

Renewable Energy The Driving Force for Energy Transformation

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2019.9.19

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The oil crisis of 1973 promoted human beings to move from resource dependence to technology dependence, the trend is irreversible.

A remark by Saudi oil minister, deafening to the ear: The Stone Age did not end because man ran out of stones! The rapid development of renewable energy, especially photovoltaic technology, let us see the dawn of farewell to fossil energy.

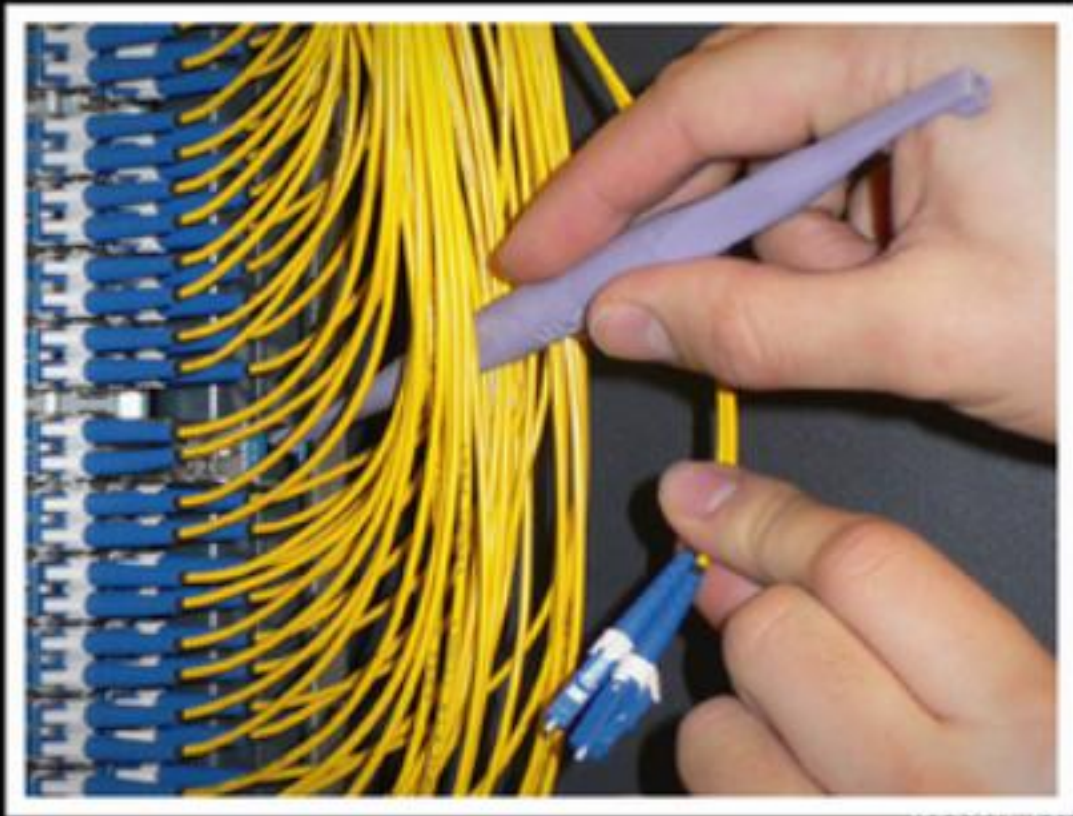
Comparison of Resource-Driven and Technology-Driven development

- **Resource-Driven, with continuous development, resources are becoming scarcer and even depleted, this will inevitably lead to:**
 - **Increased development costs and insufficient development potential**
 - **Emergence of a number of resource-exhausted cities and regions**
 - **Resource competition, international disputes, and even war**
 - **Unsustainable development**
 - **The resource curse**
- **The technology on which the Technology-Driven development relies is constantly advancing, technological progress can be superimposed and accumulated, and will never retreat, this will inevitably lead to:**
 - **Constantly updated development**
 - **Continuously declining cost of development**
 - **Development patterns that can be learned and imitated**
 - **Sustainable development**

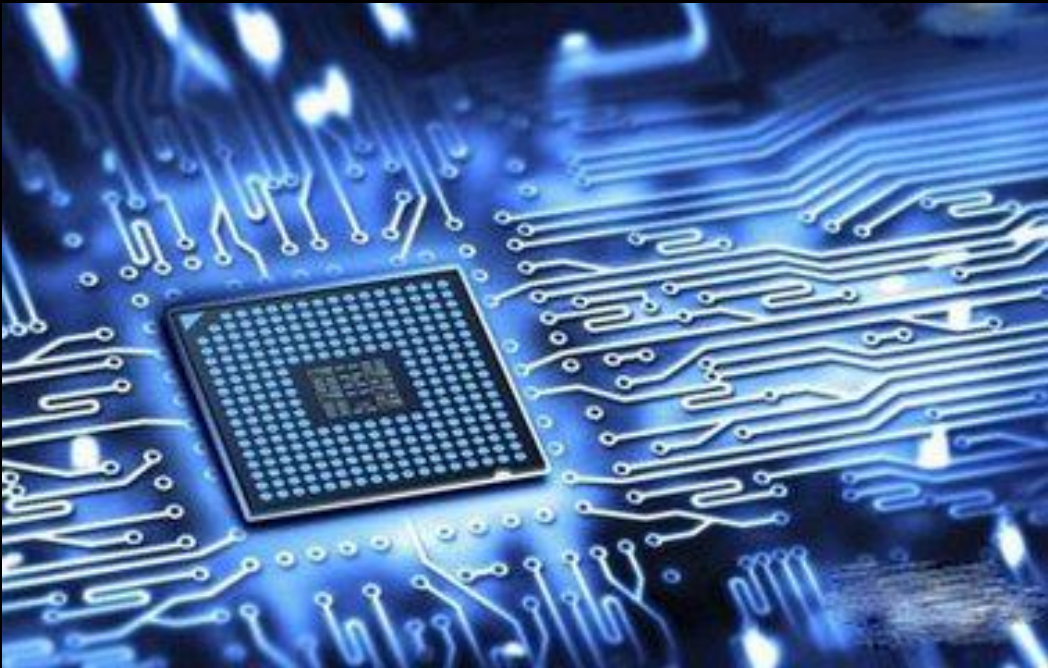
In the past 50 years, a batch of new technologies emerge

