



## **China's future energy consumption and emission pathways: Insights from soft-linking two global models**

**Dai, Hancheng; Mischke, Peggy; Xie, Xuxuan**

*Publication date:*  
2014

[Link back to DTU Orbit](#)

*Citation (APA):*

Dai, H. (Author), Mischke, P. (Author), & Xie, X. (Author). (2014). China's future energy consumption and emission pathways: Insights from soft-linking two global models. Sound/Visual production (digital)

---

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# China's future energy consumption and emission pathways: Insights from soft-linking two global models

**Hancheng Dai**

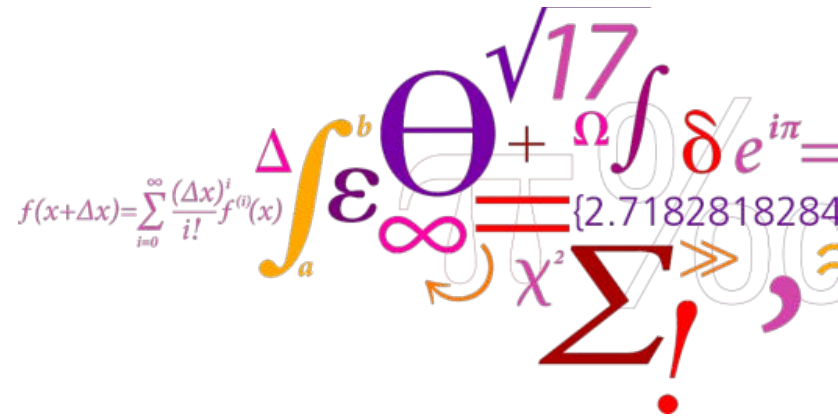
The National Institute for Environmental Studies (NIES), Japan  
[dai.hancheng@nies.go.jp](mailto:dai.hancheng@nies.go.jp)

**Peggy Mischke**

Technical University of Denmark (DTU), Energy System Analysis  
[peym@dtu.dk](mailto:peym@dtu.dk)

**Xuxuan Xie**

Energy Research Institute, National Development and Reform Commission, P.R. China  
[xiexx@eri.org.cn](mailto:xiexx@eri.org.cn)



The 6<sup>th</sup> International Conference on Applied Energy – ICAE2014  
 Taipei, Taiwan

# Motivation and research interest

## **CHINA's RISE:**

An improved understanding of plausible future pathways for China's economy and energy system is becoming more important to understand global energy markets, energy security, greenhouse gas emissions and environmental impacts.

## **DIFFERENT ECONOMIC DEVELOPMENT STAGES IN CHINA:**

China's provinces are in very different stages of economic development today. Global energy models that account for regional economic and energy system differences within China do hardly exist.

## **CHINA-SPECIFIC GLOBAL MODEL LINKING FOR IMPROVED DECISION-MAKING:**

We aim to soft-link two global models for an improved regional economy and energy system analysis of China's future energy policies.

## Literature review – Linking models

- Böhringer 1998; 2008: macro-economic top-down (TD) and technological bottom-up (BU) models for assessing energy and climate policies.
- Hourcade, Jaccard et al. 2006: three categories of linking BU and TD models - soft-linking existing models; 2) focusing on one model type with a simplified representation of the other; 3) hard-linking
- Fortes, Simões et al. 2013: Linking CGE and TIMES model for Portugal
- Riekkola et al (2013): soft-linking a CGE model with an energy system model of Sweden
- Dai, Mischke (2014, in press): Hardly any soft-linking of global bottom-up and top-down models for of China

