



## Research Article

# Ensuring Information Disclosure and Environmental Impact on Nanoradioactive Operation of Civil Nuclear Facilities in China

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Japan was struck by a massive earthquake that triggered a tsunami in March 2011, which led to a severe nuclear accident at the Fukushima Daiichi Nuclear Power Plant of the Tokyo Electric Power Company. Now, more than 10 years later, it is widely acknowledged that the civil nuclear industry is of great importance in reducing greenhouse gas emissions, improving natural environmental quality, and safeguarding national energy security. Nanomaterials and nanotechnologies, which have gained wide consideration in recent years, have shown a wide variety of application potentials in the future nuclear energy system. Thus, China has been developing its civil nuclear industry throughout the years, despite the nuclear accident in Fukushima, Japan. As a result, China is currently one of the countries with the most nuclear power plants. However, due to the potential radioactive risk, the public has an instinctive fear of civil nuclear development. To alleviate the public's antinuclear sentiment, the *Nuclear Safety Law* was formally implemented in 2018, and *Measures for Disclosure of Nuclear Safety Information* were issued by the Ministry of Ecology and Environment of China in 2020, both stipulating that the public has the right to obtain information about nuclear safety and be involved in related activities. The purpose of such legislation is to eliminate the public's doubts and phobia about the development of the civil nuclear industry. However, challenges still exist. Although such suggestions have been proposed, such as information disclosure and social involvement should begin as early as the siting of such nuclear facilities, mechanisms to provide sufficient compensation to the public living near nuclear facilities should be established, and these suggestions still have not been applied in the law of China and either not been practiced exactly so far. So, even though all the suggestions have strong feasibility themselves under today's circumstances in China, it is not easy to judge the effectiveness of these suggestions until they are fully practiced. It is the biggest problem of existing works in this paper. To highlight the serious problems in information disclosure and public involvement in the siting and construction of civil nuclear facilities, several case studies were investigated as the major methodology in this research. Moreover, a legislation study was used to analyze the current content of related legislation and regulations. A qualitative methodology was also adopted to summarize the legal problems surrounding information disclosure and social involvement during the siting and construction of civil nuclear facilities. Information disclosure and public participation still face several obstacles in China, even though laws and regulations guarantee people the right to access available information and take part in pertinent decision-making. This is particularly true when it comes to the siting and construction of civil nuclear facilities. Thus, in the last several years, several antinuclear incidents have been initiated by the public due to a lack of information and mechanisms to participate. According to the examined cases, information disclosure and public involvement are still not sufficient during the siting of nuclear facilities. A relevant compensation mechanism for people living around nuclear facilities has not been established, and public education on basic nuclear safety is lacking. Therefore, public involvement cannot be completely realized. To ensure information disclosure and public involvement in civil nuclear facilities, this article proposes that information disclosure and social involvement begin as early as the siting of such facilities. Furthermore, operators of nuclear facilities and local governments should establish mechanisms to provide sufficient preventive compensation to the public living near nuclear facilities and attempt to popularize the science of nuclear safety to avoid public misunderstanding.

## 1. Introduction

A large portion of the early development of nuclear energy came from military initiatives that started during the Second World War. Governments at the time and for a long time afterward treated information on nuclear technology and material as confidential because they believed it to be very sensitive [1]. Because nuclear activities may have an impact on the environment and produce environmental data, it has become crucial to provide the public with as much information as possible about the development and use of all nuclear facilities to foster public understanding and confidence in the civil nuclear industry. But at the beginning of the civil nuclear industry, most decisions about the siting, construction, and operation of nuclear facilities have been made by senior officials and specialists in the nuclear field. Therefore, the public could not understand nuclear science and technology. They generally estimated the nuclear risks from “Intuition” by a process called “Perception of Risk” [2]. There has been a big gap between the evaluation of nuclear risks of the specialists in the nuclear field and the cognition of this risk of the public [3]. According to Beck’s theory of “Risk Society,” the public’s concern for civil nuclear facilities is because nuclear risks have outstanding particularities compared with other risks of today’s world [4]. For instance, even when the maximum level of safety has been attained, nuclear and radiological mishaps still have a chance of happening. And the concern of the public has become one of the most significant reasons that hinder the development of the civil nuclear industry in many countries [5].

At all stages of advanced nuclear plants, nanomaterials and nanotechnologies are projected to be able to play significant roles and have enormous application potential. The necessary individuals must be aware of what is going on in their environment, comprehend what is happening, and participate in the decision-making process to assure the development of the civil nuclear business. The Rio Declaration, commonly known as the Earth Charter, which was published in 1992, declares in Principle 10 that it is better to address environmental challenges with the involvement of all interested persons. The 1998 Convention on Access to Information, Public Participation in Decision-making, and Access to Justice in Environmental Matters (Aarhus Convention) mandates the establishment of both a system that allows the public to ask for and receive environmental information from public authorities as well as a system that allows public authorities to actively gather and disseminate environmental information to the public without being asked. All nuclear facility construction and operation information unquestionably qualifies as critical environmental information. The Aarhus Convention’s Article 6 also guarantees the public’s right-to-participate. Therefore, during the entire process of civil nuclear facility siting, building, operation, and even decommissioning, governments that are developing such facilities must ensure information transparency and public involvement.

