

## A Study on Legal and Institutional Improvements for the Deployment of Small Modular Reactors

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### 1. Introduction

Amid the accelerating global transition toward energy systems aimed at addressing climate change and achieving carbon neutrality, nuclear power continues to be regarded as an important baseload energy source due to its stability and low-carbon characteristics. However, conventional large-scale nuclear power plants have revealed structural limitations, including long construction periods, substantial upfront capital costs, and social conflicts arising during site selection processes. These limitations have acted as major constraints on the deployment of new nuclear power plants and have raised the need to reconsider the role of nuclear energy within the broader energy transition.

Against this background, the Small Modular Reactor (SMR) has emerged as a next-generation nuclear technology capable of mitigating the structural limitations associated with large-scale nuclear power plants. SMRs are characterized by relatively small power output and modular designs based on factory fabrication. Through the application of passive safety systems, they are designed to maintain safety functions without external power supply or active intervention in the event of an accident. Furthermore, by combining multiple SMR modules, phased capacity expansion becomes feasible, and various deployment scenarios have been proposed, including distributed power generation, electricity supply to industrial complexes, district heating, and hydrogen production.

Nevertheless, for the technological advantages of SMRs to be realized within actual energy systems, institutional acceptability must be secured in addition to technological development. Nuclear facilities are inherently subject to strict legal, regulatory, and licensing frameworks, and technological feasibility alone does not determine their deployment. In particular, the Korean nuclear regulatory framework has evolved incrementally on the premise of large-scale light-water reactor nuclear power plants, with relatively uniform assumptions regarding reactor output, site conditions, business structures, and operational models. Such institutional path dependency may act as a constraint in accommodating reactor concepts with technological and

operational characteristics that differ from those of conventional large-scale plants, such as SMRs.

Previous studies on SMRs have primarily focused on technical aspects, including reactor design development, safety evaluation, economic analysis, and grid integration feasibility. Although discussions on the policy and industrial implications of SMRs have recently expanded, systematic analyses of the Korean legal and institutional framework from a comparative perspective with the licensing structure of large-scale nuclear power plants remain limited. In particular, studies that comprehensively examine how institutional structures designed around large-scale nuclear power plants generate structural mismatches in the process of SMR deployment are insufficient.

Accordingly, this study addresses the following research questions.

First, under what assumptions has the Korean nuclear legal and institutional framework been designed, and how is it linked to the licensing structure centered on large-scale nuclear power plants?

Second, when this institutional structure is applied to various SMR deployment scenarios, what types of legal and regulatory inconsistencies and bottlenecks arise? Third, do these issues stem from interpretative ambiguities within individual statutes, or from structural limitations embedded in the overall regulatory framework?

To answer these questions, this study establishes the licensing and approval procedures for the construction and operation of large-scale nuclear power plants in Korea as a reference model and applies them to three representative SMR deployment scenarios: baseload power generation, distributed power supply within industrial complexes, and conversion of retired coal-fired power plant sites. Major statutes—including the Electric Utility Act, the Nuclear Safety Act, the National Land Planning and Utilization Act, the Environmental Impact Assessment Act, the Building Act, and the Electric Technology Management Act—were reviewed at the article level. Institutional issues were derived through a comprehensive analysis of the proposed SMR Special Act, the Special Act on the Promotion of Distributed Energy, selected international cases, and consultations with legal experts.

The objective of this study is not merely to attribute institutional barriers to excessive regulation or procedural inefficiency, but to analyze them from the perspective of structural compatibility between technological characteristics and regulatory frameworks. By doing so, the study explains why the technological advantages of SMRs are not sufficiently realized within the existing institutional system and provides foundational material for future discussions on legal and institutional reforms for SMR demonstration and commercialization.

## 2. Research Methodology

This study applies a three-dimensional analytical framework consisting of “statute–procedure–applicability” to structurally examine legal and institutional issues related to the deployment of SMRs. Rather than relying on fragmentary interpretations of individual statutory provisions, this methodology is designed to systematically identify structural compatibility issues arising when a licensing framework originally developed for large-scale nuclear power plants is applied to the technological characteristics of SMRs.

At the level of applicability, three representative SMR operational scenarios were established. The first scenario (S1: single-site baseload model) assumes the deployment of multiple SMR modules concentrated at a single site, operating in a manner similar to conventional large-scale nuclear power plants to provide baseload electricity. The second scenario (S2: industrial complex distributed combined heat and power model) assumes distributed installation within an industrial complex to supply both electricity and heat. The third scenario (S3: coal-site conversion model) considers the installation of SMRs on decommissioned coal-fired power plant sites. By distinguishing these scenarios, the study enables a comparative analysis of how different institutional bottlenecks may arise depending on site configuration and business structure, even under the same statutory framework.

At the procedural level, the construction and operation process of large-scale nuclear power plants in Korea was established as a reference model. This model includes the sequential stages of planning and site selection, environmental impact assessment, reactor site approval, design and construction licensing, construction and commissioning, and operation licensing followed by the commencement of commercial operation. Based on this reference process, applicable statutes and responsible authorities at each stage were mapped in order to identify points at which additional requirements, regulatory overlaps, or interpretative uncertainties may arise in the context of SMR deployment.

At the statutory level, major laws directly related to SMR deployment were selected for analysis. These include the Electric Utility Act, which governs the

**Table I: Typology of Institutional Bottlenecks**

Type	Definition
T1 Absence of Definition	Cases in which the SMR category or its applicability is not clearly defined in statutory provisions.
T2 Rigidity of Criteria	Cases in which capacity, siting, or operator requirements remain fixed based on standards established for large-scale nuclear power plants.
T3 Regulatory Overlap	Cases in which multiple licensing or supervision procedures are applied to the same facility.
T4 Jurisdictional Conflict	Cases in which conflicts arise in the allocation of authority between central and local governments.
T5 Interpretative Uncertainty	Cases in which the applicability of statutory provisions depends on administrative interpretation, resulting in low regulatory predictability.

licensing structure for electricity generation businesses; the Nuclear Safety Act, which regulates reactor installation and safety oversight; the National Land Planning and Utilization Act, which governs land use and spatial planning; the Environmental Impact Assessment Act, which prescribes prior environmental review procedures for development projects; the Building Act, which establishes building permitting requirements; and the Electric Technology Management Act, which regulates the design and supervision of electrical facilities. Each statute was reviewed at the article level.

Based on this three-dimensional analytical framework, institutional bottlenecks arising at each intersection of scenario and procedural stage were categorized into five types. The first type (T1: absence of definition) refers to cases in which the category or applicability of SMRs is not clearly defined within the relevant statute. The second type (T2: rigidity of criteria) refers to situations where capacity, siting, or operator requirements remain fixed according to standards established for large-scale nuclear power plants. The third type (T3: regulatory overlap) refers to cases in which multiple licensing or supervision procedures apply to the same facility. The fourth type (T4: jurisdictional conflict) refers to conflicts in the allocation of authority between central and local governments. The fifth type (T5: interpretative uncertainty) refers to situations in which the applicability of statutory provisions depends heavily on administrative interpretation, thereby reducing predictability. Table 1 presents the typology of institutional bottlenecks identified through the three-dimensional analytical framework.

