Challenges of Decarbonization Polices and Technological Innovation toward Carbon Neutral Society in China

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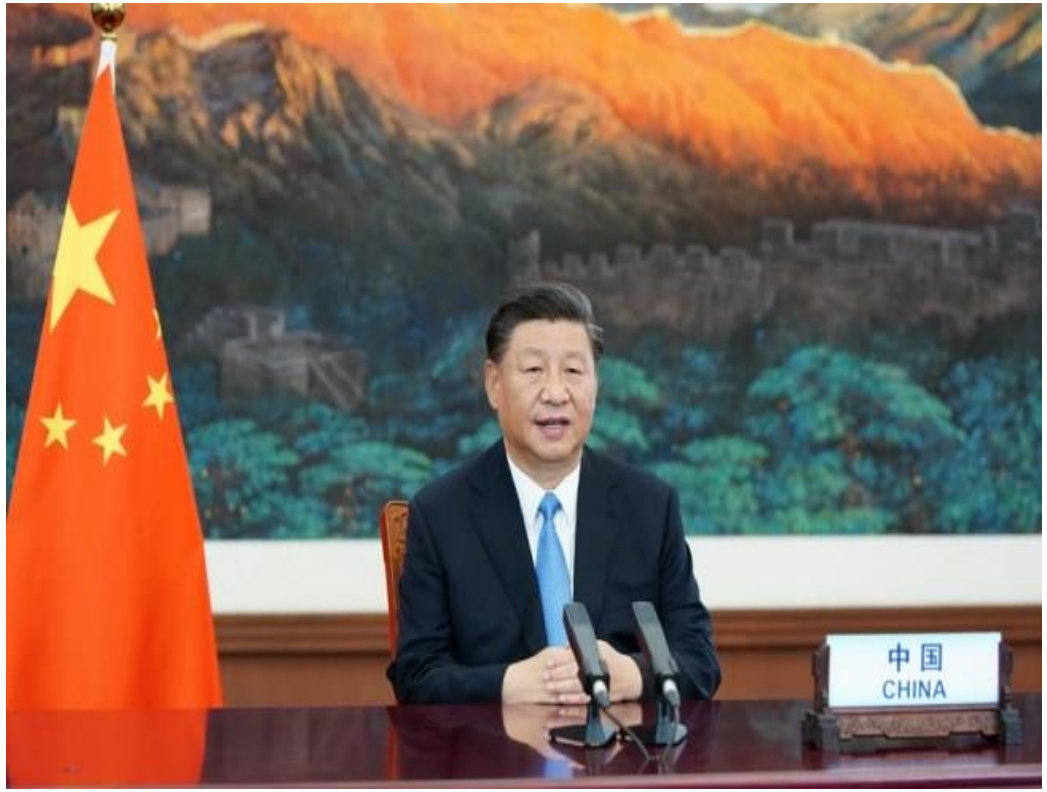
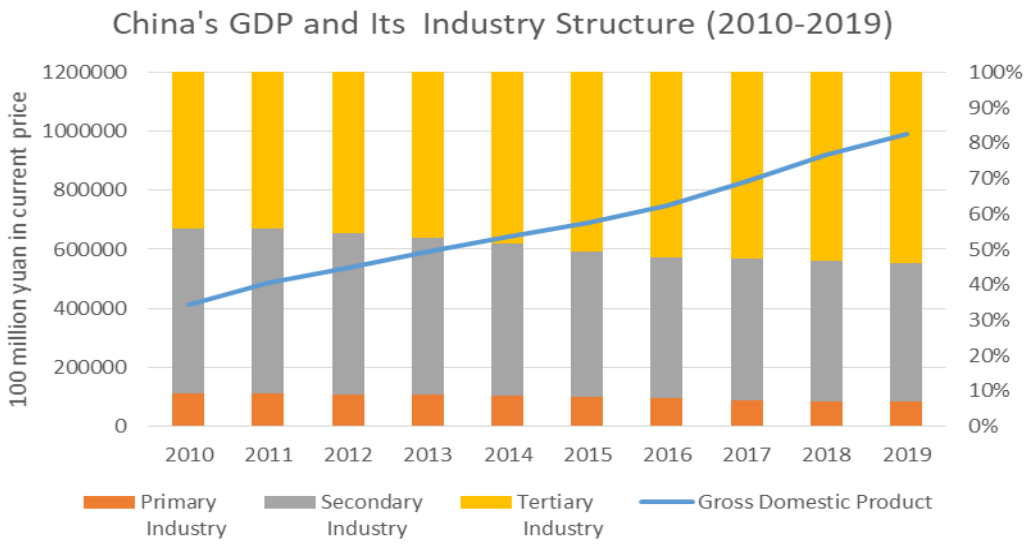
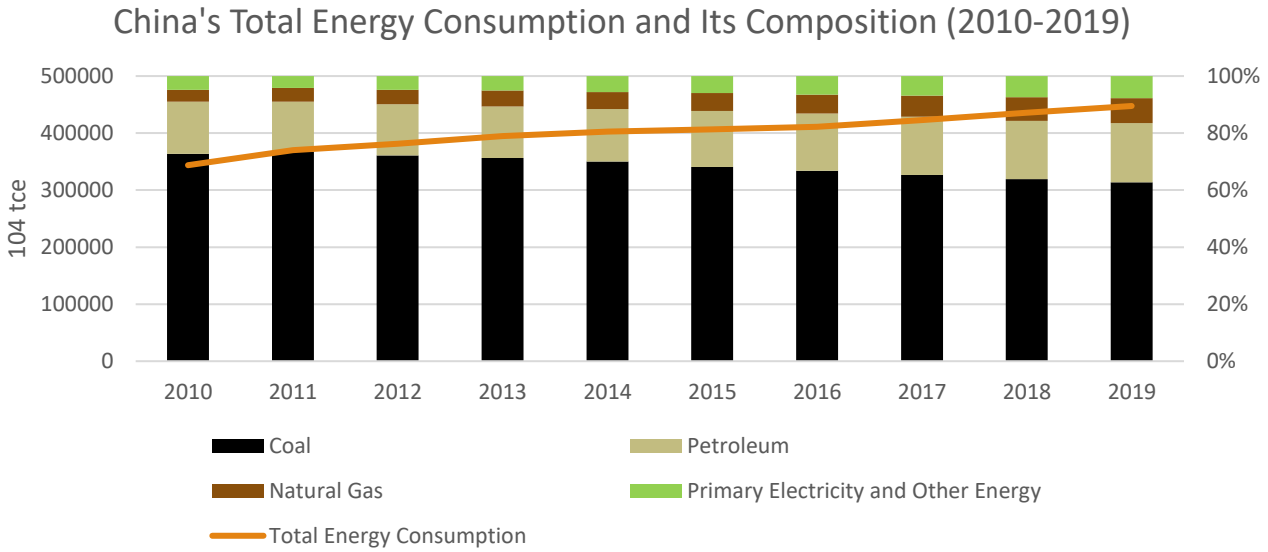
1. China's Carbon Neutrality Targets

