



# Global Energy Interconnection-based Pathway to Global Carbon Neutrality

**Global Energy Interconnection Development and Cooperation Organization (GEIDCO)**

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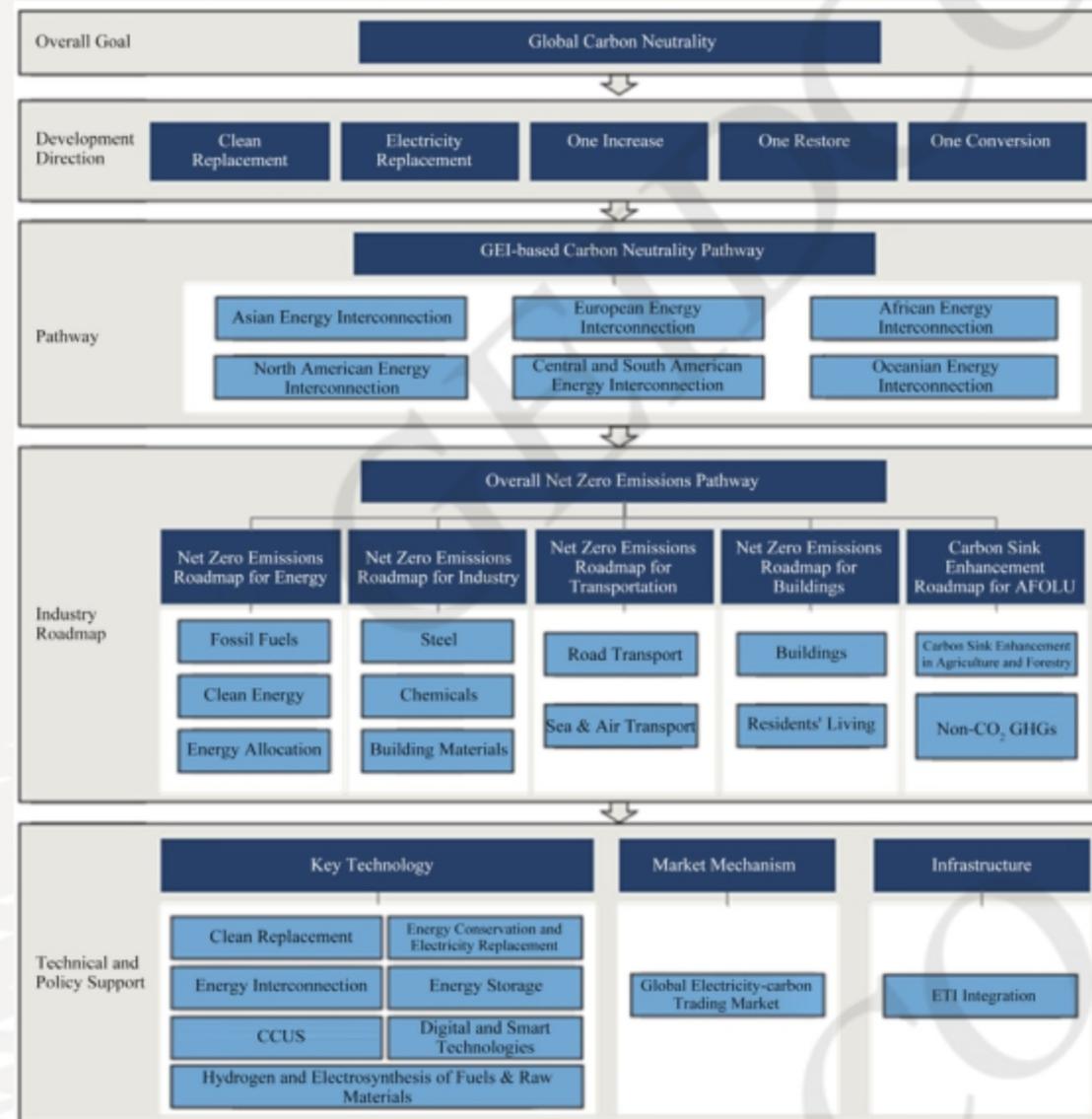
**November 15, 2022**

Climate change is a daunting challenge facing the world, posing a threat to the very survival and development of humankind. UN Secretary-General Mr. António Guterres has called on all nations to declare a state of "climate emergency", and to make concrete efforts to mitigate emissions and achieve carbon neutrality. While many countries have announced their carbon neutrality goals, we are still a long way off achieving the emission mitigation target. The key problem lies in the lack of feasible solutions.

Excessive use of fossil fuels constitutes the root cause of the climate change. To secure carbon neutrality, we must focus on energy, the linchpin of the problem, to achieve energy security and green and low-carbon energy transition. Based on research output in energy transition, clean development, climate and environment, GEIDCO has studied targets and requirements, pathways and schemes, and key issues in carbon neutrality. As a result, it has proposed GEI-based carbon neutrality pathway and released the monograph *The Road to Global Carbon Neutrality*.

# Scheme Framework

With the concept of green, low-carbon, and sustainable development, and based on the needs of economic and social development, the GEI carbon neutrality scheme reveals the current climate and environment crisis, analyzes the significance and challenges of achieving carbon neutrality, and proposes the solution of GEI development based on "Two Replacements, One Increase, One Restore and One Conversion" for achieving carbon neutrality. It also systematically expounds the roadmaps for net-zero carbon dioxide emissions in key areas, each continent's carbon neutrality pathway, key technological innovations and market mechanism construction, and demonstrates its great comprehensive value in the coordinated development of the economy, society and environment. This scheme also presents groundbreaking, holistic and operable research results.





## 1. Green and Low-carbon Development

## 2. GEI-based Carbon Neutrality Pathway

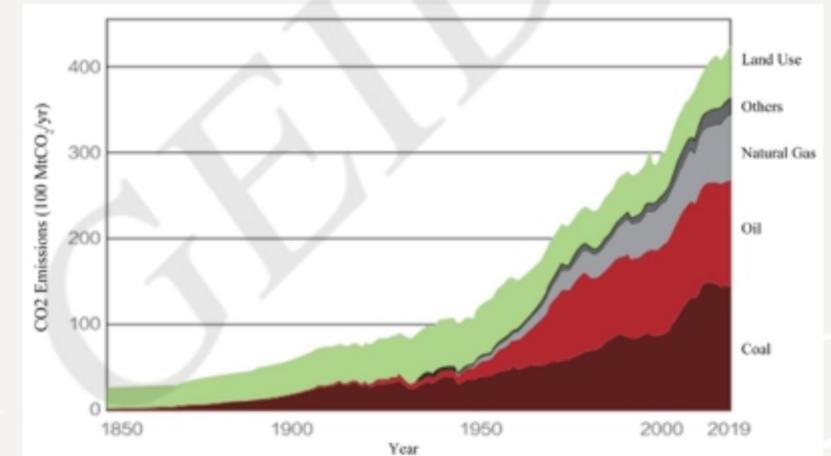
## 3. Energy Interconnection Scheme by Continent

## 4. Key Technologies and Policy Mechanisms

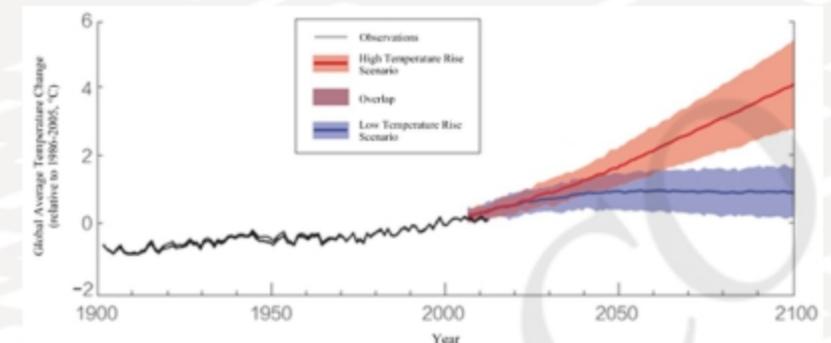
# 1.1 Global Climate Change Dynamics

GHG emissions from fossil fuels combustion are the main cause of climate change. The rising concentration of GHGs in the atmosphere has given rise to frequent extreme weather and climate events, posing a tremendous impact on earth ecosystems and human society. Without a timely response, climate change will evolve into a global climate and environment crisis, threatening the survival of humanity.

- **Causes of climate change:** Rapid growth of global population and economy has led to a quick increase in fossil fuel usage. CO<sub>2</sub> emissions from fossil fuels combustion account for about 85% of the world's total. The concentration of CO<sub>2</sub> in the atmosphere is 1.5 times higher than that of pre-industrial times, and the temperature has risen by 1.2°C.
- **Impacts of climate change:** Climate change has had wide-ranging impacts on natural environment and human society. Climate-related disasters incur an annual average economic loss of USD 500 billion.
- **Climate and environment crisis:** Climate change is developing into a climate and environment crisis at an accelerating rate. The earth system is on the fast track to a "total crisis". Up to now, 9 out of 15 climate flip-flops have been triggered, and more will turn up due to climate change, with more serious impacts.



