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Ex Ante Nuclear Safety: Financial Assurance Mechanisms for Nuclear Damage

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Abstract

Nuclear energy, as a high-risk clean energy source, is exposed to the risk of nuclear damage during its utilization. Nuclear damage has wide-ranging impacts and persists over time, necessitating a financial assurance mechanism. This paper focuses on the relevant contents of the financial assurance system for nuclear damage compensation in international legislation and domestic law, and combines the domestic legislative practice of the world's major nuclear power countries. Financial assurance mechanisms for nuclear damage applied by States include nuclear damage insurance and mutual-aid mechanisms. The establishment of a sound financial assurance mechanism for nuclear damage is conducive to the further development of the nuclear energy industry.

Keywords: nuclear, nuclear damage, financial assurance mechanism

1. Introduction

At the United Nations Climate Change Conference (COP28) in Dubai, 22 countries signed a commitment to triple installed nuclear power capacity by 2050 from the 2020 baseline. As a clean energy source, nuclear power plays a key role in achieving the global goal of net-zero greenhouse gas emissions by 2050, as well as maintaining the 1.5-degree target. At a time when traditional sources of energy are becoming increasingly exhausted, humankind has turned to cleaner sources of energy such as nuclear power. Since the use of nuclear energy for civilian purposes, there have been three serious nuclear accidents that have aroused widespread concern worldwide: the Chernobyl nuclear accident in the former Soviet Union, the Three Mile Island nuclear accident in the United States, and the Fukushima nuclear accident in Japan. In the history of nuclear energy utilization, although the probability of nuclear accidents is extremely low, the severity of the hazards arising from such accidents is extremely high. After the Fukushima nuclear accident in 2011, as of October 2024, Japan's Tokyo Electric Power Company (TEPCO) has completed a cumulative total of ten rounds of nuclear contaminated water discharge to the sea, the total nuclear contaminated water discharge of more than 78 million tons, March 6, 2025, TEPCO announced that the Fukushima Daiichi nuclear power plant contaminated water of the eleventh discharge to the sea as soon as possible will be initiated in the 12th of this month, and the subsequent discharge program is expected to continue to continue for 20 to 30 years.As of February 28, 2025, TEPCO's compensation estimate has exceeded 1,147.97 billion yen. Without prior prevention and preparation, the burden of large amounts of compensation on operators of nuclear facilities will be difficult to fully discharge in a short period of time, and operators will avoid investing in the nuclear energy sector based on the great risk of nuclear damage, which will have a negative impact on the peaceful use of nuclear energy and the development of the nuclear industry.

2. The Concept of Financial Assurance for Nuclear Damage

2.1 Definition of Basic Concepts

2.1.1 Nuclear Damage

The research on financial assurance for nuclear damage require a clear definition of nuclear damage, which means resolving the questions of what nuclear damage is, thereby determining the connotation and extension of the concept. Without discussing what constitutes nuclear damage, it is impossible to identify the victims and determine the types of damages that should be compensated. Without clarifying what nuclear damage is, even if compensation measures are put in place, the victims will not be successful in receiving the compensation. In comparison with other damages, nuclear damage is characterized by (1) long duration; (2) causing large-scale damage; (3) latency and uncertainty; (4) seriousness of consequences; (5) causing transboundary damage; and (6)

difficulty in removing the consequences of damage. Compared to other types of damage, the specificity of nuclear damage is evident. General damage includes t personal injury and damage to property. The initial definition of nuclear damage naturally followed the concept of general damage, the 1963 *Vienna Convention on Civil Liability for Nuclear Damage* defined the scope of nuclear damage only in two categories, including personal injury and damage to property.[1] As humanity began to address nuclear damage compensation, the practical differences between managing compensation for nuclear damage and relief for general damage became apparent, leading to a deeper understanding of the unique aspects of nuclear damage. It became clear that nuclear damage could not be adequately remedied by considering only the scope of general damage.The 1997 amendments had extended the scope of nuclear damage to environmental damage and the costs of preventive measures, as well as damage resulting from loss due to the application of preventive measures, and the 2004 amendments to the *Paris Convention on Third Party Liability in the Field of Nuclear Energy* (*Paris Convention*) had likewise refined the scope of nuclear damage to bring it into line with the provisions of the Vienna Convention on the scope of nuclear damage. Therefore, the concept of nuclear damage should be inherited from both civil and environmental law.[2]

