



Economic Research Institute
for ASEAN and East Asia

**Reconciliation of Use of Coal and the
Environment : Evidence of Declining Emission
Intensity from China**

Xunpeng Shi PH.D, Associate Researcher

Presentation to the International Energy Workshop
Stanford University, CA
6-8 July 2011

Introduction

- Coal is important. 70% steel production; 80% electricity in China, Poland, South Africa and Australia.
- But, also primary polluter. Regionally, SO₂, NO₂ and dust and globally CO₂.
- THEREFORE, it is often that the future of coal is gloomy based on the latent assumption that coal cannot be reconciled with the environment
- **QUESTION:** Have the use of been Reconciled with the Environment?

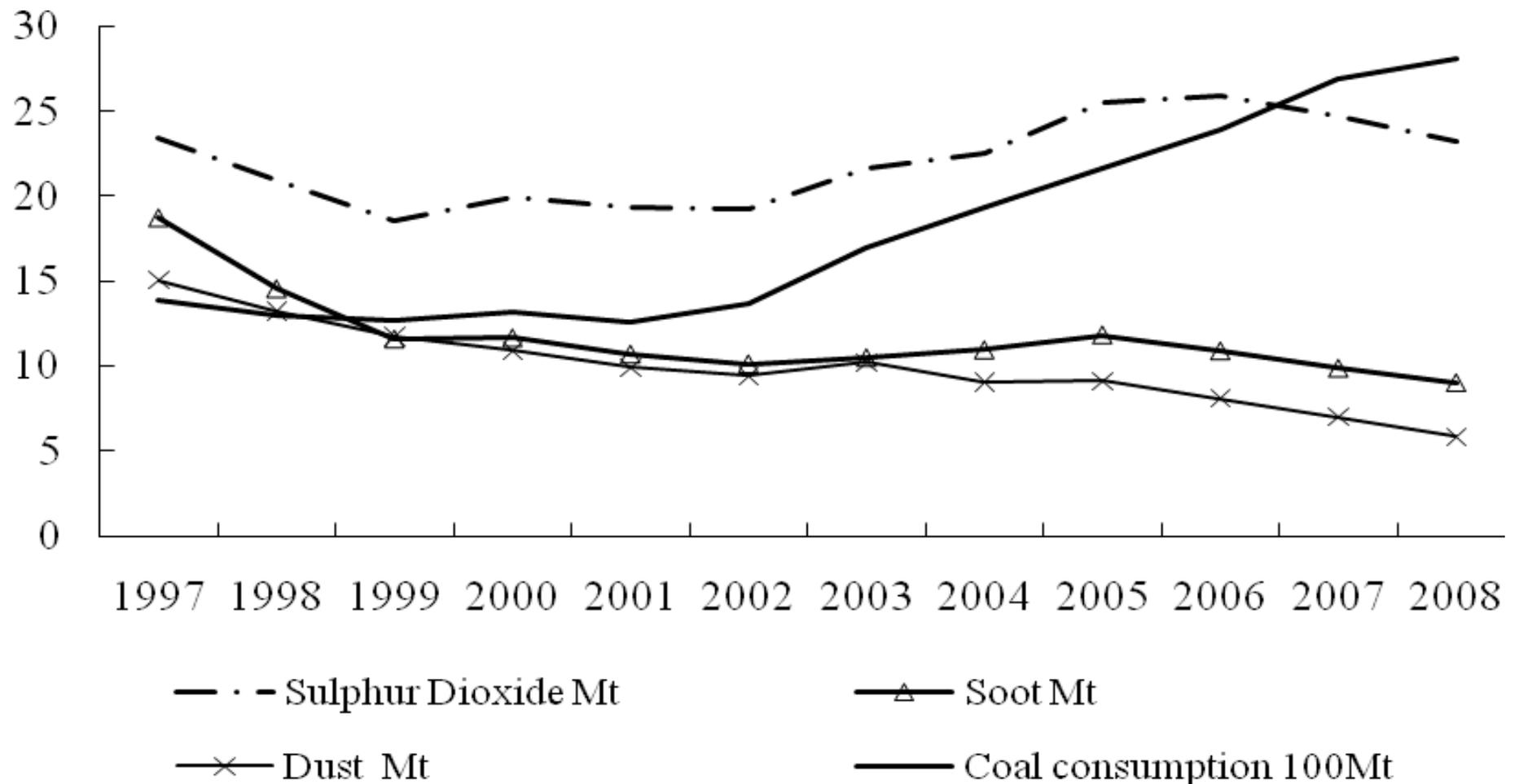
Hypothesis

- There is a declining emission intensity of coal.
- This declining emission intensity will make coal become a clean energy
- And thus will reconcile coal and the environment
- **Objection: To examine declining emission intensity with China's empirical data on Non-CO2 emissions and draw implications for reduce CO2 emissions**

CO₂ emission is not studied

- CO₂ emissions are often inferred by assuming constant emission intensity for each fossil fuel
- Therefore, are not suitable for this analysis
- However, since technically CO₂ emissions from coal combustion can be reduced, findings from the study of non-CO₂ emission may be able to be applied to the case of CO₂
- Extend the discussion to the case of CO₂ and climate change

Fact: Coal consumption and air pollution emissions



Model 1: Fixed Effects Model

$$WGE_{itj} = \beta_0 + \beta_1 FuelC_{it} + \beta_2 FeedC_{it} + (\beta_3 FuelC_{it} + \beta_4 FeedC_{it}) T + \beta_5 1 + \beta_6 FuelC_{it}^2 + \beta_7 MatC_{it}^2 + \delta X_{it} + \alpha_{ij} + u_{itj}$$

- WGE denotes pollutant emissions;
