China Europe Water Platform (CEWP)

6th High-Level Dialogue

November 7-8, 2018, Beijing, China

Flexibility in Clean Energy System Transition and the Role of Hydropower

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Seminar on Water and Energy Technology Innovation in the process of urbanization

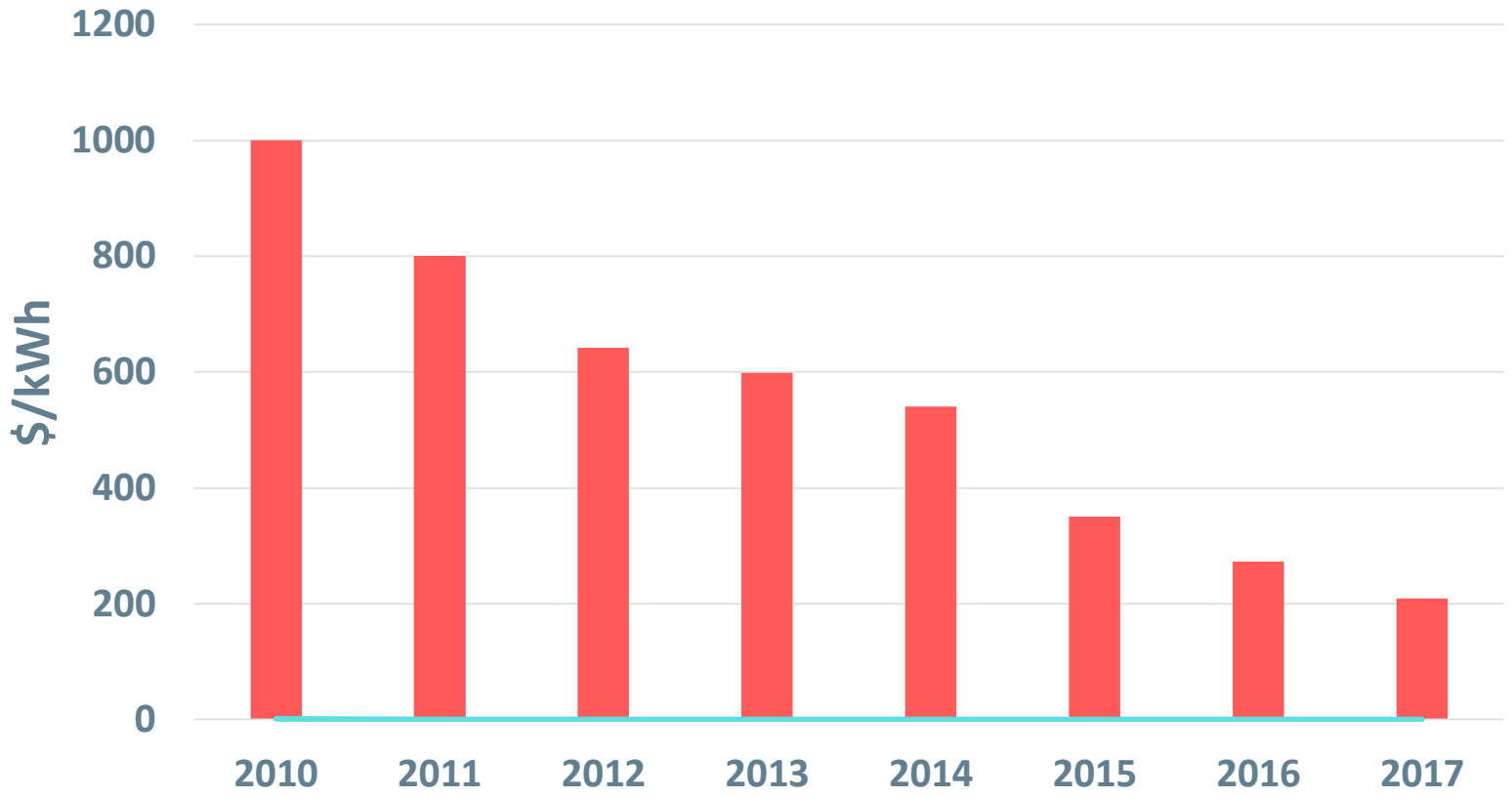
9:00-12:00, 8 November, 2018, Beijing, China

Shifting global narrative on clean energy transition and needs for acceleration

- The clean energy transition is faster than anticipated
- It is largely no long about the cost, but a conducive and functional power system/market in which flexibility is essential – power sources, transmission network, as well as demand side management
- Reaching the global climate target requires acceleration of the clean energy transition

Electric Viechel

Lithium-ion battery prices (battery pack price, $/kWh)



Data source: Bloomberg New Energy Finance

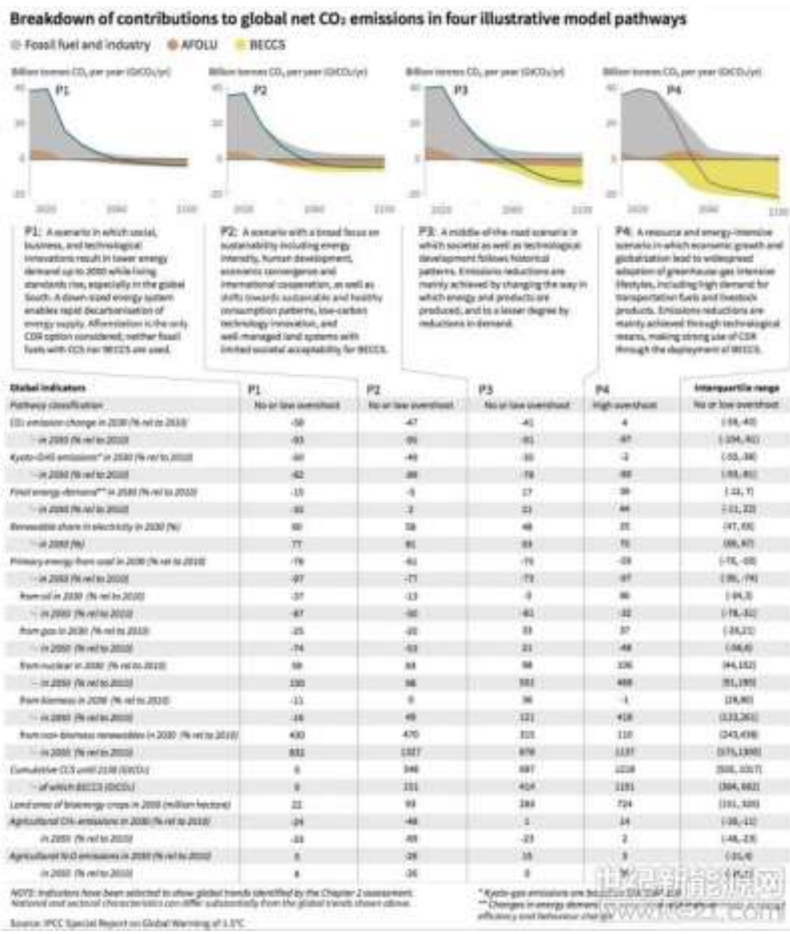
Renewable energy (exclude large hydro) share of power generation : EU