As the most important legislation in the nuclear field of China, the *Nuclear Safety Law* was established as a mecha-

nism of overall-process safety supervision. The aims of the *Nuclear Safety Law* include protecting the public interest and involvement, strengthening information disclosure, eliminating people’s distrust, and increasing people’s confidence in the development of the civil nuclear industry. Article 11 of the *Nuclear Safety Law* states, “A citizen, a legal person or any other organization shall be entitled to access to nuclear safety information by the law.” Additionally, Chapter Five of the *Nuclear Safety Law*, named “Information Disclosure and Public Participation,” stipulates the measures and methods of guaranteeing information disclosure and social involvement. *Measures for Disclosure of Nuclear Safety Information*, issued by the Ministry of Ecology and Environment in 2020, also include the information disclosure obligation of operators of nuclear facilities and governmental supervisors of nuclear safety.

This essay covers China’s civil nuclear facility siting, building, and operating laws as they relate to information disclosure and public participation. Although laws and regulations guarantee individuals the right to obtain information and participate in pertinent decision-making, public participation and information disclosure nevertheless confront several obstacles, particularly when civil nuclear plants are being built and siting takes place.

Since very few scholars would like to do specific academic research in human and social sciences on civil nuclear facilities and nuclear-related matters, few books on this topic have been published, such as the following:

“Social Construction of Nuclear Risks in China: the Public’s Participation in Civil Nuclear Issues from the Start of the 21<sup>st</sup> Century” written by Dr. Xiang Fang

“Public Communication: the Ideal mode to solve the difficulty of NIMBY” by Yue Zuo

“Government Communication Effectiveness on Local Acceptance of Nuclear Power: Evidence from China” by Dr. Yue Guo

“Public Acceptance of Nuclear Power: Research, Reflection, and Ways to Go” by Professor Chao Fang and Yuhong Chen

However, all of these above academic achievements are from the aspects of sociology, public administration, and public policy science, and they study the topic through statistics, questionnaires, and modeling methodologies; none of them explore this issue from the legal perspective or apply methodologies from the field of law.

Thus, it is the characteristic of this paper to summarize the related challenges by analyzing real cases and propose suggestions on how to improve information disclosure and public involvement in the field of civil nuclear from the perspective of the law.

## 2. Literature Survey

Castiglione et al. [6] in a study titled “Rule of law and the environmental Kuznets curve: evidence for carbon emissions” show that there exists a negative relation between the status of laws and pollution. They argue that when there is a strong governing law, therefore, we observe improvement in environmental preservation.

Kueny [7] in a study titled “Environmental radiological protection and nuclear law: from the protection of humans to the protection of the environment per se?” addresses the problem of international laws and regulations regarding the effects of ionizing radiation on the environment and nature; and that nuclear laws not only cover human societies, but nonhuman species are also protected from hazardous effects of ionizing radiations.

Sousa Ferro [8] in research titled “The future of the regulation of nuclear safety in the EU” considers the prevention of harm to workers, people, and the environment among the fundamental issues discussed in nuclear safety laws and regulations, although he stresses that regulations must not limit themselves to nuclear power plants but should cover all effective factors within the nuclear fuel cycle including radioactive waste management.

Qiang [9] in a study titled “Nuclear energy and the environment” attempts to compare the environmental effects of generating electricity through nuclear technology and coal. This comparison shows that the nuclear electricity generation process, effect on the environment, human health, and emission of greenhouse gases are far less than generating electricity using coal. In this course, accelerating the development of nuclear energy is considered one of the main solutions for solving environmental pollution problems.

Riley [10] in his research titled “Justification of the continued development of the peaceful use of nuclear energy” to justify the development of peaceful nuclear energy applications explains the scientific application of nuclear energy in different fields, the economic advantage of this technology compared to many other current options, and its positive effects on health, safety, security, and finally environmental protection.

Gharib [11] in his evaluation titled “Nuclear energy and nonproliferation,” while explaining the legal issues around peaceful applications of nuclear energy, accounts for it as a new, effective, and efficient source of energy and realizes that the prerequisite of a world transition of movement toward peaceful nuclear energy usage, apart from utilizing related technical and scientific equipment, requires governments and international organizations’ adherence to international laws.

Bhattacharjee [12] in his study showed that by expanding diverse applications of nuclear technology in various fields including industrial, medical, and agricultural fields, governments have realized the fact that to respond to technical and managerial requirements of environmental protection, safety, and human health, creating a well-organized legal framework, especially in the fields of government liability instead of nuclear harm, is essential.

