

Energy Use and CO₂ Emissions in China: Retrospect and Prospect

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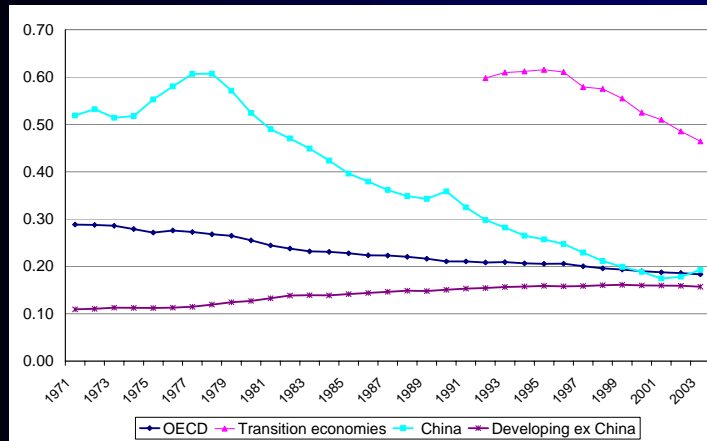
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The Issues

- Slow growth in energy use 1979-2001
 - 4.8% pa on GDP growth of 8.5% pa
- Surging energy use 2001-2005
 - 11.6% pa on GDP growth of 9.8% pa
- How do we interpret these two trends?
- What do they mean for the future?
- What are the best projections that can be made of energy use and CO₂ emissions to 2030?

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Figure 1. Energy intensity of GDP: China, other developing countries and transition economies, actual 1971–2002, mtoe per billion US\$ GDP, in 2000 PPPs



Source: IEA database.

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Table 1. Projections of Primary Energy Use and CO₂ Emissions, China, various periods

	Timeframe	Reference projection		
		Growth in primary energy use (% pa)	Growth in CO ₂ emissions (% pa)	Long-run energy elasticity of GDP
Panel A: Independent Projections				
ERI/LNBL (2003)	1998-2020	3.8	3.6	
EIA International Energy Outlook (DOE 2005)	2001-2025	4.1	3.6	0.66
APERC Outlook (2002)	1999-2020	2.7	na	
IEA World Energy Outlook (2004)	2002-2030	2.6	2.8	0.52
Panel B: China National Energy Strategy and Policy to 2020 (2004)				
Scenario A – Existing Policy	2000-2020	4.7	4.6	0.64
Scenario B – Alternative Policies	2000-2020	4.1	3.9	0.54
Scenario C – Advanced Policies	2000-2020	3.3	2.9	0.40

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Table 2. Projections for Selected Variables, Scenario A, National Comprehensive Energy Strategy and Policy to 2020, and Actual Values for 2005

	Actual	Strategy Report – Scenario A			Actual
	2000	2005	2010	2020	2005
Primary energy demand (mtce)	1297	na	2137	3280	2225
Electricity generation capacity (GW)	319	402	559	947	505
Demand for fossil fuels					
Coal (100 m tons)	12.7	16.2	20.0	29.0	21.4
Oil (100 m tons)	2.3	2.9	3.8	6.1	3.0
Natural gas (100 m cubic metres)	272	399	840	1654	500
Output of main energy intensive products					
Iron and steel (m tons)	128.5	250	300	280	352
Cement (m tons)	597	680	790	1070	1060
Ethylene (10,000 tons)	450	790	1200	2000	756
Synthetic ammonia (10,000 tons)	3346	3600	3800	4000	4222 ¹
Paper (10,000 tons)	2487	4000	5000	7500	4864 ¹

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Approach to the Issues

- Different development patterns, 1980-2005
- Decomposition of energy use, 1980-2005
- Interpreting and projecting changes in the energy industry of GDP
- A simple project of 2030
- Conclusion

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Table 3. Real GDP by Sector, 1970-2000, estimated 2000 values

	Agriculture	Industry	Services	Total
Annual growth rates	(per cent per annum)			
1970-1980	2.0	9.1	6.0	5.1
1980-1990	6.2	9.5	12.3	9.4
1990-1997	4.2	15.7	10.6	11.5
1997-2001	2.9	8.7	9.4	8.0
2001-2005	4.2	11.2	9.9	9.8

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Table 4. Trends in Fixed Asset Investment and Exports, China, 1991-2005

	Investment in fixed assets (billion yuan, 1991 prices)	Ratio of investment in fixed assets to household consumption (real terms, %)	Exports (US\$billion)	Exports/GDP in yuan (%)	Ratio of change in exports to change in GDP over period, in yuan (%)
1993	896.0	69.7	91.7	15.0	15.0
1997	1382.5	78.3	182.8	19.2	18.9 ¹
2001	2044.7	86.9	266.1	20.1	14.8 ²
2002	2384.9	94.4	325.6	22.4	46.1
2003	2981.0	110.8	438.2	26.7	60.3
2004	3581.1	114.2	593.4	30.7	53.3
2005	4263.5	123.6	762.0	35.6	70.0

Notes: ¹For the period 1993-1996 inclusive. ²For the period 1997-2000 inclusive.
Sources: NBSC (2005a), NBSC (2006a) and estimates of the authors.

