**Legal and Regulatory Challenges in Introducing SMR Technologies**

**In Slovakia**

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**Abstract**

 The updated Integrated National Energy and Climate Plan (INCP) is a strategic document in the field of energy and the environment until 2030. Part of INCP is the safe use of nuclear energy as a low-carbon source of electricity. In terms of security of energy supply and energy diversification efforts, the INCP confirms the importance of new innovative technologies. With regard to innovative technologies like Small Modular Reactors (SMRs), the Plan sees potential in their ability to meet the need for flexible energy supply in the form of electricity, hydrogen and heat for heating and industrial purposes. It is envisaged that the updated INCP will be approved in 2024. A feasibility study is under preparation to introduce SMR in Slovakia. The legal framework for nuclear energy consist of several laws and regulations. These legal instruments are based on EU legal instruments, international treaties and agreements and on IAEA Safety Standards and WENRA Reference Levels. In Slovakia only pressurised water reactors in operation and are planned (PWR). New SMR technologies with different designs and technologies as the present nuclear power plants in operation might represent a challenge for the future particularly considering the possible impact of new technologies on the existing legal framework and vice versa. A new Policy, Principles and Strategy for the Safe Use of Nuclear Energy is under preparation which in a holistic manner will describe ways and means to face future challenges and expectations.

## INTRODUCTION

Nuclear energy has a long tradition in Slovakia The beginnings of the nuclear era go back to the early 1950s when decisions have been taken by the Czechoslovak government to develop its own nuclear program based on its own nuclear energy technology. This happened in parallel with the development of its own nuclear research and technological capabilities. As a result the first nuclear power plant was sited in Slovakia and put in operation in 1972 with a heavy water gas cooled technology. Later on pressurised water technology was introduced with VVER 440 technology and the first unit was put into operation in 1978. The regulatory and legal framework was at that time behind the rapidly evolving nuclear technologies. A specific independent regulatory body in the understanding of present definition was not in place. The legal framework was continuously developed but also not with the speed that would be at least be developed in parallel with the fast development of the nuclear industry . In addition there was a limited experience with the operation of nuclear power plants and a limited experience in regulating this new technology. The first legal and regulatory framework for nuclear safety in the current understanding was established in 1984 which was after the independence of Slovakia replaced by the Act no.: 130/1998 and later on by the Act 541/2004 Coll. on the peaceful use of nuclear energy. The regulatory and legal framework was and is not a static one. Several amendments to the relevant acts and implementing decrees and regulations were made since their adoption. This process is influenced by the development of national legal and regulatory framework and experiences gained from the use of nuclear energy and technologies but significantly was influenced by the international developments (like the development of IAEA Safety Standards) . This is the lessons learned when nuclear technology was introduced. The present situation is different however by the introduction of new and innovative technologies the legal and regulatory framework faces new challenges.

## The future of nuclear energy in slovakia

The Integrated National Energy and Climate Plan (INECP) and the Energy Policy of the Slovak Republic are the strategic documents the field of energy and the environment until 2030. Nuclear energy is an integral part of the energy mix in Slovakia and will remain in the future. The task of the Energy Policy dated 2014 is to create a stable framework for a safely operating energy market that motivates investments into energy. Strategic targets of the Energy Policy are: achieving a competitive, low-carbon energy sector safeguarding the safe, reliable and efficient supply of all forms of energy at acceptable prices with considerations given to consumer protection and sustainable development. One of the priority of the energy policy is to increase the safety and reliability of nuclear power plants. Slovakia currently utilises and plans to continue to utilise nuclear power within its energy mix while the question of nuclear safety remains the absolute priority. The level of nuclear safety is regularly, comprehensively and systematically assessed within the context of operating experience and the latest scientific advancements and research likewise measures to increase safety are adopted on a continuous basis.