- FuelC /FeedC: consumption of Fuel Coal /Feed Coal; In level form; can be aggregated.
- j is SO2, smoke and dust respectively.

Model 2: Decomposed factors

$$WGE_i = \frac{WGE}{TC} \frac{TC}{FE} \frac{FE}{TE} \frac{TE}{Y} \frac{Y}{P} = ECFIGP$$

$$\begin{aligned} \Delta WGE_{iT} &= WGE_{iT} - WGE_{it} = E_{iT} C_{iT} F_{iT} I_{iT} G_{iT} P_{iT} - E_{it} C_{it} F_{it} I_{it} G_{it} P_{it} \\ &= \sum_K \Delta WGE_{K-effect}, K = E, C, F, I, G, P \end{aligned}$$

$$\Delta WGE_{K-effect} = L(WGE_{iT}, WGE_{it}) \ln(K_T / K_t)$$

$$L(x, y) = (x - y) / \ln(x / y)$$

Data Summary

Variables	Obs. number	Mean	Std. Dev.	Min	Max
Emitted SO2, 1000 tonnes	388	579.68	390.66	16.89	1760.06
Emitted Soot, 1000 tonnes	388	286.85	218.43	8.00	1432.74
Emitted Dust, 1000 tonnes	388	282.52	223.68	7.00	1005.81
Fuel coal, Mil. tonnes	388	40.31	37.02	0.87	248.00
Feed coal, Mil. tonnes	388	16.18	22.12	0.32	184.15
GDP per capita, 1000 Yuan	388	⁸ 11.26	8.31	2.01	57.15

Results-fixed effects SUR

	Specification I-SUR			Specification II-SUR		
	so2 coef/se	soot coef/se	dust coef/se	so2 coef/se	soot coef/se	dust coef/se
Fuelcoal	14.00*** (1.59)	5.57*** (1.23)	-2.81* (1.49)	10.88*** (1.69)	3.08** (1.25)	-3.54** (1.57)
T* Fuelcoal	-0.27** (0.12)	-0.18** (0.09)	0.01 (0.11)	-0.62*** (0.11)	-0.23*** (0.08)	0.07 (0.11)
Feedcoal	4.79*** (1.52)	12.85*** (1.18)	12.87*** (1.47)	5.66*** (1.62)	14.92*** (1.20)	16.59*** (1.51)
T* Feedcoal	-0.38** (0.15)	-1.14*** (0.12)	-0.62*** (0.15)	-0.31** (0.12)	-1.01*** (0.09)	-1.00*** (0.11)
T	14.88*** (3.97)	7.95*** (3.07)	15.74*** (3.77)	21.86*** (2.16)	3.92** (1.59)	6.70*** (2.01)
Fuelcoal ²	-0.03*** (0.00)	-0.01*** (0.00)	-0.00 (0.00)			
Feedcoal ²	0.00 (0.01)	0.02*** (0.01)	-0.01 (0.01)			
Average GDP	-8.42 (6.25)	-6.05 (4.84)	-4.88 (5.98)			
Average GDP ²	-0.01 (0.08)	0.08 (0.06)	0.02 (0.08)			

