Oil and Gas in Energy Transition

- a perspective from China

Dr. Xavier Chen
President, Beijing Energy Club

Stavanger, 28 October 2021

Energy Transition Challenged by Energy Security

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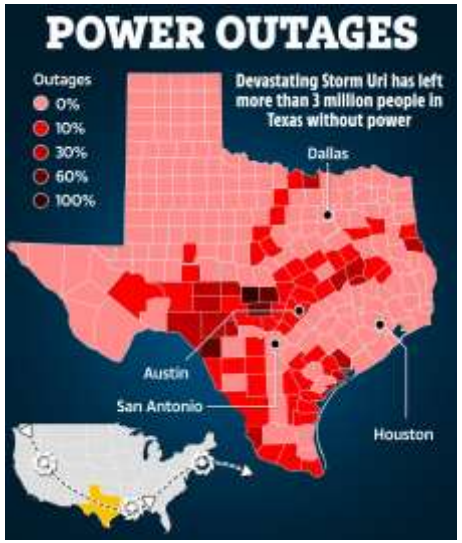

Tackling climate problem in a constrained world…

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Kaya Equation:

$$CO_2\ Emissions = \underbrace{Population}_{\text{a:}} \times \underbrace{\frac{GDP}{Population}}_{\text{b: Consumption or production}} \times \underbrace{\frac{Primary\ Energy}{GDP}}_{\text{c: Energy efficiency (intensity)}} \times \underbrace{\frac{CO_2\ Emissions}{Primary\ Energy}}_{\text{d: Emissions intensity}}$$

Climate challenge: **Min f (CO_2 Emissions) = a x b x c x d**

Subject to:

- Energy security: keeping homes warm, lights on, people and goods moving;
- Food security;
- Supply chain security;
- Growth and employment;
- Social cohesion;
- Individual freedom;
- …

In mathematics, a constraint is a condition of an optimization problem that the solution must satisfy.

… a carbon-built world, which can never be “carbon free”

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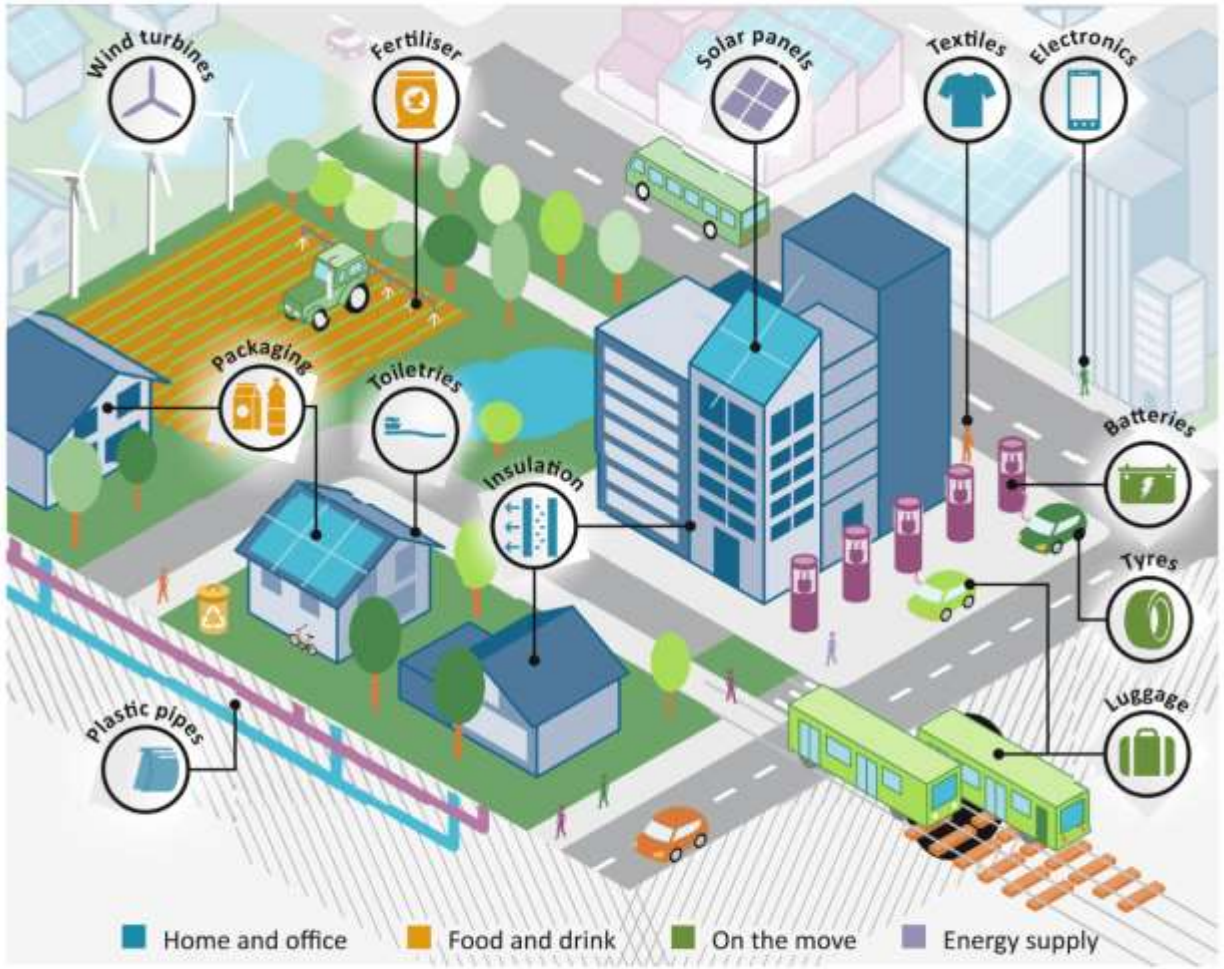
Figure 1.1 • The various roles of chemical products in modern society



Key message • Chemical products underpin many aspects of our everyday lives. We live in a world dependent on chemicals.

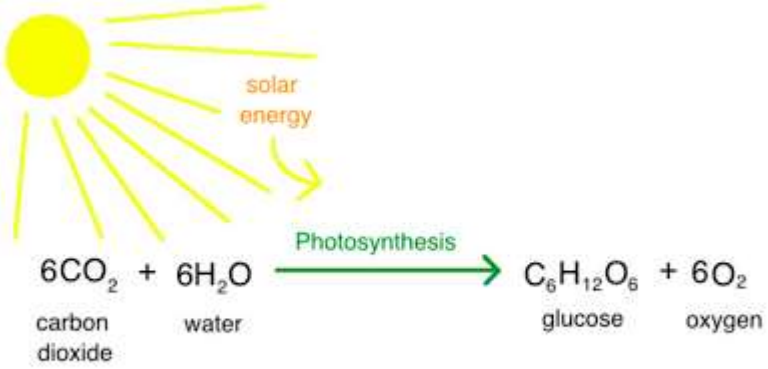
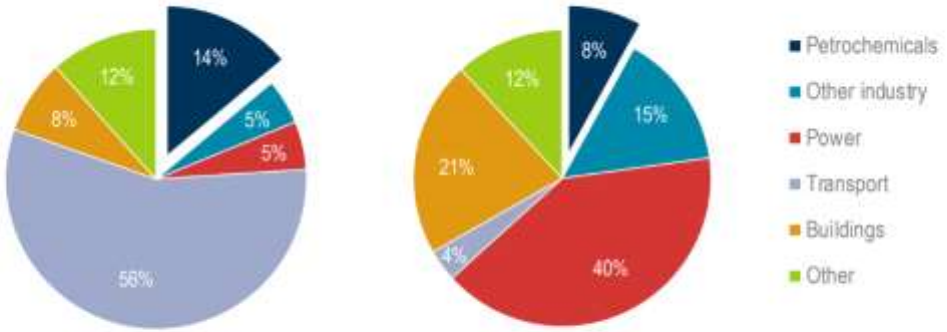