- **Intelligent Manufacturing Technology**
 - **Wisdom Meets Machine**
 - **Germany's Industry 4.0**
 - **China's "Made-in-China 2025"**
- **Energy Technology**
 - **Energy efficiency technologies, such as semiconductors**
 - **Renewable energy, shale oil and shale gas**
 - **Energy storage, smart grid, superconducting and UHV**
- **Transportation Technology**
 - **Electric vehicle**
 - **Rail transit technology, including high-speed rail**
- **Environmental Protection Technology**
 - **Air pollution control technology**
 - **Water pollution control technology**
 - **Soil pollution control technology, etc.**
- **Biotechnology**
 - **Food-related biotechnology**
 - **Bio-pharmaceutical technology**
 - **Bio-environmental protection technology**
 - **Bio-energy technology**
- **Internet Technology**
 - **Information Internet**
 - **Online shop**
 - **Energy Internet**
 - **Internet of Everything**
- **Sharing Technology**
 - **Bicycle Sharing**
 - **Catering**
 - **Tour**
 - **Office, almost omnipotent**

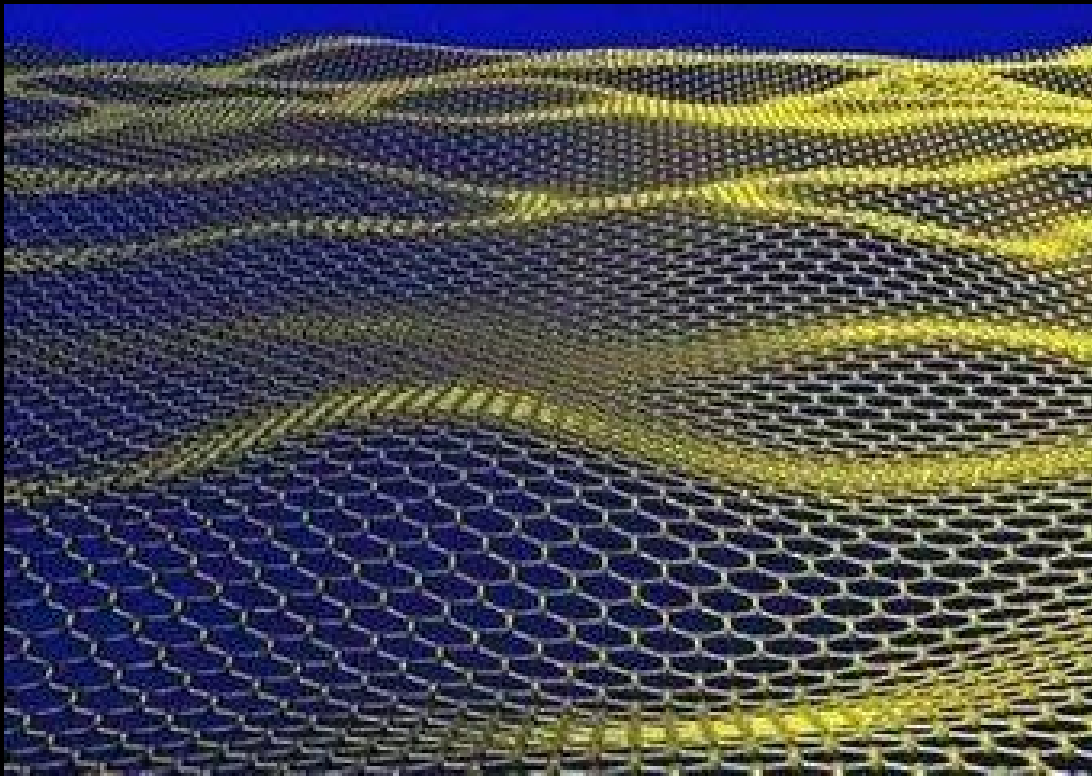
Optical Fiber technology that has changed the world



Semiconductor technology that is changing the world



Graphene technology that may change the world in future



Technological advancement has allowed renewable energy to grow by leaps and bounds.

Although the importance of renewable energy is recognized by people, it is German Chancellor Schroeder who initiated the renewable energy revolution in 2002 , that really promoted the scale development of renewable energy. Especially, since the Bonn Renewable Energy Conference in 2004, the global renewable energy has grown from small to large, from weak to strong, from inessential to significant. So far, it has become the backbone of the energy revolution.

