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The Evolution of France's Nuclear Energy Strategy: Policy Adjustments and Future Challenges from 1945 to the Macron Era

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Abstract

France has been a global leader in nuclear energy since the 1970s, with nuclear power playing a central role in its electricity supply. However, France's nuclear energy strategy is not static, but has undergone many adjustments in different historical periods. This paper reviews the evolution of France's nuclear energy strategy from 1945 to the present, focusing on the adjustments of nuclear energy policy under the Macron government and their reasons. It is found that from 1945 to 2017, France's nuclear energy strategy experienced three transitions from initial exploration to large-scale development and then to optimization of energy structure. After Macron's administration, affected by energy security, climate environment and economic factors, the nuclear energy policy has gone through a process from "gradual reduction" to "steady maintenance" and then to "full restart". However, France still faces multiple challenges in promoting the development of nuclear energy, and it is still necessary to take measures in various aspects to ensure the stable development of nuclear energy in the future.

Keywords: nuclear energy, France, Emmanuel Macron

1. Introduction

As one of the countries with the most extensive use of nuclear energy in the world, France has long relied on nuclear energy to provide stable electricity supply. The evolution of its nuclear energy strategy is not only a microcosm of energy policy, but also an important embodiment of national strategic autonomy. Since the launch of nuclear energy development after World War II, France has vigorously promoted the development of nuclear power through the Messmer Plan to achieve energy independence. However, after the Fukushima nuclear accident in 2011, France entered a period of policy adjustment, and the Hollande government put forward the goal of reducing the proportion of nuclear power generation. After Macron came to power in 2017, a series of adjustments in nuclear energy policy occurred again under the influence of security of energy supply, carbon neutrality and economic reality, especially after 2022, the nuclear energy strategy has undergone a major shift. Based on this, this paper systematically combs through the

historical evolution of France's nuclear energy strategy, divides the period from 1945 to 2017 into three phases, and focuses on the analysis of the adjustments of nuclear energy strategy during the Macron government and the reasons behind them, and discusses the main challenges and response strategies faced by France in the process of promoting the development of nuclear energy, with a view to providing lessons for the formulation of energy strategies in France and other countries.

2. Historical Evolution of the France's Nuclear Energy Strategy (1945-2017)

The evolution of France's nuclear energy strategy has been influenced by multiple factors, including energy security, economic costs, environmental policy, the international situation, and public opinion, etc. Since the 1970s, nuclear energy has been the backbone of France's energy system, and France has become a global leader in the use of nuclear energy. Since then, against the backdrop of changes in the international nuclear safety situation and the rise of environmental protection, France's nuclear energy strategy has been adjusted, but its overall reliance on nuclear energy has been maintained. However, policy adjustments in the 2010s began to limit its development, and France began to seek to optimize and transform its energy structure. This chapter analyzes the evolution of French nuclear energy policy in three phases from 1945 to 2017.

2.1 1945-1972: The Early Years of Nuclear Energy Development in France

After the Second World War, with the support of the Marshall Plan and the European Economic Community funds, France realized economic recovery, and its energy demand increased greatly. However, France's scarcity of coal, oil, natural gas and other energy resources has forced it to import large quantities of energy to meet its growing energy needs, and in the 1950s and 1960s, the degree of dependence on oil and natural gas for external use once reached more than 90 per cent.

In 1945, the French President Charles de Gaulle established the Atomic Energy Commission (CEA, Commissariat à l'Énergie Atomique), this new commission's purpose was to accelerate the industrialization of nuclear technology. In 1956, France's first 40 MW nuclear power reactor "G1" was put into operation in the south of France, and two other reactors — "G2" and "G3" — were put into operation in 1959 and 1960 respectively. In 1958, France introduced the economical and safe pressurized water reactor (PWR) technology from Westinghouse Electric Company of the United States. From the end of the 1960s, France further introduced the company's pressurized water reactor technology with a single unit power of 900000 kilowatts, and learned from Westinghouse in the areas of reactor design, equipment manufacturing, and nuclear power plant management. France basically mastered a full set of core technologies for nuclear power plants within a decade, marking the gradual shift of the center of gravity of French energy development to nuclear power.[1]