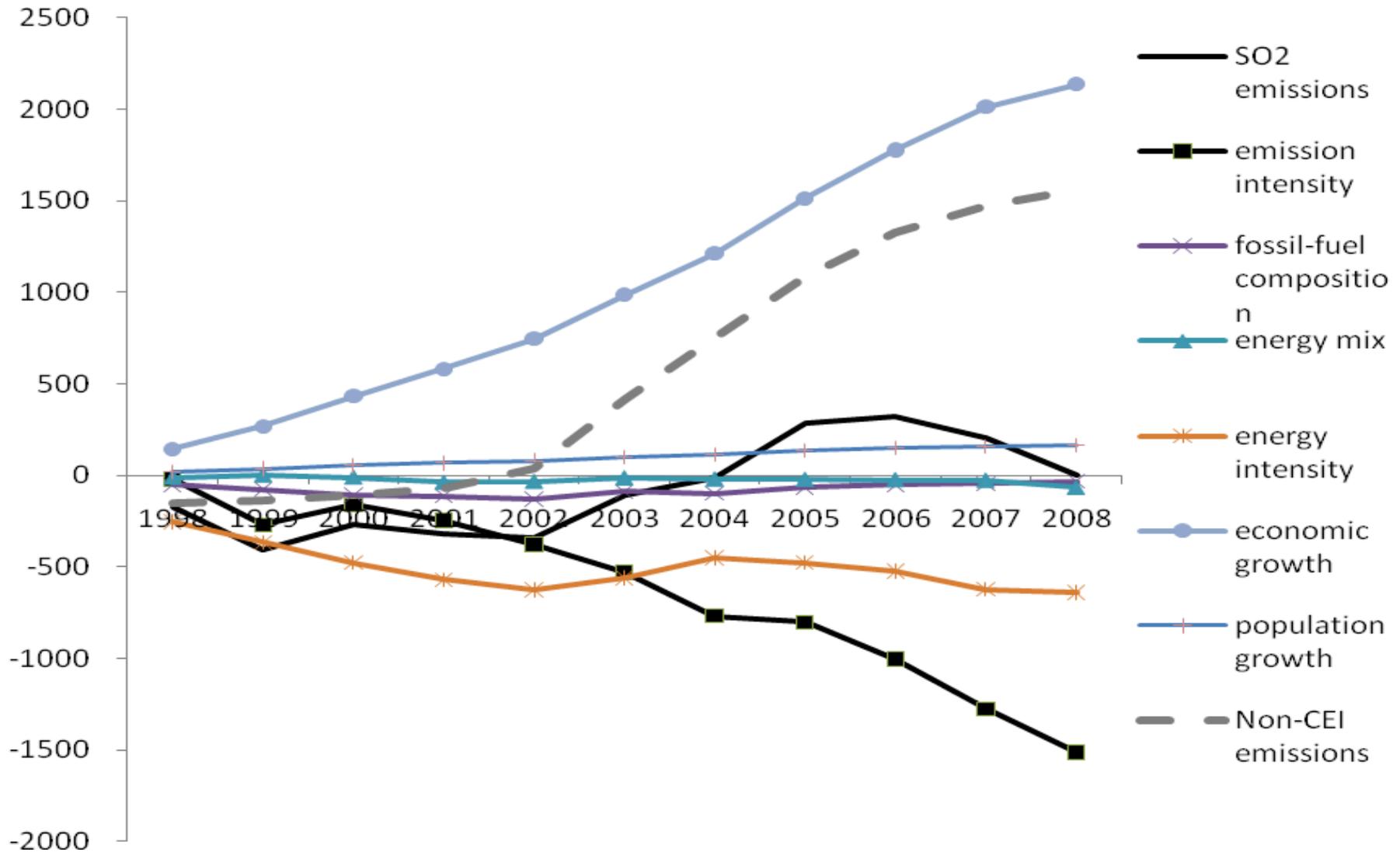
Results- Common trend and EKC

	Total coal consumption			Test of EKC		
	so2	soot	dust	so2	soot	dust
	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se
Totalcoal	9.49*** (0.95)	9.28*** (0.74)	4.79*** (1.00)			
T*Totalcoal	-0.21*** (0.07)	-0.56*** (0.05)	-0.33*** (0.07)			
T	10.74*** (3.73)	9.34*** (2.92)	27.00*** (3.86)	16.52*** (4.21)	8.58*** (3.31)	26.85*** (3.81)
Totalcoal ²	-0.01*** (0.00)	-0.00** (0.00)	-0.00 (0.00)			
Average GDP	-1.04 (5.71)	-4.13 (4.48)	-21.01*** (5.88)	21.89*** (5.71)	-7.64* (4.49)	-27.61*** (5.11)
Average GDP ²	-0.09	0.06	0.19**	-0.41***	0.05	0.25***