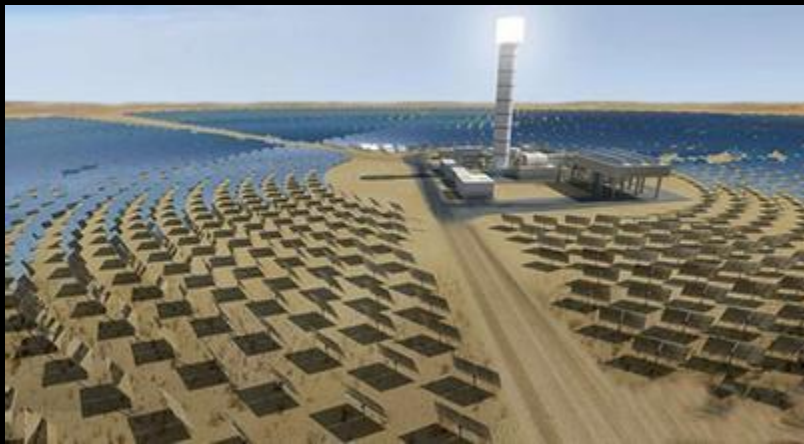
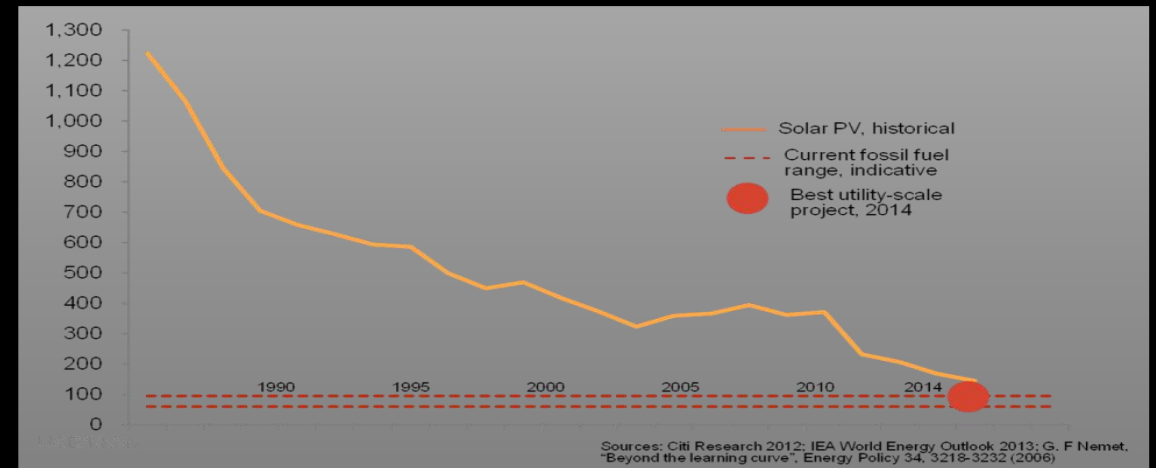
Wind power generation is able to compete with conventional power generation

- **Significant increase of proportion in power system**
 - Wind power in Denmark accounts for more than 40% of the total load
 - In the west of Inner Mongolia in China, wind power also accounts for more than 40% of power load
 - In Germany, wind power accounts for nearly 30% of the total capacity of power system
- **Significant reduction in cost**
 - In Denmark and America, the cost of wind power is able to compete with coal power
 - The gap between on-grid price of wind power and coal power in China is also shrinking



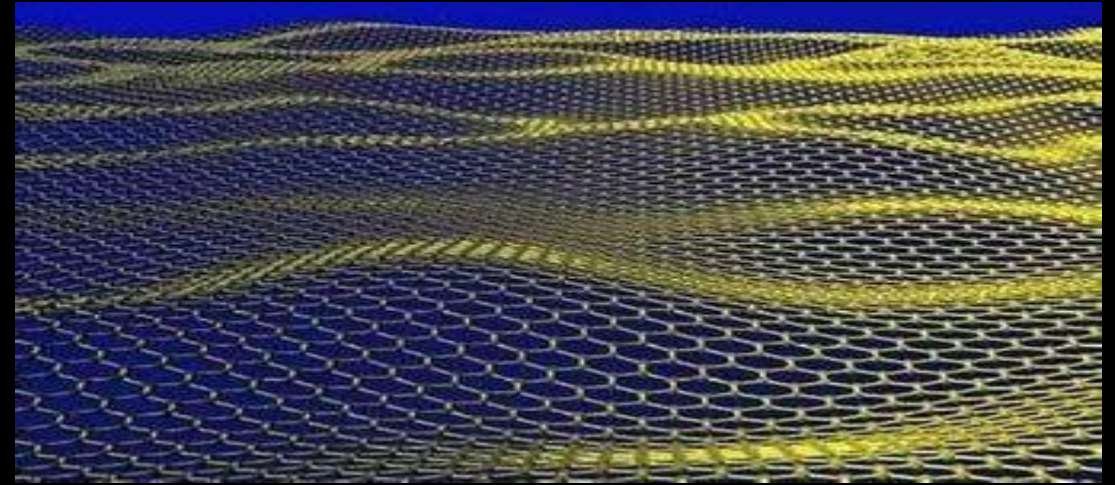
The cost of solar power has reached a tolerable range

- Since 2000, the cost of PV has dropped by 90%
- A large number of franchise projects were launched at 3 US cents per kWh
- As long as the problem of energy storage is well solved, the large-scale application of PV could reach the critical level



Charm of graphene technology?

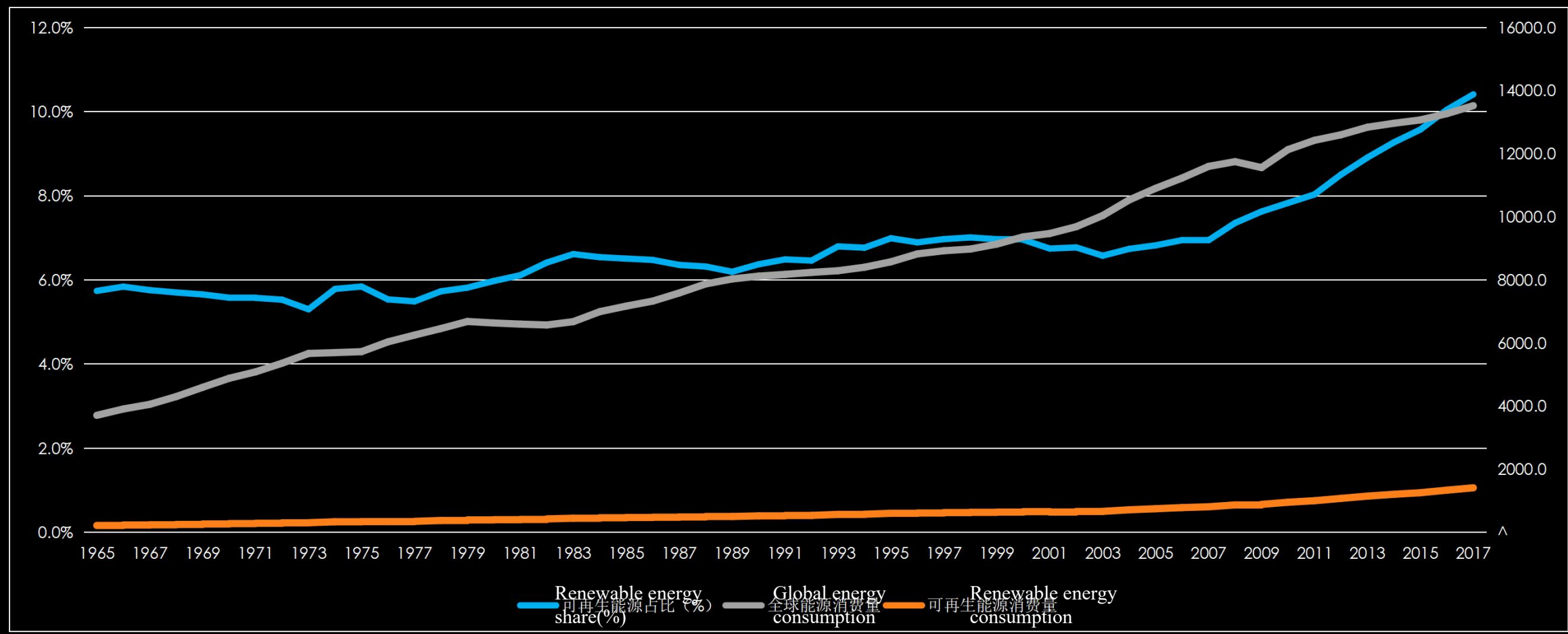
- **The invention of graphene has once given a great temptation to human beings, and it is awarded the laurel of invention that surpasses optical fibers and semiconductors.**
- **If graphene is industrialized, it can subvert PV, energy storage, and even superconductor technology, greatly speeding up the process of energy revolution.**
- **The Israelis have made a pioneering undertaking: to provide a 300km drive on a charge in five minutes.**



