



Analysing future energy system pathways of East, Central and West China in a global context

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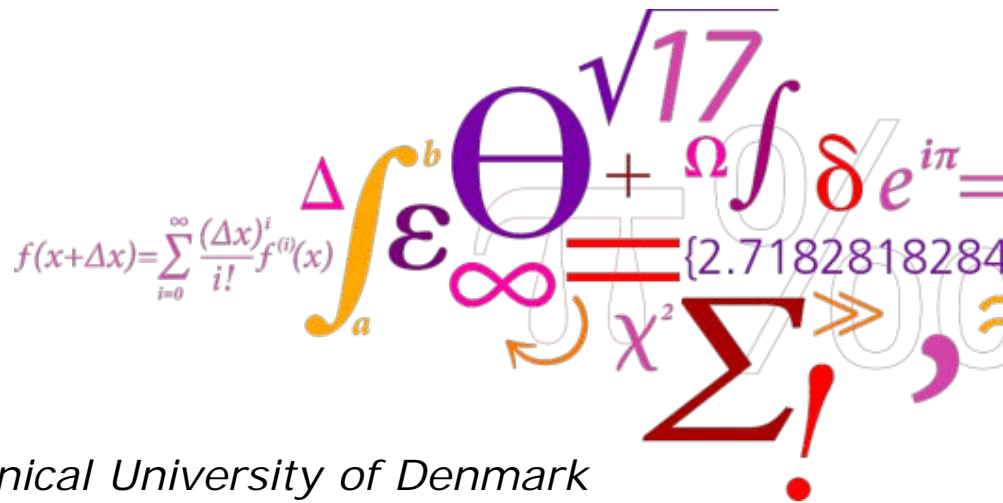
Analysing future energy system pathways of East, Central and West China in a global context

Tsinghua University
3E Institute
PhD Workshop
Beijing, China
5th November 2013

Peggy Mischke

*DTU Management Engineering, Technical University of Denmark
Energy System Analysis*

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Outline

Section I:

Personal introduction

Section II:

IEA ETSAP TIAM model background

Section III:

PhD project progress

"Global and regional energy system modelling with focus on China"

Section IV:

Next steps and discussion





Section I:

Personal introduction

Education & work experience

Education:

- Master's degree in **engineering** with a focus on energy and environmental technologies; PHD in energy planning/modelling ongoing
- **Interdisciplinary** Forcus: economics, environmental law, environmental management systems for industry,...
- Working **languages**: German, English, French, Spanish, Danish,...

Work experience:

- More than 8 years in **infrastructure** and economic development, with a strong focus on the energy sector
- **Energy Sector Expertise**: renewable energy & energy efficiency technologies, project development & implementation, carbon finance and clean development mechanism, emerging markets finance, utility management, rural electrification, international energy research, technology transfer, energy policy design and evaluation, capacity building & training,...
- **Key employers**: World Bank, Africa Energy Group; Fraunhofer Research Institute UMSICHT; Airbus aviation; German energy utilities, German Technical Cooperation GIZ, various consulting companies,...



Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences



Fraunhofer Institut
Umwelt-, Sicherheits-,
Energietechnik UMSICHT

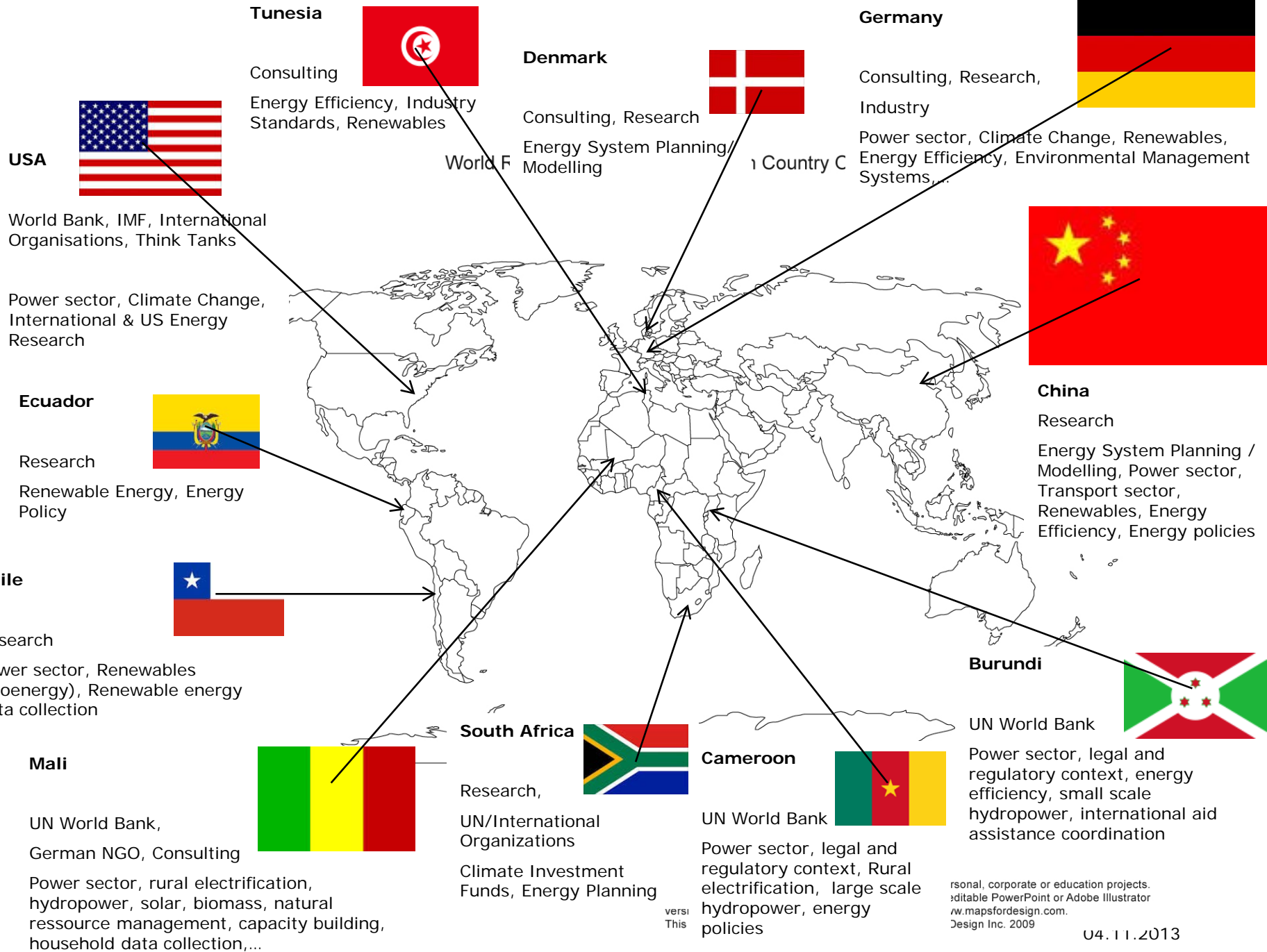


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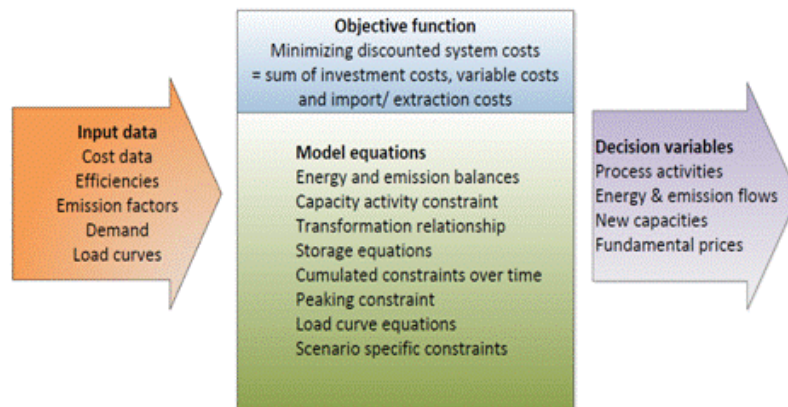
Section II:

IEA ETSAP TIAM model background

IEA – ETSAP - TIAM

- The **International Energy Agency (IEA)**, an autonomous agency established in 1974, has the mandate to promote energy security through collective response to physical disruptions in oil supply and to advise on sound energy policy.
- The **Energy Technology System Analysis Program (ETSAP)** is one Implementing Agreements (IAs) of the IEA that supports energy system model development worldwide. More information: www.iea-etsap.org
- The **Times Integrated Assessment Model (TIAM)** is one energy system model under IEA ETSAP. Its main features are described in the paper “ETSAP-TIAM: the TIMES integrated assessment”, model Part I: Model structure, by Richard Loulou and Maryse Labriet, Published online: 24 February 2007, © Springer-Verlag 2007.

Main Equations in TIMES/ MARKAL



Topic	A typical Reference Scenario in TIAM
Geographical coverage	World divided in 15 regions
Time horizon	2005-2105
GDP, POP	Exogenous – from GLOBAL CGE models
Initial year	2005, based on the IEA Energy Balances
Supply side	Annual or cumulative amounts of fossil and renewable resources, representing the available resources and techno-economic limits to their extraction
Power plants	Annual or cumulative amount of renewable resources Range of nuclear generation
End-use sectors	No long-term market shares Industry: Both energy and feedstocks are included
Energy markets	Socially optimal: no regional production quotas apart from the technico-economic limits of extraction
Energy and climate policies	Not included

