



CHINA 2050 HIGH RENEWABLE ENERGY PENETRATION SCENARIO AND RODAMAP STUDY

**CHINA NATIONAL RENEWABLE ENERGY CENTER
ENERGY RESEARCH INSTITUTE OF NDRC
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国家发展和改革委员会能源研究所

Energy Research Institute National Development and Reform Commission



中国2050年高比例 可再生能源发展情景暨途径研究

CHINA 2050 HIGH RENEWABLE
ENERGY PENETRATION SCENARIO
AND ROADMAP STUDY





Partnership

Core Working Group:



中关村储能产业技术联盟
储能专业委员会
CHINA ENERGY STORAGE ALLIANCE



国家电网
STATE GRID

国网能源研究院
STATE GRID ENERGY RESEARCH INSTITUTE



国家发展和改革委员会能源研究所
Energy Research Institute National Development And Reform Commission



国家可再生能源中心
CHINA NATIONAL RENEWABLE ENERGY CENTRE



中国科学院·电工研究所
IECCAS



中国气象局
风能太阳能资源中心
CMA WIND AND SOLAR ENERGY RESOURCES CENTER



国家电网
STATE GRID

中国电力科学研究院
CHINA ELECTRIC POWER RESEARCH INSTITUTE

Technical Support:



THE ACHIEVEMENT of “CHINA 2050 HIGH RE PENETRATION SCENARIO” IS the KEY FACTOR for OUR “BEAUTIFUL CHINA”



High Renewable Energy Penetration Scenario

Economic Dreams



Ecological Dreams



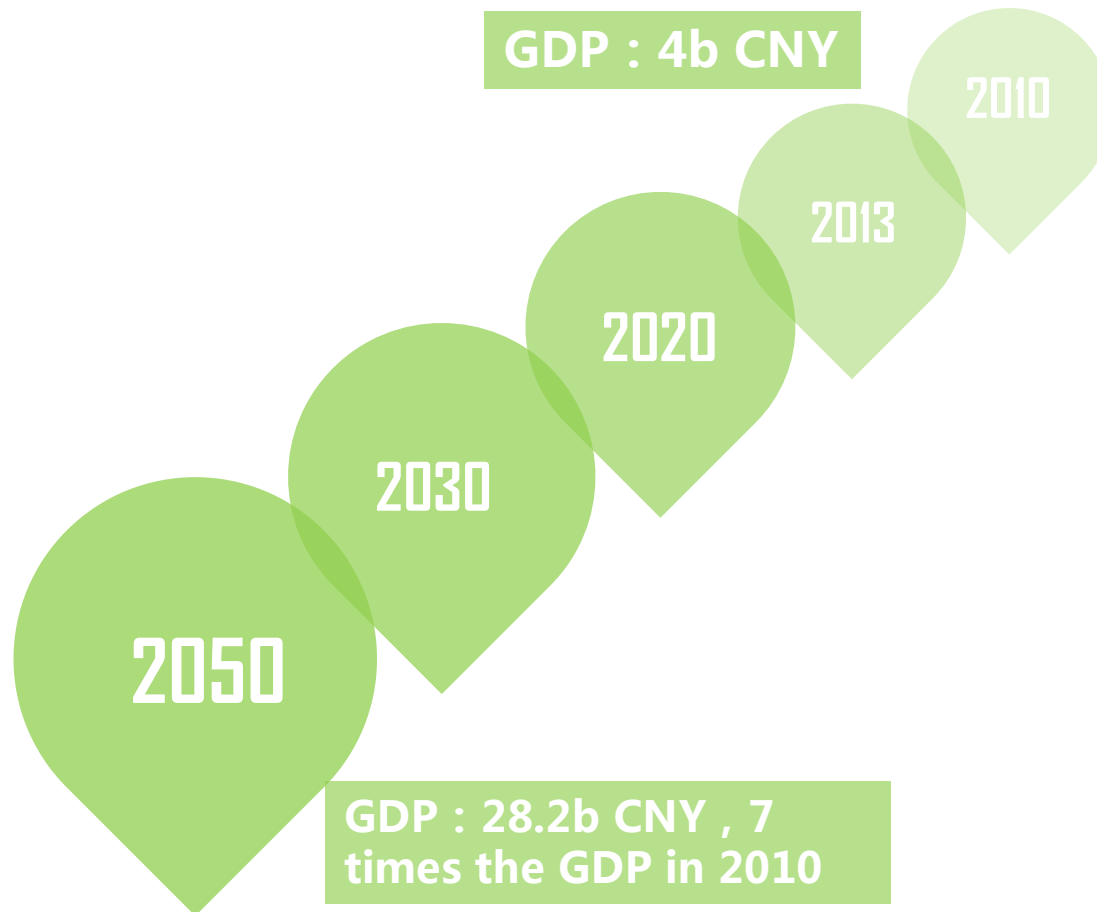
To get rid of fossil fuels is our global development trend. Ecological civilization is the moral high ground of human development.



THE ACHIEVEMENT of “CHINA 2050 HIGH RE PENETRATION SCENARIO” IS VISION AND CONSENSUS OF THE WHOLE SOCIETY



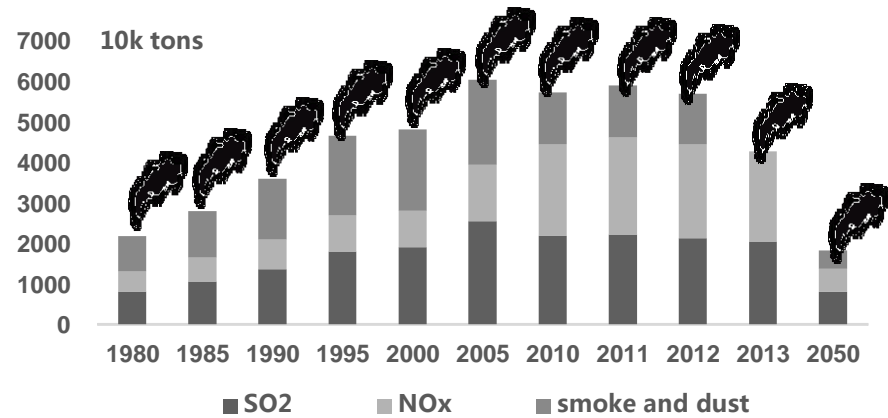
ECONOMIC DEVELOPMENT



ECOLOGICAL ENVIRONMENT

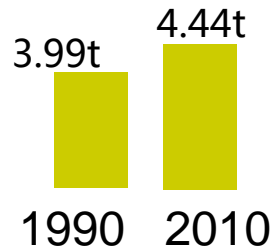


The emission trends of various main air pollutants

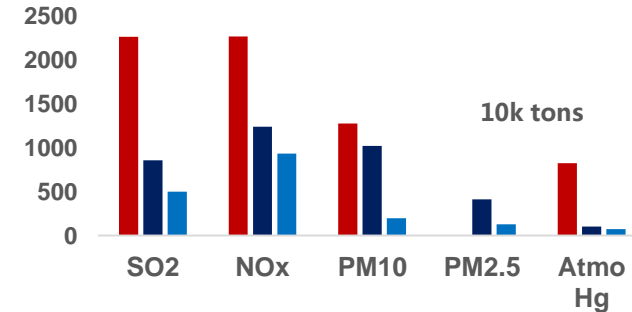
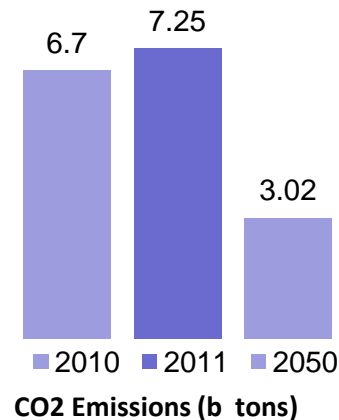


Pollutant Emissions
Below the level of emissions in 1980

CO2 Emissions
3b tons of annual CO2 emissions, 2.17 tons of emissions per capita



The level of global average emissions



Power sector emissions

1.4b tons in 2050,
3.2b tons in 2010

■ China ■ USA ■ EU



MAIN CALCULATED RESULTS for HIGH RENEWABLE ENERGY PENETRATION in 2050



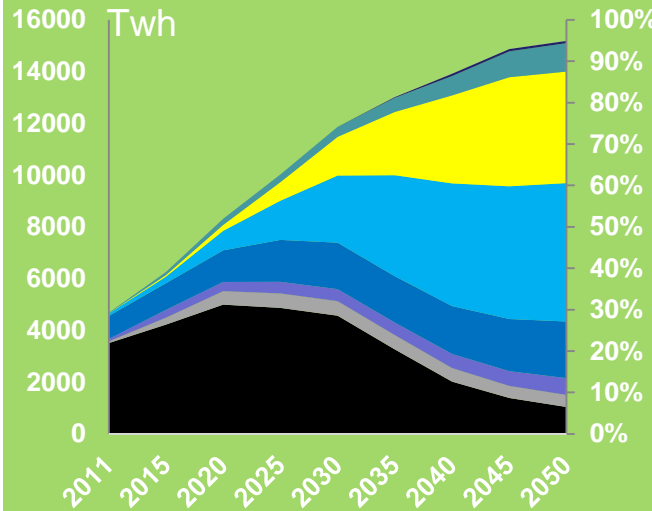
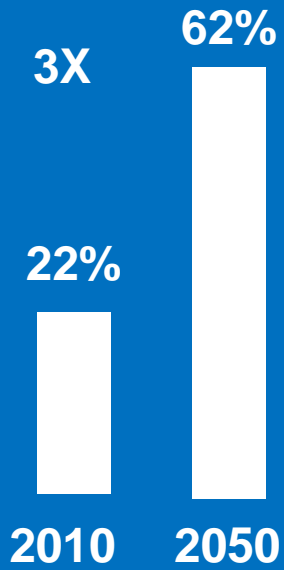
The rate of electrification to be higher than 60% in end-use energy consumption



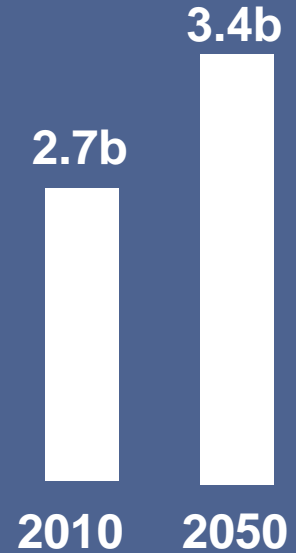
The proportion of non-fossil energy generation to be higher than 91%



3.4 billion tce of primary energy supply, and 3.2 billion tce of end-use energy consumption



2400GW of wind capacity, 2600GW of solar power capacity, and 9660TWh of total annual power generation