 The other strategic document is the INECP dated 2019 . This document reconfirms the basic approach and principles in the use of nuclear energy as contained in the Energy Policy. Utmost importance is given to the safe use of nuclear energy . A new development is represented by the draft updated Integrated National Energy and Climate Plan preparation of which started in 2023. Whereas the original INECP dated 2019 does not mentioning new nuclear technologies and Small Modular Reactors (SMRs) the draft update of the INECP recognises SMRs as having capabilities to satisfy the need for flexible energy supply in the form of electricity, hydrogen and heat for local/regional heating and industrial purposes with new safety features. The INECP ś assumption is that the main advantages of SMRs include e.g.:

* passive safety elements;
* shorter construction time of the nuclear facility;
* the potential for possible shortening of authorization processes;
* etc.

These assumptions are however can be confirmed only on the basis of the licensing documentation, which will be available after completion the first SMRs. In Slovakia SMRs are considered to be one of the appropriate solutions to ensure secure supplies of electricity and heat for example in east Slovakia after the shutdown of the coal fired Vojany Power Plant with a power output of 2x110 MWe. Implementation of the project will require strong engineering support and expertise to be prepared in cooperation with Slovak universities, technical support organizations and through strong international cooperation.

The INECP does not mentioning to which extent and by which measures the legal instruments might be changed in support of a shortened authorisation process . However a shortened licensing process of a nuclear installation including a SMR has its limitations. These limitations are given by national legal proceedings and by external factors like international obligations.

## Legal and regulatory framework

The present legal and regulatory framework for the use of nuclear power consists of a number of legal instruments and a number of institutions regulating nuclear energy. Each regulatory body operates based on its competencies in the nuclear field and within the legal framework e.g.:

* Ministry of Economy responsible for the energy industry regulating business and other related aspects;
* Ministry of Transport responsible for transport;
* Ministry of Health regulating radiation protection;
* Ministry of Interior regulating public protection - emergency preparedness and fire protection;
* Ministry of Labour, Social Affairs and Family regulating industrial safety;
* Ministry of Environment regulating environmental affairs;
* Nuclear Regulatory Authority regulating nuclear safety;
* etc.

In the case of the Nuclear Regulatory Authority it is also the construction authority issuing license for all construction related activities for example construction permit, occupancy permit etc.

The present legal framework requires that for a new power plant regardless of its power it is necessary to apply not only all national safety requirements, but also the requirements arising from the regulations and directives of the European Union (hereinafter referred to as "EU") taking into account the Safety Standards of the International Atomic Energy Agency (IAEA) and the safety reference levels of the Western European Nuclear Regulators Association (WENRA). The basic legislative instruments governing the conditions for the safe use of nuclear energy in the Slovak Republic are the Act No. 541/2004 Coll. on the peaceful use of nuclear energy (Atomic Act), and Act No. 87/2018 Coll. on radiation protection. According to the Atomic Law, nuclear safety means " Nuclear safety shall mean the technical status and the capability of the nuclear installation or transport equipment, as well as their operating personnel to prevent unauthorized release of radioactive substances or ionizing radiation to the working environment or the environment and ability to prevent events and to mitigate consequences of events at nuclear installations or in shipments of radioactive materials ".

**3.1 Aspects of environmental impact assessment**

 SMRs and innovative technologies are in the early phase of deployment. At present the activities are focusing inter alia on the issue of siting and design but also on activities related to operation, waste management and decommissioning. It is important that safety aspects will be considered in a comprehensive manner for all these areas. However particular attention should be devoted at present to siting and design of innovative nuclear technologies including SMRs.

The licensing process for a nuclear installation regardless of its type starts with the environmental impact assessment according to the Act 24/2006 on environmental impact assessment. This process of environmental impact assessment is based on the EU directive 2011/92/EU, on the Aarhus Convention [1] to guarantee rights of public participation in decision-making in environmental matters and on the Espoo Convention [2] on transboundary impact assessment. Slovakia´s latest experience with the EIA is the planned new nuclear power plant at the Jaslovské Bohunice site with pressurized water technology with an electricity output up to 1200 MWe. The EIA process started in 2013 with the preparation of the EIA documentation. The EIA documentation was subject to consultations with the public of the surrounding villages and was subject also to transboundary consultations with the interested state parties of the ESPOO convention. The EIA process was finished in 2016 three years after the process started and in 2016 the Ministry of Environment issued the final statement. The final statement included provisions with which other state institutions and future operator shall comply with during the siting construction and operation of the nuclear power plant.

