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**What are the determinants for local
communities' acceptance and disbeliefs of
interim nuclear waste storage?**

**The case of high-level nuclear waste in the
neighbourhood of NPP1 and NPP2 in Taiwan**

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List of Acronyms

DPP	Democratic Progressive Party (民主進步黨)
KMT	Kuomintang (中國國民黨)
NPP	Nuclear power plant

Abstract

The concept of risk society argued by Ulrich Beck implies science and technology are not undoubtedly objective and certain since a series of new forms of environmental crisis with the typicality of Chernobyl catastrophe disclosed the political and economic interest behind them. Nowadays the entire society is under overwhelming and uncontrollable scientific and technological errors. Various sectors in the society started to interpret science in their contexts and science needs to reconstruct its essence to be socially robust encountering with numerous doubts and distrusters. Nuclear power and waste issues have been experiencing social opposition internationally, and Taiwan, the country recognised as the most dangerous location of nuclear risk, particularly has to abolish the conventional policy mechanism of considering social opposition as irrational deeds by lay-public. It is vital to unravel the determinants for public acceptance and disbeliefs of high-level nuclear waste storage in the neighbourhood of NPP1 and NPP2 as the proposal to mitigate the social conflicts in waste management.

Qualitative interviews and secondary data collection were conducted attempting to construct a coherent storyline in the case of NPP1 and NPP2 with retrospect of historical nuclear power and waste development. The selected case here has its index significance that it is the first time of initial local uptake of nuclear waste in Taiwan's history of social conflicts over nuclear issues. The research approach is distinct from mainstream risk perception analysis which emphasises quantitative and psychometric models. This paper recognised the importance of contextualising active role of local lay people when interacting with scientific risk and historical background.

Analysis and results presented the relevant determinants and the detailed contexts behind them. The local memory of tsunami, the constant discovery of deformed fish associated with nuclear incidents, long-term failure of low-level nuclear waste disposal, issue of public and democratic participation, issue of compensation were factors causing the local disbeliefs. Sub-politics in cooperation with international environmental movements and political ideology could lead to the initial but vulnerable consensus on nearby high-level nuclear waste interim storage with the government.

Keywords

Risk society, scientific risk, technology, risk perception, nuclear waste, nuclear power

Chapter 1

Introduction

The aftermath of Chernobyl catastrophe in 1986 triggered the new academic field identifying the characteristics of science uncertainty. Beck's theory of risk society argued the outcome of uncertain scientific risks could be overwhelming and unimaginable, and transcend geological and social barriers. Indeed, science and scientific expertise could no longer be absolutely objective, and many times it is discovered that the scientific and political institutions behind which have established the exclusive science and technology decision-making and been out of robust monitoring can lead to 'organised irresponsibility.' The tremendous errors and catastrophes are inescapable, thus most of the social sectors need to cope with this era of science whose systematic errors are not under control and each social sector can conceive science differently according to its contexts. Science and technology nowadays need to be able to respond the active and challenging perspectives which generate more doubts and questions from these various sectors to persist their legitimacy composed of 'consensibility' and 'consensuality' indicated by Nowotny et. al. (2001: 174) Beck then suggested that the emergence of 'sub-politics' among the non-expertise form rational debates to change the existent harmful political and scientific institutions.

This catastrophe meanwhile broke through the geological barrier between European and Asian societies and had its impacts in Taiwan, which firstly started nuclear power in 1971, and until now there are three nuclear power plants in operation. The NPPs in the country have been internationally identified the most dangerous ones in the world. Butler (2011) in *Nature* concluded "Taiwan's 1,933-megawatt Kuosheng plant (國聖核能發電廠; i.e. NPP2) with 5.5 million people within a 30-kilometre radius and the 1,208-megawatt Chinshan plant (金山核能發電廠; i.e. NPP1) with 4.7 million; both zones include the capital city of Taipei. The findings of *Nature's* population analysis are 'scary', says Ed Lyman, a nuclear expert with the Union of Concerned Scientists in Washington DC." At the beginning of nuclear power development, the interpretation of its absolute benefits for the overall and rapid economic growth and unquestionably safe technology was prevalent. This steady myth was challenged by Chernobyl incident after some scholars reflected the situation in Taiwan and revealed the economic interest confluence between Kuomintang (中國國民黨; KMT), the only ruling party enforcing the dictatorship during the construction of nuclear power plants in Taiwan, and nuclear power expertise. Various debates questioning nuclear power transferred into different views among the lay-public, and the issue has become the most long-term and widespread environmental and scientific controversy in Taiwan.

After almost four decades of nuclear power development, nowadays the problems of nuclear waste management are becoming highly critical in Taiwan due to the fact that not only the amount of low-level¹ and high-level waste² are increasing, but also the whole contents of the plants will be waste once operation licenses end in 2018 and 2021 respectively. The pressure of waste management is even harsher as the abolition of the plants is very likely before the original due dates resulting from the nearly full high-level spent fuels on site. Facing with the challenges, the governmental solutions are mostly followed by the institutions of nuclear waste storage³, disposal⁴ and management policies whose facets are overly inclined to technical and scientific decisions regardless of the importance of lay-public that can construct social opposition and deteriorate the anticipation of successful nuclear waste management. This inherits the notion that scientific expertise is the only reliability for policy formulation whereas lay people are irrational.

This research paper selects the case of high-level nuclear waste interim storage from and NPP2 in Taiwan recognising that it is the first time in Taiwan's history of anti-nuclear controversy the local people could attain the initial consensus with the government on the nearby waste storage, although the consensus is still surrounded by many local doubts and hesitation. Hence, the research tends to analyse what the determinants for local communities' acceptance and disbeliefs of interim nuclear waste storage are? The theoretical framework stemming from Beck's risk society will be introduced, and related literature reviews will be explained with the suggestion that the approach be different from the predominant psychometric one which usually shapes the social anxiety as if it is passive to science and technology facing with scientific risks. It will put more focus on the active characteristics of lay people and how they interpret the science of nuclear waste management in their contexts.

After the background introduction of Taiwan's nuclear power and waste development, it will indicate the methodology is composed of secondary data

¹ According to US Nuclear Regulatory Commission (2017), "low-level waste includes items that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation....The radioactivity can range from just above background levels found in nature to very highly radioactive in certain cases such as parts from inside the reactor vessel in a nuclear power plant."

² According to US Nuclear Regulatory Commission (2017), "high-level radioactive wastes are the highly radioactive materials produced as a by-product of the reactions that occur inside nuclear reactors. High-level wastes take one of two forms: spent (used) reactor fuel when it is accepted for disposal; waste materials remaining after spent fuel is reprocessed."

³ Nuclear waste storage has two meanings, which are the storage where spent nuclear fuels need be stored in specially designed pools at individual reactor sites, and dry cask storage placing spent fuels at reactor sites or away from reactor sites. Dry storage is recognised safer than in the pools and has been internationally designed as the interim solution before final disposal.

⁴ According to Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility (Atomic Energy Council, Government of Taiwan 2006), nuclear waste final disposal means "permanent isolation treatment of radioactive waste."

collection and qualitative interviews, with the purpose of constructing coherent storyline to address the most relevant factors and events. Following the author's background knowledge of nuclear development and previous personal connection with knowledgeable informants, qualitative interviews on key informants are conducted. Due to the experiences and perspectives by environmental groups emphasising on the legal and administrative approaches should be distinguished from the general local perspectives, this research paper attempts to properly evaluate whether the contents of interviews can be generalised in local communities rather than the ones used by activists to call for mobilisation. All of the interviews started with the interviewees' personal anti-nuclear experiences and gradually extended to their understanding and observation of broader local contexts to further ensure that the concluded risk perception is constant with the general condition in the local communities.

Indeed, several determinants for local disbeliefs are found. The local memory of big tsunami reaching the altitude of 20 meters 100 years ago was triggered by the fear of Fukushima incident, but the waste storage of NPP2 was designed to protect from tsunami with 12-meter altitude. The constant emergence of deformed fish for more than 20 years has led to penetrative risk perception of radiation especially when fishery is one of the most important local daily economies. The long-term governmental failure of low-level nuclear waste disposal and lack of public participation have caused general local feeling of being powerless and hopeless with nuclear infliction. Contrary to the arbitrary notion that compensation can make local people accept unwelcome facilities, higher compensation in this case may not be the solution. The recent acceptance of nuclear waste storage is found to be caused by the trust on independent foreign scientists and Democratic Progressive Party (DPP; 民主進步黨), the main counterparty of KMT with pro-nuclear ideology. To be concluded, the local lay people are actively seeking for the other new form of modern science away from 'organised irresponsibility'. They relate modern science to not only local knowledge and experiences but also scientific expertise that could prove his or her impartiality. In addition to the networking where local activists are more involved to work on potential safer solution to waste storage through scientific basis, the political ideology may still be an inexorable factor in Taiwan, a newly democratised country. Hence there is still discrepancy between Taiwan's context and the sub-politics proposed by Beck. Lastly, new questions, limitations and proposals for the future research will be suggested.

Chapter 2

Problem Statement

2.1 Nuclear technology and waste and their implication for the ‘risk society’

The concept of ‘risk society’ proposed by Ulrich Beck provides us with the new era containing the challenging implication for the society by science and technology within which the Chernobyl accident, as Irwin explained (2001: 52), “added particular significance and typicality.” Beck argued that environmental crisis such as Chernobyl incident represents the breakdown of science monopoly as scientific experts who should be reliable can no longer be convincing, and experts own distinct statements if they are from different organisations. The simple truth cannot be found. The new environmental crisis creates not only the intelligence crisis but also uncertainty and risks which should be recognised through the broader socio-structural changes, especially when crisis like Chernobyl accident that “the worst-case scenario is possible and real, and that the probabilistic safety is deceptive...the amateurish mélange of state and technological authority has given way to a near-perfect procedure. A flexible implementation of maximum pollution levels; compensation; a technically oriented legal procedure which downplays the hazards; the administrative blockades of overzealous abolitionist policies; systematically celebrated symbolic detoxification in the mass media; data centralisation – all these mean that the much-lamented ‘worst database scenario’ has ultimately proved to be a highly successful policy of absorption. ” (Beck 1995: 63) Beck therefore used the term “organised irresponsibility” to define this complicity structure as the culprit.

In risk society, the prevalent scientific tools implement reductive and quantitative ‘magnitude’ and ‘likelihood’ methods in risk assessment to address environmental issues indeed can contain uncertainty and ambiguity. It occurs in the case of not only nuclear power plants but also a series of new environmental crisis which embodies the large scale of scientific uncertainty such as nuclear waste management. Hansson et. al. (2015: 57) recognised that the lifespan standard of nuclear waste disposal design is more than 3,000 years, and it is not possible to estimate the risk probability of nuclear leakage in 3,000 years. They thus concluded that the setting of time horizon and discount rates can easily be manipulated with certain political bias, and the feature of endless cost increase deprives of its accuracy. Even though the design of interim storage of high-level nuclear spent fuels is from forty to fifty years, it is still inevitably linked to the following management of final disposal. Stirling (2003: 8) interpreted that “the irony then, is that this ‘impossibility’ finding itself (in these terms) a ‘sound scientific’ result. Aspirations (still more, claims) to ‘science based’ prescriptions on risk are not just unrealistic. In a plural society, they are fundamental contradiction in terms.” In this sense, nuclear waste conforms to the predicament explained by Stirling (2003: 12) that even the assumptions own all possibilities exhaustively, they are still difficult to justify in the face of the issues like global warming, novel chemicals or genetically modified organisms, and “the random variability assumed by standard error deter-

minations is often overwhelmed by non-random influences and systematic errors.”

Beck (1992: 160) pointed out “the revelation of the risks of previous modernisation necessarily stirs up the hornets’ nest of competitive relations between the scientific professions, and arouses all the impulses to resistance that a scientific profession will have built up over generations with all of its powers (including its scientific ones) against ‘expansionist encroachment’ on its own ‘pet problems’ and on its carefully installed ‘pipeline of research funding.’” Despite of the organised irresponsibility, the reason why environmental issues become public agendas is not resulted from this complicity but “through the efforts of diverse and splintered groups such as environmental coalitions, campaigning groups and local networks.” (Irwin 2001: 60) Nowotny et. al. (2001: 166) further argued that the reliability which is essential to the definition of science is not stable, and it is more important to move “from reliable knowledge to socially robust knowledge”. They (2001:174)acknowledged that “in the context of the development of Mode-2 (the growth of complexity and uncertainty in society) knowledge production, with its shift from a discipline to a problem focus....in principle, additional criteria have to be considered in addition to traditional scientific excellence, even if it continues to be a predominant element in the quality control system...so it is essential to consider how a shift to Mode-2 knowledge production, to greater emphasis on problem-relevance and on the specific contexts of application in which this relevance arises, affects the formation of consensibility and consensuality.” The binary between the rational scientific risk assessment approach and irrational lay people must be contested considering that a lot of cases lay people may have more experiences prior to the risk assessment and be active interpreting science. It is necessary to introduce other approaches to avoid the deficits by the over-determined quantitative methodology and rebuild the consensibility and consensuality of science involving lay people when managing nuclear waste predicaments.