### **3. The Current Legislation of Public Involvement throughout the Whole Process of the Siting, Construction, and Operation of Civil Nuclear Facilities in China**

The public has the right to be protected from radioactive harm by nuclear facilities. Thus, for the public, the right to nuclear safety is always a type of passive protection [13].

However, the public’s fear of nuclear activity caused by the lack of relevant information hinders the construction and operation of civil nuclear facilities. Therefore, relevant information disclosure and public involvement are of great significance. From the aspect of the law, people’s right-to-know and right-to-participate must be realized and protected [14]. In 2013, the China Nuclear Energy Association suggested increasing the transparency of information and promoting the involvement of the public, and both of these recommendations were written into the *Nuclear Safety Law* in 2018. In addition to the *Nuclear Safety Law*, other laws and regulations about information disclosure and public involvement in the civil nuclear industry have been established, as listed in Table 1.

Figure 1 clearly depicts the simplified summary of suggestions of this work. Article 11 of the *Nuclear Safety Law* defines the public (including citizens, legal persons, and other organizations) as subjects who have the right to obtain information related to nuclear safety (right-to-know). This means that the *Nuclear Safety Law* guarantees the disclosure of information about nuclear safety and public involvement in related activities. Information disclosure is the basis of public involvement because, without the relevant information, the public is not able to participate during the siting, construction, and operation of nuclear facilities.

Chapter Five of the *Nuclear Safety Law* lays out the procedures that serve to ensure information disclosure and society involvement in nuclear safety in addition to Article 11, which lays out fundamental principles. By the law, the public may apply to the nuclear safety supervision and administration department of the State Council and the department information for access to information relating to nuclear safety. For instance, Article 65 mandates that nuclear safety information be made publicly available by the law and that it be done so promptly through government announcements, websites, or any other means facilitating public knowledge. The second example is Article 68, which grants the public the right to report any act that poses a hidden risk to nuclear safety or violates applicable legal and administrative requirements to the State Council’s department responsible for nuclear safety supervision and administration or any other relevant department. Additionally, the public assumes the obligation to not fabricate or spread false nuclear safety information. Moreover, based on the *Nuclear Safety Law*, *Measures for Disclosure of Nuclear Safety Information* stipulates the kind of nuclear safety information that should be disclosed and the methods of the disclosure. All of these provisions are the foundation of the public’s right-to-know and the right-to-participate.

Before the *Nuclear Safety Law* went into effect, Articles 53 and 56 of the *Environmental Protection Law*, Articles 21 and 23 of the *Environmental Influence Assessment Law*, and Articles 11 and 15 of *Construction Project Environmental Protection Regulation* were issued by the State Council, and *Environmental Protection Public Participation Regulation* issued by the Ministry of Ecology and Environment also required the disclosure of nuclear safety information and guaranteed public involvement in the civil nuclear field. By the above legislation and regulations, the operators of

TABLE 1: China's related laws currently.

Legislation	(i) <i>Nuclear Safety law</i> (ii) <i>Environmental Protection Law</i> (iii) <i>Environmental Influence Assessment Law</i> (iv) <i>Law on Prevention and Control of Radioactive Pollution</i>
Regulations	(i) <i>Construction Project Environmental Protection Regulation (issued by the State Council in 1998, and revised in 2017)</i> (ii) <i>Environmental Protection Public Participation Regulation (issued by the Ministry of Environmental Protection in 2015)</i> (iii) <i>Measures for Disclosure of Nuclear Safety Information (issued by Ministry of Ecology and Environmental in 2020)</i>

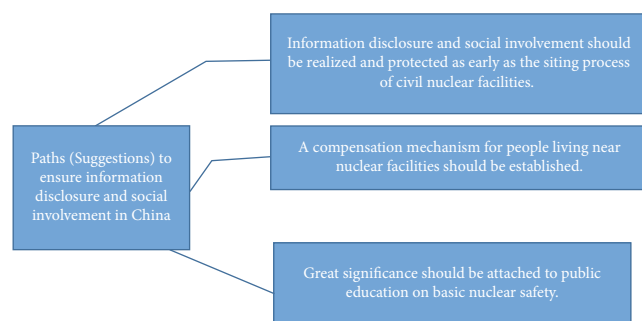


FIGURE 1: The simplified summary of suggestions for this paper.

nuclear facilities are required to submit environmental influence reports for certification. Before submitting, the operators are obligated to hold public hearings about nuclear safety situations. Furthermore, all environmental protection departments are required to disclose environmental information and establish a public participation mechanism. Otherwise, the *Law on Prevention and Control of Radioactive Pollution* grants the public the right to accuse nuclear operators of radiation pollution when supervising the nuclear safety of nuclear facilities. It is believed that “accuse” is one of the most important functions in allowing the public to realize “public involvement”.

