

Dalian Dalican Low-carbon Society Study <Progress of Modeling>

15th AIM International Workshop
National Institute of Environmental Studies, Tsukuba, Japan
Feb. 20th 2010

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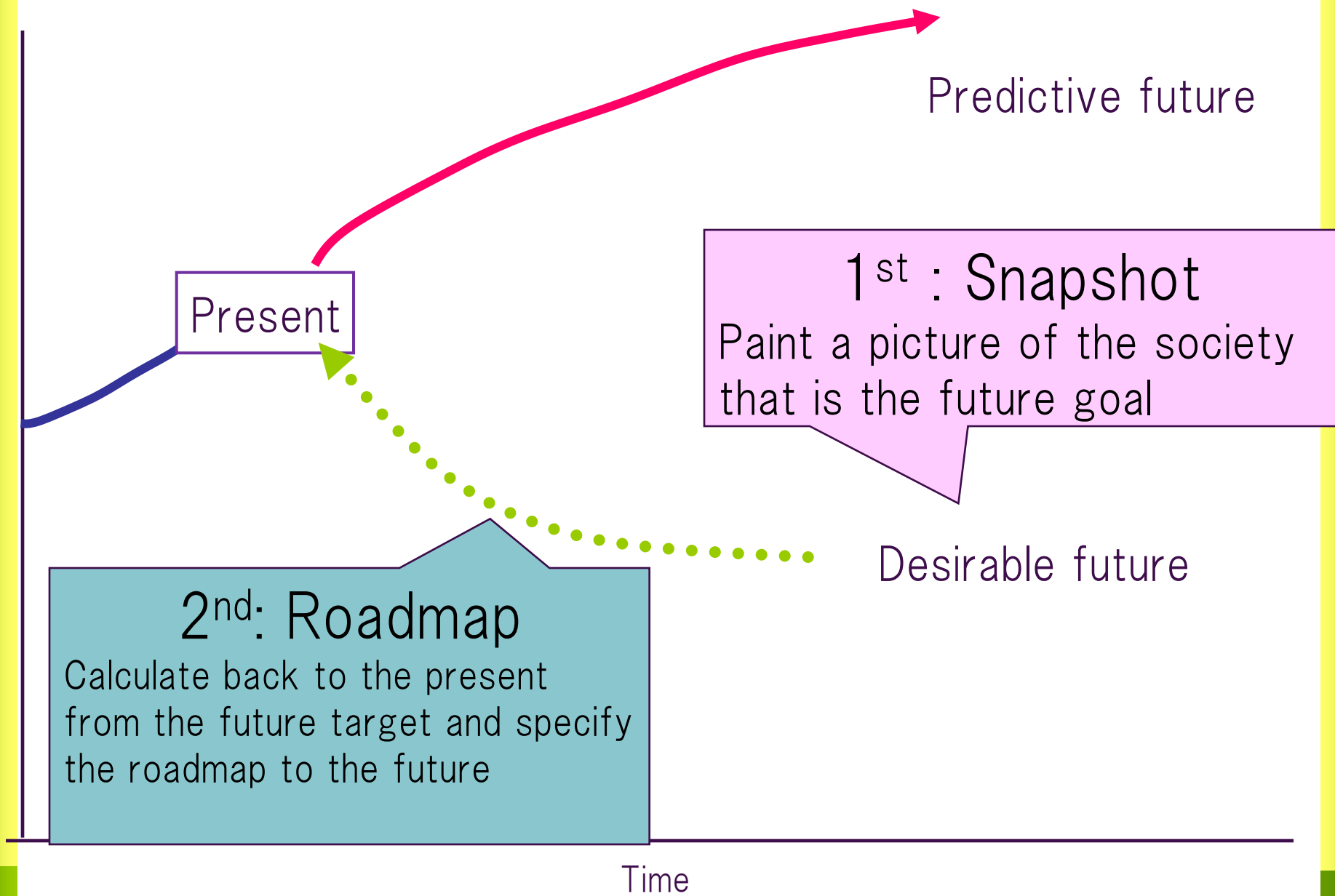
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Background

