ELSMOR

Towards European Licensing of Small Modular Reactors

Summary report of stakeholder input and Institutional/ Organisational Strength-in-Depth

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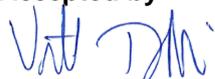
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Summary

This report summarizes the results of a small case study on the needs and expectations of some key stakeholders in Finland regarding SMRs. This case study provides a preliminary snapshot of stakeholders' needs and expectations regarding SMRs and gives important additional input to understand the challenges and opportunities related to regulation, licensing, stakeholder interaction and interfaces etc. from different stakeholders' perspectives. The report also suggests some preliminary solutions to deal with these from an organisational perspective to proceed with SMRs in the future. Based on interview data, four main categories of needs were identified: need for strong energy-political backing for SMRs, need for common forum for all key stakeholders within the SMR ecosystem, need for information and communication, and need for competence building and understanding risks. Overall, the work attempted to contribute to identifying prerequisites for establishing robust and resilient Institutional Strength-in-Depth for SMRs in Finland and Europe and acts as a basis for further studies on this topic.

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Contents

1. Introduction

The objective of this report was to summarise the results of a small case study on the understandings and expectations of some key stakeholders in Finland regarding small modular reactors (SMRs). This case study provides a preliminary snapshot of stakeholders' needs and expectations regarding SMRs in Finland. The study provides important additional input to understand the licensing and related challenges and opportunities from different stakeholders' perspectives, and what could be the solutions to deal with these to proceed with SMRs in the future.

Stakeholders are defined as entities who have an interest in a successful implementation of a project, or may have a positive or negative influence in the completion of an endeavour. The stakeholders may vary in the degree of interest and influence they exert on the activities and outcomes.

In this study, it is important to notice that key stakeholders are also all institutions that can influence the safety outcome of SMRs. The ELSMOR project task 6.1 aimed at exploring the possibilities to proactively integrate the IAEA's Institutional Strength-in-Depth (ISiD model, INSAG-27, IAEA, 2017) into defence-in-depth thinking relevant for SMRs. The ISiD model highlights three layers and interactions between them: industry, the regulator and stakeholders. It postulates that nuclear safety and sustainability of national nuclear safety systems are affected by several different organisations, e.g. licensees, ministries, safety authority, vendors, non-governmental organisations, public and media. Effective leadership and good safety culture are at the core of the Institutional Strength-in-Depth.

This work contributes to identifying prerequisites for establishing robust and resilient Institutional Strength-in-Depth for SMRs in Finland and Europe. This summary report acts as a basis for further studies on this topic.

2. Theoretical background

2.1 Institutional Strength-in-Depth

The theoretical background for this study draws on Institutional Strength-in-Depth (ISiD) - a concept and framework launched by the International Atomic Energy Agency (IAEA) expert group in 2017, following the Fukushima accident and lessons learned (INSAG-27, IAEA, 2017). The ISiD model is shortly defined as "independent institutional subsystems to prevent a nuclear accident to happen". These subsystems consists of "a strong nuclear industry, a strong nuclear regulator and a strong set of stakeholders who ensure a capable institutional framework" (INSAG-27, pp. 3-4). In this context, "strong" refers to "an inner strength to encourage and welcome challenge, to challenge others, to question and consider others' options and advice, and to possess the competence and capacity to fulfil functions and duties." (IAEA, 2017:4).

ISiD framework is targeted to the study of safety in the inter-organisational, usually in a country-specific context - it aims at establishing and maintaining a robust overall nuclear safety system. The concept is based on the idea that it is not enough that there are good technical tools and safety standards, but these standards need to be implemented efficiently. ISiD refers to a network of organizations, such as governments, industry, regulatory body,

media and NGOs, and interfaces between them that assure that the tools and safety standards are efficiently applied. For instance, strong self-regulation in the context of industry, refers to internal barriers, such as experienced staff, strong safety management systems, vivid safety culture as well as peer pressures from national and international industry. Regulators' internal barriers consist of regulator capability and competence, organizational structure, international peer pressure deriving from e.g. IAEA reviews (IAEA, 2017).

