



清华大学能源环境经济研究所
INSTITUTE of ENERGY, ENVIRONMENT and ECONOMY
TSINGHUA UNIVERSITY

The Role of Innovative District Heating Solutions in China's Energy Revolution

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Outlines

- ↳ China's Energy Revolution
- ↳ Current status of DH in China
- ↳ Role of DH in the Energy Revolution
- ↳ Concluding Remarks

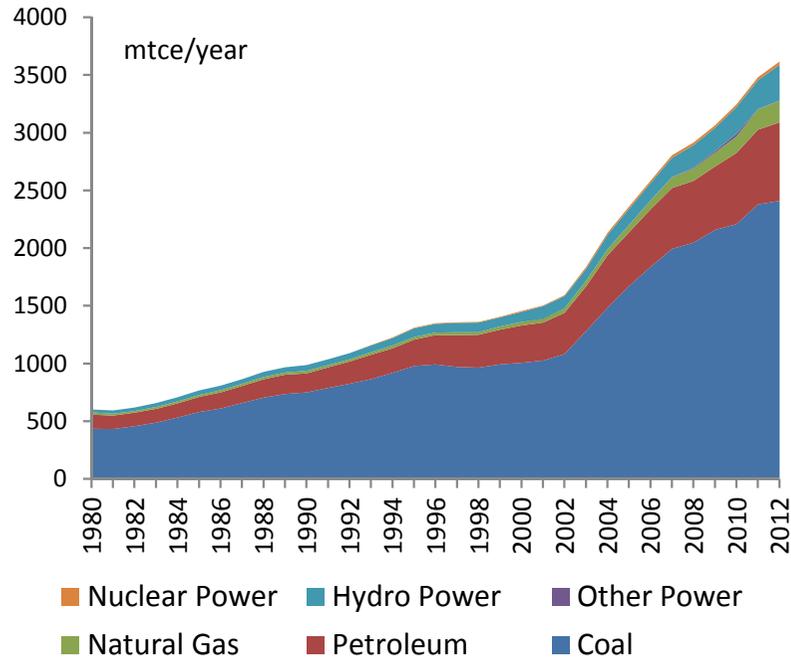


Energy and Environment Challenges in China

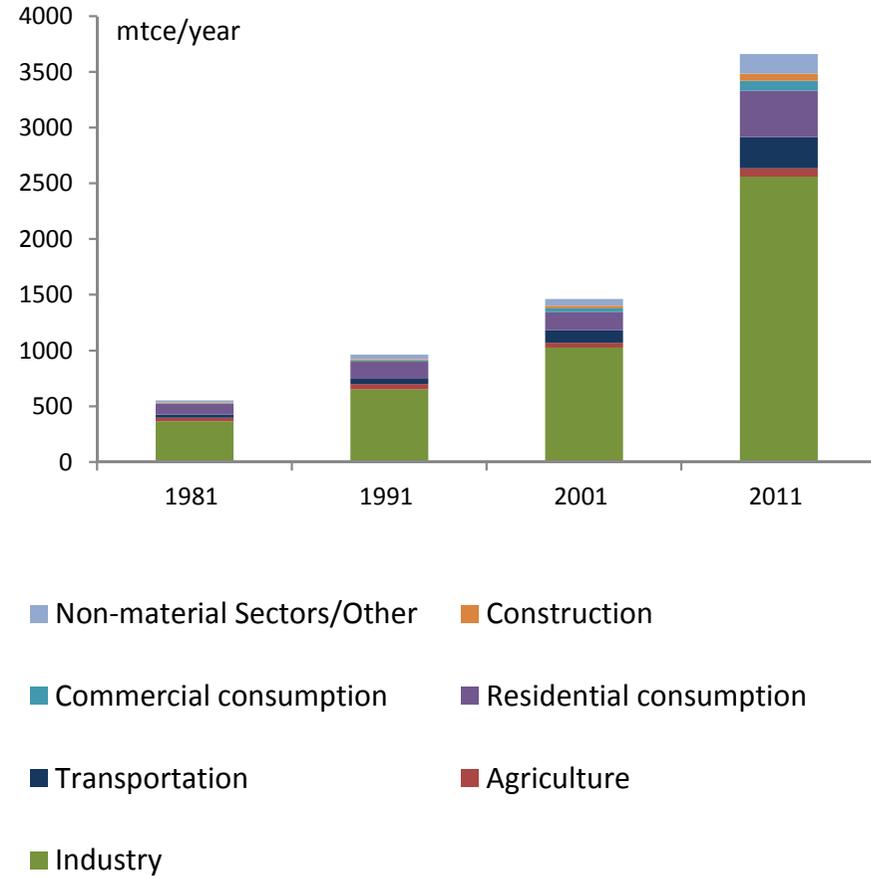
- The largest energy consuming nation in the world
 - Coal (66.1%)
 - Oil (18.5%)
 - Natural gas (5.8%)
 - 3.75 billion tons of standard coal equivalent in 2013
 - Non-fossil fuel (9.8%)
- 58% of China's oil consumption comes from international market;
- The largest CO₂ emitter in the world;
- Energy use is a major contributor to air quality degradation and smog.