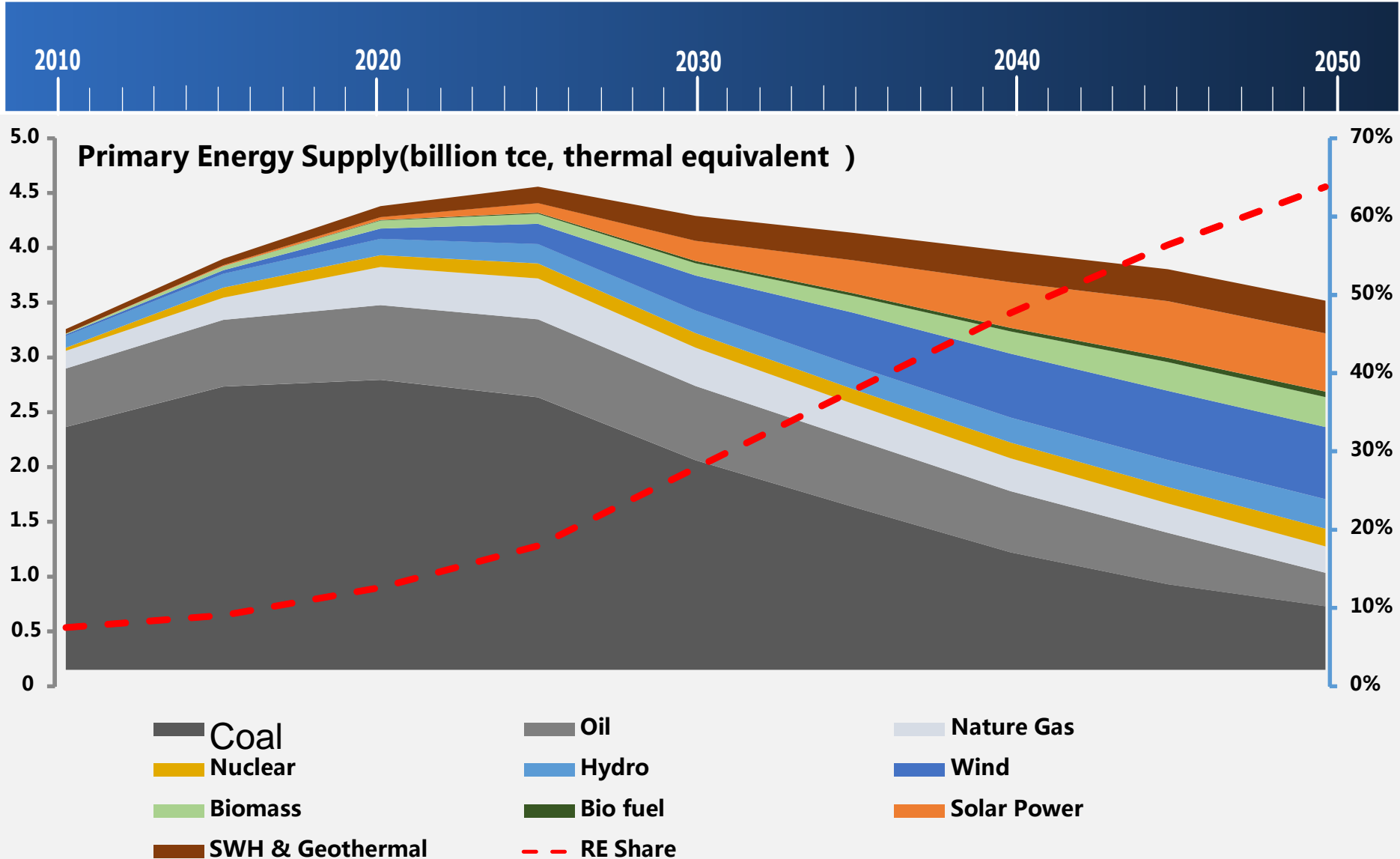
HIGH RENEWABLE ENERGY PENETRATION SCENARIO: PARTHWAY



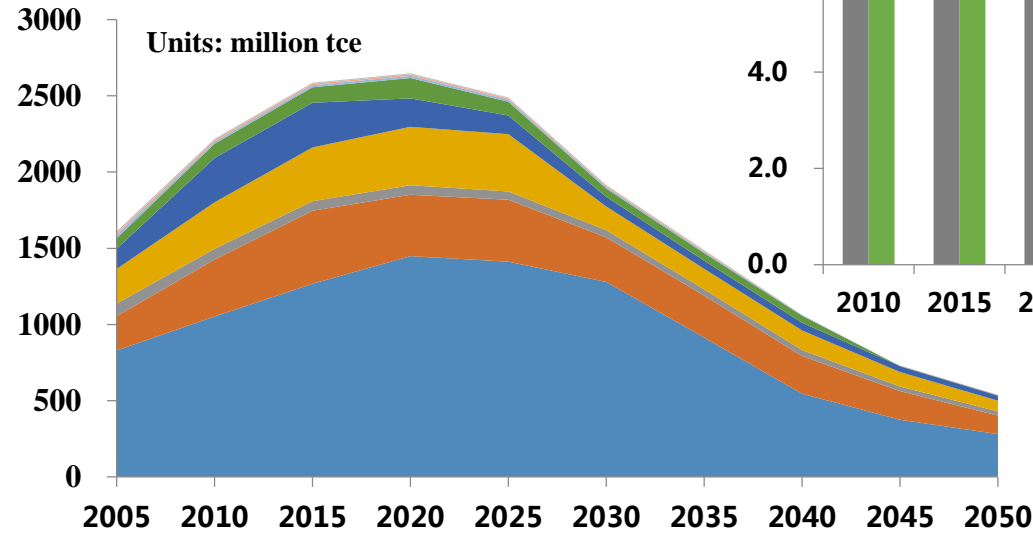
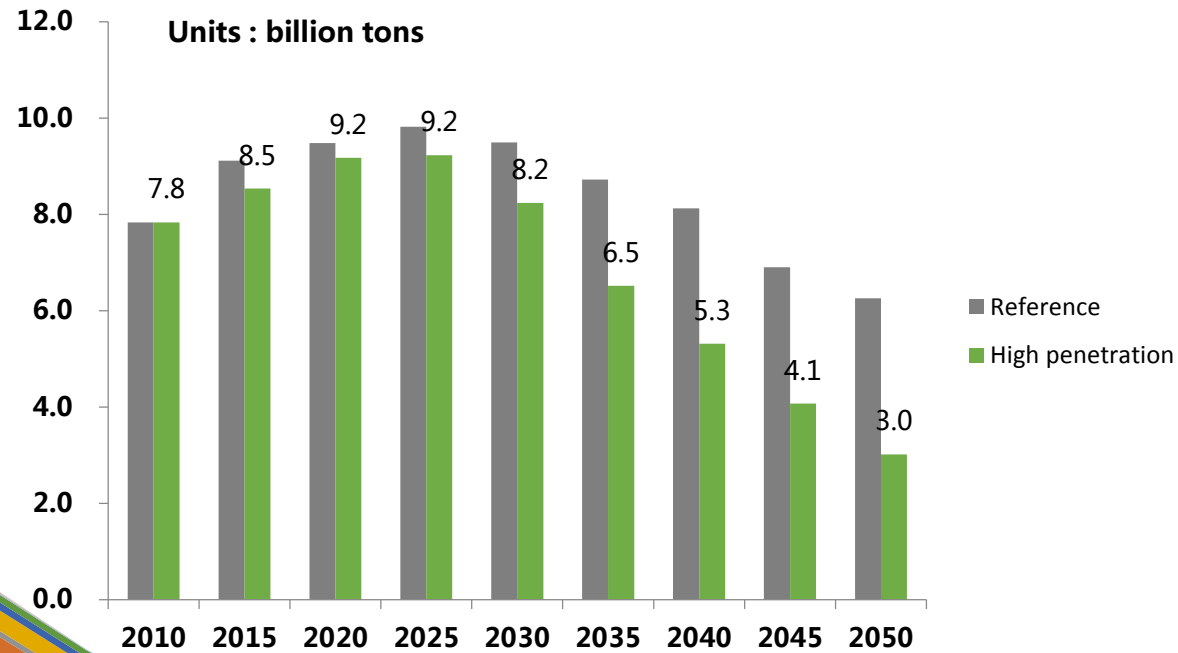
**TEN CONCLUSIONS OR
TEN THINKS?**