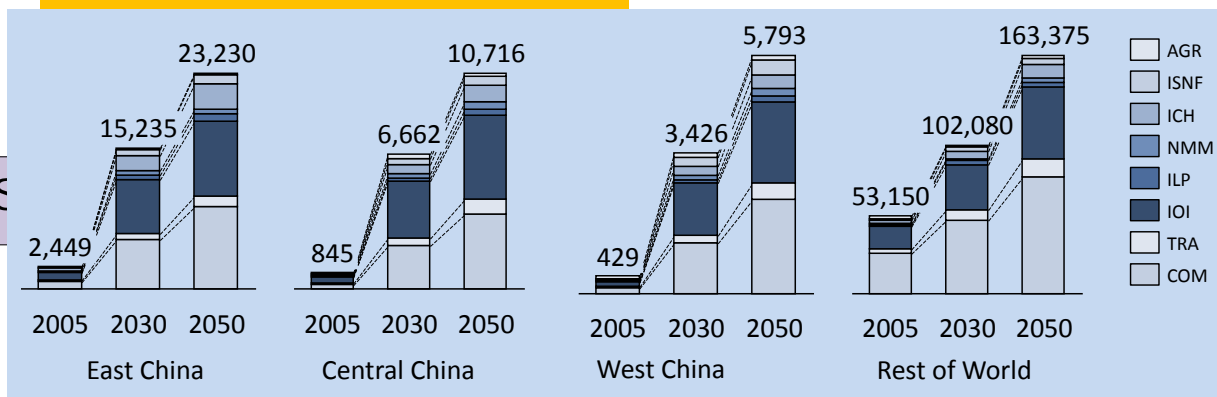
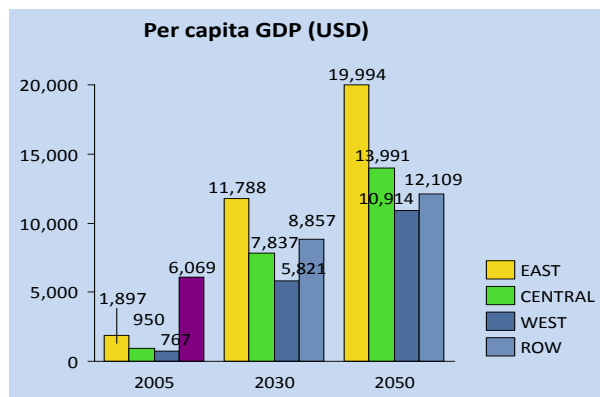
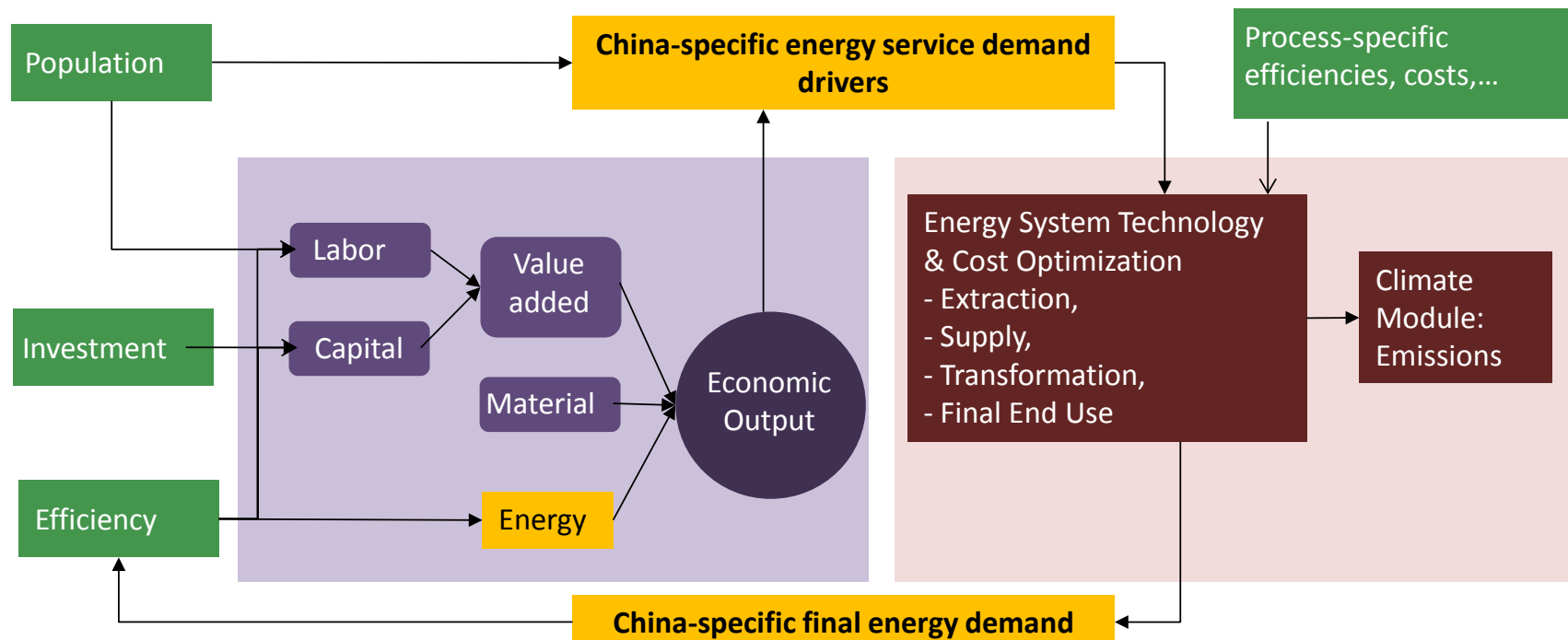
# Introducing the two China-specific global models