Sources of Global CO<sub>2</sub> Emissions

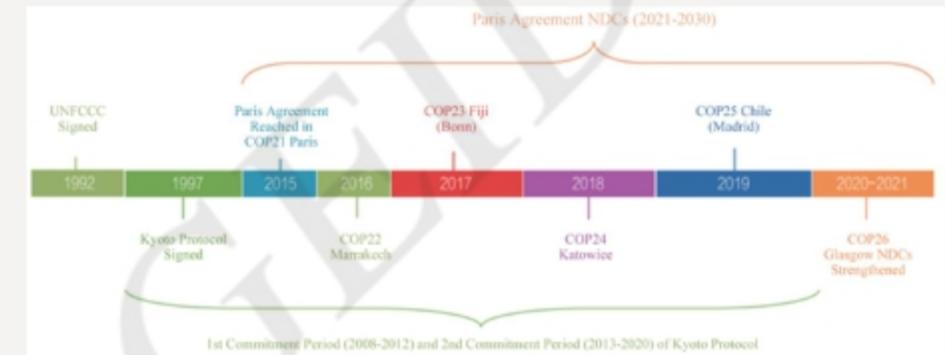


Global Average Temperature Change

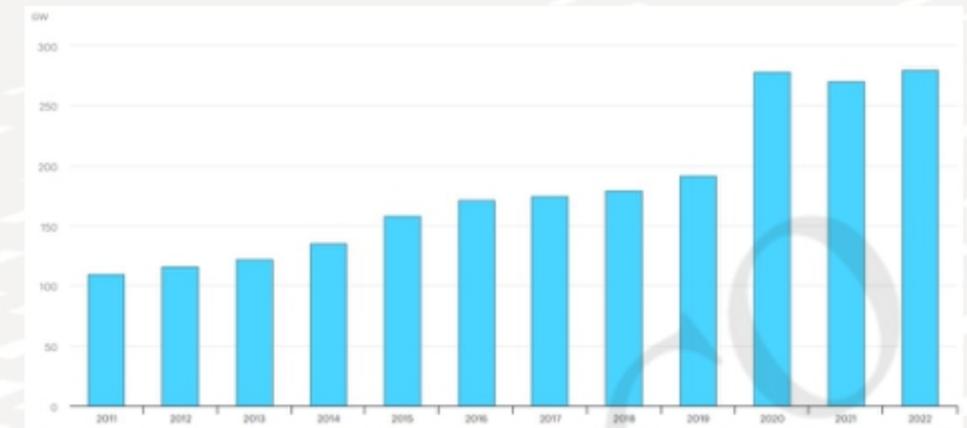
## 1.2 Green and Low-carbon Development

Under the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement, all nations have together forged a global climate governance system to conduct emission mitigation actions and international cooperation, with more concrete efforts in achieving carbon neutrality and green and low-carbon energy transition.

- **Global climate governance in progress:** All nations have conducted climate governance under the UNFCCC, and established a two-stage climate governance process under the Kyoto Protocol and the Paris Agreement.
- **Clearer carbon neutrality goals:** More than 100 parties to UNFCCC have come forward with carbon neutrality commitments, thus enhancing the global efforts to achieve carbon neutrality by the middle of this century.
- **Accelerated clean energy development:** The installed capacity of renewable energy power generation continues to soar up, with a record 295 GW of newly-added installed capacity of renewable energy generation in 2021, mainly from China and Europe. In the first half of 2022, global wind power and PV power generation rose by 300 TWh, meeting 77% of the newly-added power demand globally and 92% of the newly-added power demand in China.
- **Improved carbon trading markets:** 25 carbon trading systems are in place in the world, with participating countries accounting for 55% of global GDP.



Global Climate Governance Process

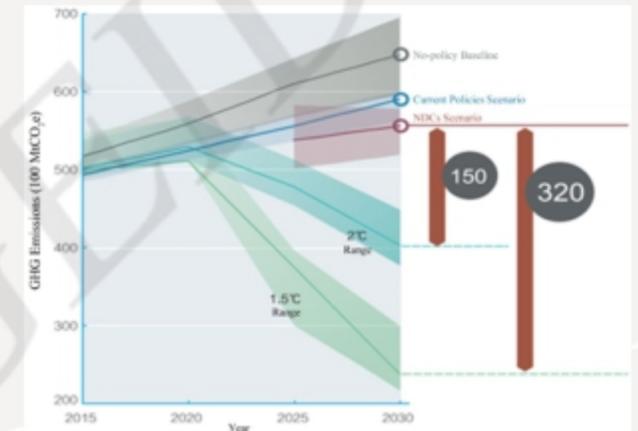


Global Newly-added Installed Capacity of Renewable Energy Power Generation

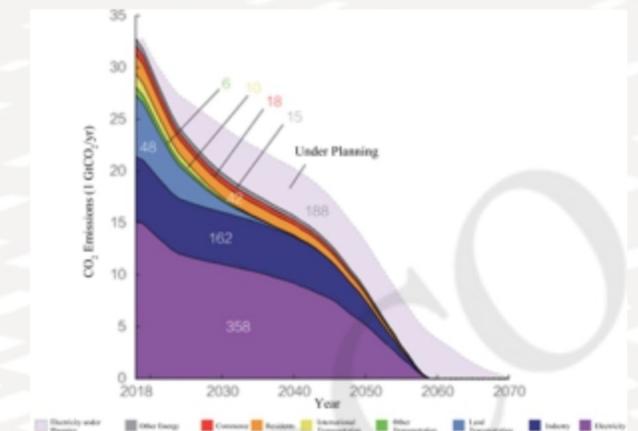
# 1.3 Challenges in Achieving Carbon Neutrality

We are facing grave challenges to achieve carbon neutrality, including the difficulty in ensuring energy security, large gap between the current progress and the mitigation goals, strong dependence on traditional development paradigm, a lack of holistic schemes, and insufficient global cooperation. We need to formulate global solutions that are conceptually advanced, technically feasible, holistic, efficient and cost-effective.

- **Difficulty in ensuring energy security:** Geopolitics and extreme climate disasters have made it difficult for many countries to secure energy and electricity supply, dragging down global economic recovery.
- **Large gap to reach carbon mitigation goals:** The world is running out of room to emit GHGs, and without strong action, the global carbon budget will soon be exhausted at current emissions levels. The window period for mitigation is transient.
- **Strong dependence on traditional development paradigm:** The relationship between the traditional economic and social development and fossil fuels shows strong coupling characteristics, and the status quo of the "carbon lock-in" in energy infrastructure is difficult to change in a short period of time. Therefore, we need to eliminate the dependence on fossil fuels.
- **Lack of holistic schemes:** All nations are facing challenges such as imbalance between economic development and emission mitigation, developmental disequilibrium between regions and sectors, and incompatibility between short-, medium- and long-term goals, with a lack of implementable, replicable, inclusive and win-win carbon neutrality schemes.



Global Emissions Gap by 2030



Fossil Fuel-related Emissions from Infrastructure under Planning



**1. Green and Low-carbon Development**

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**2. GEI-based Carbon Neutrality Pathway**

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**3. Energy Interconnection Scheme by Continent**

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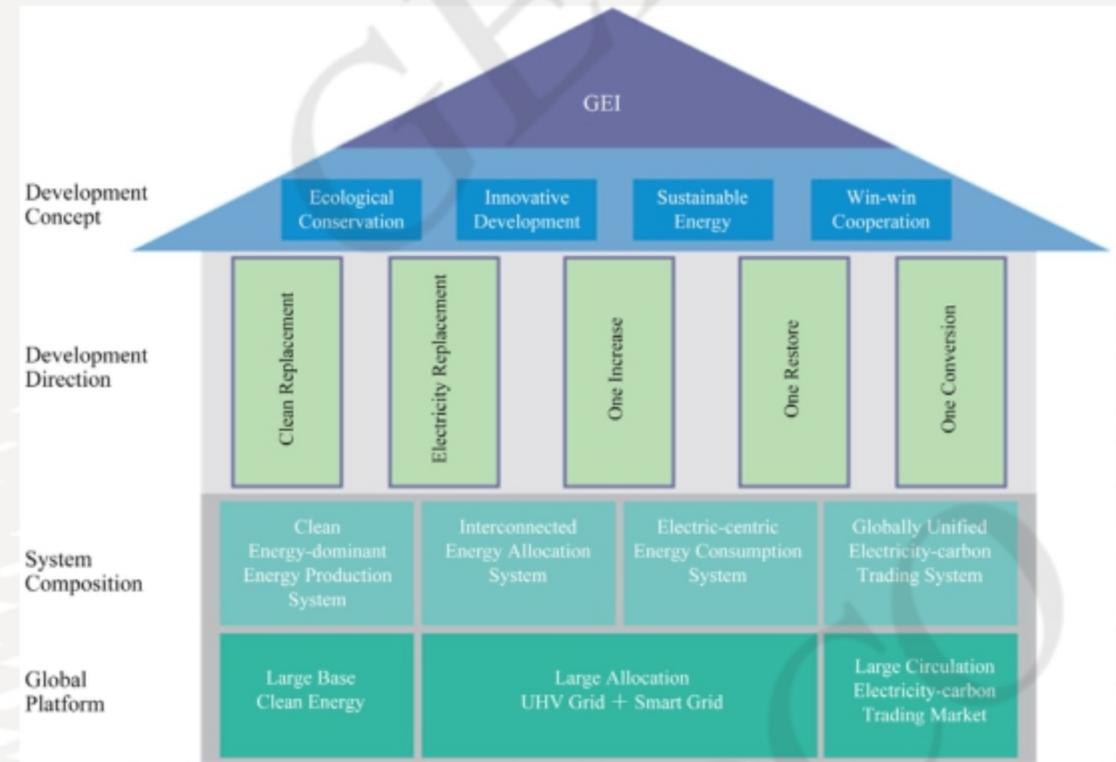
**4. Key Technologies and Policy Mechanisms**