BY 2050, RENEWABLE ENERGY COULD MEET MORE THAN 60% OF PRIMARY ENERGY DEMAND

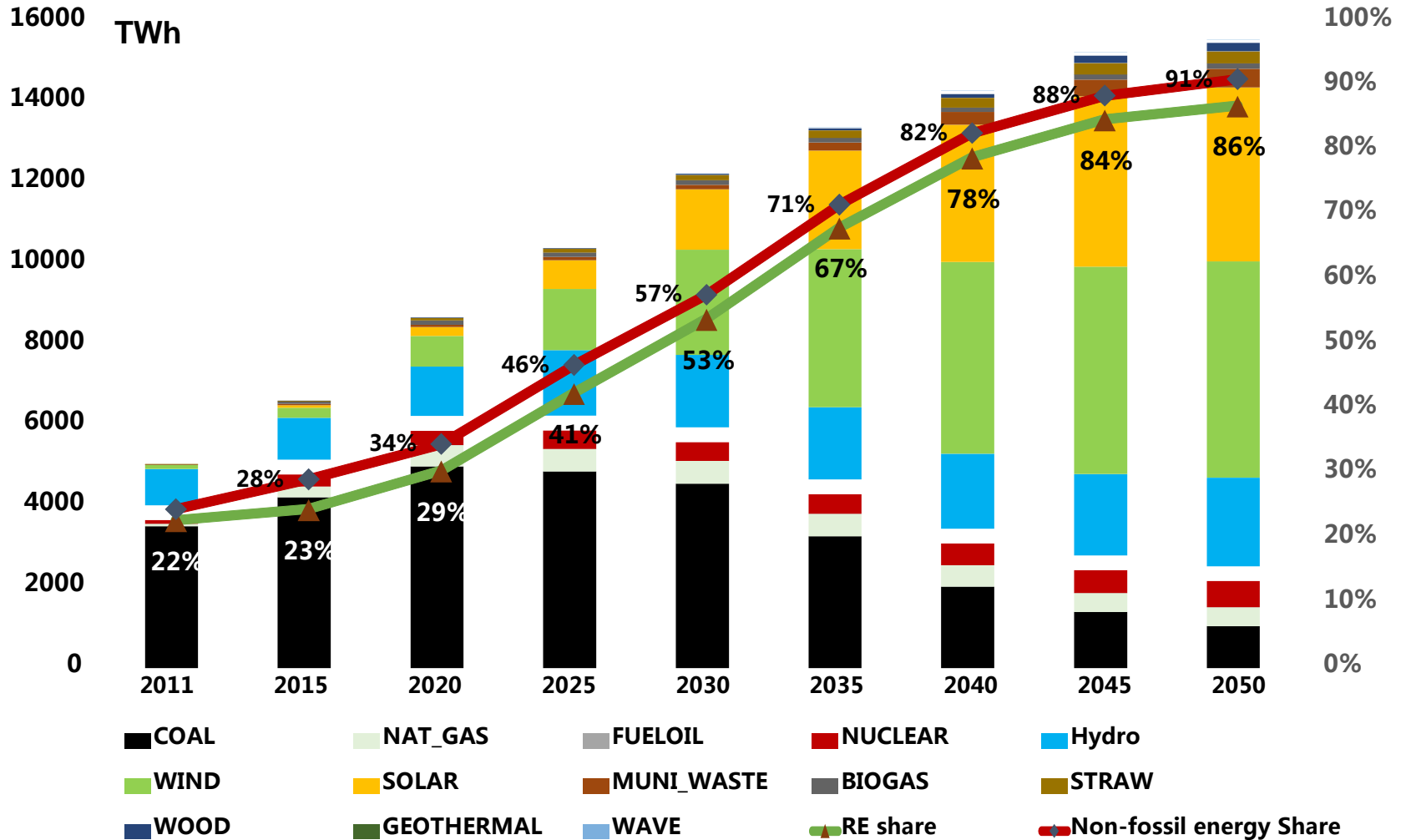


HIGH RENEWABLE ENERGY PENETRATION WILL PROMOTE FOSSIL ENERGY CONSUMPTION AND CARBON EMISSIONS TO PEAK BY 2025

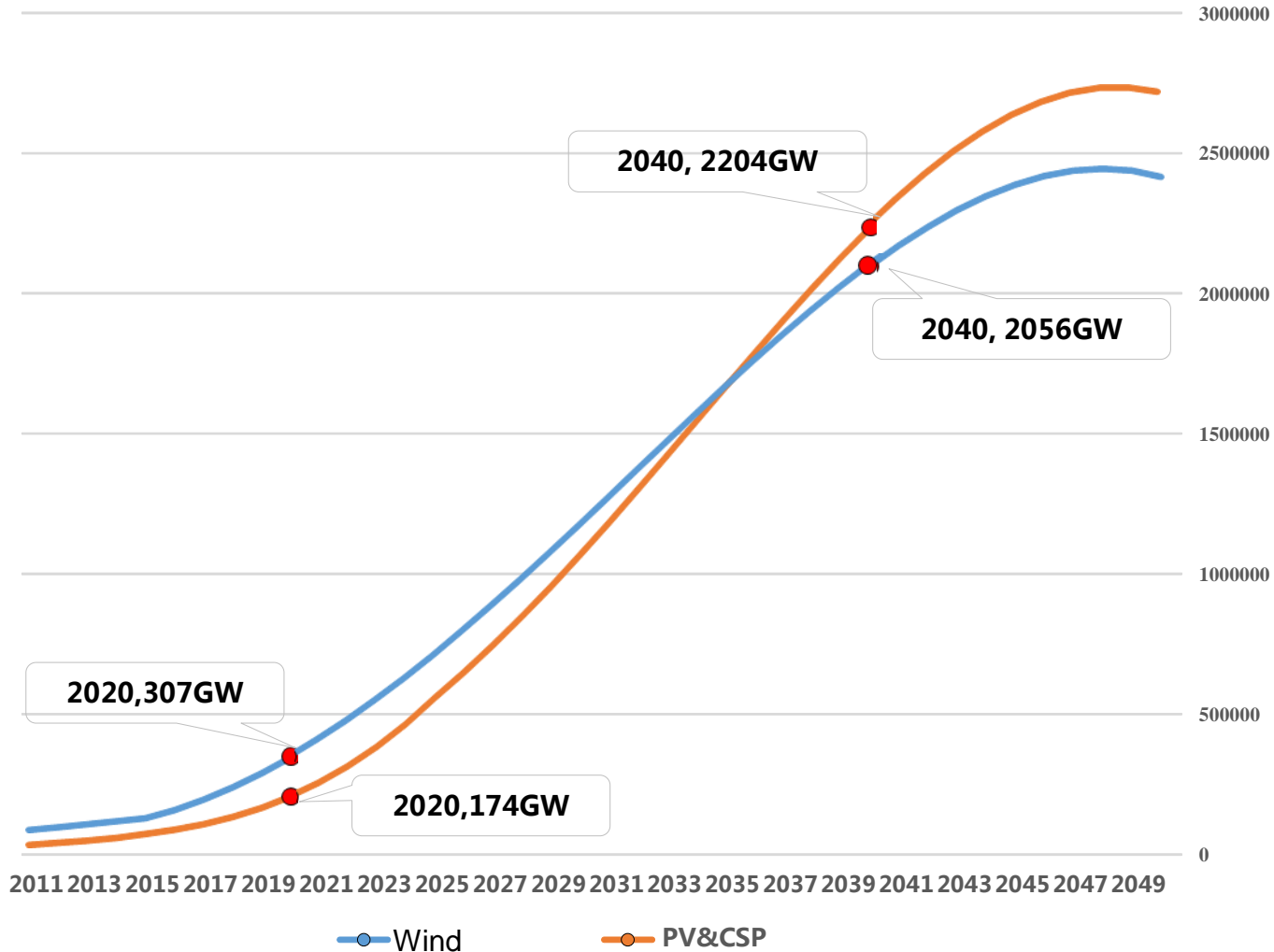


- Electricity
- Coke
- Chemical
- Manufacturing
- Metal smelting
- Services
- Residents
- Transport
- Agriculture

RENEWABLE POWER IS THE ESSENTIAL REPLACEMENT FOR FOSSIL ENERGY



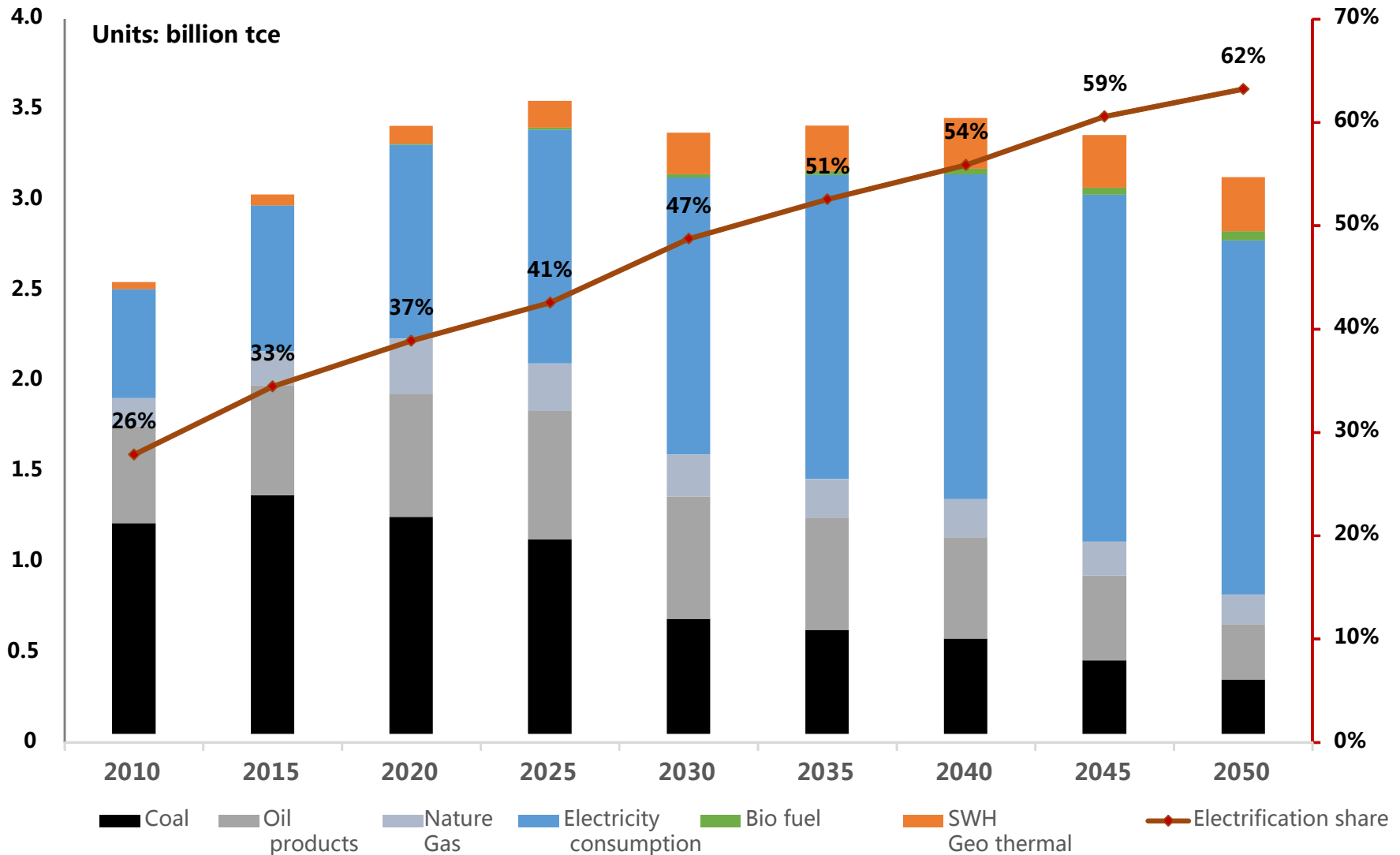
WIND POWER AND SOLAR POWER WILL BECOME IMPORTANT PILLARS OF THE FUTURE POWER SUPPLY



Development Phase Diagram of Wind and Solar power in High Penetration Scenario



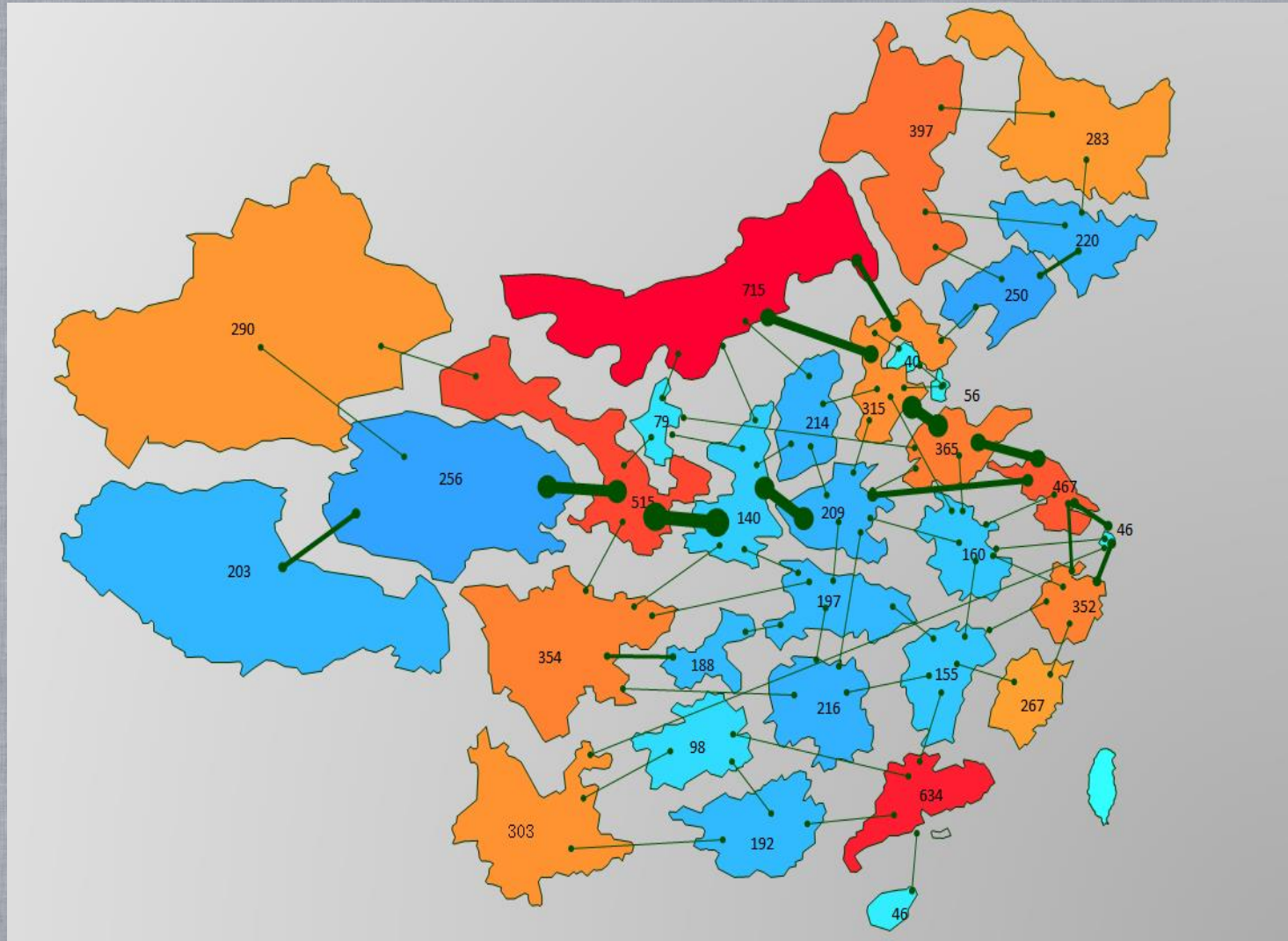
HIGHER ELECTRIFICATION RATE BRING HUMAN SOCIETY INTO MORE HIGHER LEVEL OF CIVILIZATION FORMATION