Figure 2.1 • Primary oil (left) and natural gas (right) demand in 2017 by sector

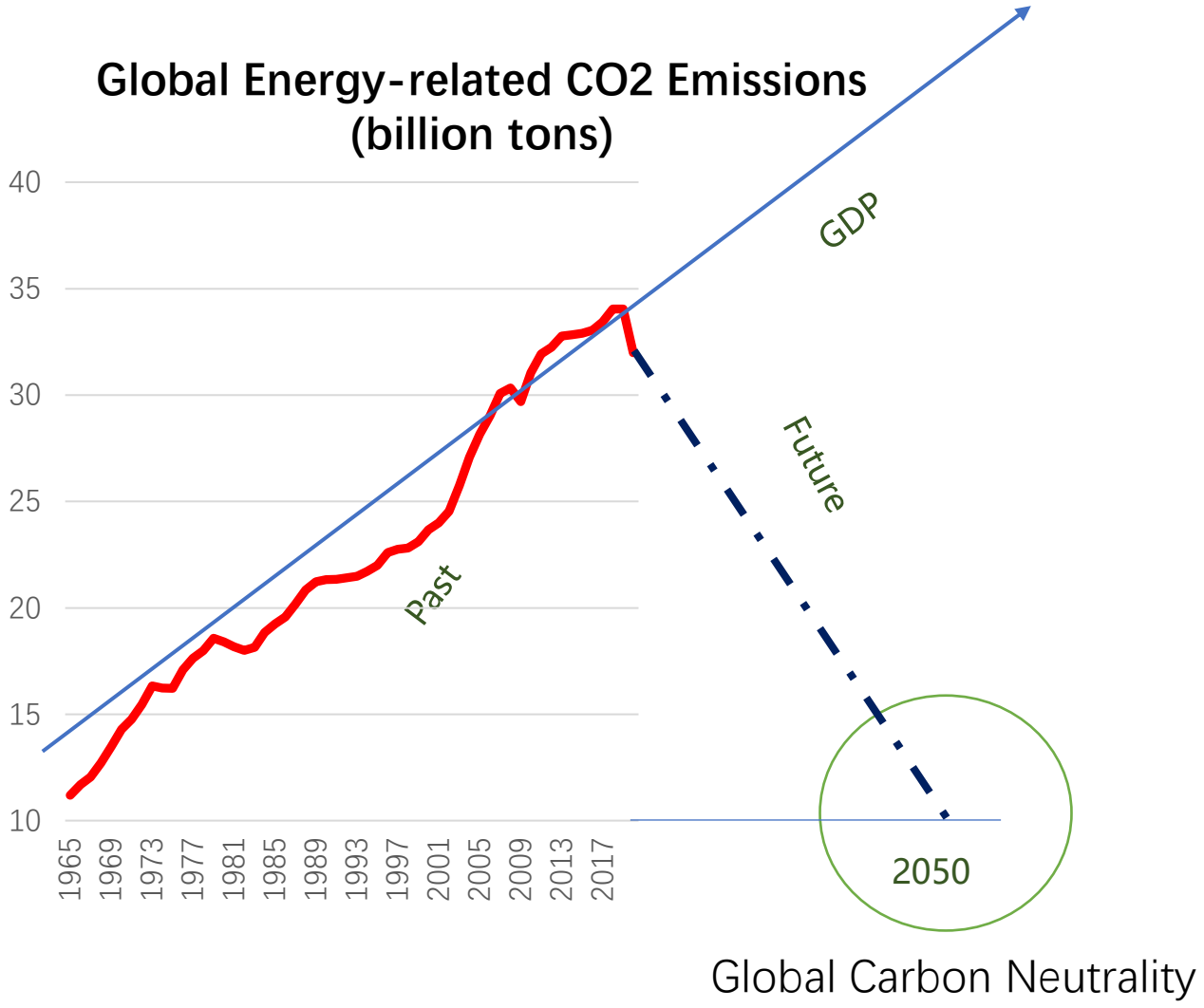


Note: *Petrochemicals* includes process energy and feedstock.

Key message • Petrochemicals account for 14% and 8% of total primary demand for oil and gas respectively.

Source: The Future of Petrochemicals, IEA, 2018

Reversed V shape curve requires “Reverse Engineering”



Global Carbon Neutrality

- **Power generation**: from underground minerals **to above ground renewables**;
- **Mobility**: from noisy engines **to silent motors;**
- **Heat production**: from steam engine **to “reverse steam engine”;**
- **Carbon use**: from simple burring **to utilisation and recycling**
- **Hydrocarbons**: from combustion **to “reverse combustion”;**
- **Business Model**: from selling carbon **to reducing carbon, to grow GDP while rewarding “reversed engineering” activities.**

Source: BP Statistical Review of World Energy, 2021.

Oil and Gas in Energy Transition

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- Oil and gas provide not only **energy**, but also indispensable carbon-based **materials** which can not be produced by electricity or hydrogen. We need them so long as we exist as humans in earth.

- There is a climate crisis and urgency, but energy transition takes time due to **inertia and rigidity** of energy infrastructure and capital stocks. Roma took time to build.

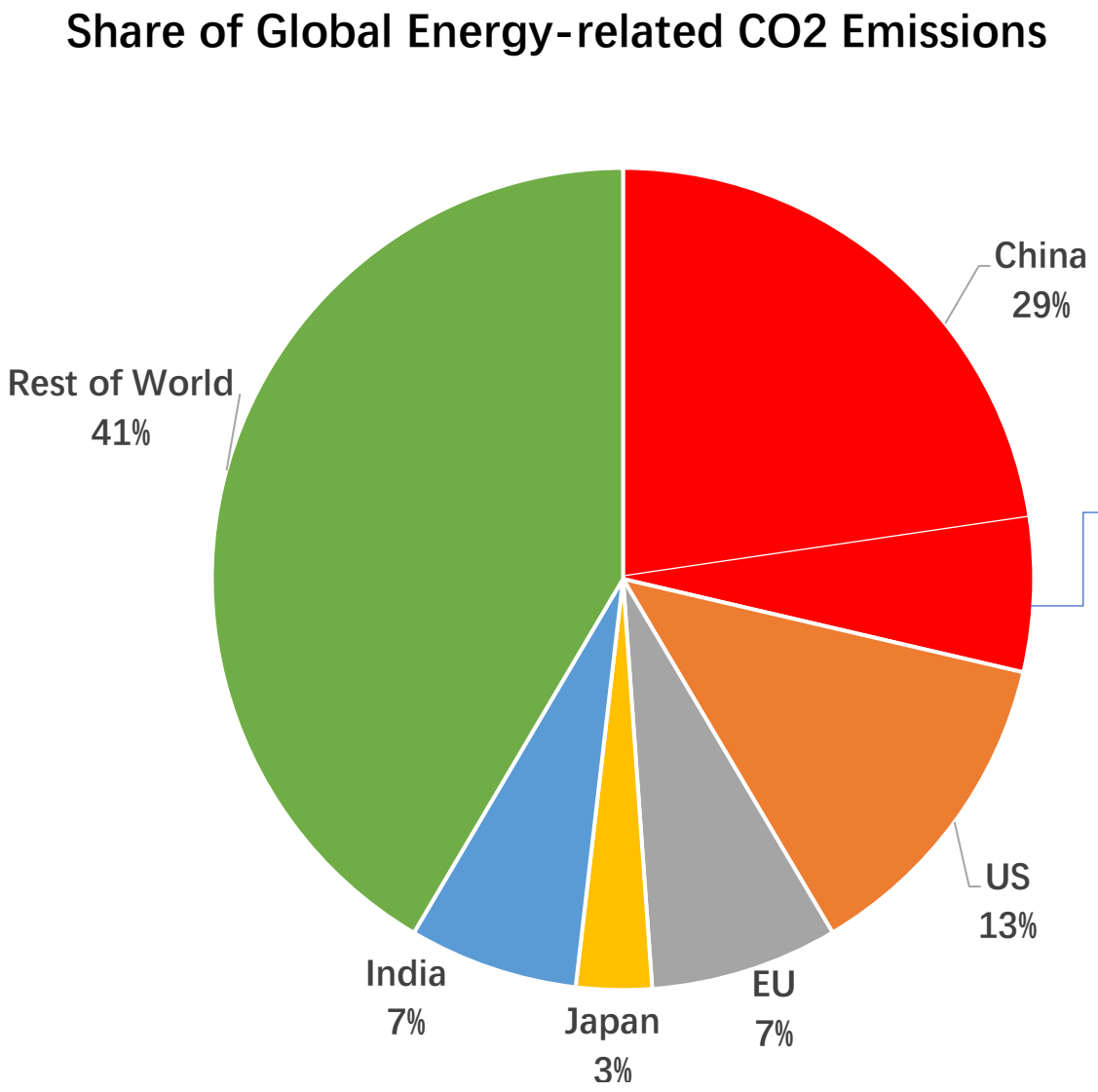
- Energy transition will not happen if **energy security** is undermined. Consider the feeling of those deprived with heating during a cold winter.