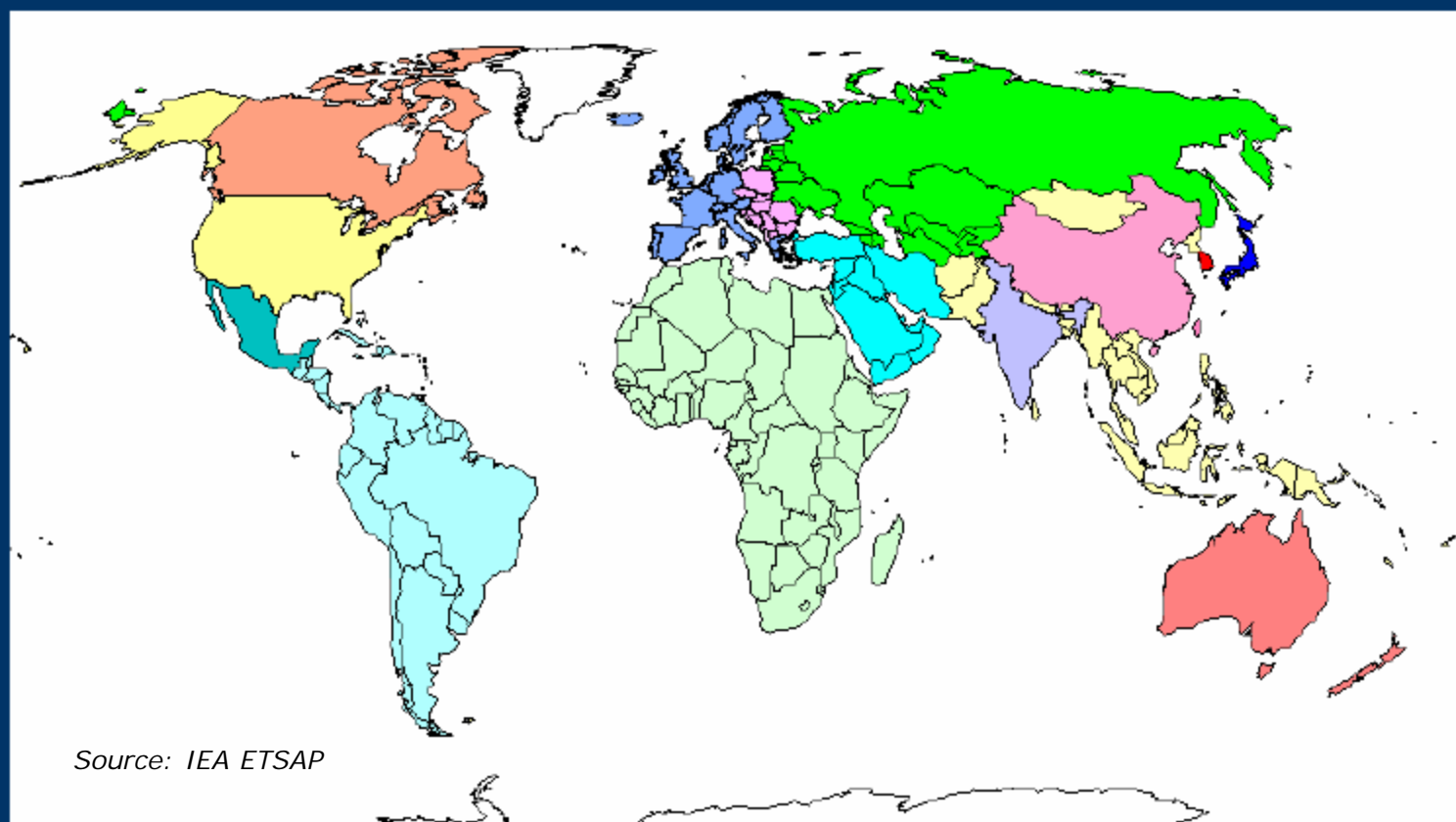
15 regions + OPEC/Non-OPEC

Africa*
Australia-New Zealand
Canada
Central and South America*
China

Eastern Europe
Former Soviet Union
India
Japan
Mexico

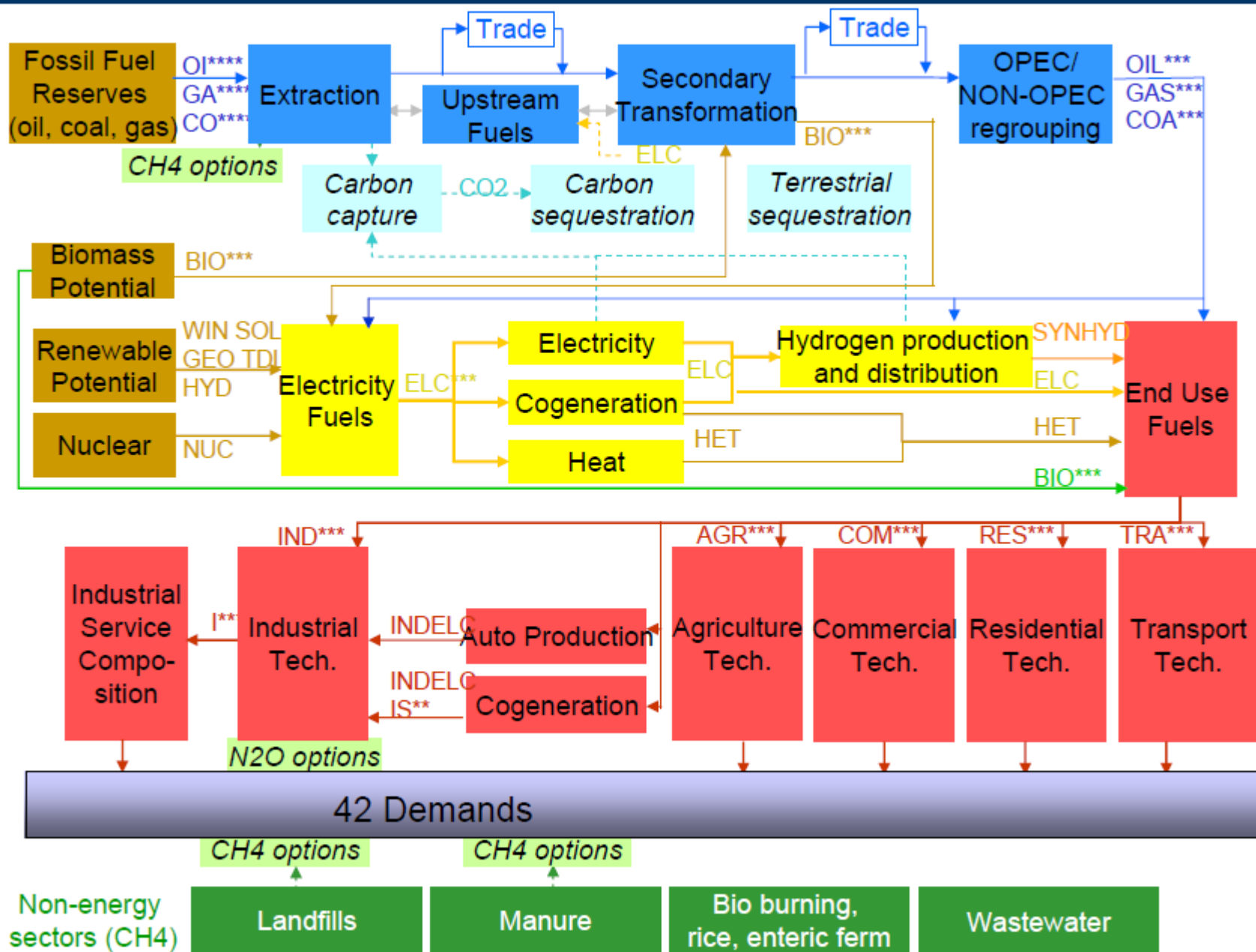
Middle-East*
Other Developing Asia*
South Korea
United States
Western Europe