2.1.2 Nuclear Damage Financial Assurance

Financial assurance refers to the provision of sufficient financial resources by a business or operator in the course of its operations to ensure the availability of quick and easy emergency funds in the event of unforeseen circumstances to compensate for damage to persons, property and the environment, or to meet the costs of restoring the environment. Instruments such as insurance, funds, bonds and corporate guarantees are commonly used. A nuclear damage financial assurance system is established in advance by the operator of a nuclear facility before a nuclear accident occurs to cover shortfalls in funding for compensation for nuclear damage. Nowadays, nuclear energy is attracting much attention that can both combat climate change and reduce reliance on fossil fuels. However, in the event of a nuclear accident, it can cause damage to people and property. This requires a mature and stable ex ante preventive mechanism to safeguard it, and therefore a system of financial assurance for nuclear damage is of particular importance.

2.2 Historical Evolution of Financial Assurance for Nuclear Damage

2.2.1 Sources of International Law

In the nuclear industry, high safety standards are complemented by a very low accident rate, but once an accident occurs, the damage caused by the accident is extremely serious, and if the aftermath and assurance work is not carried out in a timely manner, the scope of the impact of the damage caused by the serious nuclear accident will be transboundary. Therefore, in the context of nuclear accidents, it has become a much more important issue to be dealt with not only in domestic law, but also at the level of international law.[3] The current development of international treaties relating to nuclear and transboundary nuclear damage is described below.

The main international treaty relating to nuclear damage are the Paris Convention system and the Vienna Convention system. The Paris Convention framework is based on the *Paris Convention*, signed by the Organization for Economic Co-operation and Development on 29 July 1960, and the *Brussels Convention Supplementary to the Paris Convention on Third Party Liability in the Field of Nuclear Energy*, which was concluded on 31 January 1963 to supplement the Paris Convention. In the late In the 1950s and early 1960s, countries in Western Europe constructed large nuclear power plants and implemented their own national legislation. The geographical proximity made environmental damage from nuclear accidents in neighboring countries a matter of widespread concern. As domestic laws concerning compensation for such damages varied from country to country, a common approach was needed to address the issue, and the Paris Convention emerged from this process. The Vienna Convention system is the *Vienna Convention on Civil Liability*, signed by the International Atomic Energy Agency (IAEA) on 21 May 1963, together with the *Protocol to Amend the Vienna Convention*, adopted in 1997. The Paris Convention was a regional convention focusing on Western European countries, and an international treaty on nuclear damage compensation systems involving all States needed to be implemented as well, and the Vienna Convention, as a global treaty, had been adopted with the support of the International Atomic Energy Agency.

The basic principles of the two international conventions mentioned above include (1) concentration of liability, (2) strict liability, (3) limitation of liability, (4) financial assurance, and (5) exclusive jurisdiction. As mentioned earlier, the member states of the Paris Convention are mostly Western European countries, while the member states of the Vienna Convention are more diverse.[4] Financial assurance is a principle and a specific mechanism in the International Convention on Compensation for Nuclear Damage.