China's energy system: A snapshot

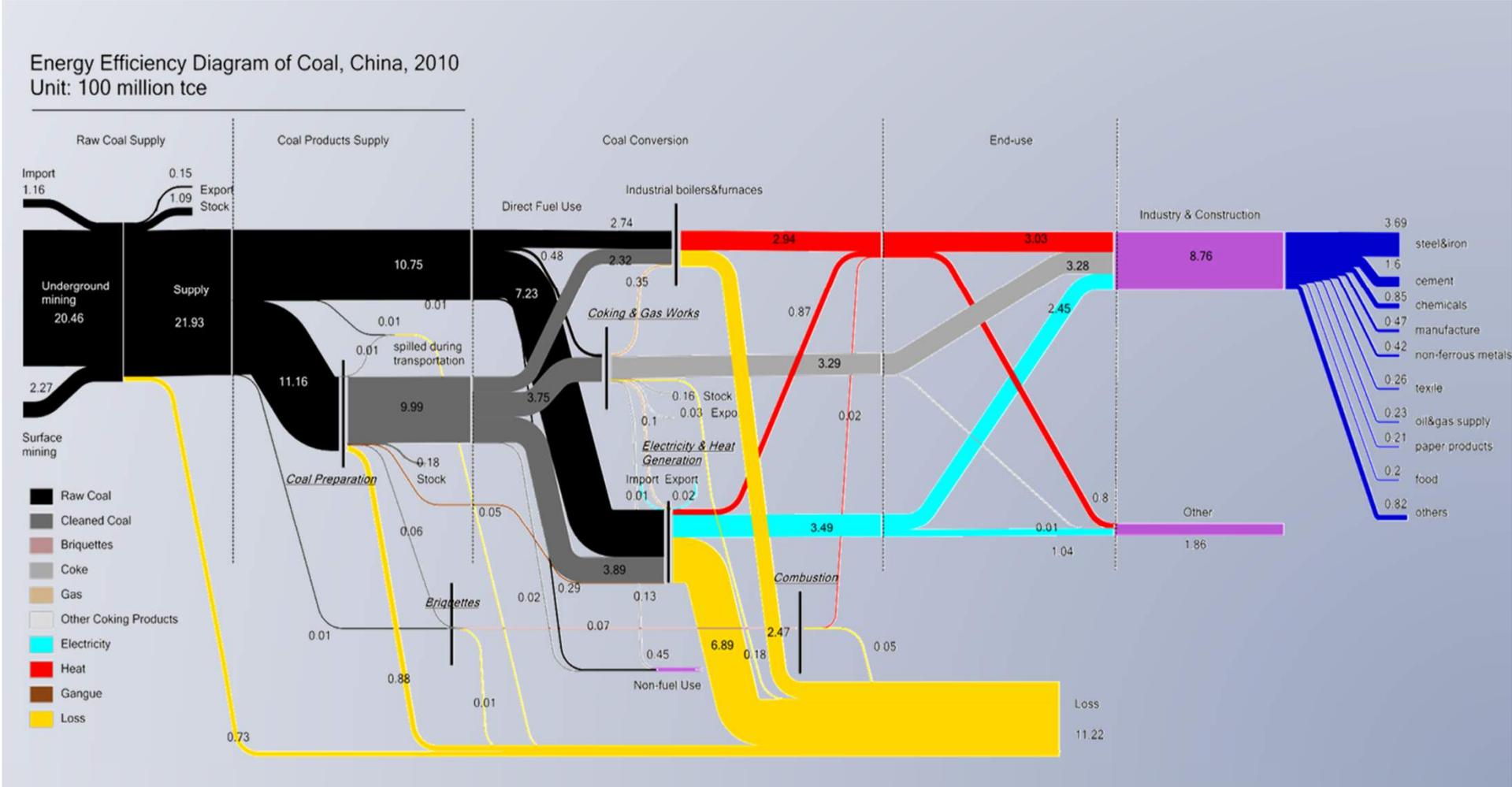
By primary energy type



By end-use sector



Energy Efficiency Diagram of Coal

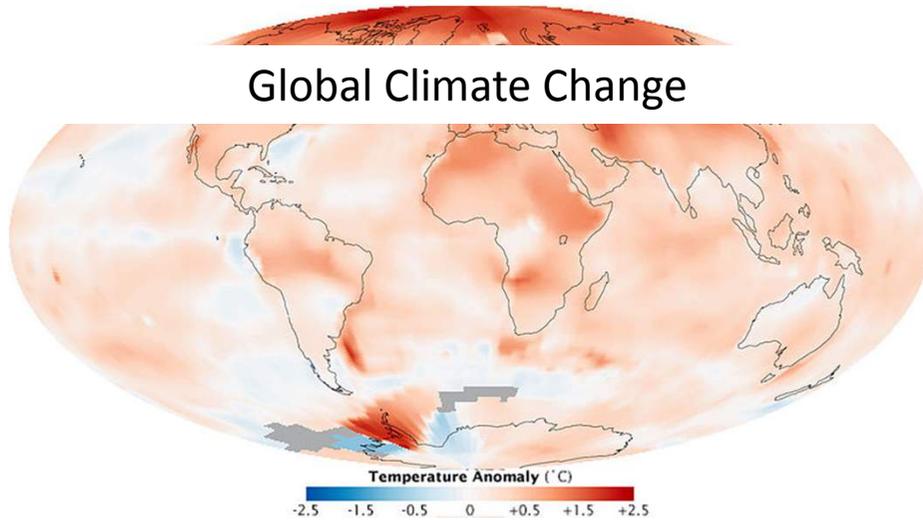


Source: Ma LW, 2013, Tsinghua BP Center



How to balance?