- China and Europe share the same climate goals, but **differ in perspectives** on oil and gas role. For example, gas is considered transition fuel in Europe, but a clean main fuel in China.

- Oil and gas companies role:

  - ✓ The world still needs oil and gas products, ensure their supply security is key.
  - ✓ No doubt about Scope 1 and Scope 2 emission reduction, but questions abound on Scope 3.
  - ✓ No need for all oil and gas companies to convert into renewable power companies.
  - ✓ Accelerate and deploy innovations, or **otherwise will be overthrown by innovation**.

China is critical to global carbon neutrality



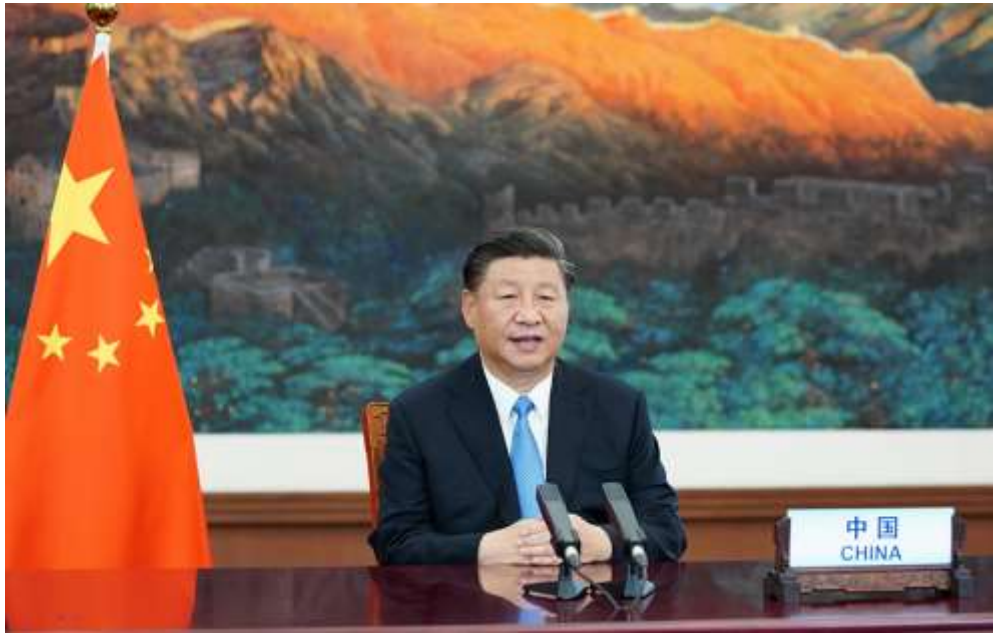
Embedded emission in exported goods is around 25% of Chia's total.

If these goods have to be made somewhere to meet global demand, would "Made-in-China" also contribute global emission reduction, given the efficiency of its supply chain?

Source: BP Statistical Review of World Energy, 2021

China's Track Record in Global Efforts

Global Efforts	China's Commitments
1997 Kyoto Protocol √	Participating through **CDM** and contributed the biggest share of CERs.
2009 Copenhagen Accord √	By 2020, reducing **CO2/GDP** by 40-45% vs 2005 level, increasing share of **non-fossil fuels** to around 15%, **afforestation** by 1.3 billion cubic meters.
2015 Paris Agreement	By 2030, reducing **CO2/GDP** by 60-65% vs 2005 level, increasing share of **non-fossil fuels** to around 20%, **afforestation** by 4.5 billion cubic meters. **Peaking** emission **around** 2030.



President Xi set new targets:

1) **2030:**
   - **Reduce CO2/GDP by over 65% vs 2005 level;**
   - **Non-fossil fuels to reach 25%;**
   - **Increase afforestation by 6 billion cubic meters;**
   - **1200 GW of solar and wind capacity;**
   - **Peaking CO2 emissions before 2030;**
2) **2060: reach carbon neutrality before 2060, with non-fossil fuels accounting for over 80% of energy supply.**

Delivering 2030/2060 goals: "1+N" policy framework

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1 top design document: 22 September 2021

Central CCP Committee and State Council: "Opinion on the complete, accurate and comprehensive implementation of the new development concept to do a good job on carbon peaking and carbon neutrality".


