

Comparative Study of the Politics of Nuclear Decommissioning between Great Britain and South Korea

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Abstract

This paper attempts to make a diachronic examination of the politics of nuclear decommissioning between Great Britain and South Korea. Great Britain has been the first country to explore the nuclear power plant since 1956, and the state-run Nuclear Decommissioning Agency(NDA) was established in 2004. Ever since then, NDA has committed to working with its supply chain, from the largest to the smallest players, to improve opportunities for involvement in decommissioning. It contributes to creating the right environment for success with a wide range of technical and service suppliers. This NDA linking with a supply chain could be the most successful so far and possibly the largest of its kind in Europe. On the other hand, South Korea built its first nuclear plant in the 1970s, and is now expected to decommission twelve nuclear plants by 2030. Devising a nuclear decommission strategy in South Korea is urgent. We examine both technical and social issues in order to pursue a reliable model for the Korea's nuclear decommissioning. This paper could demonstrate an important element in state-business interrelationships in the nuclear decommissioning market. Furthermore, this paper can serve as a model for future comparative studies involving other countries with advanced nuclear power facilities including the USA, France, Germany and Japan.

I. Introduction

There is growing concern on importance of nuclear decommissioning in the world nuclear society. Nowadays, 140 nuclear power plants (NPPs) have permanently ceased commercial operation, 96 NPPs are waiting for a decision after it ceases its operation.¹ A half of the world's nuclear reactors are likely to be closed by 2030. The global market of nuclear decommissioning is increasing along with the expansion of construction of NPPs in the world. One source foresees the market size to be approximately \$81,484 million by 2030.²

Decommissioning nuclear facilities is a challenging project. To completely decommission a one million KWh nuclear power plant takes several decades and \$500 million USD. Technical challenges are complex, including a cutting and removal facility, which is likely to be contaminated by radioactive substances. In addition, chemical and mechanical decontamination is essential to ensure not only the safety of workers but also environmental restoration, to satisfy the public. The social costs will also be immense. Given the social sensitivity toward unsafe facilities like nuclear power plants, it is inevitably necessary to build a consensus among diverse stakeholders through every stages of decommissioning.

When it comes to initiating such huge national project, of particular important in this regard is to establish governing stakeholders' involvement since technical and socio-political issues are mixed. Government's role to set up the legal guideline is important for clean-out facility in order to maximize social and workforce safety. To date, however, there has been minimal research regarding nuclear decommissioning in the context of political science.

Central to this paper is to shed the lights on the challenges of building up national system in South Korea through comparing cases with others. Discussion will center around finding the key to define what make national system different from each other. Nuclear decommissioning is a complex issue which has not yet definitely resolved. At the outset, thus, it is imperative to clarify what we mean on the concept of decommissioning when we talk about its initiation system. Since this is very beginning study, we will limit ourselves to outlining a case of the United Kingdom of Britain. We shall see how the British government establishes the unique system to handle the issues of cleaning out nuclear facilities. Other cases will be briefly mentioned in conceptualizing part.

This paper also attempts to arouse attention on the necessary of engaging social science into the nuclear decommissioning study. Although the decommissioning is oriented from science and technologies, attention from social sciences is necessary to govern the stakeholder involvement within legal framework. The efforts allow following up study to extend further analysis about other cases in the context of political science.

¹ Early generation of nuclear power plants were designed for operating life of about 30 years, while newer plants are designed for a 40 to even 60 years. Most of countries, however, allow possibility of continuing operation in accordance with strict regulation of maintenance.

² Wood, L. (2013). Research and Markets: Nuclear Reactor Decommissioning Industry-Global Market Size and Competitive Landscape Analysis to 2030.

II. Conceptualizing Nuclear Decommissioning

The term nuclear decommissioning refers to the comprehensive process to restore nuclearized site to its original status.³

The strategy to accomplish the goal is twofold: immediate dismantling (DECON) and deferred dismantling (SAFSTOR). The DECON strategy is to remove equipment, structure, and portions of the facility following decontamination to a level stipulated by government regulation. SAFSTOR, on the other hand, is the strategy in which the process develops gradually from decontaminated to contaminated portion of facility. While those non-contaminated parts are removed or dismantled, the others are stored in safe allowing the radioactivity to decay. Besides, another strategy in deferred dismantling, ENTOMBment, is occasionally quoted as a third option that radioactive contaminants are permanently encased on site in structurally sound material such as concrete. However, ENTOMB option is nowadays excluded since the next phase of storage (e.g. site restoration) is not included.⁴