#### 4. Typical Cases of Antinuclear Activity during the Process of Siting and Construction of Civil Nuclear Facilities

Despite the above legislation and regulations, relevant information disclosure and public involvement still face several challenges. Therefore, in the past several years, several antinuclear incidents have been initiated by the public due to a lack of information and methods to participate.

(For several reasons, the real names of the relevant places and operators of nuclear facilities are anonymized, and abbreviations are used instead.)

*4.1. The Siting of the First-Stage Project of the PZ Nuclear Power Plant Was Boycotted by the WJ Public.* In 2009, the safety analysis report and environmental influence report about the siting of the first-stage project of the PZ Nuclear Power Plant were ratified by the National Nuclear Safety Administration. However, residents of WJ County, located in another province on the other side of the river, were fiercely against the siting. Four retired cadres in WJ County wrote a Petition to Suspending PZ Nuclear Power Plant.

Their petition claimed that the nuclear plant's safety analysis report contained false information, that the seismic standard was inadequate, and that the reactor was located close to an industrial area; moreover, there were serious problems with the process and results of the public opinion survey. Due to the petition, the public in WJ County, whose right-to-know and right-to-participate were not realized, began to boycott this project.

The manner in which the Nuclear Engineering Institute disclosed information and surveyed the public was inadequate. At first, the target audiences of information disclosure and involvement were only the people who lived in PZ County, but the people who lived in WJ County, merely 10 kilometers away from the siting of the nuclear power plant, were completely ignored. At that time, the relevant information about the siting of the PZ Nuclear Power Plant was only disclosed on the local government website and in the local newspaper, but the public from WJ County seldom checked this website, and the newspaper was not sold in WJ County. As a result, the people of WJ County were not able to obtain relevant information. It had infringed on the WJ County public's right-to-know about nuclear safety.

Moreover, when the public opinion survey was performed in WJ County, some people from PZ County who were very familiar with several villagers in WJ County collected opinions only from acquaintances and bribed them with small gifts. Thus, only 10 percent of the participants of the opinion survey lived in WJ County, and most of them responded to the survey to receive gifts. These approaches infringed on the WJ County public's right-to-participate. Thus, the results of the public opinion survey were not accurate.

Furthermore, one Nuclear Engineering Institute conducted two subsequent surveys. However, the government and public of WJ County did not receive any information before the siting of the PZ Nuclear Power Plant. The institute did not analyze the results of the public opinion survey and release the relevant results to the public nor did it receive suggestions from the public after the opinion survey. Both of the surveys violated the principles of scientific design and information transparency, so the WJ County public's right-to-know and right-to-participate about nuclear safety could not be realized. Meanwhile, the hearings held by this Nuclear Engineering Institute were also questioned by the WJ public. This Nuclear Engineering Institute held two hearings, and only one participant involved in the hearings was from WJ County; the remaining 52 participants were from other places. Thus, without sufficient involvement of the WJ County public, there were serious problems with the hearings.

Since the public from WJ County fiercely boycotted the nuclear project, and some people even stopped construction, the construction of the PZ Nuclear Power Project was suspended, and more than 3 billion CNY of investment was wasted.

*4.2. The Project of a Nuclear Fuel Factory Was Strongly Opposed by the Public of HS.* One large Nuclear Corporation planned to construct a nuclear fuel factory in HS of JM City. In July 2013, the government of JM published a “Social Stability Assessment” for the project and asked the public to provide opinions within 10 days. In other words, the JM public only had 10 days to obtain the information, express their opinions, and participate in the decision-making process. Thus, the public thought that 10 days was too short and that the government did not really care about their opinion and just wanted to start the project. The public of JM City was strongly opposed to the plan. In order to boycott the project, the JM public held a demonstration along the main street of the city and even held a rally in front of the municipal government. To ease the anger of the JM public and sustain social stability, the nuclear fuel factory plan was abolished, and a large amount of money was wasted.

*4.3. The Siting of a Commercial Spent Fuel Recycling Factory Was Boycotted by the Public of LYG.* With more nuclear power plants being constructed over the last several years, spent fuel is increasing in China. In China, the ability to process spent fuel does not satisfy the demand for processing it. In order to solve this problem, one of the largest Nuclear Corporations in China, in cooperation with a nuclear operator in France, planned to establish a large commercial spent fuel recycling factory. In the plan, the French corporation was in charge of technology research, and the Nuclear Corporation in China was responsible for the siting of the future spent fuel recycling factory. In July 2016, the members of the Nuclear Corporation in China visited the city of LYG, which was announced on the website of the Nuclear Corporation. The announcement said, “the establishment of the large commercial spent fuel recycling factory can realize the sustainable development of nuclear power projects and promote the technical level of the civil nuclear industry.” Actually, at that time, this project was still in the first stage, and the city of LYG was just one possible site. However, the reports on the website were processed by We Media, and the spent fuel recycling factory was misunderstood to be a nuclear waste processing factory. After that, reports spread rapidly and became a hot topic on WeChat, Weibo, and other social platforms. Finally, the spread of this misinformation caused a public demonstration to protest the siting plan. In order to calm the angry LYG public, the local government published an announcement on their official Weibo account that “the people’s government of LYG decided to prevent the Nuclear Corporation from taking LYG as the siting of the commercial spent fuel recycling factory.”