Global Climate Change



www.wikimedia.org

Local Pollution



www.flickr.com



Human Development



globalchange.mit.edu



Industrial Development & Resource Needs



www.china.org.cn

China's Energy Revolution

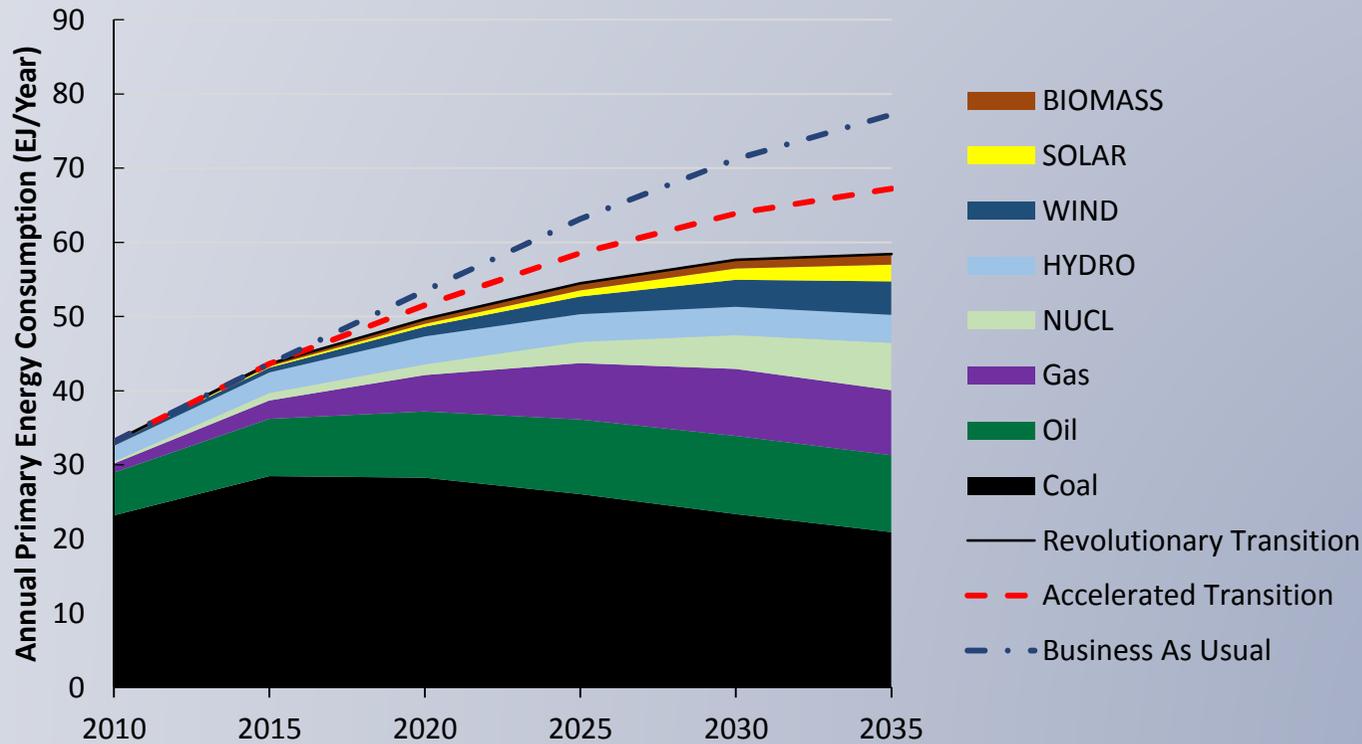
↳ *President Xi's Energy Paradigm*

- Energy consumption revolution
- Energy production revolution
- Energy technology revolution
- Energy institutional revolution
- International cooperation