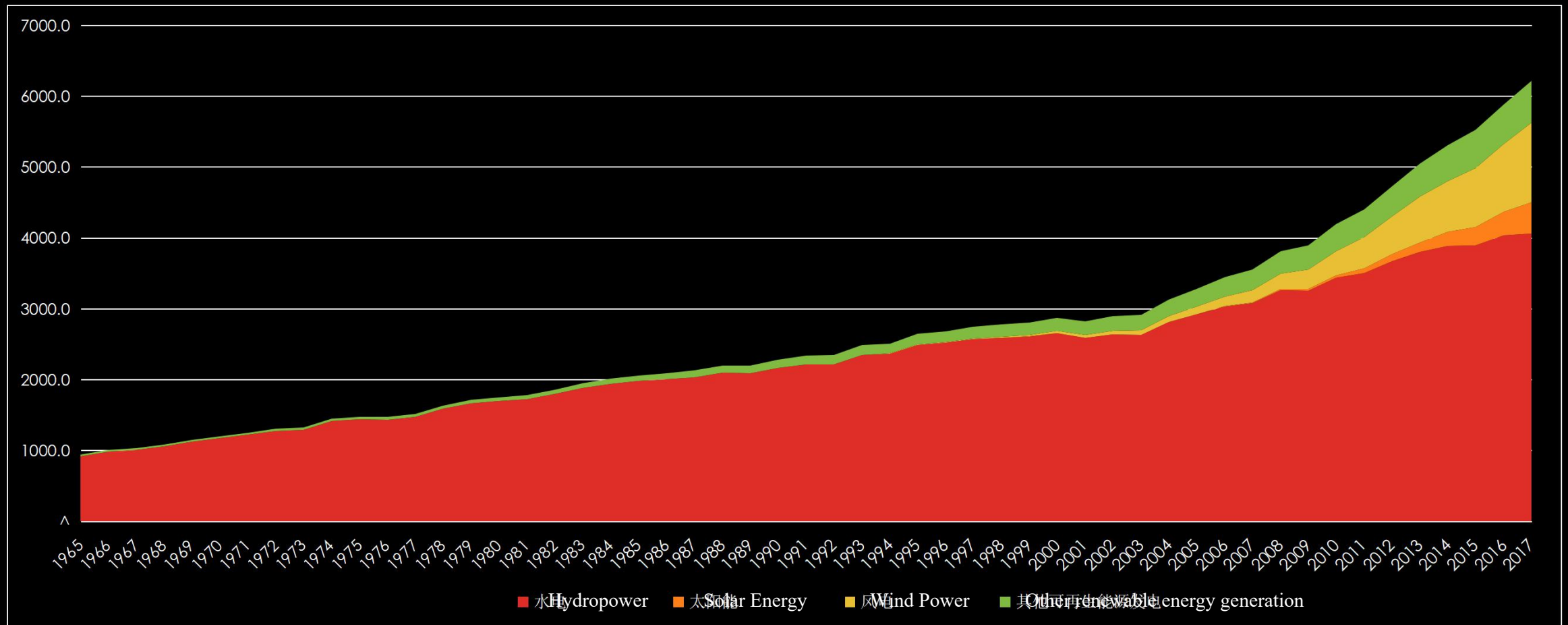
Status change of renewable energy

- **2002-2017**
 - **Global share of renewable energy increased by 5 percentage points**
 - **EU's energy consumption has decreased by 80 MTOE, renewable energy supply increased by 126 MTOE**
 - **OECD's total energy consumption: new energy demand in 2017 is mainly satisfied by renewable energy**
- **2010-2017**
 - **China's coal consumption has fallen by 9 percentage points, the share of renewable energy increased by 5 percentage points**
 - **China's coal-fired electricity has fallen by 15 percentage points**
- **Changes after the Paris Agreement**
 - **Two of America's largest coal companies went bankrupt**
 - **Germany's E.ON and Japan's Marubeni have sold all their coal-fired electricity assets, focusing on renewable energy generation**
 - **France's energy industry has also begun to sell its coal assets, focusing on renewable energy**