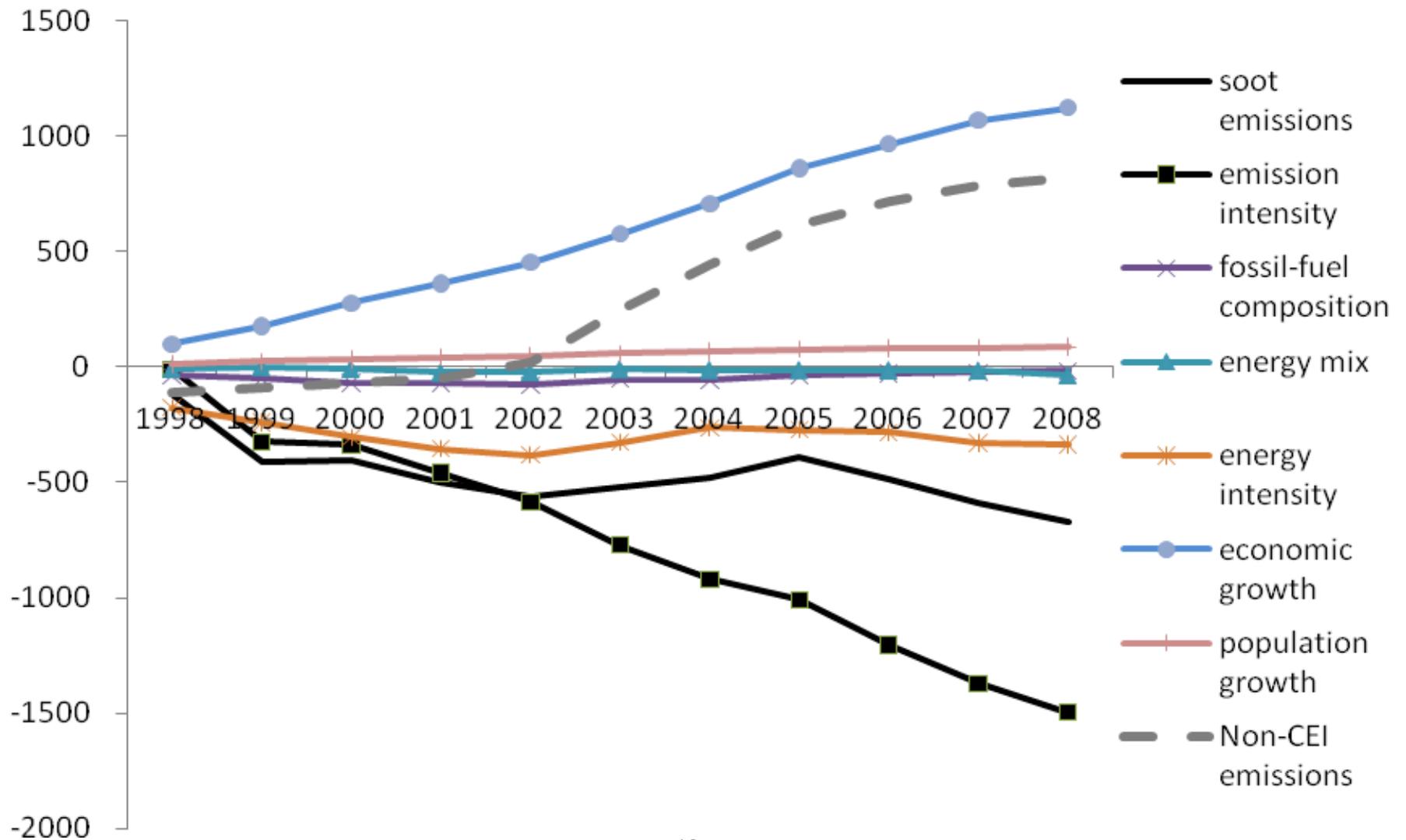
Results- Decomposed effects

	ΔWGE	E-effect	C-effect	F-effect	I-effect	G-effect	P-effect
SO2	55.20	-1512.45	-32.55	-66.48	-639.36	2136.15	164.21
Soot	-671.40	-1495.95	-17.12	-34.97	-336.29	1123.56	86.37
Dust	-920.10	-1585.54	-13.82	-28.22	-271.40	906.75	69.70