Each country is slightly different in terms of preferred strategy for decommissioning. National policy on nuclear power is the most important in this matter. The U.S. provides the guideline that stipulate a NPP operator chooses one of three strategies, though ENTOMB is only available within limited condition of protecting public health and safety in accordance with the regulation. France prefers to immediate dismantling, while Japan, Canada, Italy recommend deferred one. The UK prefers SAFSTOR since the country has been limited in choosing strategy due to most of NPPs consisting of gas cool reactor (GCR) type. The strategy preference is also influenced by macro policy change on the energy mix. Germany who recently declared denuclearization has changed its position from the deferred to immediate decommissioning that includes full scope of environmental restoration.

Regarding the governance of decommissioning project, it is crucial to define roles of groups that each one participating in each different stage of decommissioning project harmoniously share for achieving ultimate goal of safety and restoration. Stakeholders, in this context, consisting of a licensed NPP operator, regulator, and civil society, would be asked to join the project along with different role and responsibility.

A NPP operator is major player who inherently holds the duty to draft decommissioning plan. The operator takes a role of project management; ensure appropriate amount of funds; have responsibility to report to not only regulator but also the public as to the development of decommissioning activities. Regulator is watchdog for surveillance operator's work progress from very beginning to the end and making permission of the project initiation and cessation.

³ The definition of decommissioning has been diversified in terms of targeted final stage. International Atomic Energy Agency (IAEA) defines the decommissioning as the administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility. European Union's stance on the decommissioning embodies the general strategy of environment strategy of environment restoration after the final suspension of the industrial activities. These views are different from final destination of decommissioning action; while the IAEA aims at the status of deregulation, the EU delineate the environmental restoration of nuclear site. Regarding concept of nuclear decommissioning, see IAEA (2014). Decommissioning of Facilities. General Safety Requirements Part 6 No. GSR Part 6. IAEA Safety Standards (IAEA: Vienna), 2014. p.1; European Commission Official website (<http://www.eu-decom.be/introduction/initintroduction.htm>)

⁴ Entombment used to be mentioned one of three strategies, but recent discussion at the IAEA board meeting in March 2014 removed Entomb option from the decommissioning strategies. See OECD (2006). Selecting Strategies for the Decommissioning of Nuclear Facilities. *Nuclear Energy Agency NEA No. 6038*. (OECD: Paris)

Civil society’s participation should be included in the process in terms of enhancing public acceptance. All stakeholders’ roles should be defined within institutional framework.

Once decommissioning is recognized, a government, as a control tower, needs to take systemic approach to manage stakeholders’ tasks on each different stage. The decommissioning process is categorized into three: preparation, dismantlement, and restoration.

For the preparation stage, it has to define who draft the decommissioning plan and who recognize it. The plan has to include the direction of how to raise and organize the fund, radioactive waste materials in accordance with safety regulation. The plan needs to be submitted to authority and wait for recognition. In the U.S case, the licensee drafts the decommissioning plan entitled as the Post-Shutdown Decommissioning Activities Report (PSDAR) to the regulator after permanent shutdown, the U.S. Nuclear Regulatory Commission (NRC). The PSDAR must include decommissioning strategy, project timeline, possible cost and funding plan. The NRC opens the PSDAR to the public and permits the NPP operator’s initiation.

On the dismantlement stage, the licensee set to work in earnest in accordance with regulatory guideline. It is essential to maintain a level of safety that ensure public and occupational health and safety. Regulatory arrangements should be traceable to current international standards. All parts, equipment, and portions of facility have to be decontaminated and proved to the appropriate level. Throughout the process, is environmental restoration followed if stakeholders including civil society recognize the decommissioning achievement in terms of safety and wellness.