2.2 1973-2011: Large-Scale Development of Nuclear Energy and France's Emergence as a Nuclear Power

The first global oil crisis erupted in 1973 when the price of oil skyrocketed, causing a downturn in the world economy. The oil shock, triggered by geopolitical tensions in the Middle East, led to a four-fold increase in France's oil bill within two years (1972-1974). With American and Western support on the Israeli side, Iraq and Saudi Arabia threatened and eventually imposed an oil embargo.[2] The crisis has made it clear to France that over-reliance on imported energy is too risky for the French economy and represents a very unfavorable situation. The Government identified that France needed energetical independence. France has therefore begun to explore alternative energy sources and is determined to expand its nuclear power generation and to formulate plans for the large-scale development of nuclear power. On November 30, 1973, the French Prime Minister Pierre Messmer announced the acceleration of the French nuclear program in a speech on the channel ORTF. He also emphasized the need for a European energy policy and announced the construction of a uranium enrichment plant EURODIF in the southeast of France, which would be in operation from 1978 to 2012.[3]

In March 1974, the Prime Minister Pierre Messmer announced the launch of an ambitious nuclear development program accompanied by

[1] Jiang Tao. (2023). A brief history of nuclear power in France. https://mp.weixin.qq.com/s/aO0U-aarFZkha3RyzgV8sQ

[2] Christoph. (2023). France's Nuclear Odyssey. https://www.wtsenergy.com/frances-nuclear-energy/

[3] Le Gros, G. (2020). La naissance du parc nucléaire français: le plan Messmer. *Revue Générale nucléaire*, (5), 56–59.

a series of energy sobriety measures — a kind of green deal more than 45 years ahead of time — known as the "Messmer Plan". The Prime Minister stated: "It is true that France has not been very favored by nature in terms of energy resources. We have almost no oil on our territory, we have much less coal than England and Germany, and less gas than Holland. Our great chance is our electrical energy of nuclear origin".[1] The goal of the plan is to build 80 nuclear reactors by 1985 and 170 nuclear reactors by 2000, and ultimately to realize that all of France's electricity will be provided by nuclear power. Under the impetus of this program, the construction of nuclear power in France was successfully put on the fast track. In the 1980s, a total of 44 new nuclear reactors were put into operation in France. Since the 1980s, nuclear power has become the "main force" of France's energy supply, with oil-fired power generation falling from 39% of total power generation in 1973 to 2% in 1986, and nuclear power generation rising from 7% in 1975 to 75% in 1990. Years of technological accumulation have given France a mature nuclear industry system, forming a group of nuclear power enterprises including EDF, Areva and Framatome.

The fact that nuclear energy in France has developed so rapidly and with such great success is due to the combined efforts: a consistent national policy over time, a unique cultural climate, strong governmental awareness and popular cooperation, and the introduction of technology and innovation.

First, the French Government is firmly committed to vigorously developing nuclear energy. The release of the French nuclear power program actually triggered off a wave of strong opposition throughout the country at the beginning, with more than 400 scientists joining hands to boycott the program and request the Government to postpone the construction of nuclear power. However, despite the massive anti-nuclear wave and demonstrations, the French government was determined to develop nuclear energy. Even after the outbreaks of nuclear accidents at Chernobyl and Three Mile Island, which led to a drastic brake on the nuclear power construction process in the whole of Europe, with most countries slowing down or even shelving their nuclear power development plans, France still continued to plough ahead in the field of nuclear power. Philippe de Ladoucette, then president of the French Energy Regulatory Commission, said, "Despite major nuclear accidents in the international community, France's nuclear energy development program will never be modified, and the fight for energy independence has been a French credo since the end of World War I."[2] Nuclear power requires long-term commitment, sustained political and institutional support.[3] Going back to the 20th century, successive French governments, regardless of political affiliation, have given firm and strong support to the policy of developing nuclear power, and this unique consensus has ensured the long-term continuity of the French nuclear power development policy, allowing the French nuclear power business to flourish.