	Top-down CGE	Bottom-up TIAM
<b>Modelling approach:</b>	general equilibrium model	Technology-rich linear optimization model
<b>Key inputs:</b>	Population, Efficiency assumptions, future economic growth targets for China	Population, household, economy and energy service demand projections
<b>Key outputs:</b>	Sectoral economic output, household income, GDP etc.	highly-detailed, cost-optimized energy use data
<b>Global Regions:</b>	15 (Africa, Australia-New Zealand, Canada, Central and South America, China, Eastern Europe, Former Soviet Union, India, Japan, Mexico, Middle-East, Other Developing Asia, South Korea, United States, and Western Europe)	
<b>China Regions:</b>	30 provinces, municipalities, excl. Tibet	3 (East, Central, West China)
<b>Time horizon:</b>	2002 - 2050	2005 - 2100
<b>Economic sectors:</b>	22 economic sectors and 3 final demand sectors	energy resources/extraction, transformation and final energy use
<b>Fuels and energy carriers:</b>	Coal, Crude oil, petrol oil, manufactured gas, electricity	Coal, Crude oil, oil products, natural gas, electricity, heat, biomass, biofuels, ethanol/methanol, hydrogen, ...
<b>Emissions and pollutants:</b>	CO <sub>2</sub> , CO, NH <sub>3</sub> , NMVOC, CH <sub>4</sub> , N <sub>2</sub> O, NO <sub>x</sub> , SO <sub>2</sub>	CO <sub>2</sub> , N <sub>2</sub> O and CH <sub>4</sub>



