# On track to become a low carbon future city? -

## First findings from the pilot city of Wuxi

2nd World Sustainability Forum

**Authors:** Carmen Dienst[1]*; Clemens Schneider[1]; Mathieu Saurat[1]; Chun Xia[1]; Thomas Fischer[2]; Marco Gemmer[2]; Andreas Oberheitmann[3]; Urda Eichhorst[1]; Daniel Vallentin [1]

Wuppertal Institute for Climate, Environment and Energy

1) Wuppertal Institute
2) NCC
3) CER

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*Corresponding author: carmen.dienst@wupperinst.org

# Agenda

- **Introduction LCFC project and city Wuxi**
- Purpose of Study and Methodology
- Emission inventory & key sectors
- Vulnerability to Climate Change
- Resource utilization
- Current Policy Scenario
- Conclusions

**Project Duration:** March 1, 2011 – February 28, 2014

**General Objectives:**

Developing an integrated low carbon, resource efficiency and adaptation strategy for **Wuxi** in a mutual learning process with **Düsseldorf+** region

**Specific objectives :**

- Tap synergies between CO2 mitigation, adaptation and resource efficiency in an integrated urban low carbon strategy with high potential for implementation and replication.
- Show good practice that has high potential for transferability to other urban areas
- Enable and support mutual learning and information exchange between Wuxi and Düsseldorf+ region

# Case study: Wuxi City, China

**Location:**

In Jiangsu province near the East coast of China, approx. 120 km North-West of Shanghai

**Size:** About 6 million inhabitants

**Relevance:**

- One of China‘s most rapidly developing cities
- Growing industrial sector (car manufacturers, electrical industry, automobile industry)
- Regional centre of Chinese solar industry
- City government plans to foster development of low-carbon industries
- City government has established low-carbon research centre

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# Purpose of the study & Overview

## Status quo and trend assessment of City of Wuxi

- **Emission inventory: Status of current greenhouse gas emissions**
  - → Crucial to understand dimension of GHG emissions and identify most relevant sector
  - → Basis for mitigation paths & reduction targets
- **Changes in Parameters and Vulnerability to climate change**
  - → View on development of last 50 years and future challenges until 2100
  - → Basis to identify future needs and possible measures for adaptation on city level
- **Resource utilization**
  - → Current resource use and material flows in energy & construction sector (considering all direct and indirect resource inputs (domestic and foreign)
  - → Future projections until 2050 to understand the dimensions and environmental challenges linked to Wuxi‘s energy and building sector
- **Current policy scenario**
  - → Modelling of most likely development and future emissions under current policy framework
  - → Basis for more ambitious low carbon future paths and measures in upcoming scenarios
- **Identification of key sectors**
  - → Concentrate on sectors with high relevance for an integrated Low Carbon strategy
  - → Comparability of sectors crucial (to data, studies, among pilot and other cities

# Methodology and Data

## Status quo and trend assessment

- **Emission inventory**
  - Based on IPCC Guidelines (2006) on inventory reporting;
  - Basic data from Wuxi Statistical Yearbook;
  - Focus on 2009; „territorial emissions“; Energy related emissions 2003 – 2009
- **Changes in Parameters and Vulnerability to climate change**
  - Based on observations for 7 stations in Wuxi 1961-2009 and
  - Based on ensembles of three General Circulation Models (GCMs):
    - ECHAM5/MPI-OM, CSIRO-MK3.5, and NCAR CCSM3 (with SRES A2, A1B, B1) (Gemmer/Fischer
- **Resource use**
  - Use of two methods taken from a wider material flow analysis (MFA) toolbox:
    - MIPS (Material Input per unit of Service) and
    - EW-MFA (Economy-wide material flow analysis)
- **Current policy scenario**
  - Modelling approach consisting of one core model and five sub-models
    - Industry, Building, Household appliances, Service Sector, Transport and Power & Heat Sector model
  - Future development based on „Wuxi Low Carbon City Development Plan“ and estimations of NDRC Energy Research Institute (Jiang 2008)
- **Identification of key sectors**
  - Considering $CO_2$e emissions, relevance for resource use, vulnerability, region/policies

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# Important Outcomes of Wuxi emission inventory

## Energy-related $CO_2$ emissions

- 70% emissions from raw coal, 25% other coal; only 3-5% not coal related
- Energy industry: 42 Mio. t $CO_2$; ≈24% of NRW and 11% of German $CO_2$
- Manufacturing Industry: 29 Mio. t $CO_2$; ≈46% of NRW $CO_2$

## Non-$CO_2$ emissions

- Non-$CO_2$ emissions most likely in:
  - Steel industry; Cement industry; Chemical industry; Electronics; ODS Substitute, etc.
- Currently no correct calculation possible due to data and method gap
- Waste: most likely high reduction potential, no data for calculation
- Agriculture: probably less important; but a lot of data missing