The second is the uniquely French culture of love for large-scale projects and respect for technical experts. Claude Mandil, the General Director for Energy and Raw Materials at the Ministry of Industry, said that France has a tradition of large, centrally managed technological projects and they are popular. "French people like large projects. They like nuclear for the same reasons they like high-speed trains and supersonic jets."[4] And part of the reason for the popularity of nuclear power is that the status of scientists and engineers is much higher in France than in the United States. Many senior civil servants and government officials have been trained as scientists and engineers (as opposed to lawyers, as in the U.S.), and unlike U.S. federal administrators, who are often looked down upon, these technocrats form a special kind of elite. According to Mandil, respect and trust in

[1] Jan Bartak, Noël Camarcat. (n.d). Nuclear Power in France and its Contribution to Reaching EU's Climate Objectives. https://www.nucadvisor.com/post/nuclear-power-in-france-and-its-contribution-to-reaching-eu-s-climate-objectives

[2] Zhang Fuqiang, Yan Xiaoqing. (2019). French energy strategy — nuclear energy first. *China Energy News*. https://paper.people.com.cn/zgnyb/html/2019-03/18/content_1914701.htm.

[3] Jan Bartak, Noël Camarcat. (n.d). Nuclear Power in France and its Contribution to Reaching EU's Climate Objectives. https://www.nucadvisor.com/post/nuclear-power-in-france-and-its-contribution-to-reaching-eu-s-climate-objectives

[4] Jon Palfreman. (n.d). Why the French like nuclear energy. https://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/french.html

technocrats is widespread. "For a long time, in families, the good thing for a child to become was an engineer or a scientist, not a lawyer. We like our engineers and our scientists and we are confident in them."[1] In addition in the recent history of French science, many of the scientists who won Nobel Prizes, such as the Curie family, Anthony Henri Becquerel, and Jean Baptiste Perrin, won their awards for reasons related to nuclear research, which inclined the French to associate nuclear scientific research with a sense of national honor, and some even believed that the success of France's development of nuclear power could effectively wash away France's World War II defeat by Germany's shame, so the French public is also more willing to accept nuclear power out of a sense of honor. Moreover, France is an independent nation, and the French public will not be willing to keep relying on other countries to provide energy. Therefore, whether it is the unique preference for large-scale projects, the respect and love for technical experts, or the desire for national honor and independence, the majority of the French people are willing to accept and support nuclear energy.

Thirdly, the Government and the industry have made great efforts to publicize the program and to increase public acceptance of it. Following the launch of the "Messmer Plan", the Association of Scientists for Information on Nuclear Energy was set up on December 15, 1975, under the auspices of the Government to ensure that the French nuclear industry provides truthful and transparent information to the public. Moreover, French authorities have been trying to make people aware of the benefits and risks of nuclear energy. Brilliant TV commercials reinforce the link between nuclear energy and the electricity that makes modern life possible. Nuclear power plants invite people to visit them and six million French people have accepted the invitation. Today, nuclear energy is a family affair in France. However, there is also the view that public discourse in France has linked nuclear power to nationalism and to the strength of the French state. Because of the rhetoric, the government and the media have sometimes portrayed opposition to nuclear power as being against the public interest. This has legitimized both police suppression of protestors and the expropriation of property when the government wanted to construct a power plant.[2] In conclusion, the French official campaign has had a remarkable effect and the public has become much more receptive to nuclear energy.

The fourth is the introduction and innovation of technology. In the 1970s, the French Government localized pressurized water reactor technology after obtaining a technology license from Westinghouse and carrying out digestion, absorption and re-innovation. In the ensuing 1980s, France achieved large-scale batch construction and standardized operation of nuclear power, with 40 pressurized water reactor nuclear power plants built and put into operation during the peak construction period of 1978-1988. Unified and standardized reactor technology brought about a significant reduction in investment and operating costs, with investment costs below 1000 euros per kilowatt, equivalent to half of the world's average investment level in nuclear power, and operating costs 40% lower than those in the U.S., thus making France one of the countries with the lowest prices for industrial and civilian electricity in the world.

