



Comments and Discussions on 「Challenges of Decarbonization Policies and Technological Innovation toward Carbon Neutral Society in China」
Presented by Prof. Jun PANG

Hongbo Ren

Shanghai University of Electric Power

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Summary of presentation by Prof. Pang

➤ **Pathway for China to achieve Carbon Neutrality**

Stage One (2021-2030): Reach Carbon Peak; Stage Two (2031-2045): Rapidly Reduce Carbon Emissions; Stage Three (2046-2050): Deep Decarbonization.

➤ **Challenges of Policies toward Carbon Neutrality in China**

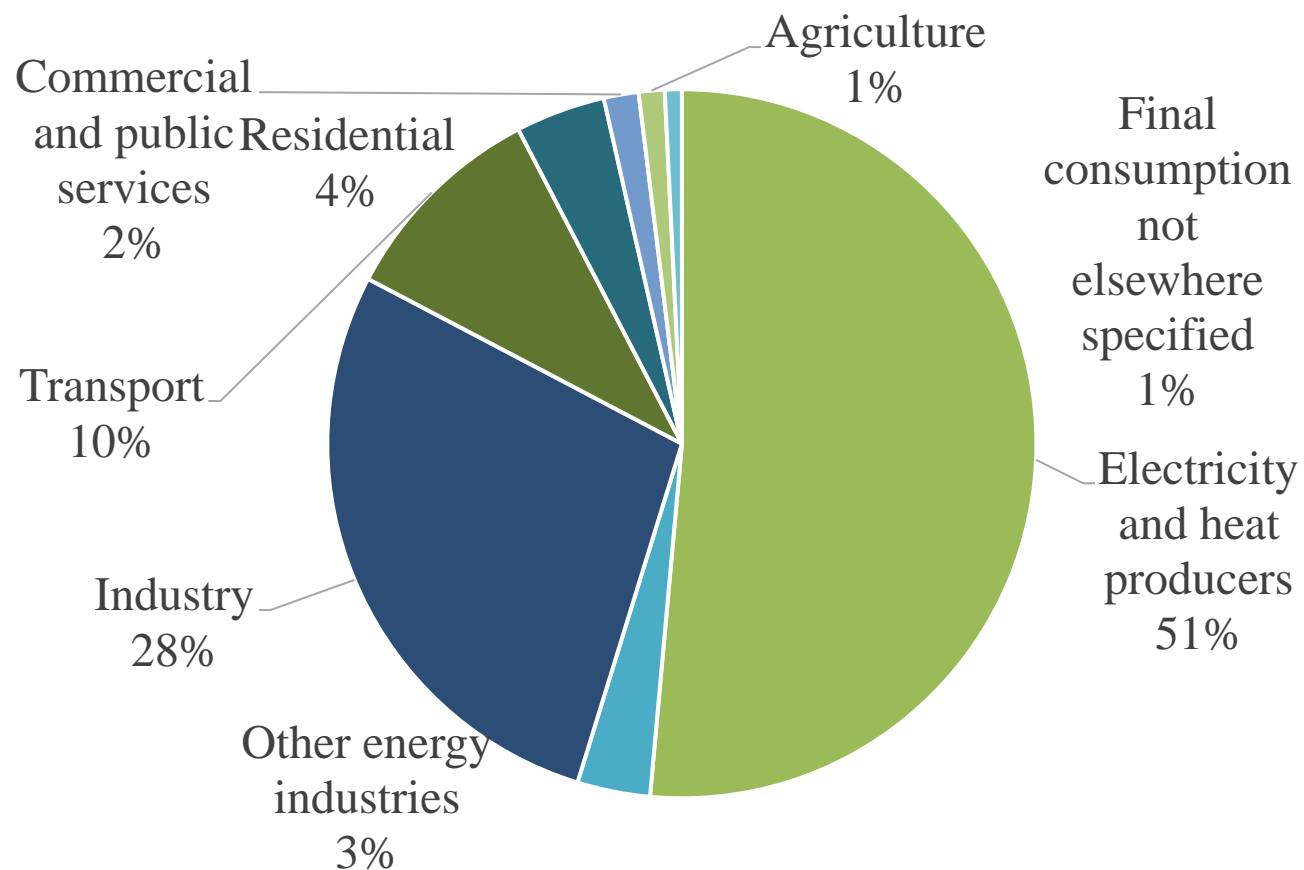
- ✓ Carbon tax V.S. ETS;
- ✓ Renewable energy development policy (Subsidy, tradable green certificate mechanism, renewable portfolio standard;
- ✓ Total coal consumption cap strategy.

➤ **Challenges of technological innovation toward Carbon Neutrality in China**

- ✓ Industrial sector;
- ✓ Power generation sector;
- ✓ Offshore wind power;
- ✓ Transportation sector;
- ✓ Construction sector;
- ✓ CCUS