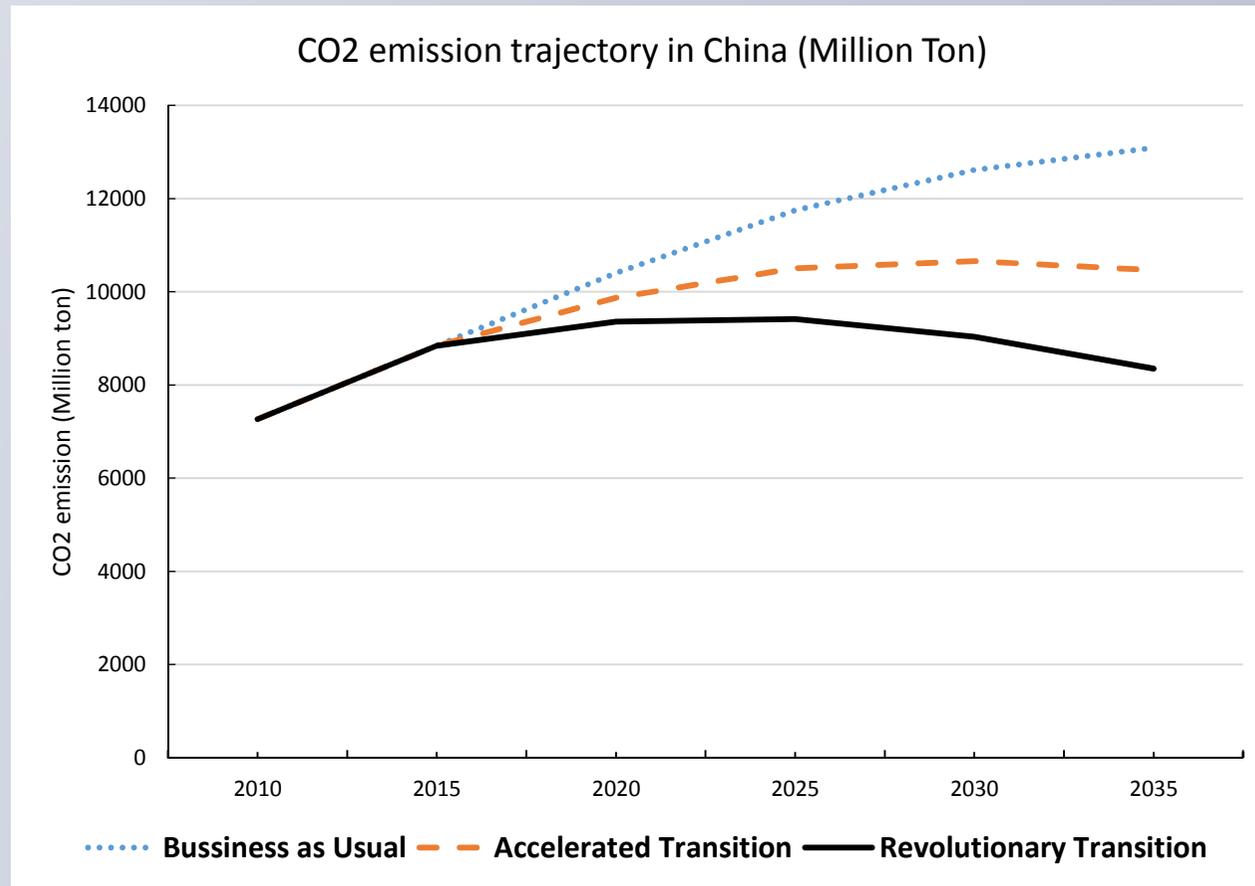


China's Energy System Transformation

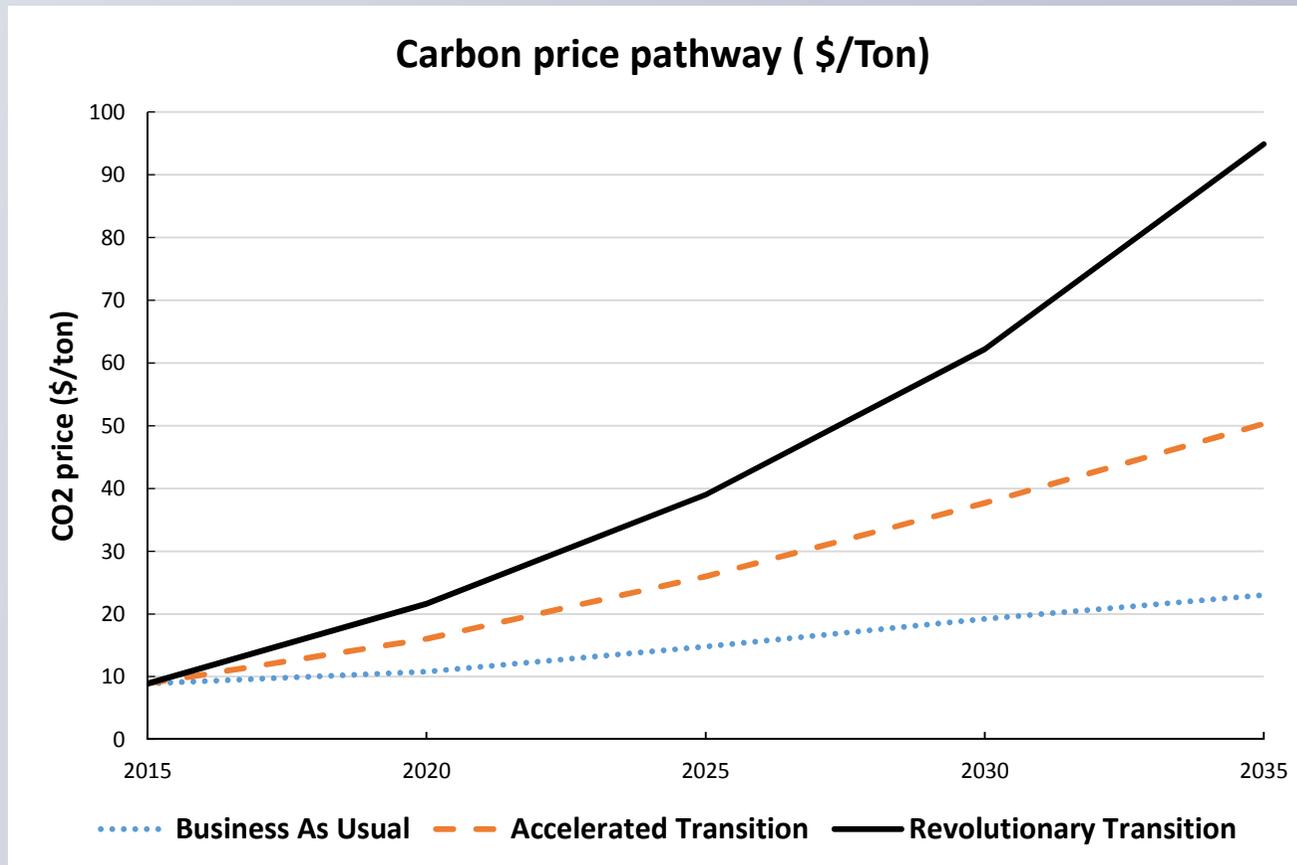
Primary Energy Consumption Mix and Pathways towards 2035



China's carbon emission trajectory



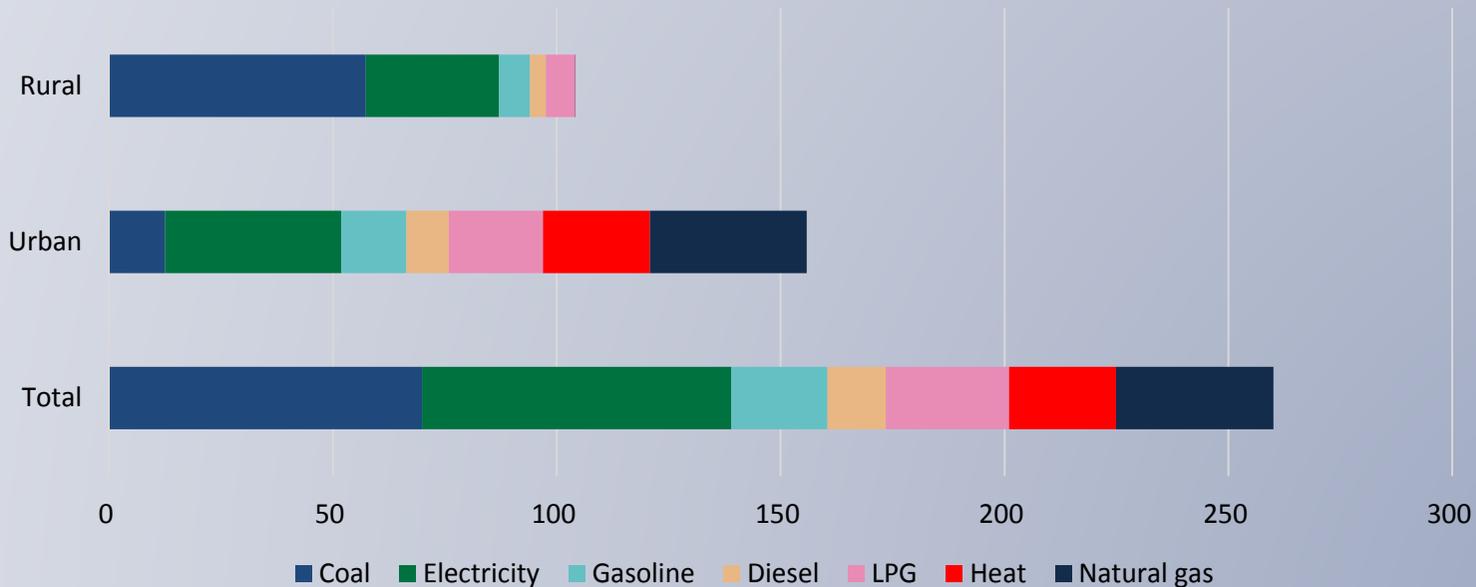
Carbon Price for the Energy System Transformation