2.3 2012-2017: Optimizing the Energy Structure and Reducing Reliance on Nuclear Energy

The Hollande government's adjustment of France's nuclear energy development strategy is an important turning point in France's energy policy, and its core objective is to reduce the proportion of nuclear energy and promote the diversification of the energy structure in order to meet the multiple challenges of safety, environmental protection and politics. This is the result of multiple factors, including the safety reflection after the Fukushima accident, domestic political games and international environmental pressure. Although its goals were not fully realized, this phase provided the policy framework for France's energy transition and triggered a deep debate on the role of nuclear energy and the future of sustainable energy. The policy swings of subsequent governments have also highlighted the complex position of nuclear energy in France's energy strategy.

In 2011, after the Fukushima nuclear accident, many countries in Europe turned negative towards nuclear power and put forward nuclear abandonment plans one after another, Germany

[1] Jon Palfreman. (n.d). Why the French like nuclear energy. https://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/french.html

[2] Wiliarty, S. E. (2013). Nuclear power in Germany and France. *Polity*, *45*(2), 281-296.

being one of them. The Fukushima accident had a great impact on the global nuclear power industry, and Areva's loss in 2011 amounted to 2.4 billion euros. Under the influence of the anti-nuclear wave, the French government's confidence in the development of nuclear power has also been shaken.

In 2012, François Hollande, the Socialist candidate in the French presidential election, promised to gradually reduce the share of nuclear energy in France's electricity supply in order to accelerate the development of renewable energy. This commitment stems in part from his alliance with the French Green Party to garner support from environmental voters. During Hollande's administration, the French government has introduced a series of policies to try to reduce the share of nuclear energy in the energy mix and promote renewable energy.

In August 2015, the French government enacted "Energy Transition for Green Growth Act" and one of the goals is to diversify electricity generation and reduce the share of nuclear to 50% by 2025. The main context in which the Act was introduced is as stated in its preamble: Most of the energy that we consume today causes pollution, is expensive and is derived from increasingly scarce fossil resources. Energy transition is a plan for the post-oil era and a step towards a new French energy model, which is stronger and more sustainable in its response to key energy supply challenges, changes in prices, the depletion of resources and environmental protection requirements.[1] Moreover, the ageing of nuclear power plants is a growing problem. Most of France's nuclear reactors, built in the 1970s and 1980s, are approaching or have exceeded their original design life, and maintenance and upgrades are costly. In addition, the nuclear energy industry itself faces serious economic challenges. Areva experienced a severe financial crisis in the 2010s, with its flagship projects — the Flamanville 3 EPR reactor in France and the Olkiluoto 3 reactor in Finland — both suffering huge losses due to schedule delays and cost overruns. [2] These factors forced the French government to revisit its nuclear energy strategy.

In 2016, the Hollande government announced the official closure of France's oldest nuclear power plant, the Fessenheim plant, even though it could still be operated for many years, a move that signaled a substantial move to reduce the government's reliance on nuclear energy. However, due to opposition from EDF and the local government, the closure process has been delayed until 2020 for finalization. [3] The Hollande government has also vigorously promoted renewable energy, particularly wind and solar, in an attempt to bridge the electricity gap following nuclear energy cuts. However, France's wind and solar industries are underinvested and growing much slower than expected, and in the short term the country remains indispensable to the supply of nuclear energy. Moreover, the French power grid has long been based on nuclear power, making it difficult to quickly adapt to the volatility of renewable energy. In addition, some regions are opposed to the construction of wind farms, and administrative approvals are hampered. As a result, the development of renewable energy has not been able to quickly fill the gap created by nuclear energy cuts, despite the government's goal of reducing the proportion of nuclear energy.

3. Adaptation of French Nuclear Energy Strategy Under the Macron Government (2017–Present)

After the election of Emmanuel Macron as President of France in 2017, nuclear energy policy continued the basic direction of the Hollande administration, which continued to push forward with the Energy Transition Program. Macron initially expressed support for the goals of the Energy Transition Law and planned to gradually reduce the proportion of nuclear power generation. However, the government's position on nuclear energy policy began to be adjusted in the face of growing demand for electricity in France and the failure of renewable energy development to meet expectations. In particular, after the outbreak of the Russia-Ukraine conflict in 2022, the issue of France's energy security came to the fore, and the government's attitude toward nuclear energy