Proceedings related to cross-border impact on the environment are carried out in the case of projects implemented on the territory of Slovakia which could affect life and the environment on the territory of a neighbouring state contracting party to the convention. The current international practice related to the construction of a nuclear installation - regardless of its technology or power – is generally characterized by the assumption that these projects has a cross-border impact on the environment, although demonstrated that they have no impact on people or the environment (even in the case of an accident). Currently, there is no different approach to small modular or innovative reactors in this direction even they have favourable safety features and represent a significantly smaller potential risk for the environment, mainly for the following reasons:

* lower power level ,
* smaller amounts of produced radioactive waste and spent fuel
* new safety features

It should also be emphasized that the design solutions of SMR reactors use passive safety systems and inherent safety features, which significantly increases the safety of these reactors and limits the size of the emergency planning zone. However only on the bases of detailed design knowledge these assumptions can be confirmed. Impact assessments whether on national or international level are an important part of the confidence building measure toward the public and the neighbouring states. Even the impacts are negligible a transparent and open dialog is of utmost importance for the smooth implementation of the project. This is of particular importance in case when the site of a SMR is in the neighbourhood or even part of a densely inhabited area or city.

**3.2 Licensing phases**

In Slovakia the involvement of regulatory organisations in the licensing process depends on which licensing step is subject to regulation. Licensing of a nuclear installation consists of several (main) steps:

* Siting according to the Atomic Act (only for nuclear power plants)
* Siting of all kind of nuclear installations according to the Spatial Planning Act
* Construction
* Operation
* Decommissioning and dismantling

All these steps are interrelated. This means that the next steps can start when the previous step is completed from the legal, regulatory point of view and practical implementation of the project as well. These steps cannot be combined for example combining the process of siting with construction or construction with operation. This is given by the fact that each of these steps have different legal requirements, different requirements on documentation and based on the type of the process different involvement of stakeholders (see Table 1).

TABLE 1. EXAMPLE OF DOCUMENTATION FOR DIFFEREN LICENSING STEPS (according to the Atomic ACT)

|  |  |  |  |
| --- | --- | --- | --- |
| Type of licence (number of documents) | Siting (8) | Construction (14) | Operation (25) |
| Type of document  | Inception safety report | Preliminary safety report | Pre-operational safety report |
|  | Inception decommissioning plan | Preliminary concept of decommissioning | Concept of decommissioning |
|  | QA requirements | Management of QA + QA requirements + evaluation  | Management of QA + QA requirements + evaluation |
|  | Draft emergency zone  | Preliminary emergency zone  | Detailed emergency zone + regional public protection plan  |
|  | etc. | etc. | etc. |

The more advanced the project is the more detailed documentation is required according to the Atomic act. In addition and before the construction starts the Construction Act steps into the process. The Construction Act requires to submit design documentation and statements of other involved governmental authorities to the Nuclear Regulatory Authority as the main authority in the construction process. This means that the Nuclear Regulatory Authority is in charge for two licensing processes: according to the Atomic Act and according to the Construction Act. Under normal circumstances the approval process for siting and construction lasts up to 12 month each. This timeframe depends on many factors: completeness of the documentation, involvement of public, judicial proceedings etc. These factors can significantly prolong each of the licensing process. At present the Construction Act from 1976 is in the process of being significantly revised. This revision also includes specific provisions regarding nuclear installations. The revision started in 2020 and is not finished yet. A group of experts have been established to finish the process to have a new legislation for construction by 2025. It is difficult to predict to which extent the new construction act will respond to new challenges stemming from innovative reactor designs including SMRs.