In the past decade, the EU has moved significantly on increasing the penetration of renewable energy power generation

Countries	2007	2017
UK	1%	28%
Denmark	24%	69%
Spain	13%	29%
Italy	10%	32%
Germany	11%	37%
CHINA		**7.84%**

Data Source: BNEF 2018; NEC, China

To still have the possibility of reaching the 1.5 ^{0}C target, the share of renewable electricity need to be 70% to 85% by 2050



IPPC Special Report

This requires power market transformation and investment…

- According to IEA data, 2015, the share of renewable energy in the electricity generation was only 23%.
- Electric power system will need significant capacity for large scale energy storage capacity that combines pumped storage hydro, battery, gas, hydrogen, etc.
- And to increase the renewable penetration to the expected level by the IPCC 1.5 report, the world would need to eliminate coal power and invest $2.4 trillion a year in green energy technologies. According to Bloomberg New Energy Finance, global investment in renewable energy is only $138.2 billion USD during the first half of 2018

“ Power market transformation is a race for flexibility”

Future Energy Summit, New York, April 2018

What are required to enhance the flexibility?

Integration

一体化

What are required to enhance the flexibility?

Energy storage capacity
儲能

What are required to enhance the flexibility?

Smart Grid
智能化

What are required to enhance the flexibility?

Aggregation

集成

What are required to enhance the flexibility?

Decentralized/Distributed

多元化

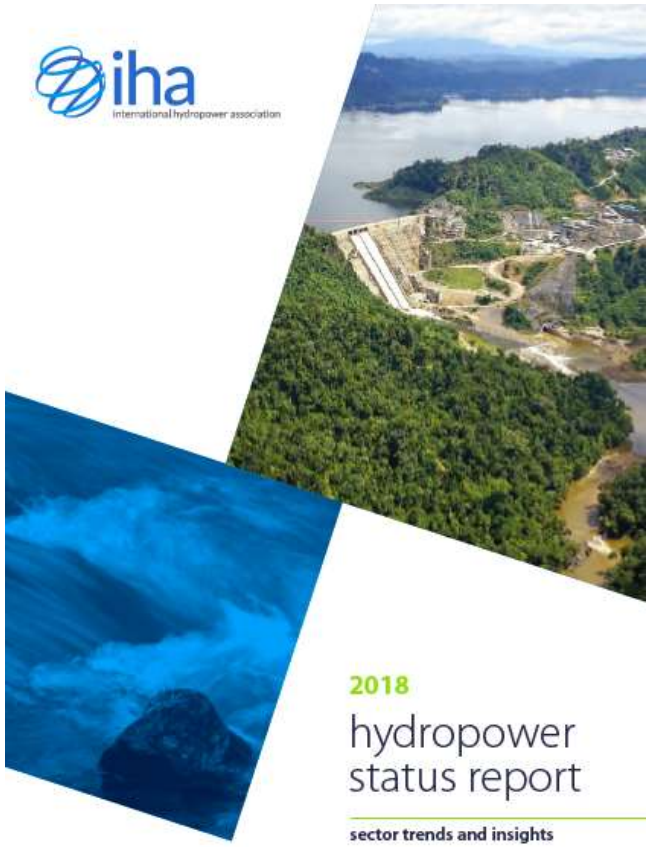
What are required to enhance the flexibility?

Market Design
市场设计

The role of hydropower –
a new dimension in sustainable hydropower use and integration

Global status of hydropower

- Globally, installed hydropower capacity reached 1,267 GW in 2017, 4,185 terawatt hours (TWh) in electricity was generated.
- Newly added capacity in 2017 was 21.9 GW, including 3.2 GW of pumped storage, bringing global pumped storage capacity to 153 GW.
- It has significand benefits for reducing carbon emission, as well as other coal related air pollutants.

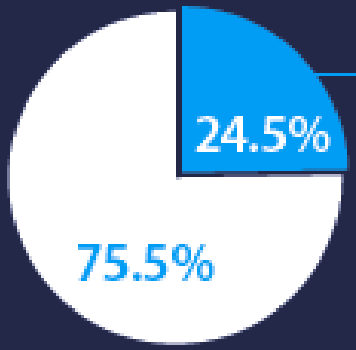


Source: International Hydropower Association (IHA), 2018 Hydropower Status Report

SHARE OF GLOBAL ELECTRICITY GENERATION

Source: REN21 2017

Hydropower is the world's largest source of renewable electricity generation.



16.6% of electricity was produced by hydropower

- 4.0% WIND POWER
- 2.0% BIOPOWER
- 1.5% SOLAR PV
- 0.4% OCEAN, CSP AND GEOTHERMAL POWER

THAT'S MORE THAN DOUBLE ALL OTHER RENEWABLES COMBINED.

