWh/10000 t-km

4 Energy consumption

2005

	Unit	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike	Mtoe	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3
car	Mtoe	0.0	11.2	0.0	0.0	0.0	0.0	0.0	0.0	11.2
bus	Mtoe	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	4.1
railway	Mtoe	0.0		0.0	0.0	0.0	0.0	0.0	2.1	2.1
aviation	Mtoe	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	6.5
Maritime	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
	Mtoe									0.0
	Mtoe									0.0
	Mtoe									0.0
	Mtoe									0.0
	Mtoe									0.0
	Mtoe									
	Mtoe									
	Mtoe									
Total	Mtoe	0	22	0	0	0	0	0	2	24

2030 A scenario

	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike	0.0	0.6	0.0	0.2	0.0	0.0	0.0	0.2	1.0
car	0.0	4.3	0.0	1.8	0.0	0.0	1.7	0.0	7.9
bus	0.0	4.3	0.0	1.8	0.0	0.0	1.7	0.0	8.0
railway	0.0	0.0	0.0	4.7	0.0	0.0	5.0	7.1	16.8
aviation	0.0	10.2	0.0	0.0	0.0	0.0	0.0	0.0	10.2
Maritime	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0	20	0	9	0	0	6	7	42

2030 B scenario

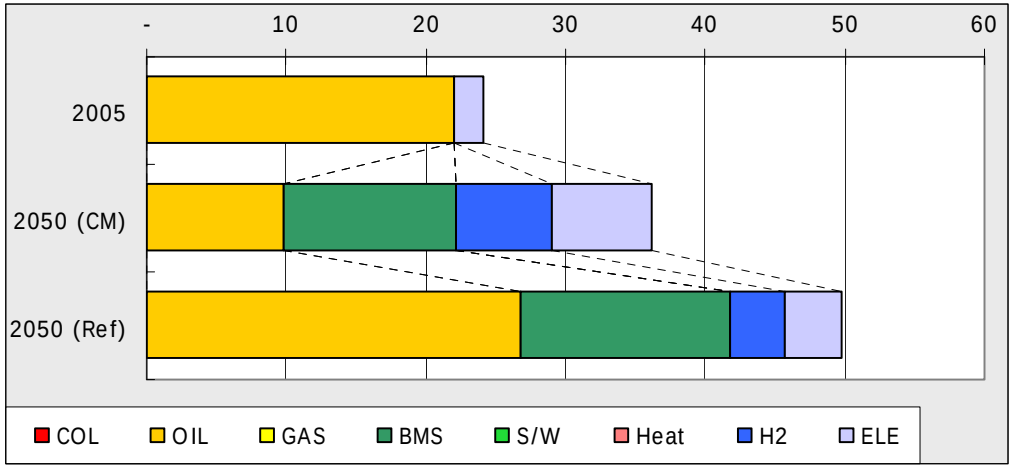
	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
car	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
bus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
railway	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maritime	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0	0	0	0	0	0	0	0	0

Passenger Transportation - Grounds for Parameters

- The data of base year is from the statistical yearbook.
- Because of living standard improvement and dramatic social transition (the size of urban population will more than double), the demand for passenger transportation will increase around 500% during the projected period
- Per capita annual transportation distance: 2005: 1335 km, 2050 (ref): 6669 km
- Such an estimate on passenger transportation demand increase is based on the reality that currently the figure in Europe and Japan is more than 10,000 km per capita per year
- Demand is reduced through increasing load factor of vehicles and encourage bus and railway transportation
- Under the countermeasure scenario, the share of biofuel and H2 is much higher than the reference scenario