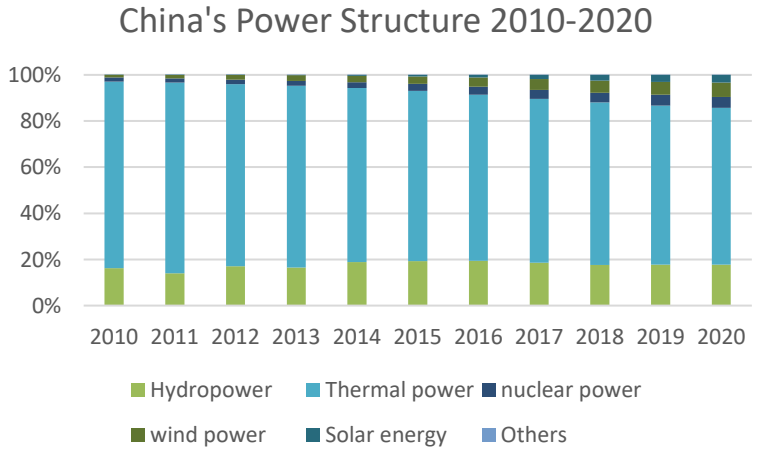
- On 22 September, 2020, President Xi Jinping announced to the world on behalf of the Chinese government at the United Nations General Assembly that China is willing to contribute more to the fight against climate change, as it aims to bring carbon emissions to a peak by 2030, and achieve carbon neutrality by 2060 with more forceful policies and measures.

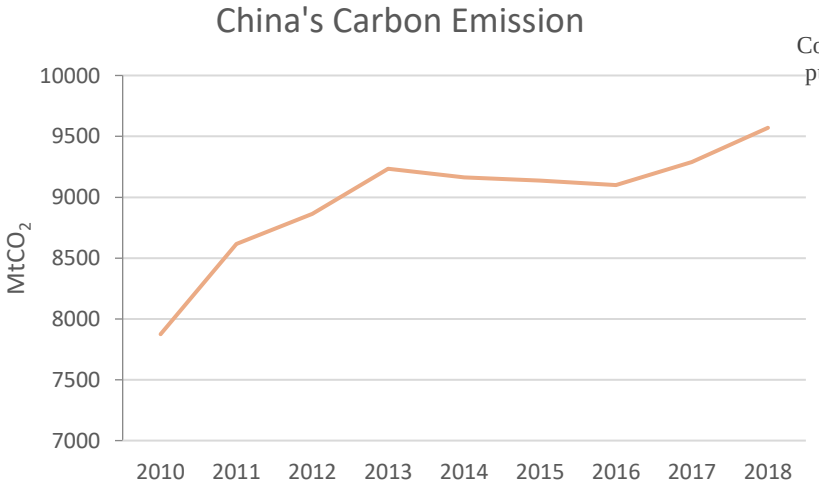


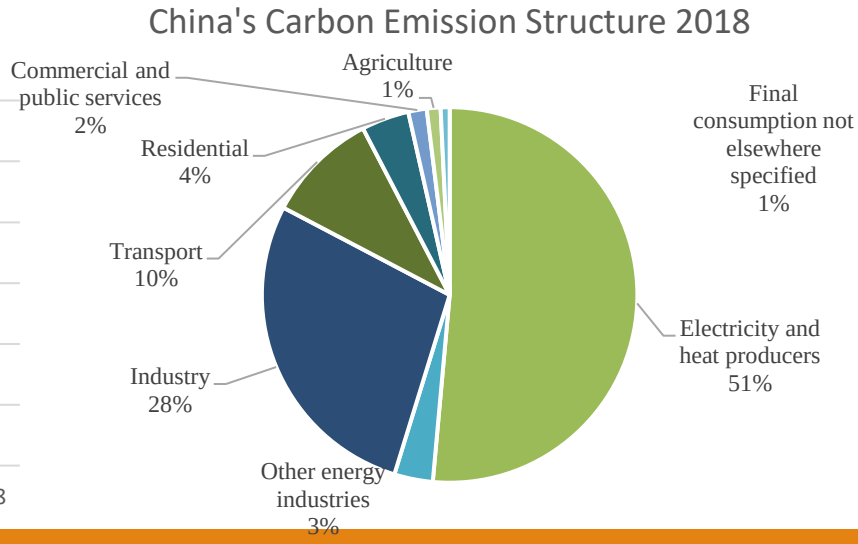
2. Background of China's Carbon Neutrality Targets