Role of hydro: Range of issues

Technical:

- System design
- Scheduling and optimization
- Forecasting and uncertainty

Planning and operation

- Operational planning – multiple actors. Stakeholder planning
- Operation schemes
- Flexibility and optimization

Role of hydro: Range of issues

Risk, ecological and other impacts

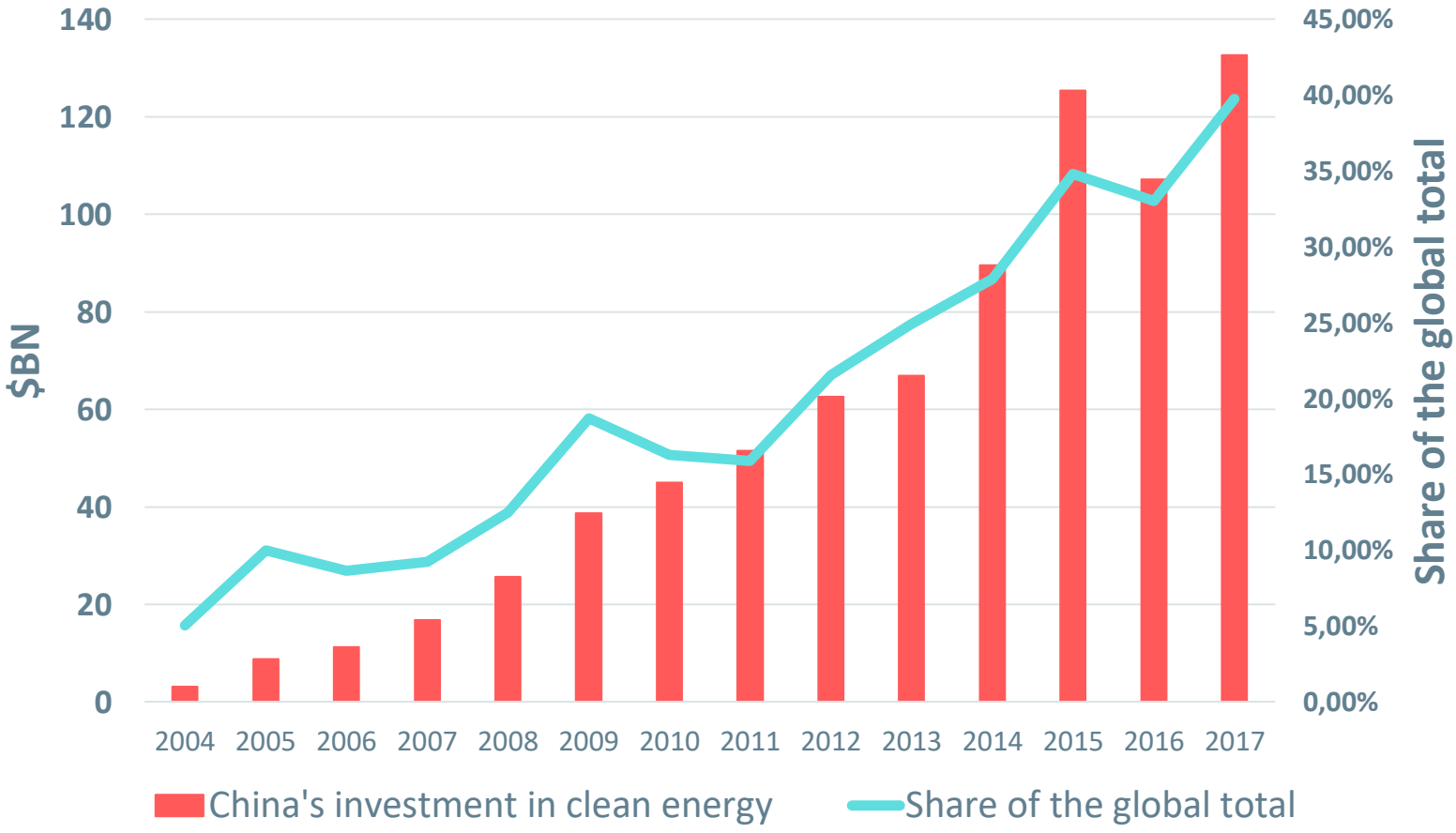
- System risks due to variable power generations
- Ecological impacts of large-scale wind/solar power integration with hydropower
- Other impacts on the integration of hydro, wind and solar power

Regulatory frameworks – power market design and reform:

- Enabling market conditions – price mechanism
- Ancillary service
- Market integration