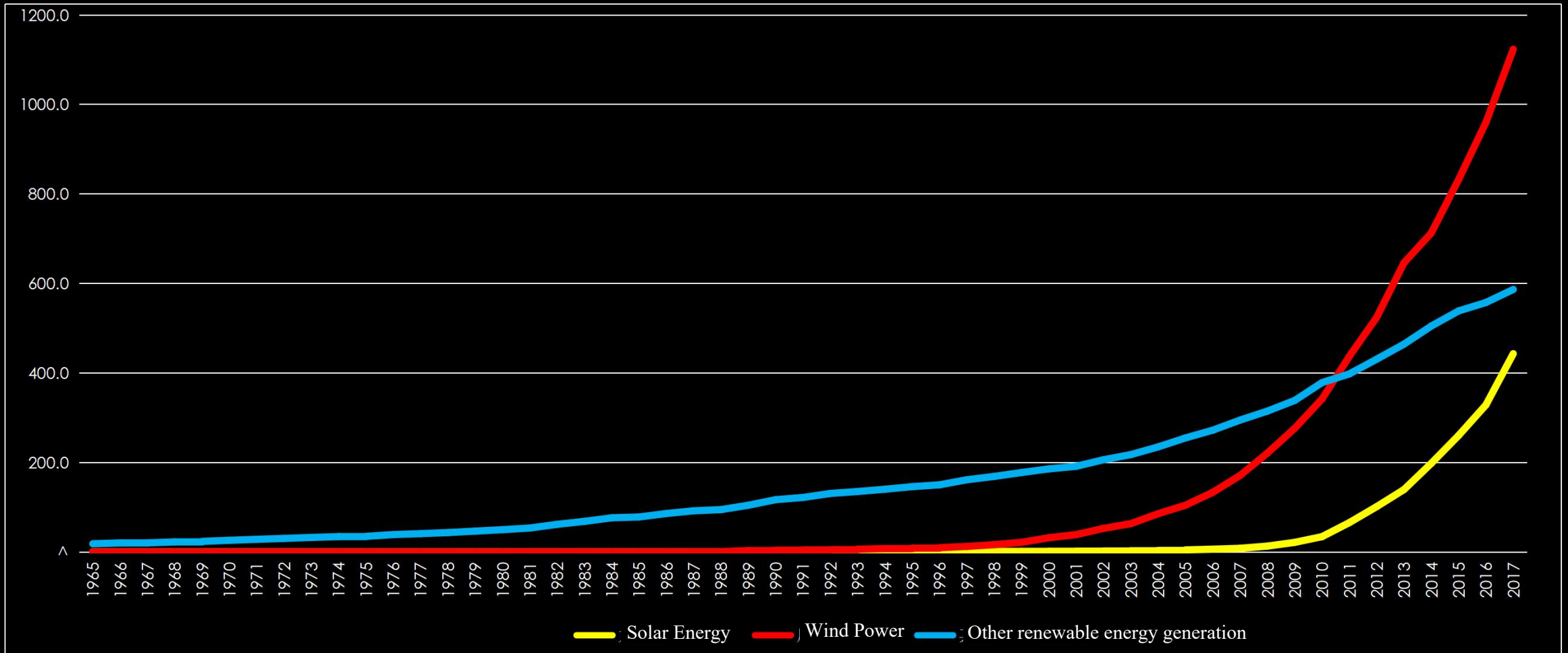
2002-2017: Global share of renewable energy increased by 5 percentage points



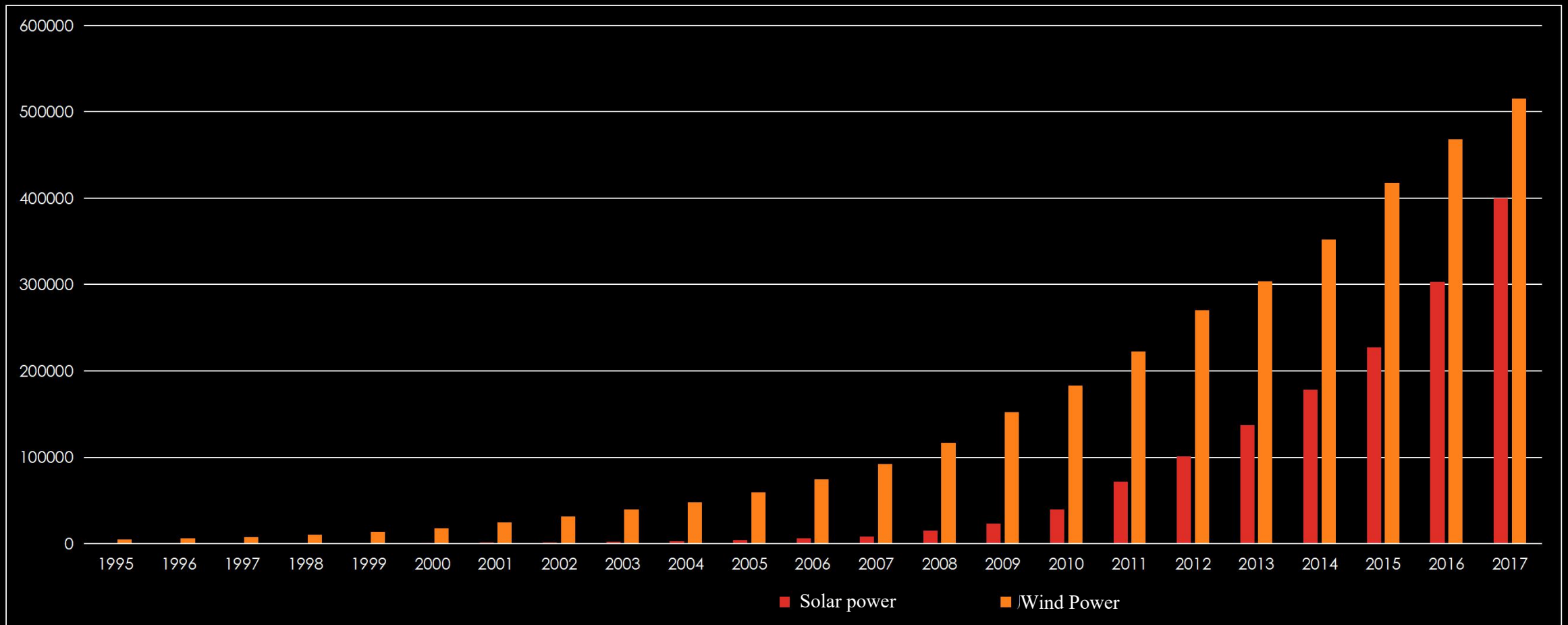
2002-2017: Electricity generation from renewable energy increased by 2.14 times