中共中央文件

中发〔2021〕36号

中共中央 国务院

关于完整准确全面贯彻新发展理念

做好碳达峰碳中和工作的意见

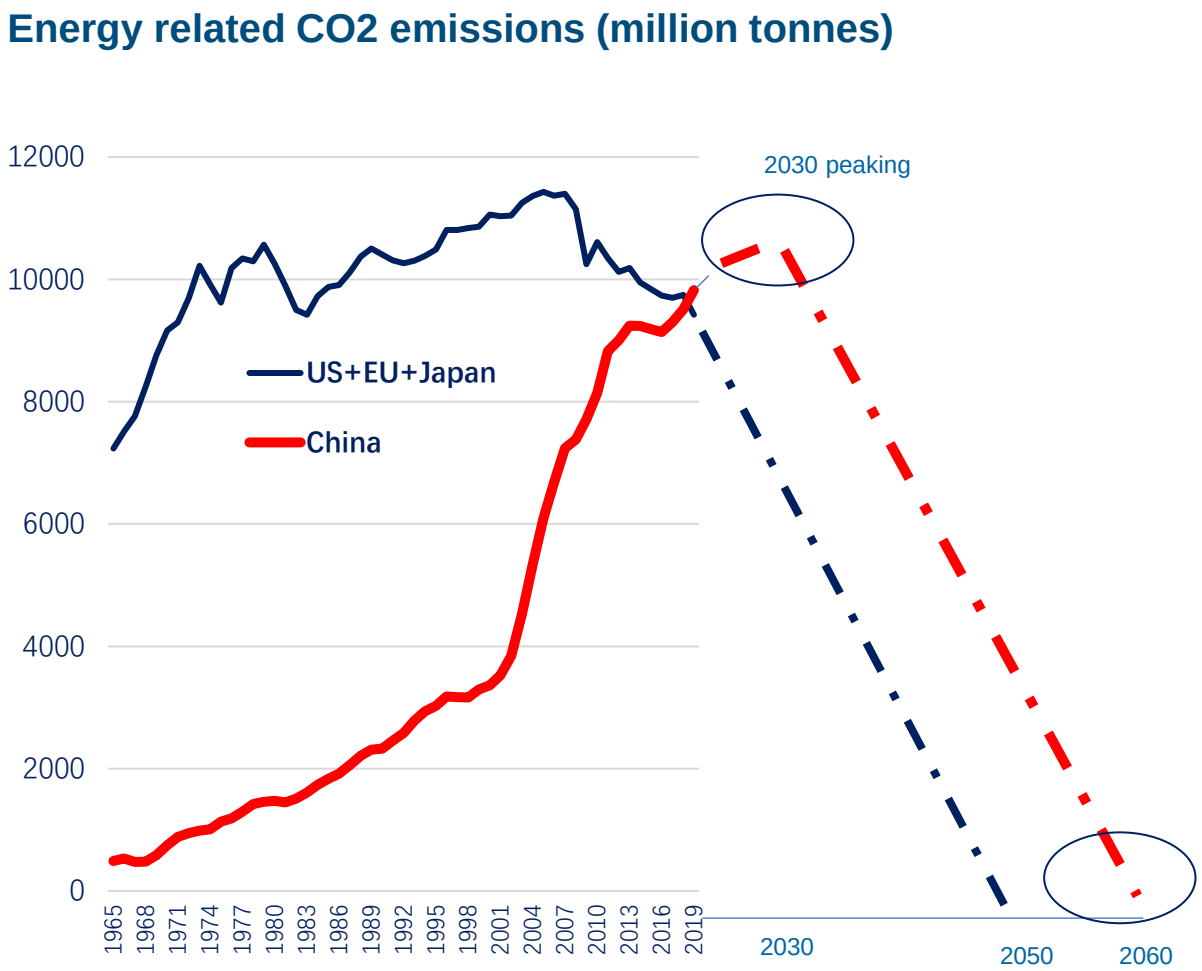
(2021年9月22日)

N key sector policies: peaking action plan, plus more to come...

2030 peaking action plan

Source: BP Statistical Review of World Energy, 2021

China's carbon peaking and carbon neutrality challenges



Source: BP Statistical Review of World Energy, 2020

- Artificial peaking vs natural peaking
- Reversed V shape, no plateau after peaking
- Infrastructure rigidities: change takes time and costs
- Inertia in society's consumption behavior;
- Lack good business model
- Lack competences in "subtracting"
- Regulatory barriers: monopoly of electricity business

How can China achieve carbon neutrality ?

Energy Saving

Gas

Renewables

Nuclear

Hydrogen

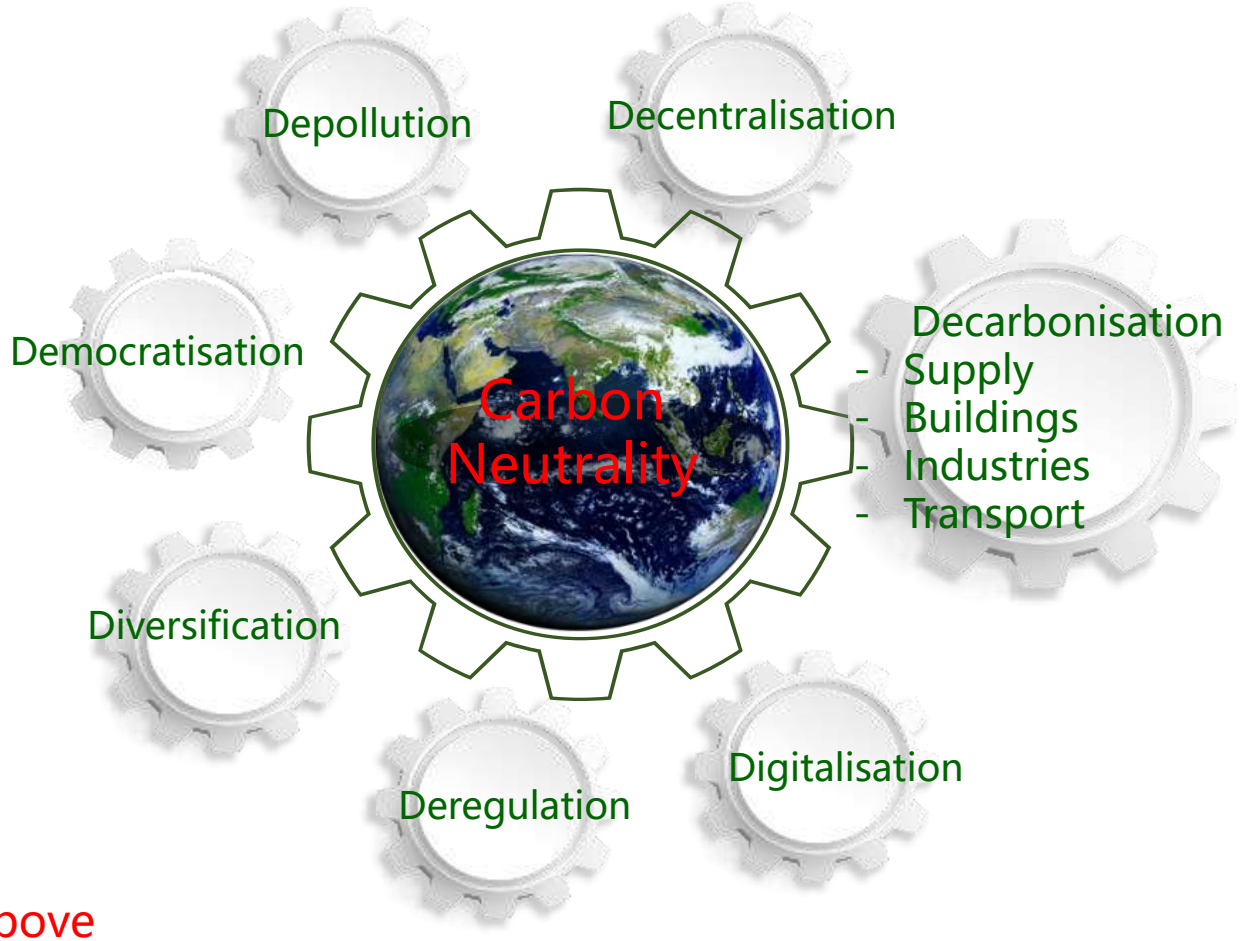
CCUS

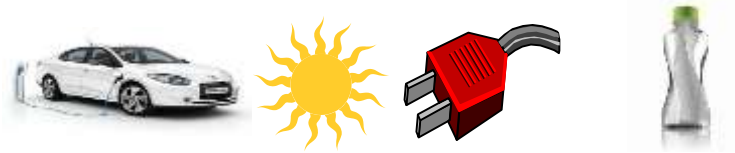
Electrification

Carbon sink

All-of-the-Above

7Ds driving China' s energy transformation





Energy + Material Security

Policy and regulation

Innovations

Market forces

Economic Development

as reflected in the climate policy document of 22 September published 20th October 2021.