Current status of DH in China

↳ District heating in household energy consumption

Household Energy Consumption (Mtce)



Source: China Energy Statistic, 2012



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Current status of DH in China

↳ Most of cities in Northern part of China requires more than 90-day annual heating period



Source: IEA, 2007 , Tsinghua, 2014



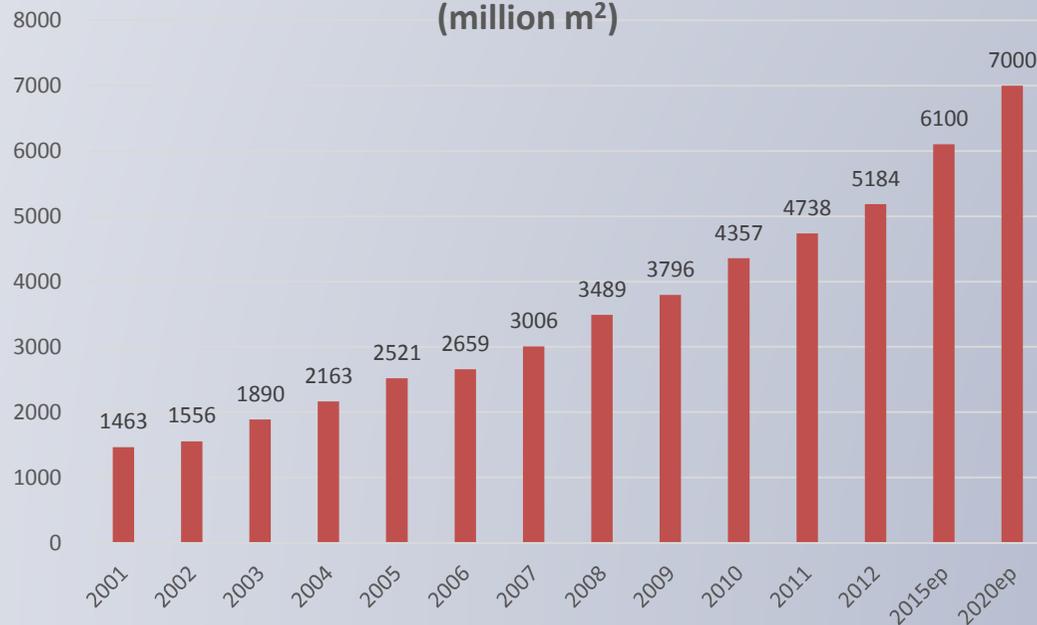
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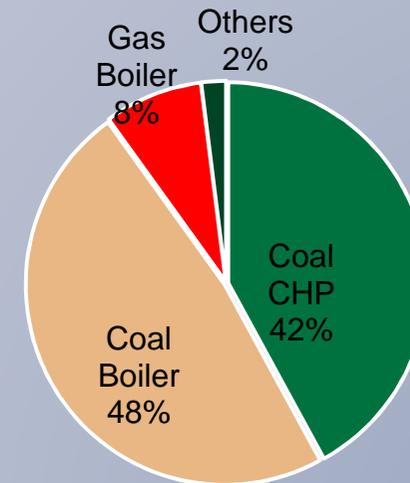
Current status of DH in China

↳ Growing demand and coal reliance in district heating

Building area served by district heating in China
(million m²)



Share of heat production for different technologies in District heating in 2013

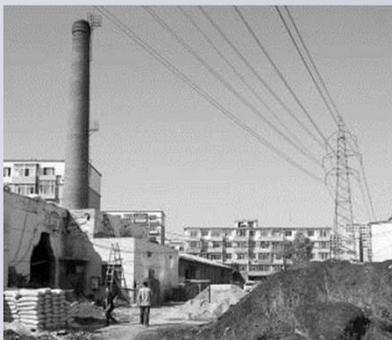


Current status of DH in China

↳ Energy waste in supply, transmission and consumption

Supply

Low efficiency of coal boiler(60%)
Air pollution resource



Transmission

Grid loss (15%~30%)