* *OPEC and Non-OPEC countries are separated in primary and secondary sectors \Rightarrow oil production strategies and oil price control by OPEC countries*



Source: IEA ETSAP

Reference Energy System



TIAM energy service demands – Multiple options for energy policy analysis

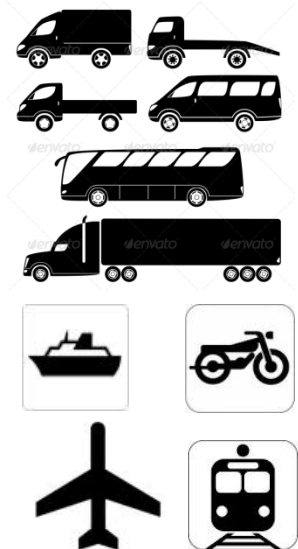
Industrial Energy-Service Demand

Iron and Steel Industry
Chemical Industry
Pulp and Paper Industry
Non-ferrous metals Industry
Non Metal Mineral Industry
Other Industries
Industrial and Other Non Energy Uses
Other non-specified consumption



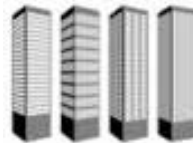
Transport Energy-Service Demand

Domestic Aviation
International Aviation
Road - Bus
Road - Commercial Trucks
Road - Three Wheel Vehicles
Road - Heavy Trucks
Road - Light Vehicle
Road - Medium Size Trucks
Road - Auto
Road - Two Wheel Vehicles
Rail – Freight transport
Rail – Passengers transport
Domestic Navigation
International Navigation



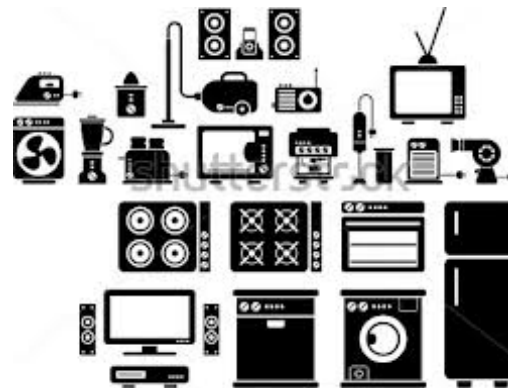
Agriculture Energy-Service Demand

Generic agriculture demand



Commercial Energy-Service Demand

Commercial Cooling
Commercial Cooking
Commercial Space Heat
Commercial Hot Water
Commercial Lighting
Commercial Office Equipment
Commercial Refrigeration



Residential Energy-Service Demand

Residential Cooling
Residential Clothes Drying
Residential Clothes Washing
Residential Dishwashing
Residential Other Electric
Residential Space Heat
Residential Hot Water
Residential Cooking
Residential Lighting
Residential Refrigeration
Residential Others



Section III:

PHD project progress

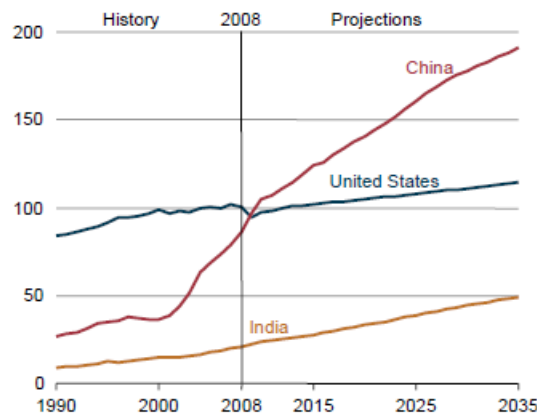
Global and regional energy system modelling with focus on China

2012 - 2015

Added value of my research: An improved modeling of China's regional energy characteristics in a global context

- China is at the centre of an unprecedented shift in the global economy and the global energy industry. Over the past decades China has experienced fast economic growth, accompanied by rapid urbanization, increasing energy consumption, widening regional disparities and soaring green house gas emissions.
- This remarkable growth has led to twin challenges for China: (i) improving environmental sustainability and regional economic development and (ii) enhancing energy security.
- Any major effort to minimize, mitigate and adapt to the adverse effects of climate change will need to better understand and integrate China's future energy system pathways and related policy targets.