China's advantages in enabling innovations

1. **Scale** and diversity: 1.4 billion consumers
2. Political stability and **policy continuity**
3. Regulatory **flexibility** to test solutions
4. **Visible + Invisible hands**, e.g. five-year program cycle
1. **Speed**: fast decision + modularity + 24/7 work schedule + fast mobilisation

7 January 2019:Tesla Shanghai Factory Inauguration

23 October 2019: factory completed

- 1 car every 2 minutes
- 65% cost reduction over US factory
- 30% local content, growing to 100% in future

Global Netting-Zero needs Chinese manufacturing capabilities…

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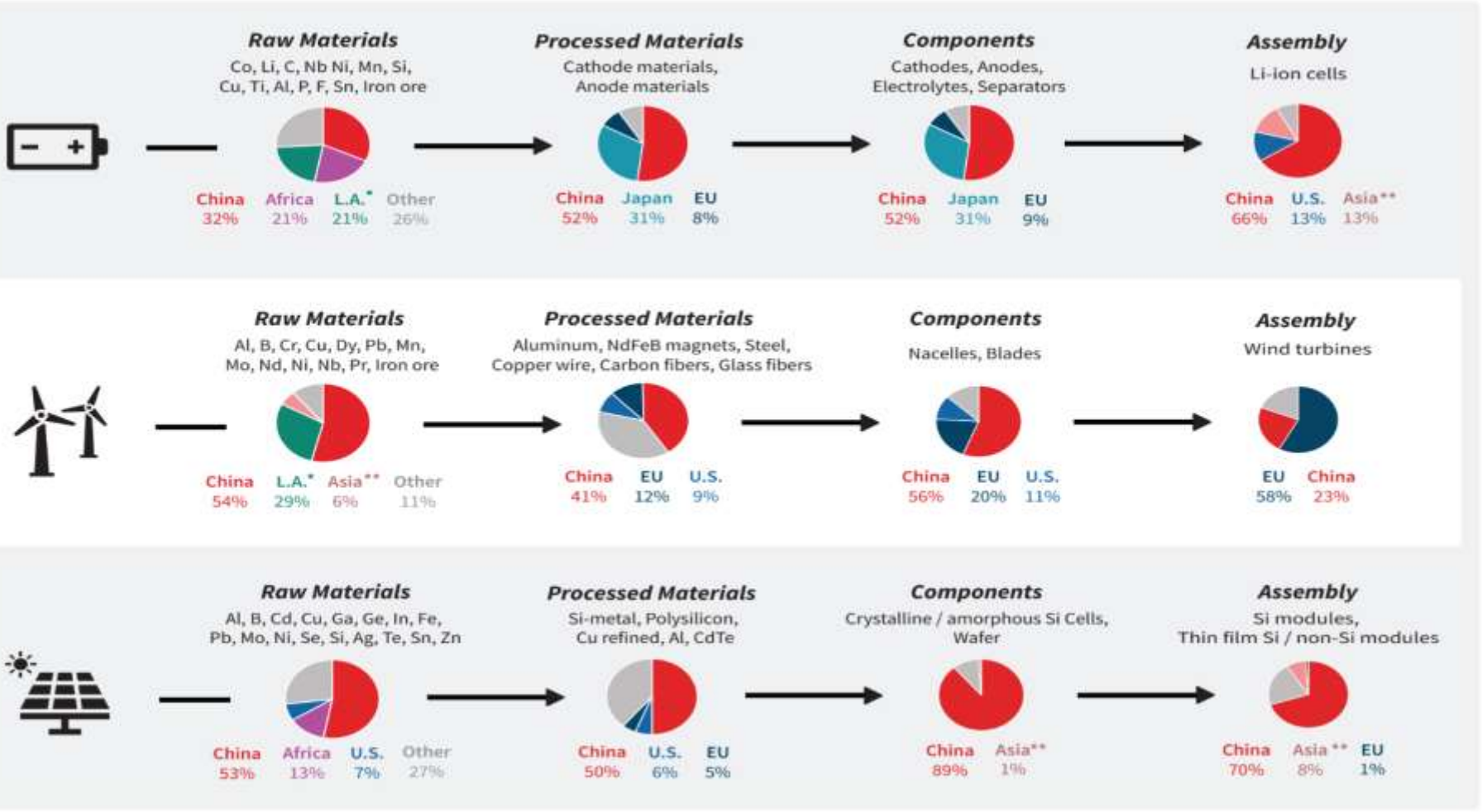
Clean Energy Mineral Supply Chains and Top Global Suppliers

Batteries, Wind, and Solar PV



* Latin America

** Excluding China and Japan

Source: Created by Ian Barlow based on data from European Commission, *Critical materials for strategic technologies and sectors in the EU - a foresight study, 2020* (Brussels: European Commission, 2020).

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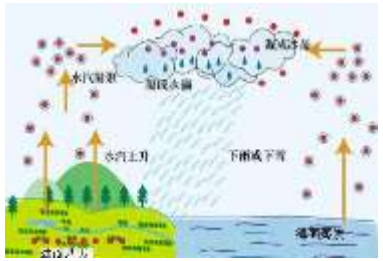
… and Chinese innovations as well

"Reverse steam-engine": Water-vapor heat pump – a proven technology



More efficient than air-sourced heat pump,: 1kg of condensed water from 10C° releases 593kcal of heat (60 g of oil).

Replacing natural gas for central heating can save 74.1% of energy consumption.

Captures pollutants, produces clean water.

"Reverse combustion": CO2 conversion technology – industrial pilot ongoing

$$CO_2 + H_2O \longrightarrow C_xH_y + O_2$$

Industrial waste heat or solar heat

Plasmon catalyst that converts CO2 and H2O into hydrocarbons under normal conditions at large scale and very low cost, i.e. ½ of oil products.