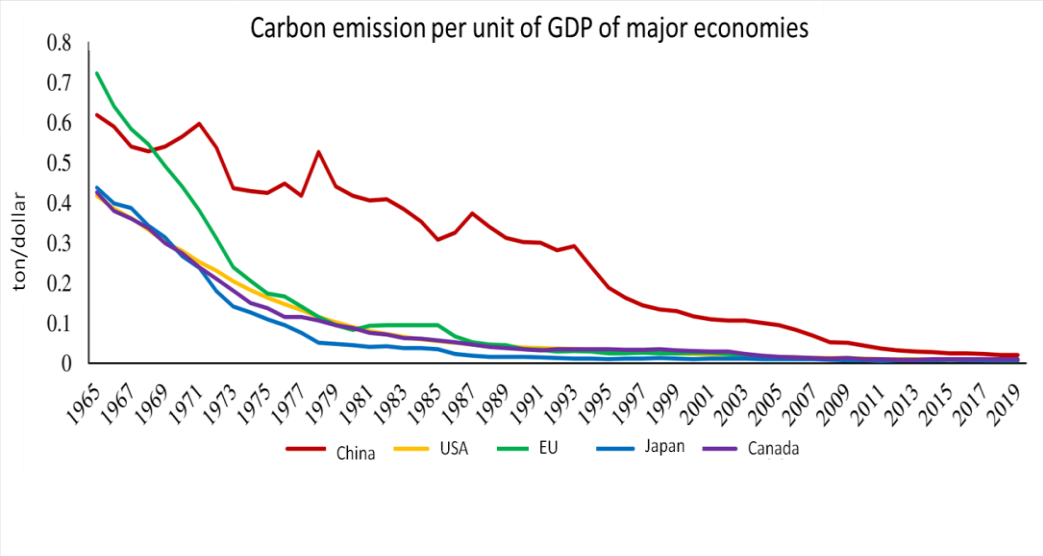


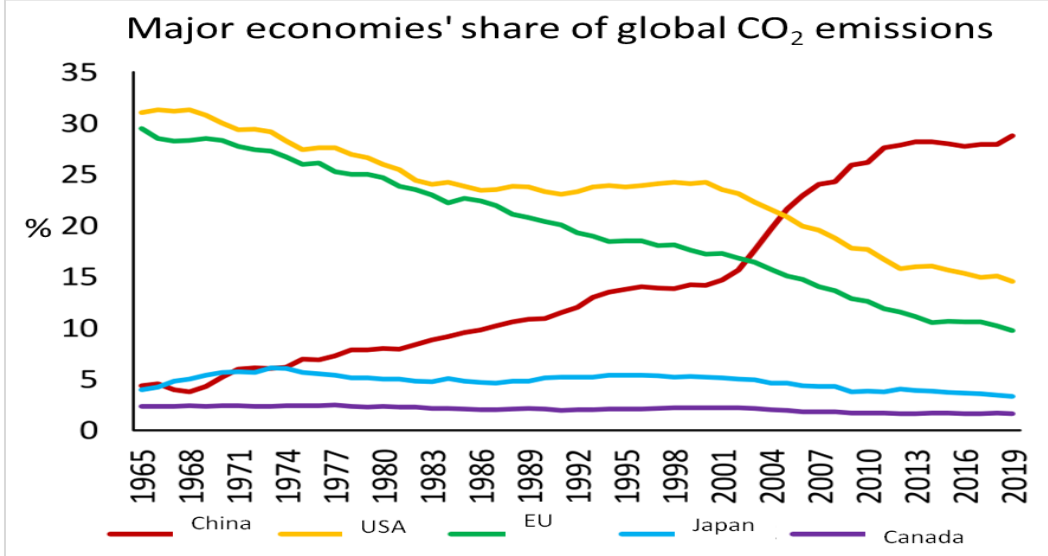


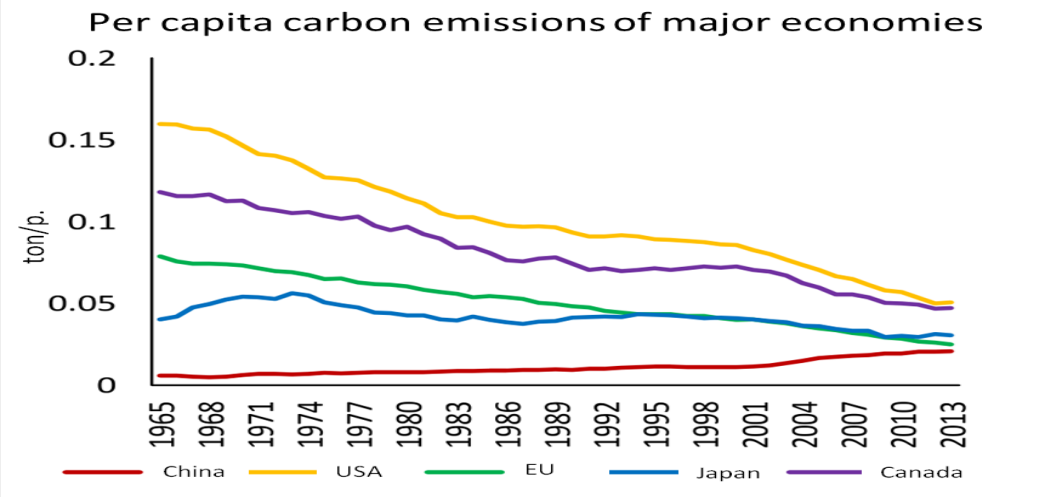


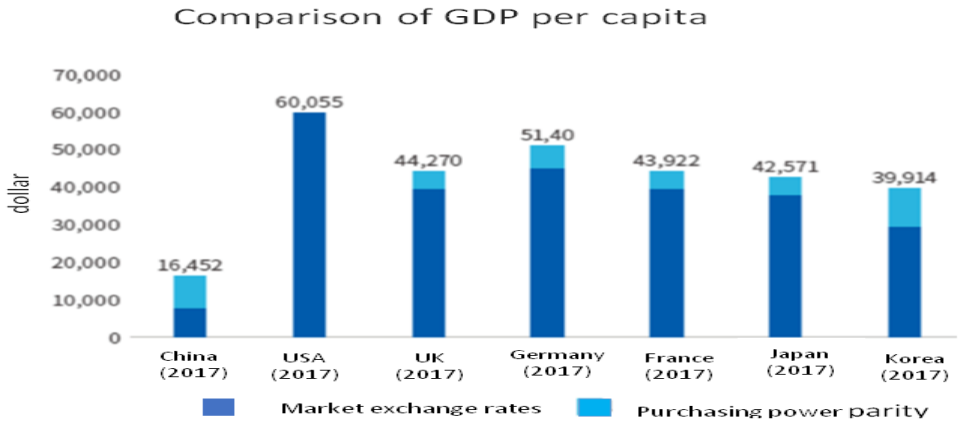
（Data sources: China Statistical Yearbook 2020, China Energy Statistics Yearbook 2020,China Electricity Council, IEA）

2. Background of China's Carbon Neutrality Targets







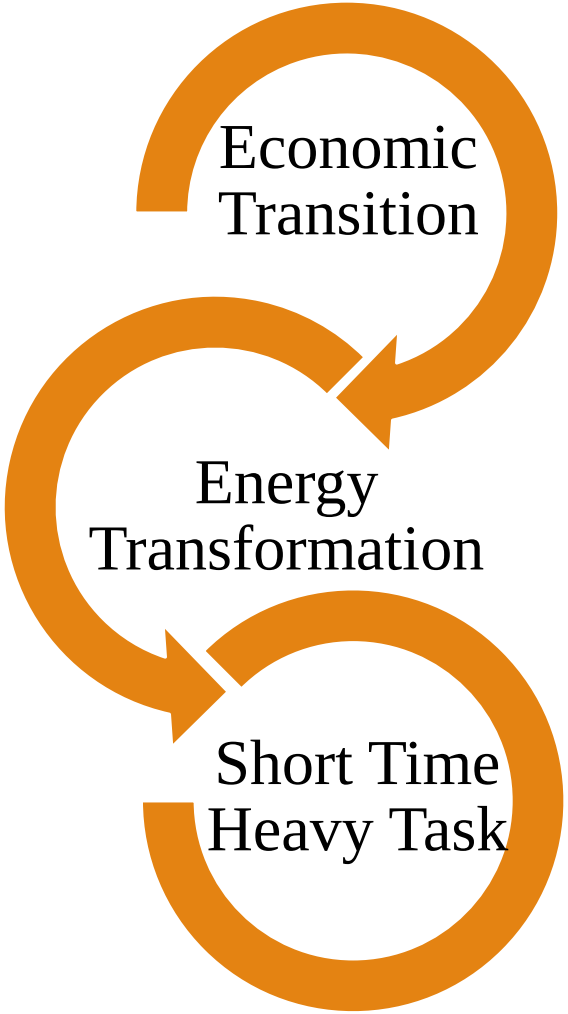


（**Source: https://www.doc88.com/p-948617657594 52.html;** China 2050: A Fully Developed Rich Zero-Carbon Economy, Rocky Mountain Institute, 2021）

3. Time of Carbon Peak and Carbon Neutrality in Major Countries

Country	Carbon Peak	Carbon Neutrality
UK	After reaching its peak in the early 1970s, UK has been in a plateau period for a long time. At present, its carbon emissions have decreased by about 40% relative to the peak level.	2050
Germany	After reaching its peak in the late 1970s, Germany has been in a plateau period for a long time. At present, its carbon emissions have decreased by about 35% relative to the peak level.	2050
USA	After reaching its peak in 2007, the United States has showed a slow downward trend. At present, its carbon emissions are about 20% lower than the peak level.	2050
Japan	Japan reached the peak of carbon emission in 2013, and its future emission trend remains to be observed	2050
Korea	Carbon peak not reached	2050
China	2030 (Expected)	2060

4. Challenges for China to Achieve Carbon Neutrality Targets



Energy consumption per unit of GDP is 1.4 times the world average and 2-3 times that of developed countries .

Coal consumption still accounts for more than 50% of total energy consumption. Carbon intensity per unit of energy consumption is about 30% higher than the world average.

Many developed countries have reached carbon peaks, so they have 50-60 years to achieve carbon neutrality, but China has only about 30 years from carbon peaks to carbon neutrality.

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1. Stages of Carbon Neutrality in China