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Decomposition of Energy Use, 1980-2005

Four effects

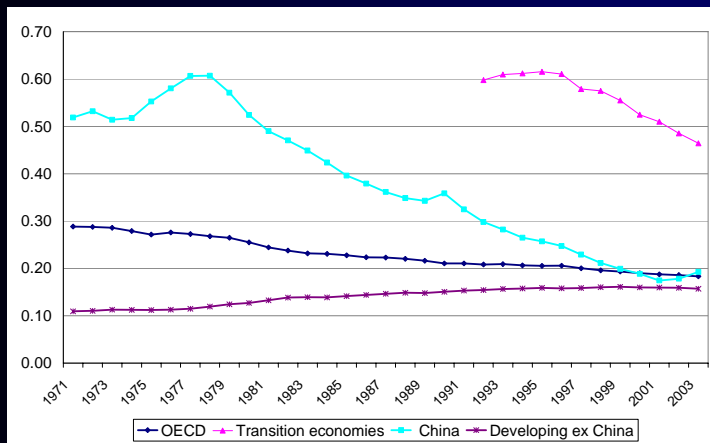
- - *the pure growth effect* – that due to the increase in total GDP, for opening sectoral shares and energy intensities;
- - *the pure intensity effect* – that due to changes in sectoral energy intensities, at opening GDP levels by sector, and that due to the product of the change in GDP in sectors, for given GDP shares, and in sectoral energy intensities;
- - *the pure sectoral effect* – that due to the change in sectoral GDP shares, for opening energy intensities; and
- - *the interaction effect* – that due to the joint interaction of the changes in sectoral shares and intensities, in relation to both the opening level of total GDP and its change.

Table 5. Components of Increase in Energy Use, Selected Periods, 1980-2005, as a proportion of opening total energy use

	1980s	1990s	2000-05
	(Increase in energy use over the period, as a proportion of opening energy use)		
Growth component	1.40	1.63	0.57
Intensity component	-0.87	-1.39	0.05
Sectoral component	0.22	0.58	0.06
Interaction component	-0.10	-0.37	0.00
Total	0.64	0.45	0.67
	(% per annum)		
Growth of total energy use in period	5.1	3.8	10.9

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Figure 1. Energy intensity of GDP: China, other developing countries and transition economies, actual 1971–2002, mtoe per billion US\$ GDP, in 2000 PPPs



Source: IEA database.

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Table 6. Elasticity of energy use (TPES) with respect to GDP, developing countries, actual 1971-2002

	Elasticity of TPES with respect to GDP		
	1971-2002	1971-1990	1990-2002
China	0.57	0.73	0.35
India	1.15	1.34	0.89
SE Asia	1.28	1.19	1.47
Other	1.46	1.64	1.18
All developing countries	1.04	1.35	0.64

Source: IEA database.

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Projecting China's Energy Elasticity

- Adjustment from command economy levels appears to be completed
- Developing countries generally elasticity greater than one
- Energy rationing no longer possible; investment in energy conservation lower
- Energy intensive strategy continuing
- Data problems

CONCLUSION

- Difficult to achieve elasticity much less than one

Projection framework

- Simple model

$$M_{ij} = \sum m_{ijr} s_{ijr} \cdot E_{O_i} (1 + \varepsilon_{ij} \alpha_{ij})^n$$

- Elasticity: 1.0 2006-10; 0.85 2010-2020; 0.75 2020-30
- Growth: reduction to 8% by 2010; 7% by 2010-20; 6% 2020-30
- Fuel shares: Revision from IEA (2004) for recent trends – higher coal and non-fossil fuel use, much lower oil use
- Emission intensity of fuel use: taken from IEA (2004)

Table 7. Summary of Unchanged Policy Projections

	1971- 2002	2002-10	2010-20	2020-30	2002-30
	Change over period (% per annum)				
GDP PPP \$2000USb	8.5	9.3	7.0	6.0	7.3
Total Primary Energy Supply ¹ (excluding biomass; mtoe)					
Coal and coal products	4.8	10.5	5.8	3.9	6.4
Oil	6.5	9.7	5.5	4.0	6.1
Natural Gas	8.9	13.4	8.3	8.1	9.7
Non-fossil	9.3	16.2	8.1	8.5	10.5
Total	4.8	10.6	6.0	4.5	6.7
CO ₂ emissions ² (MtC)					
	4.9	10.2	5.9	4.2	6.5
Elasticity of Energy Use with respect to GDP					
	0.57	1.14	0.85	0.75	0.92

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Conclusions 1

- Falling energy intensity of GDP may now require major new policies or a revised development strategy
- On unchanged policies, projected growth in energy use 2002-2030 is 6.7%pa and in CO₂ emissions from fuel combustion is 6.5%pa
- Even this requires a halving of the growth in energy use over 2010-30 relative to 2002-2010

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Conclusions 2

- Projected Chinese CO₂ emissions for 2030 are 5.8 billion tonnes of carbon
- Global CO₂ emissions from fuel combustion in 2000 were 6.4 billion tonnes
- Neither China nor the world can afford such an outcome