Although the LYG government and the Nuclear Corporation compromised, giving up the siting not only wasted a large amount of money but also did nothing to alleviate anti-nuclear sentiments among the public. Table 2 shows the summary of above cases.

## 5. Legal Challenges of Public Involvement Have Been Exposed by the Cases above

Although there are relatively sound legislation and regulations, the three typical antinuclear cases above clearly demonstrate that there are still legal challenges about information disclosure and social involvement, especially during the siting and construction of civil nuclear facilities.

*5.1. The Lack of Information Disclosure and Public Involvement during the Siting of Nuclear Facilities.* Insufficient information and the preclusion of public participation can exacerbate the public’s nuclear phobia and antinuclear activities. Information disclosure and public involvement are important ways to alleviate nuclear phobia of the public. The *Environmental Protection Law*, *Environmental Influence Assessment Law*, *Construction Project Environmental Protection Management Regulation*, and other legislation and regulations all stipulate that after determining the site of facilities such as nuclear power plants, all information must be published, and public opinions need to be collected. Moreover, the *Law on Prevention and Control of Radioactive Pollution* stipulates that during the operation of nuclear facilities, the public can ask for information to be disclosed and even initiate a lawsuit if some of their rights cannot be realized. By Chapter Five of the Nuclear Safety Law, operators of nuclear facilities and relevant local governments are required to publicly disclose information regarding nuclear safety as part of their respective roles and responsibilities. “The nuclear site operators shall collect the opinions of relevant parties on key nuclear safety concerns involving social interests through questionnaire survey, hearing, discussion meeting, and symposium or by any other methods and submit feedback in a suitable form,” states Article 66. Thus, it is clear that information related to the construction, operation, and other activities of nuclear facilities must be disclosed to the public, and the public should be involved in these processes, including during decision-making. However, it is unclear whether the process of siting, which occurs just before determining the size of a nuclear facility, falls under Article 66, “major nuclear safety matters involving public interests.” In other words, do people have the right-to-know and right-to-participate before the site is determined? Should potential alternative sites be presented to the public? Should the public be involved during the siting period?

By current legislation and regulations in China, the siting process before determining the actual site does not seem to fall under “major nuclear safety matters involving public interests.” Therefore, during the siting process, relevant information need not be disclosed, and public involvement in decision-making is not required. However, in the case of “the siting of commercial spent fuel recycling factory was boycotted by LYG public,” the project was just in the preliminary siting phase of the recycling factory, so relevant departments only described the issue briefly in the news on the website of the Nuclear Corporation, and the LYG public had no way to obtain such information or become involved in the decision-making. Thus, their right-to-know and right-to-participate were restricted. In fact, at that time, the

TABLE 2: The summary of above cases.

<i>What happened</i>	<i>When</i>	<i>How</i>	<i>Result</i>	<i>Why</i>
<i>The siting of first-stage project of the PZ Nuclear Power Plant was boycotted by public</i>	2009	<i>People were fiercely boycotted the nuclear project</i>	<i>Project was suspended, and investment was wasted</i>	<i>Disclosed information and surveyed the public was inadequate</i>
<i>The project of a nuclear fuel factory was strongly opposed by public</i>	2013	<i>Public held a demonstration along the main street of the city a rally in front of the municipal government</i>	<i>Plan was abolished, and investment was wasted</i>	<i>Time for participate in the decision-making process was too short</i>
<i>The siting of a commercial spent fuel recycling factory was boycotted by public</i>	2016	<i>Public demonstration to protest the siting plan, the local government prevent the Nuclear Corporation from taking LYG as the siting</i>	<i>Siting was cancel and cannot alleviate public's antinuclear sentiments</i>	<i>Information disclosure channels and means were wrong, and the public were lack of knowledge of nuclear</i>

recycling factory was just at the siting stage, and it had not been determined whether LYG would be the site of the spent fuel recycling factory; therefore, based on the existing legislation, the local government and environmental protection departments were not obligated to publish information about the influence of the factory, which directly caused the event of “LYG public boycotted the siting plan of recycling factory” and postponed the whole project of the recycling factory in China. It is believed that if the people of LYG had received information about the siting of the future recycling factory through public official media and had been able to participate and express their views about it, they would not have protested the factory so violently, and the spent fuel recycling factory could have been constructed in LYG or other sites of China by now.