TRANSFORM THE ELECTRICITY TRANSMISSION NETWORK TO A PLATFORM FOR OPTIMIZING RESOURCES ALLOCATION

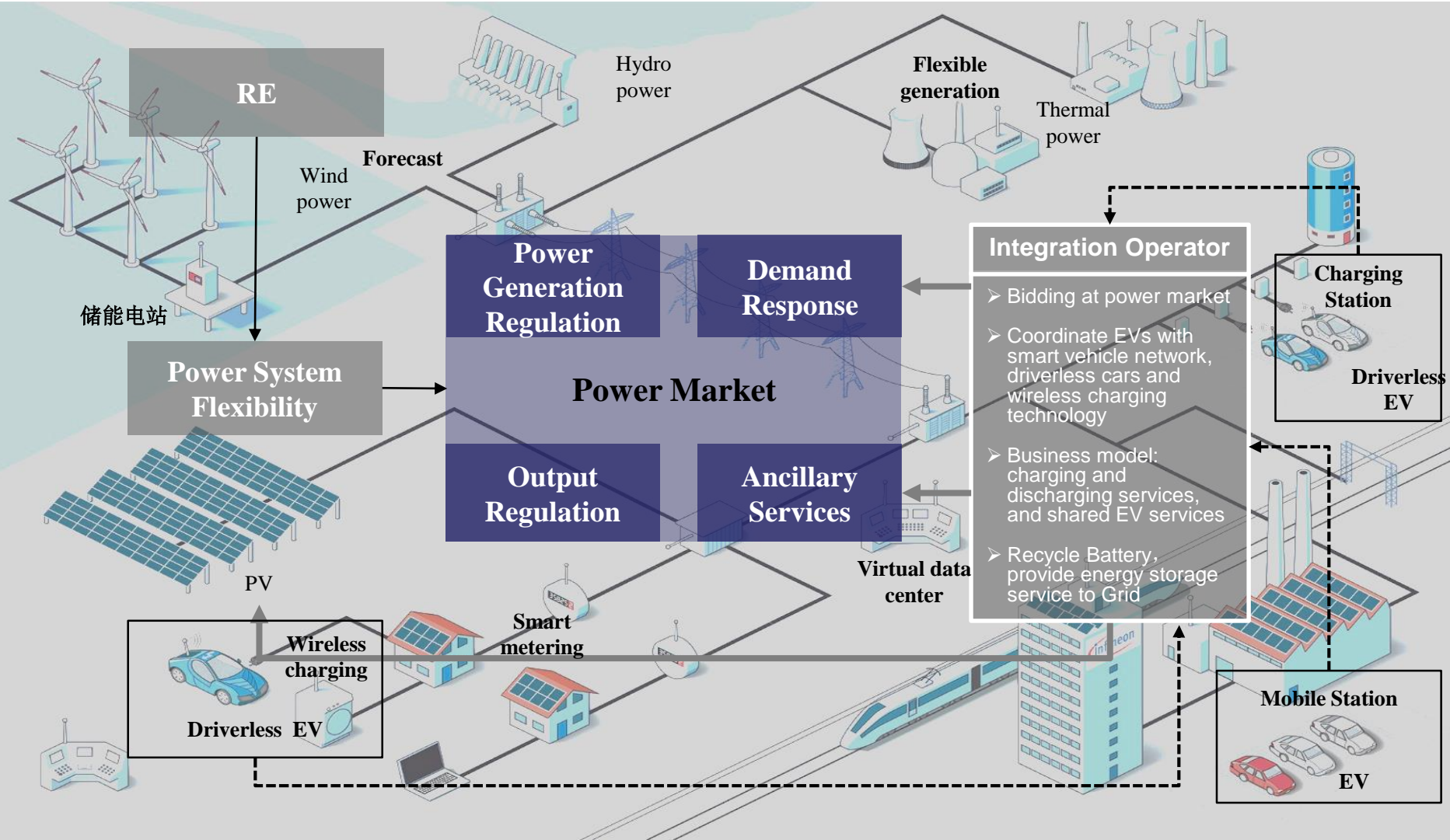


2011



Inter-provincial Transmission Capacity Demand in High Penetration Scenario (GW)

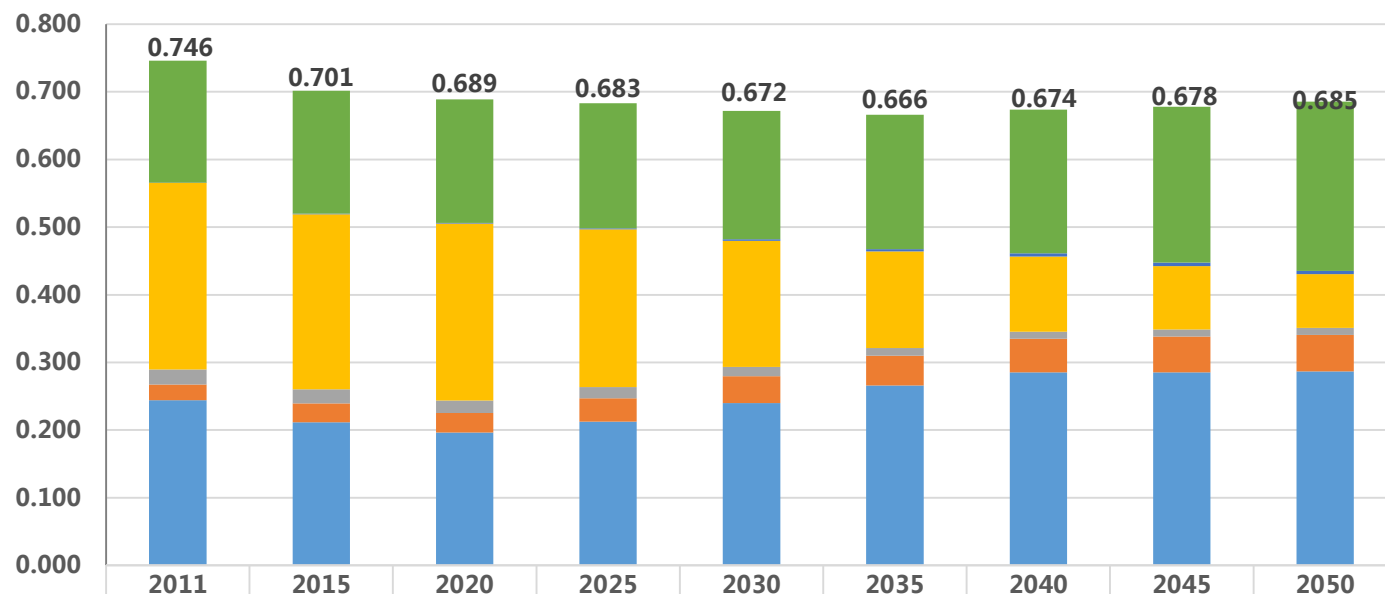
TECHNOLOGICAL AND INSTITUTIONAL INNOVATION IS THE FOUNDATION BUILD A HIGH RENEWABLE ENERGY PENETRATION POWER SYSTEM



BUILDING A HIGH RENEWABLE ENERGY PENETRATION POWER SYSTEM AT A SMALL OR NON-INCREMENTAL COST



Yuan/KWh



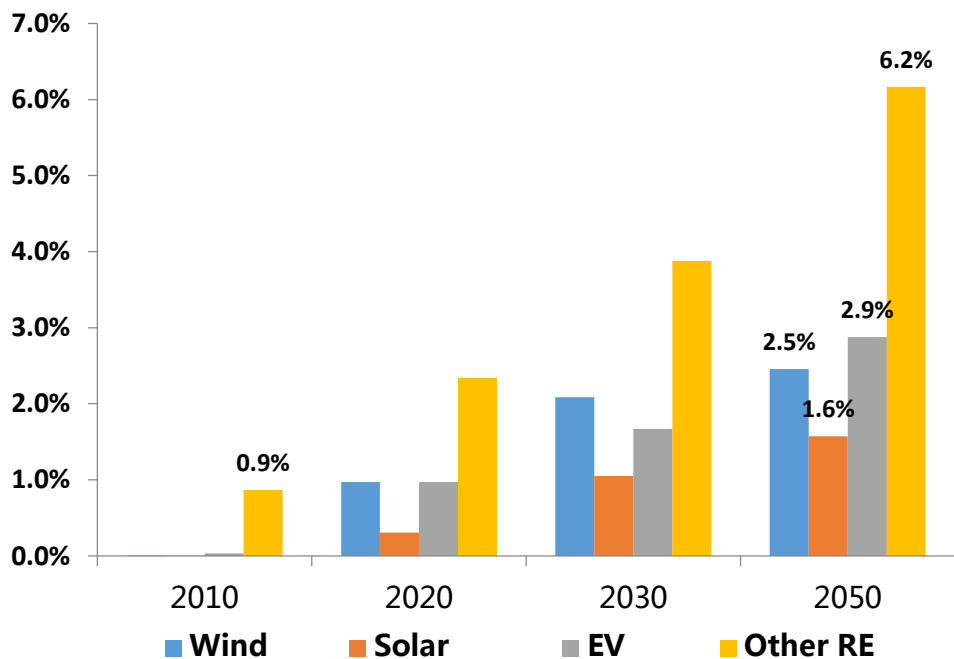
	2011	2015	2020	2025	2030	2035	2040	2045	2050
■ Transmission Cost	0.180	0.182	0.183	0.185	0.190	0.199	0.213	0.230	0.250
■ Start-up costs	0.000	0.001	0.001	0.001	0.002	0.003	0.005	0.005	0.005
■ Fuel Cost	0.276	0.259	0.262	0.233	0.186	0.143	0.111	0.094	0.080
■ Variable O&M	0.022	0.021	0.019	0.016	0.014	0.011	0.010	0.010	0.010
■ Fixed O&M	0.023	0.028	0.029	0.035	0.040	0.044	0.050	0.053	0.054
■ Capital Cost	0.244	0.212	0.196	0.212	0.240	0.266	0.285	0.285	0.287

kWh Cost Development Trend in High Penetration Scenario

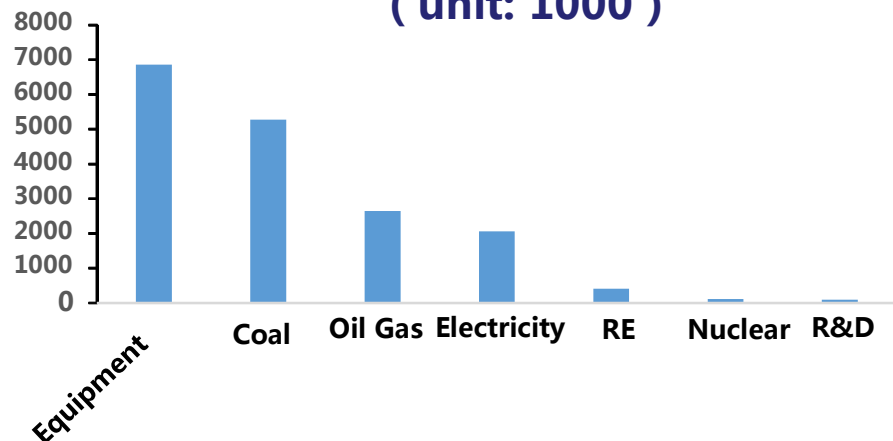
AS A NEW ECONOMIC GROWTH POINT, RE CAN SIGNIFICANTLY IMPROVE DEVELOPMENT QUALITY OF OVERALL ECONOMY