Summary of presentation by Prof. Pang

China's Carbon Emission Structure 2018



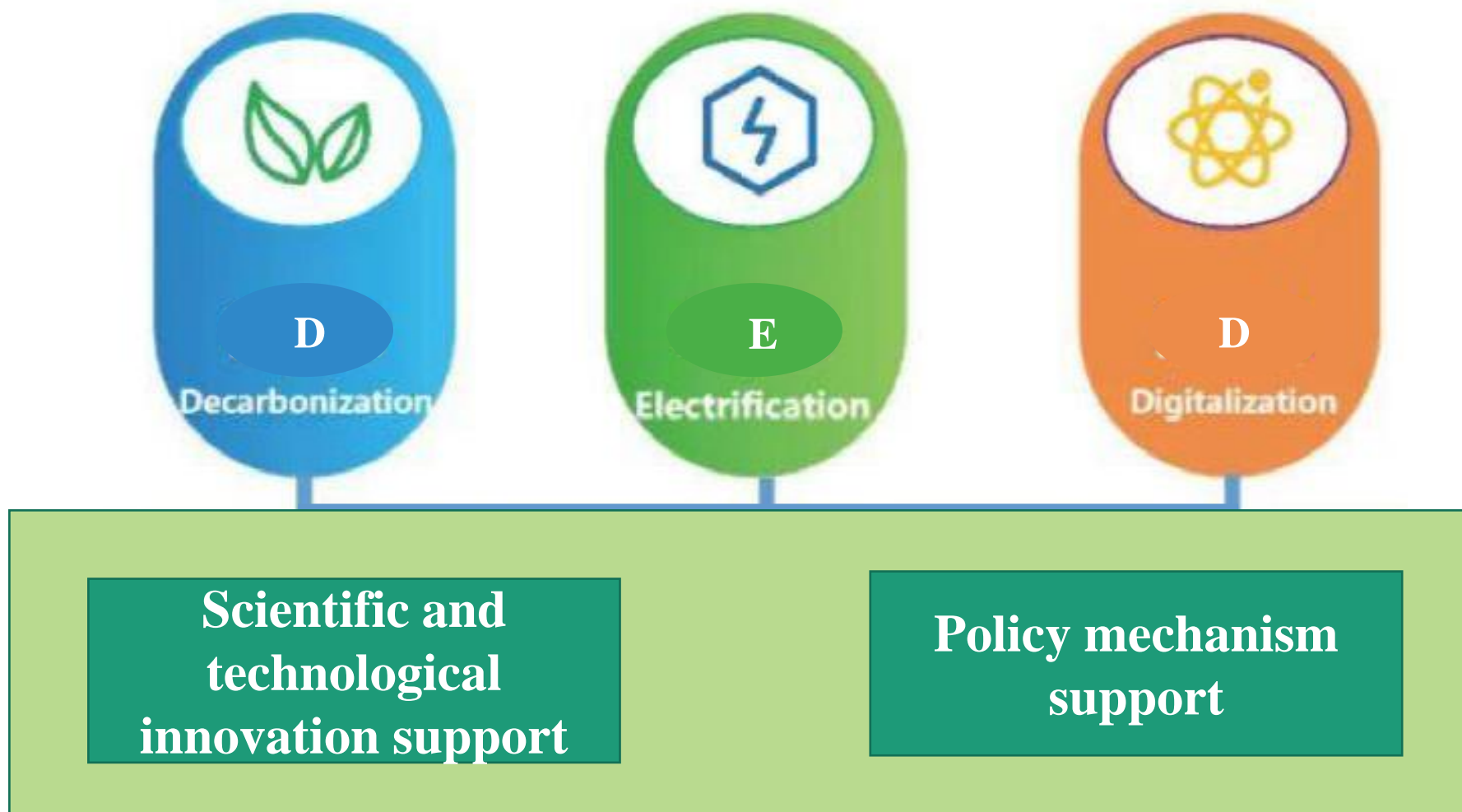
Energy sector

Industry sector

Transportation sector

Building sector

Key path of carbon neutrality



Key path of carbon neutrality

Supply-side

Renewable
energy



Zero-carbon



Zero-carbon
Electricity



Power to X



Zero-carbon fuel

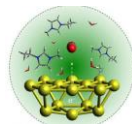
CO₂



H₂



Synthetic
fuel



Demand-side

Re-electrification



Intelligence



High-efficiency

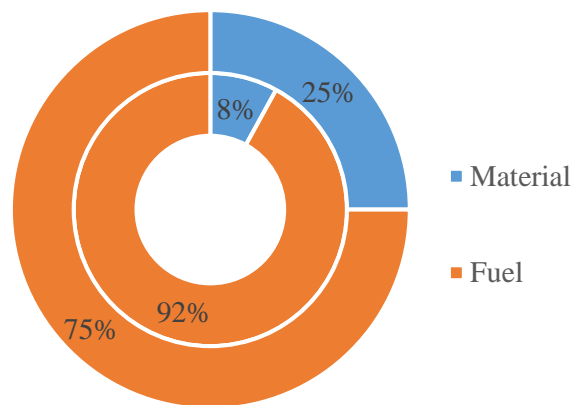


Supply-side strategy

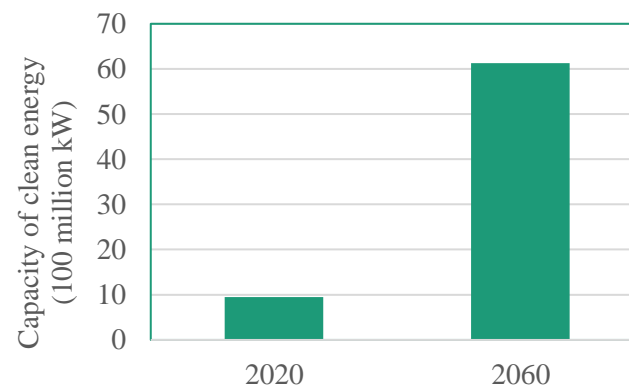
- Reduce carbon emissions from the producer side, replace fossil energy fuels by non-fossil energy sources, use its raw material properties, and increase the share of non-fossil energy consumption.
- Increase the capacity and power generation of clean energy, 40 years later, new energy sources will replace fossil fuel as the main fuel source, its installation capacity will achieve **5.2 billion kW**.
- The current carbon emissions by industry is up to 1.3 billion tons. To reduce the emissions, low-carbon raw materials should be used instead of high-carbon materials, so that the emission will drop to **less than 300 million tons** in 2060.