[1] Loi de transition énergétique pour la croissance verte, Le gouvernement français, le 13 décembre 2016, https://www.ecologie.gouv.fr/politiques-publiques/loi-transition-energetique-croissance-verte

[2] Mycle Schneider, Antony Froggatt. (2019). The World Nuclear Industry Status Report 2019. https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2019-HTML

[3] Mycle Schneider, Antony Froggatt. (2020). The World Nuclear Industry Status Report 2020. https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2020-HTML

underwent a major shift. Since 2017, nuclear energy policy has gone through a process from "gradual reduction" to "steady maintenance" to "full restart' after 2022". This chapter analyzes the changes and major shifts in France's nuclear energy policy under the Macron administration and examines the main factors that have influenced policy adjustments.

3.1 2017-2022: Swings and Adjustments in Nuclear Energy Policy — From "Gradual Reduction" to "Steady Maintenance"

After Macron came to power, his initial energy policy basically continued the approach of the Hollande government: continue to cut back on nuclear energy and vigorously develop renewable energy sources. In 2019, the French government released its Multi-Annual Energy Plan (Programmations Pluriannuelles de l'Énergie, PPE), which still emphasized reducing the proportion of nuclear energy in electricity generation from 75% to 50%, only postponing its realization from 2025 to 2035 and proposing the gradual closure of 14 nuclear reactors by 2035.[1]

Despite the Government's commitment to reducing the share of nuclear energy, many practical challenges have been encountered in the actual implementation process. First, the development of renewable energy is lagging behind and has not met expectations. Although France has vigorously promoted the development of wind and solar energy, the pace of their development has not been able to meet the electricity shortfall following the reduction of nuclear energy, owing to insufficient investment, land planning constraints and technological immaturity. Second is that the closure of nuclear power plants has led to a tight supply of electricity in France, especially during the winter peak season, the French power grid is not flexible enough, and France has to rely on neighboring countries to import electricity, weakening its energy independence. Then there is EDF's long-standing problems of high debt and rising maintenance costs for its aging nuclear plants, the closure of which means the company's revenues are falling, further exacerbating its financial woes. These challenges led Macron to gradually slow down the pace of nuclear energy cuts, and policy adjustments became inevitable. Against this backdrop, the French government has begun to reassess the role of nuclear energy in France's energy structure, and is gradually adjusting its nuclear energy policy from "gradual reduction" to "steady maintenance" and providing more support for the nuclear energy industry.

3.2 After 2022: The Great Policy Shift — A Full Restart of Nuclear Energy Development

Between late 2021 and early 2022, turbulence in global energy markets and soaring natural gas prices exacerbated uncertainty about France's energy supply. Especially after the outbreak of the Russia-Ukraine conflict, European gas supplies were severely affected, the energy crisis intensified, and the French government faced unprecedented pressure on its energy security. The French government's attitude has begun to change significantly, and it has begun to consider the possibility of building new nuclear power plants in order to ensure the stability of future power supply. The French government has become more aware of the key role of nuclear energy in guaranteeing energy independence. In this context, the Macron Government has finally decided to completely reorganize its nuclear energy policy.

In October 2021, Emmanuel Macron has presented the "France 2030" investment plan — a plan that follows 10 objectives to better understand, better live, better produce in France by 2030. The first Objective is to bring small, innovative nuclear reactors with better waste management to France and 1 billion euros will be invested between now and 2030.

In his energy policy speech in Belfort on February 10, 2022, Macron formally announced the nuclear renaissance plan, with France building six new EPR2 (Evolutionary Power Reactor 2) nuclear reactors and starting up eight others over the next few decades to achieve energy independence and a low-carbon transition. He suggested that he would like to extend the operational life of some of France's operating nuclear reactors, if conditions permit, and that France needs to parallel the development of renewable and nuclear energy. Macron's statement formally declared that France has "embraced" nuclear power again, marking a fundamental shift in France's nuclear energy policy from "reducing the proportion of nuclear energy" to "strengthening the nuclear energy industry". "What our country needs is the rebirth of France's nuclear industry," Macron

[1] Programmations pluriannuelles de l'énergie (PPE), Le gouvernement français, le 7 mars 2019, https://www.ecologie.gouv.fr/politiques-publiques/programmations-pluriannuelles-lenergie-ppe

said, "The time has come for a nuclear renaissance."[1]