Taking the case of “The project of nuclear fuel factory was strongly opposed by the HS public” as another example, the local government and the operator of the nuclear facility did not publish any information for the public until they confirmed the siting in HS. Then, they only gave the public 10 days to become involved by expressing their opinions. “Ten days” was too short for the public to read all of the information about the nuclear fuel factory and participate in decision-making. As a result, the public was easily misled by incorrect information and became terrified about the nuclear fuel factory plan, which resulted in its cancellation of the nuclear fuel factory plan.

Therefore, the length of time for information disclosure and public involvement of Civil Nuclear Facilities in China is not long enough, and information disclosure and social involvement are difficult to realize during the siting process of nuclear facilities. This not only infringes on the public's right-to-know and right-to-participate and potentially exacerbates nuclear phobia, but it also hinders the development of the civil nuclear industry in the whole country since, in the above cases, large nuclear-related plans have been canceled just because the public could not obtain sufficient information and be involved in decision-making during the siting process.

**5.2. The Lack of a Relevant Compensation Mechanism for People Living Near Nuclear Facilities.** During siting and construction, people living near nuclear facilities can participate in two ways. On the one hand, the public can realize its right-

to-know and right-to-participate by focusing on scientificity and rationality during the siting and construction processes of nuclear facilities. On the other hand, the public can advocate for compensation during the siting and construction processes, as people are likely to worry about their health and financial interests. In other words, the public pays close attention to whether compensation from the siting and construction of nuclear facilities is sufficient and can satisfy their personal expectations. It was said that “an important failing of current practice in siting locally noxious facilities is the strategic problem which results from failure to pay compensation to neighbors who suffer costs (loss in property values or less measurable amenity costs) not covered by the law” [15]. Likewise, paying compensation is an effective method of realizing public involvement, because nuclear facilities constructed and operated nearby may influence the quality of life and the surrounding environment and cause real estate value to decline.

Article 31 of the *Environmental Protection Law* states that “the State establishes and improves eco-compensation system.” Based on this part of the legislation, if people living near nuclear facilities had been provided with enough economic compensation for the decreasing value of their real estate and other potential losses associated with the risks of nuclear facilities, the public's hostility towards nuclear facilities could have decreased, and people would have been more likely to accept the nearby construction of nuclear facilities. Once again, taking the case of “the siting of commercial spent fuel recycling factory was boycotted by LYG public” as an example, the regulations of *Temporary Measures for the Use and Management of the Spent Fuel Treatment and Disposal Fund for Nuclear Power Plants* and *Management Measures for the Spent Fuel Treatment and Disposal Fund for Nuclear Power Plants* in China state that the spent fuel processing fund can be used for the transportation, storage, further processing, and even retirement of spent fuel, as well as other outcomes of spent fuel reprocessing. However, *Measures* does not specify a portion of the fund that can be provided as financial compensation to people living in the area. Currently, there is no such public compensation mechanism for people living near civil nuclear facilities in China. Local governments and operators of nuclear facilities do not compensate individuals who may be influenced by the siting and construction of nuclear facilities.

Bestowing economic compensation according to the public's opinion would not only make the public accept the siting and construction of nuclear facilities but also benefit the nuclear industry itself. Paying compensation to the affected public is the result of realizing public involvement. However, at present, the public's opinion about requiring compensation is ignored, decreasing the value of public involvement to some extent. Therefore, the lack of a relevant compensation mechanism for people living near nuclear facilities is a key problem in China.

*5.3. The Lack of Public Education on Basic Nuclear Safety.* Even if all information is disclosed and transparent, the public's right-to-know cannot be effectively realized because of the lack of knowledge about the civil nuclear industry and nuclear safety, which limits public involvement during the siting, construction, and operation of civil nuclear facilities in China. The largest contributor to the public's nuclear phobia is the lack of knowledge of nuclear safety. One of two trends appears when the public only knows a little about nuclear safety. One is that the public ignores the danger of nuclear activities and overly trusts in the safety of nuclear facilities, so the construction of nuclear facilities is always encouraged, regardless of the actual influence. The other one is that the danger of nuclear facilities is exaggerated, and all types of nuclear facilities are boycotted by the public. Due to the lack of relevant knowledge or a misunderstanding of nuclear safety, the danger of nuclear facilities will be exaggerated, which causes tension between the public and nuclear projects and results in public opposition to the siting, construction, and operation of civil nuclear facilities.