Solar and wind power developed rapidly: ——Electricity generation in 2017 is 29 times than that in 2002

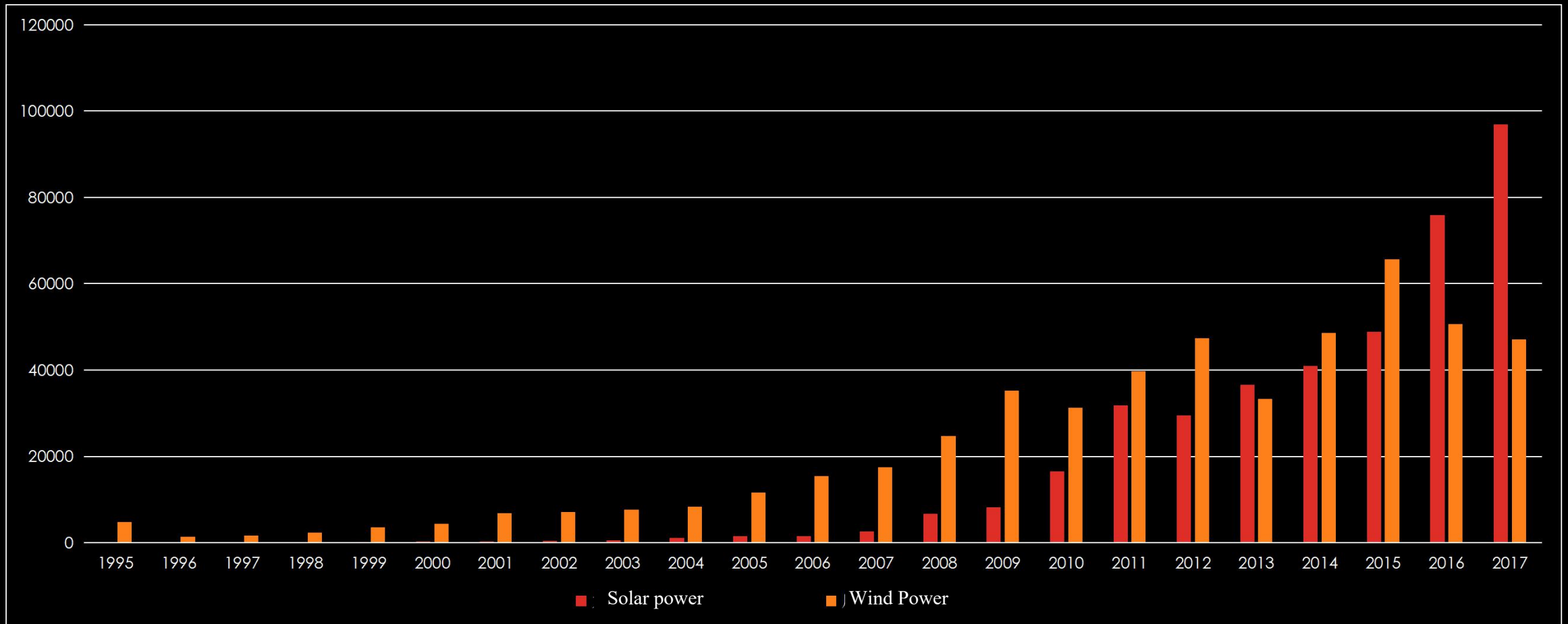


Solar and wind power developed rapidly: ——Total installed capacity exceeded 600 and 500 GW respectively



In recent years, PV has become the fastest installed power source

—In 2017, more than 100 GW of new PV were installed

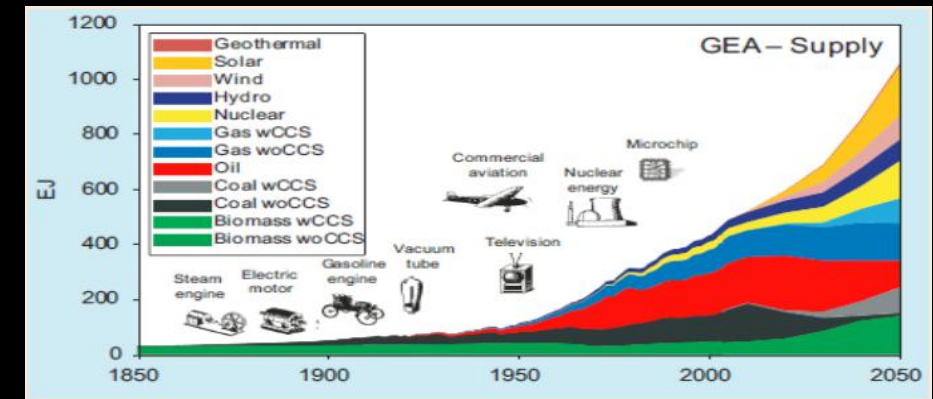


Power system has become an ally of renewable energy development

From rejection to acceptance and embrace renewable energy, power grid companies have completed their own transformation and gorgeous turn.