2.2.2 Sources of Domestic Law

The system of financial assurance for nuclear damage was originally created by domestic law, and has evolved in response to the needs of practice over the years. To promote the peaceful use of nuclear energy, the United States enacted the *Atomic Energy Act* in 1946 to provide a stable framework for the steady operation of civil nuclear energy. Unlike the previous state-led development and use of nuclear energy, the industrialization of the nuclear sector has raised a new issue, which is who should bear the responsibility for nuclear damage caused by a nuclear accident and how it should be allocated. Based on the traditional tort theory, private subjects should compensate for the personal and property damage caused to victims by tortious behavior, which means that nuclear energy operators should compensate for the personal and property damage caused by nuclear accidents. The low-frequency, high-damage nature of nuclear accidents has become a major obstacle to the participation of private actors in the civil nuclear industry. To mitigate the conflict between the growth of the nuclear industry and the private sector's reluctance to confront substantial financial risks, the United States enacted the *Price-Anderson Act* in 1957. This legislation was pioneering in mandating that operators of nuclear facilities secure financial assurance. Through the establishment of ex ante financial assurance, a compromise has been found that balances the encouragement of the commercial use of nuclear energy with the provision of sufficient and timely compensation to victims of nuclear accidents.[5]

Major nuclear powers around the world have also established their own financial assurance systems for nuclear damage by means of domestic legislation. In Japan, the financial assurance system for compensation for nuclear damage is stipulated in the Nuclear Damage Compensation Law, the Enforcement Decree of the Nuclear Damage Compensation Law and the Nuclear Damage Compensation Support Organization Law. In 2007, China proposed in the Reply of the State Council on the Liability for Damages Resulting from Nuclear Accidents that the operator of a nuclear facility should make appropriate financial assurance arrangements, and in the Nuclear Safety Law, which came into force in 2018, the obligation of the operator to provide financial assurance was reiterated in the form of a principle regulation.

2.3 Models of Financial Assurance for Nuclear Damage

When a nuclear accident occurs, the operator, as the cause of the accident and the primary responsible party, has a mandatory obligation to compensate the victims. However, without sufficient funds to provide this compensation, it is still impossible to achieve the deserved relief in reality. The most effective way to solve this problem is to use different forms of financial assurance beforehand to ensure that the operator has sufficient capacity to cope with potential liability.[6] Currently, the world's mainstream operational models of financial assurance for nuclear damage include nuclear liability insurance, mutual assistance mechanisms and self-insurance.

2.3.1 Nuclear Liability Insurance

The insurance, as referred to by the insurer, is liable to compensate when the insured is held liable to another party in accordance with the law. Nuclear damage is characterized by suddenness, latency and continuity, and the consequences are exceptionally severe. Under the existing technical conditions, the occurrence of nuclear accidents cannot be completely avoided, and the operators of nuclear facilities have to face the risk of nuclear damage caused by nuclear accidents. According to the provisions of the relevant international conventions, operators should bear the responsibility of compulsory insurance. As the most conventional and widely used measure of risk control, the model of covering nuclear damage with insurance is the first and most mainstream method of financial assurance, and it is now most frequently applied in the practice of various countries. Based on the theory of risk control, when an operator takes out a nuclear liability insurance policy, the risk of nuclear damage is partially transferred to the insurance company, and the insurance company compensates the victims within the limits of the amount of compensation after an accident occurs. There are three main models for the regulation of nuclear insurance in countries around the world, which are parallel models of domestic legislation and international treaties, the model of regulation through domestic legislation only and the model of neither domestic legislation nor participation in international conventions.[7]

Since nuclear accidents are catastrophic risks, it is challenging for individual insurance companies to offer adequate funding to cover compensation claims in the aftermath of such an event. Therefore, in addition to obtaining insurance from individual insurance companies, an insurance pool is formed by multiple insurers collaborating. This joint effort consolidates the resources of each company into a community to mitigate the risk that individual insurers might be unable to underwrite insurance due to excessively high financial risks. The world's first nuclear insurance community was established in the United States in 1956 under the *Price-Anderson Act*. Subsequently, countries such as the United Kingdom, Germany, Canada, and Japan have established nuclear

insurance pools in succession. Currently, 31 countries worldwide have established nuclear insurance pools to cover nuclear risks.