ISiD builds on the existing safety principles, such as the safety culture, and the defence-in-depth principle that is thereby extended from the technical context to organizational context. ISiD complements the defence-in-depth thinking, adjusted it to the organizational context. The philosophy of defence-in-depth means in the organizational context that each of the key organizations i.e. industry, regulator, government and stakeholders in the nuclear domain forms an independent safety layer or barrier that is further strengthened by multiple internal barriers, such as competent actors, safety management system and vivid safety culture (IAEA, 2017; Ylönen 2020). Within and between organizations there should be atmosphere of openness, transparency and a good safety culture and leadership.

Thus, ISiD focuses on inter-organisational interfaces and relevant roles and responsibilities of key stakeholders in the production of safety and could be applied to other contexts as well, including SMRs. The framework helps illuminating the interfaces, current roles and responsibilities of stakeholders, as well as the future needs of the stakeholders.

In this study, ISiD framework is applied not only regarding safety but the overall situation regarding the possibilities and challenges in terms of licensing and proceeding with the SMRs. Establishing robust and resilient ISiD for SMRs is important for public acceptance and for ensuring safety. Currently, the SMR technology developments are driven by the industry and closely followed by the regulators. The public, municipalities, educational institutions, etc. other key stakeholders are also following the developments but needs and expectations of different stakeholders should be better understood and taken into account for effective enabling of SMRs in the future.

2.2 Use cases of the theoretical background and the Canadian example

The motivation to apply the ISiD perspective to SMRs context can be described as follows. In the context of SMRs, ISiD provides a framework to analyse the robustness of national nuclear community and other relevant actors involved in SMRs. It would be possible to expand ISiD beyond country-specific context to regard international nuclear community, or European actors involved in SMRs, and to analyse and develop internal barriers relevant to core actors in the SMRs context. ISiD could be used to define the roles and responsibilities of actors in the SMRs context, as well as the interfaces or relations between them. ISiD could be complemented with the identification of uncertainties related to SMRs, including identification of technical, societal, organizational and sociotechnical aspects.

While not necessarily based on the ISiD framework, the Canadian SMR roadmap (2018) could be seen as driving forward similar points of building capacities and prerequisites for the utilisation of SMRs and building connections between various relevant stakeholders. The Canadian SMRs roadmap integrated input from 55 different organisations to share their views on what kind of a role SMRs would have in the future Canadian energy sector. This level of stakeholder engagement is crucial when it comes to nuclear industry initiatives.

A few of the especially relevant points from the Canadian study's priority recommendations include "Regulatory efficiency and nuclear security" and "Capacity, engagement and public confidence". The first point focuses on achieving a graded approach based regulation together with a variety of stakeholder groups including the industry and the general public.

As noted, ISiD framework drives forward the point that it is not enough that there is a clear rule set in place, but the enforcement of those rules should also be driven by a strong safety culture and leadership both inside organisations and between them. Building the basis of regulation together with the various stakeholder groups would ensure that the different parties would understand justification of the rules and builds a basis for strong connections and interfaces between the relevant parties for long-term sustainable development.

Similarly while the second raised point from the priority recommendations in the Canadian study highlighted especially the questions regarding indigenous engagement in Canada, the primary points would apply to achieving acceptance for nuclear anywhere. Having a clear fact-based two-way engagement and communication with local communities (towns, municipalities), which could potentially consider accommodating an SMR would affect the successful implementation of a SMR project. The concept of *governance for safety in inter-organizational project networks* has been utilized mainly in large complex projects but it might be a relevant concept to be considered also for future SMR projects, which may become complex as well (Gotcheva et al., 2020).

3. Technical and regulatory context

The term "small modular reactors" (SMRs) has been adopted globally to refer to all small reactor designs. Still, there are significant differences across the major types of approximately 70 SMR concepts that are currently under development. According to OECD NEA (2021), small modular reactors (SMRs) are generally defined as:

> *"Nuclear reactors with power outputs between 10 megawatt electric (MWe) and 300 MWe. SMRs present several technical features that enhance construction predictability and lead to potential reductions in construction costs and delivery times. Those designs with power outputs smaller than 10 MWe – often for semi-autonomous operation – have been referred to as micro modular reactors (MMRs).*

Generally talking about SMRs as an unified field is fairly difficult and problematic due to wide variety of designs, but this report attempts to stay on fairly general level. As noted in the OECD NEA report (2021), many of these designs contain features that could be generalised to overlap between different designs. For the ISiD framework, relevant areas from the reports "key design features of SMRs" would for example be inherent safety features, improved modularisation and manufacturability and enhanced flexibility. The questions listed related to these specific features here are by no means meant to be a complete list, but at least a starting point for what kind of issues we should consider when making sure that SMRs could successfully utilize the ISiD framework while still retaining a possibility of being realized as feasible projects.