Through this analytical approach, the study conceptualizes barriers to SMR deployment not as issues

of regulatory stringency alone, but as structural compatibility problems between existing regulatory premises and the technological characteristics of SMRs. This framework provides the theoretical and methodological foundation for the subsequent analysis of statute-specific issues and the derivation of legal and institutional reform directions.<sup>7</sup>

### **3. SMR Deployment Scenarios and Institutional Analysis Framework**

Unlike conventional large-scale nuclear power plants, SMRs encompass a wide range of variations in terms of output capacity, installation configuration, operational objectives, and siting conditions. These characteristics suggest that SMRs should not be defined as a single category of power generation facility, but rather understood as a class of technologies requiring differentiated institutional application depending on their deployment purpose and installation environment. Accordingly, the analysis of legal and institutional frameworks for SMR deployment must be grounded not in abstract technological concepts, but in concrete operational scenarios.

As a benchmark for analyzing institutional acceptability, this study establishes the licensing and approval procedures for the construction and operation of large-scale nuclear power plants in Korea as a reference model. Given that the current nuclear regulatory framework has been developed on the premise of large-scale nuclear power plants, this reference model provides an appropriate basis for examining institutional path dependency. The model is subsequently applied to representative SMR deployment scenarios in order to derive structural compatibility issues and institutional mismatches.

Based on potential SMR deployment models likely to be discussed in Korea, three representative operational scenarios were defined. Each scenario reflects variations in the scope of applicable statutes and the structure of licensing procedures.

#### *3.1 Single-Site Baseload Model*

The first scenario considers the use of SMRs as baseload power sources in a manner similar to conventional large-scale nuclear power plants. In this scenario, multiple SMR modules are concentrated at a single site or adjacent sites to secure the required generation capacity, while maintaining overall plant availability through module-level operation and maintenance.

From a technical perspective, this scenario performs a role similar to that of large-scale nuclear power plants in electricity generation. However, the modular design introduces potential differences from existing institutional frameworks, including the possibility of phased construction permits, staggered commencement of commercial operation, and module-level safety

verification. In particular, if standards established for large-scale nuclear power plants are applied without modification to reactor installation licensing, environmental impact assessment, and emergency planning zone designation, the specific design characteristics of SMRs may not be adequately reflected.

This scenario serves as a baseline case to examine whether the current regulatory framework applies uniform regulatory structures regardless of output scale and whether modular design concepts can be institutionally accommodated.

#### *3.2 Industrial Complex Distributed Model*

The second scenario assumes the deployment of SMRs as distributed power sources within areas requiring high electricity reliability, such as industrial complexes, data center clusters, and advanced manufacturing zones. This scenario directly reflects the distributed and proximity-based characteristics of SMRs and is structured as a complement or alternative to centralized power supply systems.

Under this scenario, SMRs function not merely as power generation facilities but as customized energy infrastructure serving specific demand centers. Consequently, multiple legal and institutional issues arise simultaneously, including the classification of SMRs under the Electric Utility Act (distinguishing between generation business and new electricity business), compatibility with distributed energy policy, land use zoning and urban planning authority under the National Land Planning and Utilization Act, and the scope of application of the Building Act.

This scenario is intended to assess whether an institutional framework designed primarily for large-scale nuclear power plants can accommodate urban or industrial-site SMR deployment, and how the allocation of authority between central and local governments may affect SMR introduction.

#### *3.3 Coal Site Conversion Model*

The third scenario considers the installation and operation of SMRs on decommissioned coal-fired or thermal power plant sites. This approach has been discussed as a practical alternative for SMR deployment, as it enables the reuse of existing generation infrastructure, transmission networks, and cooling systems, thereby potentially reducing construction costs and shortening licensing timelines.

However, converting a former fossil-fuel power plant site into a nuclear facility introduces new institutional issues, including the scope of environmental impact assessment, the validity of prior site approvals, and the applicability of licensing deeming provisions under the Electric Power Source Development Promotion Act. In particular, when the type of power generation source changes within the same site, clear statutory criteria governing such transitions are not explicitly defined.

This scenario is used to evaluate whether the current institutional framework can accommodate energy source conversion in the context of energy transition (coal-to-nuclear), and whether licensing exemptions or special provisions can be applied differentially depending on technological characteristics.

#### 4. Construction and Operation Process of Large-Scale Nuclear Power Plants and Applicable Legal Framework

The legal and institutional framework governing nuclear energy in Korea has been developed on the premise of the construction and operation of large-scale nuclear power plants. It is structured based on a centralized generation model in which large-scale facilities are installed and operated over a long period at a single site. Accordingly, factors such as reactor output capacity, business entity structure, siting conditions, and safety management approaches have been assumed in a relatively uniform manner. In order to clarify these institutional premises, this section organizes the licensing procedures and the structure of applicable laws for large-scale nuclear power plants as a reference baseline.

In general, large-scale nuclear power plants undergo a phased process consisting of: incorporation into the national power supply plan and site review; environmental impact assessment and public consultation; reactor site approval; design and construction approval; construction and commissioning; and finally, operating license and commencement of commercial operation. This structure has functioned as a multilayered verification system to ensure the safety of

nuclear facilities. At the same time, however, the sequential linkage of procedures has contributed to the prolonged duration of project implementation.

The licensing system is not governed by a single statute but rather by a complex structure in which multiple individual laws apply at different stages, including the Nuclear Safety Act, the Electric Utility Act, the Environmental Impact Assessment Act, the National Land Planning and Utilization Act, the Building Act, the Electric Technology Management Act, and the Electric Power Source Development Promotion Act. In addition, various administrative authorities are involved, such as the Nuclear Safety and Security Commission, the Ministry of Trade, Industry and Energy, the Ministry of Environment, the Ministry of Land, Infrastructure and Transport, and local governments. This multi-agency and multi-statute structure has functioned as an institutional safeguard for managing large-scale, high-risk facilities such as nuclear power plants. However, it also entails regulatory overlap and institutional rigidity.

The current licensing framework is based on several implicit assumptions. First, that reactors are large-scale facilities concentrated at a single site. Second, that project developers are primarily the state or large public enterprises. Third, that nuclear power plants function as part of a centralized electricity supply system. Fourth, that safety regulations are applied in a relatively uniform manner regardless of reactor output capacity. While these assumptions reflected the technological and industrial structure at the time the system was designed, they may operate as constraints in an environment characterized by technological diversification.