## Challenges for inventory work

- Detailed statistics for "above-scale" industry reported (revenues > CNY 5 million/ > 580,000€) → No data for "below-scale" industry; commercial sector
- Differentiation of industrial processes not clear for Non-$CO_2$ calculation
- Calculation methods - often default values used

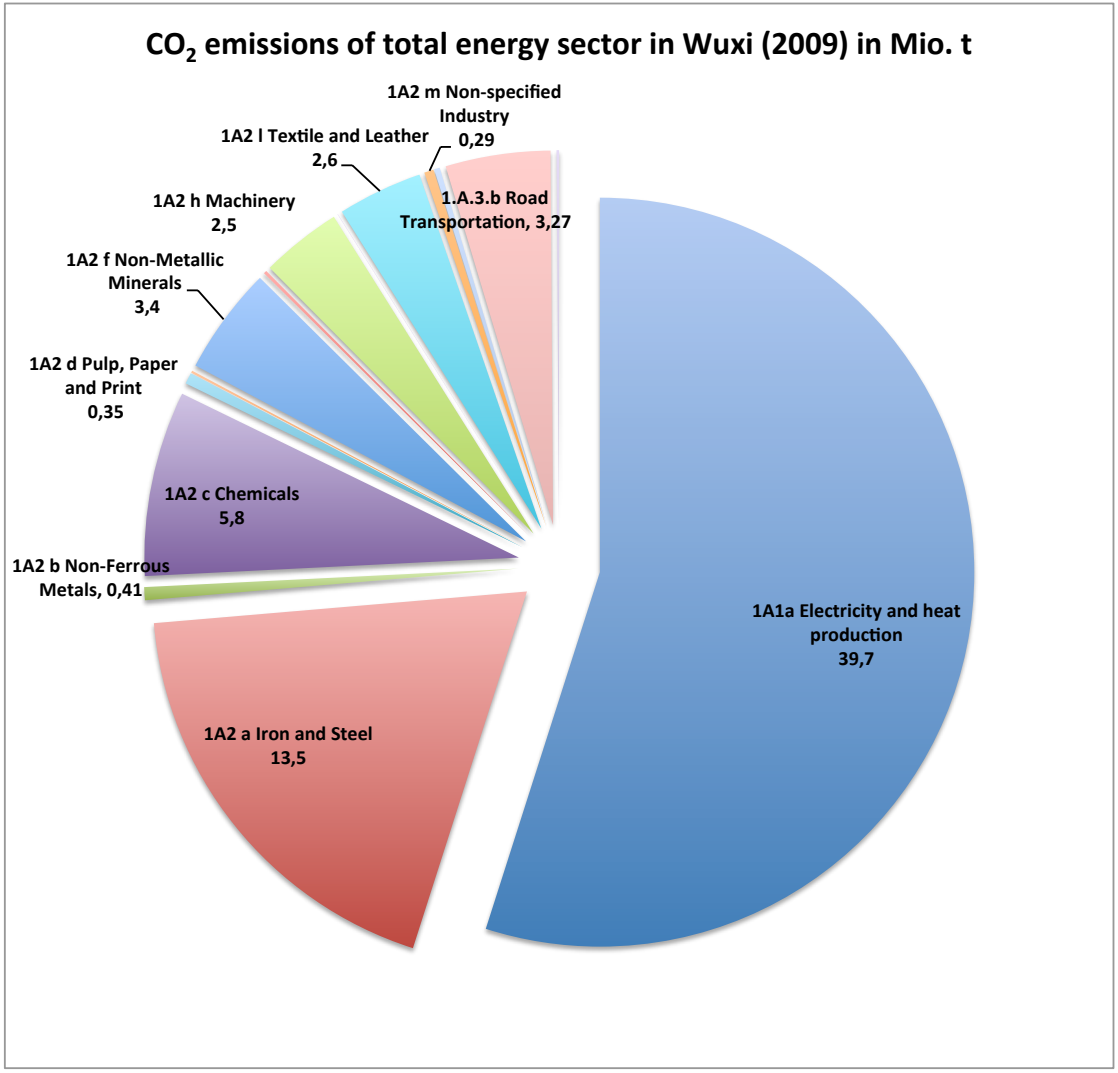
## Future Perspective

- Improvement of data/methods needed (industry; emission factors; transport)
- Future statistics including less data ("above-scale" > CNY 20 million)