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## 2.1 Concept of GEI

As a combination of "Smart Grid + UHV Grid + Clean Energy", based on "Two Replacements, One Increase, One Restore and One Conversion", GEI provides a solution for large-scale development, allocation and consumption of clean energy, and the construction of an interconnected energy system dominated by clean energy and centered on electricity.

- **Two Replacements** include clean replacement and electricity replacement. Clean replacement means replacing fossil fuels with clean energy on the energy supply side. Electricity replacement means replacing coal, oil, gas and primary biomass energy with electricity on the energy consumption side.
- **One Increase** means increasing the level of electrification and energy utilization efficiency to promote energy conservation and reduce energy intensity.
- **One Restore** means restoring fossil fuels to their basic attributes, mainly as industrial raw materials and materials.
- **One Conversion** means using clean electricity to convert carbon dioxide, water and other substances into fuels and raw materials such as hydrogen, methane and methanol, in a bid to ensure the green production and sustainable supply of important raw materials.



Overall Framework of the Theoretical System of GEI

## 2.2 Basis of GEI-based Carbon Neutrality Scheme



**GEI is technically feasible and economically competitive, characterized by abundant resources and interconnected grids, providing a solid guarantee for carbon neutrality.**

- **Abundant resources:** The world is rich in clean energy resources. The theoretically exploitable amount of hydroenergy, wind energy, and solar energy is equivalent to 38 times the remaining proved and recoverable reserves of fossil fuels around the world.
- **Feasible technology:** The clean energy power generation technology is developing. The UHV transmission network has been established worldwide, and the smart grid technology is widely used. China has completed 34 UHV power transmission projects, including 15 AC and 19 DC ones, and Brazil has completed a two-circuit  $\pm 800$  kV UHVDC power transmission project.
- **High cost-effectiveness:** The cost of clean energy power generation is falling rapidly. It is expected that by 2025, the competitiveness of PV and onshore wind power generation will surpass that of fossil fuels power generation in all respects.
- **Interconnection:** Large transnational interconnected grid networks have been completed in Europe and North America, as well as from Russia to the Baltic Sea. The Gulf Region, South America, Southeast Asia and Africa are also promoting transnational grid interconnection.



**UHV Grid Interconnections in China**



**Belo Monte UHVDC Project in Brazil**

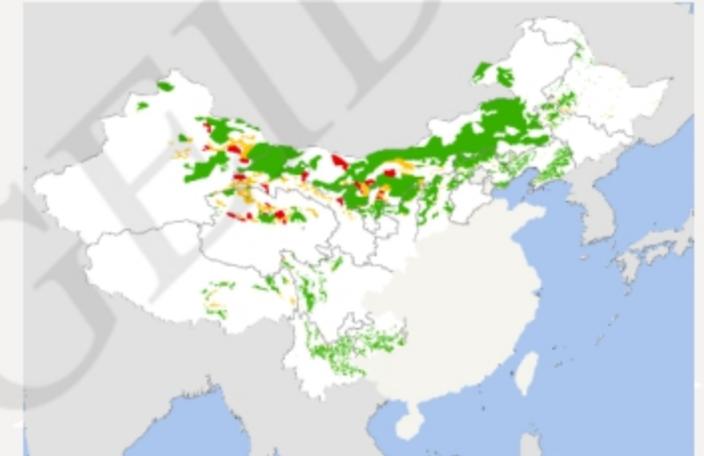
## 2.2 Basis of GEI-based Carbon Neutrality Scheme



Global Energy Interconnection  
Development and Cooperation Organization  
全球能源互联网发展合作组织

China has made great efforts to build China Energy Interconnection dominated by a new power system, and a new energy supply and consumption system based on large-scale wind and PV power bases and with UHV technology as the carrier, so as to ensure energy transition, improve security and resilience, and realize carbon emissions peak and carbon neutrality.

- **Accelerating clean energy development:** We need to accelerate the construction of large wind and PV power bases in deserts, Gobi and wastelands in northern and western China and hydropower stations in southwest China. By 2060, the installed capacity of wind and PV power generation in northern and western China will come to 4.2 TW, and the installed hydropower capacity in southwest China will exceed 300 GW. China will advance the integrated development of hydropower, wind power, and PV power in western region, and better develop and utilize renewable energy on a large scale.
- **Enhancing power grid interconnection:** China will apply UHV power transmission technology that is characterized by long transmission distance, high capacity, high efficiency, low line loss, reduced land use, and good safety, build a nationally interconnected and high-efficiency UHV grid network, and develop China Energy Interconnection dominated by clean energy and centering on electricity.
- **Ensuring energy security:** Relying on China Energy Interconnection, clean energy development and electrification rates will rise by more than 1.5 times. By 2060, China's clean energy consumption will account for more than 90% of the primary energy consumption, and clean energy power generation will take up more than 95% of the total, thus enabling sufficient, cost-effective, and reliable energy supply for economic and social development, and achieving carbon emissions peak and carbon neutrality.



Layout of Wind, PV and Solar Thermal Power Bases in Northern and Western China



China's UHV Backbone Grids by 2060

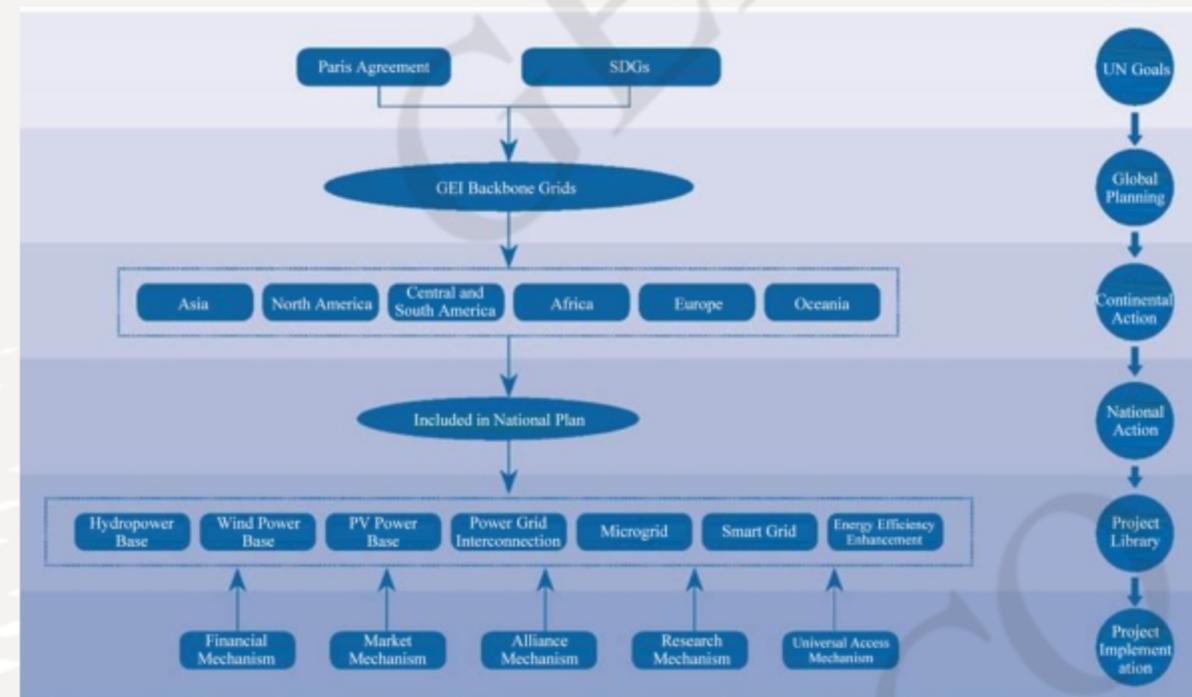
## 2.3 Overall Idea of GEI-based Carbon Neutrality



Based on GEI and adhering to the concept of green, low-carbon and sustainable development, we need to place equal emphasis on energy security and carbon mitigation as well as short-term and long-term goals, and stick to complementation of regional advantages and synergy of industry decarbonization. The GEI-based carbon neutrality scheme also suggests building a pattern featuring dominant roles of clean energy in energy production and electricity in energy consumption, as well as decoupling of economic development from carbon emissions, in an effort to achieve carbon neutrality and build a clean development pattern with a balance among economy, society and environment.