Stage One (2021-2030): Reach Carbon Peak

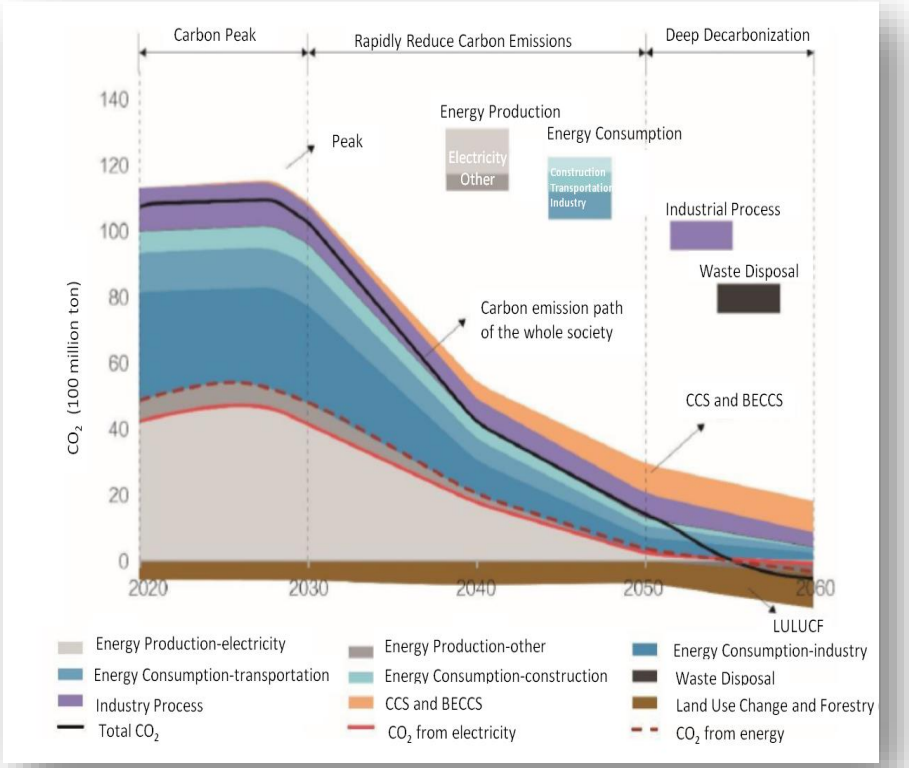
- Improve energy efficiency and gradually replace coal for power generation and industrial coal consumption with clean energy.
- Promote the substitution of new energy vehicles for traditional fuel vehicles and guide residents' low-carbon consumption.

Stage Two (2031-2045):Rapidly Reduce Carbon Emissions

- To achieve comprehensive electrification of the transportation sector.
- Increase the use of CCUS, BECCS and other negative carbon emission technology. Complete the transformation of emission reduction in primary industry.

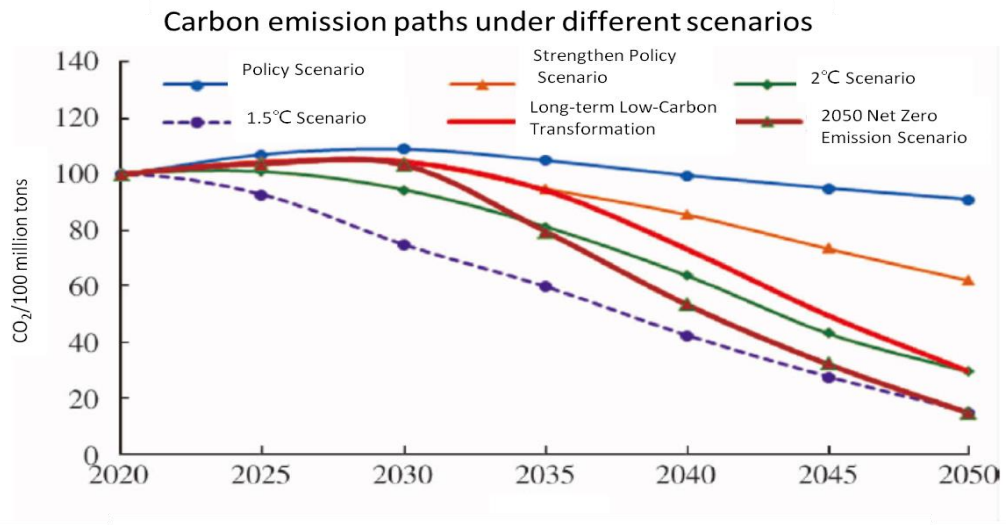
Stage Three (2046-2050): Deep Decarbonization

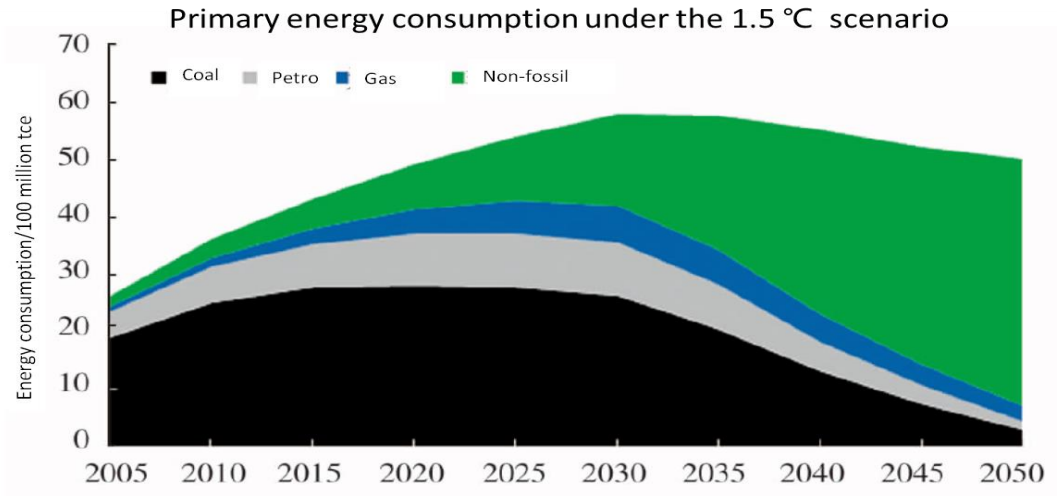
- Commercial use of renewable energy, energy storage, hydrogen energy, CCUS, BECCS and other related technologies.
- For those that cannot achieve zero carbon emissions, carbon neutrality can be achieved through negative carbon emission technologies such as carbon sinks, CCUS and BECCS.