Taking "the project of nuclear fuel factory was strongly opposed by the HS public" and "the siting of commercial spent fuel recycling factory was boycotted by the LYG public" as examples, the local governments and operators of nuclear facilities overlooked the importance of public education on nuclear safety, which caused people to lack relevant knowledge and to be easily misled by false information available on the Internet. In the era of the Internet, misinformation can spread rapidly on different We Media, which increases the fear that people have of nuclear facilities (nuclear fuel factory and spent fuel recycling factory). If the public in LYG had been effectively educated about spent fuel, they would not have been misled by misinformation and believed that spent fuel was a radioactive waste, which caused people to fear that spent fuel pollutes the surrounding environment and poses risks to their safety. The existing challenge in China is that regardless of education level, including master's and Ph.D. levels, people lack basic knowledge of nuclear safety and blindly boycott nuclear facilities.

Although the current legislation and regulations in China grant the public the right-to-know and provide ways to be involved in decision-making during the construction and operation of nuclear facilities, due to the lack of knowledge on nuclear safety, public involvement cannot be completely realized.

## 6. Paths Forward to Ensure Information Disclosure and Social Involvement

To meet the above challenges and ensure public involvement during the siting, construction, and operation of civil nuclear facilities in China, several recommendations are proposed below:

*6.1. Information Disclosure and Social Involvement Should be Realized and Protected as Early as the Siting Process of Civil Nuclear Facilities.* The Rio Declaration of 1992's Principle 10 states that it is best to address environmental concerns with the involvement of all concerned persons. The Convention on Access to Information, Public Participation in Decision-making, and Access to Justice in Environmental Matters (Aarhus Convention) of 1998 calls for a system that allows the public to request and receive environmental information from public authorities as well as a system that allows the public to participate in environmental decision-making in an informed manner. Environmental information also includes nuclear-related information, such as the location of nuclear facilities, and should be made available to the general public.

The International Atomic Energy Agency (IAEA) recommended that bodies involved in the development, use, and regulation of nuclear energy make available all pertinent information regarding how nuclear energy is being used, particularly concerning incidents and abnormal occurrences that could have an impact on public health, safety, and the environment. France is a good example of the effectiveness of such an approach. The French government communicates with the public during the siting process, which helps the public obtain information about planned nuclear facilities and participate as early as the siting of facilities. Thus, more than 70% of energy in France is nuclear power, and the people who live around nuclear facilities seldom complain about the siting, construction, and operation of the facilities, because all relevant information is open and transparent, and the public's opinions and questions are respected [16]. In Finland, numerous surveys and interviews are held during siting, and the public can receive the latest information about nuclear facilities and related environmental effects. In addition, the public in Finland can express their opinions freely, and great importance is attached to these opinions.

The *Nuclear Safety Culture Policy Announcement*, which was published in 2015, proposed that "By information disclosure, public involvement and public education, the public's right-to-know, right-to-participate, and right-to-supervise should be realized and protected; the decision makers should hear different opinions on different channels from the public on civil nuclear safety and development." This mechanism gives the public right-to-know and right-to-participate during different processes, including the siting, construction, operation, and even decommissioning of civil nuclear facilities. The earlier that people understand civil nuclear-related information and are involved in such activities as decision-making, the more easily they can accept nuclear facilities constructed in the area.

Therefore, the siting process, which occurs before determining the actual site, needs to be viewed as one of the “major nuclear safety matters involving public interests” in Article 66 of the *Nuclear Safety Law*. The public should have the right-to-know and right-to-participate as early as the siting process. Local governments, related governmental departments, and operators of nuclear facilities should communicate with the public, establish a communication mechanism, disclose relevant information, collect opinions from the public, and increase the democracy of decision-making as early as the siting process. In this way, the public should be rendered sufficient time to get all the information, become involved, and fully demonstrate their views.

*6.2. A Compensation Mechanism for People Living Near Nuclear Facilities Should Be Established.* Acceptance by the public is one of the great difficulties in the development of the civil nuclear industry and nuclear safety supervision. There are several reasons to compensate people living near nuclear facilities. For instance, nuclear facilities may harm the health of people nearby, and the value of the surrounding real estate may decrease because of the siting, construction, and operation of nuclear facilities. As a response, the law should protect people who live in the area, because they might be exposed to more risks. A preventive compensation mechanism means that the public can demand preventive compensation because they might be physically and financially influenced by nuclear facilities. Giving a certain amount of compensation to the public can alleviate their phobia of and resistance to civil nuclear facilities.

Thus, a preventive compensation mechanism should be established by designing compensation standards, processes, amounts, and channels for people living near nuclear facilities. More importantly, standards and assessments of the compensation should be released to the public during the siting process, which would promote the acceptance of civil nuclear facilities by the public living in the area. As a result, the public’s phobia and resistance to nuclear facilities’ siting, construction, and operation in nearby areas can be alleviated, and their physical and financial interests and right-to-know and right-to-participate can be protected by this kind of financial motivation.