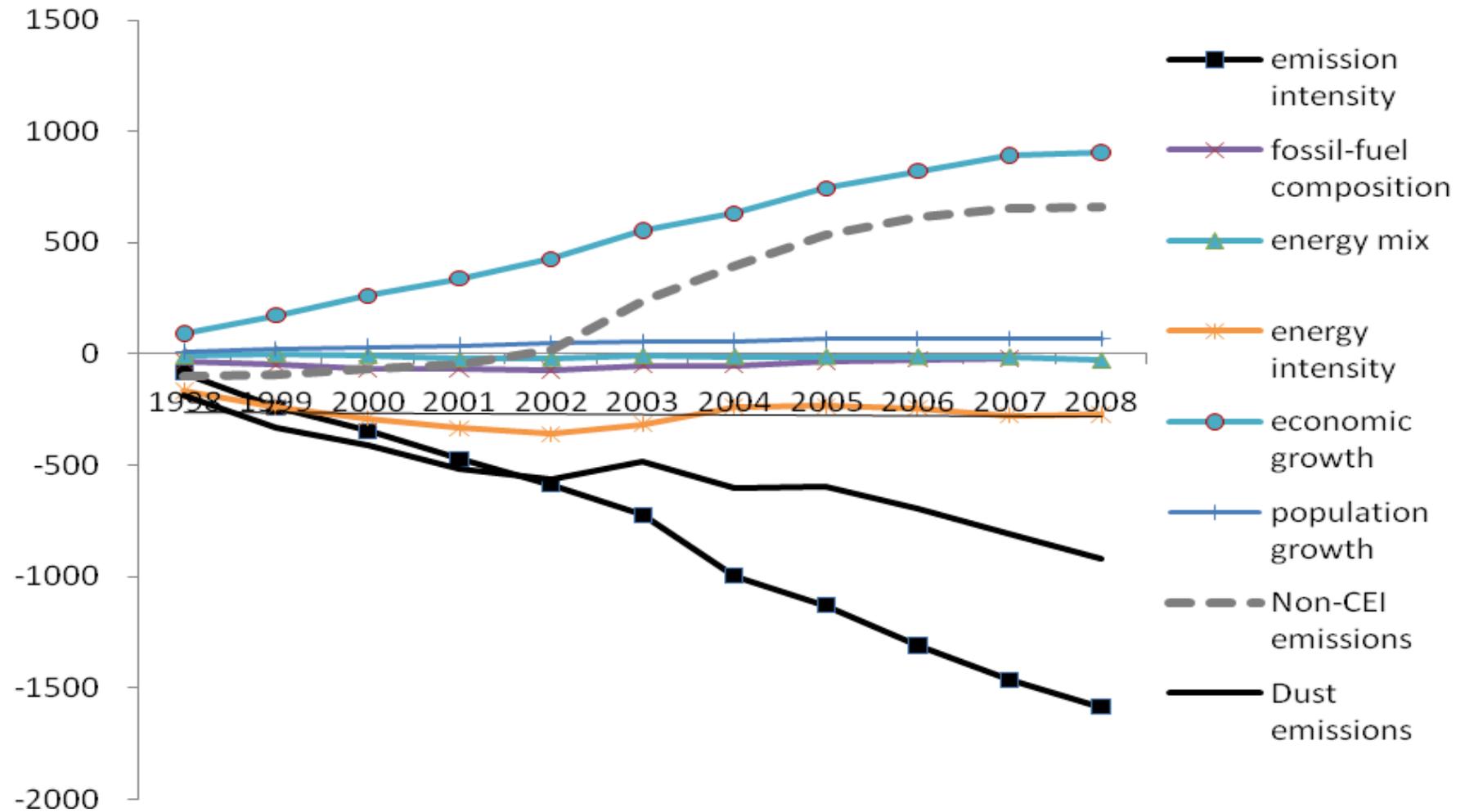
Results-ID: SO2 Emission



Results-ID: Soot Emission



Results-ID: Dust Emission



The future of coal (1)

- The, second largest coal user, the USA has also demonstrated this reconciliation.
- India, the world's third largest coal consumer, is unfortunately an exception to the reconciliation.
- Complete phasing out of coal worldwide is not practical in the near future because of reasons such as the dominance of coal in the energy mix in many countries, affordability, and vested interests in coal and related industries. E.g electricity.

The future of coal (2)

- Coal is very likely to continue its dominance in the Chinese energy mix in the future.
- it is important for China to find ways to reconcile the continuous use of coal and the protection of the environment
- Given that China is the world's largest coal consumer, the clean use of coal is of great concern both to China and to the global community.

Policy Implications

- The development and utilization of CCTs should be promoted to make coal use more environmentally acceptable.
- Appropriate regulations should be in place to force or encourage coal users to reduce their emissions, because many emissions were produced due to lack of application of, rather than a shortage of, available CCTs.
- Many CCTs have both environmental and economic benefits and a push for CCTs' adoption does not always result in negative impact on economic growth.
- ✓ IGCC technology could increase generating efficiencies.