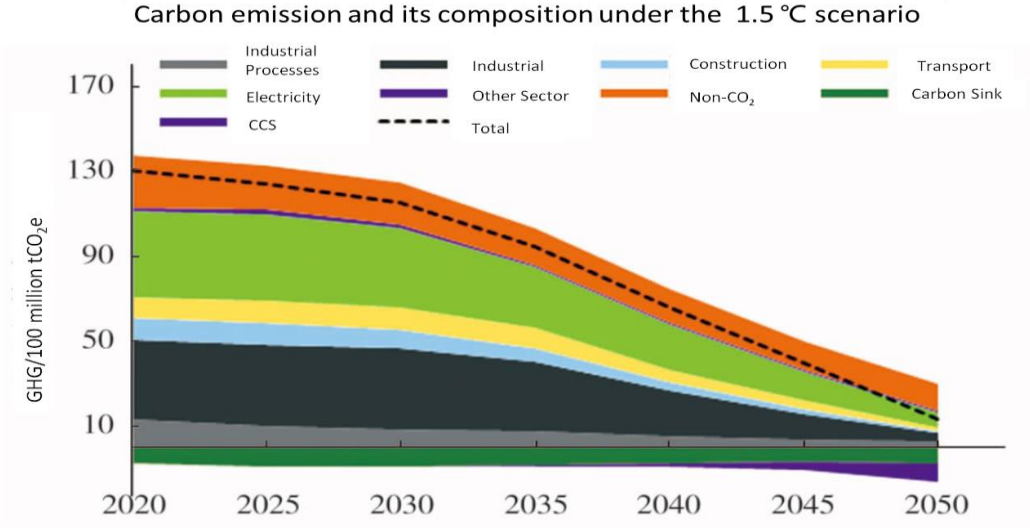


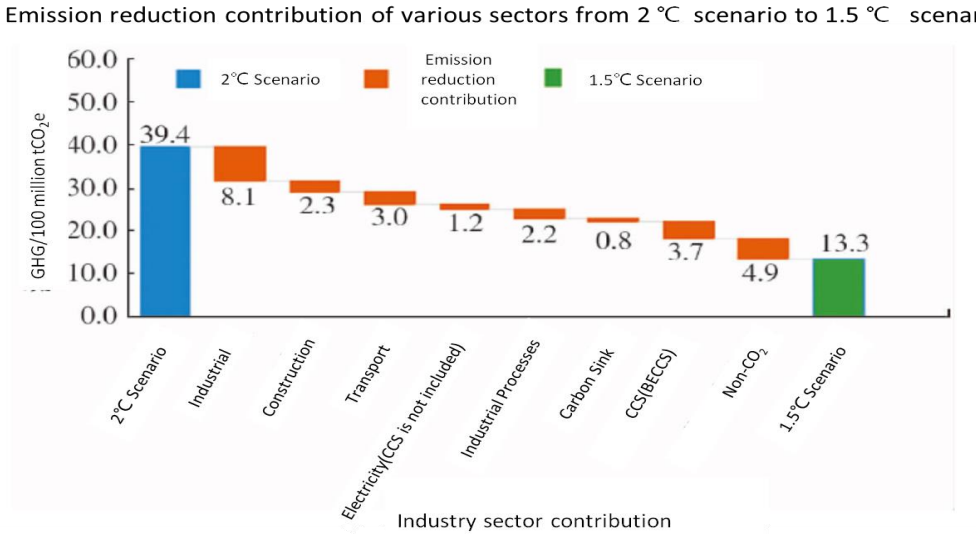
(Source: Report on Carbon Neutrality of China by 2060, Global Energy Interconnection Development and Cooperation Organization,2021)

2. China's Carbon Neutrality Transformation Path









(Source: China's Long-Term Low- Carbon Development Strategies and Pathways Comprehensive Report. 2021, Tsinghua University)

Contents

1. China’s Climate Change Strategies

- **2011, Twelfth Five-Year Plan for National Economic and Social Development**

  By 2015, the proportion of non fossil energy in primary energy consumption will reach 11.4%, and the carbon emission per unit of GDP would be reduced by 17% than the level of 2010.

- **2014, National Climate Change Plan（2014-2020）**

  By 2020, the carbon emission per unit of GDP would be 40% ~ 45% lower than that in 2005, and the proportion of non fossil energy in primary energy consumption will reach about 15%.

- **2015, Strengthening Climate Change Action- China ' s National Independent Contribution**

  By 2030, carbon emissions will peak around 2030 and strive to reach the peak as soon as possible; Carbon emissions per unit of GDP decreased by 60% - 65% compared with the level of 2005. The proportion of non fossil energy in primary energy consumption will reach about 20%.

- **2016, Thirteenth Five-Year Plan for Controlling Greenhouse Gas Emissions**

  By 2020, the proportion of non fossil energy must reach 15%, and the carbon emission per unit of GDP will be reduced by 18% than the level of 2015.

- **2020, Carbon Neutrality Target – 2021 National Emission trading system launch**

  By 2030, China's CO_2 emissions per unit of GDP will be more than 65% lower than that in 2005, the proportion of non fossil energy in primary energy consumption will reach about 25%. Carbon emissions will reach the peak by 2030 and carbon neutrality will be achieved by 2060.

2. China’s Actions for Mitigating Climate Change

- **Industrial structure** a**djustment :** transformation and upgrading of petrochemical, power, coal, steel and other industries. Eliminating backward production capacity with high energy consumption and environmental protection.
- **Energy efficiency improvement:** promoting energy-saving technologies and products in industrial, construction, transportation and public sectors.
- **Energy structure optimization:** promoting clean utilization of fossil energy, promoting clean heating in northern China and developing non-fossil energy.
- **Controlling of non-carbon dioxide greenhouse gas emissions:** agriculture, waste, industry.
- **Increasing ecosystem carbon sink:** Forest carbon sink, grassland carbon sink, wetland carbon sink, agricultural soil carbon sink.
- **Promoting low-carbon pilot projects in selected provinces and cities:** In 2010, China launched a national "low-carbon province and low-carbon city" experimental project in five provinces and eight cities.