 The legal and regulatory framework for the safety of nuclear installations is mainly based on IAEA Safety standards and WENRA Reference levels. There is a mature legal and regulatory framework for current technologies but the challenge might be for innovative and new technologies that are first of its kind, which do not have operating records and there is no experience with the licensing. In addition it is a particular challenge when the technology is of a kind which is not a light water technology. In Slovakia the present nuclear power technology is based on pressurised water technology and the legal framework was developed and is applied for such kind of technology.

In many countries a so called pre licensing processes is e introduced with the aim to ease the introduction of new nuclear technologies and ease the safety review and assessment during the licensing process. The legal framework in Slovakia does not recognize any kind of pre-licensing procedure but might be considered in future.

## **3.3 Aspects of siting**

In Slovakia there are two siting procedures applicable for nuclear power plants. One siting procedure is according to the Atomic Act and the second procedure is according to the Construction Act. In addition to these acts the Decree of the Nuclear Regulatory Authority of the Slovak Republic No. 430/ 2011 Coll. on nuclear safety requirements is applied for any kind of nuclear installations. This Decree specifies the type of assessments to be performed for the selected site and it shall include e.g.:

* probabilistic analysis of seismic threat (PSHA);
* assessment of seismic and geological conditions in the region and of engineering-geological aspects and geo-technical aspects of the proposed site;
* The assessment of a threat due to earthquake induced ground motions etc.

Regardless of the results of analyses carried out according to the above the minimum level of seismic loading of the site determined for siting of the nuclear installation shall be represented by a horizontal free field standardized response spectrum corresponding to peak ground acceleration value equal to 0.1g.

Area features which exclude the siting of nuclear installations when it is not possible to ensure during operation, abnormal operation or in the event of a nuclear or radiological emergency e.g.:

* to keep the established radiation doses;
* protection of life, health and property against consequences of extraordinary events;
* Protection against harmful effects of extreme weather conditions and floods etc.

 In addition areas are excluded which inter alia extends into a protective zone of industrial or other economic structures (e.g. chemical factory) with which there may be undesirable operational clashes and the population density and distribution in the area does not ensures an effective use of emergency preparedness measures possible. In parallel to the requirement of effective emergency preparedness the present practice is that emergency planning zones are planned around nuclear installations. In the case of nuclear power plants the planning zones (EPZ) are 20 km for the Mochovce nuclear power plant (NPP) site and 21 km for the Bohunice NPP. In the case of other nuclear installations the emergency planning zone is delineated by the physical boundaries of the nuclear installation. . The bases for EPZ are the classification of the events at the nuclear installation and in the case of an incident or accident, the method of determining the degree of its severity and expected development over time. During the administrative procedure it is up to the licensee (not of the designer or supplier) to propose the emergency planning zone which is then subject to review by the responsible regulatory authorities.

The present situation in Slovakia is that the minimum EPZ for nuclear power plants is 5km regardless of the size or type of the NPP. There is an important incentive for the surrounding. Municipalities (villages or towns) which falls within the territory of the EPZ are entitled to receive financial compensation. This financial compensation will not be available in case when the EPZ of the nuclear power plant like a SMR is reduced to the boundaries of the installation. This could create difficulties in attracting the siting of a SMR close to an inhabited area. According to the Act on local taxes municipality to whose cadastral territory the nuclear facility is sited is entitled to collect taxes . This is a regular tax applied to any property. These two incomes the one coming from the emergency planning zone and the other one from the property taxes represent a significant income for the development of the municipality.

An additional aspect is the siting and emergency preparedness for a single NPP with multi reactor modules with shared structures. With such a solution Slovakia´s experience is that when to the existing units additional reactors are added then the emergency planning zone of the original unit will be changed to accommodate the additional unit and in this case there will be a common EPZ for all units for a single licensee. If the licensee will be a different company a specific EPZ will be established for the new units/licensee.