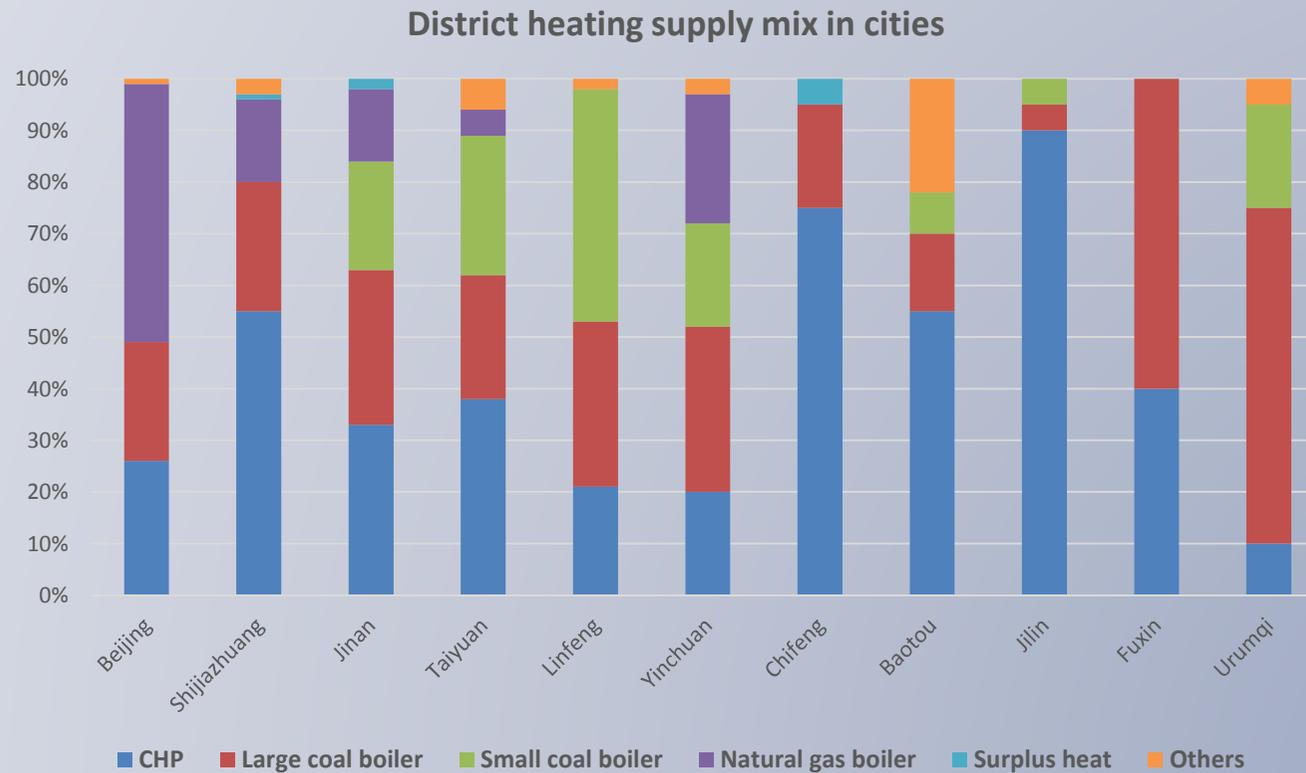
Consumption

Uncontrollable temperature



Current status of DH in China

↳ Diversity in district heating supply among cities



Source: Tsinghua University, 2015



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Innovative district heating solutions

↳ Technology Solutions

- ↳ Expansion of CHP reconstruction in condensing power plants
- ↳ Low-grade heat resource utilization by heat pumps
- ↳ Low temperature transmission grid

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↳ Policy solutions

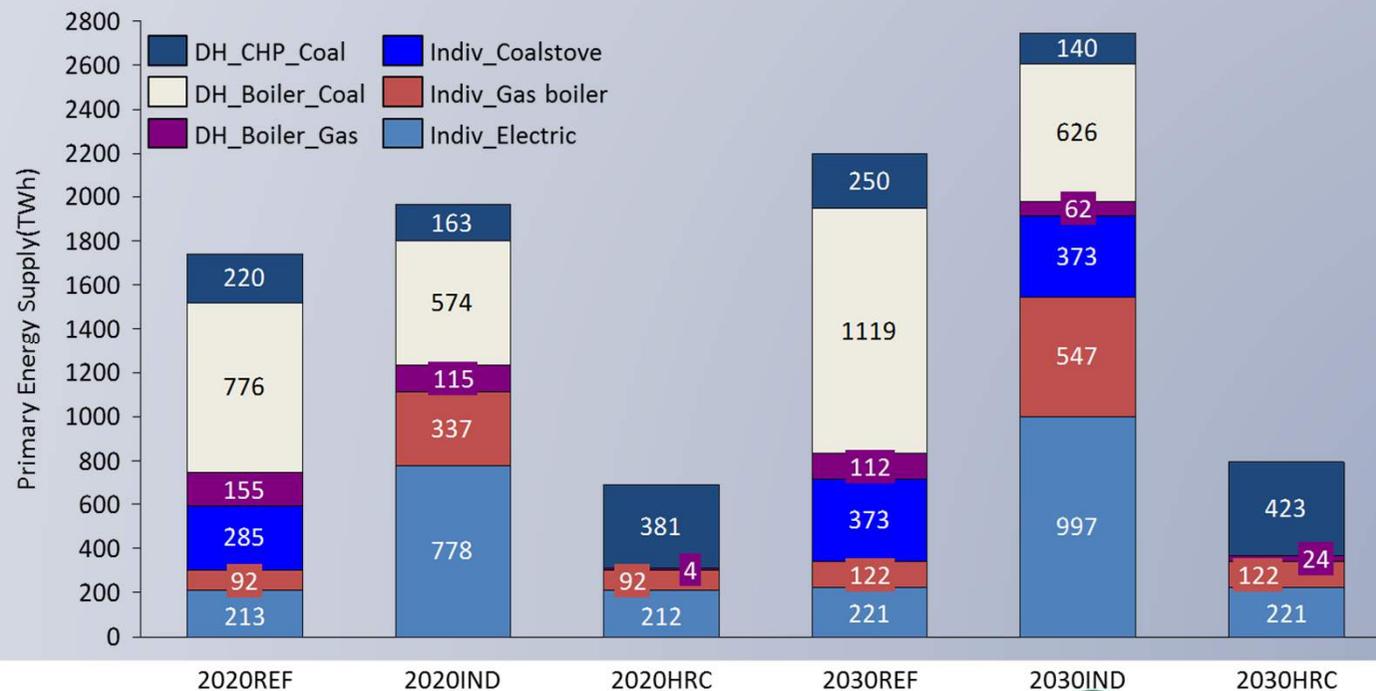
- ↳ Heat pricing system reform
- ↳ Heating grid infrastructure ownership reform
- ↳ Integration with energy system

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Role of DH in the Energy Revolution

- By EnergyPlan Modelling, our study indicates the potential to reduce energy consumption in DH by CHP expansion, surplus heat recovery and heat pricing reform (~60% for building heating sector compared with reference scenario, and individual heating scenario)



Role of DH in the Energy Revolution

- ↳ **Great potential in district heating sector**
 - ↳ Reduce the primary energy supply (~60% for building heating sector and ~3% for entire energy system)
 - ↳ Reduce the 3%~ total CO2 emissions
 - ↳ Reduce the costs of the energy system (~15% for building heating sector)



Role of DH in the Energy Revolution

- ↳ **Broaden sources of “heat income”**
 - ↳ Waste heat for heat pump in power plants, industry and sewage water...
 - ↳ Huge fleet of coal-fired condensing plants could be changed to CHP
 - ↳ Multi-heat source could provide flexibility to heating grid...