Therefore, the large-scale nuclear power plant-centered licensing framework should not be regarded as

Procedure	Competent Authority & Applicable Act	Relevant SMR Legal Provisions
Planning & Site Designation	<ul style="list-style-type: none"> <li>Electric Utility Act – Ministry of Trade, Industry and Energy (MOTIE)</li> <li>National Land Planning and Utilization Act – Ministry of Land, Infrastructure and Transport (MOLIT)</li> <li>Electric Power Source Development Promotion Act – MOTIE</li> </ul>	<ul style="list-style-type: none"> <li>Article 7, Electric Utility Act</li> <li>Article 36, National Land Planning and Utilization Act</li> <li>Article 6, Electric Power Source Development Promotion Act</li> </ul>
Environmental Impact Assessment & Public Hearings	<ul style="list-style-type: none"> <li>Environmental Impact Assessment Act – Ministry of Environment / Nuclear Safety and Security Commission (NSSC)</li> </ul>	<ul style="list-style-type: none"> <li>Article 22, Environmental Impact Assessment Act</li> </ul>
Reactor Site Approval	<ul style="list-style-type: none"> <li>Nuclear Safety Act – Nuclear Safety and Security Commission (NSSC)</li> </ul>	<ul style="list-style-type: none"> <li>Article 2, Nuclear Safety Act</li> <li>Articles 11 and 14, Building Act</li> </ul>
Design & Construction Approval	<ul style="list-style-type: none"> <li>Nuclear Safety Act – NSSC</li> <li>Building Act – MOLIT</li> <li>Electric Technology Management Act – MOTIE</li> </ul>	<ul style="list-style-type: none"> <li>Article 6, Electric Technology Management Act</li> <li>Articles 11 and 14, Building Act</li> </ul>
Pre-Operation Inspection	<ul style="list-style-type: none"> <li>Nuclear Safety Act – NSSC</li> </ul>	<ul style="list-style-type: none"> <li>Article 6, Electric Technology Management Act</li> </ul>
Generation Business License & Commencement of Commercial Operation	<ul style="list-style-type: none"> <li>Nuclear Safety Act – NSSC</li> <li>Electric Utility Act – MOTIE</li> </ul>	<ul style="list-style-type: none"> <li>Article 7, Electric Utility Act</li> </ul>

Fig. 1. Regulatory and Licensing Framework for Large-Scale Nuclear Power Plants and Relevant SMR Provisions.

a normative model to be directly applied to SMRs. Rather, it functions as a reference baseline for identifying potential institutional mismatches that may arise in the process of applying the current legal framework to SMRs. The next chapter builds upon this baseline model to analyze in detail the structural constraints imposed by the existing legal and institutional system on SMRs characterized by small output capacity, modularity, and distributed deployment. Fig. 1 presents a summary table of the construction process for large-scale nuclear power plants, the competent authorities and applicable laws at each stage, and the key legal provisions relevant to SMRs.

## **5. Major Statutory Issues in the Introduction of SMRs**

As previously discussed, The legal and institutional framework governing the construction and operation of nuclear power plants in Korea is structured around a sequential process consisting of planning, environmental impact assessment, site approval, design and construction licensing, construction and commissioning, operation licensing, and the commencement of commercial operation [1]. Throughout this process, multiple statutes—including the Nuclear Safety Act, the Electric Utility Act, the Environmental Impact Assessment Act, the National Land Planning and Utilization Act, the Building Act, and the Electric Technology Management Act—are applied at different stages. Various administrative authorities are involved, including the Nuclear Safety and Security Commission, the Ministry of Trade, Industry and Energy, the Ministry of Environment, the Ministry of Land, Infrastructure and Transport, and local governments.

This licensing structure has been formed on the premise of large-scale nuclear power plants characterized by centralized generation at a single site, public-sector-oriented business structures, and long construction and operational periods. As a result, while each statute has contributed to securing safety and public interest at individual stages, the framework has also institutionalized procedural overlap and regulatory rigidity.

The issue arises when this institutional structure is applied uniformly to SMRs, which are characterized by small output capacity, modular configuration, and distributed deployment. In such cases, institutional inefficiencies unrelated to technological risk may occur. SMRs are designed based on fundamentally different technical and operational premises compared to conventional large-scale nuclear power plants, including shorter construction periods, phased installation and operation, and flexible siting options. Nevertheless, the current legal and institutional framework applies identical licensing structures and regulatory standards to SMRs without adequately reflecting these differences, thereby creating the potential for structural mismatches between technology and regulation.

Using the previously outlined large-scale nuclear power plant development process as a baseline, the following analysis examines major statutory issues anticipated in the context of SMR deployment. The review focuses on Article 7 of the Electric Utility Act (licensing structure and market participation), Article 36 of the National Land Planning and Utilization Act and Article 6 of the Electric Power Source Development Promotion Act (siting and spatial planning), Article 22 of the Environmental Impact Assessment Act (environmental review procedures), Article 2 of the Nuclear Safety Act (definition of reactor and regulatory scope), Articles 11 and 14 of the Building Act (building permitting), and Article 6 of the Electric Technology Management Act (design, supervision, and technical personnel requirements).

Each subsection analyzes: (1) the issue identified under the current system, (2) the institutional or structural cause of the issue, and (3) the mismatch between SMR technological characteristics and the existing regulatory framework, thereby systematically identifying institutional bottlenecks that may arise during SMR deployment.

### *5.1 Article 7 of the Electric Utility Act: Ambiguity in Business Classification and Licensing Criteria*

Article 7 of the Electric Utility Act provides that a person intending to engage in the electricity business shall obtain authorization from the Minister of Trade, Industry and Energy or the relevant provincial governor, depending on the type or scale of the business. Although the current legal framework classifies electricity businesses into categories such as “generation,” “transmission,” “distribution,” “sales,” and “new electricity business,” interpretative uncertainty exists as to whether SMRs, due to their small-scale and distributed generation characteristics, fall under the category of “generation business” or may be classified as a “new electricity business.” As a result, there is no clear standard for determining whether an SMR operator must obtain a generation business license or whether registration as a new electricity business would be sufficient.

Furthermore, while Article 7 distinguishes authorization by “type or scale,” specific capacity criteria are delegated to subordinate legislation, and no licensing standards specifically tailored to small-capacity SMR generation projects have been established. Consequently, SMR facilities in the range of 50–300 MW may be subject to the same technical and financial requirements as large-scale power plants, which may impose excessive regulatory burdens on private SMR operators or projects led by small and medium-sized enterprises.

In addition, Article 7(3), which provides that “no person shall be granted authorization for more than two types of electricity business,” makes it institutionally difficult to accommodate integrated SMR systems combining electricity generation, heat supply, and

hydrogen production [2]. Although detailed standards are delegated to subordinate regulations pursuant to Article 7(6), current subordinate legislation does not contain any provisions for SMR-specific exceptions or procedural simplification, which has also been identified as a structural limitation.

In sum, issues related to Article 7 of the Electric Utility Act correspond, first, to absence of definition (T1) in that the business classification of SMRs is not clearly defined within the legal framework, and second, to rigidity of criteria (T2) in that standards established for large-scale generation facilities are applied uniformly regardless of output scale. This represents a typical case of structural mismatch between the small-scale and modular characteristics of SMRs and the existing institutional criteria.