### Advantages of GEI-based carbon neutrality:

- **Advanced and efficient:** By building a wide-area and interconnected power grid and an electricity-carbon trading market, and by optimizing allocation to take advantage of differences in resource availability, time zones, seasonal patterns and electricity prices, GEI enables the security of energy supply and transition towards green and low-carbon energy in a cost-effective and high-efficiency way.
- **Viable:** GEI provides an operable, replicable and promotable scheme to address energy security, ecological protection, power access, poverty and health issues.
- **Win-win:** GEI provides abundant public products and innovative governance mechanisms for the purpose of resolving climate crisis and promoting concerted actions. It is therefore able to align with the UN's work frameworks, to serve regional strategic development, and to promote the policy coordination among countries.

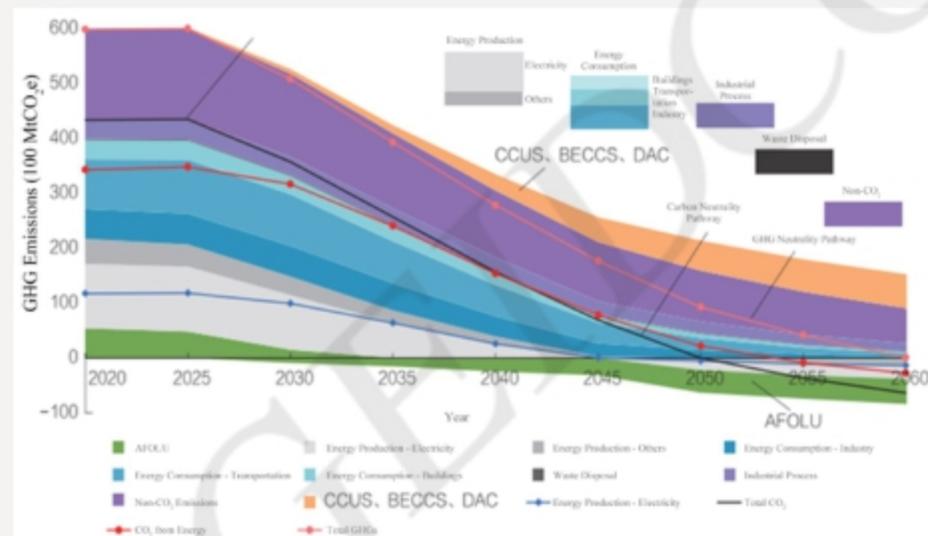


GEI's Global Governance System and Cooperation Platform

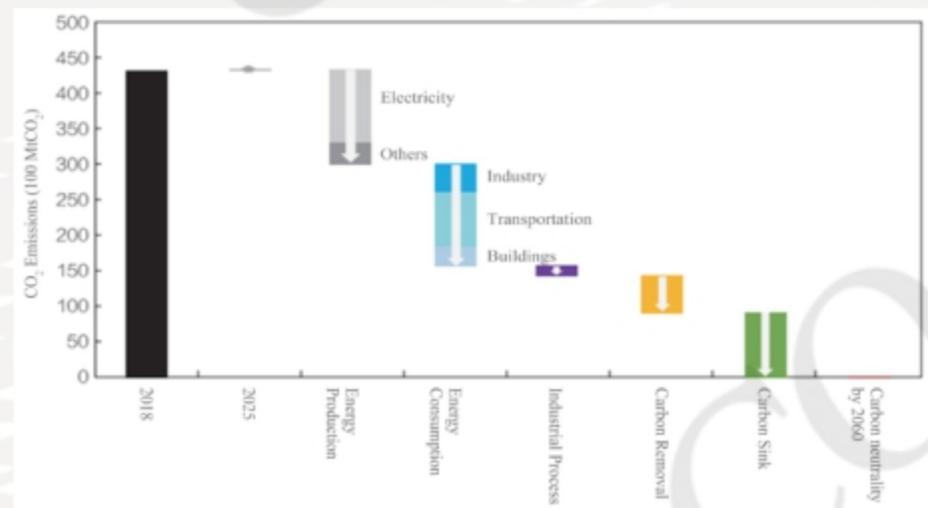
## 2.4 Global Net Zero Emissions Pathway

### 1 Overall Net Zero Emissions Pathway

- **Stage I: carbon emissions peak.** With focus on the control of fossil fuel consumption, new energy demand will be mainly met with clean energy, and the overall carbon emissions will peak around 2030. The core of peaking carbon emissions from energy activities is to control the peaking of fossil fuel consumption. GEI will advance the peaking of energy-related carbon emissions and control the peak at a reasonable level, thus playing a greater role in achieving carbon neutrality and leading the low-carbon transition.
- **Stage II: carbon neutrality.** The energy transition and GEI development will play a crucial role in accelerating the replacement of fossil fuel stocks, thereby achieving carbon neutrality. Carbon emissions from energy activities will drop by about 80% compared with the carbon emissions peak. Combined with carbon sink and carbon removal from Agriculture, Forestry and Other Land Use (AFOLU), overall carbon neutrality will come true by the middle of this century.