- 14.08.2014

# Soft-linking Methodology



# Comparing models

## Ref: coal use 2005-2050 (EJ)

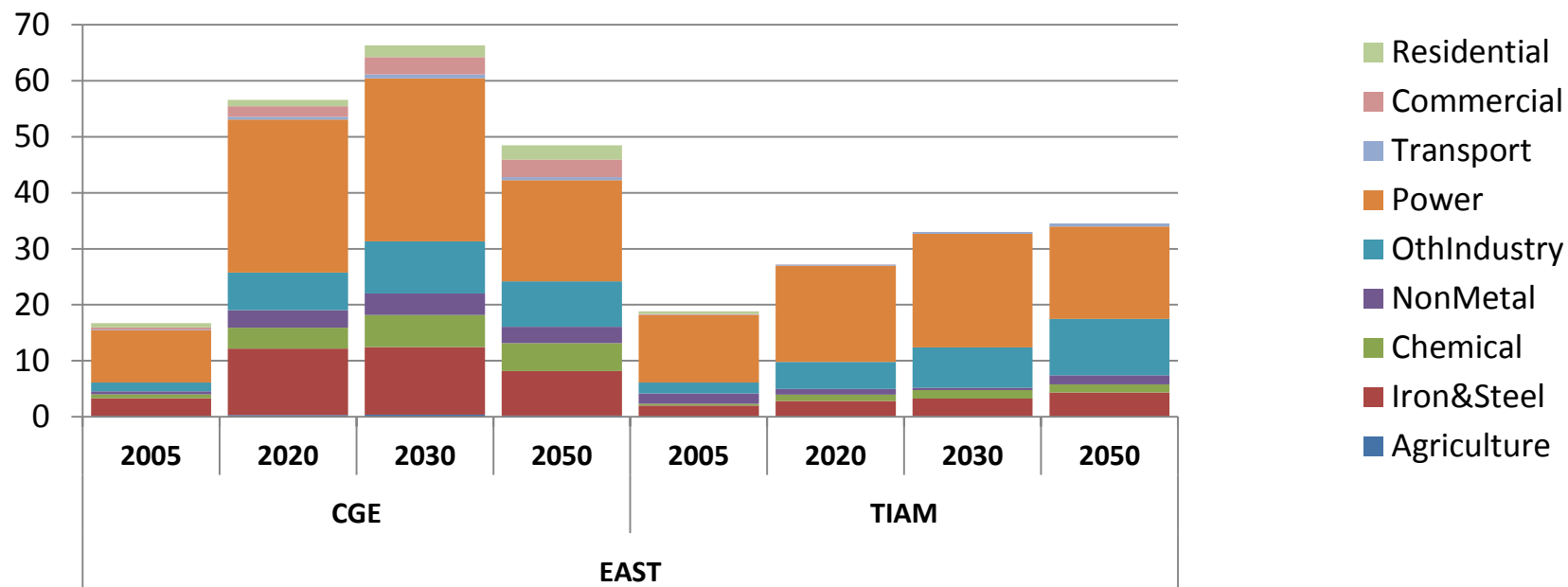
### Agreement

Coal consumed for key sectors (power generation and other industries)

### Disagreement

**CGE:** Higher total coal consumption in China; in sectors like iron, steel, non-ferrous metal, chemicals, non-metal production