→ Vision: Annual inventory of total GHG to monitor future mitigation

# Energy-related $CO_2$ emissions in sub-sectors (in Mio t $CO_2$)

## Total $CO_2$-emissions of Sector 1A, Energy (1A1 to 1A3), divided in sub-sectors (in Mio t $CO_2$)



# Relevant key sectors and emissions

## Data availability, Relevance for Non-$CO_2$

| IPCC No. (IPCC 2006) | Sub-Sector | Emissions in Mio. t $CO_2$ | Relevant non-$CO_2$ | Data Availability | | Key sectors |
|---|---|---|---|---|---|---|
| 1A1 | Energy Industry | 39.7 | | ++ | | ++ *Electricity + heat prod.* |
| 1A2 | Manufacturing Industry | 29.0 | ++ | + | | (++) *Sub-sectors below* |
| 1A2a/2C1 | Iron & Steel Industry | 13.5 | ++ | +/- | | ++ |
| 1A2c/2B | Chemical Ind. | 5.8 | ++ | +/- | | ++ *diverse* |
| 1A2f/2A1 | Non-Metallic Minerals | 3.4 | (+) | +/- | | ++ *Cement* |
| 1A2h | Machinery | 2.5 | | - | | ++ *Electronic industry* |
| 1A2k | Construction | NE/ND | | (+) | | ++ |
| 1A3b | Road transportation | 3.27 | | (+) | | ++ |
| 1A4a/b | Residential& Commercial | IE | - | - | | ++ |
| 3 | AFOLU | | ++ | - | | |
| 4 | Waste | | ++ | -- | | |

++ high; + middle; NE/ND not estimated not available data/factors; IE included elsewhere; Data: -/-- not available, (+) in parts available

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# Changes in climate parameters in Wuxi

## No significant trends in recipitation or water resources 1961-2100*

- Precipitation patterns (daily, average, monthly) did not change significantly in the past 50 years and are not projected to change in future.

- Water levels and discharge of the hydrological stations in Wuxi and its hinterland have not undergone trends since 1950 and are not projected to change in future either.

## Significant trends in temperature 1961-2100*

- Indices for temperature had significant trends, leading to
  - higher average and maximum temperatures in winter and summer
  - higher mean, maximum, and minimum temperatures in each month.

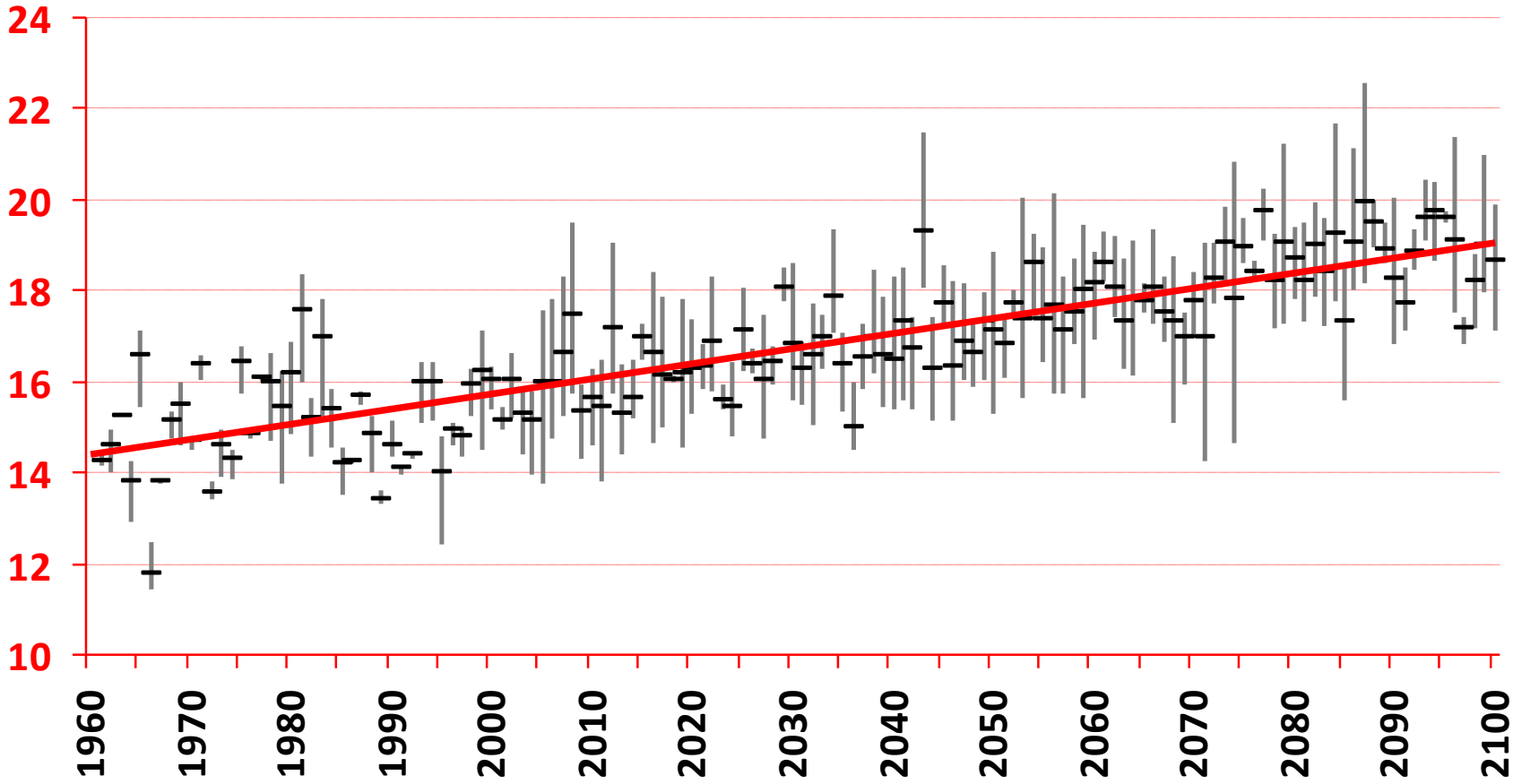
- Cold spells decrease(d) and warm spells increase(d).