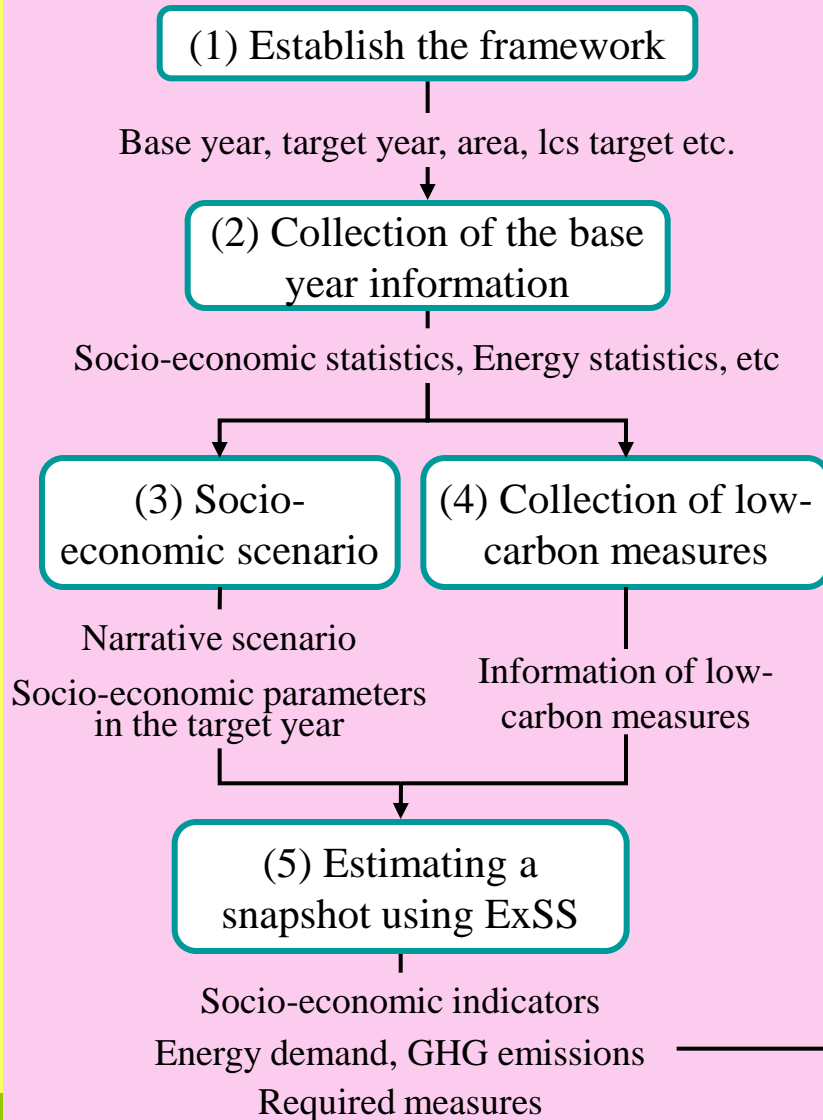
- At the Copenhagen Climate Change Summit, Chinese Premier Wen Jiabao declared that China will cut carbon dioxide emissions per unit of GDP by 40–45 percent by 2020 from the 2005 level.
- Chong Qing follow the suit of the central government to set the target of reducing the carbon emission of 40% comparing with the base year of 2005.
- Dalian has set the goal of transforming Dalian into a eco-friendly and green city, through the using of new energy and energy efficient technology.
- Dalian is shifting its industry structure from heavy industries to service and knowledge based economy by attracting new FDI from IT sector.
- We have developed a method to develop scenarios towards low-carbon target based on the idea of backcasting.
- Using the method, it is possible to formulate strategies considering both economic growth and low-carbon development.

Basic Idea of “Backcasting”