Beck’s observation of public scientisation which he defined as sub-politics constituted of diverse groups such as environmental coalitions and local networks could be more intricate and different from his argument in the non-Western societies where may be still under authoritarian powers , gradually continuing democratisation or recently democratised. Irwin (2001: 94) noticed in Beck’s arguments that the significance of possible complexity is not sufficiently addressed when the public perceive the new form of environmental risks, and he emphasised the “significant social differences as well as similarities within public reconstructions of environmental matters.” He (1995: 40) offered the example of nuclear power to clarify the opposition to it may be due to the vast distrust on the centralised and large-scale technology which is considered as the source of tremendous quantifiable risk, but this opposition is equally owing to the reflection of wider social, moral and ethical preferences.

2.2 The impasse of nuclear waste management caused by social conflicts and the new development of involving lay people in the international contexts

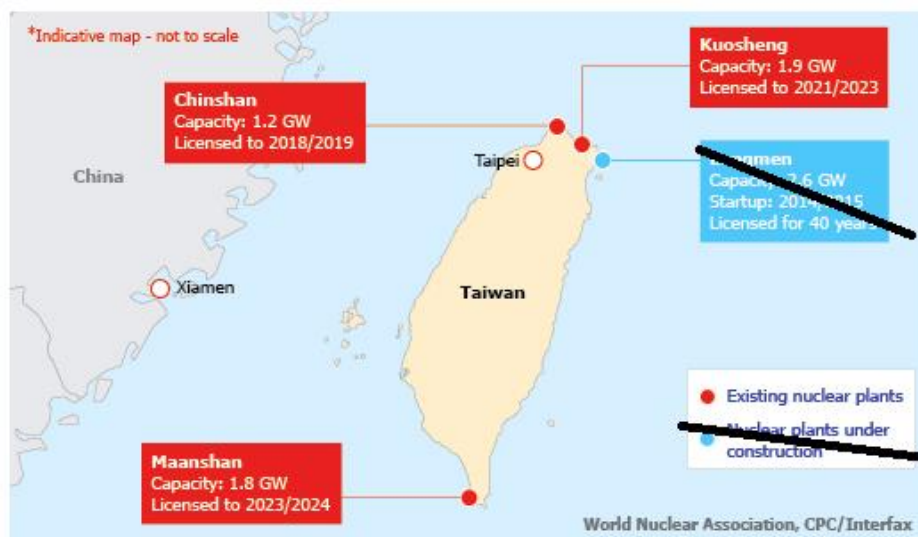
Nuclear technology has been confronting with uncertainty and risks and generated countless social conflicts in many countries. The safety requirement many times has been prioritised when the governments decide the waste repository siting; however, the exclusive scientist-based decision-making ignores the risk perception in the society which is inexorable due to the inherent characteristics of nuclear waste that its economic, social and environmental cost does not have general standards of calculation, and the outcome of nuclear waste management is not foreseen among the present generation. Some countries facing with nuclear waste stalemates have recognised the expensive social cost. For instance, OECD Nuclear Energy Agency (1999: 69) indicated that “public acceptance and political decisions are the major factors which may significantly affect the disposal cost”, and “information provided by Germany (Konrad) and Switzerland demonstrate how socio-political factors significantly increase the planning and construction costs.”

Several countries have been pursuing solutions to the tremendous social cost. Callon (in Anshelm and Galis 2009: 271) observed that the separation between experts in the confined worlds which include laboratories, scientific committees, etc. and lay people is more unacceptable when techno-science becomes the more significant key factor in the Western societies. He argued that “previously excluded group strove to make the abovementioned separations progressively more illegitimate. Lay people refused experts’ monopoly on knowledge production and sought to intervene in research processes and technological development.” They (2009: 270) identified that Sweden is the country mostly dedicated to the problem of long-term storage of spent nuclear fuel, and “the Swedish approach was acknowledged as one of the most ambitious, technologically advanced and trustworthy suggestions for final storage.” However, its vanguard and advancement cannot be considered only by the technological perspectives regardless of its long history of difficult confrontation with the public opposition. The continuous intervention of lay people finally made the waste management issue become public agendas and the inclusion of lay knowledge plays a significant role in the shift from the traditional decision-making which is lean on experts in the confined world. According to Anshelm and Galis (2009: 273, 276), the Swedish experience showed that from 1970s local lay people started to refer to statements by the Nobel Prize recipient Hannes Alfvén who warned the mass production of nuclear waste would jeopardise the earth and humanity based on his physics profession. Later on the issue was concentrated in whether the experts including geologists, engineers and radiation experts from various fields and associated with local movements could obtain the space for discussion over alternatives management with nuclear industry, and whether the private company owned by nuclear energy industry would take its responsibility for waste management. They (2009: 272) moreover explained the decision-making was the process that the controversies of techno-science such as nuclear waste are “continually configured and reconfigured” and “recurrently done and enacted”. When the controversy is placed in the public sphere, “the translation of techno-science matters of concern enact and are enacted by arguments (articles in newspapers), practices (methods for managing and storing nuclear waste), organisations (SKB, anti-nuclear groups), the content of the controversy, expert hegemony and the involvement of lay people in technology development.”

2.3 The local opposition and exclusion of lay people in the nuclear waste management in Taiwan

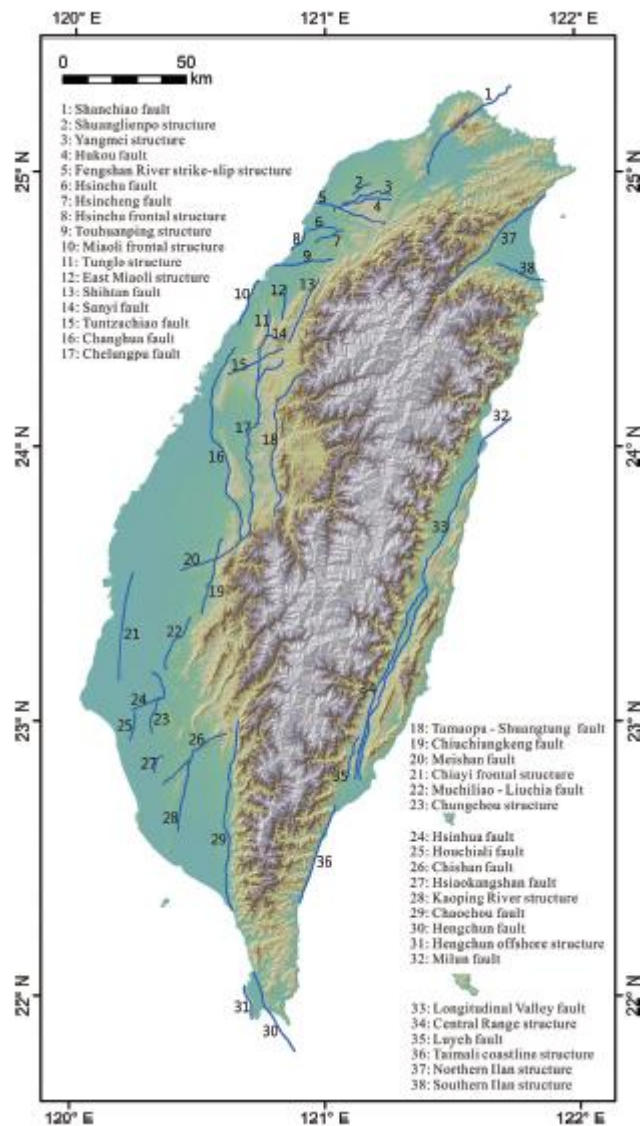
According to Taiwan's Central Geological Survey (2017), there are 33 active faults in this small island, and it is widely conceived that Taiwan is one of the countries with the most density of active faults and earthquake frequency. Hence, the difficulties of safe storage in Taiwan are more tremendous than all of the countries with nuclear waste, and even worse than Japan, the nearby country with extraordinarily high density of faults and earthquake but much larger territory. Especially after Fukushima incident in 2011, people in Taiwan started to own higher risk perception of nuclear power plants and waste, and largely decreased the confidence that Taiwan is able to discover safe repository sites for nuclear waste. Liang and Ho (in Liang 2014: 57) found 56.0% of people in Taiwan were opposed to nuclear power in 2012 compared with 46.8% in 2011; and 57.5% of people distrusted on the safety of nuclear power in 2012 compared with 54.3% in 2011. Furthermore, the general risk perception of the waste in the country should be inevitably higher as the waste is highly unwanted. Thus, the vast social protest stalled the construction of NPP 4 in Taiwan which has been enduring controversy for more than thirty years. The local communities which confront with nuclear waste repository also experience with strong opposition. The most important case is the low-level waste storage in Orchid Island (蘭嶼) which started to be in operation in 1982. This small island aside from Taiwan is the location of indigenous tribe Dawu (達悟), and the local indigenous people initiated the protest urging the removal of low-level nuclear waste mostly produced in NPP1 and NPP2 in 1988.

Map 1: Map of nuclear power plants in Taiwan



(In Museum of the City, n.d.)

Map 2: Map of major seismogenic structures in Taiwan



(Shyu et. al. 2015: 315)

However, Taiwan's authority has not offer the comprehensive formal institution with the inclusion mechanism of lay people. There is only one legal article related to the public participation in the nuclear waste regulation and it was amended in 2006 in Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility (Atomic Energy Council, Government of Taiwan 2006) whose article 11 indicates that "for a recommended candidate site determined under Article 9 or Article 10 of this Act, a local referendum shall be held in the county (city) in which the site is located within 30 days after the end of the period of public announcement, without being limited by the provision of Article 2 of the Referendum Act. With the consent of the public through referendum, the site may be listed as a candidate site." Even with this article, Huang et.al (2013: 1564) concluded that the local residents of the selected sites found the participation process contained " (1) direct discrimination and coercive exclusion from decision-making; (2) the absence of opportunities for participation in decision-making and the asymmetry of power between the people and Taiwan Power Company/government; (3) lack of in-

formation from Taiwan Power Company/government and their attempts at deliberate obfuscation; (4) Taiwan Power Company and the government's failure to pay any attention to local knowledge; (5) mistrust of Taiwan power and the government; (6) the lack of recognition shown to indigenous communities. In fact the referendum can hardly take place since local governments usually lead the protest against being selected as the disposal sites which can take over the low-level waste in Orchid Island.

According to the current laws and regulations regarding the repository siting of nuclear waste in Taiwan, it is notable that the scientific aspects are prioritised with attempt to ensure the safety of the waste location and management. Unfortunately, the social conflicts and protests are historically labelled as irrational lay people's reaction to scientific knowledge interpreted by the experts participating in the nuclear waste management. For instance, the Article 5 of the Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility says that:

"The site selection group referred to in the preceding paragraph shall consist of 17 to 21 members assumed by representatives from relevant government agencies, experts and scholars, among which the experts and scholars must be no less than 3/5 of the total members." (Atomic Energy Council, Government of Taiwan 2006)

2.4 Unravelling the determinants for local acceptance and disbeliefs of high-level nuclear waste storage as the proposal to mitigate the conflicts in waste management in Taiwan

Taiwan firstly started its nuclear power operation in 1979, and until now there are three nuclear power plants in operation. After almost 40 years of nuclear power, the country has been confronting with the frequent and long-term local opposition to the nuclear waste. The case of NPP1 and NPP2 is the first time in Taiwan's history of nuclear waste predicament that local communities reached the initial agreement on the nearby high-level radioactive waste storage with the government, under the situation that high-level radioactive spent fuel pools are about to be full very soon and are in urgent need for interim dry storage which can last approximately forty years. This first-time consensus between the local communities and government is the index case and it is vital to understand the origins of the phenomenon. Wexler (in Kuppler 2012: 106) argued that the inherent traits of nuclear waste policies, that is, "no clear boundaries and no clear information, no agreement on responsibilities, no other cases to learn from, and stakeholders with the views of their own", and Kuppler (2012: 106) concluded that the fully social agreement on its policies can never be expected. Dryzek and Niemeyer (in Kuppler 2012: 106) further indicated that "the meta-consensus can theoretically include the recognition of the legitimacy of disputed values, the acceptance of credibility of disputed beliefs and the agreement on the nature of disputed choices." The initial consensus on the interim waste storage of NPP1 and NPP2 is fragile and still surrounded by more local hesitation and disbeliefs, and this research paper tends to unravel the determinants for local acceptance of high-level nuclear waste storage,

meanwhile eliciting the factors which generate the local disbeliefs as the proposal to mitigate the conflicts in waste management in Taiwan.

In addition, rather than thoroughly adopting Beck's view that sub-politics can function as a new political culture that encourages the broad activation of citizens to change the power relations in a society, and achieves a real democratisation, it is worth contemplating whether the case of Taiwan which is a newly transformed democratic society can subsequently be applicable. Mythen (2004: 173) indicated that "Beck is justified in identifying a widening trend of activity outside the formal democratic system, but the transformative power of sub-political activities remains to be seen." And it should be acknowledged that in the context of Taiwan, nuclear power issue has long been entangled with the intricate conflicts between the previous ruling party KMT and the current ruling party DPP. KMT enforced dictatorship when the nuclear power plants were under construction and the initial stage of operation until 1986 and for the first time lost its political power both in the presidential and parliamentary election in 2016; while DPP which was the biggest counterparty of KMT launched the discourse that 'anti-nuclear is anti-authoritarian government' and has been holding the 'nuclear-free country' slogan in its party charter since 1986.