**TIAM:** Higher total coal consumption in ROW



# Comparing models

## Ref: refined oil use 2005-2050 (EJ)

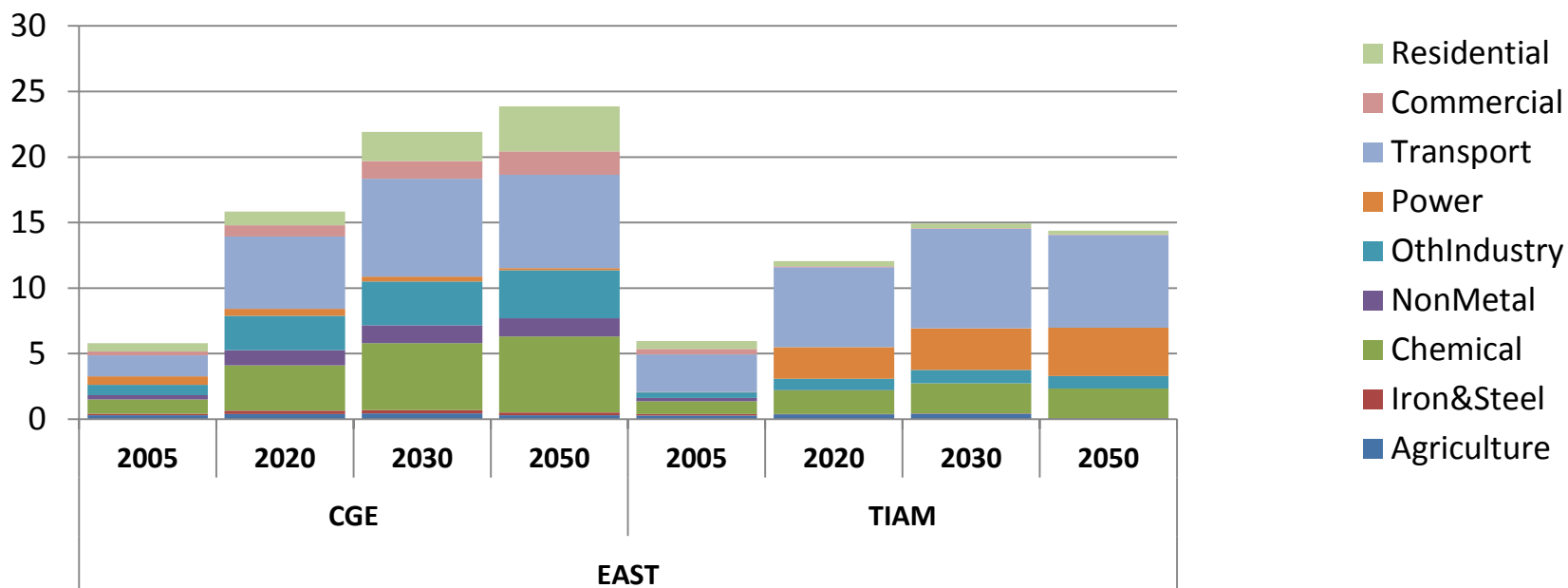
### Agreement

Refined oil consumed for transport and chemistry sectors

### Disagreement

**CGE:** More oil by transport and chemistry sectors

**TIAM:** More oil for power generation in east China;

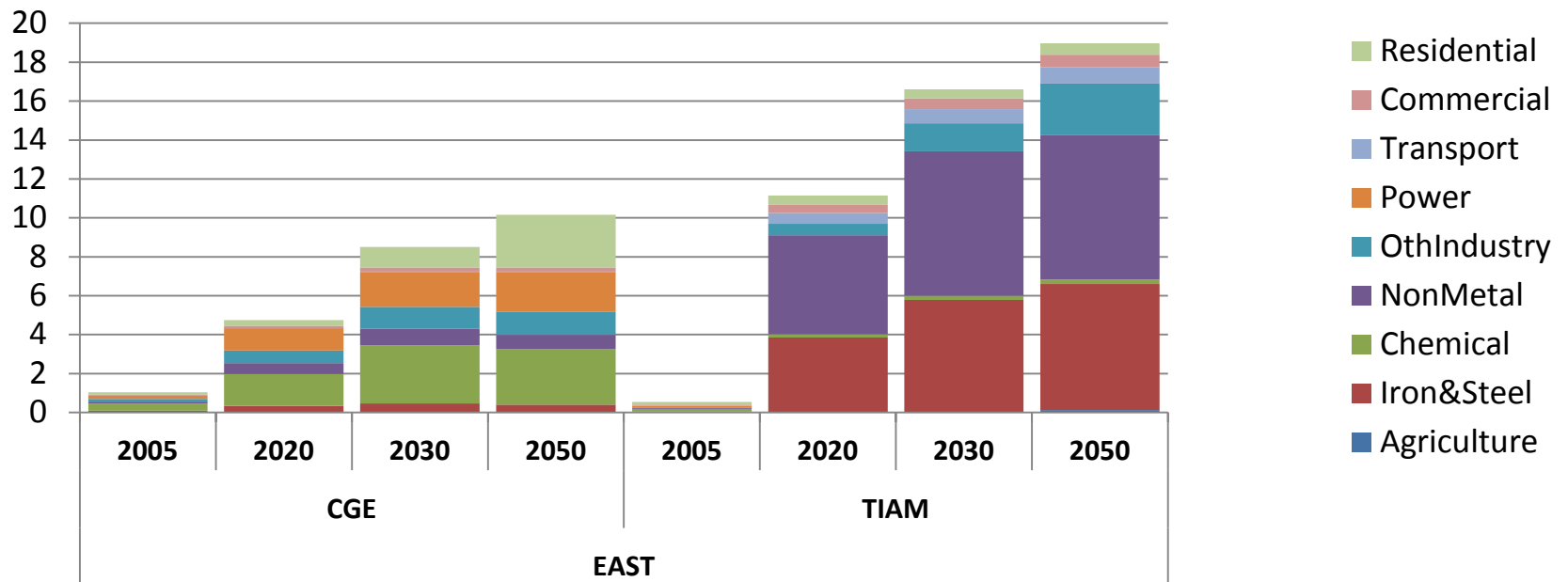