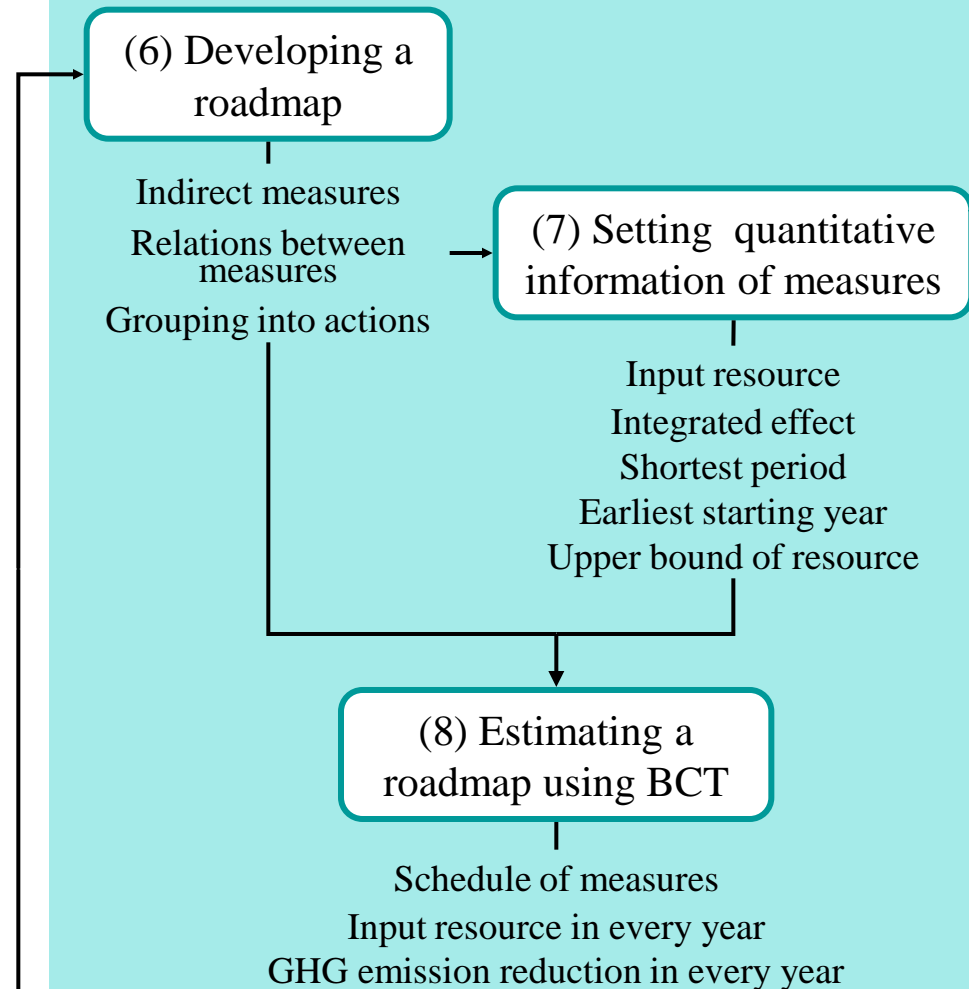


Methodology

1. Snapshot

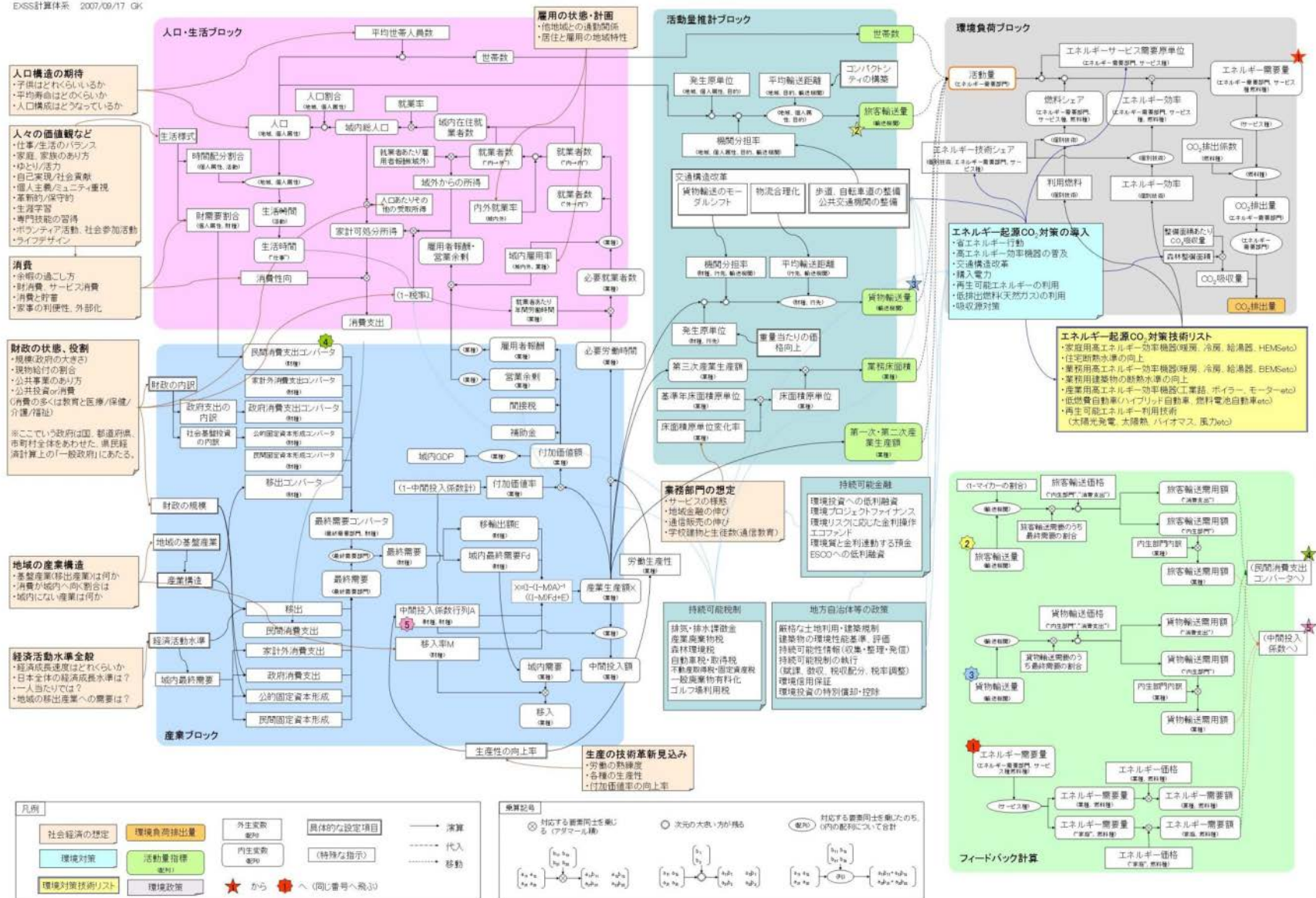


2. Roadmap



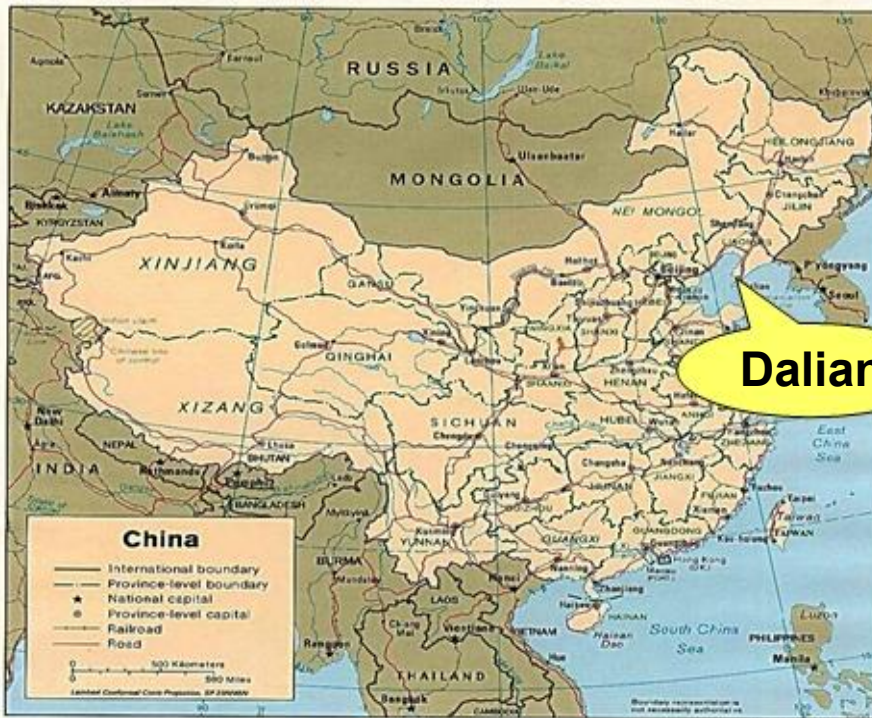
Extended Snapshot Tool (ExSS)

EXSS計算体系 2007/09/17 GK



1. Profile of Dalian

Dalian lies on the Liaodong peninsula, adjacent to the Bohai Sea Rim region, with a population of 6 million people. Dalian covers an area of about 12,500 sq.km, which is divided into six districts, three cities, and one county. Dalian is the most convenient gateway to the Northeast Asia region.



land area:12,574sq.km

Population:6.13 million

Industrial structure:
Primary:Secondary:Tertiary
= 7.5 : 51.7 : 43

GDP in 2008:385.82
billion RMB
(Approx.\$56.5 billion)

ExSS application for Dalian City

- Objective
- To prepare a summary of a quantitative scenario study on the establishment of a sustainable low-carbon society in Dalian.
- To create awareness among local government, authorities and the community urgent and decisive actions to be taken to realize a robust growth and low-carbon Dalian.