After addressing the introduction of risk society theory and problem statement in this chapter, the following theoretical framework will focus on more detailed methodologies practiced in international and Taiwan's contexts.

Chapter 3

Theoretical Framework

3.1 The summary of literature review in international contexts

In order to analyse risk perception, Beck (1995: 162) recognised that hazards need scientifically objective methodology to be perceivable in the society, but “it is equally correct to say that hazards always remain dependent on standards of tolerance which can vary from culture to culture, from group to group, indeed from one day to the next.” However, Harrington and Elliot (2015: 284) found that when the public risk perception of the emerging environmental issues such as nuclear power and nuclear waste, “much attention has been paid to hazard characteristics as a determinant of risk perceptions, relatively less has been paid to the socio-cultural influences that comprise the various places where risk is experienced.” The paradigm which is more commonly employed is based on the field of psychology, and Harrington and Elliot (2015: 285) defined it as the ‘psychometric paradigm’ which focuses on “the individual demographic and cognitive characteristics that determine perceived risk.” The typicality is represented by Slovic. He (1993: 677-678) conducted the survey to rate the level of correspondents’ perceived risk under the acknowledgement of 45 hypothetical news events regarding the management of large nuclear power plants in their communities, and found several events can largely increase people’s distrust on large nuclear power plants, such as the records of the plants were falsified, employees were drunk on the job, a potential safety problem was covered up, etc. The model is rooted in the preposition of anticipating the hazards of radioactive leakage catastrophes, and can be applicable for the nuclear waste storage.

However, the psychometric paradigm embodies “focus upon the subject as an unemotional rational actor.” (Mythen 2004: 104). Other paradigms attempt to enforce the social, economic, political and cultural factors in order to contextualise different local communities which contain various social and cultural prepositions. For instance, Sjöbergs (in Harrington and Elliot 2015: 285) used the Swedish population to analyse how people rate nuclear risks, and concluded that “psychometric measures of risk may explain up to 20 per cent of the variation in risk perception, while cultural theories explain about 5-10 per cent.” The Not In My Back Yard theory (NIMBYism) is perhaps the most commonly identified by the decision makers and the public. Dear (in Devine-Wright 2009: 430) put the definition of NIMBYism that “residents who want to protect their turf. More formally, NIMBY refers to the protectionist attitudes of and oppositional tactics adopted by community groups facing an unwelcome development in their neighbourhood...residents usually concede that these ‘noxious’ facilities are necessary, but not near their homes.” This succinct explanation for local opposition has been challenged through various researches which disapprove the space determinism, and “some local people actually prefer development to take place in their locality in comparison to other regions.”(Devine-Wright 2009: 431)

In the case of nuclear waste, it is difficult to be considered as the necessary facility with the benefits for certain groups of people in the public sphere, and the observed local preference may not occur as what was argued by the rebuttal against NIMBYism. But the factor of the proximity cannot be totally deprived and ignored, and more delicate analysis on other factors should also be made. Devine-Wright (2009: 434) further deepened the concepts of place attachment; he clarified that both unjust process of decision-making and the negative outcomes of development can significantly affect residents' place attachment that the facilities would bring negative and immediate changes on their lands. This can be composed of three local interpretations: the stigmatisation of a place, threat on place-related continuity, and threat on the place-related self-efficacy if the decision-making process is believed to be "exclusive, secretive or inequitable."

Harrington and Elliot (2015: 285) analysed the cultural theory paradigm of risk perception when it comes to the condition that particular groups sustain and strengthen their social relations and values confronting the facilities, or different cultural biases, such as fatalism, hierarchical, individualism and egalitarianism, may hold different levels of risk perception of nuclear power. They (2015: 287) proposed that risk perception outcomes are mediated by general risk attitudes, trust and coping, and the sociocultural, political, economic and physical environment are the overall contexts surrounding the local people. Also, Kaspersen et. al. (in Harrington and Elliot 2015: 286) explained social amplification of risk framework paradigm that the "informational processes, institutional structures, social group behaviours, and individual responses shape the social experience of risk".

Huang (2014: 13-14) summarised the international researches from different continents on the determinants for local acceptance low-level nuclear waste, such as Chung and Kim (2009) found local perception of economic benefits, risk perception, trust and perception of competition are the determinants for the local acceptance of nuclear waste storage residents in Gyeongju, South Korea. Sjöbergs (2004) analysed that the attitudes toward nuclear power is one of the determinants for local acceptance of nuclear waste facilities, and the perception of high-level nuclear waste and trust are both the other determinants under the conditions that the local municipalities are able to provide with sufficient information and the arguments in the contents of public communication are logical in the four cities in Sweden. He further conducted the other similar research on Swedish population in 2009 and concluded that the trust on knowledge and the scale of negative outcomes significantly influence people's acceptance of nuclear waste. In the region of the US and Canada, Huang (ibid.) addressed some examples, such as Krannich and Albrecht (1995) found health and safety hazards, trust on the authorities, expected benefits for local residents and the concerns over environmental pollution are the factors influencing local acceptance of nuclear waste in rural areas in Nevada and Nebraska; Jenkins-Smith et al.(2011) found demographic variables, geographic familiarity, political ideology, political fractions and policy-making process are the determinants, and interestingly the residents who own the highest level of acceptance live nearest to nuclear waste storage in southern New Mexico; Hine et al.(1997) concluded that the trust on the authorities, the confidence of technology and expected cost are the factors in four local communities in northern Shield in Canada.

3.2 The summary of literature review in Taiwan

The research on Taiwan's local residents risk perception and acceptance of nuclear waste is concentrated in low-level nuclear waste, which has been temporarily stored in Orchid Island and now is under the policy decision that it will be moved to Daren Township (達仁鄉) in Taitung County (台東縣) and Wuchiu County (烏坵鄉) in Kinmen County (金門縣). Huang (2014: 9-12) summarised the related research made by Hsiao and Huang (2006), Tang (2009) and Huang (2010). The case study conducted by Hsiao and Huang focused on more than two third of the households in Wuchiu and concluded that trust and fairness are the important factors influencing the local acceptance among the variables of socio-economic factors, decision-making process, trust, fairness, the necessity of facility, social pressure, local sense of responsibility and risk perception on facility. Tang emphasised the local political contexts to investigate whether they affect local perception on nuclear waste facility, and concluded the source of information matters, meanwhile proposing for increasing the compensation to facilitate local acceptance. Huang argued that the local risk communication to establish trust on authorities can be the solution to risk perception. He therefore identified several determinants in the Taiwanese context, which are "trust (on the government overall, administration, management capacity), risk perception, process (just, fair, open, transparent, participatory) and the effects of compensation for individual economic benefits." He proposed for the methodology of structural equation modelling with the assumption that "local acceptance is affected by risk perception and trust on government, risk perception and expected benefits are influenced by trust on government, and expected benefits are taken into account of risk perception." The factors are defined with the detailed composition that the trust on government is divided into whether most of governmental deeds are right, whether government pursues for maximum benefits for all, and whether the policies can attain their original goals; the expected benefits are divided into whether the final disposal is beneficial for all, whether the compensation is beneficial for local communities and whether part of the compensation will be provided directly to the residents; the risk perception is divided into whether the nuclear leakage will cause environmental risk, whether nuclear leakage will cause health risk and whether final disposal will stigmatise local image; and finally the acceptance is divided into whether the interviewee agrees the final disposal placing in his or her county or township. The conclusion was "the higher the trust on government and expected benefits are, the lower the risk perception is and the higher acceptance is; but the acceptance is mostly influenced by risk perception, and the expected benefits are more significantly influential on risk perception than trust on government."

Regarding the research on NPP1 and NPP2 whose high-level nuclear waste is the topic of this essay, the most important research was made by Hung and Wang (2011: 668) on NPP2 "by using a novel methodology that incorporates a comprehensive risk perception (CRP) model into ethnographic approach called risk perception mapping (RPM)." The determinants of local nuclear power risk perceptions were firstly examined and then integrated with PRM to explain the spatial factors of risk perception. "The findings demonstrated that the respondents regard the nuclear power plant as an extremely high-risk facility, causing them to oppose the NPP2 and reject the compensation to accept its continuing operation. Results also indicated that perception

of nuclear power was mainly influenced by social trust, psychological and socio-economic attributes, proximity, and the perceived effects of the NPP2 on the quality of everyday life.”(ibid.) The finding was that in the case of NPP2 compensation does not significantly influence risk perception. The implication is that “the trade-off between acquiring compensation payment and taking risks is not obvious. As suggested by previous studies, compensation is observed to have little effectiveness in gaining public acceptance for nuclear power plants.” (Hung and Wang 2011: 676) Their research showed “the respondents with higher levels of distrust in Taiwan Power Company and college reports would perceive significantly higher levels of risk. As expected, social distrust plays a role in enhancing risk perception”, “respondents with higher levels of trust in neighbours’ information would significantly perceive higher levels of risk” and “more than 60% of the respondents expect the NPP2 to be built neither in their neighbours’ backyard nor in other locations” (ibid.) This rebutted the traditional notion of NIMBYism. In order to explain how the social distrust in the neighbourhood of NPP2 was formed, they (2011: 680) found “several respondents complained that they were only ‘pawns’ in a political chess match for opposition to nuclear power plants. Their concerns or requirements were never seriously considered by either the government or Taiwan Power Company. In particular, some risk perception void communities were often omitted from the public consultation process or ignored by the public participation programs.” The next chapter would like to address the methodology and data collection in this research.

Chapter 4

Methodology and Data Collection

4.1 Methodology and data collection

The main objective of this research paper is to identify what are the determinants for local communities' acceptance and disbeliefs of interim nuclear waste storage in the case of NPP1 and NPP2 in Taiwan. It tends to implement both pattern matching and explanation building. The pattern matching here will be referred to Slovic's (1993: 678) account that the factors leading to public decreasing trust on nuclear power can be the lack of government inspector, government being irresponsible to any problems, lack of local advisory board establish, non-convincing evacuation plan, etc., and the literature review on the local risk perception of low-level waste and NPP2 in Taiwan will be integrated, such as trust on government, political bias and compensation. The explanation building is based on exploring other inexorable determinants through secondary data collection and qualitative interviews. Thereby it aims to construct the coherent storyline from the time when the nuclear power was developed by Taiwan's government in the 1970s until the meta-consensus on interim dry storage was reached last year in order to unravel the complexity of nuclear power and waste predicament. It should be recognised that the method of storyline construction addresses the most relevant factors and events; while it still has the limitation that insufficient research time and resources could not place the research base in the local communities of NPP1 and NPP2 for comprehensive observation of every historical events with details, how they impact on local trust and distrust on nuclear waste storage and to what level their impacts are. Among these events there are some already acknowledged, such as every leakage of NPP1 and NPP2 which occurred many times especially during the early stage of their operation and the local late discovery of ground water intake which may be contaminated by radiation.

The initiation of data collection stems from the author's previous work experiences, including the 4-year position at Green Formosa Front which is an environmental NGO with the interviewee Lin Chang-Mao (林長茂) as the long-term consultant, and as legislative assistant of Legislator Yu Mei-Nu (尤美女) from DPP in Taiwan's parliament for four and half years. The author's experiences dealing with the nuclear power and waste were the political alliance with mass social opposition to NPP4 from 2012 until 2014 when the halt of its construction was made by the president Ma Ying-Jeou (馬英九) through the intensive strategy-building with the representative anti-nuclear environmental groups and continuous interpellation to the Prime Minister and ministers. The author also assisted with forming the political cooperation with other legislators from DPP to take actions for abolition of NPP4, and Legislator Yu was one of the legislators who strongly focused on the issues and constantly had meetings with the leading anti-nuclear NGOs. The work related to NPP4 controversy was followed by the issue of high-level waste management of NPP1 and NPP2, a couple of their safety errors during the operation with the goals of earlier decommissioning than the scheduled time and indoor dry storage of

the waste. This is the channel where the author was able to work with the local communities' representatives particularly Kuo Ching-Lin (郭慶霖) at Legislature and attain mutual trust with the interviewees.

This paper is designed to review the communication platform experiences of nuclear waste management among Taiwan's authorities, Taiwan Power Company, technical experts, the local communities and environmental NGOs from 2007 when the dry storage initially communicated with local communities by the authorities through the public hearing on construction license for high-level nuclear waste storage of NPP1. It is according to the official meeting reports including the abovementioned public hearing of waste from NPP1, the public hearing on construction license of high-level interim nuclear waste storage of NPP2 in 2012, the nuclear waste management negotiation platform between civil societies and government (民間與官方核廢料處置協商平台) from 2013 to 2014, the public hearing on decommissioning project of NPP1 in 2016, the meetings held by the promotion team of nuclear-free homeland under National Council of Sustainable Development in Executive Yuan (行政院國家永續發展委員會非核家園推動小組), and the meetings held by New Taipei City Nuclear Safety Monitoring Council (新北市核能安全監督委員會).