2.3.2 Mutual Aid Mechanisms

Funds belong to the mutual assistance mechanism in the financial assurance for nuclear damage. In addition to insurance, mutual funds are one of the most common forms of financial assurance. They are a type of mutual aid organization, funded collectively by all participants in the industry. The purpose of the establishment of mutual funds is to cater for the preparation of a certain amount of funds for possible nuclear accidents beforehand, and the mode of operation can be divided into pre-withdrawal and ex-post responsibility. Withdrawal beforehand means that at the initial stage of the establishment of the fund, each operator is required to pay a certain amount of money; responsibility after the event means that after the occurrence of a nuclear accident, each operator will share the losses proportionally. Fundamentally, the main function of the fund is to continue to bear the liability in the event that it exceeds the scope of compensation that can be borne by the nuclear liability insurance.

2.3.3 Captive Insurance

A captive insurance company falls within the category of insurance companies. It is established by a parent company to provide insurance services exclusively to the parent company and its subsidiaries, which the parent company directly controls. The main business management activities include underwriting, claims processing, and investment behavior. [8] Professional captive insurance companies emerged in the mid-19th century, yet for a considerable period, they did not attract widespread attention. By the end of the 1950s, there were only 40 captive insurance companies in the world. Risk financing mechanisms, in the form of insurance or reinsurance instruments, assist companies in managing risks by providing insurance products. Since its inception, captive insurance companies have evolved into a significantly prominent risk management tool, spanning nearly all industry sectors and international regions.

3. Financial Assurance of Nuclear Damage in Major Nuclear States

3.1 Legislative Model

Financial assurance for nuclear damage was initially established by the Price-Anderson Act at the legal level, which made it possible to set up a specific system in practice. All major nuclear countries in the world unexceptionally have chosen to bring the financial assurance for nuclear damage to the legal level through legislation. The general law in the nuclear energy is the Atomic Energy Act, and the system of financial assurance is under the category of compensation for nuclear damage. Provisions on compensation for nuclear damage have been implemented differently in the legislative process of various countries, which has resulted in the choice of different legislative models, including the stand-alone legislative model represented by the United States and Japan, the consolidated legislative model represented by the United Kingdom and Germany, and the decentralized legislative model represented by China.

3.1.1 Single law Legislative Model: U.S. and Japan

In addition to the general law in nuclear energy, the financial assurance mechanism for nuclear damage is provided for in the special law on nuclear damage compensation, which is a single law legislative model, and the main representative countries of this model are the U.S. and Japan.

As the front-runner in the civil nuclear field, the United States maintained a high-speed development of the nuclear industry and a large industrial scale in the 1960s.During this period, there were several small nuclear accidents, and the insurance industry was hesitant to provide insurance for the nuclear industry due to the high risk of nuclear damage compensation. Against this backdrop, the regulation of the civil nuclear industry's financial assurance, the *Price-Anderson Act*, was established. In 1957, Congress passed the *Price-Anderson Act* as an amendment to the *Atomic Energy Act*. It outlines the allocation of liability for nuclear accident damages, compensation limits, litigation jurisdiction, and other specific details.It offers a legislative framework for the further development of the nuclear industry in the United States. Since its enactment, the Price-Anderson Act has been amended several times in 1966, 1975 and 1988. The latest round of the Price-Anderson Act will extend its application until 2025. The Energy Policy Act, Section 606, requires the U.S. Nuclear Regulatory Commission (NRC) to submit a "report on the need for continuation or modification of the Price-Anderson Act" to Congress in 2021 in order to "determine whether to continue the project beyond 2025 ". In its report, the United States and the Regulatory Commission concluded that "Price-Anderson will continue to provide significant funding to any victim of a nuclear incident for at least the next 10 years".