*6.3. Great Significance Should Be Attached to Public Education on Basic Nuclear Safety.* Nuclear power is a form of clean energy, which has certainly been accepted in the professional field. However, the public lacks relevant knowledge, so high-quality public education on basic nuclear science is a good tool against nuclear resistance and phobia among the public. Public education on basic nuclear science, the popularization of nuclear safety culture, and the cultivation of the public’s informed view of nuclear safety are of great significance. Most developed countries focus on educating the public about basic nuclear science. For example, most nuclear facilities in Finland have a science museum that is open all day, so the public can visit these museums without any application. In America, professionals assist people who live around nuclear facilities to understand different professional standards and data on nuclear safety in

order to improve the rational judgment of the public and alleviate their nuclear phobia [17]. Local governments in France teach people living near nuclear facilities the basic science of nuclear safety and radiation protection. The operators of nuclear facilities in France offer such public education on basic nuclear science through the Internet and other modern technologies to promote information transparency and public involvement. Overall, public education on basic nuclear science is as important as disclosing information and public involvement.

In China, according to Article 67 of the *Nuclear Safety Law*, “the operators of civil nuclear facilities should take the following measures to conduct nuclear safety science education: (1) Opening the nuclear facility to the public in an orderly manner on the premise of ensuring the safety; (2) Cooperating with educational organizations to conduct nuclear safety science education for students; (3) Establishing nuclear safety science education centers, printing and issuing pertaining materials; (4) Other measures provided for by the laws and administrative regulations.” Moreover, the *Law on Prevention and Control of Radioactive Pollution* states that “local governments shall organize propaganda nuclear safety activities, make the public know about related science knowledge.” However, what can the operators of nuclear facilities and local governments do specifically about public education on basic nuclear science?

Establishing long-term campaigns and public education on basic nuclear science needs to occur at the right time, with the right content and in the right form. Public education on basic nuclear science should be executed as early as possible throughout the siting, construction, operation, and even decommission of civil nuclear facilities. The content of the public education on basic nuclear science should be objective and cover all questions that the public may ask, including basic knowledge, nuclear industry attributes, environmental protection, and nuclear safety management. The forms of public education can be classified into a “one-way form” and “interactive form.” The “one-way form” includes providing science manuals, books, animation, web pages, and other instructive materials about the civil nuclear industry and nuclear safety for the public, and the public can learn basic knowledge of nuclear science through both traditional media and new media such as WeChat and Weibo. The “interactive form” can give the public a greater sense of involvement than the “one-way form.” Examples of interactive education include holding face-to-face interviews and video communication in communities and schools between the public and professionals from operators of nuclear facilities; inviting the public to visit civil nuclear facilities; and holding nuclear safety knowledge contests. Media should play a significant role in public education. Thus, it is important to strengthen the neutrality and promote the authority and reliability of both traditional media and new media in providing public education on basic nuclear science with the aim of alleviating the public’s nuclear resistance and phobia.

Once receiving sufficient education on nuclear safety and knowing more about the civil nuclear industry, the operation principles of nuclear facilities and related protection



measures, the public will truly enjoy its right-to-know and can be better involved in relevant activities during the siting, construction, operation, and even decommission of civil nuclear facilities. Moreover, events such as resisting and boycotting civil facilities will become rarer and may be eliminated one day in the future.

## 7. Conclusion

China's civil nuclear industry has been developing rapidly in recent years. Meanwhile, more concern is arising about the realization of information disclosure and social involvement. Information disclosure is the basis of social involvement. The *Nuclear Safety Law* and other related legislation and regulations, such as *Measures for Disclosure of Nuclear Safety Information*, stipulate the guarantee of social involvement in nuclear safety issues. However, as demonstrated in past anti-nuclear cases, the public remains unable to completely realize its right-to-know and right-to-participate, and operators of nuclear facilities and local governments do not propose compensation mechanisms for people living near nuclear facilities. Moreover, the lack of public education on basic nuclear science influences the realization of information disclosure and transparency and social involvement.

This paper proposes several remedies. Firstly, the public's right-to-know and social involvement should also be realized and protected during the siting of nuclear facilities. Only in this way can the public obtain information and be involved in pertinent decision-making during the siting process. Secondly, a preventive compensation mechanism should be established for people living near nuclear facilities in order to satisfy the public's compensation demands for their potential physical and financial losses. Thirdly, great importance should be attached to public education on basic nuclear science, which will eliminate nuclear phobia of people and help them truly realize their right-to-know and right-to-participate. Even though all the suggestions have strong feasibility themselves under today's circumstances in China, it is not easy to judge the effectiveness of these suggestions until they are fully practiced. It is the biggest problem of existing works in this paper.

As information disclosure and public involvement are of great significance for the development of the civil nuclear industry in China and all over the world, the study of this topic will not end after this paper. In the nearest future, this issue will be mainly about the nuclear accident at the Fukushima Daiichi Nuclear Power Plant of TEPCO, its compensation, and legislation renewal, whose influence on public acceptance of civil nuclear power plants is quite strong and cannot be ignored today in China.

## Data Availability

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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