Net Zero GHG Emission Roadmap by Sector

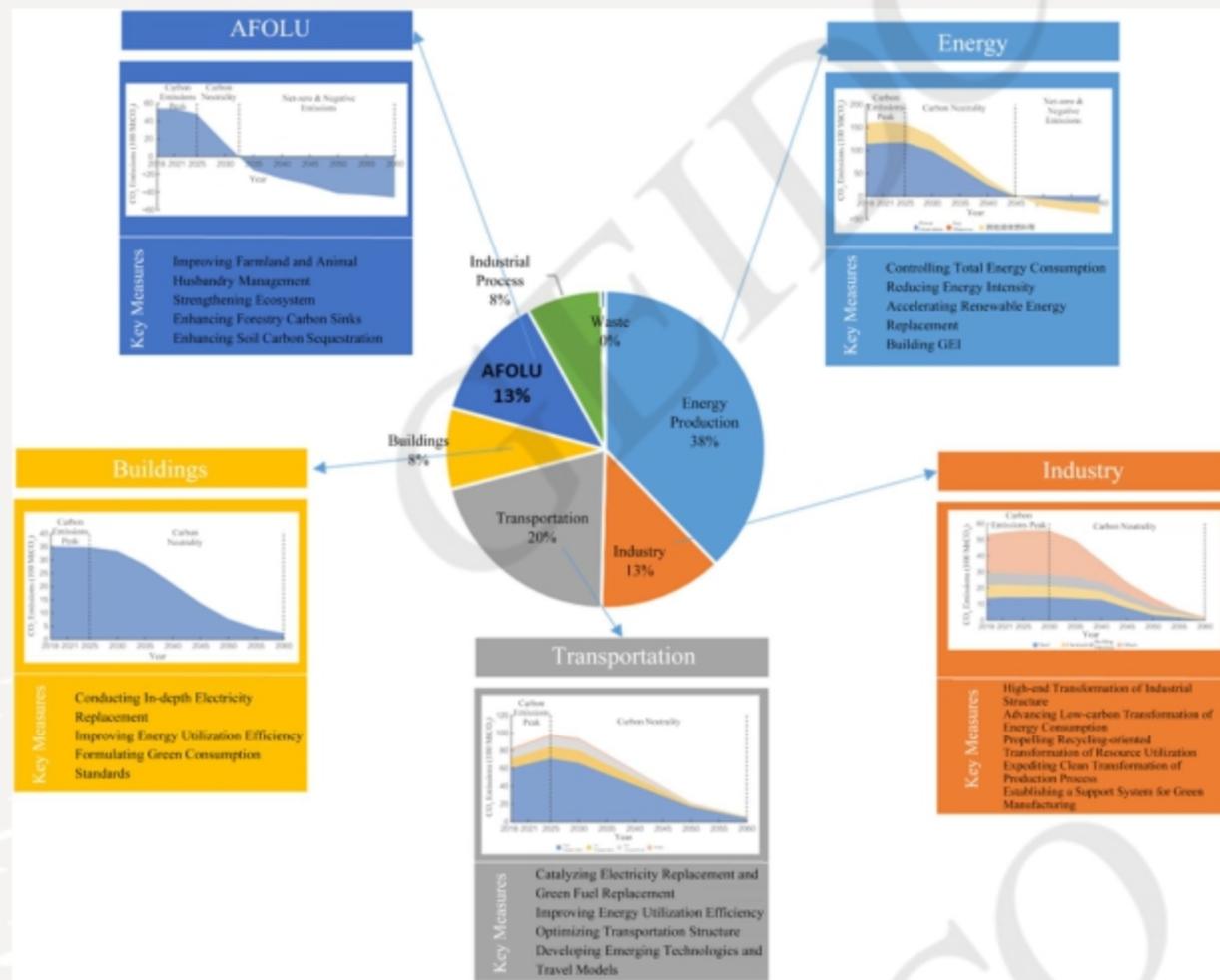


Prospects of CO<sub>2</sub> Emission Mitigation by Sector

# 2.4 Global Net Zero Emissions Pathway

## 2 Net Zero Emissions Pathway by Sector

- **Decarbonization of energy production:** Carbon emissions from energy production account for 38% of the total. Key measures include controlling the total energy consumption, reducing energy intensity, accelerating the renewable energy replacement, and building GEI.
- **Decarbonization of industry:** Carbon emissions from industrial production account for 13% of the total. Key measures include advancing the high-end transformation of the industrial structure, the low-carbon transformation of energy consumption, the recycling-oriented transformation of resource utilization, and the clean transformation of the production process, and establishing a support system for green manufacturing.
- **Decarbonization of transportation:** Carbon emissions from transportation account for 20% of the total. Key measures include catalyzing electricity replacement and green fuel replacement, improving energy utilization efficiency, optimizing transportation structure, and developing emerging technologies and travel models.
- **Decarbonization of buildings:** Carbon emissions from building sector take up 8% of the total. Key measures include carrying out in-depth electricity replacement, improving energy utilization efficiency, and formulating green consumption standards.



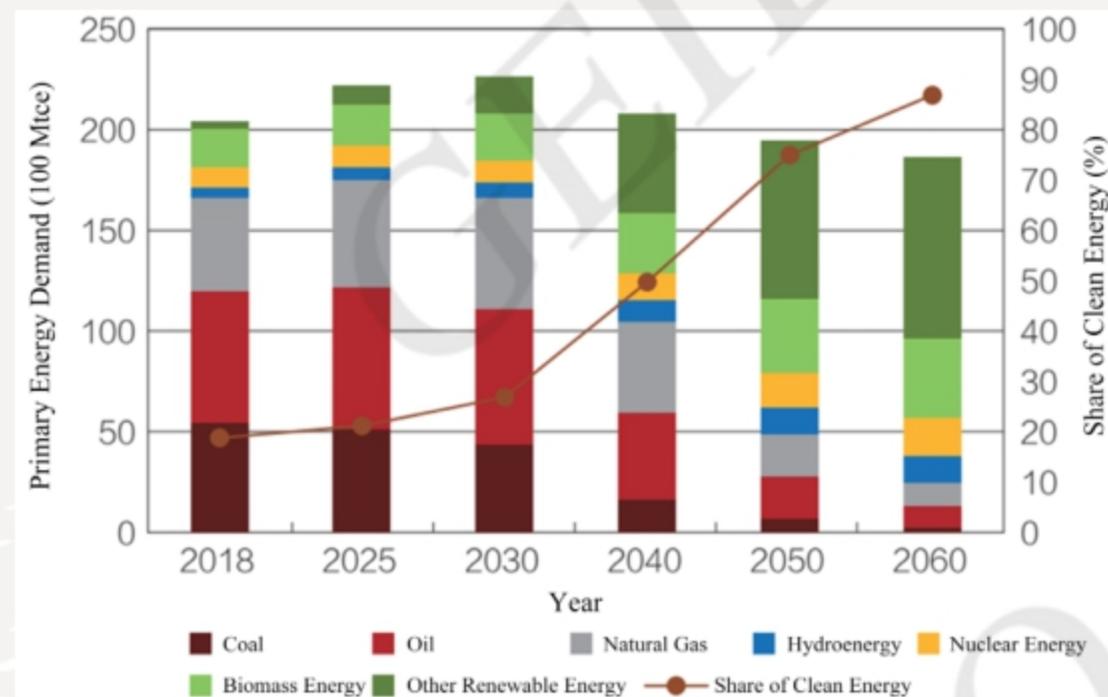
Projected CO<sub>2</sub> Emission Mitigation by Sector

## 2.5 Energy Transition Pattern

GEI will propel the establishment of a clean energy-dominant and electric-centric global energy system, and a low-carbon energy supply and electric-centric energy consumption pattern. It will rely on a solid backbone grid network to flexibly regulate resources, thus ensuring safe, clean and efficient energy development.

### 1 Clean and Low-carbon Energy Supply

- **Phase-out of fossil fuels accelerates.** Coal consumption has hit a plateau, and oil and natural gas consumption have accelerated to peak. A certain proportion of coal will be reserved in the long term, mainly for flexible regulation and safe supply.
- **Development of clean energy accelerates.** Clean energy will become the main source of energy supply. By 2060, clean energy will account for 85% of primary energy, and the installed capacity of clean energy power generation will take up 92%. Based on the Global Renewable-energy Exploitation Analysis (GREAN) platform of GEIDCO, GEI aims to build 90 large PV power bases, 94 large wind power bases, and 35 large hydropower bases.
- **Carbon removal promotes decarbonization of energy mix.** The amount of carbon capture using carbon removal technology is rising year by year, and carbon capture technologies (CCUS, BECCS, DAC) are the key to achieve carbon neutrality.

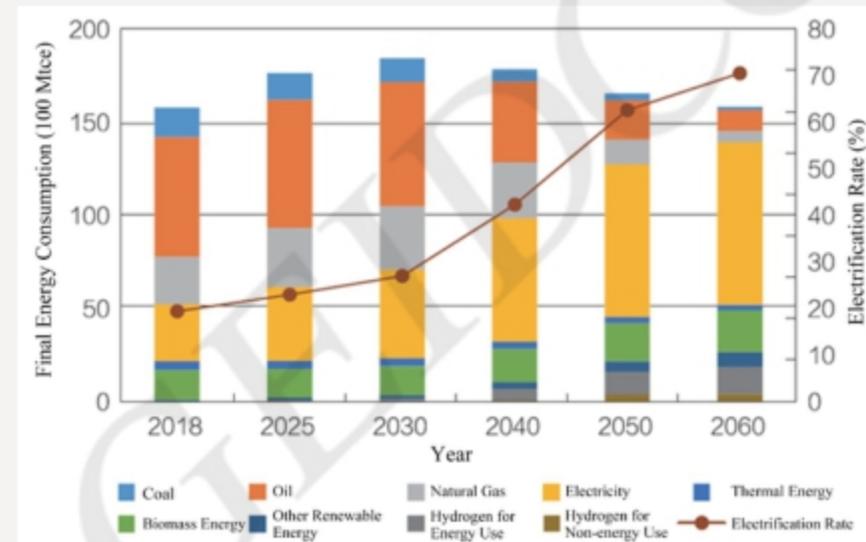


Projected Primary Energy Consumption and Its Structure

# 2.5 Energy Transition Pattern

## 2 Electric-centric Energy Consumption

- **An electric-centric pattern is taking shape quickly.** By 2050 and 2060, the global electricity consumption will increase to 83,000 TWh and 89,000 TWh respectively, accounting for more than 63% and 65% of the total final energy consumption.
  - **Industry sector:** Steel, chemical, and construction materials industries will gradually build an electric-centric energy consumption system featuring electricity-hydrogen-biomass complementation. The electrification rate will reach 60% by 2060.
  - **Transportation sector:** The land, air and sea transportation industries will accelerate the transition of the fuel-dominated energy consumption structure through electricity replacement. The electrification rate will reach 46% by 2060.
  - **Building sector:** The residential and commercial building industries will facilitate the electricity replacement, improve energy efficiency, and gradually build an electric-centric energy consumption system. The electrification rate will reach 75% by 2060.
- **Green hydrogen facilitates in-depth decarbonization.** By 2060, the electrohydrogen production will come to 360 million tons, and final hydrogen consumption will account for about 10% of energy consumption. Among them, 60 million tons of hydrogen will be used for flexible energy storage, 70 million tons will be used as industrial raw materials, and the rest will be used as energy in industry, transportation and buildings.