In order to ensure the data credibility and understand the potential bias of stance by the limited number of representatives in meetings, eight qualitative interviews on key informants were conducted. The interviews started from Green Citizens' Action Alliance (綠色公民行動聯盟) which is one of the two oldest anti-nuclear environmental NGOs in Taiwan recognising that before its formation it was the Taipei branch of Taiwan Environmental Protection Union (台灣環境保護聯盟), the other oldest anti-nuclear environmental NGO in Taiwan, and has been one of the leading anti-nuclear groups in charge of mass demonstration after Fukushima. The interview on Tsuei Su-Hsin (崔愷欣), the Secretary General of Green Citizens' Action Alliance was with regard to more historical contexts, and on Hong Shen-Han (洪申翰), the vice Secretary General of Green Citizens' Action Alliance focused on the public participation into official meetings held by Executive Yuan since 2013. Both of the face-to-face interviews were almost two hours, and thereby more complete historical anti-nuclear movement process and its affinity with the case of communities of NPP1 and NPP2 could be pictured.

Besides, other interviewed key informants include the local leader Kuo Ching-Lin who initiated Coast Anti-Nuclear Action Alliance (北海岸反核行動聯盟), the biggest and most active local anti-nuclear group, and is now its executive director; Wong Chong-Ming (王鐘銘), the environmental activist beginning to be highly dedicated to nuclear issues and closely work with people near NPP1 and NPP2 in 2010; Tsai Ya-Ying (蔡雅滢), the legal attorney from Wild at Heart Legal Defence Association (蠻野心足生態協會) and in charge of lawsuits against dry storage of waste from NPP1 and NPP2; Lin Chang-Mao (林長茂), a highly experienced and dedicated environmentalist starting to work on anti-nuclear issues in various cities and townships from the late 80s; and Chang Yu-Yin (張譽尹), the lawyer and president of Environmental Jurists Association (環境法律人協會) working as local people's legal consultant

in the case of environmental assessment of decommissioning project of NPP1. All of these interviews lasted for almost two hours except the one on Chang Yu-Yin was one hour. The experiences and perspectives by environmental groups emphasising on the legal and administrative approaches should be distinguished from the local perspectives; for instance, during the interviews both Tsai Ya-Ying and Chang Yu-Yin mentioned their understanding of local anti-nuclear contexts is restricted to certain official meetings and lawsuits. Whereas, other interviewees are more involved in the interaction with local residents, and undoubtedly Kuo Ching-Lin is the most significant informant because of not only his role of local leader since 2013 but also being a literary and historical worker beforehand since 1989 and equipped with profession of ethnography. Even though he started to be actively involved in local anti-nuclear movements after Fukushima, he shows his strong ambition to inherit the movement from other local activists of the old generation and be in charge of local interaction and communication. In addition, all of the interviews started with the interviewees' personal anti-nuclear experiences and gradually extended to their understanding and observation of broader local contexts, such as the questions that how do they explain the local perspectives while collecting people's opinions? And would they admit these aspects are not widely supported by local people? The analysis and results would like to establish the framework of local acceptance and disbeliefs while still addressing the initial meta-consensus can be more solid among the local activists instead of the communities. Lastly, it is inevitable to identify several key informants who are absent in the interviews of this research paper owing to the lack of accessibility, such as Hsu Fu-Hsiung (許富雄) and Hsu Lu(許爐) who are the oldest anti-nuclear leaders in the communities and were pointed out by Kuo Ching-Lin and Green Citizens' Action Alliance, and 64 local activists who already passed away.

Chapter 5

The development and political contexts of nuclear power and nuclear waste in Taiwan

5.1 The timeline of nuclear power and waste development in Taiwan

Table 1: The timeline of nuclear power and waste development in Taiwan

Year	Ruling party in Taiwan	Domestic development of nuclear power and waste in Taiwan	International contexts	Events of NPP1 and NPP2	Events of NPP4	Events of nuclear waste in Orchid Island
1971	KMT (Martial Law)	NPP1 under construction				
1972	KMT (Martial Law)					
1973	KMT (Martial Law)	Construction of nuclear waste storage in Orchid Island with the attempt of sea disposal				
1974	KMT (Martial Law)					
1975	KMT (Martial Law)					
1976	KMT (Martial Law)					
1977	KMT (Martial Law)					
1978	KMT (Martial Law)			Severe radiation leakage from NPP1		
1979	KMT (Martial Law)	NPP1 in operation	Three Miles Island incident which triggered the initial international			

Year	Ruling party in Taiwan	Domestic development of nuclear power and waste in Taiwan	International contexts	Events of NPP1 and NPP2	Events of NPP4	Events of nuclear waste in Orchid Island
			anti-nuclear movements			
1980	KMT (Martial Law)	Initial project of NPP4 construction		The cooling water operation was blocked in NPP1		
1981	KMT (Martial Law)	NPP2 in operation				
1982	KMT (Martial Law)	Nuclear waste storage in operation in Orchid Island		One employee in NPP1 was exposed to massive radiation and passes away.		
1983	KMT (Martial Law)					
1984	KMT (Martial Law)	NPP3 in operation				
1985	KMT (Martial Law)					
1986	KMT (Martial Law)		Chernobyl incident		First mobilisation against nuclear power	
1987	KMT (Lift of Martial Law)	Formation of Taiwan Environmental Protection Union				
1988	KMT			Two employees and soil were exposed to radiation contamination of NPP2	Formation of Gongliao Anti-Nuclear Power Self-Help Association	First local anti-nuclear protest
1989	KMT			Formation of Northern coast branch of Taiwan		

Year	Ruling party in Taiwan	Domestic development of nuclear power and waste in Taiwan	International contexts	Events of NPP1 and NPP2	Events of NPP4	Events of nuclear waste in Orchid Island
				Environmental Protection Union		
1990	KMT					
1991	KMT					
1992	KMT					
1993	KMT		London Convention's ban on ocean disposal of low-level radioactive wastes	The initial discovery of deformed fish near NPP2 Outdoor nuclear waste of NPP1 was found with radiation contamination		
1994	KMT				Local referendum on NPP4 construction, and more than 96% of voters asked for halting its construction.	
1995	KMT	Legislature passed the budget of NPP4 construction				
1996	KMT; first presidential election with suffrage in Taiwan, and Lee Teng-Hui (李登輝) was elected	Legislature passed the budget of NPP4 construction Taiwan Power Company promised to remove the nuclear waste in Orchid Island in 2002		Taiwan Environmental Protection Union cooperated with governor and legislative election campaigns to promote the issues of nuclear power		The low-level waste in Orchid Island was shipped back to NPP1 and NPP2 under the pressure of Dawu protestors in Orchid Island but stalled by local protestors of NPP1 and

Year	Ruling party in Taiwan	Domestic development of nuclear power and waste in Taiwan	International contexts	Events of NPP1 and NPP2	Events of NPP4	Events of nuclear waste in Orchid Island
				The low-level waste in Orchid Island was shipped back to NPP1 and NPP2 but stalled by local protestors		NPP2
1997	KMT					
1998	KMT	Legislature decided the halt of NPP4 construction, but the decision was rebutted by Executive Yuan, hence the initial construction of NPP4 started				
1999	KMT	Chen Shui-Bian as presidential candidate promised to remove the nuclear waste in Orchid Island				
2000	DPP; first time DPP won the presidential election. Chen Shui-Bian (陳水扁) was elected, but most of the seats Legislature were owned by KMT	Executive Yuan decided to halt NPP4 construction, but the decision was interpreted as unconstitutional by the Justice of the Constitutional Court. The Prime Minister Chang Jiunn-Hsiung (張俊雄) agreed to reconstruct NPP4. Chen Shui-Bian took the decision to continue with the project, right after a meeting with Lee Teng-Hui, in which Lee's political support for DPP was exchanged for con-				

Year	Ruling party in Taiwan	Domestic development of nuclear power and waste in Taiwan	International contexts	Events of NPP1 and NPP2	Events of NPP4	Events of nuclear waste in Orchid Island
		tinuation of the construction.				
2001	DPP	Prime Minister Yu Shyi-Kun(游錫堃) apologised to Dawu people for being incapable to remove nuclear waste				
2002	DPP	Executive Yuan formed the committee working on nuclear waste removal from Orchid Island and included Dawu representatives				
2003	DPP					
2004	DPP					
2005	DPP					
2006	DPP					
2007	DPP					
2008	KMT; Ma Ying-Jeou won the presidential election, and most of the seats Legislature were owned by KMT			The interim nuclear storage of NPP1 passed its environmental impact assessment		
2009	KMT					
2010	KMT					
2011	KMT	President Ma Ying-Jeou announce decommissioning time of the nuclear power plants would not be delayed	Fukushima incident			
2012	KMT	Massive anti-nuclear demonstration in the country The interim nuclear storage of NPP1 started its first phase				

Year	Ruling party in Taiwan	Domestic development of nuclear power and waste in Taiwan	International contexts	Events of NPP1 and NPP2	Events of NPP4	Events of nuclear waste in Orchid Island
		of operation trial				
2013	KMT	<p>Massive anti-nuclear demonstration in the country</p> <p>Prime Minister Jiang Yi-Huah established the communication platform among government, local representative and environmental NOGs over nuclear waste management</p> <p>The interim nuclear storage of NPP1 started its second phase of operation trial</p>		Formation of Coast Anti-Nuclear Action Alliance		
2014	KMT	<p>Massive anti-nuclear demonstration in the country</p> <p>Prime Minister Jiang Yi-Huah announced the halt of NPP4 construction</p>				
2015	KMT					
2016	DPP; Tsai Ying-Wen (蔡英文) won the presidential election and for the first time most of the seat in Legislature are owned by DPP	Initial consensus between Prime Minister Lin Chuan and local people on high-level indoor and interim waste storage		Initial consensus between Prime Minister Lin Chuan (林全) and local people on high-level indoor and interim waste storage		

5.2 The development and political contexts of nuclear power and nuclear waste in Taiwan

Taiwan had been under of Martial Law which was imposed by the only ruling party KMT and lasted for 38 years with the main goal of reclaiming Mainland China territory by 1987, and the three nuclear power plants were all designed and initially operated during this dictatorship. The first nuclear power plant started to be in operation in 1979 and the overall nuclear power is about to be abolished by 2025 with the predicament that no final disposal sites for the waste have been decided. Hsiao (in Chen 2015: 10) briefly concluded that “in this authoritarian and technocratic context, three nuclear power plants were constructed as part of the government’s economic ‘progress’ propaganda between 1971 and 1985. Few anti-nuclear discourses were formulated and nuclear power risks were rarely represented at this stage, while people were generally ignorant of nuclear risks and convinced by the myth of the economic growth associated with nuclear power.” Especially when many Western societies began to question whether nuclear power could be undoubtedly safe after the occurrence of Three Mile Island incident in 1979, the effects of deterrence were tenuous in Taiwan under the ban on freedom of speech, as Hung and Huang (in Ho 2001: 122) found that from 1979 to 1981 there were no more than ten articles challenging the notion of nuclear safety each year.

The official promise of nuclear safety was not indeed in Taiwan. Hung and Huang (in Ho 2001: 122) also found several nuclear safety incidents happened among the nuclear power plants from 1978 to 1986 in Taiwan, but only the one that an employee working in NPP1 passed away from large exposition to radiation in 1982 made several scholars publish thirty five articles in total criticising Taiwan Power Company. Chernobyl accident in 1986 occurred following the Three Mile Island accident, and anti-nuclear discourses raised by various environmental scholars began to emerge, as they (in Ho 2001: 122) indicated that articles challenging nuclear power began to be largely published in 1985 with the number of approximately ninety. On the other hand, the Tangwai movement (黨外運動) which is the pro-democracy political movement and composed by pro-independence activists aiming at defeating the authoritarian KMT experienced the most active time during mid-1970s and early 1980s, later on it formed DPP in 1986. Some fractions of the movement tended to cooperate with anti-nuclear scholars, and according to Ho (2001: 134), even though they also concerned about environmental issues, anti-nuclear discourses could be affiliated with the problematic secrets dominated by KMT, and “the Tangwai activist mostly focused on the nuclear and pollution issues which were more political to criticise KMT’s dictatorship, opaque and secretive deeds, hiding up illegal activities, etc.” For instance, Chen (in Chou and Huang 2012: 14) in 1991 argued that CTCI Corporation (中鼎公司) was run by KMT and got the contract of construction of NPP4 (龍門核能發電廠; Longmen Nuclear Power Plant), hence KMT continued nuclear power development. The slogan ‘anti-nuclear is anti-authoritarian’ was widely used as their main strategy.

The knowledge barrier to nuclear power issues nevertheless existed among the local residents. Ho (2001: 147) also argued that nuclear leakage incidents were discussed among the international media, local scholars and Tangwai move-

ment, but “these did not trigger local grassroots protests or the genuine ‘anti-nuclear’ consciousness.” Hence, the scholars organised a series of public speech in the neighbourhood of NPP4 which was under design to raise the risk perception among lay-public. As a result, Gongliao Anti-Nuclear Power Self-Help Association (貢寮反核自救會) was formed in 1988. Anti-nuclear scholars implemented local and lay language to support grassroots mobilisation.