Reverse Steam-Engine: DY air Sourced Water Phase Change Heat Pump System

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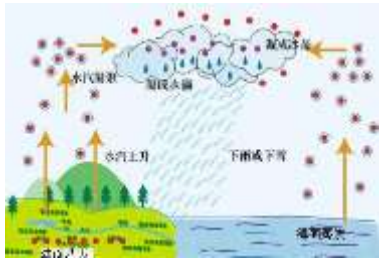
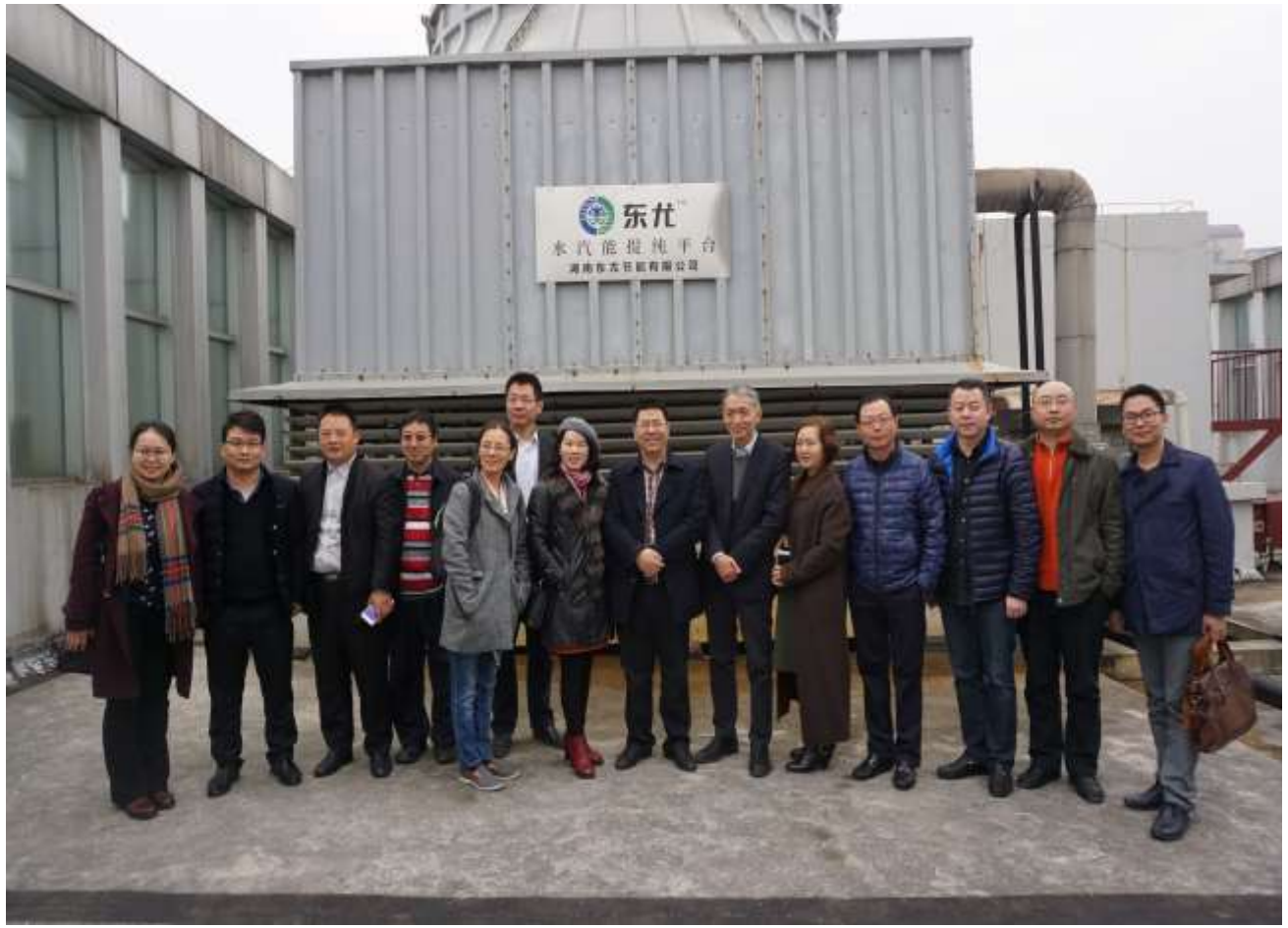


Air Water Vapor

Condensation Tower

Heat Pump

Buildings



Reverse-Combustion Technology is underway

Waste industrial heat or
concentrated solar heat

$$CO_2 + H_2O \xrightarrow[\text{Plasmon Catalyst}]{} C_xH_y + O_2$$

Guanghe New Energy (or GH) - a Beijing-based start-up company – has developed a catalyst based on surface plasmon technology that can convert CO2 and H2O into hydrocarbons using industrial waste heat or solar heat.

Industrial pilot already built with 8 reactors producing 20kg of hydrocarbons a day, 48.2% of input CO2 can be converted into hydrocarbons while energy conversion efficiency is over 20%.

GH estimates that when this technology is widely deployed, it can produce oil and gas from CO2 and water at half the cost of the current pump prices.

Tail gas and waste heat pipelines

Pressure Swing Adsorption (PSA) CO2 capture system

Plasmon CO2 synthesis fuel thermal catalytic reactor

Plasmon catalytic reaction kit and fuel product collection window

Oil and gas separation equipment

Digital control system

New ways of tackling climate change problems

$C_xH_y + O_2 \rightarrow CO_2 + H_2O + \text{Heat}$

Combustion:
main source of CO2 emission

Steam Engine

Useful Energy (H_2O + Heat) → Work

Waste Energy (H_2O + Heat) → 

Evaporation

Condensation

Reverse - Steam Engine

Heat → Heat Pump → Heating & AC

Reverse-Combustion

$C_xH_y + O_2 \leftarrow CO_2 + H_2O + \text{Heat}$

with catalysts

Carbon-neutral fuels, also suitable for permanent storage

Beijing Energy Club's work on Chinese energy transition

Founded in 2008 for 3 reasons:

- Energy is the main cause of environmental and climate problems, must be part of the solution.
- Tackling the posed challenges needs **new ideas, new technologies, new solution and new business models**.
- To commemorate the 40th anniversary of the Roma Club which was founded in 1968.

Activities so far:

- **Over 130 events on hot energy topics**
- **Over 50 global leaders addressing the club**
- **Over 120 reports**

BEC ← Beijing Energy Club

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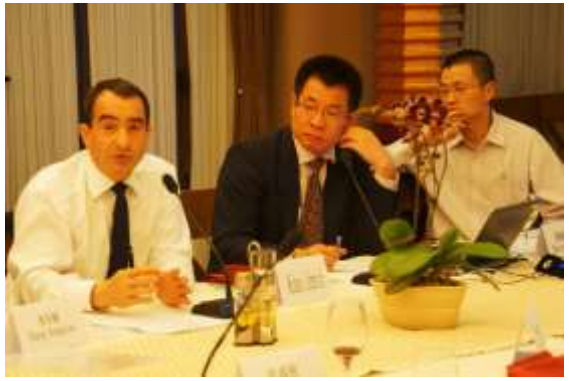
a group of people from different background with different ideas gathered under the same roof, looking for solutions to earth problems.