Consumption of fossil energy used as fuel
(0.1 billion TCE)

Year	2020	2060
Coal	27	3
Oil	8	1
Gas	4	2
Total	39	6



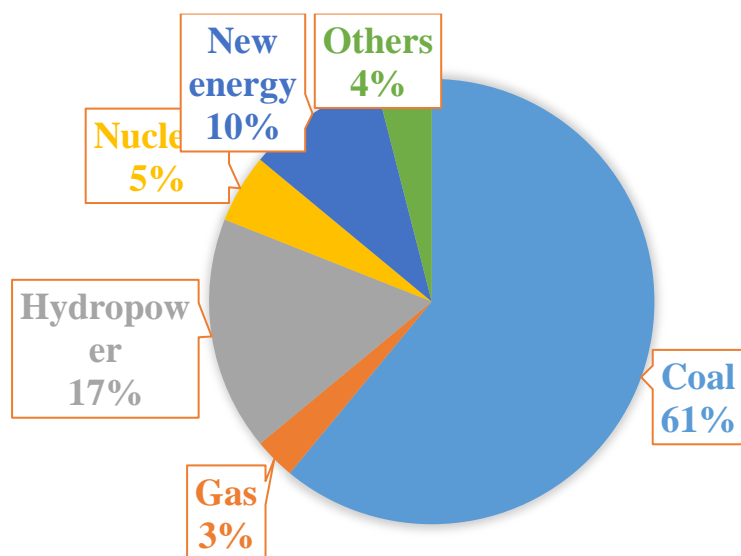
Share of fuel and material
consumption in fossil energy



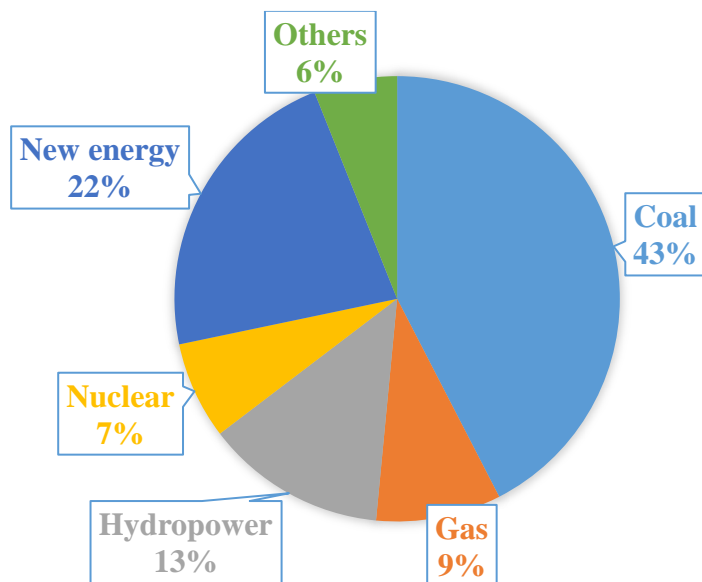
Domestic capacity of clean energy

Supply-side strategy

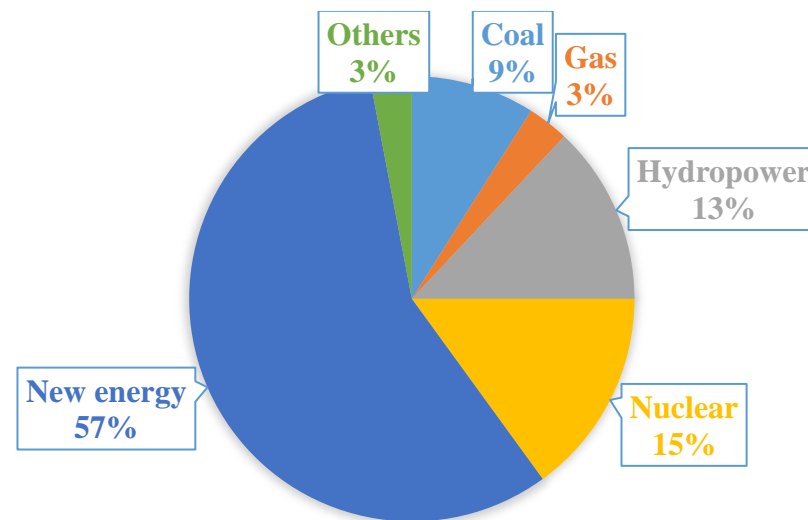
- Non-fossil power generation mainly with new energy can meet the new power demand after 2030, and it will replace the existing fossil-fuel based power generation gradually.
- After 2030, the growth rate of traditional non-fossil energy such as hydropower, nuclear power and biomass will gradually slow down due to the constraints of resources and station sites, and the development rate of new energy will further increase.