Framework of Application

- Base year: 2007
- Target year: 2020, 2050
- Area: Dalian City area
- Activity:
 - Residential, commercial and industrial activity in Dalian City area
 - Transport originated in Dalian city area
- Scenarios
 - 2020BaU and 2050BaU (without low-carbon measures)
 - 2020CM and 2050CM (with low-carbon measures)
- Gas: CO₂ from fossil fuel combustion
- Low-carbon target:
 - -40% compared to 2007 level by 2020 (CO₂ emission per GDP)
 - -85% compared to 2007 level by 2050 (CO₂ emission per GDP)
- For this study, we estimate the social-economic and other indicators with tentative, rough assumptions as a starting point for further scenario studies.

Information Source

- Statistics of Liao Ning

 - Input-Output table of Liao Ning, 2002.

 - Energy balance table of Liao Ning, 2007.

 - Statistical Yearbook of Liao Ning, 2002.

 - Statistical Yearbook of Liao Ning, 2007.

- Statistics of Dalian

 - Statistical Yearbook of Dalian, 2005.

 - Statistical Yearbook of Dalian, 2007.

 - The Eleventh Five-Year Energy Plan of Dalian.

- * Dalian IO table and energy balance table were estimated from Liao Ning's tables and relevant information of Dalian. (18x18)

Base Year (2007) Information

- Population: 5.78million.
- Average family size: 2.87 person/household.
- GDP/capita: 52 thousand RMB/person.
- Passenger transport demand (including city bus):
27494 million passenger-KM.
- Freight transport demand: 409511 million ton-KM.
- GHG emissions: 466 ktCO₂/Million RMB, 2.55 tCO₂/person.
- Power Supply: 2633MW by 2005.

Future Assumptions

- Relatively lower economic growth rate:
17.4% (2007) - 12.5% (2020) - 6% (2050). (All in real term.)

- Structural Change of GDP by Sector:
By 2007, Primary : Secondary : Tertiary = 8 : 49 : 43
By 2020, Primary : Secondary : Tertiary = 5 : 43 : 52
BY 2050, Primary : Secondary : Tertiary = 2 : 33 : 65

- Structural Change of GDP by Expenditure:
By 2007, Consumption : Investment : Net Exports = 37 : 60 : 3
By 2020, Consumption : Investment : Net Exports = 50 : 45 : 5
BY 2050, Consumption : Investment : Net Exports = 73 : 25 : 2

- Smaller Family size:
2.87/household (2007) - 2.7/household (2020) - 2.5/household (2050).

Note: Export and Import in this study include both domestic and foreign trade and service.

Socio-Economic Indicators

- Demography:

	2005	2007	2020	2020/2007	2050	2050/2007
Birth rate	0.06	0.07				
Death rate	0.05	0.05				
Person per household	2.89	2.87	2.80	0.98	2.70	0.94
Population (million)	5.65	5.78	6.50	1.12	8.00	1.38
Household (million)	1.96	2.01	2.32		2.96	

- GDP By Sector

		2007	2020	2020/2007	2050	2050/2007
GDP	billion RMB	313	1611	4.8	9253	29
Primary Industry	billion RMB	25	79	3.2	241	9
Secondary Industry	billion RMB	154	648	4.2	3016	20
Tertiary Industry	billion RMB	113	775	6.9	5932	52

Socio-Economic Indicators

- GDP By Expenditure:

		2007	2020	2020/2007	2050	2050/2007
GDP	billion RMB	313	1611	4.8	9263	29
Economic Growth Rate	Percentage	17.4%	12.5%		5.0%	
Household Consumption	billion RMB	77	564	7.3	5089	66
	Percentage	24.5%	35.0%		55.0%	
Government Consumption	billion RMB	39	242	6.2	1666	43
	Percentage	12.5%	15.0%		18.0%	
Gross Capital Formation	billion RMB	187	725	3.9	2313	12
	Percentage	59.6%	45.0%		25.0%	
Export (foreign & domestic)	billion RMB	190	806	4.2	3701	19
	Percentage	60.7%	50.0%		40.0%	
Import (foreign & domestic)	billion RMB	-180	-724	4	-3516	19
	Percentage	-57%	-45%		-38%	

Input-Output Table

Input-Output Table of Dalian, 2020

Unit: 10⁴ RMB

	Primary	Secondary	Service	Sum	Consumption	Investment	Net Export	G0
Primary	300	1165	585	2201	451	0	-920	1732
Secondary	449	16109	3399	20818	2201	6110	133	29263
Tertiary	189	5506	5030	12008	5402	1139	504	19053
Sum	938	22781	11305	35025	8055	7250	-282	50048
Capdep	49	1373	916	2569				
Wage	604	2722	3677	7935				
Surplus	116	910	788	2007				
Tax	24	1486	799	2512				
Value added	794	6482	7747	15023				
Total Input	1732	29263	19053	50048				