### *5.2 Article 36 of the National Land Planning and Utilization Act: Urban Siting and Jurisdictional Coordination*

Article 36 of the National Land Planning and Utilization Act provides the legal basis for decisions regarding urban and county management plans, as well as the designation of use districts and zones. However, the current land-use zoning system is designed on the premise of traditional large-scale power generation facilities, and therefore raises concerns regarding the lack of a clear legal basis for the siting of urban or distributed SMRs. Power generation facilities are generally assumed to be installed within industrial zones or designated power development districts. In contrast, SMRs may be deployed under various siting models, including urban-type, industrial-complex-type, and conversion of existing coal-fired power plant sites, resulting in institutional discrepancies.

In particular, the absence of explicit provisions governing the installation of “nuclear facilities within urban areas” increases the likelihood that amendments to urban and county management plans would be required for urban-type SMR deployment. This may expand temporal and administrative uncertainty at the early stages of project development.

Furthermore, while Article 36(1) grants authority over urban and county management plan decisions to the heads of local governments, SMRs require national-level safety regulation, including radiation safety oversight and the designation of emergency planning zones (EPZs) [3]. This may generate structural tension between the central government’s authority over nuclear safety regulation and local governments’ authority over urban planning decisions. Moreover, pursuant to Article 36(2), urban and county management plans must conform to urban and county master plans. However, in many master plans, “nuclear facilities” are not included as permissible facilities, thereby necessitating revisions at the master plan stage and potentially causing procedural delays.

Accordingly, issues related to Article 36 of the National Land Planning and Utilization Act correspond

to rigidity of criteria (T2), in that the existing land-use zoning system is designed on the premise of large-scale power generation facilities. At the same time, they may be classified as jurisdictional conflict (T4) due to structural tension between local governments, which hold authority over urban and county management plans, and the central government, which is responsible for nuclear safety regulation.

### *5.3 Article 6 of the Electric Power Source Development Promotion Act: Uncertainty in Licensing Deeming Provisions*

Article 6 of the Electric Power Source Development Promotion Act stipulates a special provision under which related permits and approvals are deemed to be granted upon the approval of a single implementation plan in order to promote the expeditious implementation of power source development projects [4]. However, SMRs differ structurally from conventional power source development projects in that they are small-scale, modular, and distributed generation facilities, and the statutory language does not explicitly include SMRs. Accordingly, interpretative uncertainty exists as to whether SMR project developers may benefit from implementation plan approval and the associated licensing deeming effect.

In the case of large-scale nuclear power plants, the deeming provision allows for a certain degree of reduction in overall project duration. However, if SMRs are not recognized as power source development projects, it may be necessary to proceed separately with all individual permitting procedures. In addition, the institutional structure of the Act, which presumes project entities centered on the government or public institutions, reveals limitations in terms of compatibility with privately led SMR projects.

Accordingly, the issue related to Article 6 of the Electric Power Source Development Promotion Act corresponds to interpretative uncertainty (T5), in that there is no clear legal basis as to whether SMRs are included within the scope of power source development projects. This implies the possibility of differing interpretations between project developers and administrative authorities with respect to the same facility, and may function as a structural bottleneck that reduces predictability in the licensing process.

### *5.4 Article 22 of the Environmental Impact Assessment Act: Capacity Threshold Interpretation*

Article 22 of the Environmental Impact Assessment Act prescribes the assessment procedures for prior review of the environmental impacts of development projects, and power plant construction projects fall under “energy development projects” pursuant to Article 22(1)3 of the same Act [5]. The Enforcement Decree provides that power generation facilities subject to

Table 2: Analysis of Bottleneck Types in the Application of Major Statutes Across SMR Deployment Scenarios

Statute	Key Article(s)	S1	S2	S3	Bottleneck Type
Electric Utility Act	Article 7	T1, T2	T1, T2	T1, T2	Absence of definition; Rigidity of criteria
National Land Planning and Utilization Act	Article 36	T2, T4	T2, T4	T2, T4	Rigidity of criteria; Jurisdictional conflict
Electric Power Source Development Promotion Act	Article 6	T5	T5	T5	Interpretative uncertainty
Environmental Impact Assessment Act	Article 22	T2, T5	T2, T5	T2, T5	Rigidity of criteria; Interpretative uncertainty
Nuclear Safety Act	Article 2, Article 11	T1, T2	T1, T2	T2	Absence of definition; Rigidity of criteria
Building Act	Articles 11–14	T3	T3	T3	Regulatory overlap
Electric Technology Management Act	Article 6	T3	T3	T3	Regulatory overlap

environmental impact assessment are “power plants with a total generating capacity of 100 MW or more.” Because SMRs may be installed in a distributed manner on a modular basis, interpretative differences may arise regarding the criteria for determining whether an assessment is required. Even if a single module has a capacity of less than 100 MW, the total capacity may exceed the assessment threshold when multiple modules are installed in parallel. In such cases, there is no explicit provision clarifying whether the assessment should be determined based on a single module or whether the entire site should be regarded as one power plant. As a result, differing interpretations may arise between project developers and administrative authorities, potentially leading to uncertainty and disputes during project implementation.

Ultimately, the issue related to Article 22 of the Environmental Impact Assessment Act arises from a structure that defines power generation facilities based on a single threshold of “total generating capacity of 100 MW or more,” thereby corresponding to rigidity of criteria (T2). At the same time, the absence of a clear provision specifying whether the module-level or site-level standard should apply constitutes interpretative uncertainty (T5) as a type of institutional bottleneck.

#### 5.5 Article 2 of the Nuclear Safety Act: Absence of SMR Definition

Article 2 of the Nuclear Safety Act defines fundamental concepts such as “reactor facility,” “nuclear fuel material,” and “nuclear energy user,” and serves as the starting point for determining the scope of regulatory application [6]. However, the relevant definitional provisions do not contain any explicit reference to “Small Modular Reactor (SMR)” or “modular reactor.” As a result, SMRs are encompassed as a subcategory of “reactor facilities,” forming a structure in which the same safety standards and licensing requirements applicable to large-scale nuclear power plants are uniformly applied.

In particular, the requirements under Article 11 (license for the installation of reactors and related facilities) include safety review, site suitability

assessment, radiation protection, and emergency planning zone designation, all of which are designed on the premise of large-scale nuclear power plants [6].

Furthermore, the concept of “nuclear energy user” is structured around large-scale business entities or public institutions, which has been identified as a limitation in that the legal status of SMR projects led by private companies or international consortia is not clearly defined.

Accordingly, issues related to Article 2 of the Nuclear Safety Act correspond to absence of definition (T1) in that no independent definition of SMR exists, and the structure that uniformly applies standards designed for large-scale nuclear power plants without considering differences in output scale and design characteristics may be interpreted as rigidity of criteria (T2).