- The increase in summer is lower than during winter.

* Observations for 7 stations in Wuxi 1961-2009 and projections from GCMs ECHAM5/MPI-OM, CSIRO-MK3.5, and NCAR CCSM3 (with SRES A2, A1B, B1).

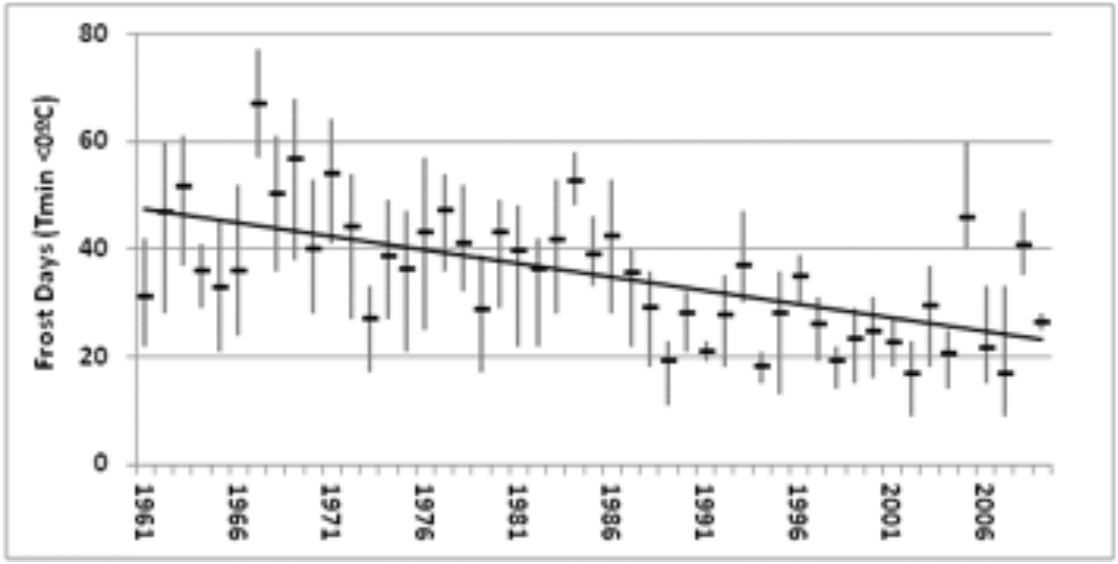
# Changes in climate parameters in Wuxi

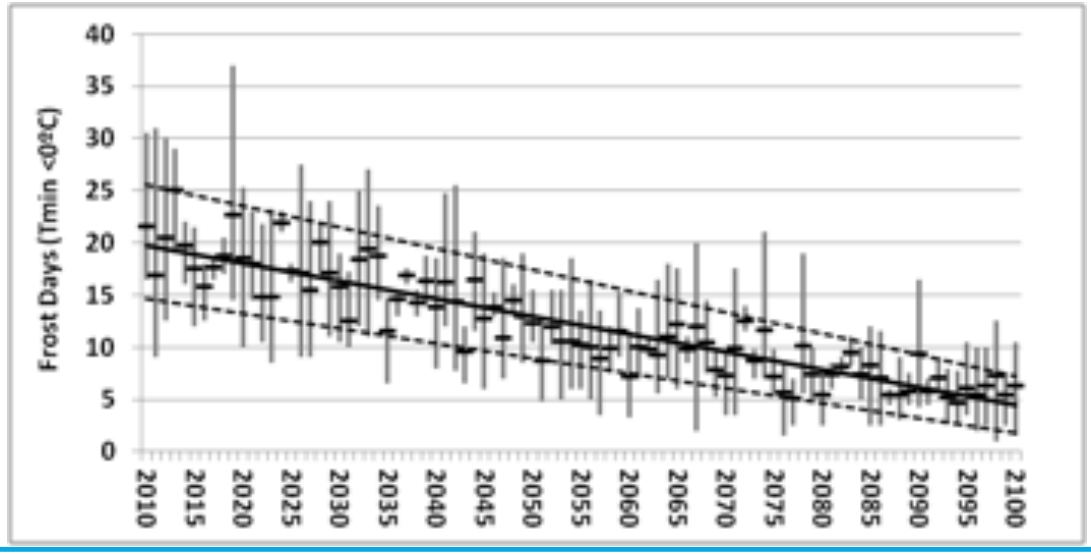
## Annual Mean Surface Temperature in Wuxi (°C) 1960-2099