The synergy among local self-help association, scholars and Tangwai activists was analysed by Wang (in Ho 2001: 150) that during the Martial Law time the Tangwai activists held strong political sense and resources, and once grassroots movement pursued to have their own leaders, the political activists are targeted. The divergence between DPP and KMT thus became solid through the national notion that KMT is pro-nuclear and DPP is anti-nuclear, meanwhile the mass protests led by DPP against the construction of NPP4 was active in 90s. The issue of NPP4 construction as the most controversial environmental issue in Taiwan’s recent history however encountered with the challenge of the divergence between the two political and environmental ideologies in 2000. When ex-president Chen Shui-Bian from DPP was first time elected in 2000, his decision of halting NPP4 was made through his problematic political strategies and was reversed; according to Arrigo (in Grano 2015: 69), “Chen Shui-Bian took the decision to continue with the project, right after a meeting with Lee Teng-Hui, in which Lee’s political support for DPP was exchanged for continuation of the project.” The political outcomes were tremendously detrimental to the environmental movement and its trust on DPP administration. After more than a decade, the new type of anti-nuclear movement away from DPP was dominant after Fukushima incident which again triggered massive risk perception in Taiwan’s society due to the closer linkage with Japan in 2011, and the mobilisation in 2013 even broke the historical record of the number of participants which was 220,000. Finally, the construction of NPP4 was halted in 2014.

Compared with the controversy of NPP4, the issue of NPP1 and NPP2 had been more invisible until Fukushima accident despite of the long-term efforts made by some local activists, environmental groups and DPP, and the geographical proximity of these three plants. Even though the comprehensive data on general and historical local level of risk perception is still absent, Hung and Wang (2011: 674) already suggested that “from 1974 to 2000, the recorded events of radiation leaks and shutdowns in the NPP2 were substantial, averaging over 20 a year.” They found the residents of NPP2 suspected the nuclear expertise and the promises made by Taiwan Power Company and Atomic Energy Council that the population was only exposed to a little radiation from the power plant. Their quantitative survey showed respondents’ rating of the levels of expected harm from the NPP2 are significantly higher than the median level on average, and the perceived probabilities of potential losses or damages for respondents were also significantly greater than a 50-50 chance. Therefore, the neighbourhood of NPP1 and NPP2 has significant risk perception of nuclear power and waste concerning the near proximity between the two. For instance, they (2011: 678) additionally discovered that the sample areas with the highest perceived level of risk encountered the threat from not only NPP1 but also NPP2, and “the distance of these respondents from NPP1 is only 2-3 km. Survey results show that they face double effects from these two existing power plants.”

The initial emergence of local awareness and risk perception of problematic nuclear power in the neighbourhood of NPP1 and NPP2 was linked to the findings of deformed fish in 1993 and the later political activities, as Lin Chang-Mao, experienced environmentalist since early 1990s explained;

“The construction and initial operation of NPP1 and NPP2 were still under Martial Law. Residents thought nuclear power should be clean energy since the governmental propaganda was powerful. I worked with various environmental scholars to hold public speech in the communities, and approximately in 1994 I started to observe that local residents owned more understanding about the problem of nuclear waste. But frankly the lecturers were more than the audience. Afterwards we tried to integrate with the mayor and governor election in 1996 so that we could make the use of campaign activities of candidates.” (Lin 2017, personal interview)

The risk perception has been augmented especially after Fukushima which the local leader Kuo Ching-Lin defined as the main trigger of overwhelming local worries and perceived risk. Wong Chong-Ming, the environmental activist works on nuclear issues near NPP1 and NPP2 stated:

“When I firstly came to the neighbourhood in 2010, I noticed that not many people had fear of nuclear disasters. Even though I distributed the flyers emphasising nuclear danger very near NPP1, people were not responsive, and there was not social conflict between pro-nuclear and anti-nuclear people. But things changed dramatically after Fukushima.” (Wong 2017, personal interview)

However, the high risk perception is not equated with active mobilisation. Wang Chong-Ming noticed the insufficient local participation;

“The case of NPP1 and NPP2 is very different from Orchid Island; many people from Orchid Island are able to come to Taipei to join the protest even though they need to spend half day travelling, whereas residents of NPP1 and NPP2 live close to Taipei without much motivation to participate.” (Wong 2017, personal interview)

The phenomenon was explained by Tsuei Su-Hsin with regard to more historical contexts:

“To be honest, the strong local protest against NPP4 has been limitedly influential on the local anti-nuclear movement in the neighbourhood of NPP1 and NPP2, because many residents perceive nuclear power plants are already in operation, it is impossible to halt them.” (Tsuei 2017, personal interview)

NPP1 and NPP2 which should be decommissioned no later than 2018 and 2021 respectively do not represent the end of confrontation with unwanted radiation. the Nuclear Materials and Radioactive Waste Management Act (Atomic Energy Council, Government of Taiwan 2002) which is applicable for the high-level waste management indicates that “during the time period for publication and display, individuals, government agencies or organisations may submit to the competent authorities reference opinions in written document stating the name or appellation and the address; and a hearing (hearings) shall be held by the competent authorities subsequently”. However, the only hearing held for NPP1 was in 2007 without any local people participating. Atomic Energy Council which is the competent authority admitted that it was not capable of organising the more inclusive hearing.

In 2008, the outdoor interim dry storage which place nuclear waste from NPP1 for at least forty years passed its environmental impact assessment. The administrative process followed the prevalence of expert-led decision as other

nuclear waste issues undergoing policy formulation. According to the Article 14 of Environmental Impact Assessment Act (Environmental Protection Agency, Government of Taiwan 2003), “the industry competent authority shall, in conjunction with the competent authority, members of the Committee and other relevant agencies, invite together experts, scholars, groups and local residents to conduct an on-site inspection and hold a public hearing within thirty days after receipt of the draft environmental impact assessment report; records of the on-site inspection and public hearing shall be maintained and submitted to the competent authority within thirty days after the on-site inspection and public hearing.” Even with the mechanism of public hearing, the government failed to robustly concern over the lay knowledge, and local opponents with the number from 500 to 600 were led by the ex-mayor of Taipei County Chou Hsi-wei (周錫瑋) from KMT to voice out. The opposition should not be solely seen as the political provocation by the mayor since at that time it was initiated by a number of local residents.

During the strong mass anti-nuclear movement after Fukushima, local residents started to have strong fear for nuclear power and waste and have broader alliance with environmental NGOs for not only monitoring the decommissioning on time but also challenging the outdoor interim storage of waste from NPP1 and NPP2. For instance, the hearing of storage license of spent fuels from NPP 2 took place in 2012 based on the aforementioned Nuclear Materials and Radioactive Waste Management Act with approximately fifty participants from local communities. Atomic Energy Agency admitted that it was its first attempt to hold more comprehensive public hearing; nevertheless, most of the questions and concerns raised by participants from local communities, environmental groups and their allied experts were not fully replied by the competent authority which refused to have the further hearing dealing with the hesitation.

After the strong social opposition to nuclear power in 2011, the ex-president Ma Ying-Jeou from KMT announced that the phasing out of NPP1 and NPP2 would not be delayed. The local leader Kuo Ching-lin realised the invisibility of the NPP1 and NPP2 issues in comparison with NPP4 and nuclear waste in Orchid Island, and thus formed Coast Anti-Nuclear Action Alliance which closely works with other environmental NGOs in 2013. The issue of interim storage from NPP1 was raised to the agenda on the cross-ministry platform which was established by ex-Prime Minister Jiang Yi-Huah (江宜樺) to communicate with local communities and environmental groups about the nuclear waste management in 2013 during the Ma Ying-Jeou administration, and it is the first time this issue was placed in the agenda of high level in administrative hierarchy. Meanwhile, the New Taipei City Nuclear Safety Monitoring Council was launched by the Mayor of New Taipei City (formerly named as Taipei County) Eric Chu (朱立倫) from KMT in 2013 to involve the local participation regarding NPP1, NPP2 and their waste storage issues. He was the presidential candidate in 2016 and has been implementing the administrative measures to impede the completion of outdoor dry storage and seems to be the long-term ally supporting the local opinions hitherto.

DPP then won the presidential and parliamentary election for the first time in 2016. The Prime Minister Lin Chuan and local communities in ChinShan (金山) and Wanli (萬里), which are located in the neighbourhood of

NPP1 and NPP2 reached the consensus that the local communities could accept the interim dry storage facilities as long as they change to the indoor and underground storage which they conceive much safer instead of the current outdoor construction. (Storm Media 2016) According to Kuo Ching-lin (Events in Focus 2016) , “the final disposal solution is still impossible, thus the safer dry storage can be taken into consideration, and it must be management by specific and responsible organisation which is able to carry out strict monitoring.” The case of NPP1 and NPP2 is the first time in Taiwan’s history of nuclear waste predicament that local communities reached the initial but still fragile agreement on the nearby high-level radioactive waste storage.

The problem of low-level nuclear waste in Orchid Island is the most controversial issues regarding nuclear power along with NPP4. So far the solution to removal the waste is still yet to come out. As the local opposition has been strong, Taiwan Power Company planned to ship the waste to its origins which are NPP1 and NPP2 in 1996, but the vessels were halted by several hundreds of local opponents from moving waste to the shore. The incident thus triggered the conflicts and misunderstanding between two groups who have been inflicted by nuclear waste. After the mass anti-nuclear mobilisation in 2013, the group from Orchid Island finally visited communities near NPP1 and NPP2 in order to understand the mutual predicaments of living with nuclear waste as nuclear victims. Coast Anti-Nuclear Action Alliance decided to work with representatives from Orchid Island and prioritise the issue of waste in Orchid Island in the national nuclear waste agenda as the strategy of movement recognising that the long-term local struggles against low-level waste.

After the background introduction of nuclear power and waste development, the next chapter will elicit the results and analysis of the determinants for local acceptance and disbeliefs.

Chapter 6

Analysis and results- What are the determinants for local communities' acceptance and disbeliefs of interim nuclear waste storage? The case of high-level nuclear waste in the neighbourhood of NPP1 and NPP2 in Taiwan

The results and analysis of this research paper recognise the jeopardy of uniformed science and the importance of developing the more socially robust scientific knowledge by incorporating how the risk perception among lay-public has been formulated in the case of high-level interim nuclear waste storage in Taiwan, and it is aligned with the account made by Stirling (2003:8) that “the scientific based’ prescriptions on risk are not just unrealistic. In a plural society, they are fundamentally contradictions in terms.”

The research on local acceptance and disbeliefs of nuclear waste in Taiwan has been concentrated in low-level waste under the governmental policy that Daren and Wuchiu are the selected sites of final waste repository which should take over the temporary waste in Orchid Island. Even though there was Hung and Wang’s research on the local acceptance of nuclear power plants in the case of NPP1 and NPP2, it was conducted before Fukushima accident in 2011. Therefore, it is necessary to investigate the situation after Fukushima accident and the case of high-level nuclear waste which contains much higher radioactive danger. On the other hand, most of the research in Taiwan has implemented quantitative methods with inclination to psychometric models at the limited moment when the research took place without retrospect of the development of nuclear power and the stalemate of nuclear waste management which represent the most controversial and long-term environmental conflicts in the country, and how the local people could actively react to them. It tends to be referred to what was argued by Wynne (1996: 41) in his case study of the hill-sheep farmers of the Lake District of northern England after experiencing the serious contamination from Chernobyl accident, the relationship with nearby Windscale-Sellafield nuclear facilities and weapons testing fall-out in 1950s; he suggested that “the advance from focusing on cognitive dimensions (often assumed public deficiencies) to trust and credibility is important. But closer examination in this case-study of the basis of trust and credibility falsifies the predominant analytical tendency to treat these as unambiguous, quasi-cognitive categories of belief or attitude which people supposedly choose to espouse or reject.” Therefore, it is noteworthy to contemplate this research paper through the following aspects which were raised by Irwin and Wynne:

“What do people mean by ‘science’ and ‘scientific expertise’?

Where do they turn for technical information and advice?

What motivates them to do so?

How do they select from, evaluate and use scientific information?

How do they relate this expert advice to everyday experience and other forms of knowledge?

What is involved in its integration at his level? “(Irwin and Wynne 1996: 11)

6.1 Historical contexts and the crisis of distrust on the authorities

6.1.1 The importance of Fukushima and the link to the big tsunami in Taiwan more than 100 years ago

Even though the communities of NPP1 and NPP2 have lived with nuclear power and waste for more than three decades, local residents started to have bigger and broader risk perception again after Fukushima in 2011. The local leader Kuo Ching-lin observed most of the residents are not able to focus on technical debates over the waste storage such as the seismic and engineering wordings, but they have strong feeling for Fukushima;

“The local awareness of the nuclear danger has largely enhanced since Fukushima incident which is more influential than Chernobyl. It is because Japan is closer to us, we feel stronger link to what occurred in Japan. The local memory about the big tsunami and earthquake in 1867 was triggered, and at that time the region of Aliban (阿里山) and Bado (八斗) on the northern coast of Taiwan were severely damaged. Thus people started to have fear. Although some scholars say there is no cycle of earthquake occurrence, people are very afraid, and the worries have been deepened. They fear that one day the communities will resemble Fukushima.” (Kuo 2017, personal interview)

The worries can be shown in increased participation during the public hearing on the application for construction license of dry storage of waste from NPP2 in 2012. Contrasting to the likened hearing on NPP1 in 2007 which none of local resident other than one representative from local alderman's office attended, approximately fifty residents gathered in the hearing in 2012 which was the first time that the official meeting on nuclear issues between the government and residents could have such active local participation. Some residents indicated what happened during the earthquake and tsunami in 1867; for instance, Lee Jin-Ji (李菁桔) explained:

“We used to have an earthquake from the primitive coral reefs inside the sea. The crack was deeper than the height of two people and the length was more than 100 meters. How can you predict when the other earthquake with similar severity will take place in the future?” (Lee, in Atomic Energy Council 2012: 58)

The environmental activist Lee Hsiu-Jung (李秀容; in Atomic Energy Council 2012: 57) from Taiwan Environmental Protection Union additionally described many local people remember the flooding level after the tsunami in 1867 was more than 20 meters reaching the stone lion next to ChinShan (金山) library, and the level was more than the safety design to protect from tsunami in Taiwan Power Company's dry storage.