The inherent safety features of SMRs can both affect the competences required from various stakeholders and require additional work for mutual understanding. At the same time, inherent safety could lead to streamlined operations and maintenance that could potentially also need to be analysed through a safety culture perspective.

One of the largest open questions regarding the feasibility of SMRs is the licensing of these new plants. As noted by Mignacca et al. (2020), one of the greatest barriers standing before SMR deployment is the licensing process of a new NPP and its duration, cost and risk. As SMRs also aim towards further standardisation of the designs that would be a base requirement for the improved modularisation and manufacturability, one of the proposed solutions has been the harmonisation of licensing requirements. There could be a push for the licensing and safety analysis done for an SMR design in a single country to be utilized in other countries with different regulatory frameworks. This has already been brought up in the literature, e.g. Bergroth et al. (2021). In the case regulators would accept changes along these lines, it would open new questions regarding the ISiD roles in the strong regulatory sub system and how well ISiD would work as a framework based mostly on national level. If there is a clear international aspect to regulatory work, this should be clearly reflected in the ISiD framework as well.

Some of the SMR designs, with their enhanced flexibility due to smaller size or other factors, would open up nuclear as a potential source of energy also for industry and non-nuclear power utilities. There are guidelines for nuclear newcomers, but there might be a need for renewal especially as the use cases might differ from the traditional electricity production.

4. Method

The method for this study was qualitative: semi-structured interviews were conducted with representatives of selected key stakeholders (institutions and organizations). This kind of small case study can highlight the relevant uncertainties, deficiencies, expectations and concerns of different stakeholders with respect to possibilities to proceed with and build SMRs.

The objective of the small case study is to shed some light on the current status of SMRs stakeholder landscape in Finland, and to collect insights into needs and expectations of some key stakeholders (Ministry of Economic Affairs and Employment (MEAE) as promoter of legislation, STUK as regulator, power companies as possible builders of SMRs and energy companies as possible exploiters of SMRs) on the topic of SMRs.

The data consists of six semi-structured interviews with representatives of MEAE, STUK, power and energy companies, research institutes and siting officials. The results of the interviews are indicative and cannot be generalised to these organizations. However, even indicative results provide a relevant snapshot of the current status and ideas to be taken into account in the future discussions if SMRs will be built in Finland. Interview data was analysed by thematic analysis to identify key overarching topics such as emerging needs and expectations.