# Changes in climate parameters in Wuxi

## Frost days 1961 – 2010 and projection 2010 - 2100





Source: (Gemmer, Fischer 2012)

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- **Resource utilization (status quo energy)**
- Current Policy Scenario
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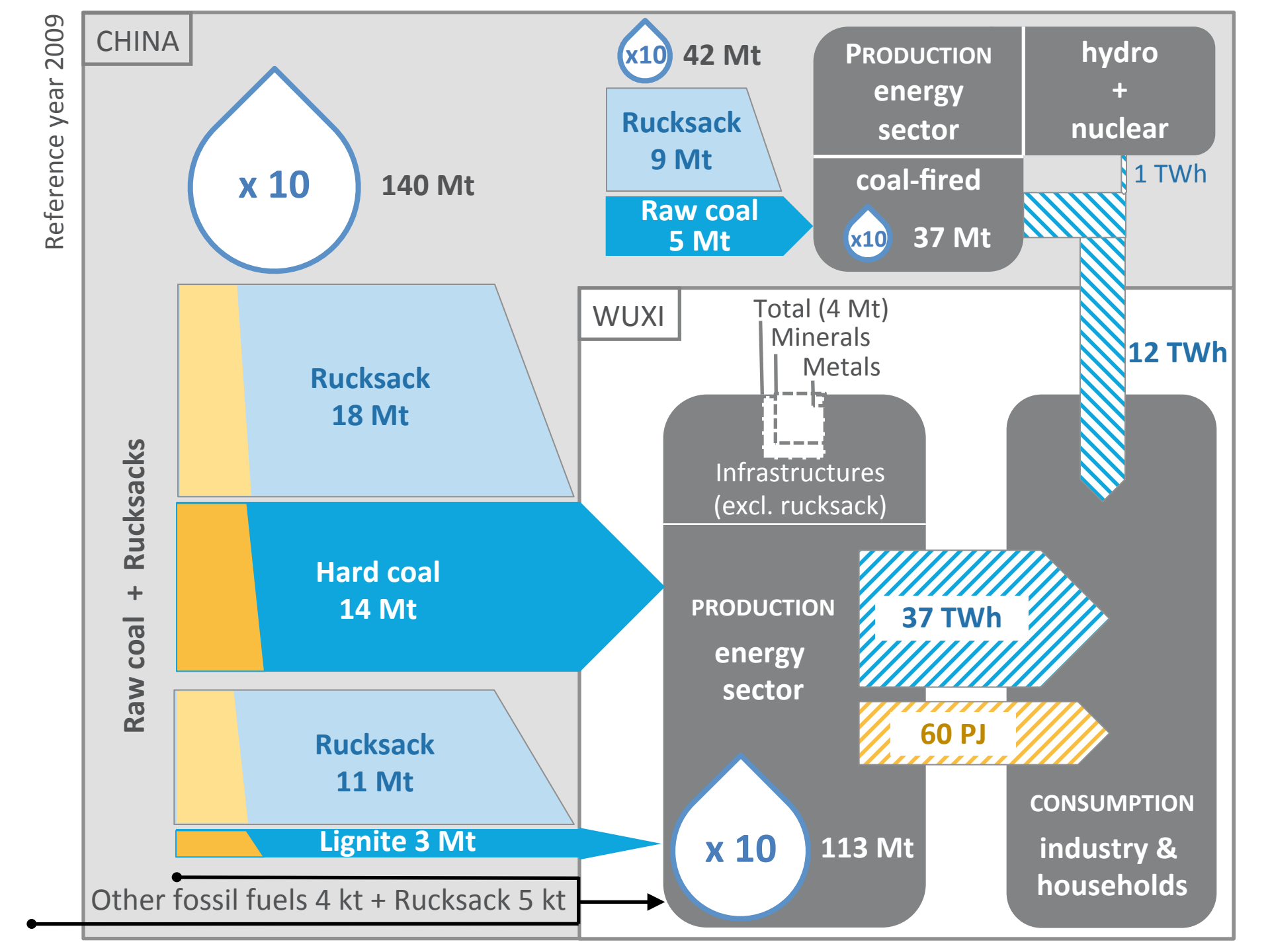
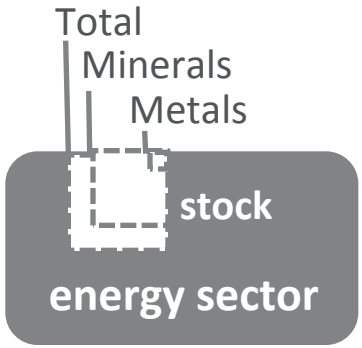