In April 2022, Macron formally proposed a motion to nationalize 100% of EDF, aiming to strengthen France's energy independence. In July, French Prime Minister Borne further clarified the relevant plans in a speech to Parliament, in which she proposed that, in order to cope with the rise in energy prices, to ensure energy autonomy, and to properly deal with the knock-on consequences of the Russia-Ukraine conflict, the French government explicitly incorporate 100% nationalization of EDF into the national reform plan, with full control of the initiative of power production. Bruno Le Maire, Minister of the Economy, Finance and Industrial and Digital Sovereignty, said this decision would give EDF the resources it needs to accelerate the implementation of the new nuclear program called for by the President of the Republic, and the deployment of renewable energies in France.[2]

In June 2023, the French National Assembly passed the "Law on the acceleration of procedures related to the construction of new nuclear facilities near existing nuclear sites and to the operation of existing facilities", completing an important legislative effort to revitalize nuclear power. Under this bill, France will remove the objective of reducing the share of nuclear power in the electricity mix to 50% by 2035, as well as the cap on nuclear energy capacity at 63.2 GW.[3]

In November 2024, the French Government published a new version of its National Low-Carbon Strategy and a draft Multi-Annual Energy Plan, marking a major shift in its nuclear energy policy, emphasizing the promotion of the construction of new units while maintaining the operation of existing units and proposing nine specific actions, including strengthening the capacity for innovation in nuclear science and technology, comprehensively improving the performance of the operation of existing units, and planning for the expansion of nuclear energy on a larger scale, etc.[4]

3.3 Analysis of the Factors Influencing the Adaptation of France's Nuclear Energy Strategy

The evolution of France's nuclear energy policy has been influenced by multiple factors.

Firstly, in terms of energy security, France and Europe as a whole are facing serious energy security challenges due to the ongoing geopolitical conflicts in recent years, especially the Russia-Ukraine conflict. With the deterioration of Russian-European energy relations, the price of natural gas in France has risen sharply, and the cost of natural gas imports in 2022 has increased by nearly 70% compared to 2021. Therefore, in order to reduce its dependence on imported energy and reduce the risks associated with fluctuations in external energy supply, France needs to strengthen its own autonomous energy supply capacity. In this context, the government has reassessed its energy structure and considers nuclear energy to be a central pillar in guaranteeing the stability of France's electricity supply. Compared with the intermittency of renewable energy sources (such as wind and solar), nuclear energy can provide a continuous and stable supply of electricity and enhance France's energy self-sufficiency, which has become an important impetus for the Macron government's policy shift.

Secondly, in terms of climate and environment, in recent years, France has been deeply affected by the negative impact of various extreme weather events. In the face of the increasingly severe climate crisis, Macron has strengthened his determination to promote the realization of carbon neutrality at the domestic level and to enhance his leadership in climate governance at the international level. [5] Nuclear energy is a low-carbon energy source that emits very little carbon dioxide or other greenhouse gases

[1] Liz Alderman. (2022). France Announces Major Nuclear Power Buildup. https://www.nytimes.com/2022/02/10/world/europe/france-macron-nuclear-power.html

[2] Pourquoi le gouvernement souhaite-t-il nationaliser EDF? le 22 juillet 2022, https://www.lafinancepourtous.com/2022/07/22/pourquoi-le-gouvernement-souhaite-t-il-nationaliser-edf/

[3] LOI n° 2023-491 du 22 juin 2023 relative à l'accélération des procédures liées à la construction de nouvelles installations nucléaires à proximité de sites nucléaires existants et au fonctionnement des installations existantes, Le gouvernement français, le 22 juin 2023, https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000047715784

[4] Zhang Yan, Wu Hao Song. (2024). France identifies nine actions for future nuclear power development. *Foreign Nuclear News*, (12), 1.