- ✓ Captured CO₂ can be injected into oil fields to increase the oil-recovery rate by 4-18 per cent.
- ✓ The creation of charcoal by the pyrolysis of biomass ("biochar"), can not only reduce atmospheric greenhouse gas levels, but can also improve soil fertility, increase agricultural productivity and improve water quality
- Improvement of energy efficiency is another practical way to ease the tension between coal uses and the environment.

Climate Change

- The Chinese government promised a 40-45 percent reduction of carbon intensity in 2020 with reference to 2005 levels
- When facing a future in which coal will continue to dominate the energy mix and the environment will be strictly protected, high efficiency and clean technology will be crucial for China.
- Zero or near-zero emissions from coal-fired power plants are technologically feasible.
- This experience in reducing non-CO2 emissions and applying CCTs might imply that reduction of the CO2 emissions of coal could be possible in future.
- CCS may be first implemented in the case where other benefits can be generated. E.g. Shenhua & CNPC.

References

- ✓ **The Prospects for Coal: Global Experience and Implications for Energy Policy**
ERIA Discussion Paper, 2009-18
<http://www.eria.org/pdf/ERIA-DP-2009-19.pdf>
- ✓ **China's Attempts to Minimise Non-CO2 Emissions from Coal: Evidence of Declining Emission Intensity**
<Environment and Development Economics>,
forthcoming



Thank you!

- Email: xunpeng.shi@eria.org