#### 5.6 Articles 11 and 14 of the Building Act: Dual Licensing Structure

Article 11 of the Building Act provides for building permits, and Article 14 establishes a notification system for small-scale buildings. If reactor containment buildings and auxiliary facilities are regarded as “buildings,” a dual licensing structure may arise in which approval must be obtained separately under Article 11 of the Nuclear Safety Act (license for installation of reactor facilities) and Article 11 of the Building Act (building permit) for the same facility [7].

Although SMRs are smaller in scale, they are specialized facilities that include radiation-controlled areas, cooling systems, and emergency planning zones. Therefore, it is difficult to regard them as subject to the notification procedure under Article 14. As a result, despite their modular design, licensing procedures similar to those applied to large-scale buildings may be imposed, which may lead to institutional inefficiency.

In addition, the factory-fabrication and on-site assembly method of SMRs differs from the existing building regulatory system, which is centered on on-site construction. The absence of clearly defined standards regarding whether modules at each stage of fabrication, transportation, and on-site installation qualify as

buildings, as well as the applicable management criteria, has been identified as a source of institutional uncertainty.

Accordingly, issues related to the Building Act correspond to regulatory overlap (T3), in that permits under both the Nuclear Safety Act and the Building Act may be applied concurrently to the same facility. This represents a structural bottleneck in which procedures overlap without differentiation in regulatory purpose.

#### *5.7 Article 6 of the Electric Technology Management Act: Supervision Overlap*

Article 6 of the Electric Technology Management Act provides that supervision shall be conducted for electrical installation works depending on the type and scale of the construction [8]. However, the electrical systems of SMRs are closely integrated with advanced nuclear technology domains, including nuclear fuel systems, radiation shielding, and safety system control logic. Nevertheless, under the current framework, there is a possibility that such works may be regarded as general “electrical installation works,” which may give rise to a mismatch between the technical scope of the supervising entity and the actual characteristics of the facility.

In addition, in privately led SMR projects, the safety review and quality assurance system under the jurisdiction of the Nuclear Safety and Security Commission may be applied concurrently with supervision requirements under the Electric Technology Management Act administered by the Ministry of Trade, Industry and Energy. This may function as dual regulation that increases project delays and administrative burdens without substantially contributing to technical safety, thereby raising the need for institutional adjustment.

In sum, issues related to Article 6 of the Electric Technology Management Act correspond to regulatory overlap (T3), in that the safety verification system under the Nuclear Safety Act and the supervision regime under the Electric Technology Management Act may be applied concurrently. This represents a structural bottleneck in which distinct regulatory frameworks overlap while pursuing the same objective of ensuring technical safety.

Table 2 presents, in matrix form, the types of bottlenecks that arise in the application of major statutes across different SMR deployment scenarios. The horizontal axis represents the SMR deployment scenarios (S1: single-site baseload model; S2: industrial complex distributed combined heat and power model; S3: coal site conversion model), and the vertical axis represents the applicable statutes. Each intersection indicates the bottleneck type (T1–T5) identified for the corresponding scenario.

## **6. Discussion on Institutional Reform through Special Legislation, International Cases, and Legal Consultation**

The preceding analysis has demonstrated that the existing legal and institutional framework in Korea, which is centered on large-scale nuclear power plants, does not sufficiently reflect the technological characteristics of SMRs. As a result, structural issues such as duplication of licensing procedures, rigidity of regulatory standards, and ambiguity regarding legal status have been identified. This section examines domestic discussions on special legislation, international cases from major countries, and the results of consultations with legal experts in order to verify the validity of the foregoing analysis and to derive practical directions for institutional reform.

The purpose of this section is not to simply replicate the institutional models of specific countries. Rather, it is to systematically examine the types of institutional choices different countries have made for SMR deployment, and to identify what kinds of structural adjustments are necessary to ensure compatibility with the existing legal framework.

### *6.1 Institutional Significance and Limitations of the Proposed Special Act on Small Modular Reactors*

In Korea, the “Proposed Special Act on the Promotion and Support of Small Modular Reactor Technology Development” has been introduced as part of efforts to establish an institutional foundation for SMR deployment. The proposed Act seeks to integrate and coordinate SMR-related provisions that are currently dispersed across individual statutes, including the Nuclear Safety Act, the Electric Utility Act, and the Electric Technology Management Act, and to establish a comprehensive support framework covering the entire lifecycle from research and development to demonstration and commercialization [9].

The institutional significance of the proposed Special Act lies in its explicit recognition of SMRs as an independent policy and regulatory subject distinct from conventional large-scale nuclear power plants. This may be understood as an attempt to institutionally acknowledge the technological characteristics of SMRs, including modular design, small output capacity, and potential for distributed deployment. In addition, the introduction of a single-window licensing procedure, provisions for expanded participation by private enterprises, designation of demonstration sites, and administrative and financial support mechanisms are meaningful in that they present directions for alleviating structural bottlenecks within the existing framework.

However, the proposed Act remains at the legislative proposal stage and is subject to limitations in that detailed implementing instruments, such as Presidential Decrees and Ministerial Ordinances, have not yet been established. Moreover, with respect to key issues—

Table 3: Comparison between the Proposed SMR Special Act and the Special Act on the Promotion of Distributed Energy

Category	Proposed SMR Special Act	Special Act on the Promotion of Distributed Energy
Purpose	Promotion and support of SMR R&D and demonstration; facilitation of private participation; strengthening international competitiveness	Establishment and expansion of distributed energy systems; contribution to stable energy supply and the national economy
Scope of Application	Small Modular Reactors and related utilization systems	Distributed energy resources in general: district energy, microgrids, small-scale nuclear power, etc
Relationship with Other Laws	Prevails over other statutes	Prevails over other statutes in matters related to distributed energy promotion, with certain exceptions under the Electricity Business Act
Planning Authority	Minister of Science and ICT; Basic Plan every 5 years	Minister of Trade, Industry and Energy; Long-term plan (10-year horizon, updated every 5 years)
Institutional Improvement Mechanism	Government-led reform of SMR-related licensing and institutional systems; administrative and financial support	Minister of Trade, Industry and Energy may recommend legislative improvements to relevant ministries
Private Sector Participation	Establishment and operation of research consortia; demonstration projects and siting by private enterprises	Registration system for distributed energy businesses; establishment of support and promotion centers
Demonstration and Siting Support	Support for SMR demonstration sites, facilities, and costs	Designation of distributed energy special zones; regulatory flexibility

including rationalization criteria for emergency planning zones (EPZs), differentiated application of safety regulatory standards, the scope of exemptions from building and siting regulations, and the allocation of responsibilities in relation to the Electric Technology Management Act—the provisions remain largely declaratory in nature. As a result, uncertainty exists as to whether the proposed Act alone can ensure substantive institutional reform. This suggests that the enactment of a special statute cannot automatically resolve structural regulatory issues, and that coordinated adjustments of subordinate legislation and the broader legal framework are required in parallel.