Reference year 2009
CHINA
x 10
140 Mt
x10
42 Mt
Rucksack
9 Mt
Raw coal
5 Mt
PRODUCTION
energy
sector
hydro
+
nuclear
coal-fired
x10
37 Mt
1 TWh
12 TWh
WUXI
Total (4 Mt)
Minerals
Metals
Infrastructures
(excl. rucksack)
Rucksack
18 Mt
Hard coal
14 Mt
Rucksack
11 Mt
Lignite 3 Mt
Raw coal + Rucksacks
PRODUCTION
energy
sector
37 TWh
60 PJ
x 10
113 Mt
CONSUMPTION
industry &
households
Other fossil fuels 4 kt + Rucksack 5 kt

## LEGEND

Energy flow (electricity)

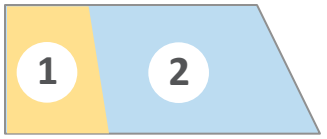
Energy flow (heat)




Material stock in process infrastructure

Process (production or consumption)


Direct material flow (with allocation, see below)




Environmental rucksack (with allocation, see below)

with allocation to generation of
1 heat
2 electricity


Water flow
(to visualize the whole water flow at the same scale as the material flows, imagine 10 drops of that size)

## KEY AGGREGATE INDICATORS: ENERGY SECTOR 2009

| Indicators | Absolute flows | Intensities |
|---|---|---|
| Direct Material Input | 17 million tonnes | 0.3 t / MWh |
| Total Material Requirement | 59 million tonnes | 0.9 t / MWh |
| Total Water Use | 332 million $m^3$ | 5.1 $m^3$ / MWh |

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# Wuxi 2050: The story and basic assumptions

## Wuxi in 2050: some assumptions

- In 2050 Wuxi will still be a prosperous municipality: The economy has been facing demographic problems but productivity has been increased
- Wuxi stays a site for industry with a special role in the Chinese economy
- The economy has been undergoing structural changes in favour of the tertiary sector and non-energy intensive industries.
- The still existing energy intensive industries are not profitable any more as they are not energy efficient.
- Households are equipped according to standards in developed Asian countries
- $CO_2$-intensity has been declining.
- Absolute $CO_2$-emissions have been rising sharply at the beginning of the century and have now been stable for 15 years.

## Socio-economics: population and GDP

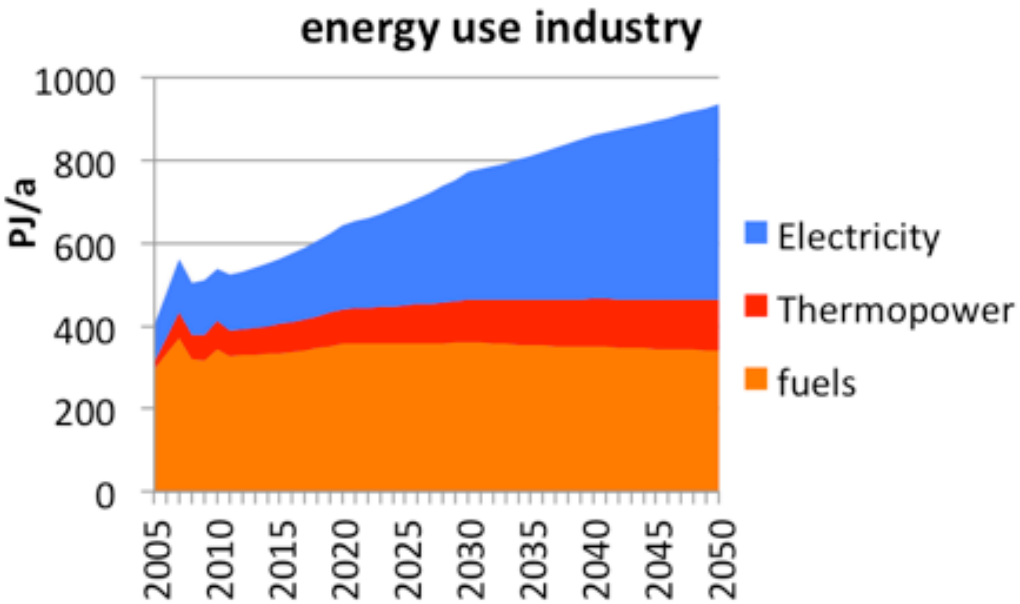
- Increasing urban population due to further immigration to Wuxi
- Since 2020 declining population due to demographic effects
- Even sharper decline in workforce because of aging society
- Productivity increases by factor 14
- Growth of secondary sector, tertiary (service) sector gaining further shares of GDP