As regards radiation protection the legal framework is based on IAEA GSR Part 7 and the EU Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation transposed by the Act 87/2018 on Radiation Protection. Dose limits are established for occupational exposure, dose limits for pregnant and breastfeeding workers, dose limits for apprentices and students (who, in the course of their studies, are obliged to work with radiation sources) and dose limits for public exposure. For the public exposure for example the limit on the effective dose for public exposure is 1 mSv in a year. The dose limits for the public are not established for a specific technology/nuclear power plant but in general on annual exposures of a member of the public resulting from all authorised practices. Specific category is represented by emergency occupational exposure.

There are different aspects to be considered when a nuclear power plant like a SMR is sited. Some of those criteria for example the minimum emergency planning zone of 5 km might be reviewed in light of the design information provided. On the other hand the incentives for the surrounding villages should be kept in mind. In addition the modular character of SMRs is also an important aspect to be considered. It might happen that at the beginning of the project only 1 or 2 modules are considered. Later on additional reactor modules might be considered at the same site. This gradually increasing number might also have impact on the originally expected impacts on the surrounding. It is therefor important to have a clear picture beforehand on the number of modules to be sited and constructed on one site.

As regards safety objectives the present EU legal framework and national legal framework requires that nuclear installations are sited, designed, constructed, commissioned, operated and decommissioned with the objective of preventing accidents and, should an accident occur, mitigating its consequences and avoiding:

* early radioactive releases that would require off-site emergency measures but with insufficient time to implement them;
* Large radioactive releases that would require protective measures that could not be limited in area or time.

Taking into account that SMR and other innovative reactors might be sited in a densely inhabited area these safety objectives should be complemented/strengthened by measures which would give sufficient assurance to the public that there is no negative impact of the operation in the short or long term and no short or long term protective measures will be necessary in the case of a severe accident because such scenarios for example are practically eliminated.

4. The new Policy, PRINCIPLES AND Strategy for the Safe Use of Nuclear Energy

In 2014 the government adopted the Policy, principles and strategy for further development of nuclear safety. In 2024 the government requested the chairperson of the nuclear regulatory to prepare a new Policy, principles and strategy of the safe use of nuclear energy by the end of November 2024. This new Policy, principles and strategy of the safe use of nuclear energy will take into account the developments and experiences during the previous decade and having a holistic approach for the coming years in the safe use of nuclear energy in all areas where nuclear energy is used (energy, health, research, industry etc.) . Due consideration is given to innovative nuclear reactors including SMR. When formulating the Policy, principles and strategy the IAEA Fundamental safety principles and relevant national strategic documents were taken into account like:

* Energy Security Strategy of the Slovak Republic
* Integrated national energy and climate plan for the years 2021-2030,
* Economic policy strategy until 2030.
* Proposal for a research and innovation strategy for intelligent specialization of the Slovak Republic 2021-2027
* Greener Slovakia – Strategy of the Slovak Environmental Policy until 2030,
* Occupational health and safety strategy for 2021-2027

The document might include an action plan for 2024-2030 with a view to 2040 to assure a holistic approach in the safe use of nuclear energy. These proposed actions concerns the review of existing legal framework, research and development activities, education and human resources development and others. The document is still in the phase of preparation with a view to submit it to the government by the end of November 2024.

5. Conclusion

The present legal and regulatory framework is characterised by a complex structure of regulatory institutions in a complex legal framework. A number of regulatory institutions regulating different aspects of the safe use of nuclear energy. At present the regulatory and legal framework is built on the assumption that the pressurised water technology will be used. This is also the case for the near future for the planned nuclear power plants. Despite the fact that the legal and regulatory framework reached an advanced stage in accordance with international best practices and in accordance with EU legal framework some aspects like siting and design needs further attention when new innovative technologies like SMR will be introduced. The possible vicinity of the installation to a densely inhabited area represent a particularly sensitive issue considering the present practice in relation to design requirements and emergency preparedness. Due account should be given to the legitimate interest of municipalities for example in considering financial or other incentives. As regards, new and innovative technologies like SMRs the present legal framework in relation to safety objectives might be reviewed and revised.

References

1. Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters.
2. Convention on Environmental Impact Assessment in a Transboundary Context.