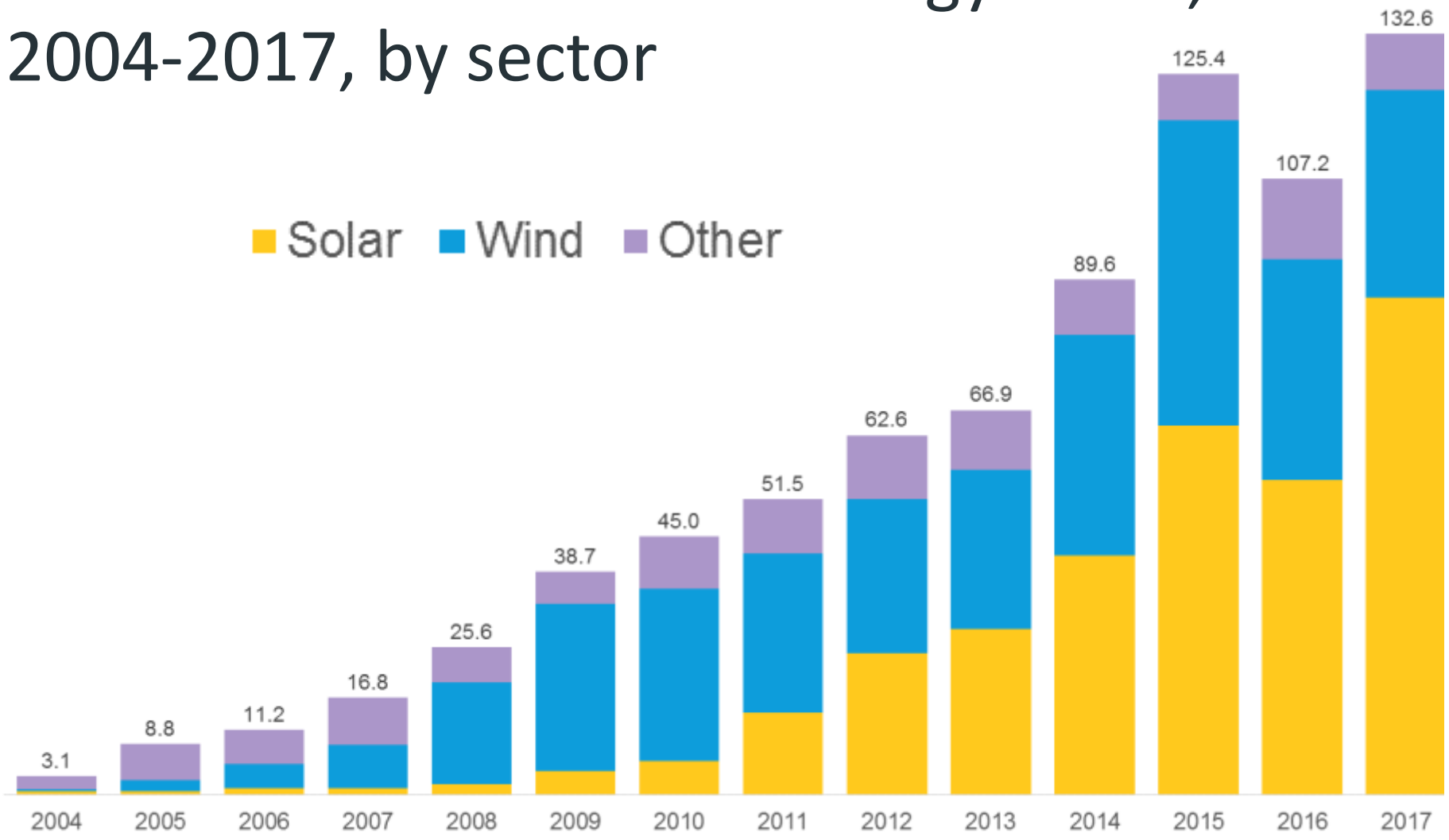
Key Challenges – Renewable curtailment in China