Figure 13. Energy consumption in the United States, China, and India, 1990-2035 (quadrillion Btu)

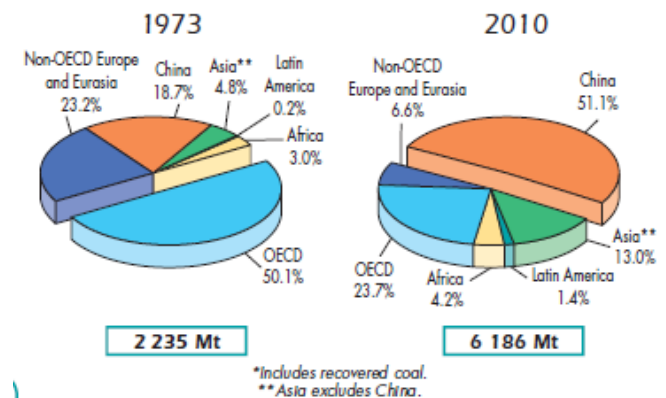


Sources:

Figure 13 from US EIA global outlook 2011 – China is the top energy consuming country

Regional shares of hard coal production, global from IEA Key World Energy statistics 2011 – China is the top hard coal producing country in 2010

1973 and 2010 regional shares of hard coal* production



PHD research project overview and timeline

completed

ongoing

planned

Mathematical energy
models and planning
tools with a China
focus
(2012-2013)

China energy system
data (incl. provincial
statistics)
&
Energy balance
methodology for global
modelling
(2013)

**PhD research
project**
**"Global and regional
energy system
modelling with focus
on China"**
2012 - 2015

China energy sector
institutions and policies -
Focus on power & transport
(2013-2014)

More collaboration in
writing of
articles/papers
(2013-2014)

Basic "survival" skills
in Mandarin/Pidgin
(2014)

Research collaboration,
project work and in-country
research stays

Oct 2012

Oct – Dec 2013

Apr – July 2014

The models and tools from a Chinese perspective: A comparison of modeling results for China's future energy system development

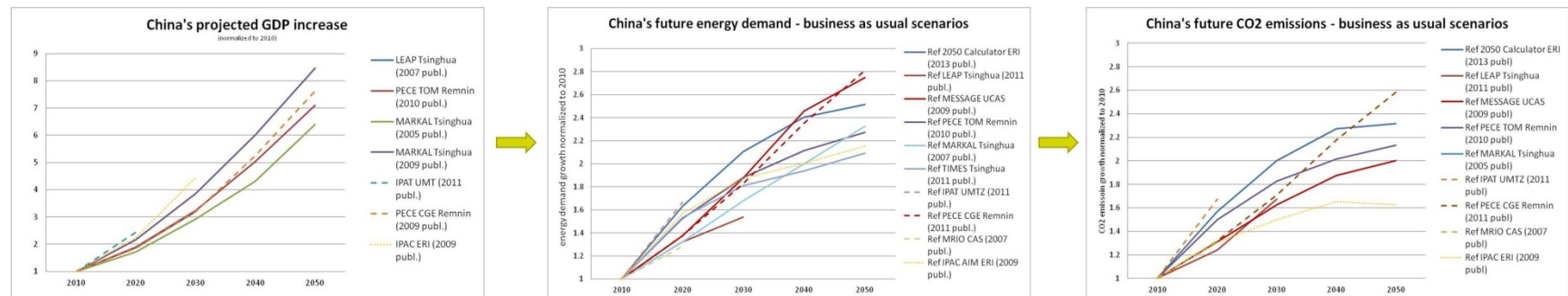
- Research area and methodology:

The modelling structure, application areas, results and conclusions from more than 15 different mathematical modelling tools developed by various Chinese institutions were reviewed and compared to evaluate China's future energy system development from a Chinese perspective.

A growing number of Chinese modelling tools is accessible in English language in academic journals and research reports since 2005, among them many bottom up and top down models.

- Research results indicate the following:

- Key application areas: economic impacts of energy and climate policies (including GDP loss); the identification of optimal technologies for China's future power system
- Key policy recommendations: a gradual and long term transition of China's energy system towards clean energy sources; likely CO₂ emission stabilization period after 2030
- Key technologies: mainly energy efficiency improvements, CCS deployment and increased nuclear power generation.



- Source: Mischke, Peggy and Karlsson, Kenneth B. (2013): *Modelling tools to evaluate China's future energy system - a review of the Chinese perspective*. ENERGY (Under Review).

The data challenge: How to deal with energy statistics "full of Chinese characteristics" in an international context?

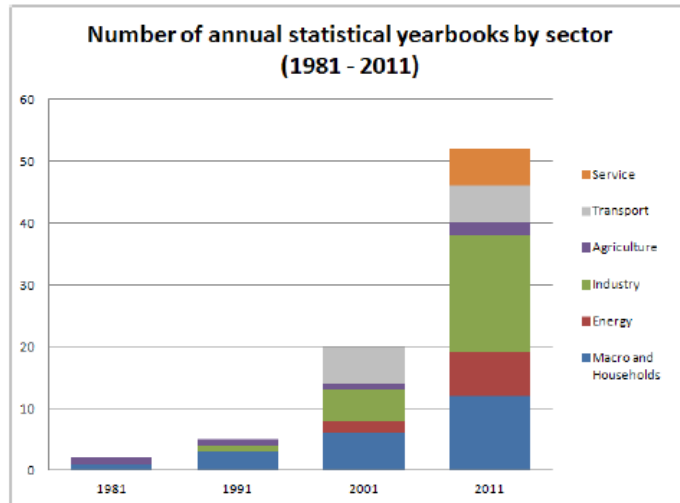


Figure 1: Increase of national statistical yearbooks in China (1981-2011)

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【全球视野下的中国能源统计：构建中国东部、中部及西部区域能源平衡表的方法论】<http://t.cn/zRUGrPh> 微评：这是迄今我看到的将中国能源统计问题描述的最清楚的报告之一，可惜作者不是来自中国。如果有关各方对中国能源统计的各种怪象持续睁只眼闭只眼，将。。。。。

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Development of a simplified methodology to integrate selected indicators from Chinese national statistics in TIAM to distinguish energy systems for East, Central and West China – based on the IEA energy balance methodology (as used for other regions in TIAM)

Source:

Mischke, Peggy (2013): *China's energy statistics in a global context: A methodology to develop regional energy balances for East, Central and West China*. MPRA DTU Working Paper 50145; published on October 1, 2013; 44 pages; <http://mpra.ub.uni-muenchen.de/id/eprint/50305>

The proposed regional representation of China's energy system in TIAM – Defining EAST, CENTRAL and WEST China

- The suggested sub-regional definition of China in TIAM is based on the PRC's Seventh Five-Year Plan (1986–1990), which grouped all provincial level divisions of China into three economic zones in order to promote medium to long term economic specialization and division of labour.