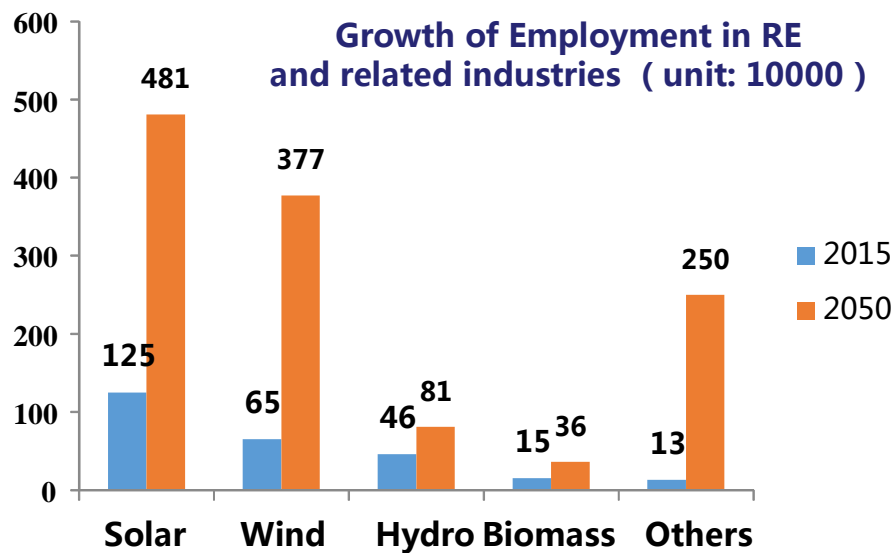
Contribution of RE and related industries to GDP



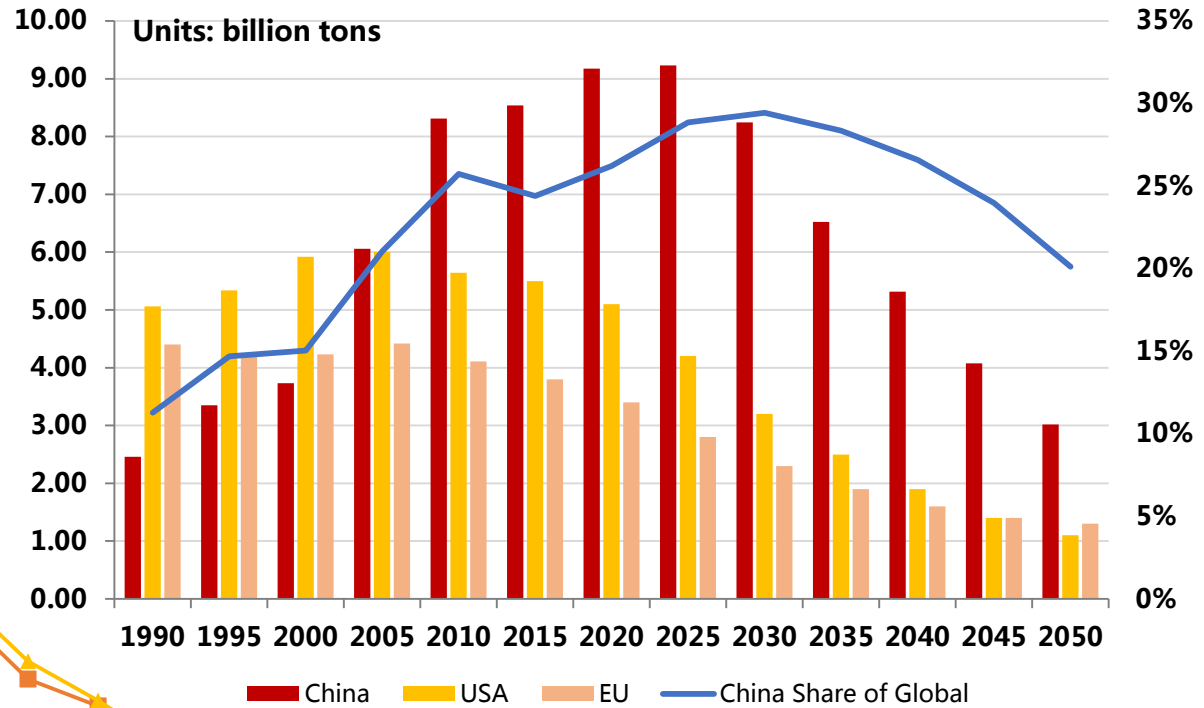
Energy Sector Employment in 2010 (unit: 1000)



Growth of Employment in RE and related industries (unit: 10000)

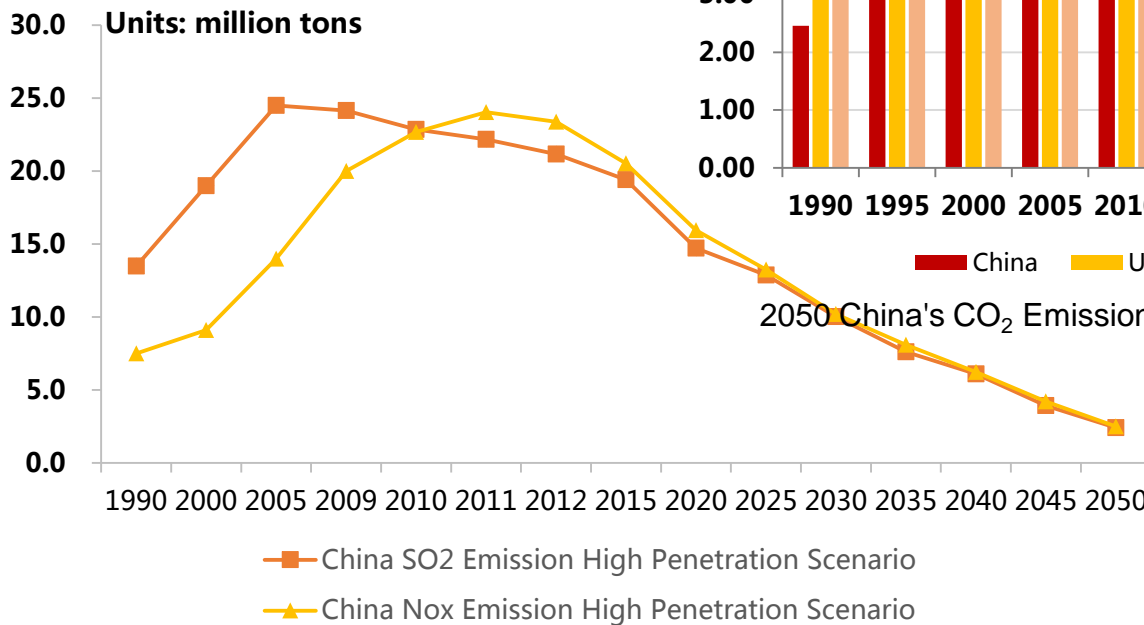


HIGH RENEWABLE ENERGY PENETRATION WILL HELP BRING BACK CLEAR WATER AND BLUE SKIES



2050 China's CO₂ Emission in the Global Contrast in High Penetration Scenario

Note: China's data after 2010 is scenario data
 And data of other countries is trend prediction
 Data from IEA ETP 2014



2050 China's SO₂ and NO_x Emission in High Penetration Scenario

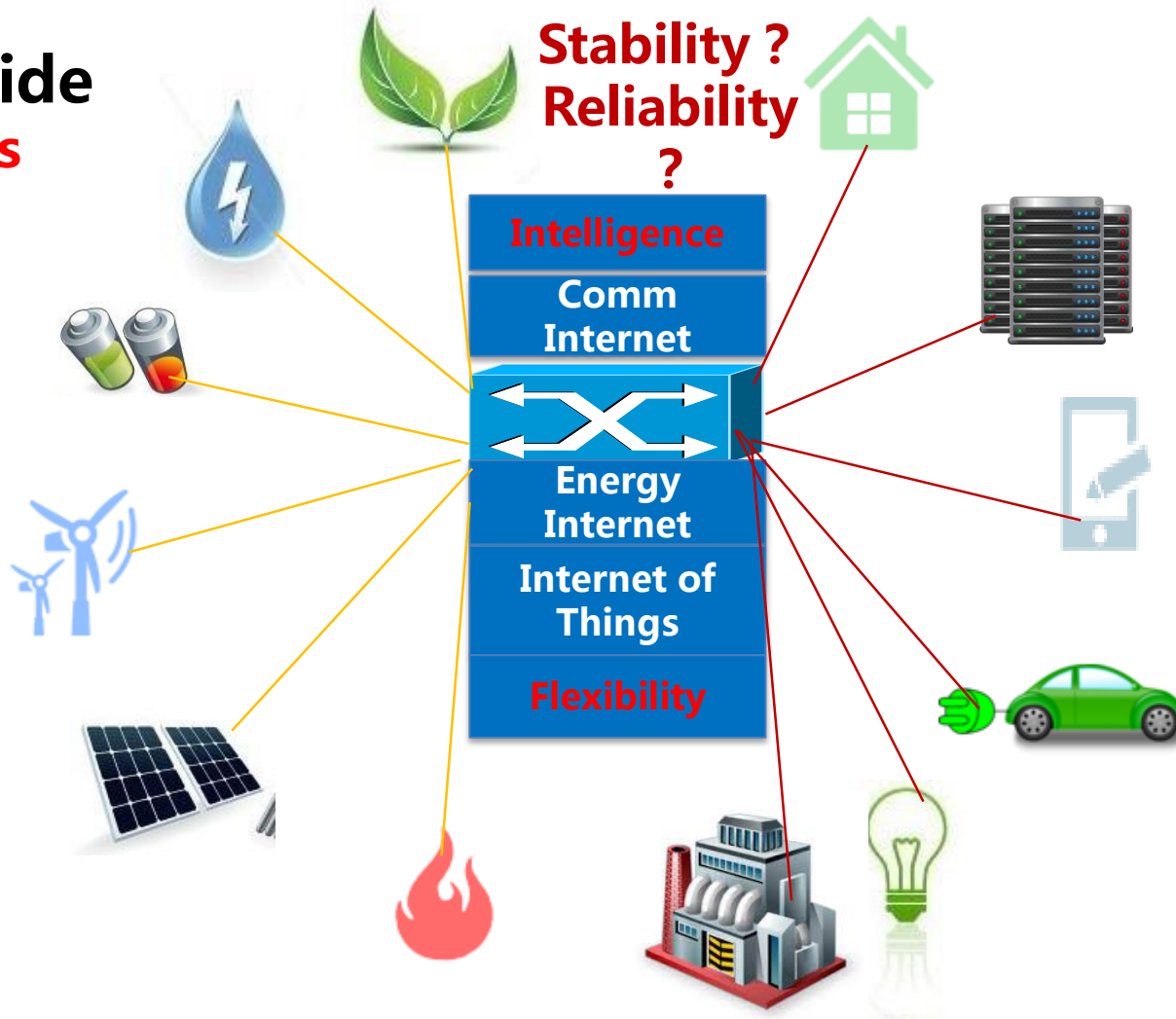
2050 HIGH PENETRATION SCENARIO: PATHWAY

**Largest Challenge:
Variability of
Renewables !**

A landscape photograph showing a vast green field in the foreground, likely a meadow or pasture. The field is filled with tall grasses. In the background, there are rolling hills and a line of trees. The sky is a deep blue, filled with wispy, white clouds that appear to be blowing across the frame. The overall scene is bright and clear, suggesting a sunny day.