Nevertheless, the authorities and scientists responded to these concerns from local memories with technical statements in the hearing which failed to reduce local worries. The repeated statements were raised by various technicians from Taiwan Power Company and could be briefly represented by Chiu Hsian-Lang (邱顯郎), the chief of nuclear back-end management division of Taiwan Power Company that;

“The time when nuclear power plants were constructed, they were based on the historical earthquake and tsunami records with additional reasonable contempla-

tion, thus the expected maximum tsunami height of NPP2 was 10.28 meters, and we built the shielding which is 12 meters. We commissioned Sinotech Engineering Consultants Ltd. (中興工程顧問公司) to conduct the overall evaluation of tsunami effects of nuclear power plants, and it turned out the maximum tsunami height is between 4.3 and 4.66 meters. It is much lower than the 12-meter shielding we currently have.”(Chiu, in Atomic Energy Council 2012: 11)

Atomic Energy Council had the same perspective as Taiwan Power Company. It (2013) clarified that the historically biggest tsunami was in 1867 and reached the height between 3.4 and 7.5 meters, hence it is almost unlikely to have the dry storages of both NPP1 and NPP2 destroyed by tsunami; let alone the shielding of storage from NPP1 is 24 meters and was confirmed with safety standards, and the materials of dry storage proved to protect from flooding and tsunami have been widely used in the U.S. Nevertheless, both Atomic Energy Council and Taiwan Power Company have yet to include local people’s memory of tsunami in their waste management of NPP2 storage, and the understanding between local resident and government is still apart hitherto. The disconnection between local memory of ancient tsunami and technical explanation by technicians and governmental officials could hence generate local distrust on the science represented by the government.

6.1.2 The historical nuclear leakage incident which is influential in shaping distrust crisis in the early years—the emergence of deformed fish for more than 20 years

The local awareness of nuclear danger was largely based on the fishermen’s findings of deformed fish in 1993, and it is considered as the beginning when people started to fear for nuclear danger. Kuo Ching-Lin explained that;

“Mr. Fan from the local communities was informed that there was deformed fish. It was sent to the laboratory in Hiroshima in Japan and the result was that the deformation was due to artificial radiation; however, the professor Shao Guang-Chao (邵廣昭) hired by the government was insistent that it was high sea temperature which caused the lack of Vitamin C in the deformed fish rather than manmade radioactive material. Professor Kuo Jin-Chuan (郭金泉) rejected Shao’s argument and said that the further research must be conducted so that it could be confirmed if high sea temperature mattered. Professor Kuo also consulted with some professors from former Soviet Union, and they replied that the cause was unlikely to be insufficient Vitamin C. Then we found professor Shao got a lot of funding from the research projects of Taiwan Power Company, he even wrote that the fish from our communities in the coastal areas could slam into nuclear power plants. In these days local people even myself still find deformed fish, but how can we do about it? The laboratories recognised by the government are restrained to TsingHwa University, Institute of Nuclear Energy Research (核能研究所), Taiwan Power Company and the military (i.e. the laboratories are all affiliated with the institutes in charge of nuclear technology development.)” (Kuo2017, personal interview)

Not only Kuo Ching-Lin observed the wide and deep local feeling for the deformed fish, but also the young environmental activist Wang Chong-Ming noticed in spite of the initial finding of deformed fish was in 1993, local people still remember it very well, and they think it is nuclear power plants to be blamed. The problem of deformed fish has been very often taken as the main strategy by local anti-nuclear activists from the old generation to mobilise peo-

ple because people can easily understand. The importance of deformed fish incident was also raised by Lin Chang-Mao;

“Local people did not know much about nuclear power in 1980s and even organised the parade to celebrate the inauguration of nuclear power plants. It is not until the discovery of deformed fish that people were aware of nuclear danger.” (Lin 2017, personal interview)

Notwithstanding the strong effects of deformed fish, many local people are unwilling to raise the phenomenon and make it known by the public especially after Fukushima. Kuo Ching-Lin analysed;

“I never think about emphasising the issue of deformed fish a lot because it will damage the local fishery and tourism industry and have strong stigmatization impact. People are afraid of experiencing the similar things in Fukushima that the fishery industry has been destroyed.” (Kuo 2017, personal interview)

The constant discovery of deformed fish represents not only the initial local fear of nuclear radiation but also the dilemma of initial confrontation with distinct scientific interpretation between scientists with and without governmental affinity. Even though the experience with deformed fish has been long, the split of understanding among different fractions of scientists could never be conflated and eventually the perception attached to the radiation risk is further strengthened by its visible negative effects and scientist without political or economic bias.

6.1.3 The impasse of nuclear waste final disposal and the delay of nuclear waste removal in Orchid Island

The most recognised nuclear waste issue in Taiwan is the low-level waste in Orchid Island. According to Fan (2006: 418), “the decision to set up an interim waste repository on Orchid Island was made by the Atomic Energy Council in the 1970s. There is an ocean trench near Orchid Island and it was considered feasible and convenient to throw nuclear waste into the ocean trench for permanent nuclear waste disposal. However, the plan was subsequently abandoned as the London Dumping Convention prohibited the dumping of nuclear waste at the sea. The site selection process was conducted behind closed doors, with privileged access for technocrats without consulting the public.” After Chernobyl, the indigenous people on the island built up alliance with various social movement groups and Tangwai activists to launch the first protest calling for waste removal in 1988. The protest did not make any progress of governmental promise until 1996 when Taiwan Power Company for the first time stated that the removal would be executed in 2002 under the condition that the final disposal site is decided. (Lin 2013) This promise was followed by ex-President Chen Shui-Bian during his election campaign in 1999, whilst the ex-Prime Minister Yu Shyi-Kun under Chen administration admitted that the government would not be capable of carrying out the promise and apologised to Dawu people in 2001. (Tao Foundation 2009) DaRen and Wuchiu were then announced by Taiwan’s authority as the potential sites for the final disposal repository of radioactive waste in 2009 and 2012 respectively, but the local governments have been refusing to hold local referendum and Taiwan Power Company has no legal solution to remove the waste from Orchid Island so far. Even though according to Hung Shen-Hen (2017, personal interview), Atomic Energy Council agreed to consider final disposal siting alternatives

without being bound to Daren and Wuchiu in 2016, there has not been obvious administrative progress of the solution.

Kuo Ching-Lin (2017: personal interview) elaborated the tremendous local worry that “since Taiwan Power Company could not find the final disposal sites, the local people started to fear for staying with waste for generations.” Chen (2015) also found the same problem on the platform between experts and local residents on interim dry storage of NPP1 in 2009, that is, the mandatory platform following the passage of its environmental impact assessment in 2008. He analysed that the experts failed to respond to the local concerns over the policies of nuclear waste. The biggest two local concerns were whether the dry storage would be placed in the neighbourhood for more than 50 years even as the long-term disposal site, and whether the local government can be the member of nuclear backend fund committee. These two concerns were not related to the scientific discussion over the nuclear waste and could not be answered by the scientists, but the government still considered the platform as a measure to communicate with local people. Also, the experts only focused on the scientific analysis for 50 years as the interim storage without mentioning if this interim storage can deal with the potential problems which may occur after 50 years. As the final disposal solution is absent, the local people could not trust the safety of interim storage although experts could guarantee it for 50 years.

Wang Chong-Ming recognised the worries over waste storage among residents near NPP1 and NPP2 are differentiated from other people in Taiwan after Fukushima. He stated;

“Although the ex-President Ma announced the decommissioning of NPP1 and NPP2 would be on time after Fukushima, residents did not feel much because nuclear waste has been staying with them for decades, and it may stay thousands of years. I notice that residents are already numb and have distinct feeling about nuclear power from other Taiwanese who mostly concern about the possibility of explosion and therefore have the stance of anti-NPP4.” (Wong 2017, personal interview)

Kuo Ching-Lin pointed out the resembled observation that:

“Most residents do not know what exactly the discrepancy between outdoor and indoor waste storage, and they concern more that the waste storage may be there forever. Some people have been tired and hopeless, and they simply think it is their destiny to live with waste and the ultimate solution is receiving some compensation from the government. Other people think at the end they can only move out. There is general local feeling that they have sacrificed too much and local development has been in stagnation.” (Kuo 2017, personal interview)

Lodziak’s (in Mythen 2004: 152) account that “a lack of visible opposition to public institutions – in the past or the present – should not be translated as lay satisfaction with the performance of expert systems. To act implies being able to do so”, and “being able to act is not determined solely by individual choice, but is instead dependent upon facilities, tools and technologies.” The lack of strong movement among local residents should not be arbitrarily elucidated as the comfortable uptake of nuclear waste, and the long-term governmental failure of final waste solution has generated the feeling of long-term powerlessness among them.

6.2 To what level should public and democratic participation be?

Hung and Wang (2011: 680) found “several respondents complained that they were only ‘pawns’ in a political chess match for opposition to nuclear power plants. Their concerns or requirements were never seriously considered by either the government or Taiwan Power Company. In particular, some risk perception void communities were often omitted from the public consultation process or ignored by the public participation programs.” It is noteworthy that this feeling of being isolated by governmental decision-making would be more acute while the distrust on authorities and expertise has been lasting for decades owing to the governmental failure to overcome local doubts over the deformed fish and final disposal solution and the increased worries after Fukushima. However, the public consultation mechanism is not completely absent after the lift of Martial Law; how has it been enforced and has impacted on local uptake and disbeliefs of nuclear waste?

The nuclear waste communication platforms already showed that the experts are in charge of communicating with local residents with the intention to only discuss over the technical and scientific issues; nevertheless, the main worried and concerns among the local communities are usually excluded from the agendas which have been decided by the authorities beforehand. Chen (2015) found the platform between experts and local residents on interim dry storage of NPP1 in 2009 that the experts failed to respond to the local concerns over the policies of nuclear waste. He furthermore indicated the local concerns over ‘establishing monitoring system’ and ‘establishing precautionary system’ were placed in the agenda; however, they were more related to governmental management rather than the profession of experts, and the experts could only passively review the data provided by the government. The majority of experts saw these meetings as the way to provide suggestion under the circumstance that the authorities had passed the safety report of the dry storage. Hence, the agenda was limited to the more trivial issues and dominated by Taiwan Power Company.

Based on the account of Tsai Ya-Ying (2017, personal interview), Atomic Energy Council admitted the public hearing in 2012 dealing with license of NPP2 high-level waste storage was the first time that the government tended to involve more local voices into the waste management; whilst many residents raised their worries over various issues, including questioning the necessity of dry storage, the likelihood of becoming final disposal site, the possibility of weak evacuation under emergency due to the local geographical and geological conditions, the memory of big tsunami, the occurrence of metal corrosion on coastal areas, etc. At the ending of the public hearing, many participants asked for the next hearing to clarify local doubts, but Atomic Energy Council did not agree.

The following Atomic Energy Council meeting to involve more local participation was the one on decommissioning of NPP1 in 2016. During the meeting, it could be seen that Atomic Energy Council continuously organised the on-site visits inviting local people and environmental groups. The questions are whether these meetings are more inclusive after Tsai administration and able to reduce local disbeliefs?

Unlike the case of Orchid Island which has been recognised by Taiwan's society for long and therefore had the opportunity to negotiate with the Prime Minister level under Chen administration through the official council over waste removal from Orchid Island, NPP1 and NPP2 had not been able to attain such level of public participation in the waste decision-making until 2013. According to Kuo Ching-Lin;

“For long local people have been excluded from decision-making; it is raised by one resident during ex-Prime Minister Lin Chuan's visit in 2016 that no officials from high level in governmental hierarchy have come to them for forty years. He even cried out. Taiwan Power Company always prefers to talk with local leaders who want to ask for compensation for their own political and economic interest. Germany has experiences of negotiating with local people for 25 years, and the process in Taiwan is too slow.” (Kuo 2017, personal interview)

Hung Shen-Han (2017, personal interview) has more critical view that the level of information transparency and public participation is not so much different between Tsai administration and Ma administration; however, Prime Minister Lin did emphasise the local opinions and attitudes a lot and is distinct from other politicians regarding nuclear waste predicaments. The problem of Tsai administration is that the Prime Minister has the political will to ensure local opinions are taken into account of policy formulation, but many ministers are not that capable. This observation was explained by Tsai Ya-Ying. She mentioned;

“Indeed, Kuo Ching-Lin is very positive towards the meeting on decommissioning of NPP1. He thinks it is more inclusive, and Atomic Energy Council was willing to communicate with people and accept their opinions. Now we see Atomic Energy Council notify people with a lot of meetings they organise, and there is even live-streaming. But I still feel that they do not include people if there is very important decision-making. Sometimes I feel the policies have been decided and the participation is there pro forma.” (Tsai 2017, personal interview)

Besides, Kuo Ching-Lin stated;

“Even though now we can participate into the nuclear-free homeland project team under Executive Yuan, still a lot of local people do not know much about it.” (Kuo 2017, personal interview)

Wang Chong-Ming explained how local people consider this team under Executive Yuan;

“I feel local people are numb with the fact that some local leaders are able to participate into the team in Executive Yuan and do not have much expectation, especially now there is only one meeting which has been held. There is still no outcome from the team to be shown to people.” (Wong 2017, personal interview)

Thus, it could be concluded notwithstanding the recent governmental progress to enhance public participation, owing to the broad hopeless feeling and inactive mobilization among the residents, the government and its technocrats still have a long way to go in order to attain local trust, and sole concentration into the issues raised by participants with the responses of technical and scientific jargons is still insufficient. How to organise people's opinions into policy-making at higher level will be the main critical challenge.