<Table-1> Features of decommissioning in each stage*

	Preparation	Dismantlement	Restoration
Minimum duration	5 years	10 years	5 years
Cost (%)	20	60	20
Tasks	<ul style="list-style-type: none"> • Planning • Fund raising • Public hearing • Permission for begin 	<ul style="list-style-type: none"> • Dismantle facility • Decontamination • Waste management • Safety evaluation • Public hearing 	<ul style="list-style-type: none"> • Site restoration • Safety evaluation • Public hearing • Termination of license
Stakeholder	<ul style="list-style-type: none"> • NPP operator • Safety regulator • Supply chain (e.g. engineering companies) 		<ul style="list-style-type: none"> • Government agencies • Civil society

* In the DECON strategy

Diverse cases on the national system of nuclear decommissioning can be categorized in terms of government involvement into the project. Three categories are suggested: state-oriented, market-oriented, and mixed systems.

State-oriented system is to precede the nuclear decommissioning project through the public resources. The state corporation who dominantly owns the right to operate a nuclear power plant is taking the major role to set the plan to clean out its facility. Top level members of

supply chain consist of state giant corporations. In France, for example, 98% of NPPs are operated by state corporation, EDF, while the nuclear engineering company, AREVA, and waste management agency, ANDRA, have dominant role in each field. During the process, the government directly engages into the development process in order to share the burden of the operator. In sum, the government has roles to set the policy direction as well as directly managing the project through its subsidiary body.

In the market-oriented system, the nuclear industry is basically in market order that private companies share the operation of NPPs. Diverse companies are competing each other in each level of supply chain. The legal framework defines the stakeholder involvement on each stage of decommissioning. Government strongly pushes the private company forward the company to handle with its ageing facility. Germany emphasizes the principle of *polluter pays* so that a NPP operator has responsibility to clean out its facility after permanent cessation. The role of government in this case is strictly limited in surveillance and regulating by making a decision on the work progress of the private sector. Civil society including local community's participation is guaranteed by related regulation to join into decision making process.

Mixed system is unique that the public and private share the responsibility of whole decommissioning process. In Japan, nuclear industry is privatized that 10 companies are shared 48 NPPs operation market. Although the system is emphasizing company's role to be in charge of decommissioning its facility, government leads the public sector to take the certain sensitive portions such as radioactive waste and fund raising management. Following table shows categorization of major five countries by three systems:

<Table-2> Decommissioning system and stakeholder involvement by system

Type	Country	Decommissioning Planner	Waste Management	Regulator	Fundraiser	Fund Management
State-oriented	France	Sate Corporation (EDF)	Public agency (ANDRA)	ASN	EDF	Government (CEA)
	UK	Public Agency (NDA)	NDA	HSE, CoRWM	NDA	NDA
Market-oriented	USA	Private NPP owner	NPP owner	NRC	NPP Operator	NPP Operator
	Germany	Private NPP owner	Private NPP owner	State Government	NPP Operator	NPP Operator
Mixed	Japan	NPP owner	State Corporation (Japan Nuclear Fuel Ltd.) , Government agency (NUMO)	AEC, NISA	Share the cost among stakeholders	Share the cost among stakeholders

III. The UK system for nuclear decommissioning

The UK has established state-oriented system for decommissioning of nuclear facility. Strong government involvement is symbolized in the legal entity of Nuclear Decommissioning Agency (NDA) that takes all necessary responsibility to clean out the legacy of nuclear facility. We begin with the historical angle because it provides the necessary background for discussing the current decommissioning system.

The UK was the first in the world that initiated successfully civil nuclear power program for commercial purpose in 1956. Like any other countries who initiate nuclear program in early 1950s, the UK also had national strategic priority to the nuclear program in order to

maximize national interest. After the U.S. showed off the world by massive power of atomic bomb in 1945, the Soviet Union quickly established nuclear program and then achieved connection to the grid in the 5 MW research reactor at Obninsk in 1954. The UK government in this context pushed forward to country being nuclearizing in military purpose, which means having nuclear facility to produce plutonium. The speed and the government's assessment of strategic necessity were placed at the top, which economic consideration was counted a bit lesser.⁵ Growing capacity of nuclear power generator was at the peak in 1997, nuclear power provided 26% of nation's electricity.

What makes the UK case unique is type of nuclear reactor. The UK nuclear industry heavily relies on the AGR that is minor popularity in current world nuclear industry.⁶ The first NPP site, Calder Hall at Sellafield, had four Magnox reactors generating 60 MWe (net) of power each. Since then, general nuclear industry had been growing up within the government support. In 1960s, nuclear research institute, the United Kingdom Atomic Energy Agency (UKAEA), developed the unique type of reactor, advanced gas-cooled reactors (AGR). Nowadays, the UK owns 16 reactors consisting of one Magnox, one pressured water reactor (PWR), and fourteen AGR generating about 18% of its electricity, while those 29 permanently ceased nuclear facilities were on decommissioning process and 15 NPPs of 16 operating NPPs likely are at stake by 2030.