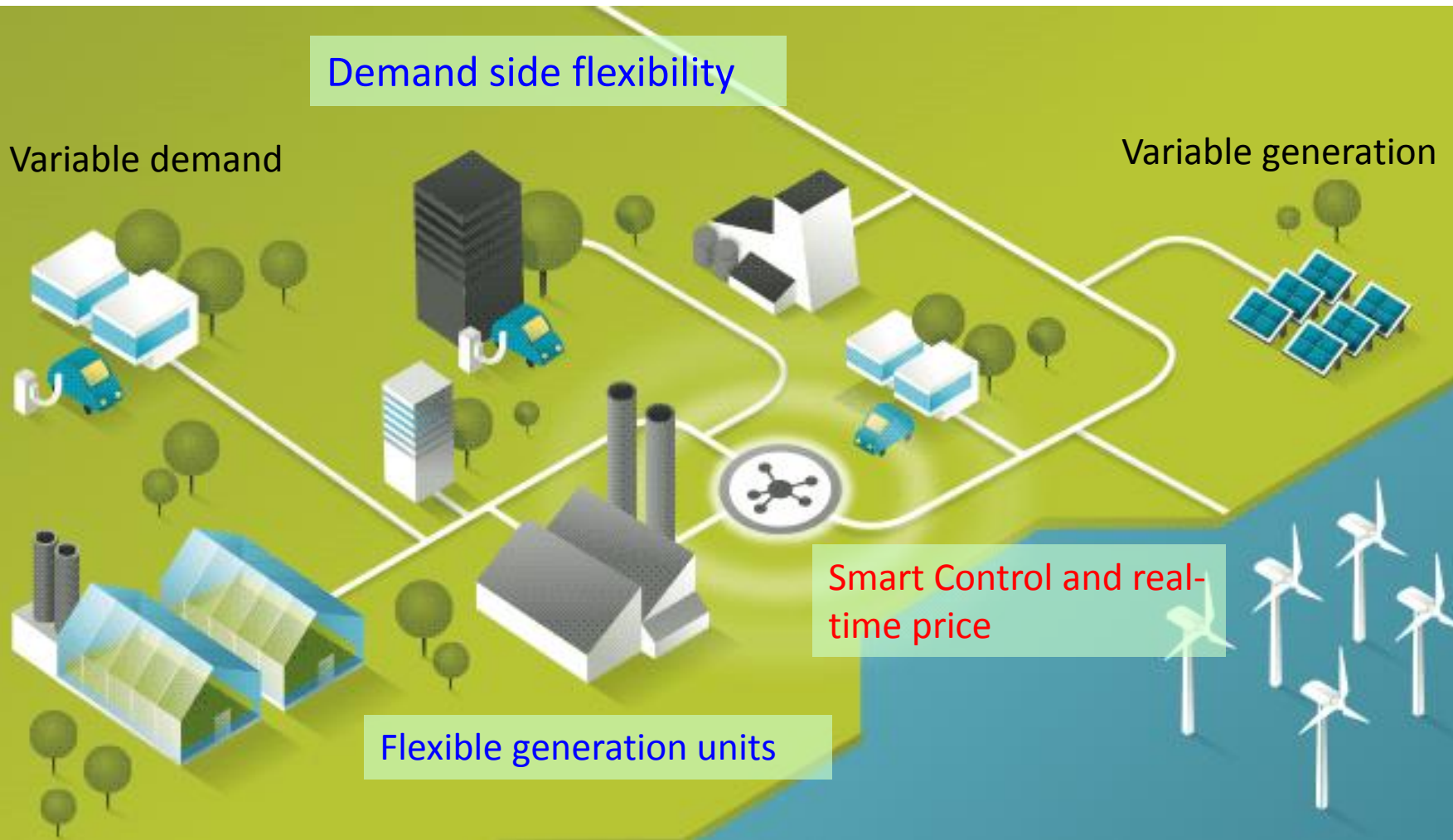
Achieve Higher-level Dynamic Stability Through Changes: Internet +

**Supply Side
Changes**

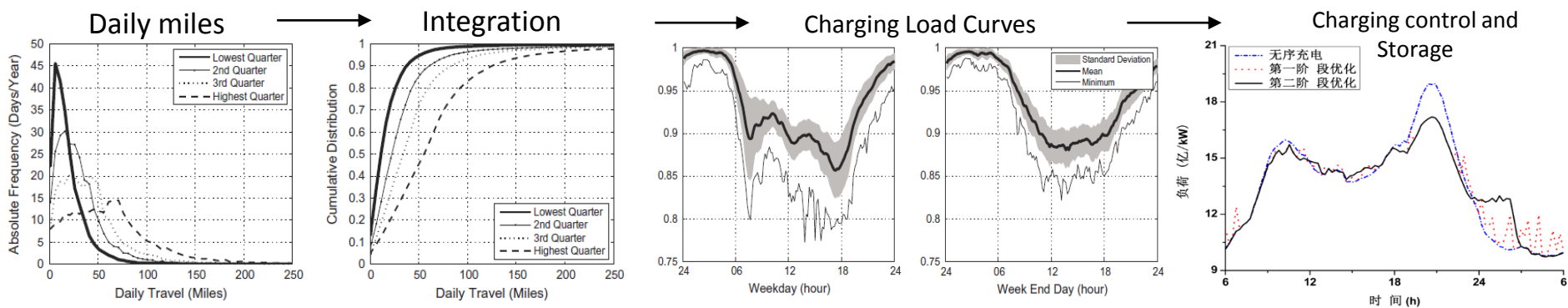
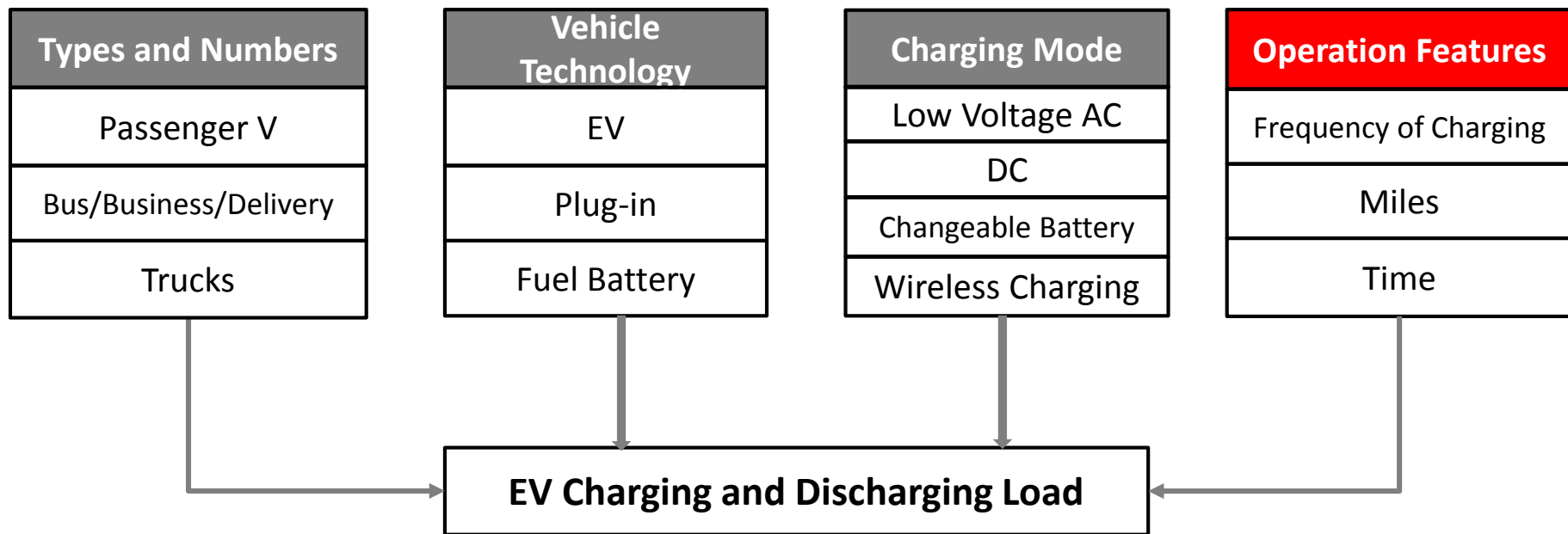


**Demand
Side
Also
Changes**

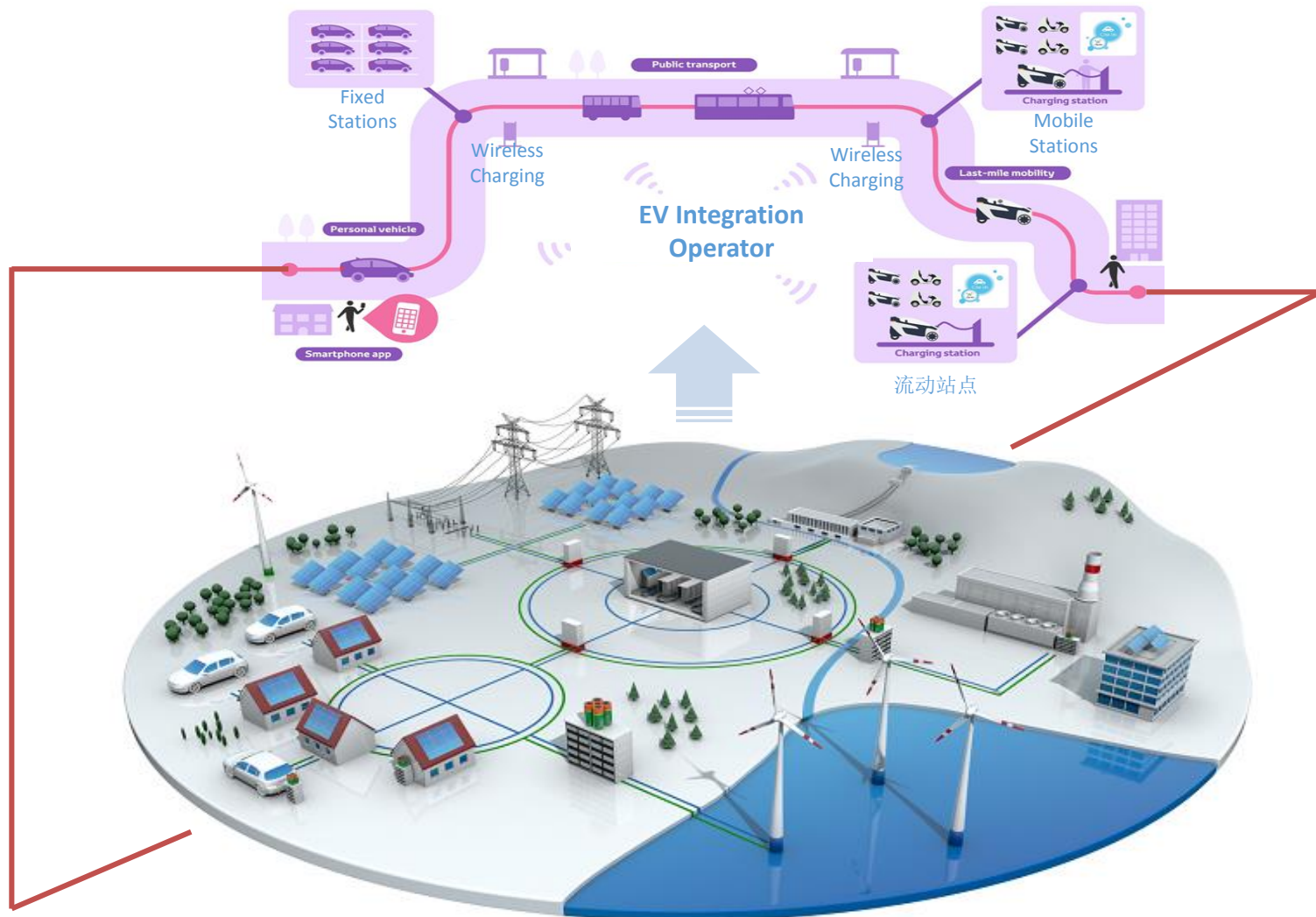
System with High RE Penetration Will Be a Reliable Power System