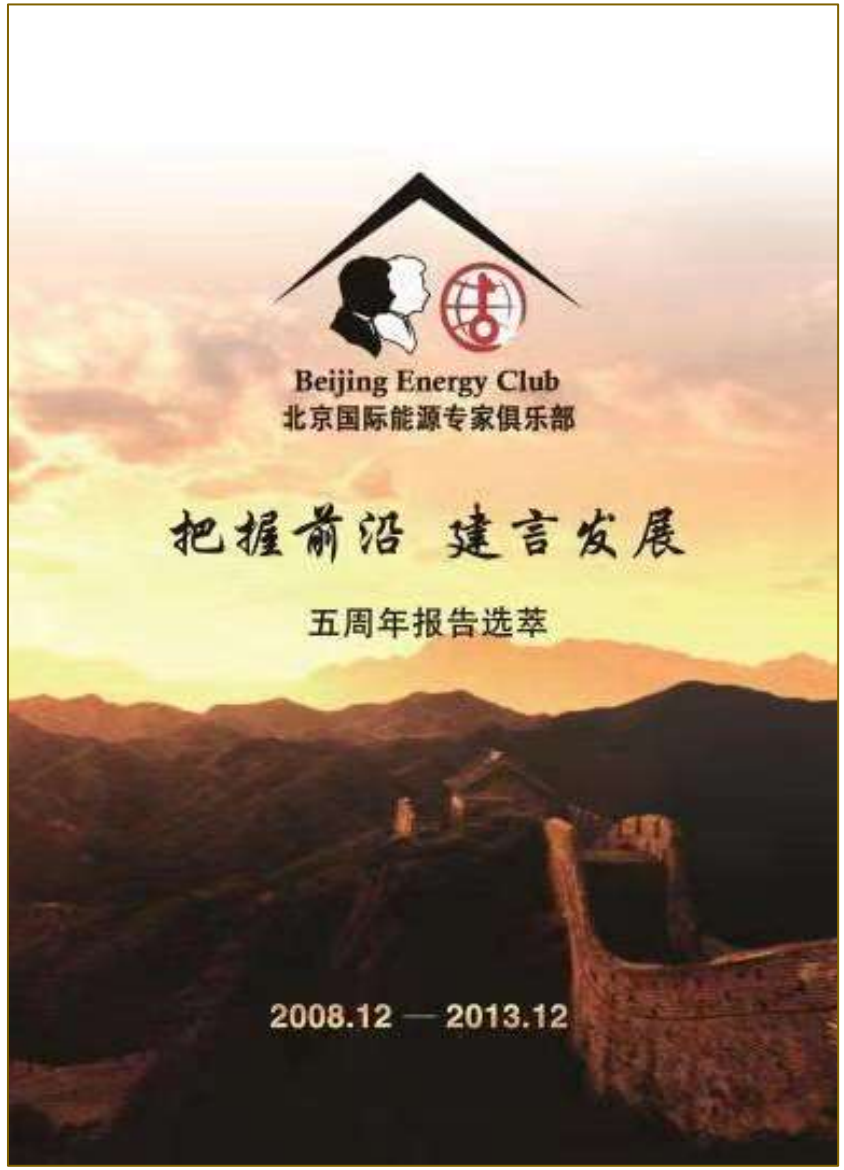

能源与可持续
Energy an Sustainabili

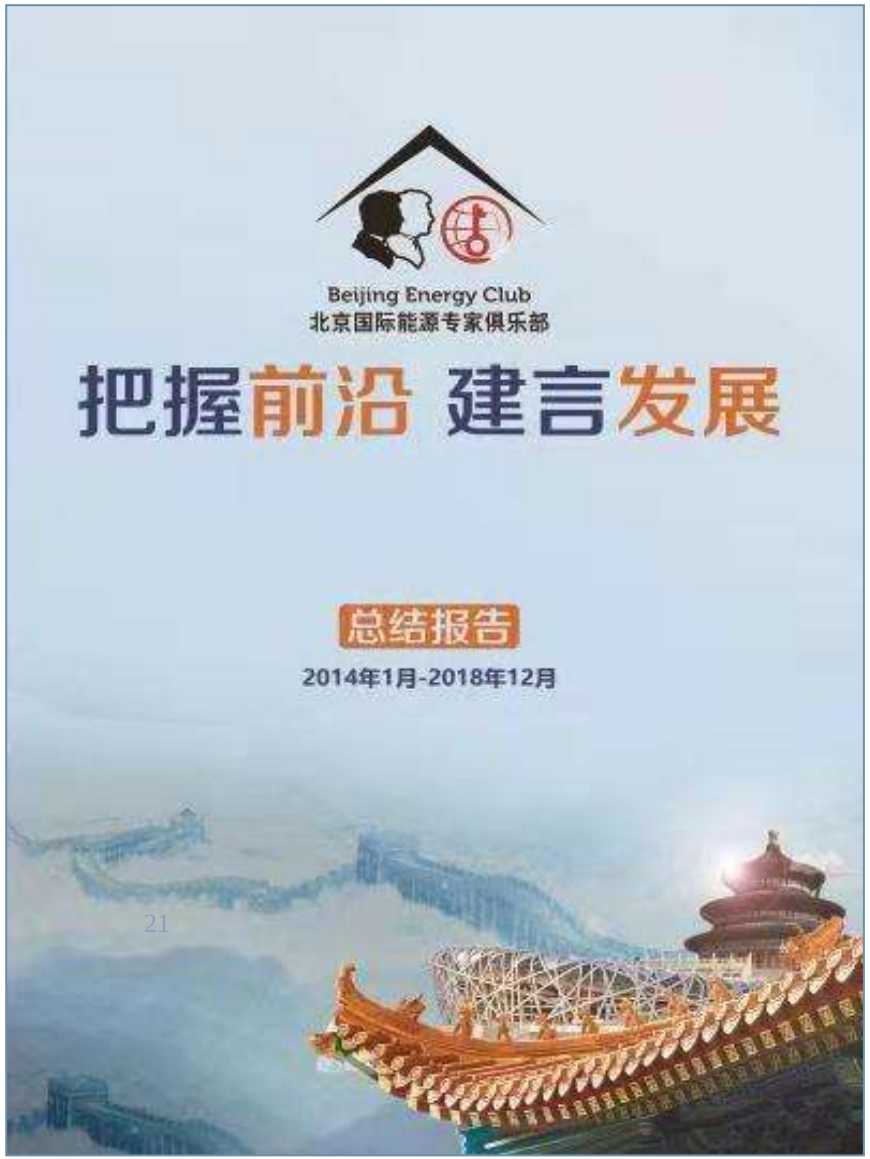

全球能源治理
Global Energy Governa


Beijing Energy Club



2 Reports Summarising 10 Year Activities





http://beijingenergyclub.org

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清洁能源 Clean Energy
技术评估与推广
Technology Assessment & Dissemination