Role of DH in the Energy Revolution

↳ Reduce “heat expenditure”

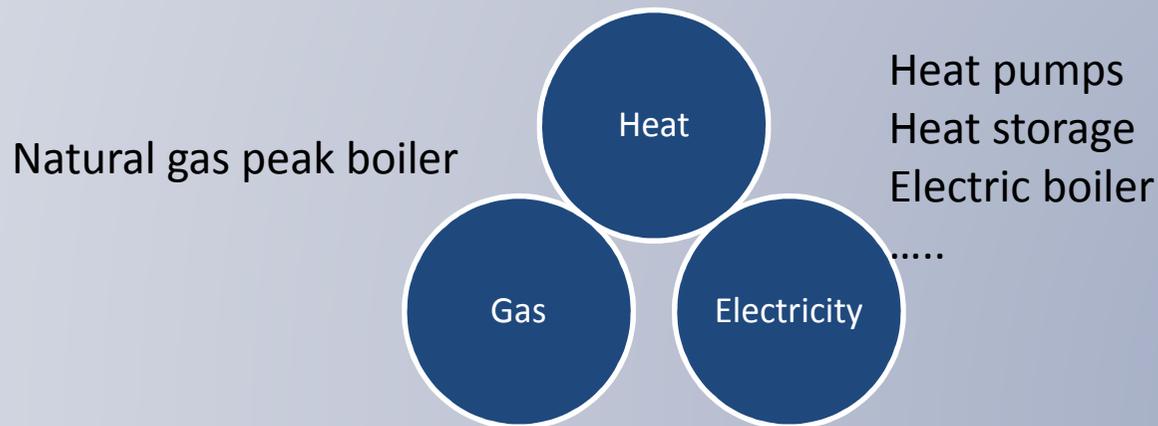
- ↳ Heat billing reform: from area-calculated to energy-calculated
- ↳ Grid efficiency: from high temperature to low temperature
- ↳ Smart control devices and high heat preservation standards for building



Role of DH in the Energy Revolution

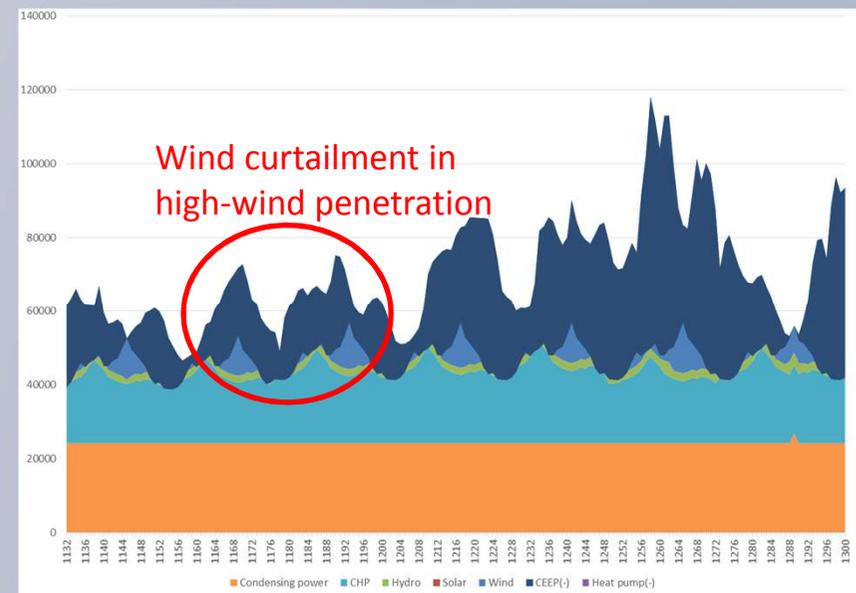
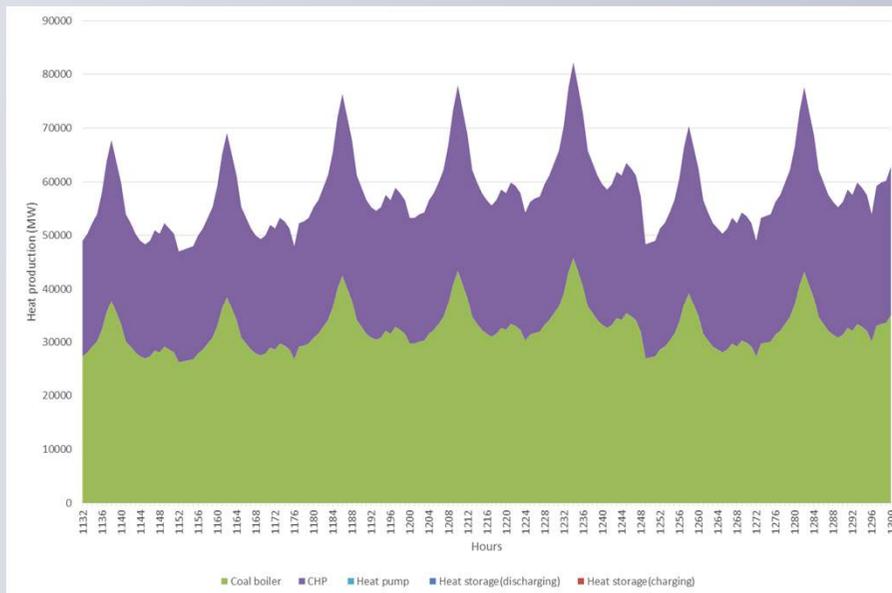
↳ Integration with energy system

- ↳ With electricity sector: surplus electricity to heat, flexible heat output from CHP
- ↳ With gas sector: peak gas boiler...