5. Results from the case study in Finland

As noted, not everything from the case study could be clearly mapped into the ISiD framework, but having an understanding of the current status of the field is an important prerequisite for establishing a robust and resilient ISiD for SMRs. In that context, the following results form a preliminary ground to not only move forward in Finland, but also hopefully raise some points that could be used similarly in other areas. Figure 1 summarizes the results from the case study, illustrated from the perspective of IAEA's ISiD framework.
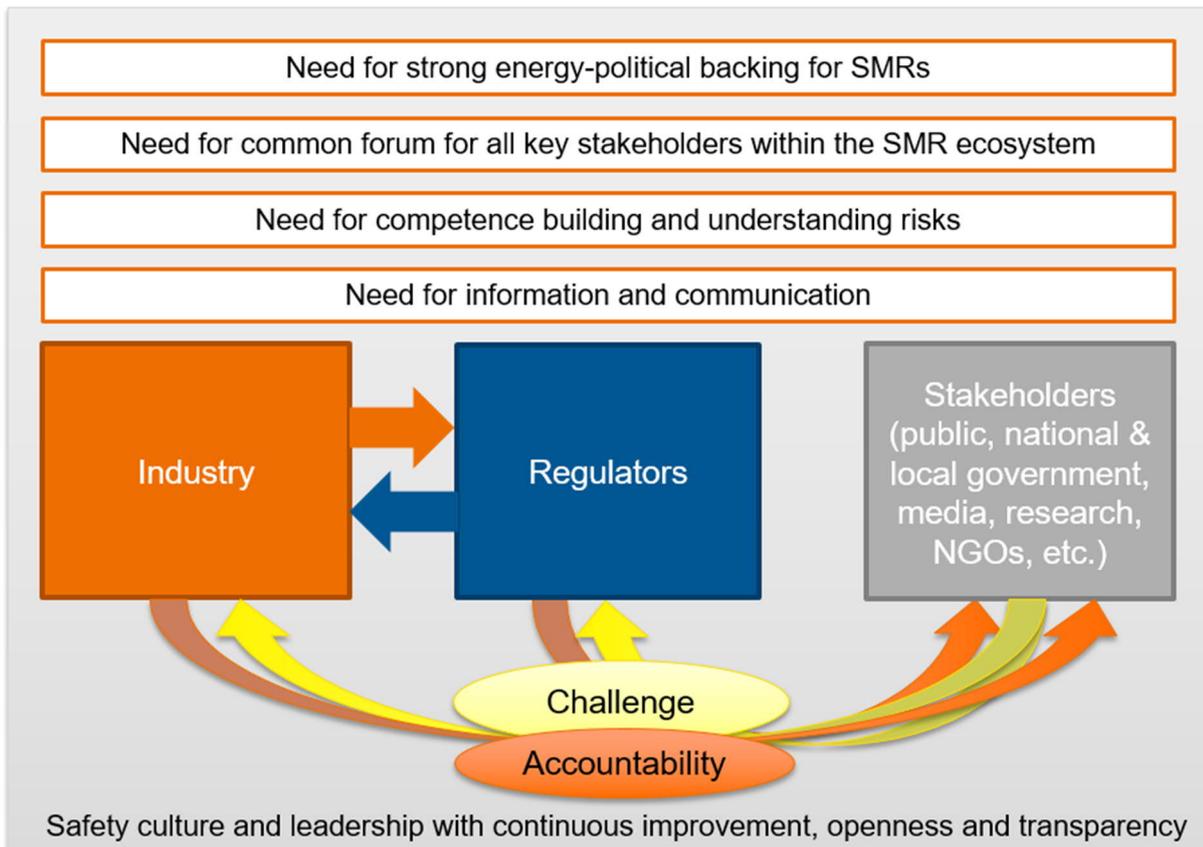
Figure 1. Main stakeholder needs identified in the case study (ISiD model adapted from IAEA, INSAG 27, 2017).

Relations between stakeholders regarding challenges and accountability (who is challenging and who is accountable) were not explicitly referred to in the interviews, but relations were accounted for with regards to need for communication, joint vision and actions, and generally the need for a common forum and vivid collaboration between different stakeholders about future SMRs. This was well recognized as it *"gives more brains to work on these problems"*.

5.1 Need for strong energy-political backing for SMRs

National energy-political will to promote SMRs needs to be clarified, formed, and expressed clearly. Only then would the deployment of SMRs be possible. But what exactly this would require is fairly unclear at the moment. As one interviewee noted, there is an empty space at the moment in the middle of the stakeholders with an interest in the technology as different parties do not want to be the first movers without clear declarations of support from others. On one hand, it would seem like there is a need for a clear message and lobbying towards the MEAE that power companies are willing to proceed with SMRs. Thus, power companies should be more active towards MEAE. On the other hand there were expectations towards MEAE that it would take a more active role in creating collaboration between different stakeholders around SMRs.

There needs to be a clear political will for these plants to become a reality. Or as one interviewee pointed out when discussing international licensing:

"There is power and politics involved. It is not about science."

It should of course be noted that nuclear energy or SMRs by themselves have no inherent value in comparison to other options, but many interviewees noted that SMRs are a valid source of low-carbon energy production and that the option would be worth exploring. For there to be energy-political backing, the political decision-makers would need to be informed about the different options.