3. Review Current ETS of China

Pilot Project Stage (2011-2014)

National ETS Preparation Stage (2015-2020)

National ETS Operations Stage (2021-)

2011

The NDRC approved two provinces and five cities as pilots of carbon emission trading (Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong and Shenzhen)

2015

Interim Measures for the Administration of Carbon Emissions Trading

2017

National carbon emissions trading market construction plan (power industry). National ETS construction started

2020

National Carbon Emissions Trading Management Measures (for Implementation) (Draft Solicitation Comments)

2021

On the 16th July, the national ETS covering 2,162 key emission units in the power generation industry has been launched. It covers about 4.5 billion tons of carbon emissions and becomes the world's largest carbon market.

MRV System,
Allowance Distribution system
……

Allowance Trading System
Registration System
…..

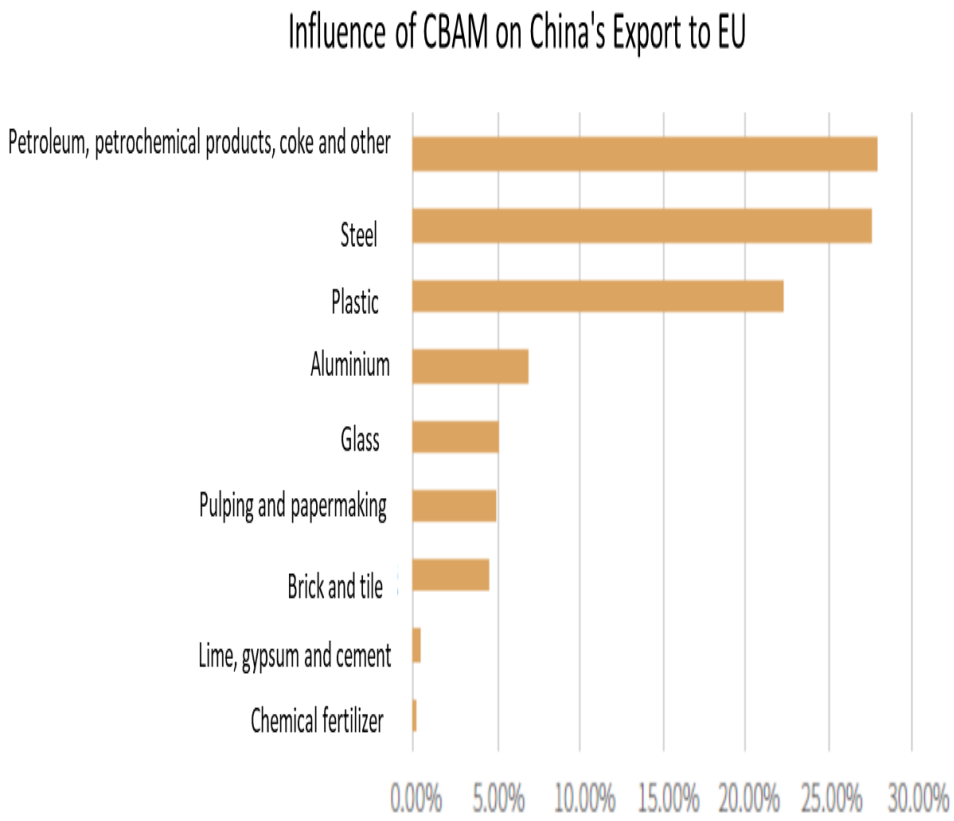
4. Future developments of ETS toward carbon neutral policies

- Carbon allowances will be allocated according to carbon emission amount rather than carbon intensity of enterprise.
- It is expected to cover 8 high carbon-intensity industries: power generation, petrochemical, chemical industry, building materials, steel, non-ferrous metals, papermaking and domestic civil aviation.
- Auction will be adopted in the allowance allocation of national ETS.
- Chinese Certified Emission Reduction(CCER) will be allowed to buy and sell in the national ETS, but will also have some strict restrictions on the amount.
- More finance policy instruments will be introduced in the ETS.
- Carbon tax is probably be imposed on the industries and enterprises that haven’t been covered by the national ETS as a supplementary policy tool.
- Non-carbon dioxide greenhouse gas need to be taken into account under ETS in the long run?

Contents

1. Carbon Tax

- Should carbon tax be a supplementary tool of ETS or the main GHGs mitigation policy tool in the future in China?
- When and how to levy carbon tax? what is the optimal carbon tax rate? How to coordinate the carbon tax with other existing tax?
- What impact will the Carbon Border Adjustment Mechanism(CBAM) of EU have on China's carbon tax policy design?
- How to coordinate carbon tax with ETS?
  - Should carbon tax be levied on those enterprises that have been covered by carbon trading market?
  - Should carbon tax be levied only on those enterprises that have not been involved in carbon trading market?
  - Should the carbon tax be levied on the free carbon allowance obtained by enterprises in ETS ?
  - Carbon tax rate V.S. carbon price in ETS.



(**Sources**: carbon border regulation mechanism: progress and prospect, green innovation development program, 2021)

2. Renewable Energy Development Policy

- In recent years, the renewable power has developed rapidly with the support of subsidy policy. But it is also faced with problems such as, abandonment of wind power and Photovoltaic power, shortage of renewable energy subsidy funds and failure to receive subsidy funds in time.
- What is the impact of renewable energy subsidy retreat?
- What are the further incentive measures for renewable energy development?
- How to implement the tradable green certificate (TGC) mechanism and the renewable portfolio standard (RPS) system?
- How to coordinate TGC with ETS?

3. Total Coal Consumption Cap Strategy

- Total Coal Consumption Cap Strategy is implemented in some key regions of China, which has synergistic effect on carbon emission reduction and air quality improvement.
- In these key regions, although purchasing electricity power from outside can effectively reduce local coal consumption, the carbon emission reduction benefits depend on the power generation technology of purchased electricity power (such as coal-fired power or renewable energy power).
- In addition, the reduction of coal may lead to the relocation of some local industries with high coal demand, resulting in the risk of carbon emission transfer.
- It is necessary to consider the availability and transportation cost of transporting fuel from the western natural gas intensive area to the key regions.