Contribution of EV's Flexibility to the Power System



New Business model of EV Will Change the Concept of Power Dispatch



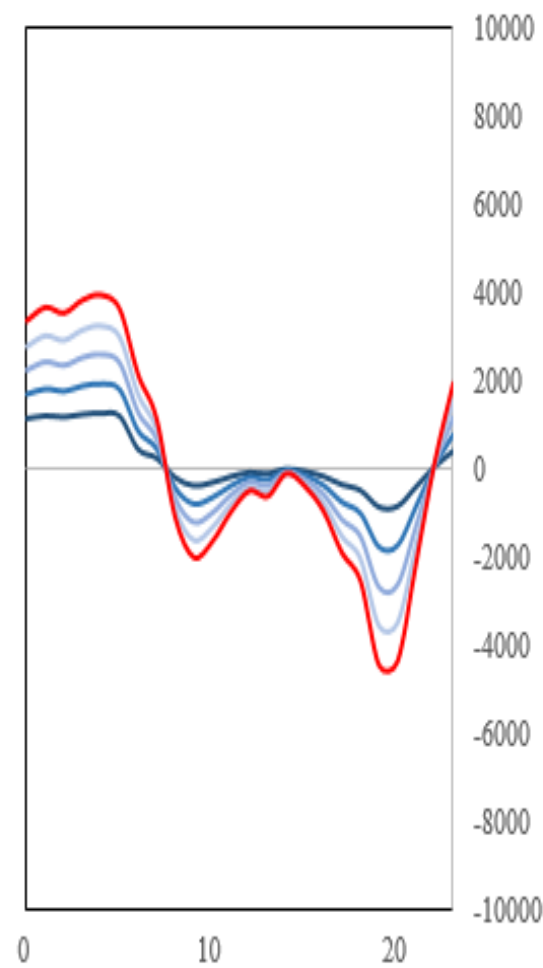
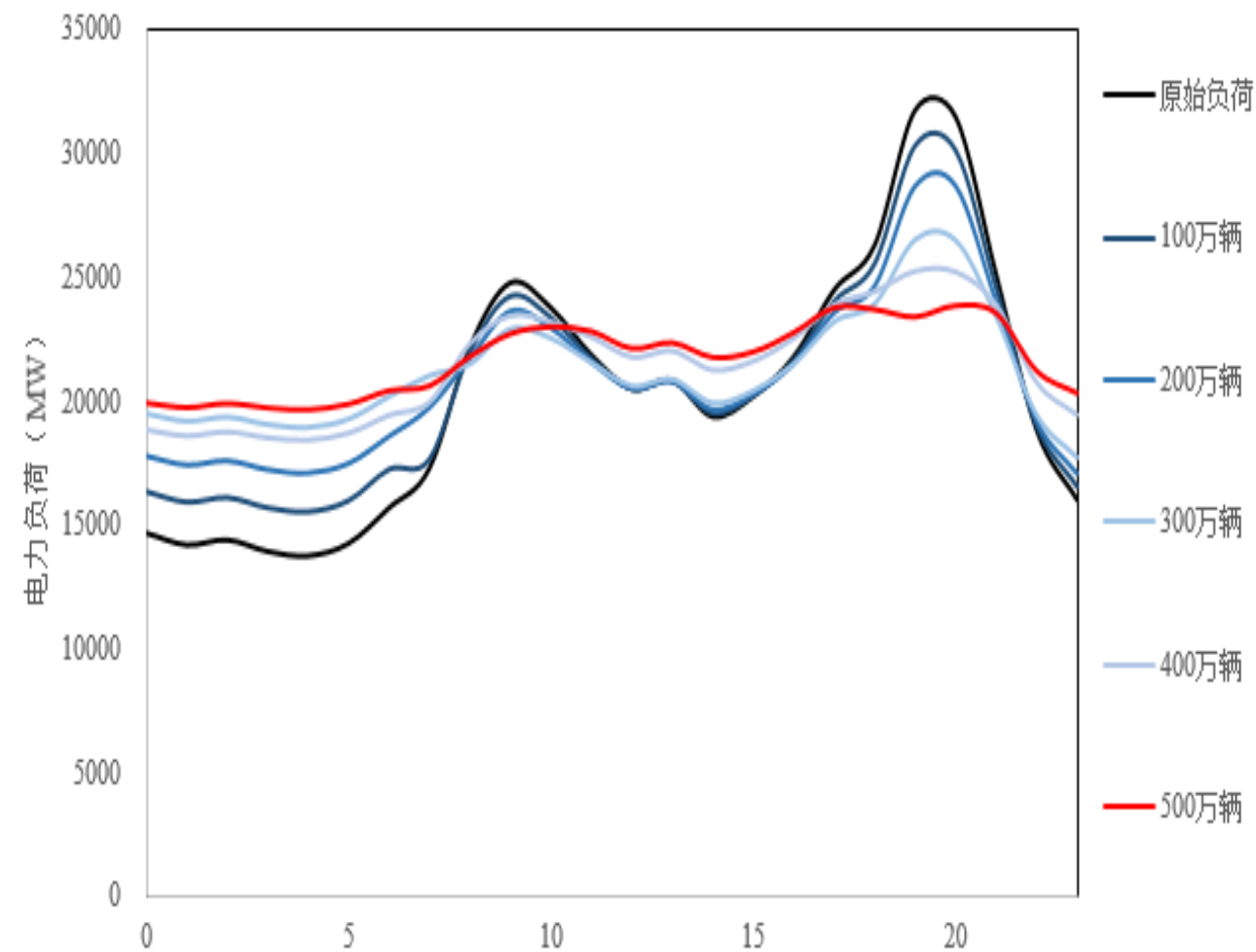
EV Business Model and Integrated Operation of Power System

Energy Storage of EV

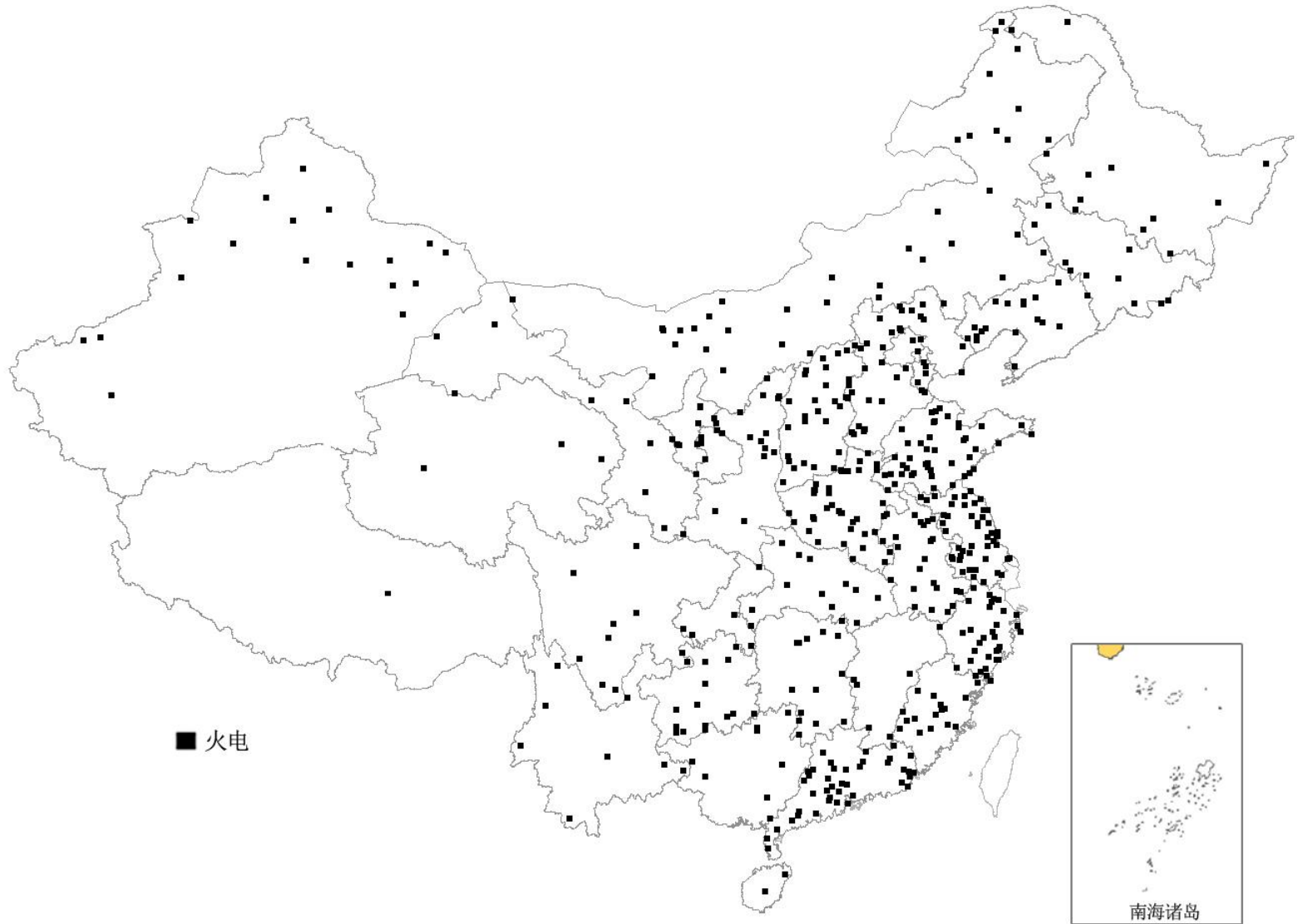
Case Study for 2030 in Beijing

北京2030电网总负荷 (MW)