Investment in clean energy: China



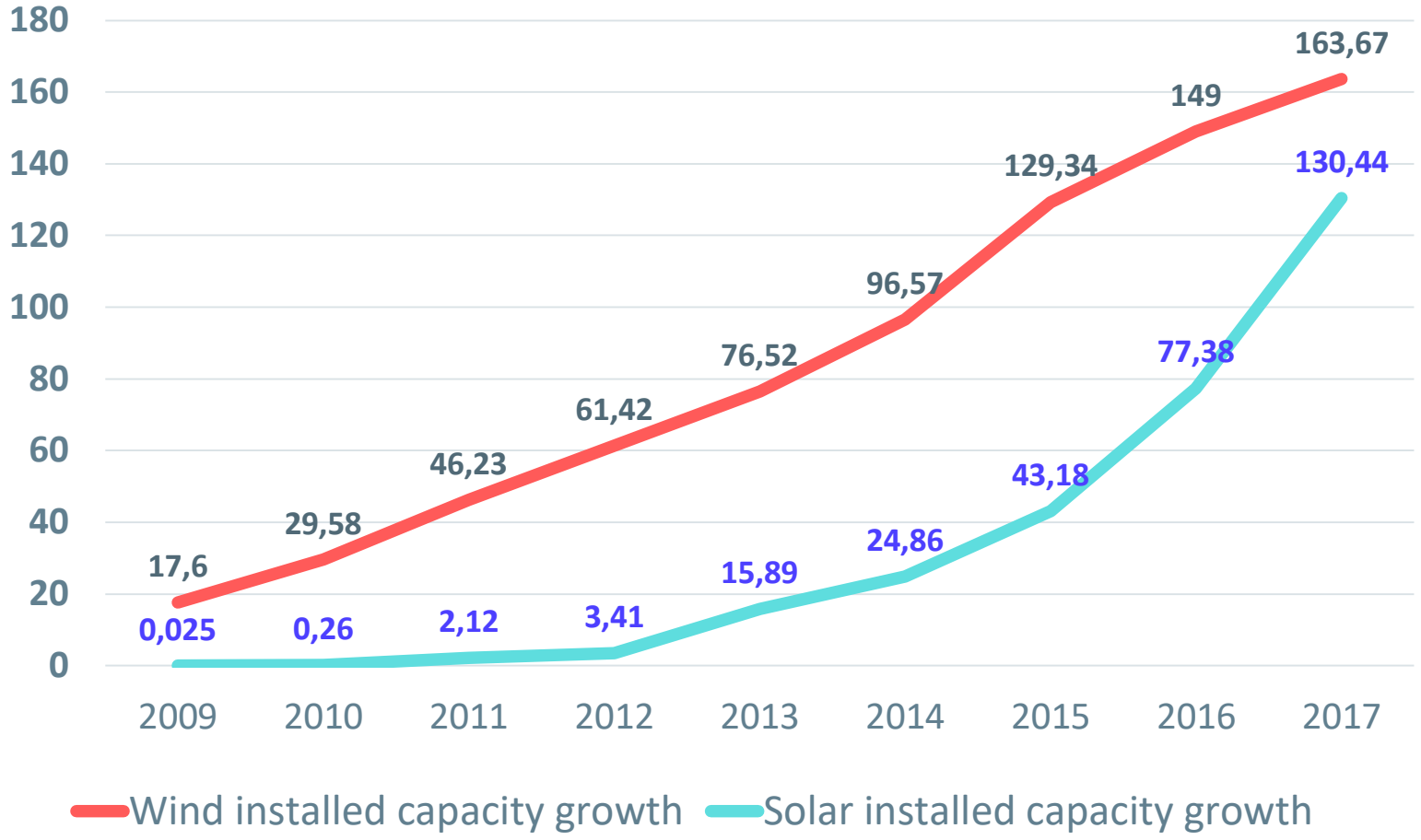
Source: Bloomberg New Energy Finance

New investment in clean energy China, 2004-2017, by sector

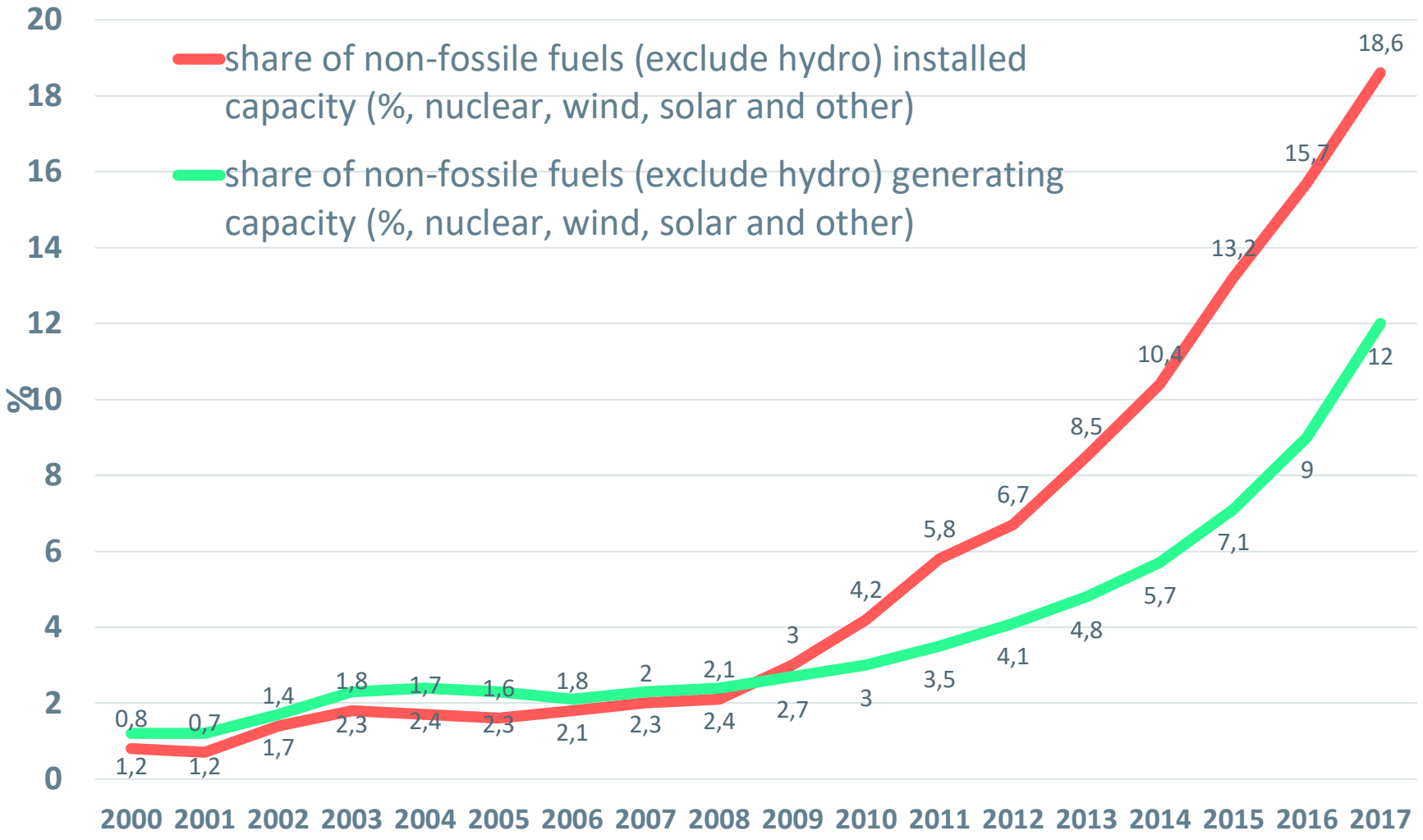


Source: BNEF, 2018

Wind and solar installed capacity (GW) in China: 2009-2017

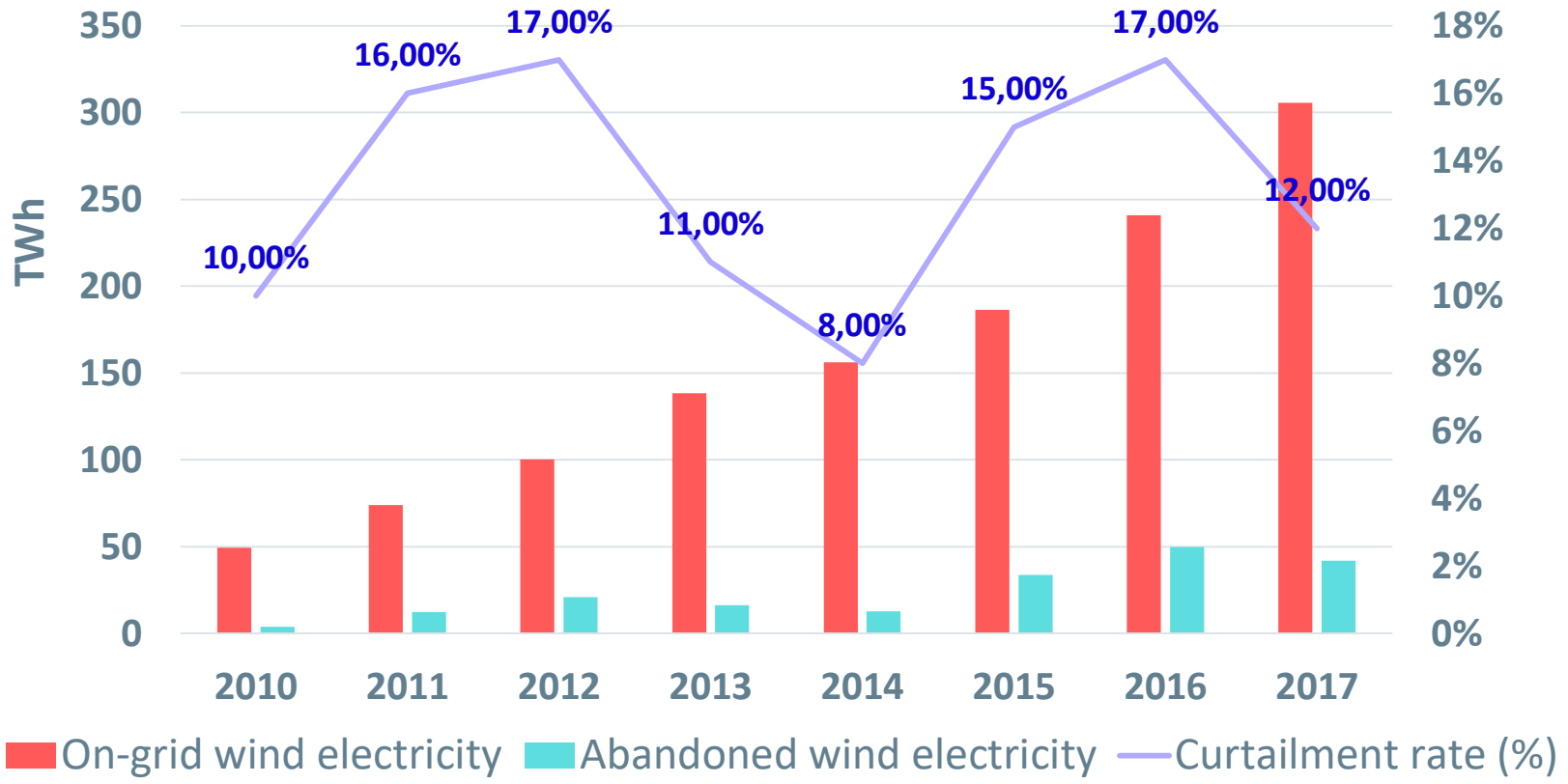