**Projected Final Energy Consumption and Its Structure**



**Projected Share of Electricity and Green Hydrogen in Final Energy Consumption**

## 2.5 Energy Transition Pattern

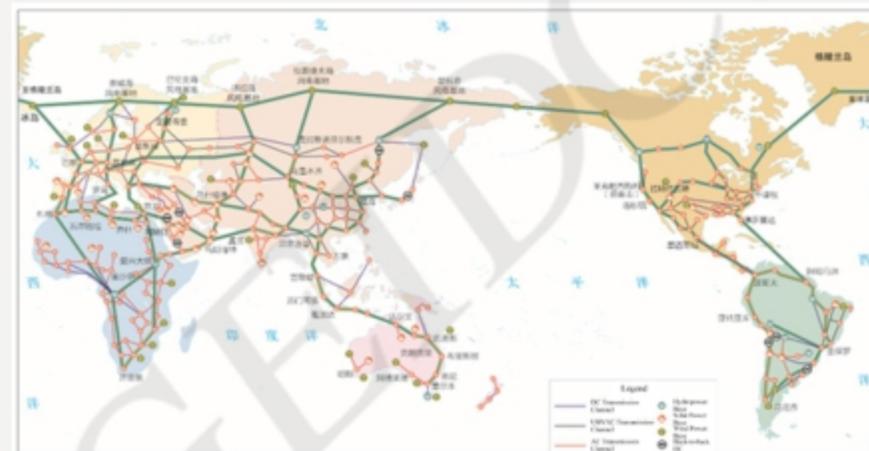
### 3 Wide-area and Interconnected Energy Allocation

#### • Backbone Power Grid Network

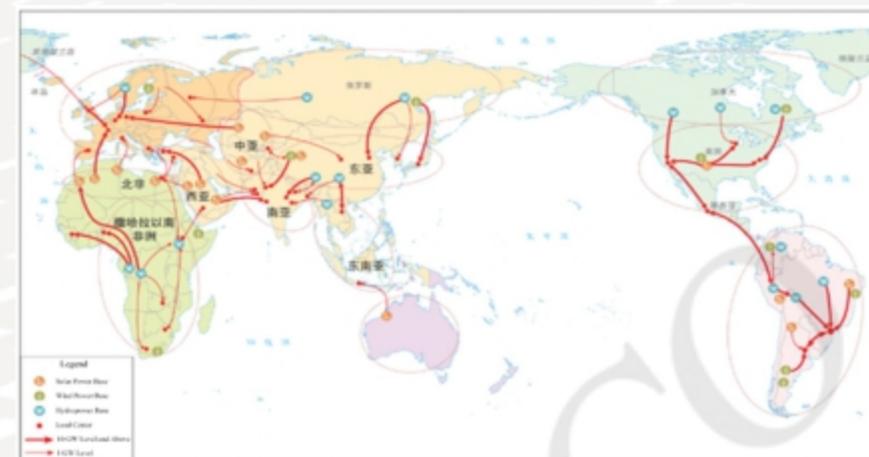
- **In the first stage (domestic interconnection)**, all nations will reach consensus, carry out technology and standard research, strengthen the interconnection of domestic power grids and the development of smart grids, and develop clean energy.
- **In the second stage (intra-continental interconnection)**, all nations will promote transnational grid interconnection and build clean energy bases within a continent.
- **In the third stage (intercontinental interconnection)**, all nations will promote the construction of transcontinental UHV backbone grids, and basically build GEI.

#### • Green Hydrogen Allocation System

The world is accelerating the development of electrohydrogen production bases, and utilizing green hydrogen in industry, transportation, and power generation. As a result, a green hydrogen allocation pattern takes shape, which combines on-site preparation and utilization with large-scale optimization. By 2050, green hydrogen will be optimally allocated across continents and within continents, with a transmission scale of about 50 million tons/year.



**Nine Horizontal and Nine Vertical Backbone Grids of GEI**



**Global Power Flow Pattern in 2050**

## 2.6 Advantages of GEI Carbon Neutrality

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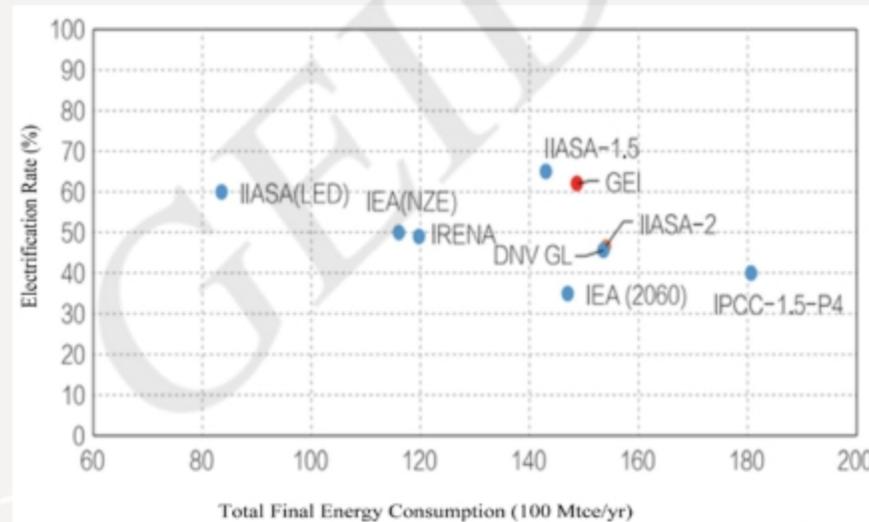
### Secure and abundant: Secure and abundant energy supply, featuring clean development and electrification

Electricity consumption will reach 83,000 TWh, significantly higher than that in other scenarios, fully ensuring energy security and sufficiency. The electrification level will exceed 65% and the cleanliness level will reach 85%, about 10-25 percentage points higher than other schemes.

2

### Win-win cooperation: Large-scale, low-cost and efficient development of clean energy via interconnection

GEI can optimally match energy demand with high-quality and low-cost clean energy, and propel national, regional and global cooperation for win-win results, thereby achieving carbon neutrality. Compared with local development and consumption of clean energy, GEI can increase the share of clean electricity by 9-12 percentage points. In Northeast Asia, for example, the interconnection model only needs an increase of 300 billion yuan of investment in grid interconnection to save about 1.1 trillion yuan of investment in clean power generation and energy storage.



Multi-scenario Comparison of Final Energy Consumption and Its Structure

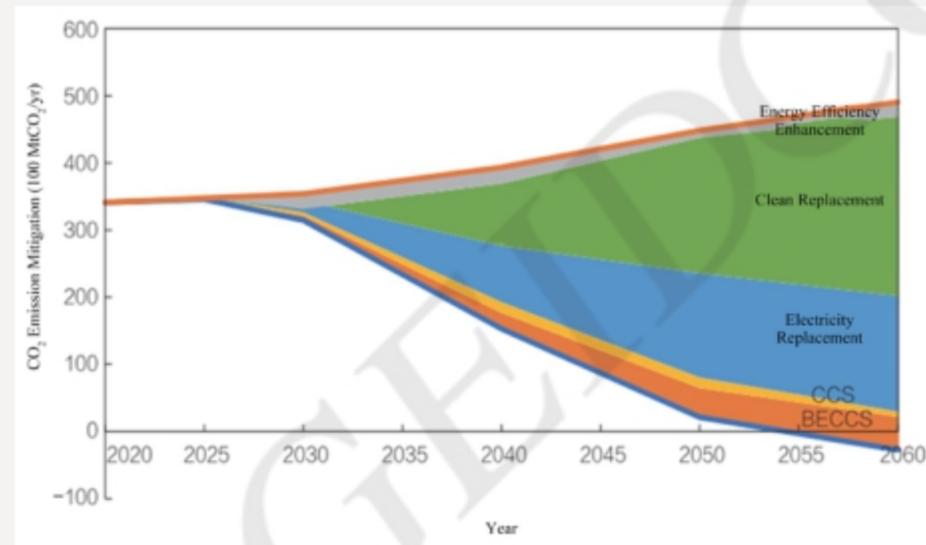
## 2.6 Advantages of GEI Carbon Neutrality

### 3 Technically advanced: Based on relatively mature and reliable technology

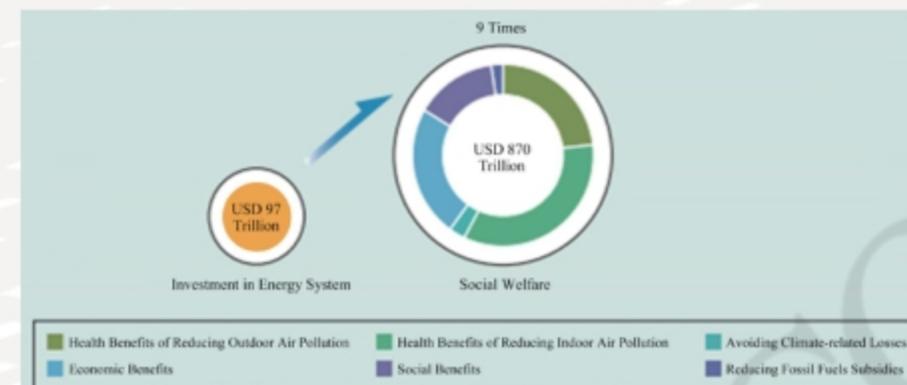
Clean replacement can control the source of carbon emissions, and electricity replacement can mitigate carbon emissions in all sectors, with a cumulative contribution of about 80% in emission mitigation. Energy efficiency enhancement as well as Carbon Capture, Utilization and Storage (CCUS) technologies can reduce emissions by 20%.

### 4 Cost-effective and efficient: Low investment, low emission mitigation cost, high comprehensive value

The investment in energy system will total about USD 97 trillion, accounting for no more than 2% of the global GDP, creating comprehensive value of more than USD 800 trillion and nearly 300 million jobs, enhancing the synergistic benefits of economy, society and environment. It is equivalent to obtaining USD 9 of comprehensive value with USD 1 of energy investment.