[5] Li Xinlei, Liu Qianru. (2024). France's nuclear energy revitalization strategy in the context of the climate-energy complex crisis: pathways, impacts and challenges. *Journal of China University of Petroleum (Social Science Edition)*, (04), 47-60. doi: 10.13216/j.cnki.upcjess.2024.04.0006.

during its production. The development of nuclear energy can work with renewable energy to reduce carbon emissions in France's energy structure, which is one of the most important ways for France to realize its carbon neutrality goal. Moreover, in the context of the global response to climate change, the active development of nuclear energy and other low-carbon energy sources will help France to show a positive posture in international climate cooperation, enhance its image and influence in global climate governance, strengthen its voice in the international energy and environmental fields, better participate in the formulation of international rules and regulations, and promote global energy transformation and sustainable development.

Finally, in terms of the economy, the nuclear energy industry is not only an important part of the French energy system, but also vital to the French economy and job market, providing a large number of jobs. Moreover, the nuclear energy industry involves many high-tech fields, such as nuclear reactor technology, nuclear fuel cycle and radiation protection. Increasing investment in nuclear energy can drive the technological innovation and upgrading of the relevant high-tech industries in France, enhance the technological level and industrial competitiveness of France in the fields of nuclear technology, material science, machinery manufacturing, etc., create more high value-added employment opportunities, and promote the transformation of the French economy into high-end manufacturing and scientific and technological innovation. In addition, France has advanced nuclear technology and rich experience in nuclear power construction and operation. The Macron government hopes that through the development of new-generation nuclear energy technology, such as small modular reactors, it can promote French nuclear technology and related products to the international market, expand overseas business, increase the export of nuclear power equipment and technology, bring more economic benefits to French enterprises, and at the same time enhance France's position in the global nuclear energy market.[1]

[1] Vivienne Walt. (2021). Nuclear plants insulate France from the energy crisis. Now Macron is doubling down on them in a $35 billion moonshot plan. https://fortune.com/2021/10/12/nuclear-power-insulates-france-energy-crisis-macron-doubling-down-on-it-35-billion-moonshot/

4. Conclusion

Although the Macron Government vigorously promotes the development of nuclear energy, it still faces multiple difficulties and challenges in the specific promotion process.

First of all, France is facing a shortage of talents and funds. In recent years, due to changes in the global nuclear power development trend, the French nuclear industry orders have declined, resulting in the loss of a large number of skilled workers, and France once huge nuclear power construction team has shrunk significantly. For Macron's proposed new multiple nuclear power units and other nuclear energy development program, the talent stock is seriously insufficient. In the nuclear reactor design, construction, operation and maintenance of various aspects, all need specialized technical personnel. The lack of sufficient talent will not only affect the speed of the new project, but also may bring potential risks to the safe and stable operation of nuclear power plants. In addition, the construction of nuclear power plants is a highly capital-intensive project, which requires huge capital investment in every aspect, from the preliminary planning and design, equipment procurement, to construction and later operation and maintenance. Such high costs make new nuclear power plant projects face enormous financial pressure.

Secondly, there are obvious political differences and public perception bias on the issue of nuclear energy development in France. Some political parties and groups are opposed to the development of nuclear energy because of concerns about safety and waste disposal. This political stalemate has made it possible for new nuclear power plant projects to encounter numerous obstacles in the approval and planning process, leading to delays in project progress. Some local governments, influenced by local people and political forces, are not highly motivated to push forward nuclear power projects, and may even boycott them, due to the influence of local people and political forces. Moreover, some French people are still very worried about nuclear safety, especially the disposal of nuclear waste and the aging of nuclear reactors. This public perception bias may lead to protests and obstruction by local residents during the construction process, increasing the difficulty and social cost of the project.

Finally, there are also differences within the European Union on nuclear energy. France is one of the main advocates of nuclear energy in Europe, but within the EU, some countries (such as Germany and Austria) have long opposed nuclear energy. France needs to seek more support at the EU level to ensure that nuclear energy investment and development is not restricted. And there are also risks in the nuclear fuel supply chain, as some of France's nuclear fuel comes from countries such as Kazakhstan and Niger, where political instability could affect uranium supply.