Share of power capacity
in 2020



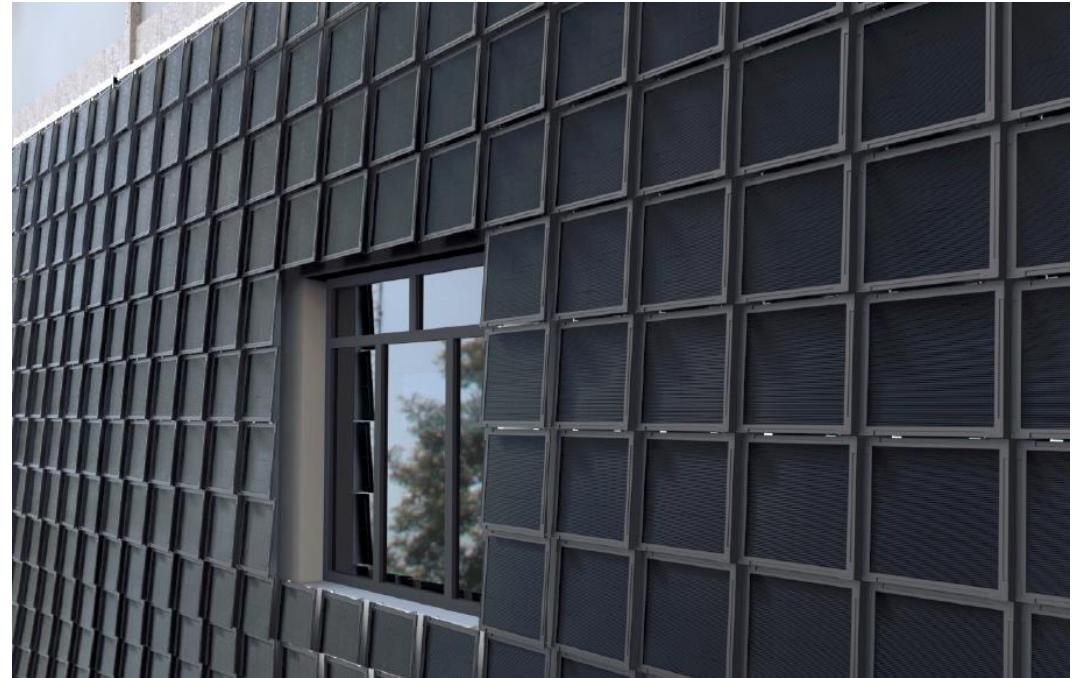
Share of power capacity
in 2030



Share of power capacity
in 2060

Supply-side strategy: PV+

- In June 2021, the Chinese government proposed a pilot scheme for the development of roof distributed PV system in the whole country (city, district), **676 counties and cities** are selected as the first batch of pilot projects.