### *6.2 Institutional Interface between the Special Act on the Promotion of Distributed Energy and SMRs*

The Special Act on the Promotion of Distributed Energy, enacted and implemented in 2023, establishes an institutional foundation for promoting the deployment and efficient operation of distributed energy resources in order to complement the centralized electricity supply system [10]. The Act presents key measures including the designation of distributed energy special zones, the

allowance of direct power purchase agreements (Direct PPA), and the development of region-based energy self-sufficiency models.

SMRs possess the potential to fall within the category of distributed energy resources in that they are relatively small-scale and distributed generation sources. In particular, when premised on industrial-complex-type or urban combined heat and power models, policy

intersections exist with the distributed energy special zone system. However, the Act is primarily designed around renewable energy and district energy facilities, and does not directly regulate safety frameworks or radiation protection standards specific to nuclear facilities.

Accordingly, if urban-type or industrial-complex-type SMRs are included within distributed energy special zones, legal uncertainty may arise with respect to the relationship with the Nuclear Safety Act, the manner of applying siting regulations, and the clarification of responsibility for safety management. In particular, if the procedural linkage between electricity generation licensing and nuclear facility authorization is not clearly established, the distributed energy framework may generate additional interpretative issues rather than facilitate SMR deployment.

Therefore, the Special Act on the Promotion of Distributed Energy is more appropriately understood not as a regulatory constraint directly limiting SMR deployment, but as an institutional platform capable of performing a complementary function, provided that systematic compatibility with existing nuclear-related statutes is secured. This suggests that incorporating SMRs into distributed energy policy requires not merely an expansion of the scope of application, but parallel structural coordination between the nuclear safety regulatory framework and the broader energy policy framework.

Table 3 presents a comparison of the two proposed legislative frameworks discussed above.

### *6.3 Institutional Reform Cases and Implications from Major Foreign Countries*

Major foreign countries are proactively pursuing legal and institutional reforms for the deployment of SMRs in consideration of their respective energy supply structures, power system stability, and strategies for strengthening industrial competitiveness. This may be understood not merely as the introduction of new technology, but as a process of redesigning existing regulatory frameworks to align with the technological characteristics and deployment scenarios of SMRs.

In Finland, the Radiation and Nuclear Safety Authority (STUK) officially abolished in 2024 the minimum distance requirement between nuclear reactors and densely populated areas, thereby shifting siting criteria from a quantitative distance-based regulation to a risk-based assessment framework [11]. As a result, the conversion of an existing coal-fired power plant site in central Helsinki into an SMR-based district heating facility has become institutionally feasible, and this is regarded as a representative case of urban SMR deployment.

In the United States, the Nuclear Regulatory Commission (NRC) has formalized a regulatory interpretation allowing the reduction of emergency planning zones (EPZs) to the plant boundary level, reflecting the passive safety systems and lower accident probability of SMRs [12]. In addition, through the Inflation Reduction Act (IRA) of 2022, tax incentives and financial support mechanisms have been established for SMR projects, and the “Coal-to-Nuclear (C2N)” strategy has been introduced to institutionally support the conversion of retired coal-fired power plant sites into SMRs. This may be regarded as a structural approach combining regulatory adjustment with financial support.

The United Kingdom has explicitly incorporated SMRs into its national energy strategy and is pursuing policies that advance technological development and commercialization in partnership with private enterprises [13]. In particular, by transforming the licensing procedure into a stage-gated review system, regulatory predictability has been enhanced and project timelines shortened, thereby promoting private investment.

Poland has designated SMRs as a strategic technology primarily aimed at meeting heat demand in industrial complexes and urban areas, and has adopted a structure led by large private enterprises [14]. In addition, by introducing a pre-licensing system, technical suitability reviews are conducted with the regulatory authority prior to formal licensing, thereby minimizing institutional uncertainty.

Common characteristics observed in these international cases include risk-based regulation, clarification of definitions, procedural simplification, and recognition of modular characteristics within regulatory frameworks. This indicates that SMRs are not regarded merely as scaled-down versions of large-scale nuclear power plants, but as an independent class of

technologies with distinct deployment purposes and siting conditions, accompanied by corresponding redesign of institutional systems.

Accordingly, in order to actively pursue SMR deployment in Korea, an integrated approach is required that goes beyond simple regulatory relaxation. This includes clearly establishing risk-based and proportional regulatory principles, ensuring compatibility among urban planning, siting systems, and power system operation frameworks, structuring financial and tax support mechanisms, establishing public-private cooperative governance, and developing strategic communication and education systems to enhance social acceptance. When such multi-layered institutional reforms are achieved, SMRs may be positioned as a substantive alternative technology in the process of energy transition.

### *6.4 Verification of the Practical Interpretation of the Domestic Legal Framework through Legal Consultation*

With respect to SMR deployment, consultations were conducted with two legal experts to examine potential conflicts and interpretative uncertainties among major statutes, including the Electric Utility Act, the National Land Planning and Utilization Act, the Building Act, the Electric Technology Management Act, and the Nuclear Safety Act. The consultation was conducted on the basis of the technological characteristics and deployment scenarios of SMRs, analyzing the applicability and scope of interpretation of each statute.

The consultation results commonly indicated that the current legal framework, designed on the premise of large-scale nuclear power plants, does not sufficiently reflect the small-scale, modular characteristics of SMRs or privately led project structures. It was further noted that even if an SMR Special Act were enacted, its practical effect on institutional reform could be limited unless coordinated adjustments across the broader legal system are undertaken, as such legislation would not fully replace existing individual statutes.

With respect to the Electric Utility Act, it was interpreted that SMRs should, in principle, fall within the category of generation business, whereas classification as a new electricity business lacks sufficient legal basis. Accordingly, difficulties in applying renewable energy incentives, concerns regarding fairness in market participation structures, and the requirement to undergo the same licensing procedures as conventional generation businesses were identified as institutional burden factors.

Regarding the National Land Planning and Utilization Act and the Building Act, it was noted that urban-type or small-site SMRs are highly likely to be subject to building permit requirements, and that urban planning regulations—such as building coverage ratios, land-use zoning restrictions, and district unit planning—may function as practical constraints in securing suitable sites. Although there exists the possibility that the installation licensing procedure under the Nuclear Safety Act may

absorb or integrate certain aspects of the Building Act procedures to a limited extent, the specific implementation methods and scope of application remain unclear.

Within the Nuclear Safety Act itself, it was observed that provisions strengthening installation licensing requirements coexist with regulatory provisions governing operational safety management, quality assurance, and emergency preparedness. This coexistence may result in regulatory combinations that are excessive or unreasonable when applied to SMR design concepts. This issue is interpreted not primarily as a matter of regulatory stringency, but as a structural misalignment arising from the mechanical application of large-scale nuclear regulatory logic to small-scale, modular designs.