Renewable energy promotes the development of a new generation of power system

- **The construction of a renewable energy-friendly power system has promoted the development and operation of modern power technology like smart grid**
 - UHV, Flexible DC and Smart Grid
 - Integrated Energy Services and Green Dispatch
- **Modern grid technology has laid the foundation for the market formation of energy storage and renewable energy technology**
- **Power system becomes the foundation and core of energy transformation**
 - Non-fossil energy is mostly electricity
 - Modern newly-added energy demand is mainly electricity
 - Electricity Replacement is an important symbol of modernization

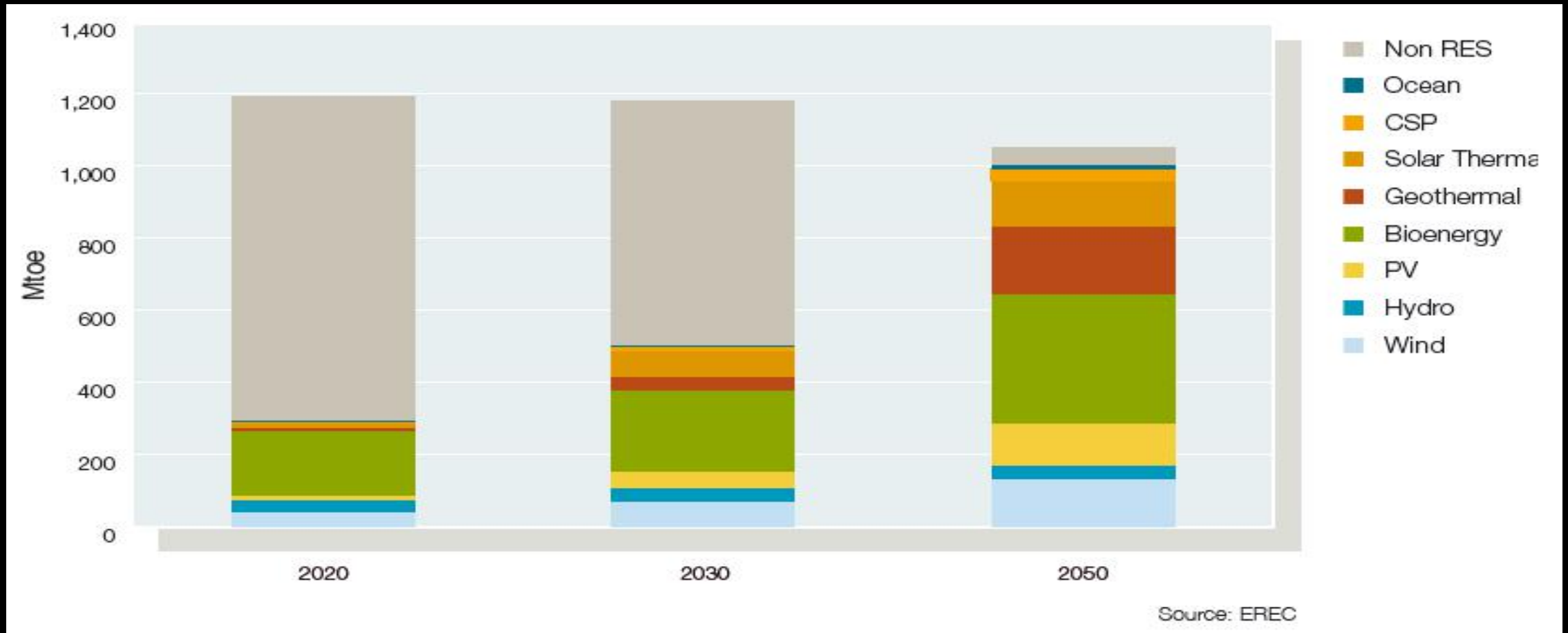


Electric Vehicles become partners of renewable energy

- Intermittence of renewable energy generation requires the development energy storage
- Electric vehicles have great potential for energy storage
 - 100 million electric vehicles have 15 billion kW storage batteries and 6-10 billion kWh peak-shaving capacity
 - Making electric vehicles an important infrastructure to promote the development of renewable energy
- The zero marginal cost of renewable energy makes electric vehicles use nearly zero cost



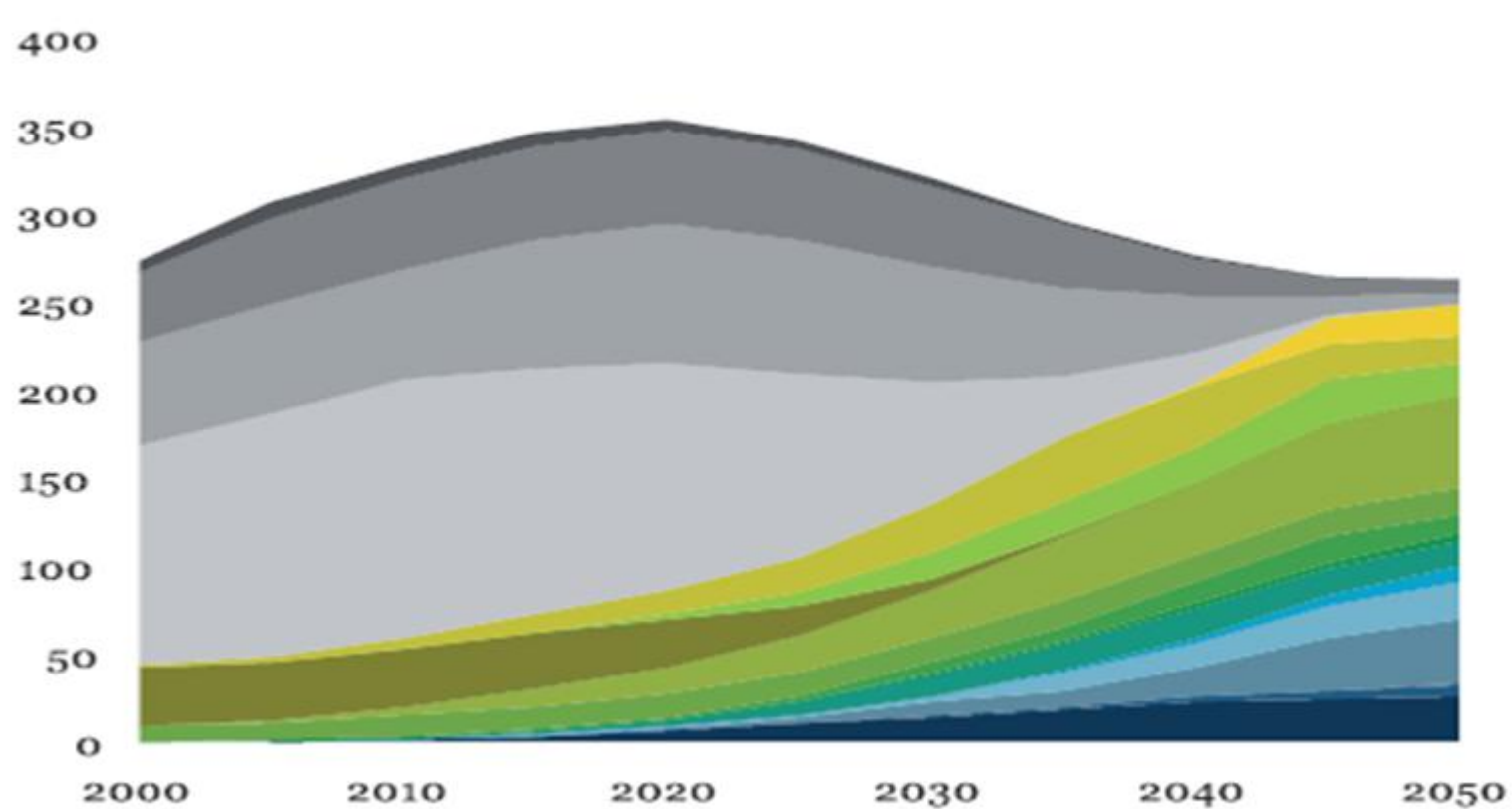
Europe has proposed a 100% renewable energy solution for 2050