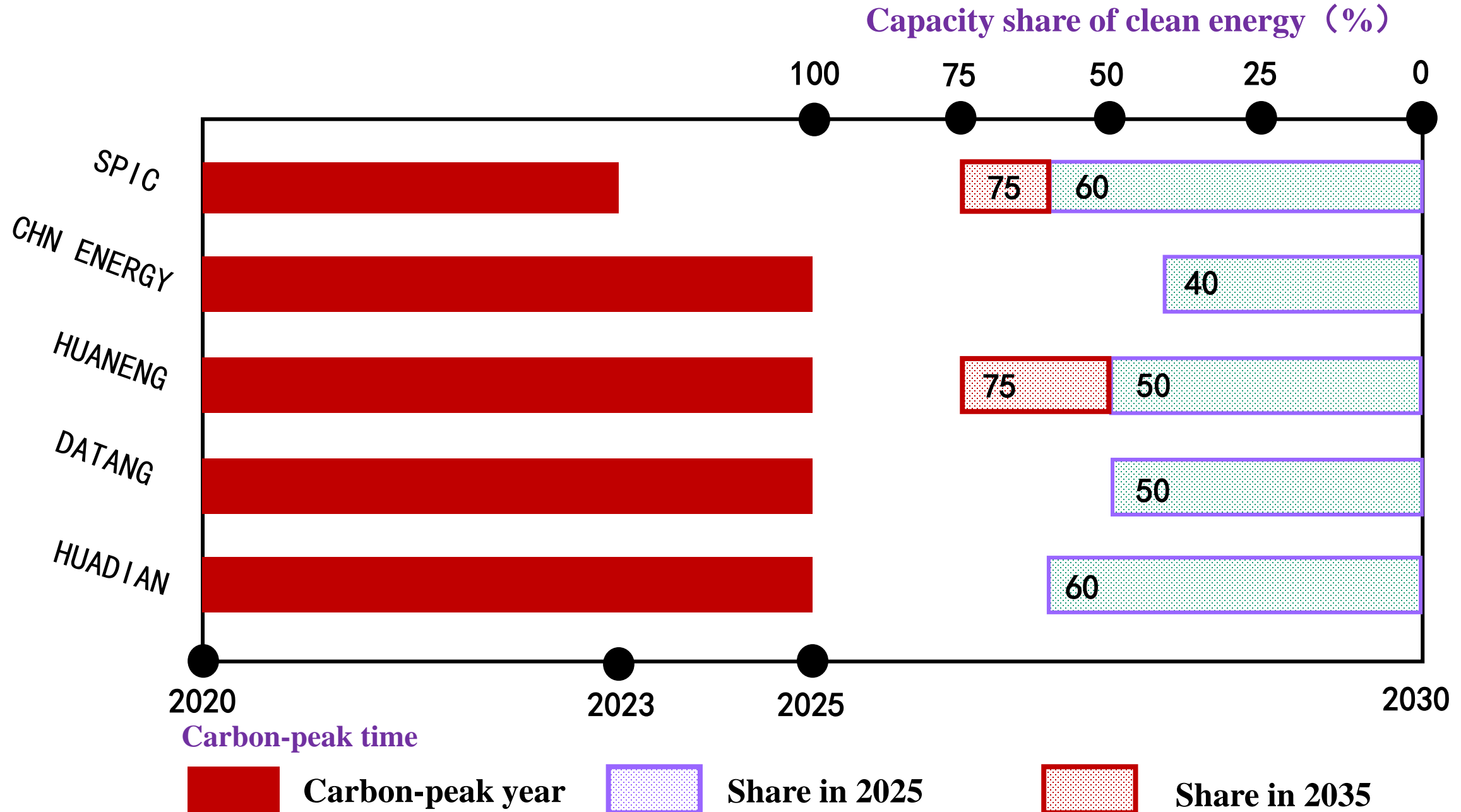


Supply-side strategy: Offshore wind power

- Accelerate the development of offshore wind power. Use the 500 million kW of exploitable volume of China's eastern seas, accelerate the layout of offshore deep water, and gradually develop in the direction of distant seas.



Supply-side strategy: Five power generation groups



Demand-side: Electrification

- Satisfy energy requirements in sectors of industry, construction and transportation with the clean electricity. It is estimated that to 2060, 95% non-fossil energy would be replaced by electricity, and the percent of the electricity over all end-use energy consumption would be more than 70%.

Energy efficiency		
Application	Electric equipment	Traditional equipment
Industrial and building heating	Electric boiler (95%) Heat pump (300%-500%)	Gas-fired boiler&coal-fired boilers (70-90%)
Cooking	Induction cooker (85%)	Gas stove (40-50%)
Transportation	Electric vehicles (90%)	Vehicles (40-50%)



Electric heat storage boiler



High efficiency heat pump



Shore power at ports



Charging infrastructure

Demand-side: Electrification



Industrial sector: annual carbon emissions is 3.3 billion tons and electrification rate is 26%. Accelerating electrification in industry and developing electric furnace steelmaking, electric boilers, etc., can lead industry to carbon peak and carbon neutrality. It is expected that the industrial electrification rate will reach 34% and 70% in 2030 and 2060 respectively.



Building sector: annual carbon emissions is 900 million tons, electrification rate approaches 40%. Promoting the electrification of building heating, hot water supply and cooking, accelerating the development of distributed energy on rooftops and walls. It is expected that the electrification rate of building will reach 50% and 80% in 2030 and 2060 respectively.



Transportation sector: annual carbon emissions are 900 million tons, and the electrification rate is less than 4%. Focus on technological progress of electric vehicles, electrified railroads, urban rail transit, port shore power and airport bridge power. It is expected that the electrification rate of transportation will increase to 10% and 50% in 2030 and 2060.