With respect to the Electric Technology Management Act, while the SMR reactor itself falls under the regulatory scope of the Nuclear Safety Act and is not classified within the first-class electrical technology category, substations, distribution facilities, grid interconnection facilities, and balance-of-plant (BOP) electrical equipment are subject to the Electric Technology Management Act. As a result, obligations regarding the securing of highly qualified technical personnel and supervision requirements may be imposed, potentially increasing cost burdens for private project developers. This overlapping structure indicates the need for coordination and minimization of duplication between the safety verification and quality assurance system under the Nuclear Safety Act and the supervision regime under the Electric Technology Management Act.

In sum, the legal consultation did not deny the legal feasibility of SMR deployment itself, but identified interpretative uncertainty in licensing and the amplification of project risks due to regulatory overlap as key issues. This suggests that institutional uncertainty may function as a greater constraint on project implementation than technological risk.

### *6.5 Comprehensive Discussion: Structural Direction of SMR Institutional Design*

Synthesizing the domestic legal and institutional issues identified in the foregoing analysis, the discussions on the proposed Special Act, the relationship with the distributed energy framework, international cases, and the results of legal consultation, the primary constraint on SMR deployment may be interpreted as arising not from deficiencies in individual statutes or excessive regulatory stringency, but from the path dependency embedded in a regulatory structure originally formed on the premise of large-scale nuclear power plants.

The current institutional framework is designed based on implicit assumptions of single-site, high-output, centralized power generation facilities. Such regulatory logic structurally conflicts with the small-scale, modular, and distributed characteristics of SMRs. Accordingly,

the core issue is not whether to relax regulation, but rather to what extent and in what manner the existing regulatory paradigm should be extended or adjusted.

The proposed SMR Special Act under discussion in Korea is meaningful in that it has institutionally surfaced this problem awareness. However, as observed in international cases, SMR institutional reform has not been achieved through comprehensive resolution via a single statute. Instead, a phased approach has been adopted in which the existing regulatory framework is maintained while regulatory intensity and application methods are differentiated according to technological characteristics. This suggests that SMR deployment is not an issue of “regulatory relaxation,” but one of ensuring regulatory compatibility and proportionality.

The relationship with the Special Act on the Promotion of Distributed Energy also complements this structural discussion. While the distributed energy framework serves as a policy instrument to supplement the centralized electricity system and may form institutional intersections with certain SMR deployment scenarios, it cannot replace the distinct domain of nuclear safety regulation. This indicates that SMRs occupy an intersection between energy policy and nuclear safety policy, and that institutional design cannot be confined to a single policy domain.

International cases demonstrate that SMR institutional reform has progressed incrementally in parallel with technological maturity. The risk-informed regulation in the United States, the redefinition of siting criteria in Finland, and the government-private partnership-based licensing frameworks in the United Kingdom and Poland may all be evaluated as cases in which existing regulatory systems have been flexibly reinterpreted to reflect SMR design characteristics and accident probability. Such approaches operate not by lowering safety standards, but by maintaining the substantive effectiveness of safety regulation while enhancing institutional predictability.

The results of legal consultation likewise support this interpretation. While SMR deployment is, in principle, legally feasible under the current statutory framework, it was emphasized that interpretative uncertainty and regulatory overlap may excessively amplify project risk. This suggests that securing institutional predictability is a core condition for SMR demonstration and commercialization.

Based on the foregoing discussion, the structural direction of SMR institutional reform may be summarized as follows.

First, SMRs should not be treated merely as exceptions within the existing large-scale nuclear regulatory framework, but should be clearly defined as a distinct regulatory category reflecting their technological characteristics.

Second, licensing procedures should not be simplified merely through integration or reduction, but should be redesigned to eliminate regulatory overlap and clarify the purpose of verification at each stage.

Third, safety regulation should be adjusted on the basis of proportional application principles that take into account output scale and accident probability.

In conclusion, SMR institutional design should be understood not as a short-term policy instrument, but as a process of structural transformation involving the gradual expansion and adjustment of the existing nuclear regulatory paradigm. This provides the theoretical foundation for the legal and institutional reform directions presented in the following section, which are not simple deregulatory measures but structural redesign efforts aimed at achieving both safety and technological innovation. simply records those counts which are above the discrimination level. A discriminator dead time is an important parameter for the SCA and is a limiting factor establishing the system count rate. The output of the discriminator model is presented in Fig. 2, as a graph of the fraction of counts that are lost versus the true count rate, with voltage and charge sensitive preamplifiers. As can be seen from the figure, due to the dead time associated with the SCA, even with a voltage sensitive preamplifier, accurate dead time corrections are necessary to achieve large and accurate count rates.

## **7. Directions for Legal Reform for the Introduction of Small Modular Reactors**

As discussed above, the current statutory framework is based on a regulatory structure formed on the premise of large-scale nuclear power plants and therefore does not adequately reflect the introduction and operation of SMRs, which possess small-scale, modular, and distributed characteristics. In particular, procedural overlap in licensing, rigidity in regulatory standards, ambiguity in business classification and legal status, and limitations in accommodating diverse siting models are understood not as defects of individual statutory provisions, but as structural problems arising from path dependency embedded in a large-reactor-centered regulatory paradigm.

Accordingly, this section synthesizes the key statutory issues identified in Section 4 and the discussions on special legislation, international institutional reform cases, and legal consultation results reviewed in Section 5, in order to present structural directions for legal reform for the introduction of SMRs. The objective is not merely to propose amendments to individual statutes, but to outline the direction of regulatory system redesign necessary to institutionally accommodate the technological characteristics and deployment scenarios of SMRs.

### *7.1 Reestablishing the Regulatory Framework to Clarify the Institutional Status of SMRs*

As confirmed in Section 5, the principal constraint on SMR deployment lies not in technical safety, but in the ambiguity of institutional status. Both the Electricity Business Act and the Nuclear Safety Act establish

regulatory categories on the premise of large-scale nuclear power plants and do not clearly define the category to which SMRs belong within the existing regulatory framework.

Article 7 of the Electricity Business Act provides that electricity businesses shall be licensed by type or scale. However, interpretative uncertainty remains as to whether SMRs fall under the category of “power generation business” or may be classified as a “new electricity business.” This creates the possibility that SMRs, despite being small-scale and distributed generation facilities, may be subject to the same licensing requirements and business structures as large-scale power plants. Furthermore, in the case of integrated SMR systems combined with heat supply or hydrogen production, the current restrictions on business types present limitations in institutionally accommodating such hybrid business structures.

Similarly, the definitional provision of Article 2 of the Nuclear Safety Act does not explicitly include the concept of an SMR or modular reactor, resulting in a structure in which SMRs are uniformly subsumed under the same safety regulatory framework as large-scale nuclear power plants. Therefore, rather than treating SMRs as exceptions within the existing large-reactor-centered regulatory regime, it is necessary to define SMRs as a distinct regulatory category reflecting their technological characteristics and to clarify their institutional status accordingly.