# Comparing models

## Ref: gas use 2005-2050 (EJ)

### Disagreement

More gas consumption in iron, steel and non-ferrous metal sector, non-metal production and other industries of all China regions in **TIAM**.



# Comparing models

Ref: power use 2005-2050 (TWh)

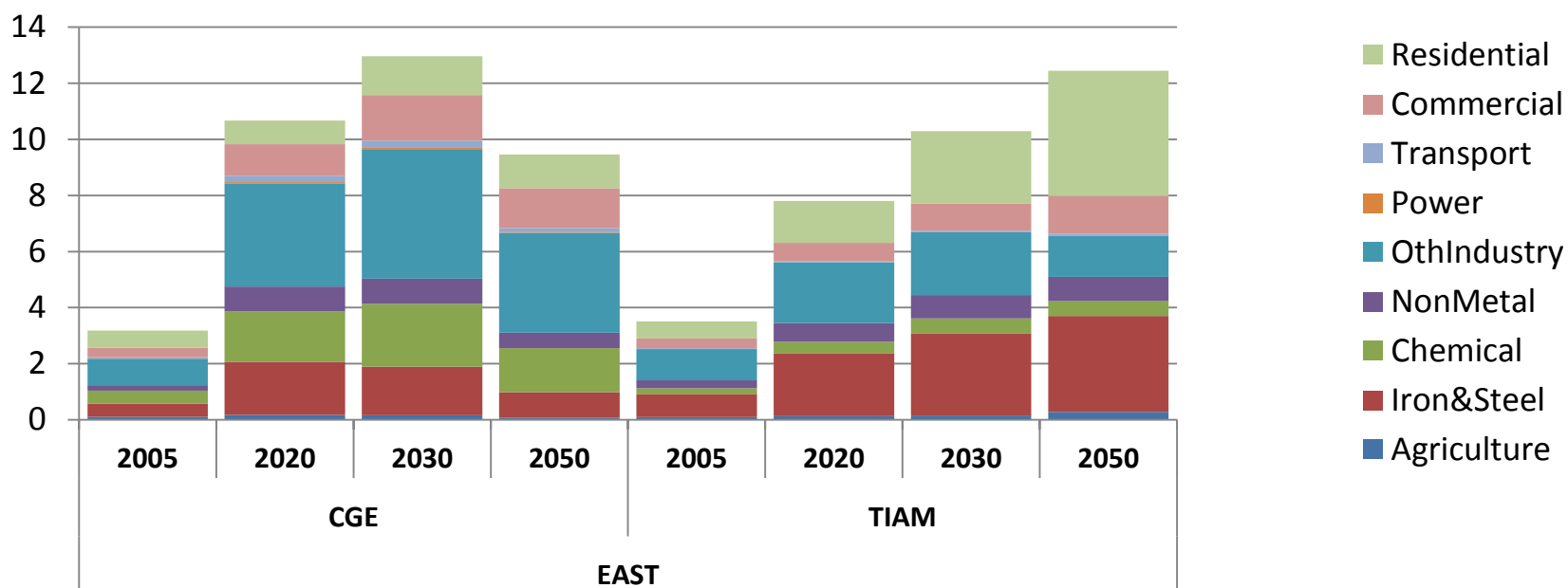
## Agreement

Electricity consumption in 2030 and 2050 in China is relatively close between two models