Source: National Bureau of Statistics of China, China Electricity Council. Global Wind Energy Council, China Photovoltaic Industry Alliance



Compiled from NEA, CEC data

Wind power and curtailment in China: 2010-2017



Original data sources: Wang 2014; NEA 2014; 2015;2016; 2017; 2018; recompiled from Qi et al. 2018

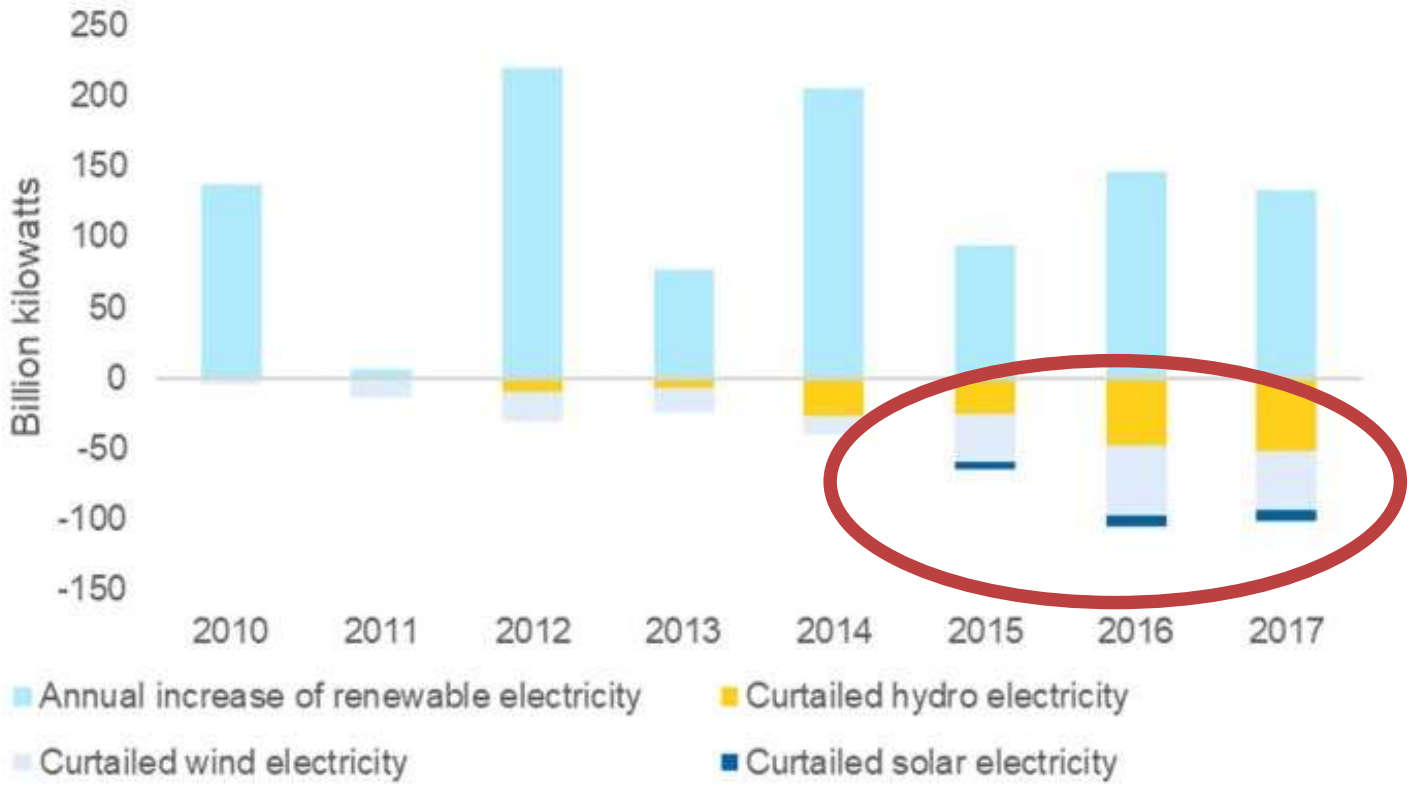
Wind curtailment in the Three North Provinces in China, 2016