### *7.2 Ensuring Coherence in Licensing Procedures and Mitigating Regulatory Overlap*

According to the analyses in Sections 4 and 5, the most realistic project risk factor in the introduction of SMRs lies not in the intensity of regulation itself, but in procedural overlap and interpretative uncertainty within the licensing process. The deemed approval provision under Article 6 of the Electric Power Source Development Promotion Act has contributed to shortening the project timeline for large-scale nuclear power plants; however, it remains unclear whether the same provision applies to SMRs. As a result, SMR developers may be required to separately comply with individual licensing procedures.

Synthesizing international cases and the results of legal consultations, the key to improving the SMR licensing framework lies not in a comprehensive consolidation of procedures, but in clarifying the purpose of verification at each stage and eliminating overlapping regulations. In particular, it is necessary to enhance project predictability by clarifying the scope of application of the deemed approval provision under the Electric Power Source Development Promotion Act to SMRs, or by establishing a legal basis that would allow its application, *mutatis mutandis*, to privately led SMR projects.

### *7.3 Flexibilization of Siting and Urban Planning Systems and Adjustment of Authority*

Article 36 of the National Land Planning and Utilization Act provides the legal basis for urban and county management plans and land-use zoning designations. However, it is not designed on the premise of diverse SMR siting models, such as urban-type, industrial-complex-type, or conversion of existing power plant sites. Consequently, the introduction of SMRs may require additional urban planning amendment procedures, thereby increasing uncertainty at the early stages of project development.

Furthermore, although SMRs are facilities that require radiation safety management and emergency planning zone (EPZ) control, authority over siting decisions is largely decentralized to local governments. This may give rise to issues concerning the coordination of authority between central administrative agencies and local governments. As observed in international cases, the introduction of SMRs near urban areas may necessitate consideration of either exceptional provisions within the urban planning framework for nuclear facility siting or the establishment of a national-level coordination mechanism.

### *7.4 Proportional Application of Environmental Impact Assessment and Safety Regulation*

Article 22 of the Environmental Impact Assessment Act designates power plants with a total generation capacity of 100 MW or more as subject to environmental impact assessment. However, this framework does not sufficiently reflect the characteristics of SMRs, which may be installed on a modular basis. The absence of a clear standard as to whether the assessment threshold should be applied based on individual modules or the entire site may generate project risk arising from differences in administrative interpretation.

Similarly, safety regulations under the Nuclear Safety Act tend to apply large-reactor standards uniformly, without sufficiently distinguishing based on generation capacity and accident impact range. Institutional reforms in major foreign jurisdictions do not aim to weaken regulatory standards; rather, they adopt proportional and differentiated regulatory systems that consider generation capacity and accident probability, thereby maintaining the substantive effectiveness of safety regulation while enhancing regulatory predictability. This approach may serve as an important reference point in discussions on domestic institutional reform.

### *7.5 Allocation of Regulatory Roles in Building and Electrical Facility Regulation and Minimization of Overlap*

The current structure, in which the building permit procedure under Articles 11 and 14 of the Building Act is applied concurrently with the installation license under

the Nuclear Safety Act, exhibits limited compatibility with the modular design characteristics of SMRs. In particular, where factory fabrication followed by on-site assembly becomes the prevailing approach, a structural gap may arise between the existing building regulatory system—centered on on-site construction—and the implementation model of SMRs. Accordingly, it is necessary to clarify stage-specific management standards and to redefine the allocation of regulatory responsibilities.

Similarly, the electrical facility supervision system under Article 6 of the Electric Technology Management Act may be applied without sufficiently reflecting the nuclear-specific characteristics of SMRs. If the safety review and quality assurance framework administered by the Nuclear Safety and Security Commission overlaps with the supervision system under the Electric Technology Management Act, regulatory objectives may be similar while administrative burdens are effectively duplicated. Therefore, it is necessary either to establish a supervision framework specifically tailored to nuclear facilities or to clearly delineate the scope of application between nuclear installations and general electrical facilities in order to minimize regulatory overlap.

## **8. Conclusions**

This study did not focus on the technical safety or economic feasibility of small modular reactors (SMRs) per se, but rather on the institutional acceptability surrounding their introduction as the core research subject. To this end, the construction and licensing procedures of large-scale nuclear power plants were established as a reference model and applied to various SMR deployment scenarios in order to examine whether the current legal and institutional framework can structurally accommodate the technological characteristics of SMRs.

The analysis confirms that Korea's nuclear-related statutory framework maintains a path-dependent structure formed on the premise of large-scale nuclear power plants. As a result, the core technological characteristics of SMRs—namely small-scale output, modularity, and distributed deployment—are not sufficiently reflected institutionally. In particular, the ambiguity of SMR business classification under the Electricity Business Act; the rigidity of siting regulations arising from the application of the National Land Planning and Utilization Act and the Building Act; interpretative uncertainty in environmental impact assessment standards; the absence of an explicit definition of SMRs under the Nuclear Safety Act; and regulatory overlap with the Electric Technology Management Act were found to stem not from isolated deficiencies in individual provisions, but from a broader structural mismatch within the overall regulatory framework.

Such structural misalignment may lead to duplication and prolongation of licensing procedures irrespective of

the technical safety of SMRs, constrain private-sector participation, and ultimately offset the economic and operational flexibility advantages inherent in SMRs. This finding carries significant implications, as it suggests that delays in SMR deployment may arise not from insufficient technological maturity, but from a lack of proportionality in institutional design.

The academic contributions of this study are as follows. First, it conceptualizes SMR regulatory challenges not as issues of statutory interpretation or procedural refinement alone, but as problems of structural compatibility between technological characteristics and regulatory systems. Second, by establishing the large-reactor-centered licensing structure as a baseline and applying it to SMR deployment scenarios, this study proposes an analytical framework that enables systematic comparison and identification of institutional bottlenecks. This approach possesses theoretical extensibility, as it may be applied to future institutional research on next-generation reactor concepts, such as high-temperature gas-cooled reactors and microreactors.

From a policy and practical perspective, the findings suggest that the enactment of a standalone SMR special act alone is unlikely to fundamentally resolve structural issues. Rather, phased and coherent reforms of individual statutes—including the Electricity Business Act, the Nuclear Safety Act, the National Land Planning and Utilization Act, the Building Act, and the Electric Technology Management Act—should be pursued in parallel. In particular, proportional and differentiated application of safety regulation, purpose-oriented redesign of licensing procedures with elimination of overlap, and institutional accommodation of business structures premised on private-sector participation emerge as key priorities.

Nevertheless, this study is primarily based on literature review and statutory interpretation, and empirical validation remains limited given the absence of accumulated SMR licensing cases in Korea. Future research should include quantitative analysis of licensing costs and timelines based on pilot SMR projects, evaluation of the applicability of risk-informed regulation, and comparative quantitative studies of overseas SMR projects.

In conclusion, by reinterpreting the constraints on SMR deployment as issues of institutional structural compatibility rather than technological limitations, this study provides a theoretical starting point for academic discussions on the redesign of Korea's SMR policy and regulatory framework.

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