Input-Output Table

Input-Output Table of Dalian, 2050

Unit: 10⁴ RMB

	Primary	Secondary	Service	Sum	Consumption	Investment	Net Export	G0
Primary	913	5837	6088	12839	254	0	-7838	5256
Secondary	1362	71624	31637	104623	13487	18498	-1471	136136
Tertiary	572	24847	51437	76856	53807	3635	10519	144817
Sum	2847	102308	89163	194318	67548	23133	1210	286210
Capdep	149	6538	8317	15004				
Wage	1835	12489	35117	49441				
Surplus	353	4068	7983	12405				
Tax	72	7067	7903	15042				
Value added	2409	30161	59321	91891				
Total Input	3097	132470	148484	286210				

Transport Demand

Passenger Transport Demand

Unit: Million person-km

	2007	2020	2020/2007	2050	2050/2007
Bus	8420	13201	1.6	19800	5.1
Other Vehicle	3898	9626	2.5	19800	2.4
Train	5172	7426	1.4	17822	3.5
Ship	784	1024	1.3	1229	1.6
Air	3675	8251	2.2	19802	5.4
Others	5546	6672	1.2	7000	1.3
Total	27494	46201	1.7	85456	3.1

Freight Transport Demand

Unit: Million ton-km

	2007	2020	2020/2007	2050	2050/2007
Vehicle	7508	28396	3.8	105103	14
Train	17985	125031	7	607674	34
Ship	383950	1567422	4.1	6094346	16
Air	69	282	4.1	1096	16
Total	409511	17211132	4.2	6808219	17

Counter Measures

- Composition of power supply

According to the Eleventh Five-Year Energy Plan of Dalian, the total capacity of electricity generation is 2633MW by 2005. The nuclear plant in construction is designed to increase the capacity by 2000MW in short run, and 4000MW in long run. Beside this, there are some other power plants under construction, their capacities sum up to about 3800MW.

For counter measures, we mainly consider the increase in solar and wind as energy sources. The ratio of solar and wind in total power supply is set up to 10% and 34% for 2020 and 2050, respectively.

- Best Available Technology (BTU)

In this tentative study, counter measures of BTU is set up to 50% in 2020, and 80% in 2050.

Final Energy Demand, 2007 Unit: kTCE

	Coal	Oil	Gas	Ele	Total
Passenger Transport		4445		157	4602
Freight Transport	374	3961		17	4352
Household Consumption (Urban)			18	219	238
Household Consumption (Rural)	419			51	470
Agriculture	202	323		71	596
Mining	26	3		5	33
Food, Beverages and Tobacco	462	65		146	673
Textile Products and Apparel	73	23		59	154
Timber, Wooden Products and Furniture	140	25		85	250
Pulp, Paper Products and Printing	129	7		24	161
Petroleum Refinery, Coke and Nuclear Fuel	2	383		159	545
Chemical Industries		130	23	324	476
Non-metallic Mineral Products	2359	219	2	421	3001
Metal Refinery and Metal Products	692	47	1	299	1039
Machinery and Equipments	1054	293	4	654	2005
Other Manufacture Industries	119	8		9	136
Recycling Industries	1				1
Electricity, Heat and Water Supply		12		192	204
Construction	206	103		55	364
Wholesale and Retail	30	12	1	64	107
Other Services	172	42		355	569
Total	6460	10098	49	3368	19975

Final Energy Demand, 2020

Unit: kTCE

	Coal		Oil		Gas		Electricity		Total	
	BAU	CM	BAU	CM	BAU	CM	BAU	CM	BAU	CM
Passenger Transport			10066	9364			226	188	10292	9552
Freight Transport	2597	2597	15154	12857			122	122	17873	15575
Household Consumption (Urban)					22	14	940	413	962	427
Household Consumption (Rural)	922	541					84	42	1006	583
Agriculture	1218	697	13981	8560			292	177	15491	9433
Mining	413	249	505	309			86	52	1004	610
Food, Beverages and Tobacco	2540	1488	3176	1946			683	413	6399	3847
Textile Products and Apparel	470	275	1314	805			323	195	2107	1275
Timber, Wooden Products and Furniture	481	281	780	478			250	151	1511	910
Pulp, Paper Products and Printing	1383	810	666	409			222	134	2271	1353
Petroleum Refinery, Coke and Nuclear Fuel	13	8	21165	12958			829	502	22008	13468
Chemical Industries			7770	4757	113	113	1835	1110	9718	5981
Non-metallic Mineral Products	11446	6779	9389	5757	8	8	1747	1057	22590	13601
Metal Refinery and Metal Products	7046	4112	4252	2604	11	11	2581	1562	13890	8289
Machinery and Equipments	6300	3667	14049	8645	17	17	3219	1947	23585	14276
Other Manufacture Industries	546	319	318	195			37	22	901	536
Recycling Industries	22	12	52	32			6	3	80	47
Electricity, Heat and Water Supply			1068	654			1681	1017	2749	1671
Construction	887	518	3972	2432			203	123	5061	3072
Wholesale and Retail	277	243	108	108	4	4	676	355	1065	710
Other Services	1579	1261	345	552		23	3703	1911	5627	3747
Total	38141	23857	108128	73419	176	190	19744	11497	166189	108963