Provinces	Abandoned wind generation (TWh)	Curtailment rate (%)	Proportion of wind power capacity (%)	Penetration rate (%)
Hebei	2.2	**9%**	18.8%	8.8%
Shanxi	1.4	**9%**	10.1%	5.4%
Inner Mongolia	12.4	**21%**	23.2%	11.7%
Liaoning	1.9	**13%**	15.1%	7.4%
Jilin	2.9	**30%**	18.6%	9.0%
Heilongjiang	2	**19%**	20.2%	9.6%
Shaanxi	0.2	**7%**	6.4%	1.9%
Gansu	10.4	**43%**	26.5%	11.2%
Ningxia	1.9	**13%**	25.6%	10.9%
Xinjiang	13.7	**38%**	22.9%	9.7%
SUM/AVG	**49.00**	**20%**	**19%**	**9%**

Close to 99% of the abandoned wind electricity are from the Three Norths

Compiled based Qi et al 2018

Curtailed hydro, solar, and wind electricity & annual increase in renewable electricity (2010-2017)



Wenjuan Dong and Ye Qi (Friday, May 18, 2018): Utility of renewable energy in China's low-carbon transition, https://www.brookings.edu/2018/05/18/utility-of-renewable-energy-in-chinas-low-carbon-transition/

Wind power curtailment by province by the end of Q1 2018

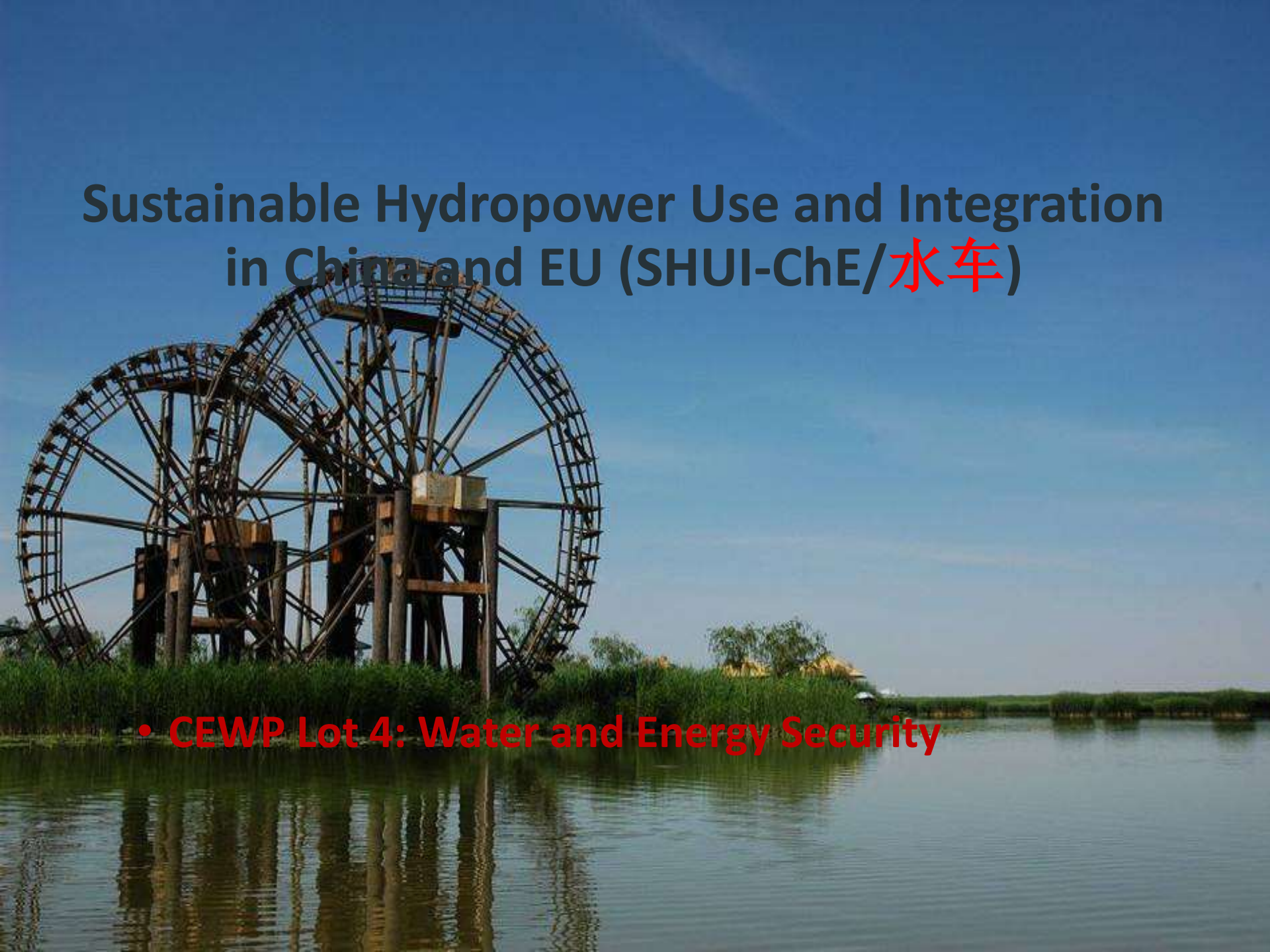
Province (autonomous region, municipality)	Cumulative grid-connected generation capacity (MW)	Electricity production (GWh)	Curtailment (GWh)	Curtailment (%)
Xinjiang	18,060	7,610	2,100	21.60%
Inner Mongolia	26,810	16,000	4,480	21.30%
Gansu	12,820	5,820	1,410	19.50%
Heilongjiang	5,700	3,390	320	8.50%
Jilin	5,050	2,510	220	8.10%
Shaanxi	3,640	2,220	60	2.80%
Hebei	12,080	8,980	240	2.60%
Ningxia	9,760	4,810	120	2.50%
Liaoning	7,190	4,260	100	2.40%
Shanxi	8,910	6,540	50	0.70%