In 1990s, the government decided rearranging the disposition of nuclear stakeholders. UKAEA transformed to British Energy (BE) following merge with minor NPPs companies. In 1998, the British Nuclear Fuel Ltd (BNFL) was directed to take ownership of ceased Magnox facility. BE and BNFL became owner of aged NPPs that worsened their liabilities status. Growing concerns on the capability of two major owners led the government to take a risk of handling nuclear facility. According to the White Paper *Managing the Nuclear Legacy in July 2002* pointed out that the government authority should take the financial responsibility for all UK civil nuclear facility including commercial activity.⁷

Moreover, most of reactor types, Magnox and AGR, are relatively more expensive than the others such as PWR since more waste materials are produced during the course of the decommissioning process.⁸ Thus, the government decided directly engaging into the decommissioning project.

The NDA was established to retake responsibility for NPP ownership as well as decommissioning project. The UK Energy Act in 2004 outlined officially mission of the NDA legal entity in charge of carrying out a decommissioning project of all aged NPPs including planning, regulating, and managing funding issues. The NDA aims to deliver safe and sustainable solutions to the challenge of nuclear decommissioning and waste management.

⁵ MacKerron, G. (2012). Evaluation of nuclear decommissioning and waste management. *Report to the Secretary of State for Energy and Climate Change*. Brighton, SPRU, University of Sussex. pp.10-11.

⁶ The world most favorite type of NPP is Pressured Water Reactor (PWR). PWR

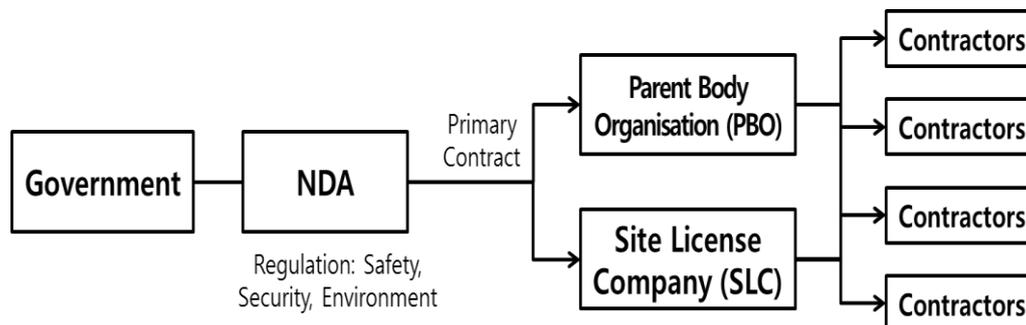
⁷ MacKerron, G. (2012). *ibid.* p.64

⁸ Bertel, E., & Lazo, T. (2003). Decommissioning policies, strategies and costs: an international overview. *NEA News*, (21), 8-12.

The role of NDA is mixed stakeholder involvement ranging from forming a strategy in accordance with national regulation guidelines, managing decommissioning project including cost and funding management to storing various level of radioactive wastes. The authority also conducts surveillance activities for ongoing projects initiated by private entities following managing supply chain of the project. NDA promotes the research and development, education and training, international cooperation in the field of nuclear decommissioning and facilitate the public awareness through diverse publication. Besides, other government agencies such as the UK Health and Safety Executive (HSE) and Committee on Radioactive Waste Management (CoRWM) are limited in only advising to NDA in guideline and regulation activities.

The UK government has been strong state-oriented system that every role of stakeholders is embedded into one legal entity. The government had to inevitably engage into the issue of nuclear decommissioning due to structural changes of nuclear industry. Whole responsibility of clean-out nuclear facility is imposed severe strain that the authority has to deal with tasks of every stage of decommissioning. Though NDA as a the specializing institute is able to accumulate the know-how with intense experiences that can be asset to upcoming global market of decommissioning, burdens derived from nuclear policy legacy are inevitably assigned from public resources.

Figure 1: Organization of Decommissioning and Waste Management



Adapted from MacKerron, Gordon. Evaluation of nuclear decommissioning and waste management. *Report to the Secretary of State for Energy and Climate Change. Brighton, SPRU, University of Sussex.* 70.