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预留
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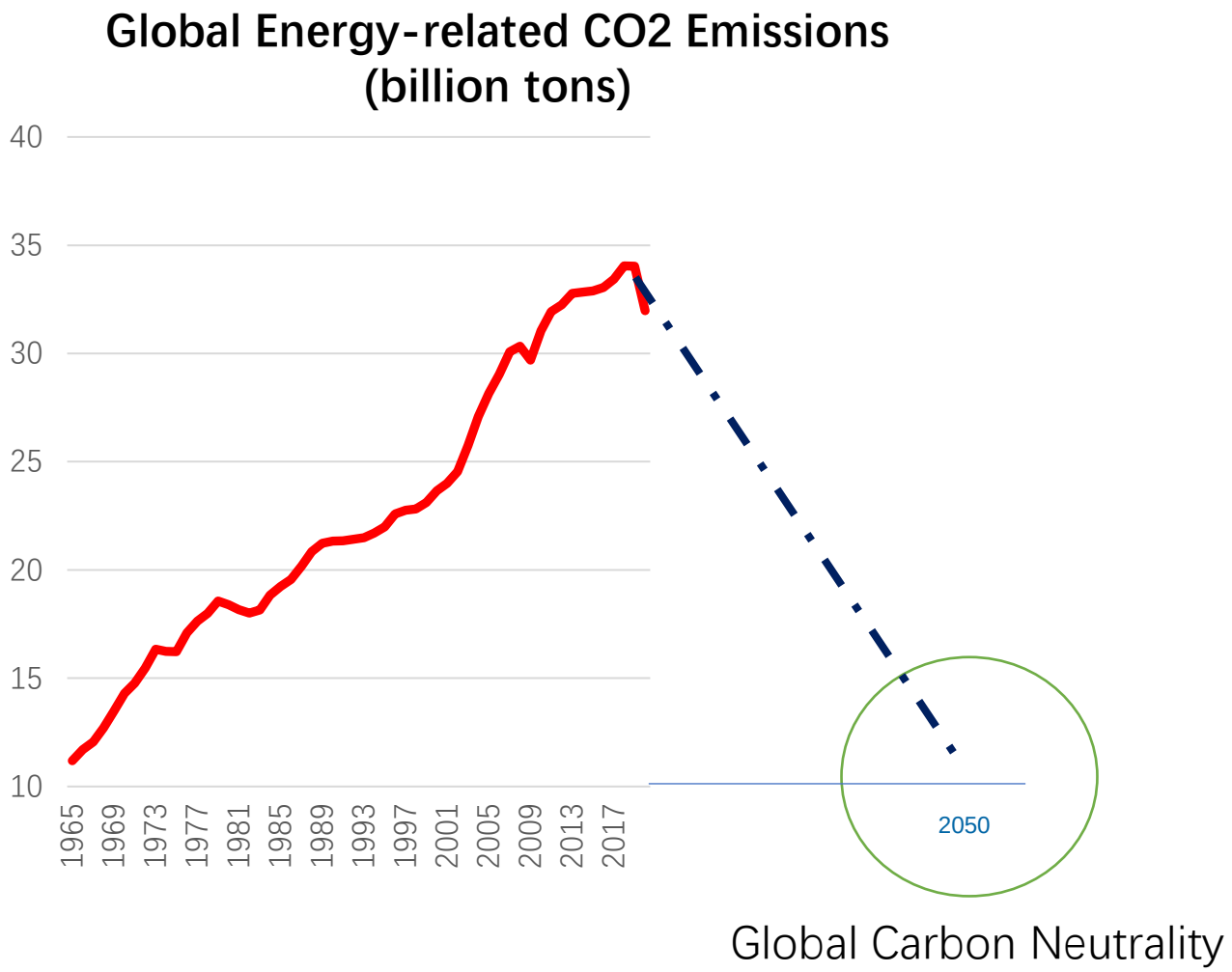
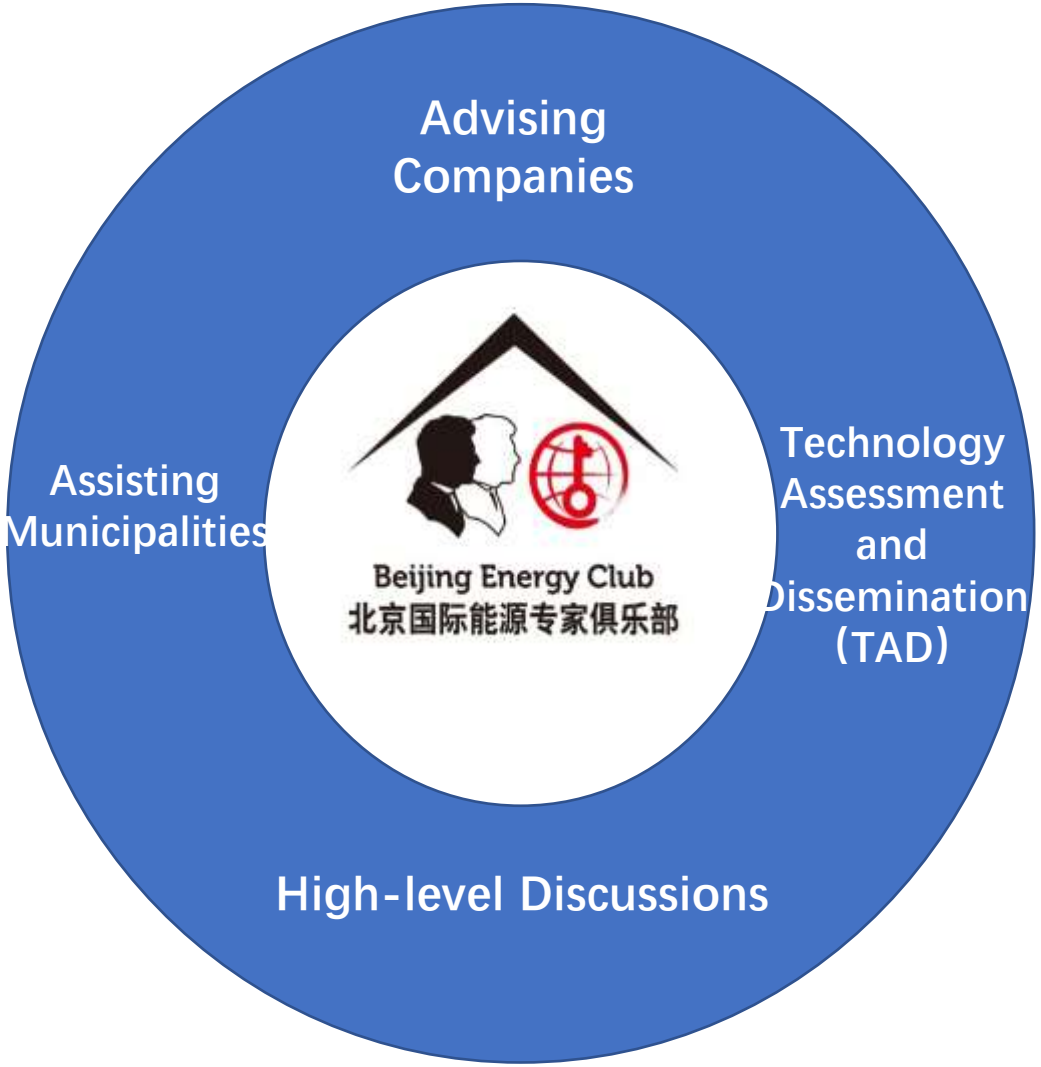
Global Netting-Zero calls for accelerated innovation



- Net-zero requires global deployment of **best manufacturing capabilities**.
- It call for **accelerated innovations** in technology, cost, regulation and business model.
- **Business model innovation** is required to
  - Efficiently deploy Chinese manufacturing capabilities in solar, wind, batteries and other carbon reducing technologies;
  - Channel global innovations to help China reducing its carbon emissions.

Beijing Energy Club: next phase of development



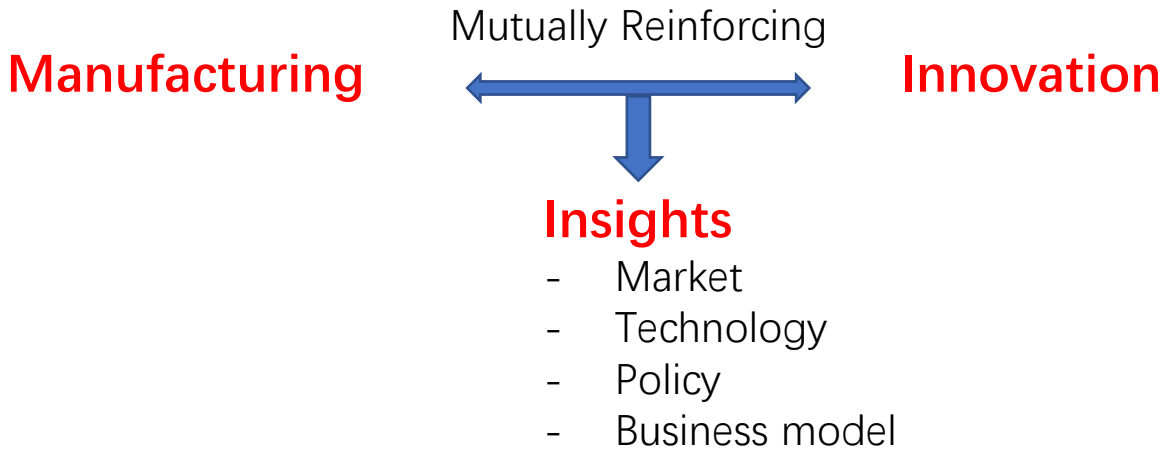
www.beijingenergyclub.org

www.cn-innovation.tech

New mission: make netting-zero easier, faster and more affordable

- Connect the global decarbonization needs with Asian/Chinese manufacturing capabilities;
- Facilitate market deployment of carbon reducing innovations;
- Provide market-leading Insights on market development and innovation capabilities.

CN: Carbon
CN: Carbon Neutrality
CN: China
CN: Carbon Network



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INNOVATION

Netting Zero Made Easier

Contact: service@cn-innovation.tech

Make a difference through innovation.