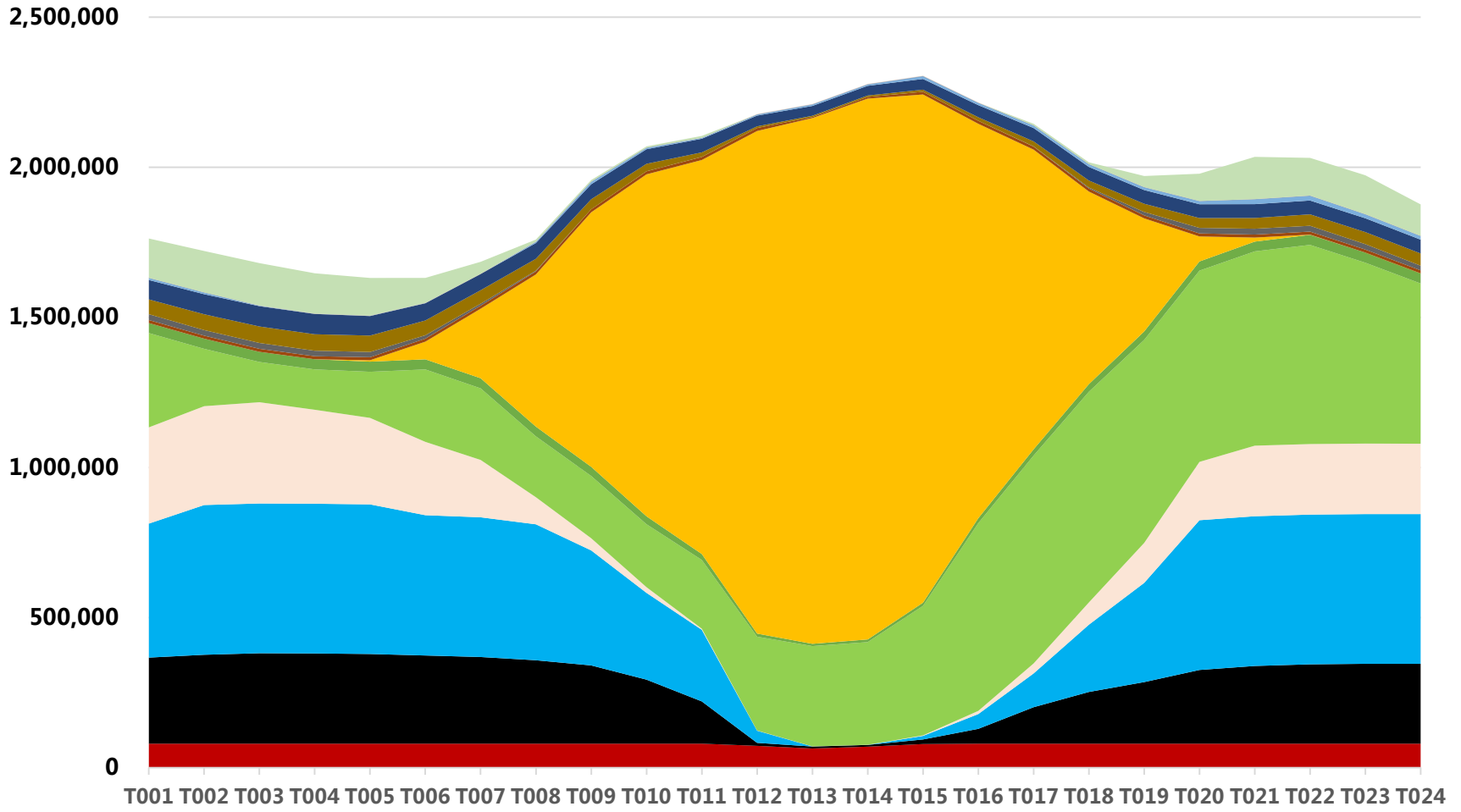
电动汽车充放电功率 (MW)



880GW Flexible Coal Will Provide Support for Stable and Reliable Operation of the Power System in 2050



Hourly Dispatch on a Typical Day in High Penetration Scenario



- NUCLEAR
- COAL
- Hydro
- NAT_GAS
- WIND
- WOOD
- SOLAR
- GEOTHERMAL
- BIOGAS
- STRAW
- MUNI_WASTE
- HEAT
- WAVE
- FUELOIL
- PUMPED_HYDRO

ACTION PLAN FOR HIGH RENEWABLE ENERGY PENETRATION



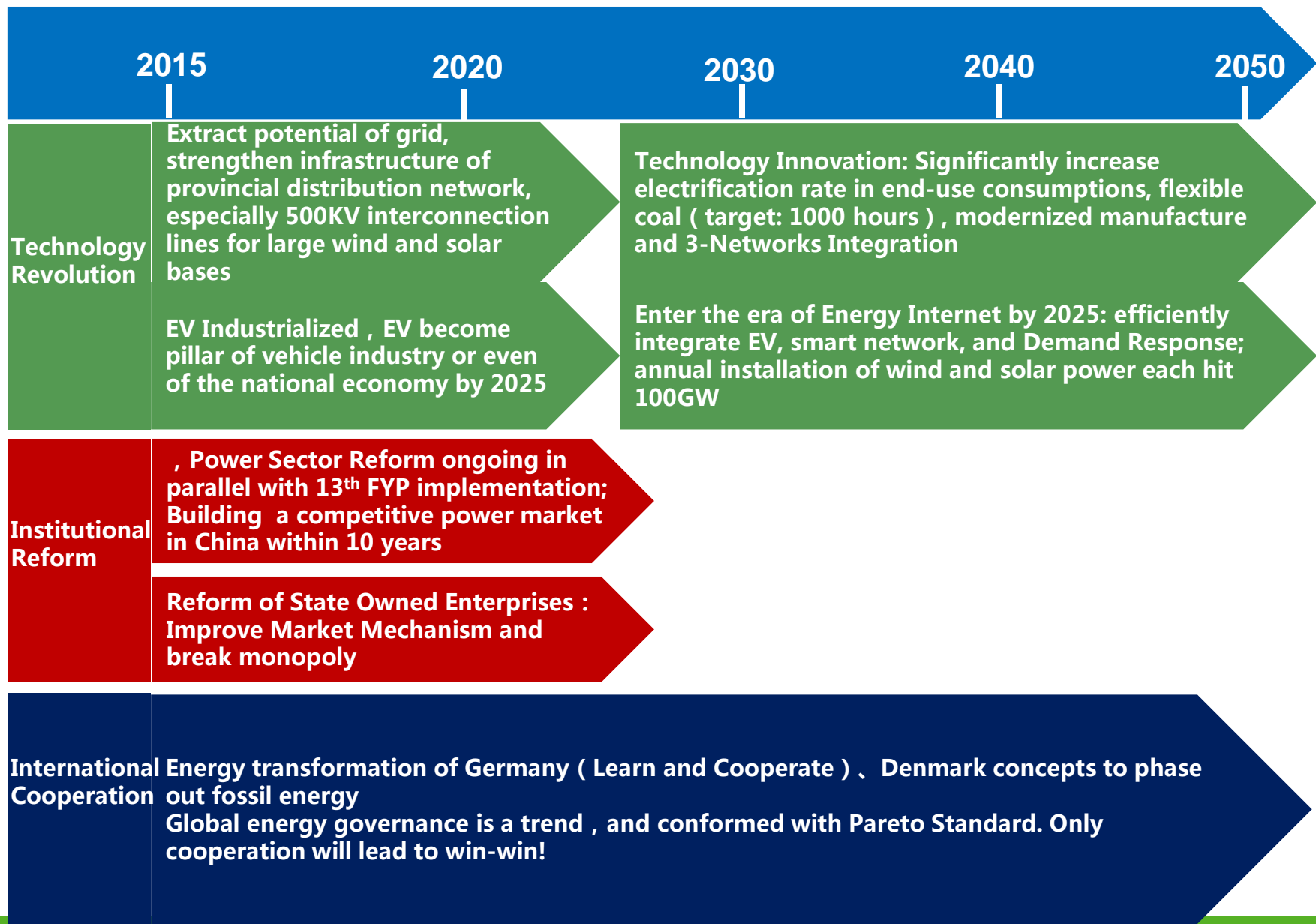
BUILDING HIGH RENEWABLE ENERGY PENETRATION FUTURE WILL BRING “NON-ZERO-SUM” RESULTS

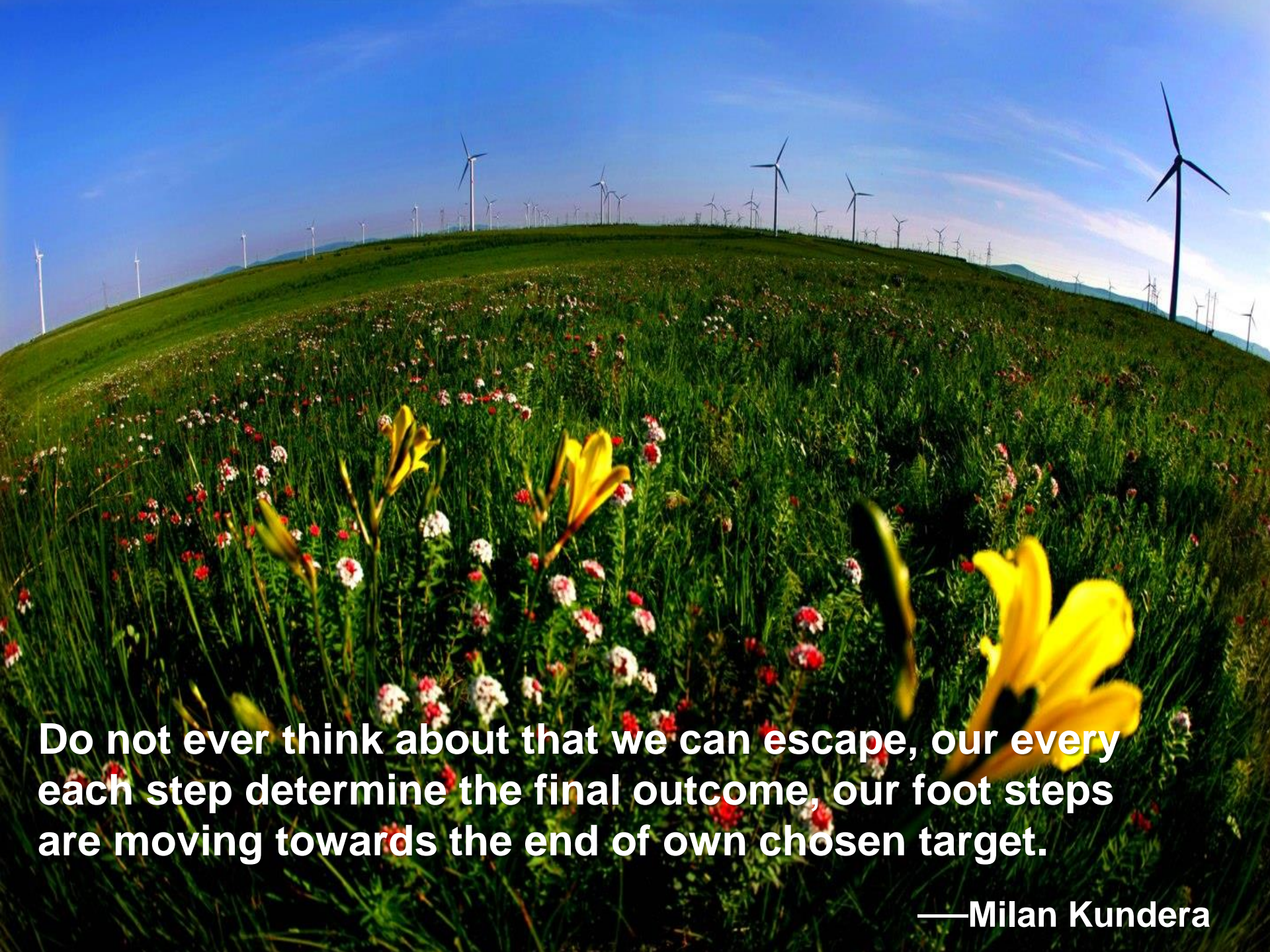


- **Market Oriented**
- **Economically Viable**
- **Consider both long term and near term**
- **Soft and Hard Supports**
- **Benefit the Whole Society**



KEY ELEMENTS of THE ACTION PLANS





**Do not ever think about that we can escape, our every
each step determine the final outcome, our foot steps
are moving towards the end of own chosen target.**

—Milan Kundera