6.3 Issues of compensation

The findings by Huang as Hung (2011: 676) showed that in the case of NPP2, “compensation does not significantly influence risk perception. The implication is that the trade-off between acquiring compensation payment and taking risks is not obvious. As suggested by previous studies, compensation is observed to have little effectiveness in gaining public acceptance for nuclear power plants.” This finding may be due to the big gap between the compensation for residents near NPP1 and NPP2 and the one for residents in Orchid Island. Kuo Ching-Lin clarified the contrast that in Chinshan one person gets TWD 6.9 (about USD 3) per day whereas in Orchid Island one person gets at least TWD 50 (about USD 1.4) per day. Wang Chong-Ming explained the local perception on compensation with regard to acceptance of interim waste storage;

“Nobody from the communities thinks about receiving compensation as a way of increasing income, people have the hopeless feeling instead. Many people are afraid that once they have more compensation others may think that all they want is money, and compensation might turn out to be unequal distribution that local powerful politicians get more benefits.”(Wong 2017, personal interview)

Hung and Wang (2011: 670) argued that “some studies suggest that compensation provides a valuable tool for gaining public acceptance for siting risky facilities. However, others suggest that the offer of compensation may be viewed as a signal of risk that would lead to an increase in individuals’ perceived levels of risk.” And the case of NPP1 and NPP2 could not be translated into the notion that higher compensation can generate local acceptance, and more sophisticated approach is necessary to contemplate the dilemma of compensation. Even though according to Kuo Ching-Lin (2017: personal interview), some people may feel that what if receiving higher compensation and accept the interim waste storage, he also mentioned this is mostly based on the hopeless attitude.

6.4 Sub-politics of cooperation with international environmental movements and the acceptance of indoor dry interim storage of high-level waste

After Fukushima the new emergence of anti-nuclear movement took place in the neighbourhood of NPP1 and NPP2 in spite of comparatively weak mobilisation. Apart from targeting the halting of NPP1 and NPP2 operation, the movement aimed at the problematic outdoor dry storage of high-level waste. Kuo Ching-Lin described that origin of the anti-outdoor dry storage movement;

“At that time Taiwan Power Company insisted that the outdoor dry storage was well-constructed. We saw Yilan Charlei Chen Foundation (宜蘭人文基金會) challenged its safety and brought up international cases that the safe solution should be indoor facility composed of metal materials without any welding. Later on several foreign experts came to share their views, and they all stated the indoor dry storage was not affected by Fukushima catastrophe.”(Kuo 2017, personal interview)

The process of integrating foreign experts was explained by Tsuei Su-Hsin (2017, personal interview) with observation that Coast Anti-Nuclear Action

Alliance has been challenging current outdoor storage with Yilan Charlei Chen Foundation which has the economic resources to consult with many foreign specialists of nuclear waste management. The Foundation focuses on the problems including lack of heat test, technical flaws, siting with deficient geological and climatological standards, wrong materials and incorrect operation standards. The alliance began to accept the indoor dry storage based on the perspectives by the Japanese nuclear waste specialist Masako Sawai (澤井正子) and Mycle Schneider, a Paris-based independent nuclear energy consultant for European Parliament and lead author of *The World Nuclear Industry Status Reports*. They visited Taiwan in 2016 and 2012 respectively. In addition to the international consultancy with Mycle Schneider who was invited by Green Citizens' Action Alliance, the Association of Japan-Taiwan Research on Earthquake Countries demolishing Nuclear Power (地震國告別核電日台研究會) invited many Japanese politicians and experts to Taiwan raising the severity of nuclear leakage in Fukushima and the urgency for demolition of nuclear power, including ex-Prime Minister Naoto Kan (菅直人), several Japanese parliamentarians, the commissioners from National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission and specialists. Masako Sawai, a member of Japan's Citizens' Nuclear Information Centre Japanese and nuclear waste management specialist, was also among the Japanese invitees and identified the acute danger of the outdoor dry storage constructed by Taiwan Power Company while confirming the safety of indoor alternative. She (in Taiwan Environmental Information Centre, 2016) clarified that the Japanese interim storage facility was built without any welding; however, Taiwanese one used the welding of stainless steel and concrete cover, hence the corrosion by stress and deterioration of materials would be inescapable. Also, the facility is on the coastal area, the salt from ocean will lead to erosion. This design is never observed in Japan and Western countries. Many seismic faults are located in Japan and Taiwan, the two countries should not refer to the standards in the US and Europe since the geological condition is different.

The uptake of indoor dry storage could be contemplated as the ambivalence of lay-public and scientist relationship, and in response to the analytical questions proposed by Irwin and Wynne at the begging of this chapter, lay people eventually need to turn for technical information and choose the scientific information from the foreign experts who should own more comprehensive and robust professional perspective, and can be impartial from any domestic political and economic interest. On the other hand, the local selection of science is also rooted in the existent distrust on government. Hung and Wang (2011: 675) argued that "respondents rated relatively higher levels of trust for the college research reports, environmental spokespersons, and neighbours, and rated lower levels of trust in governmental officials and Taipower managers", and "this implies that there is a trust crisis between the public and the leader of social institutions represented by the expertise of government and Taipower." Nevertheless, it is noteworthy that still many residents do not uptake the indoor waste storage according to Kuo Ching-Lin (2017, personal interview) since the infliction of waste is penetrative.

6.5 Does the political ideology of DPP and KMT matter?

Beck indicated the threatening technologies can challenge the exiting political system where the governments, politicians and parties are based and lead to the disempowerments of politics. Thus he aimed at the new political culture which he named as sub-politics to formulate rational debates and contemplate the problematic science uncertainty which is embedded into organised irresponsibility. However, whether the ideal sub-politics have emerged in Taiwan which is a new democracy country and has distinct political ideology experiences from Western democracies should be reflected. For instance, Chen (2015: 40-41) found there is clear polarisation over the stance towards nuclear power between four main newspapers in Taiwan, and “based on their ideological standpoints, they either supported the government taking care of technoeconomic policies, or urged direct citizen participation in deciding the policies” after Fukushima. This phenomenon is resulted from the political conflicts over the pro-nuclear and anti-nuclear between the two main parties in Taiwan.

It is difficult to judge that the local initial uptake of dry indoor storage is unrelated with political contexts, especially when Kuo Ching-Lin indicated that the majority of local residents vote for DPP during the general election in 2016 because they have higher trust on the party regarding the waste management issue.

“Local people have high expectation on DPP’s capacity of waste management, and it can be clearly observed by the local votes for DPP. But the new government still confronts with difficulties, it is impossible to eradicate old bureaucracy immediately.” (Kuo 2017, personal interview)

In addition, by the election in 2016, although local activists had increasing interaction with DPP politicians in the parliament after Fukushima and some internal interaction with Lin Chuan for a short period when the polls showed that DPP would undoubtedly win the election and reach the governmental administration, the New Taipei City Nuclear Safety Monitoring Platform was launched by the Mayor of New Taipei City (formerly named as Taipei County) Eric Chu from KMT in 2013. He was the presidential candidate in 2016 and has been holding the platform meeting every two months including relatively sufficient participation from the communities and implementing the administrative measures to impede the completion of outdoor dry storage. Local people may have seen KMT candidate more preferable if Eric Chu is widely known as the main political ally. Therefore, it should be noted that pro-nuclear image of KMT is still prevalent through not only its historical stance even after Fukushima but also the aggregation of its favourable media representation.

Chapter 7: Conclusion

7.1 What are the determinants for local communities' acceptance and disbeliefs of interim nuclear waste storage? The case of high-level nuclear waste in the neighbourhood of NPP1 and NPP2 in Taiwan

The Chernobyl catastrophe in 1986 had a significant impact on the modern society where the previous objective and definite science could no longer be unquestionable. The catastrophe brought us to risk society coined by Beck with the implication that in this new phase of social change caused by scientific uncertainty, it is clear that science particularly under the order of powerful authorities has still been claiming its indubitable characteristics, but indeed it has shown the confluence of interest constituted by political and scientific institutions could lead the society to manmade environmental crisis. Science itself entered a stalemate containing inescapable non-random influences and systematic errors. It may lead to the catastrophe whose scale is difficult to be controlled and mitigated, and its impacts penetrate considerably into various parts of society it never expects beforehand. Thus, different social sectors could interpret science through various approaches according to their specific contexts in risk society; moreover, Beck called for sub-politics which are composed of different environmental groups, grassroots alliances and experts in civil societies to overcome the harmful monopoly of dominant political and scientific powers. Science's consensibility and consensuality proposed by Nowotny would be the most relevant issue instead of its unchallengeable reliability which used to be seen as the essence. It is illegitimate to insist on the binary between the rational conventional scientists and irrational lay-public once the social opposition to the science imposition occurs, and the generalisation of irrational lay-public who is very often interpreted through the predominant stereotyped theory of Not In My Backyard is no longer valid. Nowadays we should ask the questions how lay people consider and evaluate science and scientists from different backgrounds and how these relate to their daily experiences and knowledge considering their active roles.

Even though Beck started his analysis of risk society with Chernobyl accident in Soviet Union, he noted that its aftermath is not limited to specific geological and social domains since such contamination could be expansive. It is also observed that the Chernobyl effect occurred in Taiwan, the country recognised as the most dangerous location of nuclear risk. At the time of Chernobyl incident Taiwan was undergoing the early stage of nuclear power development as the response to rapid economic growth, and it was the first time that the knowledgeable elites in Taiwan's society began to organise themselves and challenge the safety and economic myth of nuclear power produced by the authoritarian KMT government and followed by the nuclear technology prevalently from the US. Nevertheless, Beck's emphasis on lay people's consciousness of penetrative and overwhelming scientific risks is still based on their rational notion which will eventually establish the diverse sub-politics in order to make changes in the contexts of maturely democratised Western societies. Whether his argument is likely to repeat in the society under the prevalent au-

thoritarian power or the process of transformative democracy such as the case of Taiwan should be discussed. In Taiwan's case, the early stage of nuclear power development was along with governmental propaganda under Martial Law and the Chernobyl catastrophe was at the moment when Taiwan lifted the ban on Martial Law, but the shadow of dictatorship could inexorably lead to lay-public fear of expressing and discussing their thoughts freely or converting into local mobilisation. The sub-politics suggested by Beck could not be the direct consequence without any hindrance. Moreover, the discourses against nuclear safety were largely led by Tangwai movement which became Democratic Progressive Party, the biggest opposition party in Taiwan. Anti-nuclear position then turned into political ideology of the party in contrast to pro-nuclear stance by the long-term ruling KMT.

The selection of the case of local communities near NPP1 and NPP2 regarding the high-level nuclear waste interim storage in this research paper is due to the fact that nuclear power and waste have been the most long-term, controversial and widespread scientific and environmental issue in Taiwan, and it is the first time meta-consensus among the government and local people on nuclear waste storage in their neighbourhood after the historical vast social protest and conflicts over nuclear waste management. But the fragile meta-consensus is still composed of both local acceptance and intricate distrust at the same time. This research recognised the restraints that most of the international studies on lay people's risk perception of nuclear technology enforce the psychometric models which Slovic's theory represents the typicality and have been largely practiced by the related research in Taiwan. These studies evaluate the scale of lay-public's fear of science uncertainty and risks according to quantitative approaches such as economic benefits, geological proximity and different administrative measures responding to risk management, but the shortcomings can be that the historical, social, political and cultural contexts are downplayed. Thus, the analytical approach referred to the suggestion by Irwin and Wynne. They (1996: 1) explained that "the relationship between scientific expertise and the 'general public' is currently a matter of renewed attention and social concern. Although the dominant form of this renewed interest is shaped by anxieties about the 'social assimilation' of science and technology (i.e. by a concern that the public are insufficiently receptive to science and technology), we will argue that this conceals a more fundamental issue regarding the public identity and organisation of science within contemporary society." This research reviewed the historical development of the local disbeliefs of nuclear power, how it can be prolonged to the dilemma of nuclear waste storage and why the meta-consensus can be attained.

Lastly, several determinants for local disbeliefs of nuclear waste storage have been found and they include the local memory of big tsunami 100 years ago which links to Fukushima incident, the constant emergence of deformed fish for more than 20 years, the long-term failure of proper low-level nuclear waste siting and its outcome of unconvincing governmental capacity dealing with the waste, and the historical insufficient public participation. On the other hand, it is argued that the higher compensation for local communities may not be succinct solution to the uptake of waste storage as some of the previously conducted studies in Taiwan that suggested the compensation could have positive impacts on reduction of local risk perception in the case of Wuchiu and Daren which have been officially chosen as the potential sites for low-level nu-

clear waste final disposal. The recent progress of uptake of nuclear waste storage is inevitably connected to the foreign scientists who are impartial from domestic political and economic interest and potential to be considered as genuine scientific expertise by local residents, and the relatively strong trust on DPP which is the current ruling party is the other relevant determinant. In this sense, it is vital to analyse that local lay people are not completely sceptical of science; it is the confluence of science and governmental administration that has turned into institutional forms and are disconnected from the local knowledge and experiences can no longer be socially supported. But meanwhile lay-public resort to the other form of modern science that is surely evaluated as independent from these steady institutional forms, and the elements of political ideology seem to be additional to this independent form of modern science in Taiwan's society which is undergoing the transformative process of democratisation in order to construct trust on nuclear waste management.