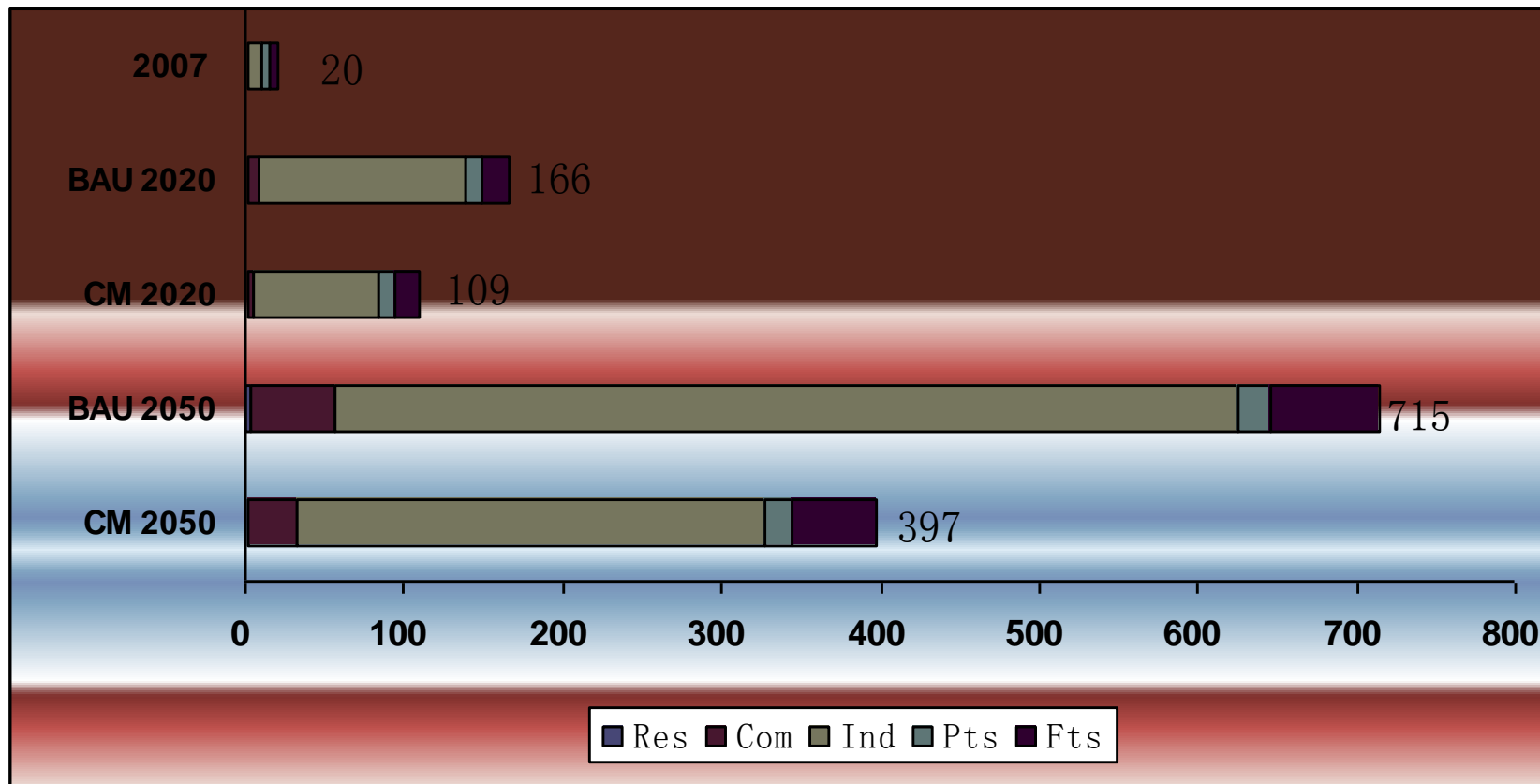
Final Energy Demand, 2050

Unit: kTCE

	Coal		Oil		Gas		Electricity		Total	
	BAU	CM	BAU	CM	BAU	CM	BAU	CM	BAU	CM
Passenger Transport			20089	17097			542	370	20631	17467
Freight Transport	12623	12623	56530	40093			591	591	69744	53307
Household Consumption (Urban)					24	13	1530	445	1554	458
Household Consumption (Rural)	1026	501					109	39	1134	541
Agriculture	3698	1707	42434	22334			887	468	47019	24508
Mining	3110	1588	3798	1999			646	341	7554	3928
Food, Beverages and Tobacco	13782	6649	17231	9080			3705	1954	34718	17683
Textile Products and Apparel	1342	646	3752	1975			921	486	6016	3107
Timber, Wooden Products and Furniture	1810	869	2932	1544			939	495	5681	2908
Pulp, Paper Products and Printing	9973	4808	4798	2538			1601	844	16371	8191
Petroleum Refinery, Coke and Nuclear Fuel	66	32	104124	54802			4080	2152	108270	56985
Chemical Industries			43058	22662	628	628	10171	5364	53858	28654
Non-metallic Mineral Products	39257	19260	32202	16984	26	26	5991	3159	77477	39429
Metal Refinery and Metal Products	34978	16778	21107	11113	56	56	12814	6757	68955	34704
Machinery and Equipments	28027	13373	62498	33131	75	75	14319	7551	104920	54130
Other Manufacture Industries	2120	1018	1234	650			144	76	3498	1743
Recycling Industries	117	54	282	149			33	12	433	214
Electricity, Heat and Water Supply			7602	4001			11972	6313	19575	10315
Construction	2311	1109	10350	5448			528	278	13189	6835
Wholesale and Retail	1616	1388	631	631	25	25	3949	1597	6222	3642
Other Services	13462	10756	2942	4706		196	31582	12902	47986	28560
Total	169317	93158	437596	250937	835	1019	107055	52194	714802	397308