Article 6 of *the Atomic Energy Damage Compensation Law* of Japan, enacted in 1961, stipulates that "the operator of a nuclear facility shall provide a financial assurance within a certain range". Two forms of financial assurance,

nuclear liability insurance and nuclear damage compensation agreements, are regulated therein. Liability insurance is the main instrument, and the operator may sign an indemnity agreement with the Government for damages not covered by liability insurance or other means of financial security. After the Fukushima nuclear accident, the Government of Japan enacted the new Support Organization Law, and in order to enable TEPCO to provide large amounts of compensation to victims in timely, the Government of Japan provided funds to the Nuclear Damage Liability Support Organization (NDLSO) through the issuance of treasury bonds. In this way, TEPCO receives financial assistance for the compensation of victims.

3.1.2 Consolidated Legislative Model: England and Germany

The consolidated legislative model is based on a special chapter on the financial assurance system for nuclear damage within the general law in the field of nuclear energy. [9] This model is mainly represented by financial assurance.

UK Nuclear Safety Act amended in 1965, which requires the nuclear operator to ensure, by insurance or other approved means, that sufficient funds are available to meet third party claims within the limits set out in the Act. In Germany, the Atomic Energy Act amended in 1959, introduced financial assurance through the creation of a special chapter on compensation for nuclear damage. Since then, the damage compensation system has been transformed through several amendments from protection of the operator to relief for the victims. After several large-scale nuclear accidents, anti-nuclear sentiments continued to grow in Germany, and the 1985 amendment was enacted to change the limited liability limitation for operator's damages to unlimited liability. In the 2002 amendment, the amount of the compensation limit was increased tenfold to €2.5 billion.[10] The original purpose of the compensation system, which was to provide relief to victims, was clarified by deleting "the promotion of research and development of nuclear energy for peaceful purposes" from the purpose of the law. A policy of phasing out nuclear facilities by 2022, with all nuclear power plants in the country to be officially shut down by 15 March 2023 was established.

3.1.3 Decentralized Legislative Model: China

The decentralized legislative model is which the content of financial assurance for nuclear damage is not provided for in a special law on compensation for nuclear damage or a general law on the nuclear field, but rather in other special laws on the nuclear field, and in other legal provisions on financial assurance for nuclear damage are found in a scattering of relevant provisions. The main representative country of this model is China.[11]

It was not until the 2007 Reply of the State Council on the Issue of Liability for Damages Resulting from Nuclear Accidents that China first determined that the operator should make appropriate financial assurance arrangements to ensure timely and effective fulfilment of the liability for damages resulting from a nuclear accident. Article 90 of the 2018 Nuclear Safety Law regulates the financial assurance for nuclear damages, requiring that the operator of a nuclear facility should provide appropriate financial assurance.[12] However, the content is too principled and lacks an operational basis for guidance. Currently, China is planning to legislate the Atomic Energy Law, the general law of nuclear energy, in order to change the dilemma that decentralized legislation has brought to the financial assurance system, and the subsequent financial assurance legislation will inevitably flow into one of the stand-alone or consolidated legislative models.

3.2 Practical of Financial Assurance for Nuclear Damage

3.2.1 Financial Assurance System for the Fukushima Nuclear Accident in Japan

On March 11, 2011, a powerful earthquake struck Fukushima, Japan, and the subsequent tsunami caused severe damage to the Fukushima Daiichi nuclear power plant, resulting in the meltdown of three reactor cores.Aside from the Chernobyl nuclear accident, the Fukushima disaster is the sole incident classified as a Level 7 nuclear accident, the highest on the International Nuclear and Radiological Event Scale (INES). The impact of the Fukushima accident has been profound, affecting the safety and economic aspects of nuclear power generation, relief efforts for victims, and numerous other domestic and international spheres. *Japan's Atomic Energy Damage Compensation Law* stipulates that compensation for nuclear damage is the unlimited responsibility of the operator of the nuclear facility, and that the State will provide support when necessary. However, there is a margin of discretion for the State to provide "assistance", and the nature of the loss-damage sharing between the nuclear operator and the State is not predetermined. 20 insurance companies established the Japan Nuclear Insurance Pool (JNIP) in 1960, through which all nuclear power operators in Japan purchased nuclear damage insurance with a coverage of up to 120 billion yen. In total, three forms of financial assurance were adopted: nuclear liability insurance, indemnity agreements and bonds.[13]