Mitigation Contribution of GEI-based Carbon Neutrality



**USD 1 of energy investment for USD 9 of comprehensive value**



**1. Green and Low-carbon Development**

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**2. GEI-based Carbon Neutrality Pathway**

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**3. Energy Interconnection Scheme by Continent**

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**4. Key Technologies and Policy Mechanisms**

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# 3. Energy Interconnection Scheme by Continent

In light of the development conditions and characteristics of six continents of Asia, Europe, Africa, North America, Central and South America, and Oceania, GEI provides a solution to mitigate emissions, advance energy transition, and build energy interconnection for achieving carbon neutrality, so as to ensure energy security and build a diversified and intelligent energy mix.



Emissions Mitigation Pathway and Clean Energy Development by Continent

## 3.1 Asian Energy Interconnection

With focus on transition towards low-carbon energy, the scheme of Asian Energy Interconnection will strive for clean development through energy transition and further accelerate emission mitigation. The scheme will also expedite intensive development of clean energy and grid interconnection, and transform resource advantages into economic benefits, thus securing synergy among economic prosperity, social progress, climate governance, and environmental protection.

- **Clean energy.** 38 large-scale PV power bases, 39 large-scale wind power bases, and 10 hydropower bases will be built in areas with high-quality resources and good development conditions. By 2030 and 2060, the installed capacity of clean energy power generation in Asia will take up 61% and 98% of the total, respectively. By 2060, the installed capacity of wind power and solar power will reach 6.1 TW and 12.4 TW, respectively.
- **Allocation network.** Asia will build a pattern of "power transmission from west to east and from north to south", with power grid network interconnected with those in Europe, Africa and Oceania. By 2050, the inter-continental and inter-regional power flow of Asian Energy Interconnection will amount to 200 GW. Asia will develop five regional grid interconnection networks, strengthen inter-continental grid interconnection, and build an overall pattern of "four horizontal and three vertical" grid interconnection channels.



## 3.2 European Energy Interconnection

With focus on building a zero-carbon society, the scheme of European Energy Interconnection will accelerate the development and utilization of clean energy outside and inside the continent, and build a platform for energy and power cooperation between Europe and surrounding areas. The scheme will also optimally allocate energy on a large scale, expedite the low-carbon transition of industries, and promote regional coordinated development.

- **Clean energy.** 17 large-scale wind power bases, and 3 hydropower bases will be built in areas with high-quality resources and good development conditions. By 2030 and 2060, the installed capacity of clean energy power generation in Europe will take up 78% and 98% of the total, respectively. By 2060, the installed capacity of wind power and solar power will come to 2 TW and 1.8 TW, respectively.
- **Allocation network.** Europe will generally present a pattern of "power transmission from north to south in the continent and inter-continental access to Asia-Africa power." By 2050, the inter-continental and inter-regional power flow will reach about 130 GW. A DC power grid pattern with continental power grid as the core will be formed, which connects wind power and hydropower bases in Northern Europe through multi-circuit DC channels, and connects clean energy bases in North Africa, West Asia and Central Asia.



## 3.3 African Energy Interconnection

With focus on green electrification and industrialization, the overall idea is to accelerate the intensive development of solar and wind energy, promote the co-development model of "electricity-mining-metallurgy-industry-trade", and build a green and low-carbon industrial system, so as to realize green electrification, industrialization and integration in Africa.

- **Clean energy.** 21 large-scale PV power bases, 12 large-scale wind power bases, and 8 hydropower bases will be built in areas with high-quality resources and good development conditions. By 2030 and 2060, the installed capacity of clean energy power generation in Africa will take up 57% and 95% of the total, respectively. By 2060, the installed capacity of wind power and solar power will reach 700 GW and 1.8 TW, respectively.
- **Allocation network.** Africa will generally present a pattern of "power transmission from central part to north and south, and mutual complementation with Asia and Europe". By 2050, the inter-continental and inter-regional power flow will exceed 140 GW. Africa will build three synchronous power grids in its north, central and west, and southeast regions, and a 1,000 kV AC channel in the north, which will serve as an important energy allocation platform connecting the continent with Asia and Europe.





## 3.4 North American Energy Interconnection

With focus on accelerating decarbonization, North America will ensure a sustained energy supply through clean development, and pursue regional coordination and complementation through interconnection. In addition, it will improve total factor productivity via electrification to eventually realize diversified and inclusive development characterized by economic growth, social progress, and climate and environment protection.

- **Clean energy.** 10 large-scale PV power bases and 12 large-scale wind power bases will be built in areas with high-quality resources and good development conditions. By 2030 and 2060, the installed capacity of clean energy power generation in North America will take up 79% and 98% of the total, respectively. By 2060, the installed capacity of wind power and solar power will reach 2.2 TW and 4.1 TW, respectively.
- **Allocation network.** North America will generally present a pattern of "power transmission from north to south, from central part to east and west, and mutual complementation with Central and South America." By 2050, the inter-continental, transnational and inter-regional power flow will reach 200 GW. North America will build three synchronous power grids, namely the Eastern Power Grid, the Western Power Grid and the Quebec Power Grid, to advance the construction of transnational and inter-regional grid interconnection channels.





## 3.5 Central and South American Energy Interconnection

With focus on multi-energy mutual support and re-industrialization, Central and South America will make full use of the advantages of clean energy, promote power grid upgrading and transnational interconnection, increase the terminal electrification rate, and support re-industrialization with clean electricity, thus achieving coordinated development of economic growth, energy transition, and emission mitigation.

- **Clean energy.** 15 large-scale PV power bases, 9 large-scale wind power bases, and 14 large-scale hydropower bases will be built in areas with high-quality resources and good development conditions. By 2030 and 2060, the installed capacity of clean energy power generation in Central and South America will take up 68% and 96% of the total, respectively. By 2060, the installed capacity of wind power and solar power will reach 500 GW and 800 GW, respectively.
- **Allocation network.** Central and South America will form a pattern generally characterized by "hydropower transmission from north to south, wind power transmission from south to north, PV power transmission from west to east, and mutual complementation with South and North America". By 2050, the inter-continental, inter-regional and transnational power flow will come to 91 GW. Central and South America will develop three synchronous grids in eastern and western South America, southern South America and Central America, and the Caribbean will develop inter-island AC or DC grid interconnection.



## 3.6 Oceanian Energy Interconnection

The overall idea is to enable the development of energy mix without coal, and enhance the adaptability of small island states to climate change. Moreover, mitigation and adaption need to be advanced together, and regional coordination and complementation must be accelerated via networking and interconnection, so that the coordinated and sustainable development of economies, societies, resources, environment, man and nature becomes a reality.

- **Clean energy.** 10 large-scale PV power bases, 5 large-scale wind power bases, and 3 hydropower bases will be built in areas with high-quality resources and good development conditions. By 2030 and 2060, the installed capacity of clean energy power generation in Oceania will take up 79% and 100% of the total, respectively. By 2060, the installed capacity of wind power and solar power will reach 200 GW and 500 GW, respectively.
- **Allocation network.** Oceania will present a pattern of "complementation between hydropower and PV power from Australia and Papua New Guinea, and inter-continental complementation with Southeast Asia". By 2050, the inter-continental, transnational and inter-regional power flow will come to 10 GW. Five synchronous grids will be established in eastern Australia, western Australia, northern New Zealand, southern New Zealand, and the main island of Papua New Guinea. Island countries such as Fiji will build their own domestic interconnected power grids.





**1. Green and Low-carbon Development**

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**2. GEI-based Carbon Neutrality Pathway**

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**3. Energy Interconnection Scheme by Continent**

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**4. Key Technologies and Policy Mechanisms**