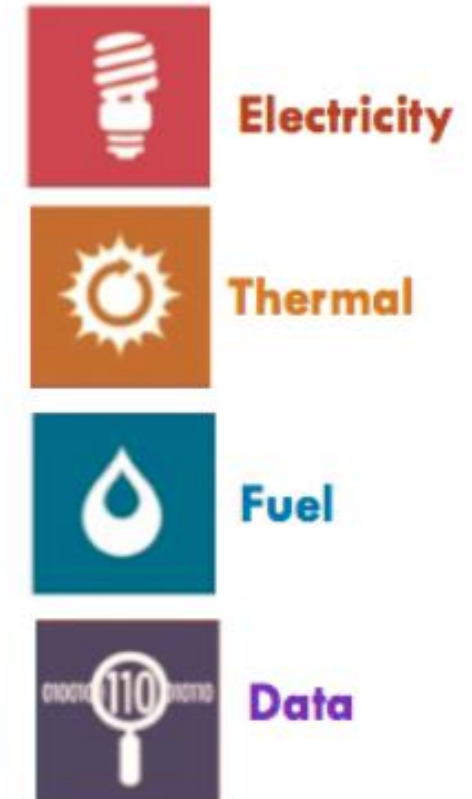
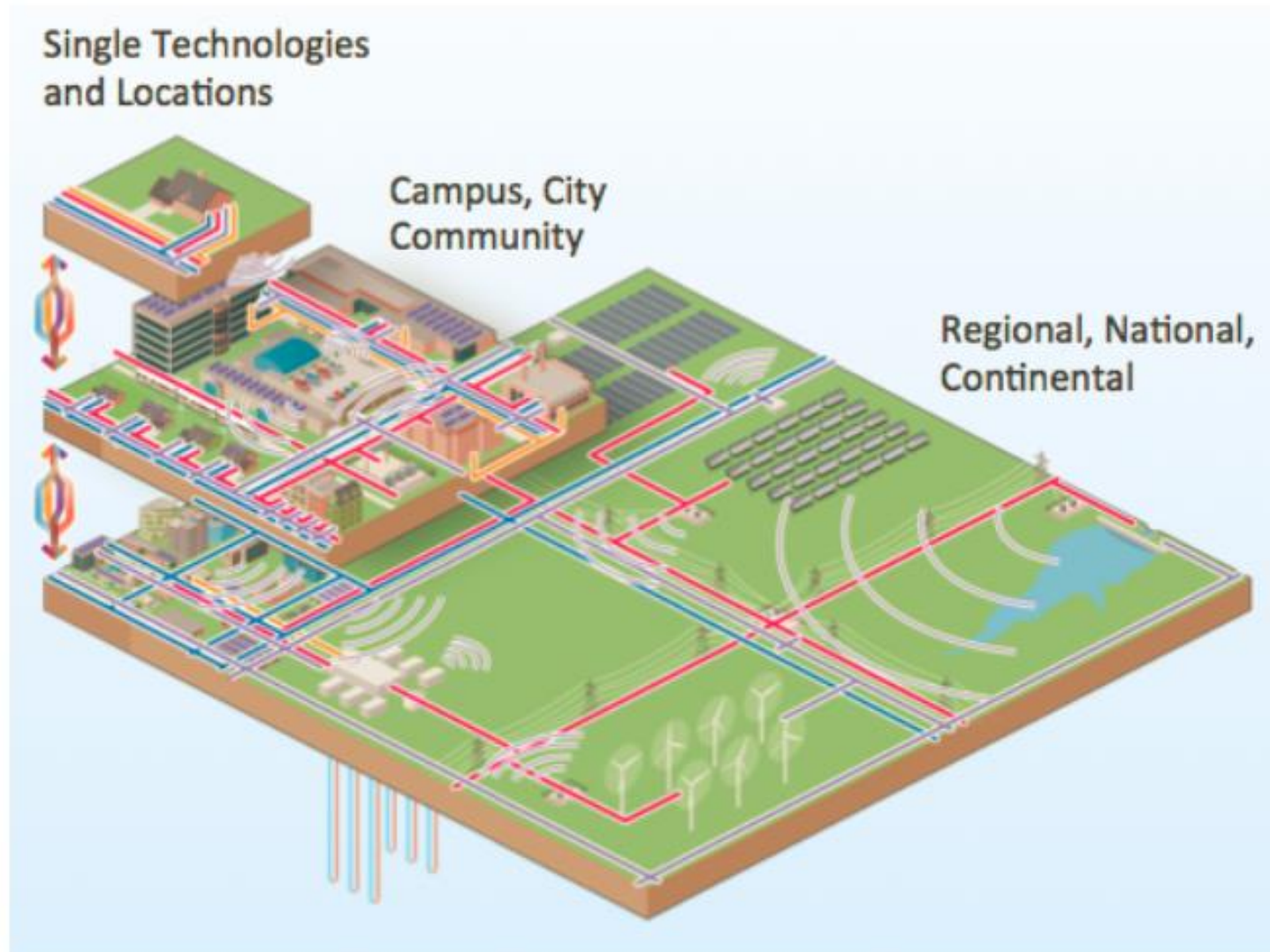
“Source-Network-Load-Storage” Integration

- ❑ The values of energy system integration is coordinating how energy systems produce and deliver energy in all forms to reach reliable, economic, and environmental goals at appropriate scales.
- ❑ The two power grid companies and the five power generation groups are actively promoting the development of integrated energy systems.



= ESI Energy Systems Integration optimizes energy systems across multiple pathways and scales

“Source-Network-Load-Storage” Integration

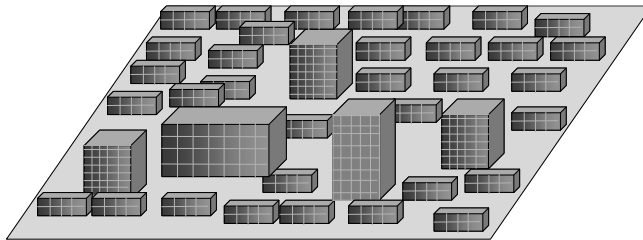


From energy system to urban planning

Urban space

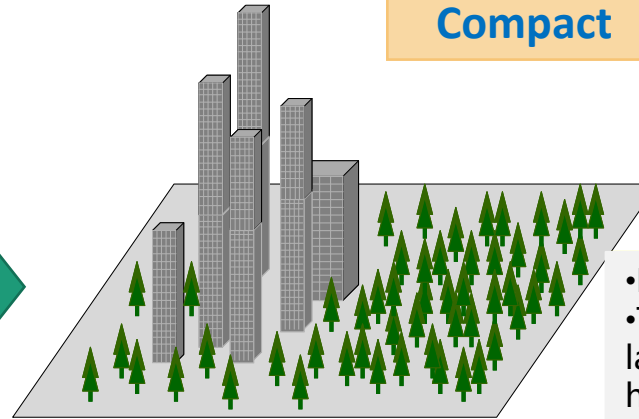
Spread

- Low-rise, low plot ratio
- Lack of green



Compact

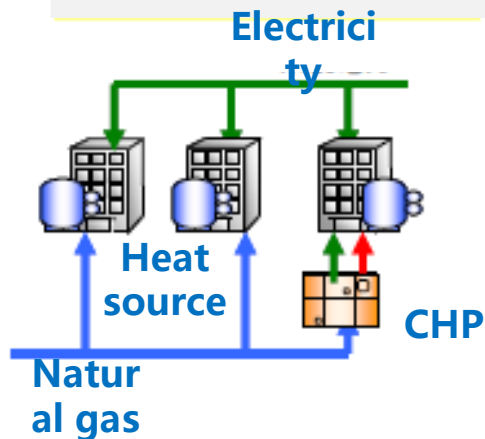
- Mixed-use
- Three-dimensional land use (High-rise, high plot ratio)
- More green space