IV. Nuclear decommissioning and South Korea’s challenge

South Korea is a fifth largest nuclear country in terms of total net electrical capacity of nuclear power. 23 NPPs provide almost one-third of total national electricity and even more NPPs are planned to construct. After the ashes of Korean War in 1950s, government focused on rebuilding country’s economy. Given a lack of natural resource on the Korean peninsula, it was prerequisite to find cost-effective energy source; one of them was nuclear power. The nuclear program was initiated by the government that dictatorship then urged speedy development along with full support to the industry. The public resources were driving force to establish such state-centered industry that forms the industrial structure consisting of state corporations, government-funded research institute, and so on.

South Korea is typical state-oriented case that government as the largest stakeholder of nuclear industry has dominant influences. Major stakeholders in nuclear industry are as follows:

- KHNP (Korea Hydro and Nuclear Power), the dominated NPP operator who owns every NPPs in South Korea,
- KEPCO (Korea Electric Power Corporation) and its subsidiaries take sole roles in the market of nuclear engineering (KEPCO E&C) and fuel-cycle (KEPCO NF)
- KORAD (Korea Radiative Waste Agency) in waste management,
- KAERI (Korea Atomic Energy Research Institute)
- KINS (Korea Institute of Nuclear Safety)

Nuclear decommissioning is national agenda in nowadays. It is because of twelve NPPs are being expired their design life by 2030. Wolsong-1 NPP already expired is waiting for regulator's official announcement whether it remains one more decade to operate or permanently cease the operation.

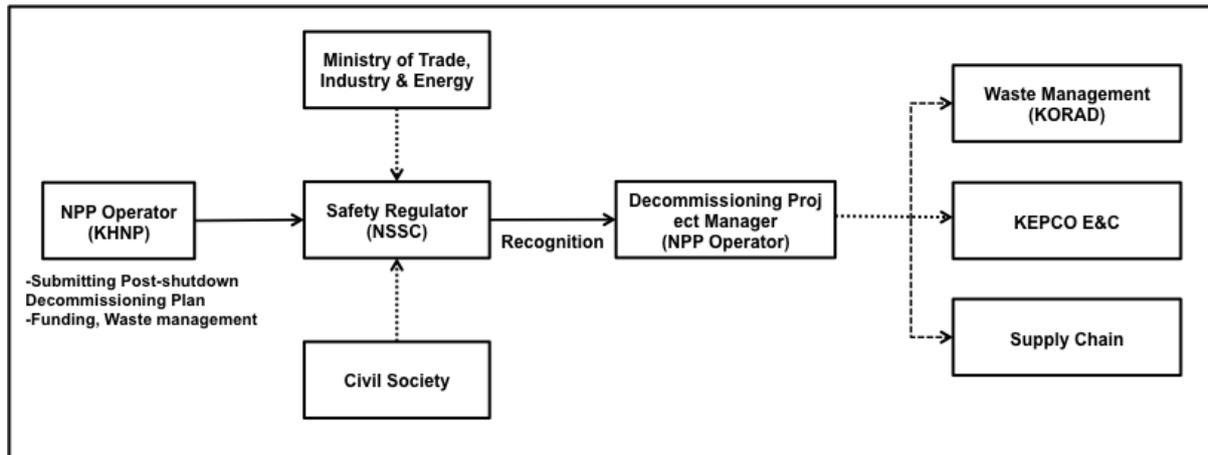
Challenges for completing the nuclear decommissioning are twofold: technical capability and institutional system. In Korea, necessary technological level is not ready for imitating program so that government announced the research development roadmap to commercialize technology by 2030.

Institutional system, on the other hand, is premature for the clean-out nuclear facility. The system is essential to maximize the safety and efficiency of nuclear decommissioning project through governing stakeholders efficiently in systematic framework. According to the IAEA recommendation, the roles and responsibilities of each stakeholder in nuclear decommissioning shall be stipulated in the appropriate safety regulation. However, South Korea's regulation has not yet delineated the whole systematic mechanism of the project.