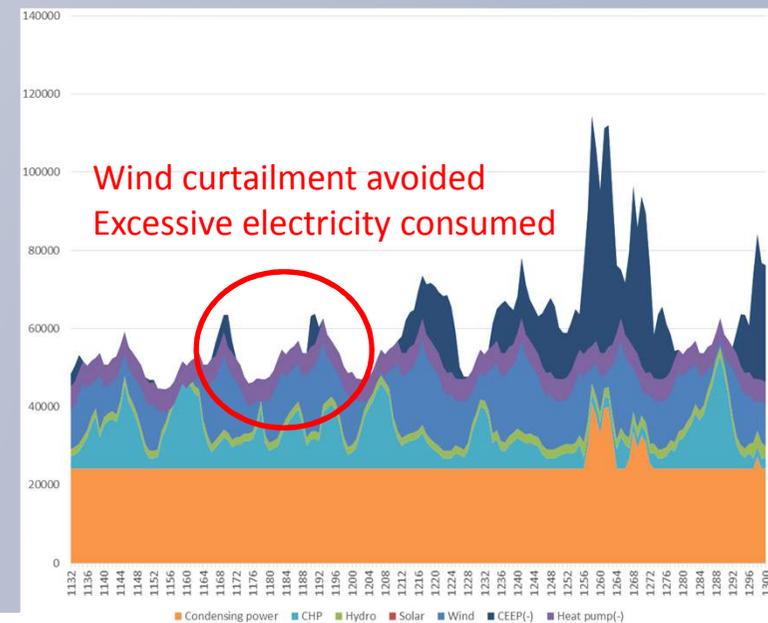
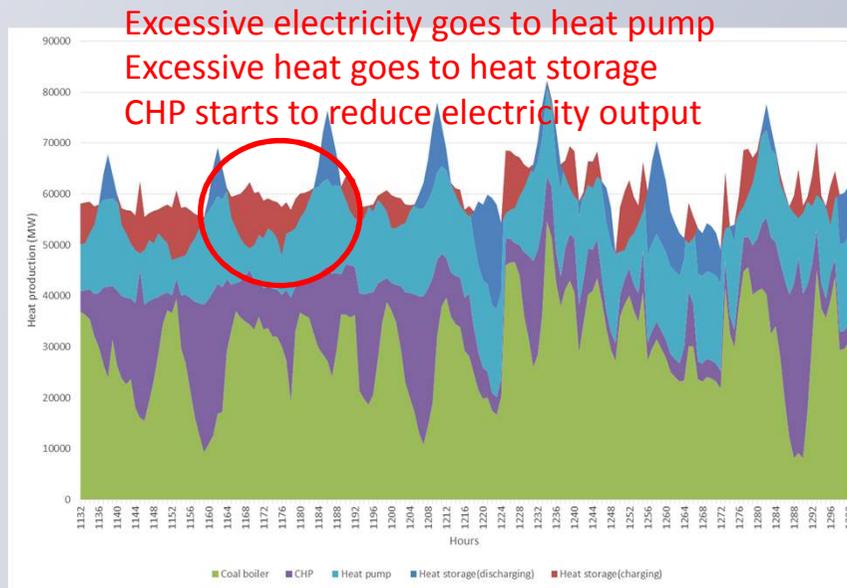
Related applications

- ↳ Wind curtailment and heat in Northeast
 - ↳ Suffering the inefficient integration of wind energy (Wind curtailment rate~25%)
 - ↳ Heat storage and flexible CHP dispatch could avoid wind curtailment in our simulation



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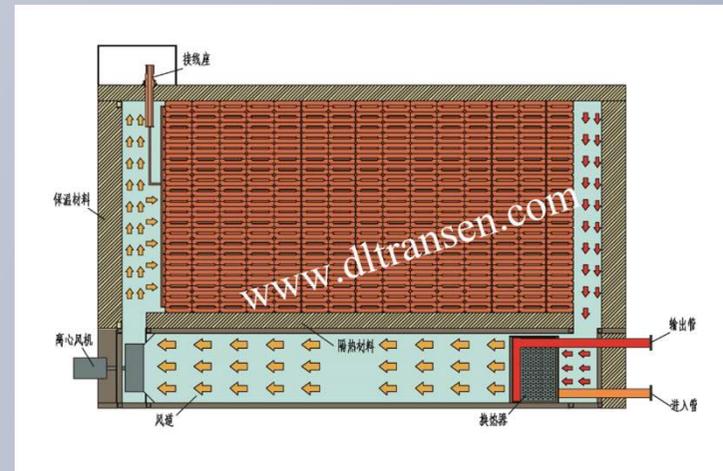
↳ Model simulation findings:

- ↳ Flexible operation of coal-fired power could help to increase wind penetration. And it is technically realistic in hourly simulation
- ↳ Implementation of heat pump and heat storage could help CHP to build connection between heat and electricity sector. The expansion of total system brings additional flexibility
- ↳ Current wind curtailment has something to do more with institutional or operational barriers than with technical issues



Demonstrations from the 4DH Project

- ↳ Demonstration projects in Northeast (Siziwangqi city)
 - ↳ Wind curtailment power to heat storage metal alloy at night, heat storage metal alloy to heat water for district heating at daytime
 - ↳ Cover 0.5 Million m², peak-valley electricity price needed



Demonstrations from the 4DH Project

- ↳ Demonstration projects in Northeast (Chifeng city)
 - ↳ Industrial waste heat recovery project from Chifeng Iron factory
 - ↳ Cover 1 million m², advanced heat pump and heat grid, 2 years to payback investment



Concluding remarks

- ↳ Heat supply and use will be a focus of China's energy revolution;
- ↳ Innovation district heating solutions can not only increase energy system efficiency but also avoid wind curtailment to a large extent in northern China;
- ↳ Institutional reform and innovative incentive schemes need to be in place to enable the wide spread adoption of the innovative DH solutions



Thank you