7.2 New questions, limitations and proposals for the further research

This research paper is the initial attempt to contextualise the relevant factors leading to local disbelief and uptake of high-level nuclear waste interim storage of NPP1 and NPP; nevertheless, there are questions which should be further analysed. Owing to the limited time and resources while conducting this research, the secondary data was mostly collected on governmental websites and could be limited to the governmental meetings which require recording. There are also meetings and other kinds of interaction held by either governmental officials or Taiwan Power Company and can dispense with recording, but their information is not accessible enough. Even the more sufficient data collection of the interaction between government and local communities is prepared, it still requires a more delicate process-tracing approach in order to picture the historical time-line and recognize detailed historical events from the time nuclear power plants started in order to unravel what are the other relevant events and how their impacts have been. Besides, it is inevitable to identify several local key informants who are absent in the interviews of this research paper due to the lack of accessibility, such as Hsu Fu-Hsiung and Hsu Lu who are the oldest anti-nuclear activists in the communities, and double confirm with the counterparts they may address to.

Once the more robust accessibility to the key informants and data collection is attained, the approach of contextualisation should be implemented to evaluate to what extent these elicited results could affect local risk perception, and the thoughts of lay-public from non-key informants should be properly included considering that they can be unwilling or unable to express their ideas because of the hopeless sentiments by constant nuclear infliction. Therefore, sophisticated and delicate methods should be conducted to further analyse the same research question.

Appendices

Appendix 1: List of informants

Chang Yu-Yin (張譽尹), lawyer and president of Environmental Jurists Association (環境法律人協會)

Hong Shen-Han (洪申翰), vice Secretary General of Green Citizens' Action Alliance (綠色公民行動聯盟)

Kuo Ching-Lin (郭慶霖), Executive Director of Coast Anti-Nuclear Action Alliance (北海岸反核行動聯盟)

Lin Chang-Mao (林長茂), consultant of Green Formosa Front Association (綠色陣線協會)

Tsai Ya-Ying (蔡雅滢), legal attorney from Wild at Heart Legal Defence Association (蠻野心足生態協會)

Tsuei Su-Hsin (崔愨欣), Secretary General of Green Citizens' Action Alliance

Wong Chong-Ming (王鐘銘), environmental activist

References

- Anshelm, J. and V. Galis (2009) 'The Politics of High-level Nuclear Waste Management in Sweden: Confined Research Versus Research in the Wild', *Environmental Policy and Governance* 19(4): 269-280.
- Atomic Energy Council, Government of Taiwan (2002) 'The Nuclear Materials and Radioactive Waste Management Act'. <
<http://law.moj.gov.tw/Eng/LawClass/LawContent.aspx?PCODE=J0160015>>
- Atomic Energy Council, Government of Taiwan (2006) 'Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility'. <
<http://law.moj.gov.tw/Eng/LawClass/LawAll.aspx?PCode=J0160079>>.
- 行政院原子能委員會 (2012) 〈台灣電力股份有限公司核二廠用過核子燃料乾式貯存設施建造執照申請案聽證紀錄〉，行政院原子能委員會。
- Atomic Energy Council (2012) 'Report of Public Hearing on Taiwan Power Company's Application of Construction License for Dry Storage of Spent Fuels from NPP2', Atomic Energy Council
- 行政院原子能委員會 (2013) 〈澄清說明〉 2013 年 5 月 22 日
<<https://goo.gl/JeY8Wu>>。
- Atomic Energy Council (2013) 'Clarification' 22 May <<https://goo.gl/JeY8Wu>>.
- Beck, U. and R. Mark (1992) *Risk Society: Towards a New Modernity*. Sage Publications (CA).
- Beck, U. and A. Weisz (1995) *Ecological Politics in an Age of Risk*. Wiley.
- Central Geological Survey (2017) Government of Taiwan, Taipei, accessed 10 February 2017
<<http://fault.moeacgs.gov.tw/MgFault/Home/pageMap?LFun=3>>
- Butler, D. (2011) 'Reactors, residents and risk', *Nature* 21 January
<<http://www.nature.com/news/2011/110421/full/472400a.html>>.
- Chen, M. J.(2015) 'Representations of Nuclear Power Risks in Taiwanese Newspapers: Rethinking the Media's Sub-political Role in a Risk Society', MSc thesis. London: University College London.
- 陳穎峰 (2014) 〈「民間參與，專家代理」？核廢料議題專家會議的迷思－以核一廠乾貯場專家會議結論與其執行成果為例〉，國立臺灣大學社會科學院風險社會與政策研究中心，2017 年 6 月 8 日取得
<<http://rsprc.ntu.edu.tw/zh-TW/9-articles-category/social-innovation/88-myth-nuclear-waste-issues-expert-meetings>>。
- Chen, Y.F. (2014) 'Public Participation, Expert Representativeness? The Myth of Expert Meeting on Nuclear Waste – the Case of the Platform between Experts and Local Residents on Interim Dry Storage of NPP1 in 2009', Risk Society and Policy Research Center of National Taiwan University, Accessed 8 June 2017 <<http://rsprc.ntu.edu.tw/zh-TW/9-articles-category/social-innovation/88-myth-nuclear-waste-issues-expert-meetings>>.

- 周桂田、黃維明 (2012) 〈災害與風險公共領域—以福島核災在台灣의 效應為例〉，第4屆發展研究年會論文，台北(10月20日)。
- Chou, G.T. and W.M. Huang (2012) 'Disaster and Risk Public Sphere-To the Effects of Fukushima Nuclear Disaster in Taiwan', paper presented at the 4th Annual Symposium on Development Studies, Taipei (20 October).
- Devine-Wright, P. (2009) 'Rethinking NIMBYism: The Role of Place Attachment and Place Identity in Explaining Place-protective Action', *Journal of community & applied social psychology* 19(6): 426-441.
- Environmental Protection Agency, Government of Taiwan (2003) 'Environmental Impact Assessment Act'. <
<http://law.moj.gov.tw/Eng/LawClass/LawContent.aspx?PCODE=O0090001>>
- 焦點事件 (2016) 〈要安全乾貯 北海岸郭慶霖：我沒有主張提前除役〉，4月12日 <<http://www.eventsinfocus.org/news/546>>。
- Events in Focus (2016) 'Demanding for Safe Dry Storage, Kuo Ching-Lin: I Never Ask for Shifting Decommissioning to Earlier Date', 12 April. <
<http://www.eventsinfocus.org/news/546>>.
- Fan, M. (2006) 'Environmental Justice and Nuclear Waste Conflicts in Taiwan', *Environmental Politics* 15(03): 417-434.
- Grano, S.A. (2015) *Environmental Governance in Taiwan: A New Generation of Activists and Stakeholders*. Taylor & Francis.
- Hansson, S.O., K. Lilieqvist, K.E. Björnberg and M.V. Johansson (2016) 'Time Horizons and Discount Rates in Swedish Environmental Policy: Who Decides and on what Grounds?', *Futures* 76: 55-66.
- Harrington, D.W. and S.J. Elliott (2015) 'Understanding Emerging Environmental Health Risks: A Framework for Responding to the Unknown', *The Canadian Geographer/Le Géographe canadien* 59(3): 283-296.
- 何明修 (2001) 〈台灣環境運動的開端：專家學者、黨外、草根 (1980-1986)〉，*台灣社會* (2): 97-162。
- Ho, M. H. (2001) 'The Early Stages of Taiwanese Environmentalism: Intellectuals, Tangwai and Grassroots (1980-1986)', *Taiwan Society* (2): 97-162.
- Huang, G.C., T. Gray and D. Bell (2013) 'Environmental Justice of Nuclear Waste Policy in Taiwan: Taipower, Government, and Local Community', *Environment, Development and Sustainability* 15(6): 1555-1571.
- 黃東益 (2014) 〈放射性廢棄物最終處置民眾關心議題蒐集與分析〉，行政院原子能委員會委託研究計劃研究報告(編號：1032001INER047)，行政院原子能委員會。
- Huang, T. Y. (2014) 'Public Attitudes toward Low-Level Nuclear Waste Siting Issues in the Surrounding Areas of Potential Sites' (Atomic Energy Council No. 1032001INER047), Atomic Energy Council.

- Hung, H. and T. Wang (2011) 'Determinants and Mapping of Collective Perceptions of Technological Risk: The Case of the Second Nuclear Power Plant in Taiwan', *Risk Analysis* 31(4): 668-683.
- Irwin, A. (1995) *Citizen Science: A Study of People, Expertise and Sustainable Development*. Routledge.
- Irwin, A. (2001) *Sociology and the Environment: A Critical Introduction to Society, Nature, and Knowledge*. Polity Press.
- Irwin, A. and B. Wynne (1996) 'Introduction', in A. Irwin and B. Wynne (eds) *Misunderstanding Science?: The Public Reconstruction of Science and Technology*, pp. 1-17. Cambridge University Press.
- Kuppler, S. (2012) 'From Government to Governance?(Non-) Effects of Deliberation on Decision-Making Structures for Nuclear Waste Management in Germany and Switzerland', *Journal of integrative environmental sciences* 9(2): 103-122.
- 梁世武 (2014) 〈風險認知與核電支持度關聯性之研究；以福島核能事故後台灣民眾對核電的認知與態度為例〉，*行政暨政策學報* (58): 45-86。
- Liang, S. W. (2014) 'The Research on the Relation between Risk Perception and Support for Nuclear Power: the Case Study of Taiwanese People's Perception and Attitudes towards Nuclear Power after Fukushima Incident', *The Journal of Public Administration and Policy* (58): 45-86.
- 林怡廷 (2013) 〈核廢之島〉 2017 年 7 月 29 日取得 〈<https://2013.sopawards.com/wp-content/uploads/2012/11/393-isunaffairs-An-Island-Polluted-by-Nuclear-Waste.pdf>〉
- Lin, Y. T. (2013) 'An Island Polluted by Nuclear Waste' Accessed 27 July 2017 〈<https://2013.sopawards.com/wp-content/uploads/2012/11/393-isunaffairs-An-Island-Polluted-by-Nuclear-Waste.pdf>〉。
- Mythen, G. (2004) *Ulrich Beck: A Critical Introduction to the Risk Society*. Pluto Press.
- Museum of the City (image) (n.d.) Accessed 13 November 2017 < <http://www.museumofthecity.org/project/nuclear-power-in-taiwan/> >
32. Nowotny, H., P. Scott and M. Gibbons (2001) *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. Wiley.
- OECD Nuclear, E.A. (1999) *Low-Level Radioactive Waste Repositories: An Analysis of Costs*. Nuclear Energy Agency, Organisation for Economic Co-operation and Development.
- Shyu, J.B.H., Y. Chuang, Y. Chen, Y. Lee and C. Cheng (image) (2016) 'A New on-Land Seismogenic Structure Source Database from the Taiwan Earthquake Model (TEM) Project for Seismic Hazard Analysis of Taiwan.', *Terrestrial, Atmospheric & Oceanic Sciences* 27(3).

- Slovic, P. (1993) 'Perceived Risk, Trust, and Democracy', *Risk analysis* 13(6): 675-682.
- Stirling, A. (2003) 'Risk, Uncertainty and Precaution: Some Instrumental Implications from the Social Sciences', in F. Berkhout, M. Leach and I. Scoones (eds) *Negotiating Environmental Change: New Perspectives from Social Science*, pp. 33-76. Edward Elgar Publishing, Incorporated.
- 風傳媒 (2016) 〈成立非核家園推動專案小組，林全：2025 非核家園一定要達成〉，9月2日〈<http://www.storm.mg/article/161656>〉。
- Storm Media (2016) 'Forming Nuclear-Free Homeland Promotion Team, Lin Chuan: Nuclear-Free Homeland by 2015', 2 September <<http://www.storm.mg/article/161656>>.
- 台灣環境資訊中心 (2016) 〈核廢露天乾貯 日專家建議「請思考更安全的方法」〉2月28日〈<http://e-info.org.tw/node/113525>〉。
- Taiwan Environmental Information Center (2016) 'Outdoor Nuclear Waste Storage, Japanese Expert Suggested to Consider Safer', 28 February <<http://e-info.org.tw/node/113525>>.
- 財團法人蘭嶼部落文化基金會 (2009) 〈近代歷史沿革〉2017年7月27日取得〈<https://www.taofoundation.org.tw/story/history>〉。
- Tao Foundation (2009) 'Recent History' Accessed 27 July 2017 <<https://www.taofoundation.org.tw/story/history>>.
- Wynne, B. (1996) 'Misunderstood Misunderstandings', in A. Irwin and B. Wynne (eds) *Misunderstanding Science?: The Public Reconstruction of Science and Technology*, pp.19-46. Cambridge University Press.