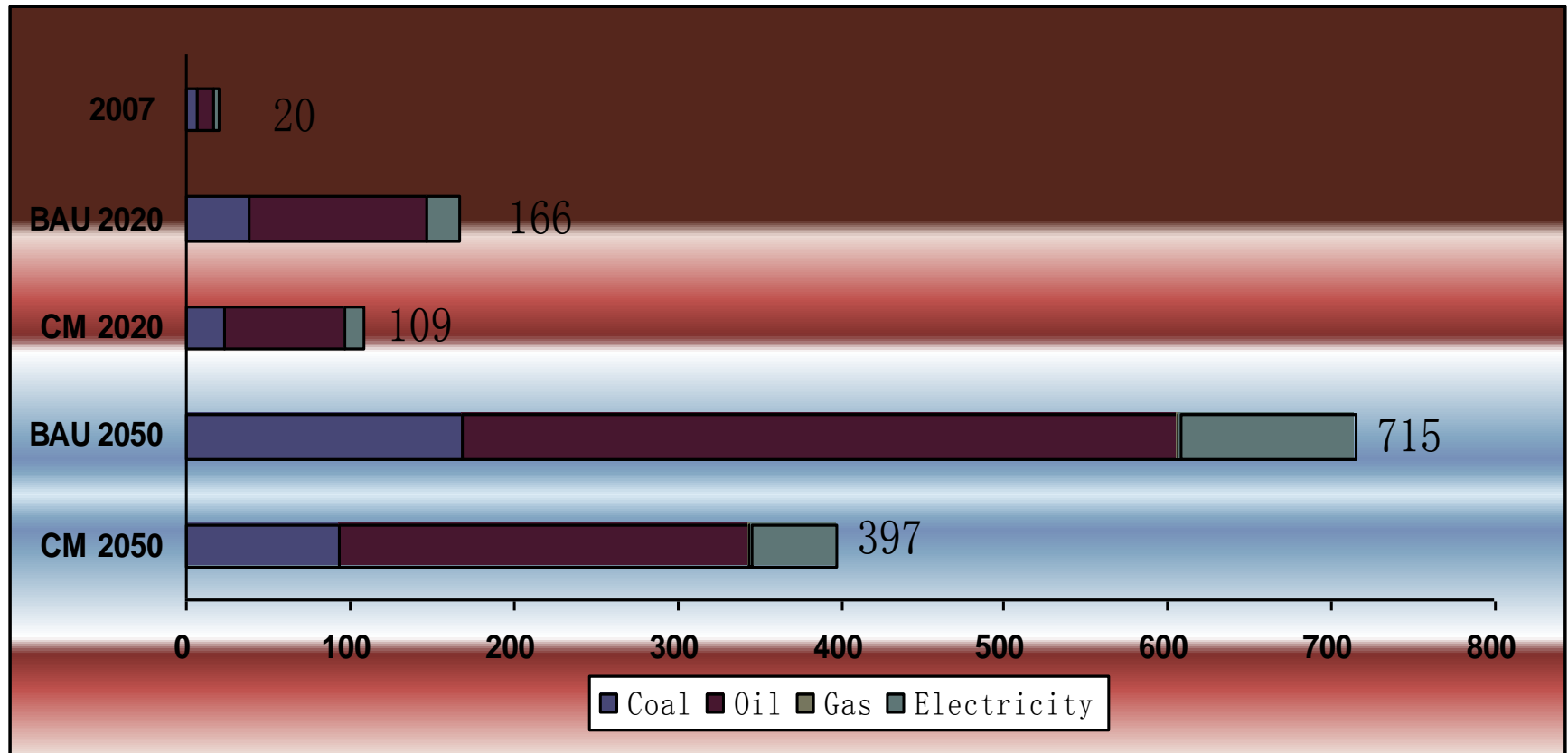
Final Energy Demand (By End user)

Final Energy Demand by End User (Million TCE)



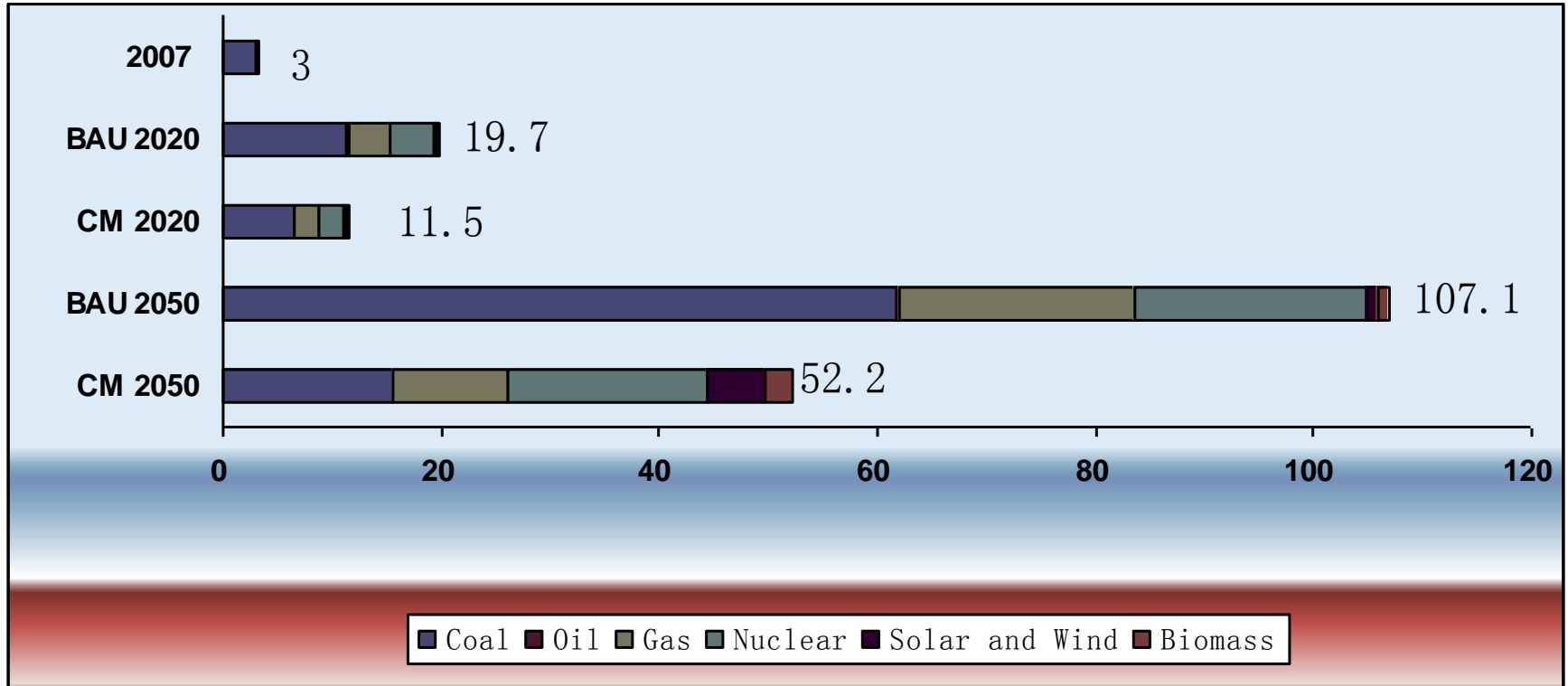
Final Energy Demand (By Fuel)