→ **18 Region global model version of TIAM**, based on 15 Region global TIAM 2011 version

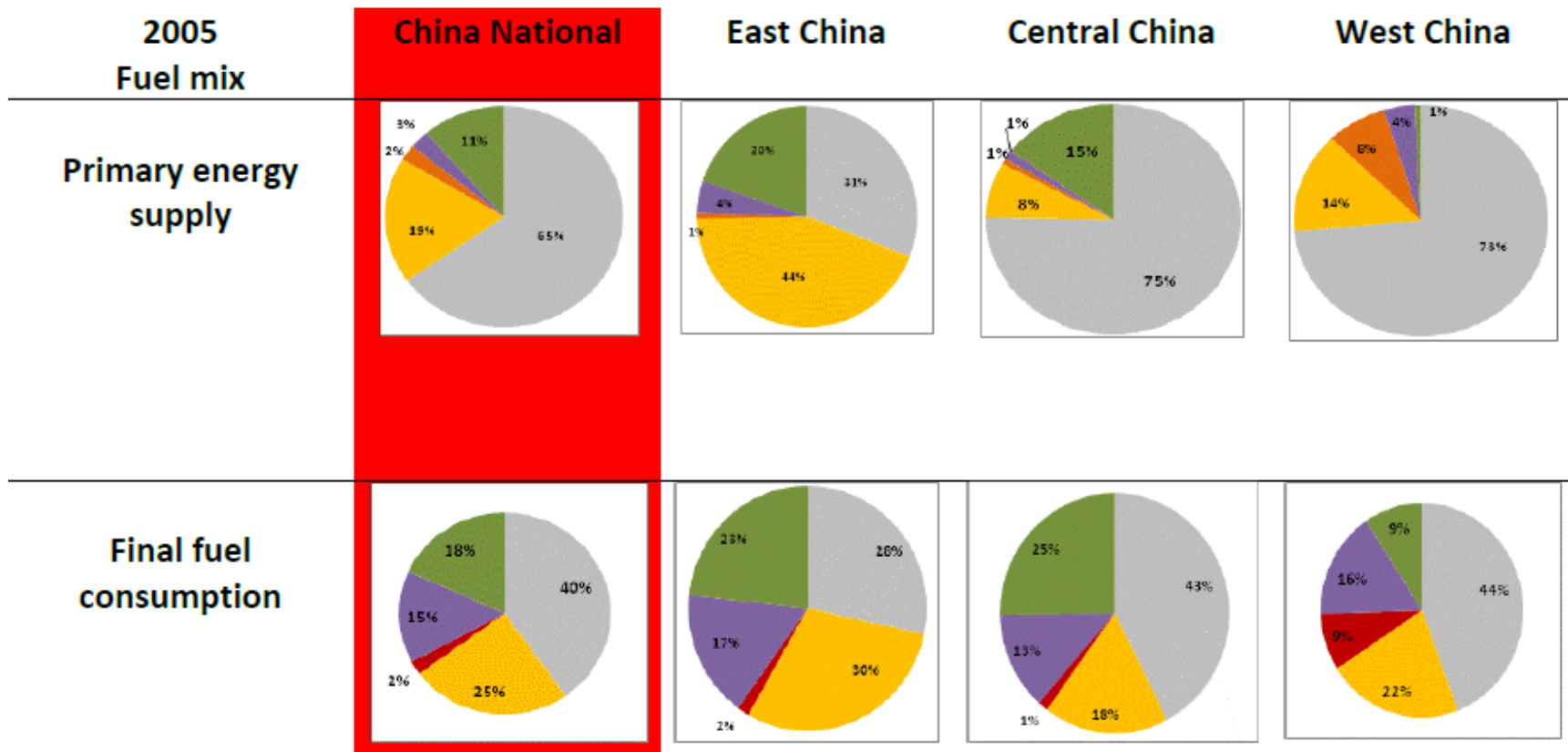
- China East Region:** export-oriented industries, including steel, chemicals, engineering and textiles; in 2010 about 578 million inhabitants (44% of Chinese population) lived on 13% of China's land area; currently the economic powerhouse, accounting for more than 92% of China's exports and about 97% of China's GDP in 2010
- China Central Region:** most of China's coal and metallurgical industries, as well as agricultural production; in 2010 about 440 million inhabitants (34% of Chinese population) lived on 29% of China's land area; crucial for supplying energy to the provinces in China's East Region.
- China West Region:** the least developed region; marginal share of about 1% in China's GDP in 2010; in 2010 about 293 million inhabitants (22% of Chinese population) lived on 57% of China's land area; major hydropower resources



Sources:

PRC NBS Statistical Yearbook 2011; Economist 2012

The new China energy balance methodology in TIAM – Fuel mix for primary supply and final consumption