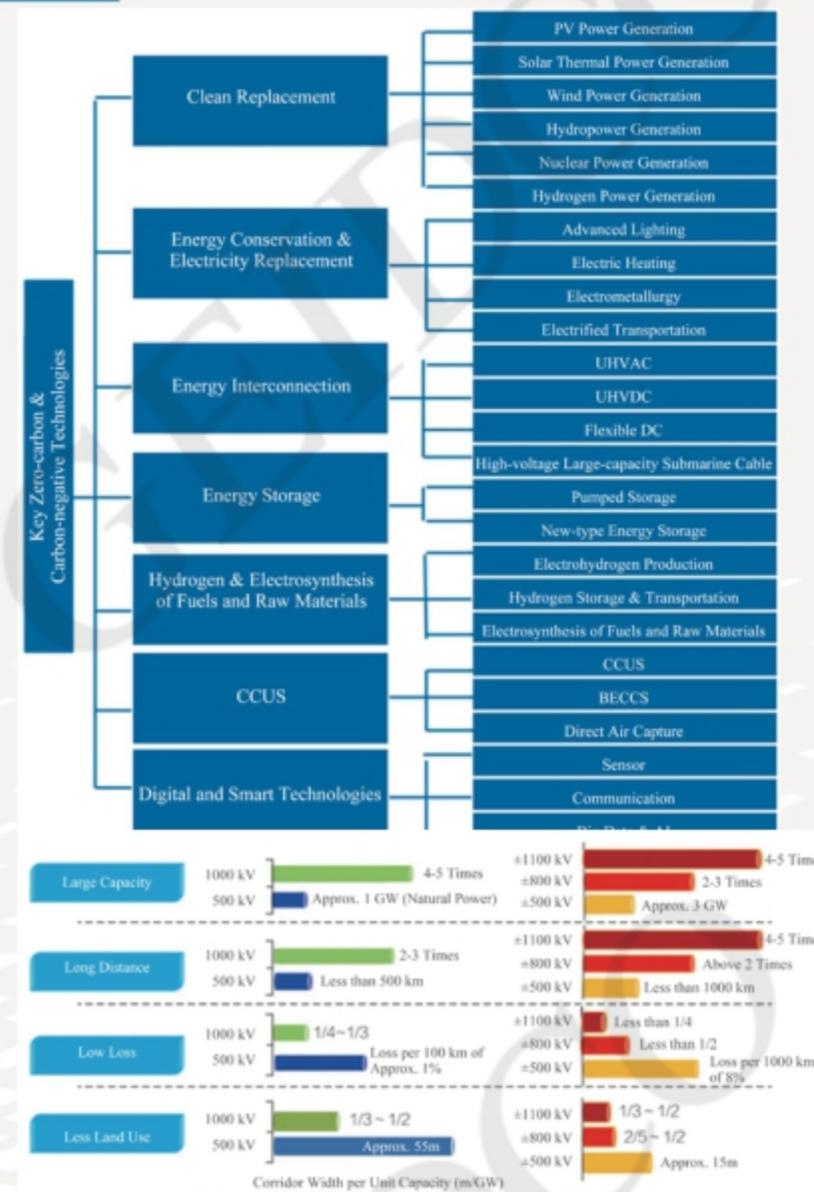
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# 4.1 Key Zero-carbon & Carbon-negative Technologies



Zero-carbon and carbon-negative technologies include more than 30 types of key technologies in 7 fields, and its innovative development will play a crucial role in achieving global carbon neutrality. The GEI-based carbon neutrality scheme takes clean energy power generation, electricity replacement and UHV power transmission technology as the core to form a feasible and optimized technology combination, which can meet the technical demands of each development stage of carbon emissions peak and carbon neutrality in a cost-effective and reliable way.

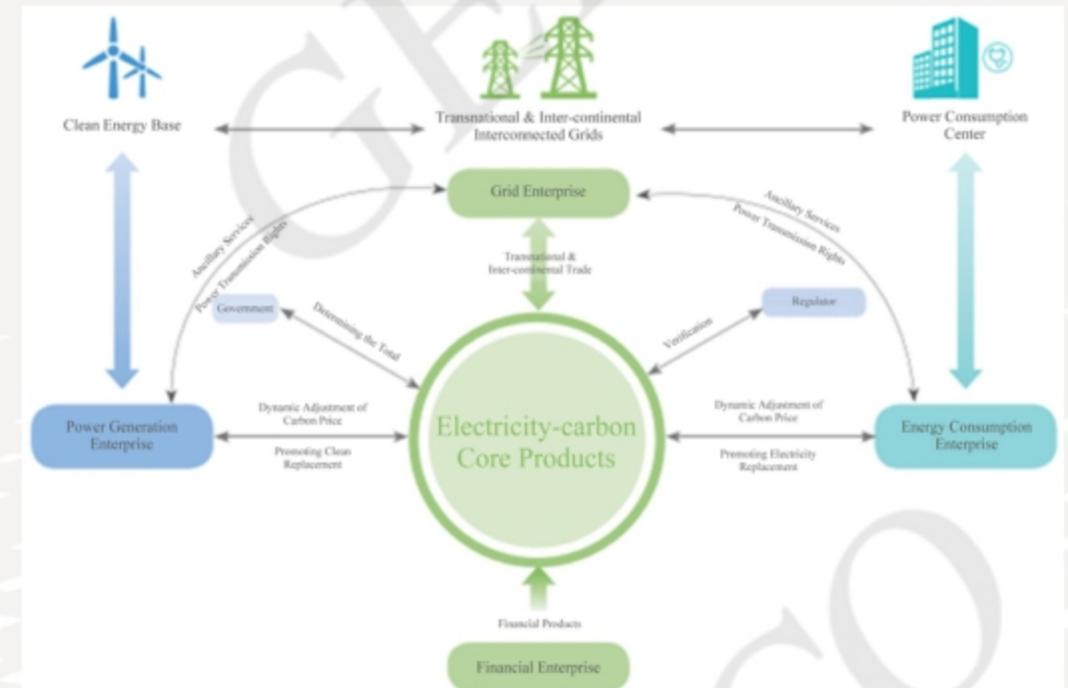
- **Proven technologies:** Key technologies such as clean energy power generation and UHV have been widely applied, playing a crucial role in power production, optimal allocation and holistic regulation of energy. Among the proven technologies, UHV power transmission technology will play a critical role in optimal energy allocation, with the cost-effectiveness continuously improved. It is estimated that by 2030, the investment in UHVAC substation and UHVDC converter station will decrease by about 28% and 10%, respectively.
- **Proven technologies that are developing rapidly:** New-type energy storage, flexible power transmission, and electric vehicle technologies are maturing and need to further improve efficiency and reduce costs, which will play a crucial role in achieving carbon emissions peak and rapid carbon emission mitigation.
- **Technologies that need to be improved:** Hydrogen, electrosynthesis of fuels and raw materials, CCUS technologies are developing towards clear goals, but the bottlenecks of key technical links and process design restrict the improvement of efficiency and cost-effectiveness. Breakthroughs should be made in these areas, so that these technologies can play a positive role in stock replacement in the carbon neutral stage.



## 4.2 Electricity-Carbon Trading Market

Global electricity-carbon trading market is crucial for achieving carbon neutrality. Its overarching idea is to adhere to the concept of innovated, coordinated, green, and open development for shared benefits, strive for building a clean, low-carbon, safe, and efficient modern energy system, and achieving carbon emissions peak and carbon neutrality. Based on energy interconnections and centered on the innovation of mechanism products, markets will be thoroughly integrated for the in-depth integration of two market management institutions, participating entities, trading products, and market mechanisms, and the integrated development of national, transnational and inter-continental markets.

- Global electricity-carbon trading market constructed in the order of "national market - intra-continental market - global market"
- **National market:** All countries are expected to build a national unified electricity-carbon trading market according to their own electricity market reform and carbon market construction.
- **Intra-continental market:** Transnational and inter-regional electricity-carbon trading will be carried out to form six intra-continental markets in Asia, Europe, Africa, North America, Central and South America, and Oceania.
- **Inter-continental market:** Electricity-carbon trading will be mainly carried out in the intra-continental market and inter-continental market.
- **Development pathway:** To build a global electricity-carbon trading market, national markets, intra-continental markets and inter-continental markets will be established step by step by the middle of this century.



Electricity-carbon Trading Market

## 4.3 Innovation of Policy Mechanisms

To realize carbon neutrality, policy mechanisms should be established to form a holistic policy framework and mechanism in clean development, cooperative governance, collaborative innovation, financial investment, and legal guarantee.

- **Clean development mechanism:** It is required to improve the clean energy development policy system, formulate the fossil fuel phase-out policy, and establish a green industry development mechanism.
- **Cooperative governance mechanism:** All nations need to establish a cooperative energy and climate governance system, improve the multilateral cooperation mechanism, and perfect the international coordination mechanism.
- **Collaborative innovation mechanism:** All countries should establish an interdisciplinary joint innovation mechanism featuring enterprise-university-research institute interaction, strengthen the role of governments in promoting innovative development, and establish an international collaboration and green and low-carbon technology achievement sharing mechanism.
- **Financial investment mechanism:** It is required to broaden funding channels, innovate financing models, and improve financial services.
- **Legal guarantee mechanism:** All nations should establish an international agreement fulfillment mechanism, ensure national legislative guarantee, and coordinate policies and regulations.



**Framework of Global Cooperative Energy and Climate Governance System**

# Epilogue

**Carbon neutrality requires coordinated efforts from all parties. Clean and green energy transition is the key to achieving carbon neutrality. The GEI-based carbon neutrality scheme is of great value for accelerating the green energy transition, addressing climate change, and realizing sustainable development of humankind.**

**With the aim of building GEI and meeting global electricity demand in a clean and green way, GEIDCO hammers at propelling energy transition, advancing international energy cooperation, and expediting the sustainable development of humankind. GEIDCO will make unremitting efforts with all sectors of society to advance carbon neutrality, and achieve the temperature control goals of the Paris Agreement and the UN Sustainable Development Goals!**

**Official website of GEIDCO: <https://en.geidco.org.cn/>**

**Official website of World of Energy Interconnection (WEI): <https://www.geidcp.com/#/>**