Without a declared energy-political will to advance SMRs, it is difficult for both the power companies and the regulatory body to advance SMRs. In Finland the regulatory body is under the Ministry of Social Affairs and Health, and will not get budget to familiarise itself with the SMR concepts if it is not publicly stated to be socially and politically accepted. This social and political acceptance is of course an ambivalent question, but there has been an upward trend in the acceptance of nuclear energy in the Finnish context. It is still a sensitive topic and time will tell how the general support translates to support for a definitive project. The sensitivity was highlighted especially by the siting officials.

When considering the timeline, it should also be noted that the processes relevant to nuclear starting from licensing, siting etc. usually take years. The general feeling could be said to be that while things should not be rushed, it would be better to be prepared sooner rather than later.

5.2 Need for a common forum for all key stakeholders within the SMR ecosystem

The key stakeholders should cover Ministries, nuclear power companies, STUK as a regulatory body, energy companies, possibly steel and chemical industry as end users, other companies, land use planners, actors from district heating domain and further. The stakeholder field for SMRs is very large, but this could be taken as a note that it would be even more important to bring all of the actors together.

Currently there are several seminars and workshops regarding SMRs in Finland but no single forum that would collect different stakeholders together. It could be stated that there is plenty of "hype" around the SMR subject. Nevertheless, for the field to move forward, a broad and "permanent" forum for the stakeholders would be necessary. Different forms of hopes for a deeper and more inclusive interface between the stakeholders came up from the interviews. A permanent forum could function as a basis for developing a clearer understanding, shaping a joint vision and building a Finnish roadmap for SMRs. As noted earlier, an example for this can be found from Canada, where ministries and representatives of regulators and industry etc. created a roadmap for SMRs together.

It is relevant to ask whose task it would be to organise and facilitate this kind of a forum. Interviewees pointed towards MEAE to have a more active role, but similarly there was a feeling that the industry itself should step up. The question then partly becomes if MEAE has sufficient resources to take care of this task. Is this Ministry the one and only actor that could drive forward arranging permanent forums for key stakeholder groups? Primarily this would point back to the importance of a clear political will and backing for the nuclear field.

5.3 Need for competence building and understanding risks

Need for SMRs-related competence building was highlighted by all stakeholders. Many interviewees highlighted the importance of developing competences, especially for potential newcomers to the nuclear industry domain. From the perspective of universities and

research organizations, the interviews highlighted their role as "road-openers", paving the way forward with scientific work, giving society new ideas and preparing for potential futures. One challenge that was raised was that in Finland there is funding for nuclear energy research, focused on existing NPPs, but there is no targeted funding for *future* nuclear energy research. What is needed is establishing a sustainable research funding instrument and infrastructure for competence building in future applications of nuclear energy.

Different interviewees also perceived many different risks related to SMRs and their deployment that should be taken into account, but also a wide array of opportunities, especially for newcomers and new end uses. As one interviewee stated:

> *"The potential is huge regarding SMRs, but from the point of view of nuclear risks one needs to be humble and be able to identify restrictions and deficiencies."*

Understanding the risks and responsibilities needed is critical for any newcomer, also from a long-term perspective. These could be taken as a clear message towards the need to bring these potential newcomers into the ISiD framework from very early on. This was echoed also by the newcomer utility interviewed as they hoped they could be more involved in different discussions. All of this should still be, in a way, considered a positive problem, one interviewee even went as far to say that we should take into account a situation where there are enough SMR projects going on at the same time that the number of competent people becomes a restriction. These kinds of competences are not built fast and having for example universities in the discussions that refer to energy political will early on could be critical.

Regarding the importance of building a strong ISiD with respect to SMRs, especially with regards to encouraging and welcoming challenges, an interviewee highlighted stagnation as a possible barrier for enabling SMRs and further developments in the nuclear field:

> *"Biggest risk is stagnation, confidence that the current situation is good enough."*

This issue could also be seen partly in the question of who would take the first steps in bringing together different parties to a common forum or take the first steps towards the deployment of an SMR. Primarily, all of these actions require resources and a strategy that putting those resources forward now would be a smart and sustainable move in the long term. This was especially clear from the industry point of view as it highlighted the need of regulatory stability. The licensing risk was taken very seriously and in this context, the regulators insufficient resources to focus on SMRs is to be considered. All of this points to the first raised point: the SMR designs themselves should be buildable, but what is needed are the resources and political and social willingness to go forward.