In the face of these challenges, France should accelerate the innovation of nuclear energy technology, relying on the "France 2030" and other investment plans, and continuously increase the financial support for the research and development of nuclear energy technology; France should also strengthen the cultivation of nuclear energy talents, and promote the cooperation between colleges and universities and enterprises to set up a training program for nuclear energy professionals, so as to attract young engineers to enter the field of nuclear industry. The French government should also actively carry out communication and coordination among domestic political parties, and let all parties fully realize the importance of nuclear energy development to France's energy security, economic development and response to climate change through policy interpretation and expert demonstration. In addition, as 2025 will mark the 61st anniversary of the establishment of diplomatic relations between China and France, France can also deepen its cooperation with China in nuclear energy, emphasize the exchange of talents and technologies, and encourage French and Chinese enterprises to cooperate in various fields of energy.

References

Chen Linfeng. (2023). Prospect analysis of nuclear energy development in France. *China Nuclear Industry*, (11), 31-33.

Christoph. (2023). France's Nuclear Odyssey. https://www.wtsenergy.com/frances-nuclear-energy/

Jan Bartak, Noël Camarcat. (n.d). Nuclear Power in France and its Contribution to Reaching EU's Climate Objectives. https://www.nucadvisor.com/post/nuclear-power-in-france-and-its-contribution-to-reaching-eu-s-climate-objectives

Jiang Tao. (2023). A brief history of nuclear power in France. https://mp.weixin.qq.com/s/aO0U-aarFZkha3RyzgV8sQ

Jon Palfreman. (n.d). Why the French like nuclear energy. https://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/french.html

Le Gros, G. (2020). La naissance du parc nucléaire français: le plan Messmer. *Revue Générale nucléaire*, (5), 56-59.

Li Xinlei, Liu Qianru. (2024). France's nuclear energy revitalization strategy in the context of the climate-energy complex crisis: pathways, impacts and challenges. *Journal of China University of Petroleum (Social Science Edition)*, (04), 47-60. doi:10.13216/j.cnki.upcjess.2024.04.0006.

Liz Alderman. (2022). France Announces Major Nuclear Power Buildup. https://www.nytimes.com/2022/02/10/world/europe/france-macron-nuclear-power.html

Loi de transition énergétique pour la croissance verte, Le gouvernement français, le 13 décembre 2016, https://www.ecologie.gouv.fr/politiques-publiques/loi-transition-energetique-croissance-verte

LOI n° 2023-491 du 22 juin 2023 relative à l'accélération des procédures liées à la construction de nouvelles installations nucléaires à proximité de sites nucléaires existants et au fonctionnement des installations existantes, Le gouvernement français, le 22 juin 2023, https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000047715784

Mauger, R. (2018). Forced nuclear energy reactors shutdown in France: the Energy Transition Act's mechanisms. *The Journal of World Energy Law & Business*, *11*(3), 270-281.

Mycle Schneider, Antony Froggatt. (2019). The World Nuclear Industry Status Report 2019. https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2019-HTML

Mycle Schneider, Antony Froggatt. (2020). The World Nuclear Industry Status Report 2020. https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2020-

HTML

Pourquoi le gouvernement souhaite-t-il nationaliser EDF?. (le 22 juillet 2022). https://www.lafinancepourtous.com/2022/07/22/pourquoi-le-gouvernement-souhaite-t-il-nationaliser-edf/

Programmations pluriannuelles de l'énergie (PPE), Le gouvernement français, le 7 mars. (2019). https://www.ecologie.gouv.fr/politiques-publiques/programmations-pluriannuelles-lenergie-ppe

Vivienne Walt. (2021). Nuclear plants insulate France from the energy crisis. Now Macron is doubling down on them in a $35 billion moonshot plan. https://fortune.com/2021/10/12/nuclear-power-insulates-france-energy-crisis-macron-doubling-down-on-it-35-billion-moonshot/

Wiliarty, S. E. (2013). Nuclear power in Germany and France. *Polity*, *45*(2), 281-296.

Zhang Fuqiang, Yan Xiaoqing. (2019). French energy strategy — nuclear energy first. *China Energy News*. https://paper.people.com.cn/zgnyb/html/2019-03/18/content_1914701.htm.

Zhang Yan, Wu Hao Song. (2024). France identifies nine actions for future nuclear power development. *Foreign Nuclear News*, (12), 1.