## Disagreement

**CGE:** More electricity by chemical and other industry sectors

**TIAM:** More electricity in iron and steel sector and household sector;



# Comparing models

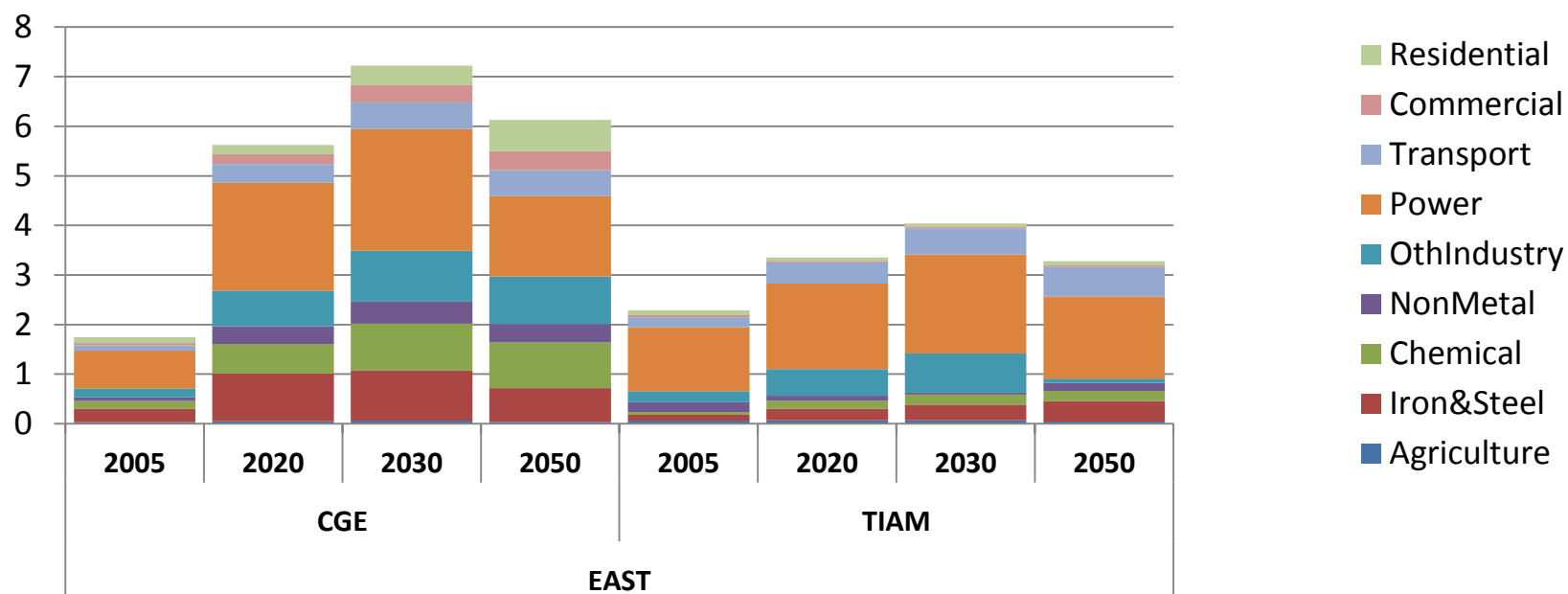
## Ref: sectoral carbon emissions (GT)

### Agreement

Sectoral CO<sub>2</sub> emissions peak between 2030 and 2050 in China.

### Disagreement

The emissions from sectors other than power generation are different.



# Reasons for disagreement

## Technology representation:

- **TIAM**: explicitly represented → sudden changes according to technical lifetimes affect energy use
- **CGE**: implicitly incorporated in CES functions → smooth technology transition; no RE in power sector → coal use much higher

## Underlying database:

- **CGE**: input-output table from China → transport sector only captures commercial transport but excludes private transport by household sector and transport service provided by other industries.
- **TIAM**: energy balance table from IEA → transport sector accounts both commercial and non-commercial transport services.