Dada source: NEA/NDRC, April 2018

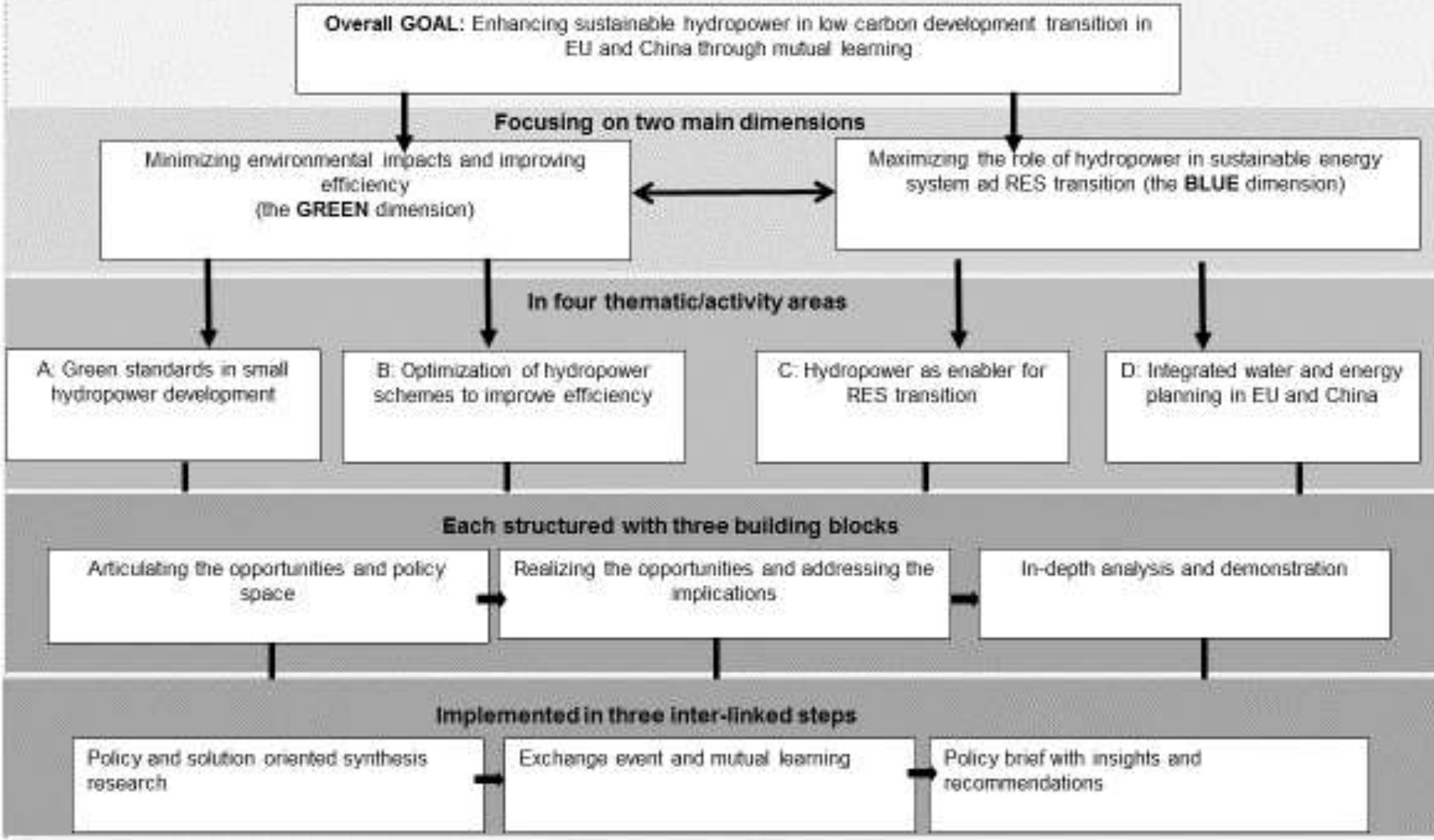
Power market reform and opportunities for cooperation

- On sources: China will continue to build renewable and clean, especially distributed solar and possibly off-shore wind
- On the power network: connection and integration to add the needed flexibility is extremely urgent
- Storage – batteries and PSH
- Demand side – electrify and “flexify” – e.g., EV, and innovation on the heating system
- Power market design and institutional framework

Sustainable Hydropower Use and Integration in China and EU (SHUI-ChE/水车)



- **CEWP Lot 4: Water and Energy Security**


Overall GOAL: Enhancing sustainable hydropower in low carbon development transition in EU and China through mutual learning
Focusing on two main dimensions
Minimizing environmental impacts and improving efficiency (the GREEN dimension)
Maximizing the role of hydropower in sustainable energy system ad RES transition (the BLUE dimension)
In four thematic/activity areas
A: Green standards in small hydropower development
B: Optimization of hydropower schemes to improve efficiency
C: Hydropower as enabler for RES transition
D: Integrated water and energy planning in EU and China
Each structured with three building blocks
Articulating the opportunities and policy space
Realizing the opportunities and addressing the implications
In-depth analysis and demonstration
Implemented in three inter-linked steps
Policy and solution oriented synthesis research
Exchange event and mutual learning
Policy brief with insights and recommendations

Thank you

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