Coal, Coke and other coal products

Oil and petroleum products

Natural Gas and NGL

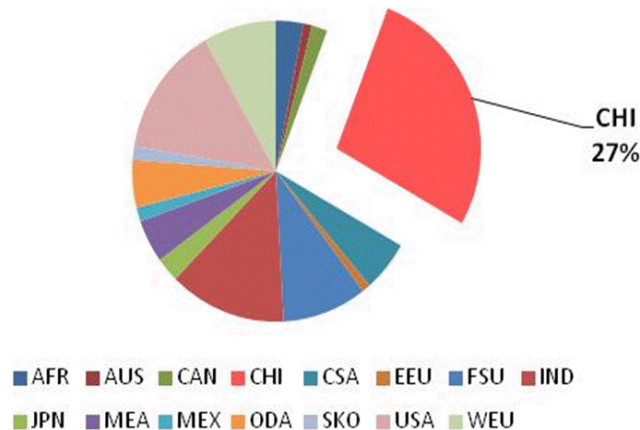
Electricity

Biomass

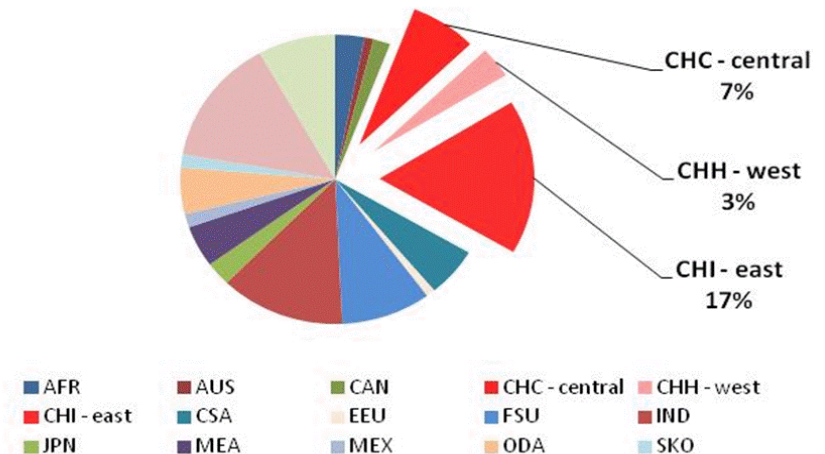
Modelling East, West and Central China in a global context (I)

Improved modelling of China's power sector – Reference scenario test

Global electricity production in 2050 in
- no regional detail of China

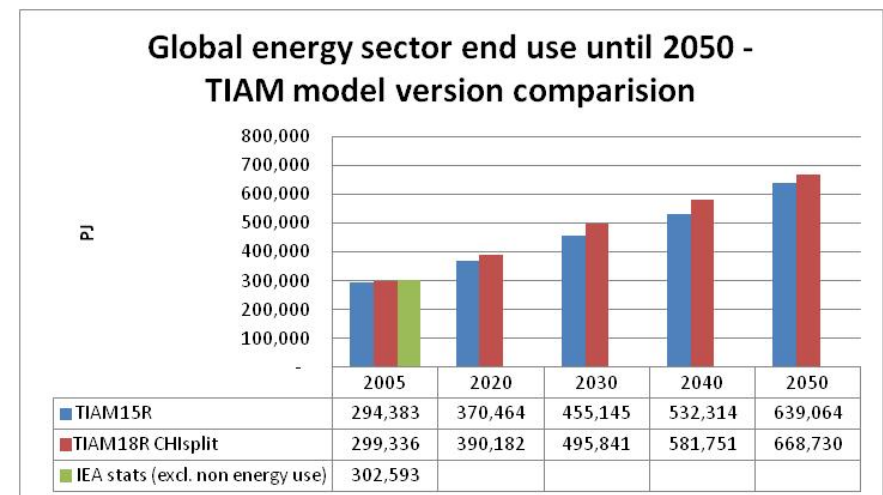
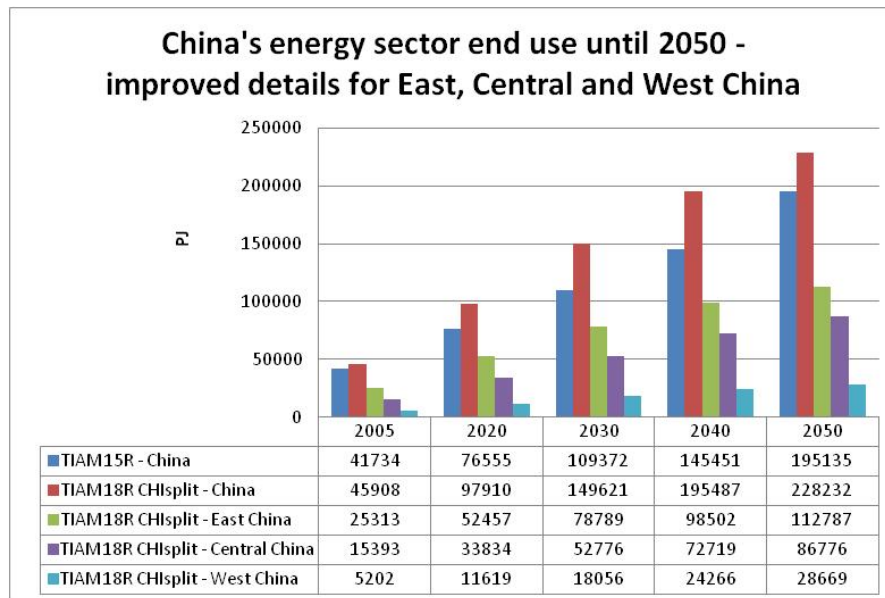