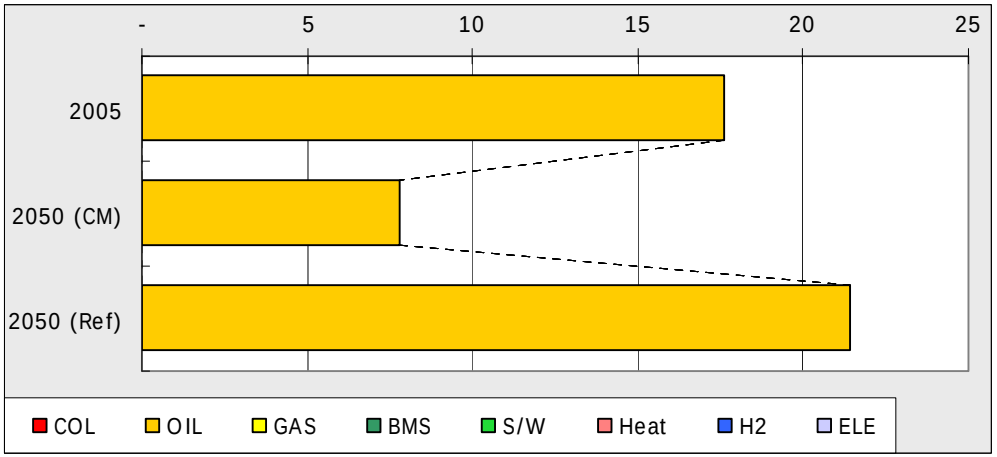
Passenger transportation – Modeling Results

Energy consumption in passenger transportation sector (Mtoe)



For transportation sector, due to technology spill-over effect and the globalisation of world vehicle market, the main factor subject to national

CO2 emission in passenger transportation sector without allocated emission from heat, H2, electricity (MtC)



In this study, the source of secondary energy is not considered, e.g. we do not consider the emission effect of fuel for the production of heat, H2, and electricity

Freight- Parameters

1 Energy service demand

	Unit	2005	2050 REF A	2050 REF B	2050 CM A	2050 CM B	2050 CM/REF A	2050 CM/REF B
Freight Road	B t-km	869	6019	6019	6019	6019	100%	100%
Freight Train	B t-km	2073	12841	12841	12841	12841	100%	100%
Freight Ship	B t-km	4967	20065	20065	20065	20065	100%	100%
Freight Air	B t-km	8	401	401	401	401	100%	100%
					0	0		
					0	0		
					0	0		

Service Share

	Unit	2000 COL	2000 OIL	2000 GAS	2000 BMS	2000 S/W	2000 Heat	2000 H2	2000 ELE	2000 Total	2050(CM) COL	2050(CM) OIL	2050(CM) GAS	2050(CM) BMS	2050(CM) S/W	2050(CM) Heat	2050(CM) H2	2050(CM) ELE	2050(CM) Total	2050(REF) COL	2050(REF) OIL	2050(REF) GAS	2050(REF) BMS	2050(REF) S/W	2050(REF) Heat	2050(REF) H2	2050(REF) ELE	2050(REF) Total
Freight Road	-	0%	100%	0%	0%	0%	0%	0%	0%	100%		60%		20%				20%	100%		75%		15%				10%	100%
Freight Train	-	21%	72%	0%	0%	0%	0%	0%	7%	79%		45%		20%				35%	100%		55%		15%				30%	100%
Freight Ship	-	0%	100%	0%	0%	0%	0%	0%	0%	100%		70%		30%					100%		85%		15%					100%
Freight Air	-	0%	100%	0%	0%	0%	0%	0%	0%	100%		70%		30%					100%		80%		20%					100%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%									0%									0%
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Energy efficiency