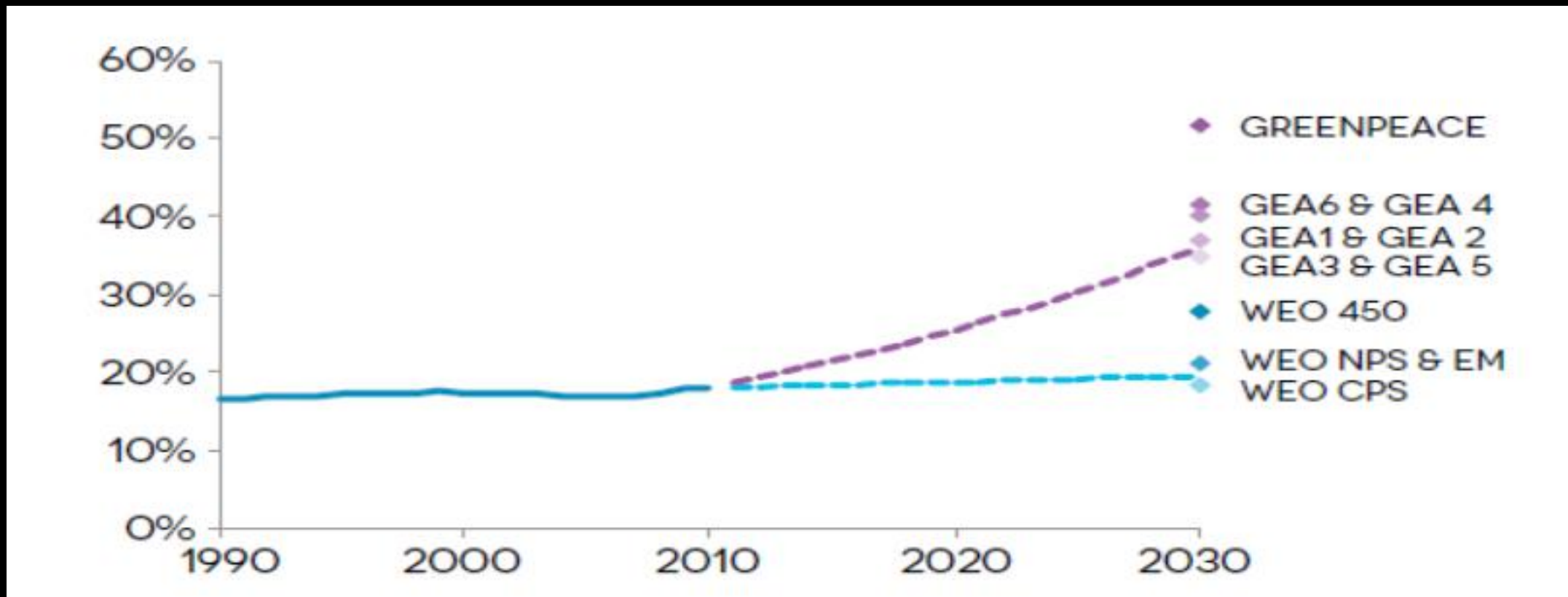
Germany actively promotes energy transformation and substantially increases the share of renewable energy



WWF has also proposed a global 100% renewable energy solution for 2050



The most conservative IEA has also set a target of 30% share of global renewable energy by 2030



China has also put forward the development goals for different time periods

- **In 2020, the installed capacity of renewable energy exceeds 700 GW**
 - **Hydropower 400 GW**
 - **Wind power 200 GW**
 - **PV 110 GW**
- **In 2030, electricity generated from non-fossil energy amounts to 50%, calculate based on 10 trillion kWh, it needs non-fossil energy to generate 5 trillion kWh electricity**
 - **Hydropower 2 trillion kWh**
 - **Wind power and PV 2 trillion kWh**
 - **Equivalent to installing 500 GW wind power, 1000 GW PV**
- **In 2050, non-fossil energy accounts for 75%- 80% of electricity generation, which is equivalent to at least 8 trillion kWh of electricity**
 - **Hydropower 2 trillion kWh**
 - **Renewable energy generates 5 trillion kWh, assuming wind power and PV undertake fifty-fifty respectively, requiring:**
 - **Wind power 1000 GW**
 - **PV power 2500 GW**

Technological innovation is changing the energy world

- **Innovation and development of science and technology have changed the traditional understanding of energy system**
 - From the fear of energy shortage to orderly use
 - Typical cognitive changes
 - Before 1992, people always worried about what we can do if energy is exhausted
 - After 1992, people's mantra becomes: The Stone Age did not end because man ran out of stone
 - Renewable energy becomes the main force of energy transformation
- **Science and technology have endorsed the transition from fossil energy to renewable energy by the end of this century**



Thanks for your attention!

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