After the accident of TEPCO's Fukushima nuclear power plant, the Atomic Energy Damage Compensation Support Agency was established in September 2011 under the Support Agency Law. In order to cope with problems such as the payment of large amounts of damages, nuclear power companies have adopted a form of co-financing to cope with claims along the lines of "mutual assistance", and in November 2014, the Diet approved Japan's accession to the Convention on Supplementary Compensation for Nuclear Damage (CSC). The CSC, like the Paris and Vienna Conventions, is an international convention on compensation for nuclear damage, which provides higher compensation for victims through co-financing by all Member States in cases where the liability limit of the country in which the accident occurred exceeds 300 million Special Drawing Rights (SDRs).

3.2.2 Financial Assurance for the Three Mile Island Nuclear Accident in the U.S.

The meltdown of part of the reactor core at the Three Mile Island Nuclear Power Station in Pennsylvania, USA, on 28 March 1979 resulted in the leakage of radioactive material. After investigation and assessment, despite the severe damage to the reactor, the radiation was effectively controlled and the impact on public health as well as the environment was negligible. The accident only affected the staff inside the nuclear power plant and was therefore not a huge nuclear accident. After the accident, the evacuation of the population and the organization of a compensation team were carried out rapidly to compensate for the damage suffered by the people in the vicinity.

The Price-Anderson Act has established a unique three-tier compensation system. The first tier is that the operator of a nuclear facility must take out nuclear liability insurance or provide other forms of adequate financial assurance; the second tier is the nuclear insurance pool, in which all operators jointly insure themselves against a pool of funds consisting of a number of insurance and reinsurance companies; and the third tier is that Congress decides whether or not to provide additional relief by the federal government [14]. The Three Mile Island nuclear accident confirmed the soundness of the financial assurance. After the accident, Congress further increased the liability cap of the Act. In the 1988 amendments, Congress increased the liability of the nuclear industry to $9.87 billion, nearly 10 times higher than the initial liability cap. [15]

4. The Future Direction of the Financial Assurance of Nuclear Damage

The core issue of financial assurance is to provide timely and adequate relief to those injured, while ensuring the stable operation and healthy development of the nuclear industry. Based on the progress of the specific nuclear industry, we should learn from past experiences, take the actual situation as our foundation, and rely on financial assurance for nuclear damage compensation to guarantee the peaceful use and development of nuclear energy. With the direction of financial assurance clarified, the future development path that satisfies both requirements should be deduced.

4.1 Improving Legislation on Financial Assurance for Nuclear Damage

Cop28 calls for global efforts to get rid of fossil fuels and accelerate the use of renewable energy, nuclear energy, in order to limit global warming to 1.5°C. The construction and utilisation of nuclear power has become an unavoidable trend. The rapid development of the nuclear industry have become unstoppable. The use of nuclear energy has also become more geographically widespread, and its potential impacts have become greater. This shift in reality has placed greater demands on national nuclear risk management and nuclear damage legislation. While nuclear energy is being vigorously developed, in the event of a serious nuclear accident, the damage caused would be exceptionally severe, and the related compensation work would be complex and arduous. Improvements in legislation are inevitably required to properly address this potentially significant challenge.[16] the Fukushima nuclear accident in Japan in 2011 has significantly heightened global concern and worries about nuclear safety. Therefore, in the context of the rapid development of nuclear power, there is an urgent need to improve the legislation on financial assurance for nuclear damage at the national level. It should designate a complete and mature law on financial assurance for nuclear damage that is in line with the current development of the nuclear industry in the country, based on international experience and taking into account its own characteristics.