		2000 COL	2000 OIL	2000 GAS	2000 BMS	2000 S/W	2000 Heat	2000 H2	2000 ELE	2000 Total	2050(CM) COL	2050(CM) OIL	2050(CM) GAS	2050(CM) BMS	2050(CM) S/W	2050(CM) Heat	2050(CM) H2	2050(CM) ELE	2050(CM) Total	2050(REF) COL	2050(REF) OIL	2050(REF) GAS	2050(REF) BMS	2050(REF) S/W	2050(REF) Heat	2050(REF) H2	2050(REF) ELE	2050(REF) Total
Freight Road	'00-1.0		0.75							-		2.25		2.25				3.75	-		1.50		1.50				3.75	-
Freight Train	'00-1.0	0.65	0.75						0.75	-		1.14		1.14				3.75	-		1.14		1.14				3.75	-
Freight Ship	'00-1.0		0.75							-		0.99		0.99					-		0.99		0.99					-
Freight Air	'00-1.0		0.75							-		1.33		1.33					-		1.12		1.12					-
										-									-									-
										-									-									-
										-									-									-
										-									-									-
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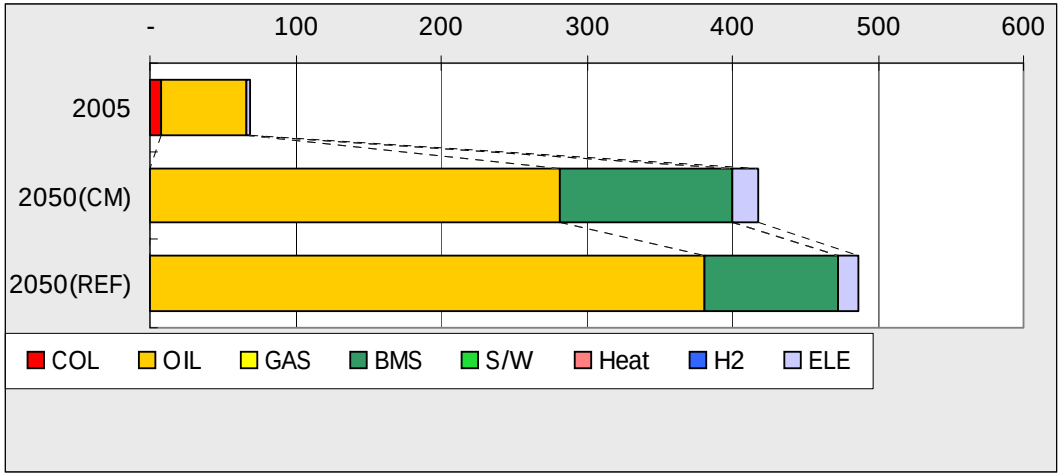
Freight – Ground for Parameters

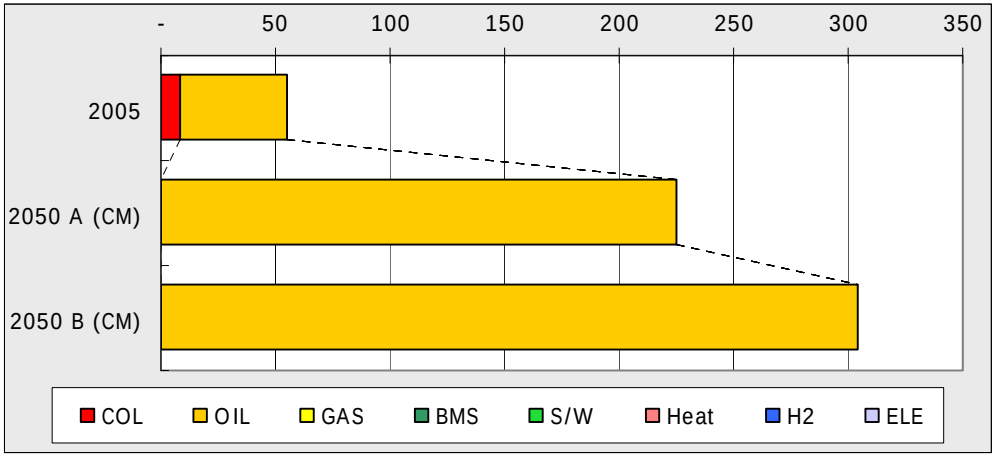
- 663% GDP increase and 21% population increase during the 2005-2050 period, mean dramatic increase in per capita income and production, leading to big growth in freight transportation demand.
- Narrowing income gap between urban and rural residents will lead to wider and more even distribution of consumption, leading higher share of road freight transport
- With technology progress and economic development, China's economic growth will be more driven by domestic consumption, instead of export, also due to the fact a larger share of China's export will be of higher value-added, instead of mass products, the share of demand for maritime transport will slightly shrink
- Higher income level will lead to increasing demand for freight transport by air
- The government's efforts for energy efficiency improvement and resource saving will make railway transport a bigger role in freight transport

Freight – modeling results

Energy consumption in passenger transportation sector (mtoe)



CO2 emission in passenger transportation sector without allocated emission from heat, H2, electricity (MtC)



In this study, the source of secondary energy is not considered, e.g. we do not consider the emission effect of fuel for the production of heat, H2, and electricity

Conclusions

- In the analysis, we do not take into account the impacts of changes in power sector
- There is great potential for future energy consumption and CO2 emission reduction in China in the coming decades, through influencing people's consumption behavior, lifestyles, increasing the share of clean energy, and energy efficiency improvement