Many pointed out that current decommissioning system need to be improved at the earliest. First of all, South Korea has to define the concept of nuclear decommissioning in accordance with national policy and energy environment. Defining roles of stakeholder involvement is also important in not only assigning certain tasks but also allowing them to join into the consequential decision about the strategy for decommissioning the facility. NPP operator, regulator, civil society – every stakeholder have the right to contribute to the successful clean-out nuclearized site. In current system, however, only NPP operator and regulator are defined for its role to draft the plan and recognition, respectively. Other stakeholder for example the public agency in charge of waste management is not included in the current framework. Absence of control tower is also pointed that who calls the right to manage the whole project.⁹

⁹ Regarding discussion on stakeholder involvement for nuclear decommissioning in Korea, see Ahn, S. K., et al. (2006). Consideration of Regulatory Systems for Decommissioning of Nuclear Power Plants.”

Figure 2: Current Decommissioning System in Korea



Secondly, there is criticism on financial readiness for upcoming decommissioning project in Korea. The South Korea's Nuclear Safety Act defines only the fundraiser, NPP operating company (KHNP), who makes the enough money to clean out without management direction. Many criticize that KHNP's funding capability is questionable to prepare enough money during decades of decommissioning process. Moreover, the cost of decommissioning will be accidentally raised due to unexpected variables. According to the nuclear regulatory entity in South Korea, Nuclear Safety and Security Commission (NSSC), the cost to decommission 100 MWe commercial nuclear power plant is 60 billion KRW (\$ about 557 million). Variables for radioactive waste management and social cost are not estimated so that the critics point the necessary of extra budget. This unexpected risk provides righteousness of government engagement to share the financial burden among stakeholder in accordance with efficient system.

Thirdly, the public relations should be handled within principle of transparency. Decommissioning nuclear facility inevitably includes dismantlement of contaminated facility and move out radioactive waste from the site. Throughout the process, the public's awareness reaches the greater uncomfortable to not only people near the site but also the whole society. Given the fact that South Korea has been struggling to meet the social consensus on nuclear program, decommissioning program without well-governed discipline leads to being at stake. The Nuclear Energy Agency of the OECD points out that civil society involvement is essential to guarantee the successful decommissioning. The NEA recommends to apply political communication such as a public hearing and allow civil leaders to participate into the critical decision making process.¹⁰ Any citation on the necessary of public engagement in nuclear decommissioning is not yet included on the national guideline.

Previous researches provide alternative models of system for the clean-out nuclear facility. Common stance is to emphasize the directive engagement of government following defining clear guideline in legal regulation. Additionally, most of studies adopt the lessons learned from overseas' cases and emphasize on establishment of the independent entity in charge of

¹⁰ Le Bars, Y. (2006). Rapporteur's report-Topical session on stakeholder involvement in decommissioning projects, November 14, 2005. pp. 15-17.

every tasks of decommissioning program.¹¹ Given the lack of systematic approach in legal form in Korea, it is very difficult to benchmark others without implicit approach to understand general environment of nuclear industry in certain country.

V. Conclusion: lessons learned

This paper discusses on importance of establishing national system for nuclear decommissioning and introduces diverse cases of the system in different environment. What we found is the importance of establishing collaborative system for every stakeholder in nuclear decommissioning project. Regarding the challenges of decommissioning, one party can hardly manage clean out activities by its own capability. Government in this context has to define role and responsibility of possible stakeholder group to share the burden and suggest clear guideline for them to follow up. Since dismantlement of nuclearized facility bring great public awareness, government should set up the principle to strengthen transparency and allow the civil society to join into decision-making process.

The necessary of government's role in national decommission system has been highlighted more than ever. In March 2014, the IAEA board committee announced new safety guideline on nuclear decommissioning that emphasizing the government's role to set up stakeholder involvement within legal framework. Those who have already initiated the decommissioning strengthen national guideline to achieve success of the project in term of efficiency and safeness.

I also found that each country is different from each other in terms of amount of public engagement. Comparing state-oriented countries like France and the UK that adopt the total engagement of the public resource into the project, the U.S and German cases show that a NPP owner is asked to take more responsibility to prepare all necessary resources to initiate the decommissioning project. Japan developed mixed system to share the burden of cleaning out nuclear facility. Particularly, the UK case shows direct engagement of government through specializing decommissioning agency. All activities are made of the public resources. South Korea is seemingly standing on the juncture to choose whether government engage more into the project or not.

¹¹ The UK case is most famous in the study of nuclear decommissioning in Korea since the special organization, Nuclear Decommissioning Authority, has been placed at the center of national decommissioning projects.

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