# CPS – Wuxi industry

## Projected energy carrier structure

- Electricity and thermopower use is projected to increase while fuel use is declining
- Absolute reduction of direct $CO_2$ emissions but total emissions (including indirect emissions) double
- While industry sector grows by 650% (2010-2050), carbon intensity decreases by 70% (direct and indirect emissions regarded)

Energy carrier structure in Wuxi's industry 2005-2050 in Wuxi Current Policy Scenario




Source: WI

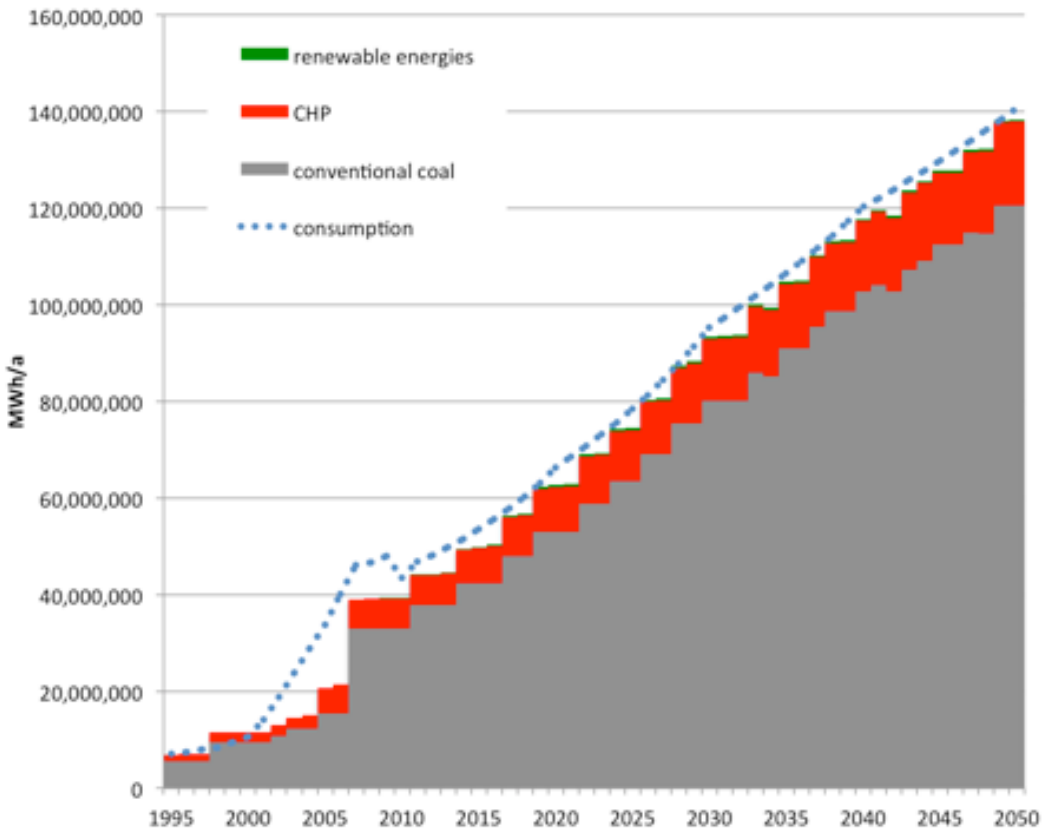
# CPS – Power and Heat

## Local electricity production and electricity demand

- Local installation of capacities is modelled as driven by expectations on future local electricity demand
- CHP installations are driven by thermopower demand of the industry sector (electricity share assumed to be 30% of overall CHP capacities)
- The Power Plants' overall efficiency increases as from 2010 on only ultra supercritical boilers will be installed
- After 2015 CHP electricity production is extended, only little extension of conventional power plants untill 2030
- After 2030 major new installations of new conventional capacities and replacement of old coal power plants

Electricity production and demand in Wuxi (CPS)