Final Energy Demand by Fuel (Million TCE)



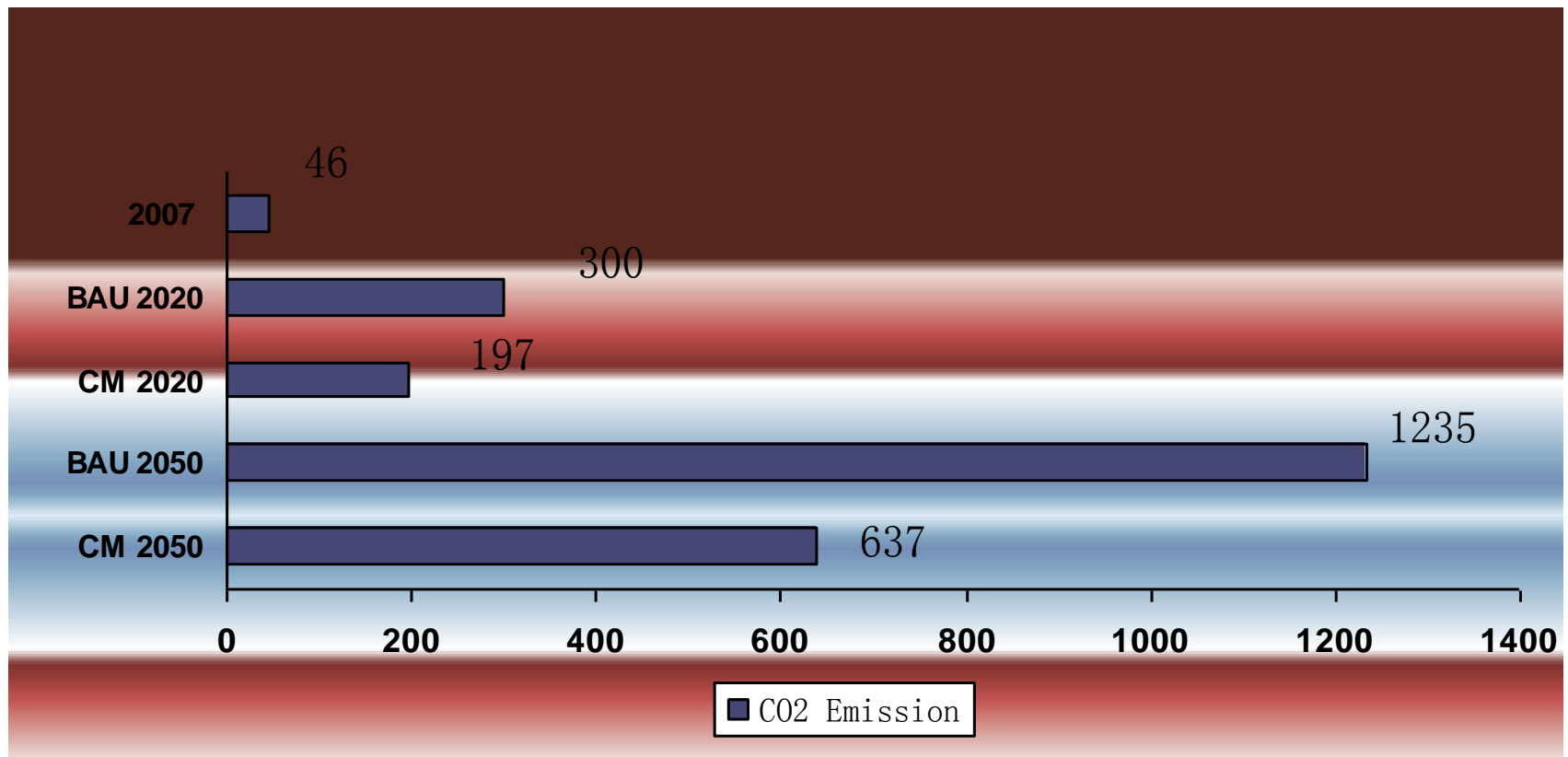
Power Supply (By Fuel)

Power Supply by Fuel (Million TCE)



CO₂ Emission of Target Year

CO₂ Emission of Target Year (Million Ton)



Future study

- More precise and detailed information
 - Economic information (IO table)
 - Energy demand
 - Realistic and desirable counter measures
 - Device diffusion ratio
 - Renewable energy potential
 - Transport demand management
- ➔ To develop the best LCS scenario of Dalian and integrate it to Dalian's 12th Five Year Plan

Low-carbon measures

- Demand side
 - Devices with higher energy efficiency
 - Transport demand management
 - Energy-saving behavior
 - Energy-efficient buildings
- Supply side
 - Fuel switch (including renewable energy)
 - Efficiency improvement
 - Carbon capture and storage