Global electricity production in 2050 -
with improved regional detail of China



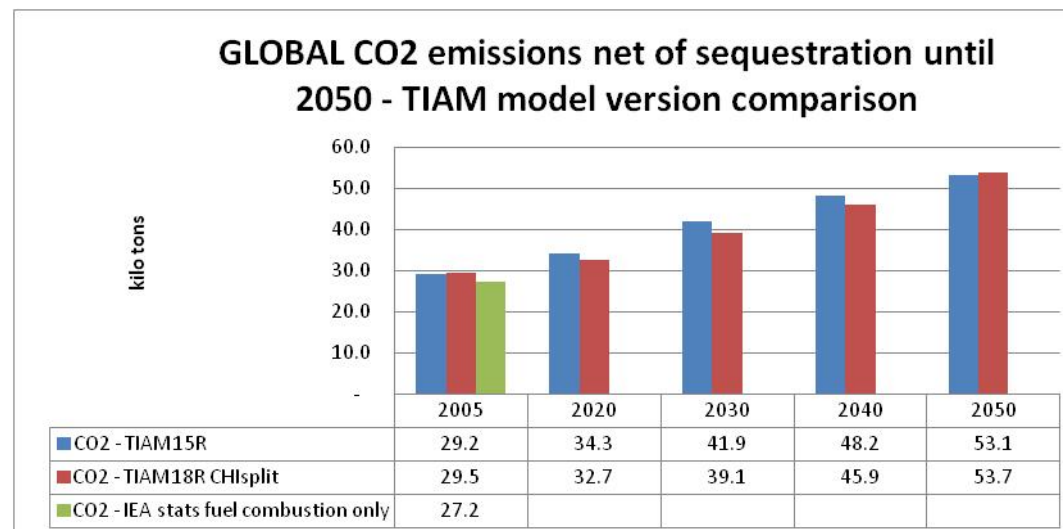
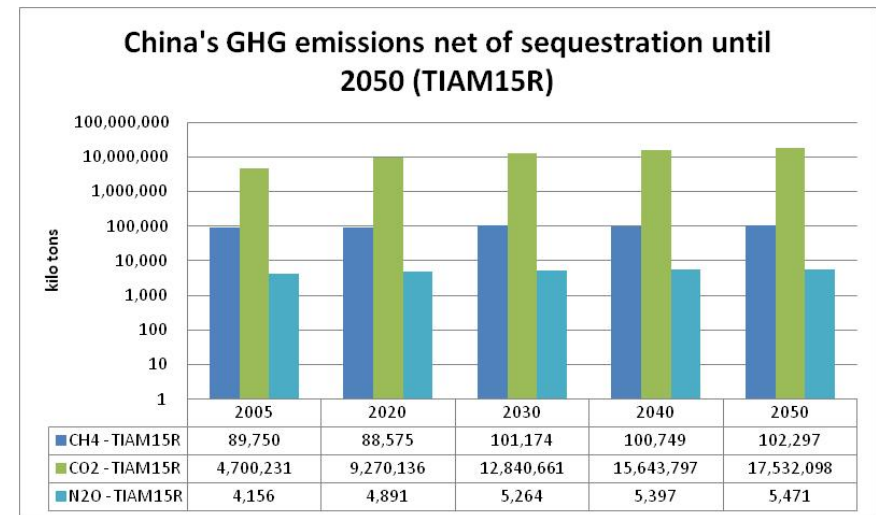
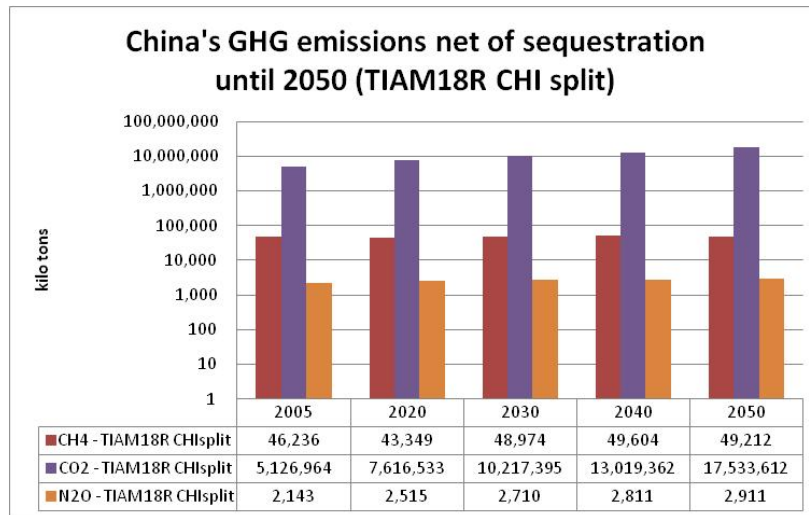
Modelling East, West and Central China in a global context (II)

Energy end use pathways until 2050 for China – Reference scenario test



Modelling East, West and Central China in a global context (III)

Future emission pathways until 2050 for China – Reference scenario test





Section IV:

Next steps and discussion

Next steps and discussion...

- ... to further improve the representation of China's regional energy system in TIAM and detailed documentation of the TIAM reference scenario assumptions
- ... to update energy service demand drivers for East, Central and West China in TIAM
- ... to focus more in depth on power and transport sector policy analysis for East, Central and West China and implement this in TIAM
- ... to plan my 2014 China research stay: 3 months around April – July 2014
- ... to brainstorm about joint publications ...
-



Thank You!谢谢! Danke! Merci bcp!

For more information:

Email me: peym@dtu.dk

Follow my China energy blog: <http://www.peggymischke.com/china-blog.html>

Connect via LinkedIn: Peggy Mischke (佩吉·密歇克), International Energy Specialist, Copenhagen Area, Denmark

氣

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