Current Policy Scenario




Source: WI

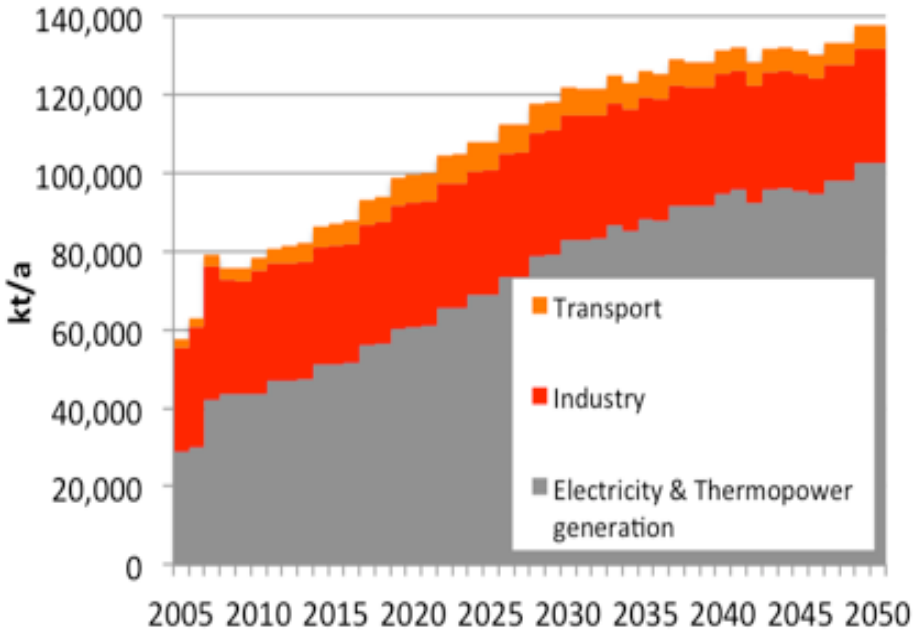
# Total $CO_2$-emissions and implications of the scenario

- The industry‘s amount of annual emission remains stable, but electricity demand is growing rapidly
- The power and the transport sector‘s $CO_2$ emissions continue to grow

## Conclusions

- Electricity saving in all sectors and renewable electricity production will be a crucial point for the forthcoming „Extra Low Carbon Scenario“
- Fuel use in the industry sector is still too high to reach ambitious mitigation targets
- Future fuel use in transport has to be reduced to achieve a carbon neutral transport system

Total $CO_2$ emissions in Wuxi (CPS)
Current Policy Scenario




Source: WI

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# Conclusions

## First findings for Wuxi pilot city within LCFC project

- Wuxi reaches beyond "normal" city industry dimensions and so do the related emissions (1/4 of the corresponding $CO_2$ emissions of German state North Rhine-Westphalia)
- Wuxi's goal to reduce $CO_2$ intensity by 50% until 2020 is a good starting point, but not yet sufficient to ensure that Wuxi will be a city with low emission levels
- $CO_2$ intensity reduction will be overcompensated due to high growth of industrial and service sectors, road transport & increase of domestic electricity production (coal)
- Demand for resources (like coal, construction materials and related water flows) are and will be of high relevance for the sustainability of the global environment and need to be kept in mind, not only GHG mitigation
- Next to emissions and resource uses, also Wuxi's vulnerability (economic losses) towards floods and heavy rainfalls is projected to grow
- Linked to higher future temperatures and higher living standards is an increased need for cooling and heating of residential buildings (→ leading to higher electricity and construction demand)
- Next step:
  - In-depth analysis of identified key sectors (representing 90% of $CO_2$ emissions), propose technological options for GHG mitigation and policy measures.
  - Development of low carbon roadmap

# Thank you!

# 谢谢大家!

## Contact


Stiftung Mercator

Daniel Vallentin
daniel.vallentin@wupperinst.org
Ph.: +49 (0)202 | 24 92 – 309

Urda Eichhorst
urda.eichhorst@wupperinst.org
Ph.: +49 (0)202 | 24 92 - 103

http://lowcarbonfuture.net/

# Projekt consortium
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Stiftung Mercator

Wuppertal Institute
for Climate, Environment
and Energy

- Wuppertal Institute for Climate, Environment and Energy (WI)
- Tsinghua University, Research Centre for International Environmental Policy (RCIEP)
- China Environment Research (CER)
- Chinese Society for Sustainable Development (CSSD), Low Carbon Group
- China Meteorological Administration, National Climate Centre (NCC)
- UNEP Wuppertal Institute Collaborating Centre on Sustainable Consumption and Production (CSCP)
- Wuxi Low Carbon Development Research Centre (WLCDRC)

## Associate partners

- Düsseldorf Environmental Office
- Wuxi Development and Reform Commission