4.2 Diversified Forms of Financial Assurance

The concept of Defense-in-Depth in the nuclear power industry requires the establishment of a series of progressive and independent protection, mitigation measures or physical barriers to prevent nuclear accidents from occurring and to mitigate the consequences of nuclear accidents. The safety orientation of defense-in-depth determines the future direction of the development of financial assurance systems for nuclear damage. Under the guidance of this concept, the establishment of a complete system and reasonable structure to take into account both the breadth and the depth of financial assurance in two logical paths. Firstly, the breadth of the financial assurance, refers to the different financial assurance operation mode can be spread as far as possible to cover the damage caused by the compensation required, is the need to build diversified forms of financial assurance. At present, insurance is still

the main form of financial assurance in practice. Mutual aid mechanisms, funds and self-insurance is relatively less used. In improving the financial assurance system, the introduction of other forms of financial assurance besides insurance can be considered in the future.

4.3 Establishment of Progressive and Independent Layers of Financial Assurance

Secondly, the depth of financial assurance, which refers to the need to establish progressive and independent tiers as a means of responding to damages by means of an appropriate number of tiers of barrier rounds of measures, is required. Multiple tiers of protection are provided, and when the first tier is exhausted, subsequent tiers may continue to provide compensation to the extent not covered by the previous tier. Looking back at the establishment tiers in various countries, the most reasonable underlying logic of financial assurance tiers should be that the operator of a nuclear facility should bear the first tier of compensation, the nuclear industry should bear the second tier of liability through mutual assistance, and finally the State should underwrite and provide full compensation for nuclear damage by way of compensation. Such progressive and independent layers cover the operator itself, the nuclear industry and the State. The operator, i.e., the producer of the damage, is the first line of financial assurance, mutual assistance within the industry strengthens the overall resilience of the civil use of nuclear energy, and the involvement of the State's liability further reinforces the preceding layers.

4.4 Dynamically Adjusting the Content of Financial Assurance

While the nuclear industry is currently thriving, it is important to consider circumstances other than the growing and increasing demand for nuclear financial assurance. The U.S. Nuclear Regulatory Commission, in its report to Congress in 2021 on whether to extend and modify, suggests that the U.S. is facing the decommissioning of a large number of nuclear reactors. Germany shut down its last three nuclear power plants on 15 April 2023, ending the era of nuclear power. This is when the limits and forms of financial assurance need to be adjusted dynamically from a realistic perspective, in order to adapt to match the risk factors of the nuclear industry under the realities of each country. Therefore, it is necessary to assess the current risk of nuclear damage in a timely manner and dynamically adjust the content of financial assurance. [17]

5. Conclusion

As a clean energy source, nuclear energy has greatly facilitated the process of improving environmental problems for mankind and is in line with the concept of sustainable development. While the nuclear industry has made great strides, the seeds of potential safety hazards have also been quietly sown. There was no doubt about the role of financial assurance mechanisms for nuclear damage in preventive remediation of damage.

The high-risk of nuclear energy determines that its development process inevitably faces the risk of damage from nuclear disasters. As an important part of the liability system for nuclear damage, a ex ante financial assurance system for nuclear damage compensation can hedge the financial liability of the operator of a nuclear facility and provide relief to victims after nuclear damage has occurred. Under this principle, in the event of an accident, the operator can obtain funds for compensation as a result of such financial assurance, eliminating the need to raise assets in the immediate aftermath of an accident, and victims can receive timely relief and effective compensation. Financial assurance established in advance can spread the cost of risk after nuclear damage has occurred, internalize the risk of nuclear energy use into the cost of the industry, and prevent the development of the nuclear industry from being hindered by the high-risk nature of the industry. Taking into account international conventions and the experience of countries in legislation and practice, the future direction of financial assurance for nuclear damage is clearly shown.

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