## Emission accounting:

- **TIAM**: upstream, refining and fuel processing emissions not included in end use sectors.

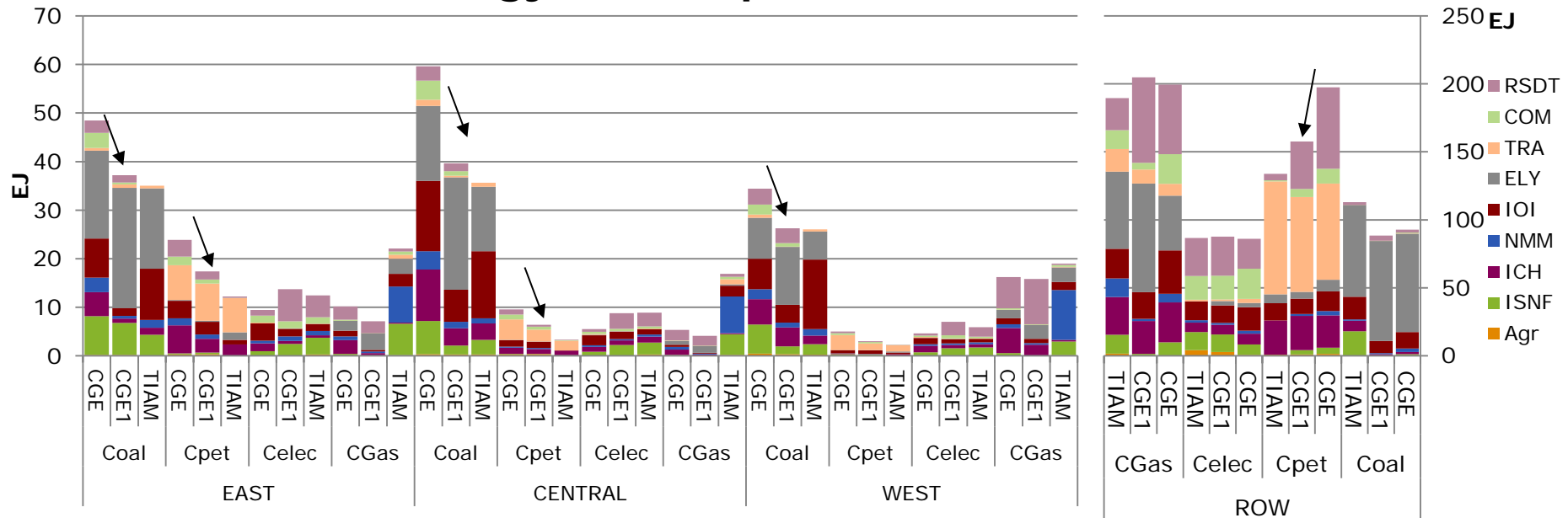
## Modelling China's future energy policy goals:

- **CGE**: accounts for phasing out of oil use in power generation in the mid- and near-terms

# Conclusion from soft-linking the models

- ✓ The first round iteration of soft-linking results in bridging the gap between the models for most total energy consumption indicators.
- ✓ Differences remain. The most important reason is that if energy efficiency parameters are changed, the production price of industrial products will change as well, consequently their demand will change.
- ✓ Policy recommendations for China could be based on different types of models. Soft-linking helps to understand differences in modelling approaches.

## Energy consumption in 2050



**Thank You! 谢谢!**  
**Danke! Merci bcp! Gracias!**

## Our contacts:

Peggy Mischke (DTU, Denmark):

[peym@dtu.dk](mailto:peym@dtu.dk)

Hancheng Dai (NIES, Japan):

[dai.hancheng@nies.go.jp](mailto:dai.hancheng@nies.go.jp)

Xuxuan Xie (ERI, China):

[xiexx@eri.org.cn](mailto:xiexx@eri.org.cn)

China energy blog:

<http://www.peggymischke.com/china-blog.html>

## In collaboration with:

