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DEVELOPMENT OF CHINA'S ALTERNATIVE ENERGY STRATEGY: PRECONDITIONS AND FORECASTS

The article is devoted to the study of the development of China's alternative energy strategy. The article states that with the growth of the world's population and the continuous development of industry, the human need for energy is growing. It is a well-known fact that the growth of industrial production and CO₂ emissions during production has caused climate change. Climate change threatens the survival of vulnerable species on earth, threatens ecosystems and biodiversity, and can threaten human survival. If the extreme weather that threatens human survival does not occur, the limitation of fossil resources will severely limit the future development of mankind. In particular, human activities since the Industrial Revolution have been a major cause of the current global warming, including emissions of carbon dioxide and other greenhouse gases caused by human production and life, land use and urbanization. The article proves that the emergence of alternative energy sources gives positive results in leveling the impact of industrial development on the environment. It is a source of energy for sustainable development and plays a key and important role in global efforts to combat climate change. Its emergence has put more and more companies and industries in the spotlight worldwide. As the global energy market is politically biased, policymakers face increasingly difficult challenges to their countries' energy security. The question of how to integrate renewable energy sources and policies to improve their efficiency was explored, so that each of them can take full advantage of their own benefits to maximize benefits and make people's lives easier. With the growth of renewable energy, the influence of individuals, governments and international orga-

nizations, as well as the role played by local, national and intergovernmental policies, are becoming increasingly important. The key principles of China's alternative energy strategy were identified, how to facilitate the development of renewable energy in the right direction and integrate energy into industrial production were identified. It is proposed to further develop this strategy in accordance with the best world experience, taking into account the national interests of China.

Keywords: alternative energy, strategy, electricity, non-renewable energy, energy security, energy policy.

JEL classification: F21, N75, Q40, Q42

РОЗВИТОК СТРАТЕГІЇ АЛЬТЕРНАТИВНОЇ ЕНЕРГЕТИКИ КИТАЮ: ПЕРЕДУМОВИ ТА ПРОГНОЗИ

Статтю присвячено дослідженню розвитку стратегії Альтернативної енергетики Китаю. У статті визначено, що зі зростанням населення світу та безперервним розвитком промисловості зростає й потреба людини в енергії. Загальновідомим є той факт, що зростання промислового виробництва і викидів CO₂, що виділяються у процесі виробництва, спричинили зміни клімату. Зміна клімату загрожує виживанню вразливих видів на землі, загрожує екосистемам та біорізноманіттю, а також може загрозувати виживанню людства. Якщо екстремальна погода, яка загрожує виживанню людства, не настане, то обмеження викопних ресурсів серйозно обмежить майбутній розвиток людства. Зокрема, діяльність людини з часів промислової революції є основною причиною нинішнього глобального потепління, включаючи викиди вуглекислого газу та інших парникових газів, викликаних виробництвом і життям людини, використанням землі та урбанізацією. У статті доведено, що поява альтернативних джерел енергії дає позитивні результати щодо нівелювання впливу розвитку промисловості на екологію. Це джерело енергії для сталого розвитку, і воно відіграє ключову та важливу роль у глобальних зусиллях щодо боротьби зі зміною клімату. Його поява поставила все більше компаній і галузей у центрі уваги на світовому рівні. Оскільки світовий енергетичний ринок є політично упередженим, політики стикаються з дедалі складнішими проблемами щодо енергетичної безпеки своїх країн. Було досліджено питання щодо того, як інтегрувати відновлювані джерела енергії та політику підвищення ефективності їх використання, щоб кожен з них повністю використав власні переваги для створення максимальної вигоди та полегшення життя людей. Із зростанням відновлюваної енергетики вплив окремих осіб, урядів та міжнародних організацій, а також роль, яку відіграє місцева, національна та міждержавна політика, стають все більш важливими. Було ідентифіковано ключові засади стратегії альтернативної енергетики Китаю, визначено як спрямувати розвиток відновлюваної енергетики в правильному напрямку та інтегрувати енергетику у промислове виробництво. Запропоновано в подальшому розробляти цю стратегію у відповідності до кращого світового досвіду з урахуванням національних інтересів Китаю.

Ключові слова: альтернативна енергетика, стратегія, електроенергія, невідновлювана енергетика, енергетична безпека, енергетична політика.

Formulation of the problem. Since the founding of the People's Republic of China for more than 70 years, especially since the reform and opening up for more than 40 years, China has been pursuing the idea of making the country strong and enriching the people, and has made many achievements. The country's main path and strategic direction are to strengthen its power. The use and strategy of alternative energy also follow the same line of thinking, seek to increase energy strength, formulate decision-making policies in line with the current real-time situation of society, and improve the ability to utilize alternative energy in the process. Before studying, it is important to understand the meaning of alternative energy: generally, it refers to non-traditional energy and energy storage technologies that have little impact on the environment.

Analysis of recent research and publications. In their articles Shi Jingli, Zhong Jian Kang and others investigated the world's renewable energy development and the energy policies and renewable energy-related plans of various countries, focusing on China's renewable energy development and their challenges. The book "Supporting China-EU Renewable Energy Power Generation Construction" edited under the policy guidance of the European Union (DG ENERGY) and the National Energy Administration of China represents the new opportunities, which are provided by the implementation of the strategy of alternative energy. Nina Khanna, Nan Zhou, David Fridley, Jing Ke in their article evaluated four recent policies for China's power sector-mandatory renewable targets, green dispatch, carbon capture and sequestration development, and coal-fired generation efficiency improvements and quantifies their energy and

carbon dioxide (CO₂) emissions reduction potential through 2050 using bottom-up energy modeling and scenario analysis. Also, they found renewable targets and green dispatch have crucial interlinked impacts on energy and CO₂ emissions that could change the shape and peak year of China's power-sector emissions outlook. The uniqueness of China's experience of reforming the country's economy is that this country, with limited energy resources, has been able to develop an energy sector that meets the energy needs of the country's industry, and its population. China has managed to avoid dependence on external energy sources and has created a self-sufficient energy sector that is a reliable support for the process of technological modernization of the country's industry. China is actively investing in energy and infrastructure projects abroad, thus addressing energy security and creating routes to promote its own products abroad. We know that the scientific community has made a significant contribution to the study of international experience in strategic planning for sustainable energy development. However, we think that in modern economic conditions the issue of deepening research on this issue in order to implement a positive experience of China's energy strategy in Ukrainian practice.

The purpose of the article is to investigate the development of alternative energy in China, to identify main points of the China's alternative energy strategy based on contemporary social development and existing energy sources.

Presenting the main material. The China is currently the world's largest emitter of greenhouse gases. The consumption of primary energy in China can be seen

from the figure 1. The data has a rapid upward trend from 1980 to 2010. During 2000–2010, the rate of increase has accelerated. China’s use of primary energy has increased. According to International Energy Agency data, China consumed 26,250 terawatt-hours of primary energy in 2009, and 20 terawatt-hours per million people. From 2004 to 2009, the use of primary energy increased by 40%, and the use of electricity increased by 70%. Energy imports tripled in 2009 compared to 2004. The import share of major energy sources in 2009 accounted for 12%. The five-year growth rate of carbon dioxide emissions (2004–2009) was 44% [2]. Energy Policy of the People's Republic of China

Figure 1 Shows the overall curve of energy products and energy consumption in China from 1980 to 2020.

From the data (fig. 2), it can be clearly seen that from

2011 to 2020, whether it is world data or Chinese data, both of them show an overall upward trend. This trend shows that in the renewable energy area, the world's demand for this field is gradually increasing.

The prospect of renewable energy is very broad. Under the leadership of future technology, the development and development of renewable energy is indispensable. Similarly, in 2011, China’s CAP output value was below 500,000, but after four years of development, China’s CAP output value exceeded 500,000 in 2015–2016. It can be seen that the development of renewable energy in China is rapid, also in the Chinese market; the prospects for development are broad. The country will vigorously promote the development of renewable energy and extend the technology to different industrial technologies (table 1).

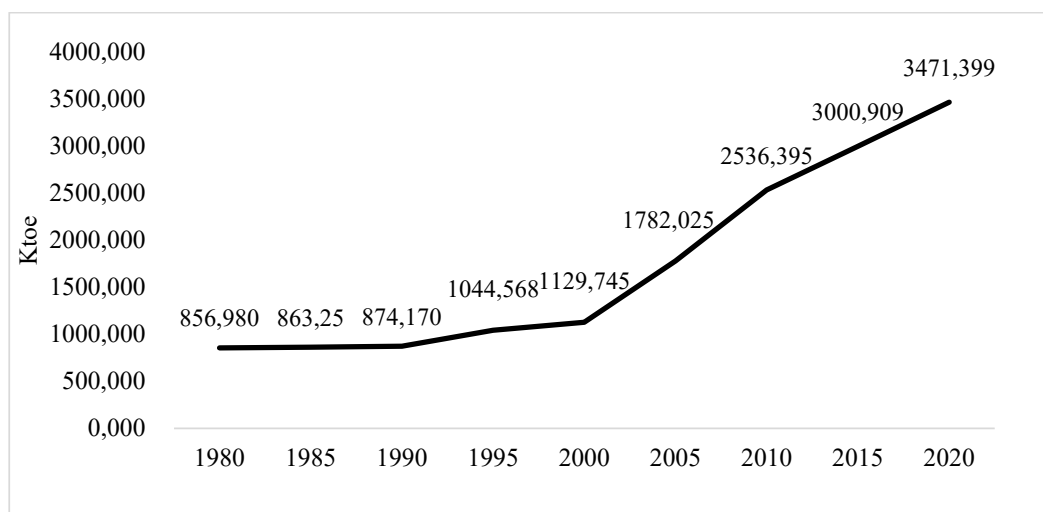


Figure 1. China's total energy consumption [11]

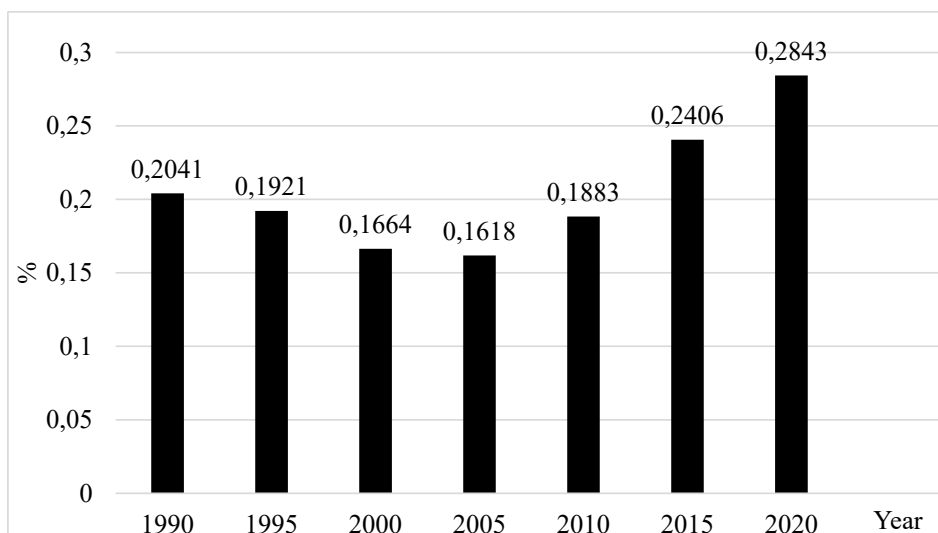


Figure 2. China's Share of Renewables in Electricity Production (incl hydro) [1]

Table 1

Total renewable energy [4]								
CAP(MW)	2013	2014	2015	2016	2017	2018	2019	2020
World	1 564 390	1 694 061	1 847 258	2 010 005	2 180 389	2 358 749	2 538 44	2 799 094
China	359 516	414 651	479 103	541 006	620 846	695 488	758 869	894 879

In 2008, China was affected by the global financial crisis. From 2008 to 2009, China's economic growth rate slowed down, and the growth rate of primary energy consumption fell sharply. However, with the subsequent introduction of relevant stimulus policies, the economic growth rate increased again and the energy demand market expanded. However, the growth rate did not rebound to the previous level. In recent years, as China's economic development has entered the "new normal", the growth rate of primary energy demand has remained at the single-digit percentage level.

In comparison with the global primary energy consumption structure, China's coal consumption in 2016 still accounted for 62%, which is twice as high as the global average. Oil, natural gas, and non-fossil energy accounted for less than the global average, as shown in Figures 3 and 4.

Considering China's abundant resources, coal will still maintain its position as the largest energy source for a long period of time in the future, but its proportion of consumption is expected to continue to decline. In addition,

China is not a big country with oil and gas resources, and its dependence on oil and natural gas is relatively high. Considering long-term energy security, it is inevitable to accelerate the transition to non-fossil energy. With social development and technological production progress, such issues as how to better formulate alternative energy resources policies and how to implement some related practices to promote energy efficiency are also worthy of our study.

From the perspective of electricity consumption, after 2012, the growth rate of China's total electricity consumption has fallen to single digits, as shown in Graph 5. After experiencing the trough in 2015, the growth rate of electricity consumption in the whole society rebounded from 2016 to 2017. Among them, electricity consumption in 2017 was 6.31 trillion kWh, a year-on-year increase of 6.6%. From 2011 to 2017, China's tertiary industry and urban and rural residents' electricity consumption has increased year by year, from 23% in 2011 to 27.8% in 2017, reflecting to a certain extent China's economic structural adjustment and power consumption structure

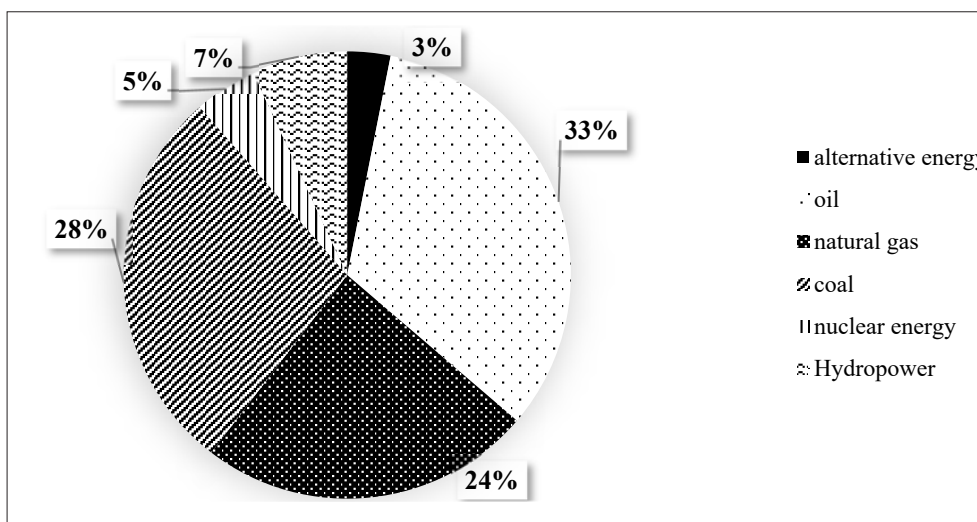


Figure 3. Distribution of energy in the world [11]

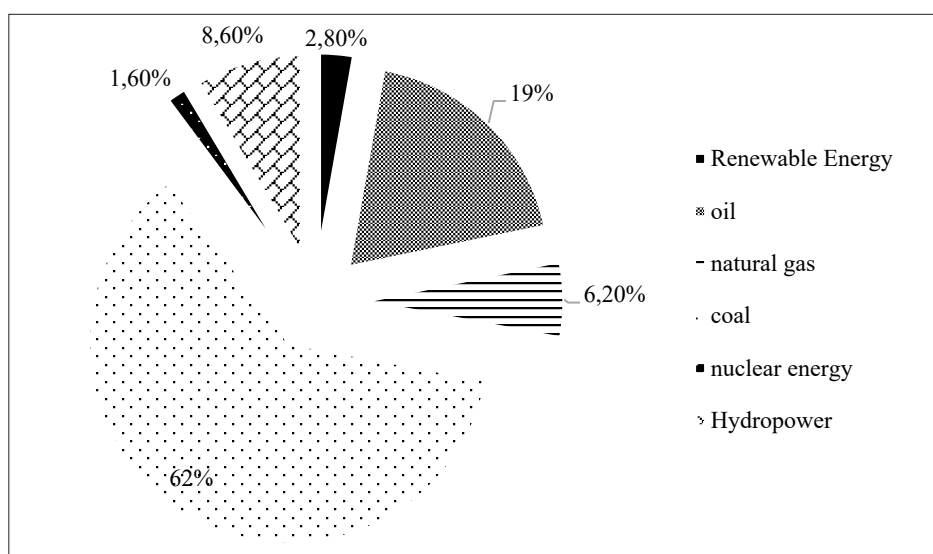


Figure 4. Distribution of energy of China [11]

transformation. However, compared with developed countries, there is still much room for improvement.

According to the above research results, it is necessary to carry out the transformation and upgrading of the energy structure. The Chinese government proposes to implement "two alternatives" – clean alternatives and electric power alternatives, which is a fundamental solution to the country's fossil energy dilemma. The so-called "two substitutions" refer to the implementation of clean substitution in energy development strategy, replacing fossil energy with clean energy such as renewable solar energy and wind energy; implementation of electric energy substitution in energy consumption, and direct consumption of fossil energy such as coal and petroleum with electric energy, to increase the proportion of electric energy in the final energy. With the changes in energy strength and international status, China's global energy strategy was developing by the stages: from focusing on domestic to external considerations, from focusing on interests to focusing on security, and from obeying the old energy power structure to constructing its own overall structure. The energy strategy goal has evolved from enhancing energy strength and energy capabilities to the stage of grasping energy power to better ensure national security and interests (figure 5) [3].

From the figure, it can be seen the different usage of alternative energy in 2018–2020. There's also represented the forecast of the usage of alternative energy in 2022–2050. In terms of large-scale development of coal power, the cost of coal power is still relatively affordable compared with other power sources. In this case, coal power continues to grow until it reaches a peak of 1741 GW around 2038, and then from 2035 to 2045, as the life of coal power is set at 30 years, there will be a certain downward trend. Compared with coal power in 2050, hydropower and nuclear power have a certain competitive construction price. They

are important base-load power sources. Hydropower and nuclear power reach the upper limit of the scale of development in the planning of each planning stage. As an indispensable power source, gas and electricity must also develop and support the development and utilization of renewable energy. However, due to the cost of wind and solar energy, the development of renewable energy is still insufficient, and in the early development stage before 2035; the scale of exploration for renewable energy usually reaches the lower limit of the developable scale. After 2035, due to the saturation of coal resource development, with the rise of coal prices and the development of new technologies, the economic power generation of renewable energy will gradually improve. Renewable energy has been further developed and utilized. By 2050, renewable energy will account for about 43% of the total power structure [10].

Alternative energy plays an important role in global efforts to struggle climate change. In recent years, China has promulgated and implemented a number of climate change and emission reduction strategies. The Chinese central government passes a plan every five years to determine the country's development direction in the next five years. In the 21st century, China's various five-year plans have formulated goals for renewable energy development, especially the key goals of the "13th Five-Year Plan" (2015–2020) are:

- Raise the proportion of non-fossil energy in total primary energy consumption to 15% by 2020 and 20% by 2030.
- By 2020, the installed capacity of renewable energy will increase to 680 GW, of which the installed capacity of wind energy will reach 210 GW.

With the reduction of production costs in the field of renewable energy, more and more countries have announced reductions in government support. Therefore,

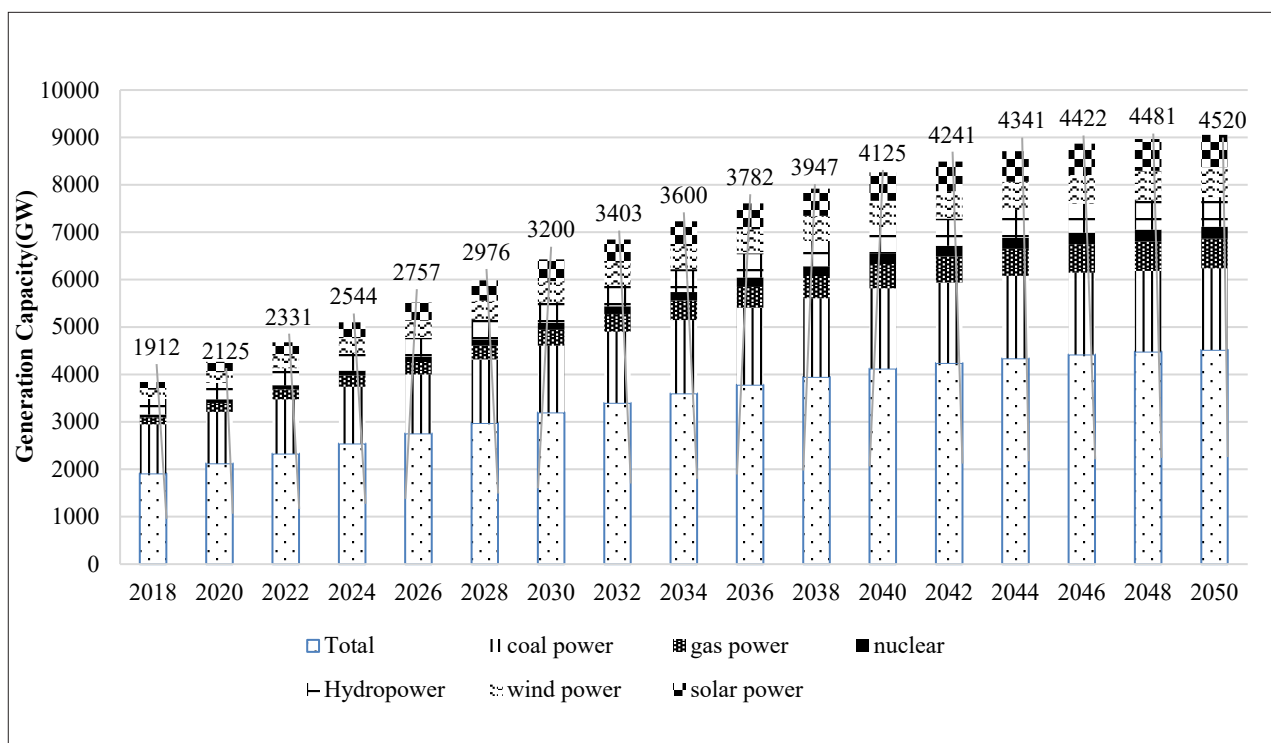


Figure 5. China's power structure from 2018 to 2050 [1]

renewable energy is gradually occupying a stable position on the competitive economic supply curve of many countries. However, measures such as energy cost control policy emission CO₂ and policy objectives can still adjust the purely economic focus. Although the supporting measures have been revised and there are difficulties in integrating into the energy system, attention to renewable energy is still one of the goals of many national energy plans. Through small batch production, renewable energy can be easily integrated into the operation of the power complex. However, the further development of renewable energy and its achievements are very important in the energy balance, setting new requirements for the energy system [4].

One of the key problems that have emerged with the expansion of renewable energy capacity is that not only a large amount of power needs to be transmitted between production and consumption centers, but also a large amount of power needs to be transmitted between different renewable energy generation areas, especially between countries (countries that use solar power for power generation and wind power generation).

The other is how to improve the conversion rate of alternative energy sources. Since this is a new industry, many situations are unknown and uncontrollable. Next, expanding the benefits and making full use of them are also issues worthy of discussion. How to use high-quality and low-cost energy sources to improve efficiency and minimize damage to the environment. At the same time, it is difficult to predict the production of renewable energy in advance, because it depends on a large extent on natural conditions. Therefore, for each country, it is necessary to find its own optimal power system configuration and a reasonable amount of renewable energy production and alternative options. The options for this type of configuration vary depending on climatic CONDITIONS [5].

The development of renewable energy poses new problems for balancing the power system. Each country must find its optimal system configuration, taking into account the climatic conditions and the availability of various redundancy options. For example, the EU Directive "On Supporting Renewable Energy" provides the following definition of renewable energy support measures: "The EU member states or EU member states apply and support the use of regulatory tools and mechanisms to reduce the use of renewable energy. The cost of renewable energy, the obligation to use renewable energy, or other ways to increase the selling price or sales volume.

The purpose of supporting alternative energy is to create conditions for the market, to make up for the lack of competitiveness of alternative energy at this stage, and to generate economic benefits for investment in power generation capacity building in this energy sector. In Europe, there are four theoretical models for stimulating the development of renewable energy [6].

1. Minimum guaranteed payment rate model (Feed-in-Tariff, FIT). This model includes ensuring at the legislative level a guaranteed fixed payment (GTsvie) for the use of renewable energy to generate electricity, exceeding the market price (Tsryn).

2. Surcharge Model This model stipulates that the surcharge (Nvie) is introduced into the market price instead of a fixed payment. The total cost of renewable energy generation is Tsryn + Nvie.

3. "Green Certificate" quota model. Compared with the price model, when using the "green certificate" model of market transactions, only renewable energy power generation is set.

4. Bidding model. When applying this method, the impact on the market is produced through bidding, in which certain parameters of production volume and capacity are determined and set. In addition, different conditions for participating in the competition and subsequent financing

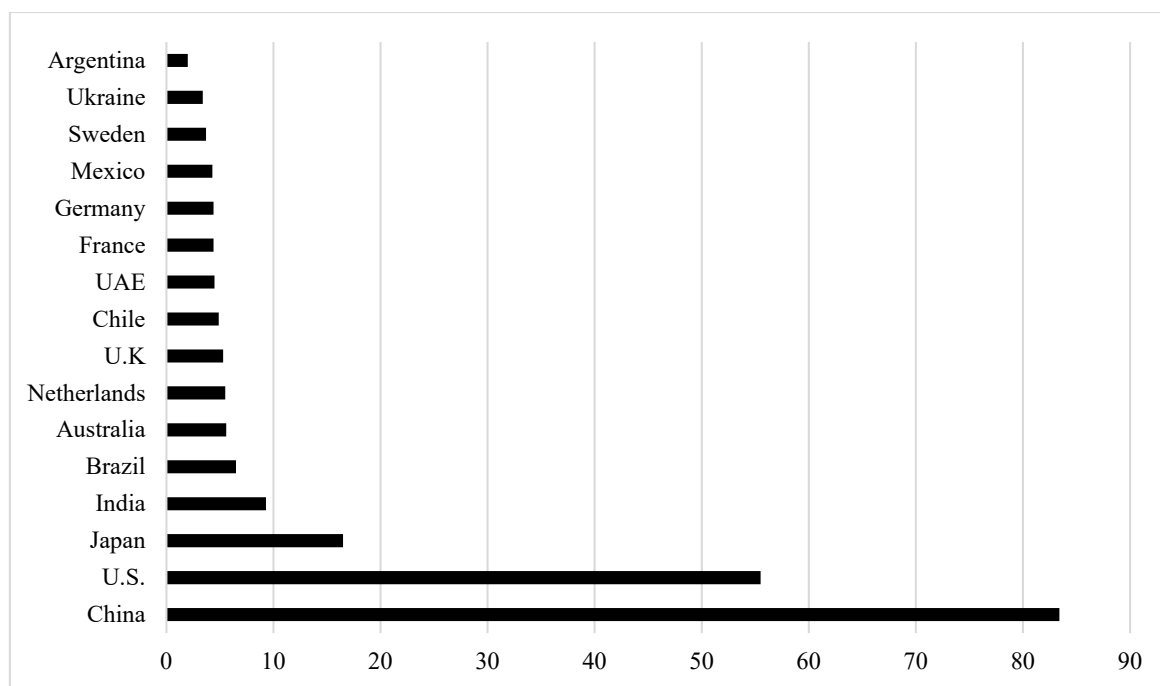


Figure 6. Investment in billion U.S.dollars [11]

methods for the project (or conditions for purchasing a certain amount of electricity) can be provided here.

The first two models refer to price instruments and the third and fourth represent quota models. The above-mentioned renewable energy support model represents the main way to support renewable energy. Subsidy distribution, tax breaks and preferential interest rates on loans are additional economic means to support renewable energy (figure 6).

Chinese investment in clean energy is the highest worldwide. In 2019, China pumped some 83.4 billion U.S. dollars into clean energy research and development. The United States and Japan had the second and third highest clean energy investments that year, at 55.5 billion and 16.5 billion U.S. dollars, respectively. All selected countries combined had spent 219.2 billion U.S. dollars on the alternative energy technologies. The leading three entries accounted for roughly 71% of total investments.

The rapid development of alternative energy sources has brought more and more companies and industries into the focus of global attention. As the global energy market becomes more politically intertwined, policymakers face increasingly complex challenges. How to integrate renewable energy and politics with high efficiency, each to give full play to their own advantages, to create maximum benefits, and to facilitate human behavior is a matter worthy of study. With the rise of renewable energy, the influence of individuals, governments and international organizations and the role played by local, national and interstate politics have become more and more important. How to guide the development of renewable energy in the right direction and integrate energy into industrial production, this is a grand goal and task [7].

In addition, social media activities can change a country's energy investment focus. Social media can actively promote and publicize the advantages of renewable energy through advertising, audio media, etc., combined with the concept of environmental protection, low-carbon and environmental protection, and actively promote renewable energy. At the same time, the government can actively promote some preferential policies for the use of renewable energy. The purpose of this is to let more people know that renewable energy is about to become the main dominant energy in the future, so that enterprises and factories can efficiently integrate renewable energy technologies and replace them. The location of non-renewable energy, such as the use of wind and solar energy to replace oil and other raw materials.

That's why it is important to develop the China's alternative energy strategy in accordance with the best world practices taking into account domestic peculiarities, conditions and trend of industrial development.

Conclusions. Rapid growth of production and energy consumption all over the world caused the growth of CO₂ emission and as a result facilitated climate changes, which threaten the survival of vulnerable species on earth, threatens ecosystems and biodiversity, and can threaten human survival. China's coal consumption in recent years still too high (was accounted for 62% in 2016), which is twice as high as the global average. This is the main reason why it is important for the country to start actively using the energy from alternative sources. Overall, renewable energy will become one of the benchmarks of the new era, and its development prospects are great. Renewable energy will bring many benefits and conveniences to humankind.

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