5.4 Need for information and communication

As noted earlier the SMR field is wide and even understanding what is being discussed when purely mentioning SMRs on a general level can sometimes be difficult. The discussion should be aimed towards more concrete ideas on a general level. Similarly, the different actors would need clear information and communication regarding the subject. What and why should be done. This is of course easier if there is a clear course for what should be considered where the roadmap approach could help. This could then be informed to various levels of society starting from the political decision makers.

The need for communication is also highlighted especially in the experiences of the siting officials. The general public needs proper information and most of all, to be heard about their needs. In general, the necessity of proper communication and proper interfaces between different levels of stakeholders should be a given.

6. Discussion and conclusion

This small study aimed at advancing the understanding of the needs and expectations of some of the key stakeholders in Finland regarding enabling SMRs, especially with regards to licensing and related challenges and opportunities from different stakeholders' perspectives, and possible solutions to deal with these to proceed with SMRs in the future.

The results indicated that in order for the different stakeholders to collaborate, to challenge each other and to boost safety improvement and development in the nuclear industry field in terms of institutional strength-in depth for SMRs, four main emerging needs have to be met: the *need for strong energy-political backing for SMRs, need for common forum for all key stakeholders within the SMR ecosystem, need for information and communication, and need for competence building and understanding risks.*

The results from the Finnish case study shed lights on the country-specific situation, but could hopefully also be on some level generalised further for European level. Clearly, a more systematic dialogue and collaboration between different stakeholders is needed to achieve concrete results in terms of enabling SMRs. On an European level, ELSMOR and other EU research projects provide important first steps. Leadership and joint visions and action plans are needed both on national and international levels.

The point of international collaboration on SMR licensing and regulation was raised by all of the energy-industry side interviewees. While it is unlikely that any kind of unified regulation can be achieved, perhaps there could be hope for more common work across national borders if different countries are considering the same SMR designs.

When comparing the preliminary results from this case study to the Canadian roadmap (2018), the main points could perhaps also be generalised elsewhere. One cannot have too much communication between the different stakeholders but this needs to be developed and implemented thoroughly with regards to SMRs. The political backing is clear in the Canadian case and there seems to be hope for a similar approach in Finland as well. Finally, bringing together the different stakeholders into the same forum seems critical. While there was not necessarily a similar highlighting of regulatory work and understanding in the Finnish cases hopes for a common forum, that would most likely be an important point to raise and a relevant subject for discussions. And naturally, also create the basis for strong ISiD if everyone involved can take part in building the regulatory approach and thus gain a better understanding of the common rules.

It is hard to say how well these commonalities between Finland and Canada apply to other countries, but nevertheless, this small case study could work as a basis for further work in the area. It is critical that all parties involved in SMRs understand the importance of nuclear safety, as well as the long-term responsibilities. Bringing all of the potential stakeholders, including newcomers, into the ISiD framework at an early stage would be important for the establishment of a good safety culture and leadership in the SMR ecosystem as well.

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Appendix

Stakeholder landscape interview scheme

- Who are the main stakeholders from your perspective in Finland with regards to enabling SMRs (including licencing)?
- What is the status of collaboration between regulators, between companies, between regulators and industry, and between industry and other actors (city planners, ministries, etc.)?
- Can safety analysis done in other country be acceptable in another country?
- What are the challenges and opportunities related to collaboration between different institutions and organizations, also international collaboration and the role of newcomers?
- What are the risks and opportunities regarding newcomers to nuclear including parties like utilities, manufacturing industry, subcontractors and municipalities for example?
- What is the status regarding laws and regulations regarding licencing of SMRs (in Finland and internationally)?
- Who should be involved in the SMRs licencing process, and in your opinion, who is driving it?
- What are/should be the roles and responsibilities between different stakeholders, including newcomers and the role of the public? Political decision-makers? The role of public, municipalities?
- What kind of interfaces there are between different actors?
- What do you think, do we have enough knowledge about social acceptability of SMRs and what are the gaps in that?
- What kind of new competences are needed (for all different stakeholders)?
- What are the future expectations and needs (regulation, legislation...) regarding SMRs? What is the timescale for licencing SMRs?