<Independent energy system>

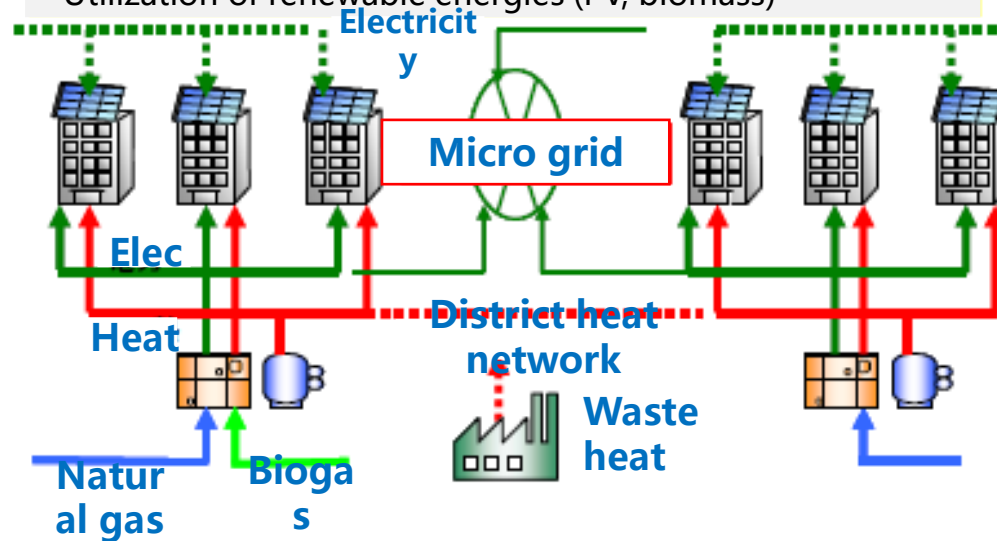
- Part-load operation
- Low heat utilization ratio

Energy system



<Area energy system based on distributed energy>

- Load leveling, improve part-load performance
- Improve heat utilization ratio and total system efficiency
- Utilization of renewable energies (PV, biomass)



Energy Internet

「CEMS」

○Share of local energy resources within the community

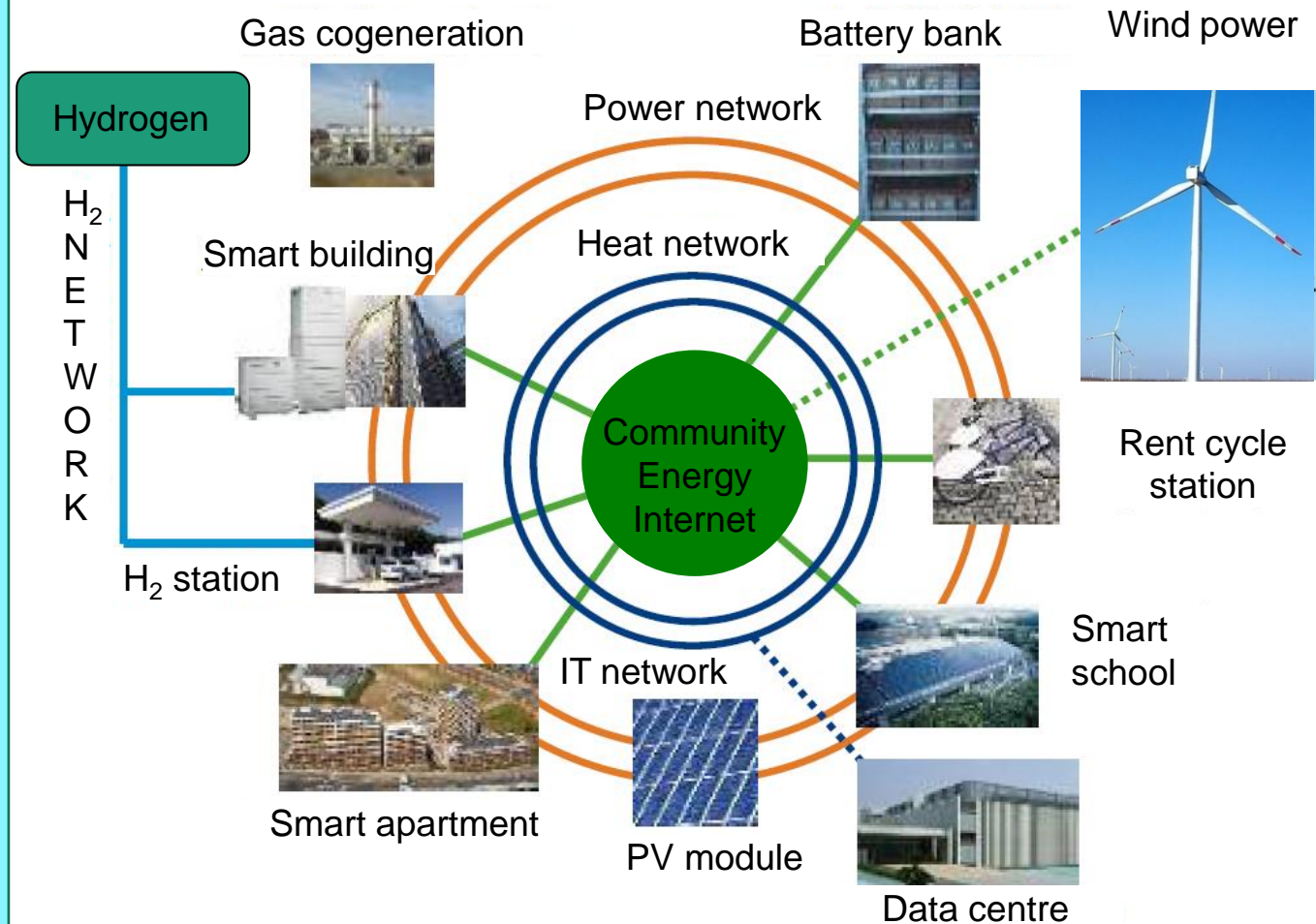
- High-efficient use of local energy
- Optimal energy management of single customer and the whole community