Contents

1. Industrial Sectors

- The clean hydrogen energy technology in the industrial field is still in the experimental stage and has not been widely pervasive.
- Carbon capture technology has not been widely used in industrial sectors with high difficulty in reducing carbon.
- Due to the extremely high energy requirements of the cement production process, it is difficult to implement the electrification in the heating system.
- The use of alternative materials (such as magnesium oxide) beyond limestone is restricted by the possible shortage of local mineral resources, and related technologies are still being tested.
- The deep decarbonization of the steel industry requires the advancement of bioenergy and hydrogen energy technology.

2. Hydrogen Reduction in the Steel Industry

- Carbon dioxide emissions in steelmaking process can be directly reduced by using hydrogen instead of carbon monoxide as reducing agent, because its reduction product is water rather than carbon dioxide.
- At present, there is no hydrogen production process that can meet both low cost and high yield. Hydrogen production from fossil fuels, which is cheaper but produces carbon emissions; Hydrogen production from industrial by-product is faced with the problem of insufficient supply of raw materials; Hydrogen production from electrolysis water is too expensive, and the existing power supplies are struggling to meet its needs.
- Large-scale storage and transportation of hydrogen remains an industrial challenge.
- The specialized planning, policy system, standard system and safety specification of hydrogen metallurgy in China lack top-level design.
- It takes time for a new technology of direct reduction process from being developed and tested to being applied on an industrial scale, and most of the relevant technologies in China are in the development and testing stage.

3. Power Generation Sector

- In China, current electric power structure is still dominated by coal-fired power generation, the advanced coal-fired power generation technologies, such as Integrated Gasification Combined Cycle(IGCC), and Carbon Capture and Storage(CCS) need to be achieved technological breakthroughs.
- The development of Ultra-High Voltage(UHV) and distributed power generation technology is needed to solve the space mismatch problem because photovoltaic and wind power resource supply and demand regions are inter-provincial mismatched in China.
- Large Scale Energy Storage Technology need to be achieved technological breakthroughs.
- Smart Grid Technology also need be enhanced to meet the requirement of large scale utilization of wind power and PV.

4. Offshore Wind Power

- Under the influence of the epidemic and the subsidy retreat, the cost is the main constraint on the development of offshore wind power projects.
- The increasingly stringent marine environmental protection regulations have gradually narrowed the development space of offshore wind resources, hindering the large-scale construction of offshore wind power projects.
- The bottlenecks of core technologies need to be broken through, and the localization level of key components needs to be accelerated. The lack of core technologies makes the cost of offshore wind not only higher than onshore wind, but also much higher than coal and gas.
- The reliability of offshore wind turbines has not been fully verified, the operation and maintenance face huge challenges, such as long maintenance cycle, insufficient intelligent diagnosis ability, operation and maintenance should be made by use of transportation tools, with high cost and many use restrictions.

5. Transportation Sector

- Decarbonization technologies for electric vehicles, commercial vehicles, and civil aviation in the transportation sector are facing bottlenecks.
- Electric vehicles mainly replace traditional vehicles in the passenger car field. There is a lack of commercialized mass-produced electrification technology in the freight and commercial vehicle fields.
- The application of hydrogen energy in the transportation field needs to solve technical problems such as low hydrogen energy conversion efficiency, high carbon emissions in the hydrogen production process of hydrogen fuel cells, and difficulties in fuel storage and transportation.
- The current battery energy density of pure electric technology for electric vehicles is limited, which limits the endurance of trucks. The conventional batteries are not suitable for long-distance driving of trucks.

6. Zero Emissions Transportation

- The integrated charging station with photovoltaic and energy storage has disadvantages such as high construction cost, low photovoltaic conversion rate, and difficulty in commercial profitability.
- Producing Hydrogen from electrolysis water for fuel cell will increase the demand for electricity. Fuel cell electric vehicles using hydrogen has problems such as high cost, lack of infrastructure, and immature hydrogen storage and transportation technology.
- The development of charging highway is limited by battery energy density.
- The cruising range and load capacity of electric vehicles are much lower than those of fuel vehicles.
- The key issues in the decarbonization of long-distance air transportation are (1) the cost-effectiveness of bio-aviation fuel and synthetic aviation fuel, and (2) the sustainable supply capacity of biomass resources.

7. Construction Sector

- Zero energy consumption building technology still needs improvement.
- Comprehensive electrification of energy consumption in the construction sector is the key to reducing direct carbon emissions, especially the full electrification of building heating, cooking, domestic hot water and steam energy consumption of special buildings in non central heating areas.
- Further strengthening of renewable energy heat pump technology is needed to promote the development of ultra-low energy consumption buildings.
- The technology of Building Integrated Photovoltaic(BIPV) System should be enhanced.

8. Carbon Capture, Utilization and Storage (CCUS)

- **Carbon Capture Technology :** the first generation carbon capture (such as post-combustion capture technology, pre-combustion capture technology and oxygen-enriched combustion technology) is becoming mature. The main bottlenecks are high cost and high energy consumption. The second generation technology (such as new membrane separation technology, new absorption technology, pressurized oxygen-enriched combustion technology, etc.) is still at the stage of laboratory research or small-scale test.
- **Conveying technology:** tank car transportation and ship transportation are at commercial application stage, but the submarine pipeline transportation is still at research stage.
- **Utilization and storage technology:** there are still some technical bottlenecks in the combination of post-combustion CO_2 capture system and chemical conversion and utilization unit.
- **Direct Air Carbon Dioxide Capture and Storage(DACCS):** still at basic research stage, the technical maturity and economy need to be improved, and the emission reduction potential is difficult to release in the short term.
- **Bioenergy with Carbon Capture and Sequestration(BECCS):** insufficient promotion of supporting technology and shortage of required biomass fuel supply.

Thanks for your attention