○Visualization and instruction of energy information

- Inclusion of users within the energy management
- Local energy interchanging

○Introduction of inception for user inclusion

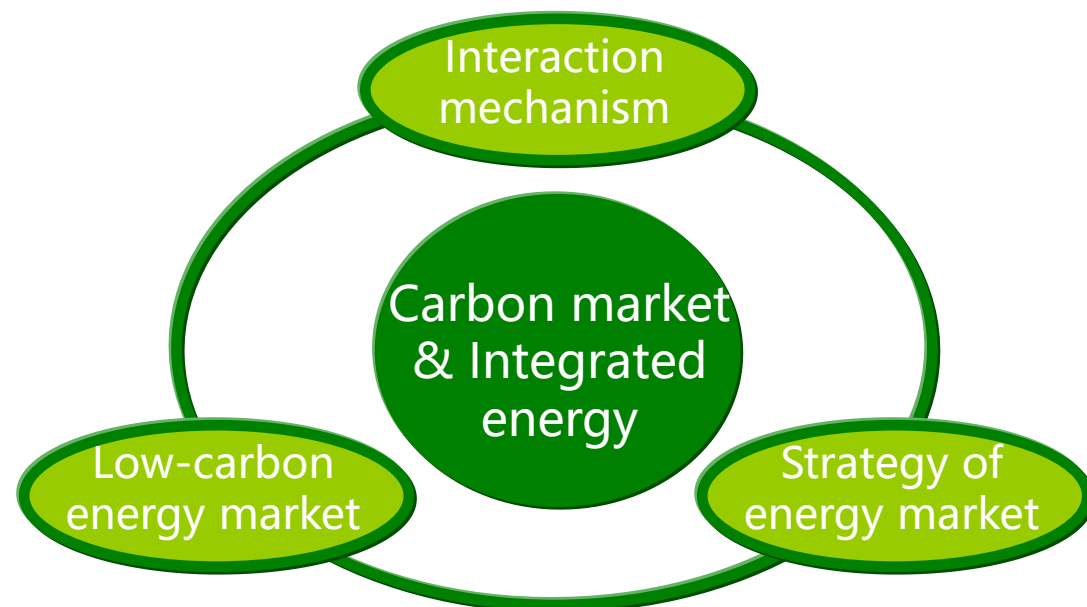
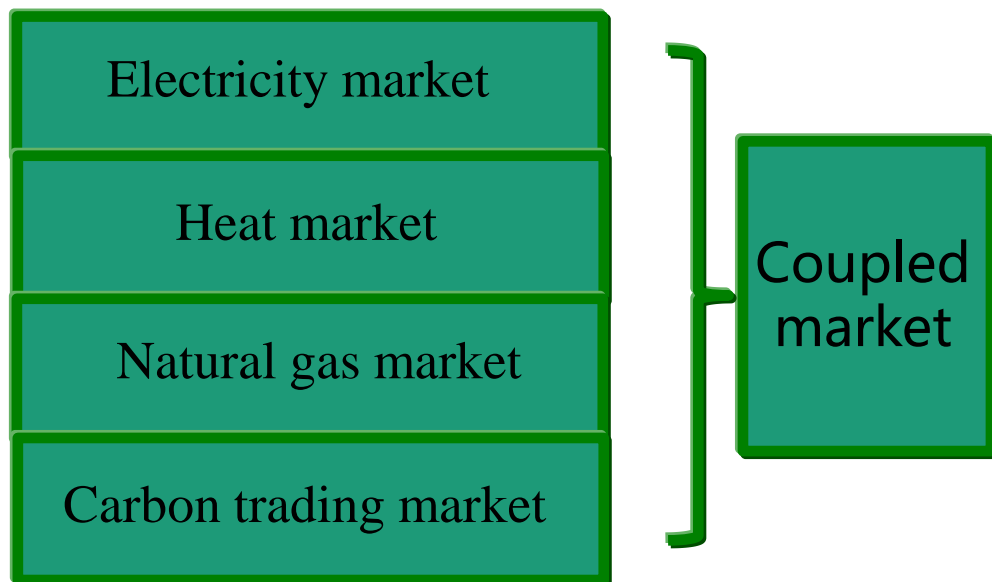
- Dynamic pricing system
- Eco-point



Minimization and cleaning of community energy utilization

Carbon market + energy market

- Under the goal of "carbon neutrality", the construction of national carbon trading market is accelerated, which may form a coupled framework of "Carbon Asset Management + integrated energy“.
- Interaction mechanism and price transmission mechanism between carbon market and multi-energy market.



Thanks!