

## **Measuring Social Impacts of Nuclear Closure and Decommissioning**

**Hana Gerbelová, Ruth Shortall**

European Commission, Joint Research Centre

Westerduinweg 3

1755 LE Petten, The Netherlands

Hana.Gerbelova@ec.europa.eu, Ruth.Shortall@ec.europa.eu

### **ABSTRACT**

This study represents a first step in the development of indicators for social impacts arising from nuclear closure and decommissioning. Social impacts have unique characteristics and tend to be neglected in policy appraisals. However, from a local point of view, the closure of such an important industrial facility may have major social impacts, especially in remote locations where nuclear power plants are the main source of local employment and income. Therefore, the development of dedicated indicators could provide effective support to measure the effects and progress of the social aspects related to closure and decommissioning activities. The context and extent of the consequences in each hosting community will vary from one site to another, therefore, we do not intend to provide a prescriptive set of one-size-fits-all indicators, rather, we provide a guidance framework for future indicator development. With this in mind, this paper presents the design and main outcomes of a participatory stakeholder workshop, which focused on the social impacts resulting from the announcement of the closure of a nuclear power plant and present examples of possible indicators for evaluating and forecasting these social impacts.

### **1 INTRODUCTION**

Independently of the policy for nuclear energy at national level, each nuclear power plant (NPP) will eventually close and enter the decommissioning phase. From a local point of view, the closure of such an important industrial facility may have major social impacts, especially in remote locations where NPPs are the main source of local employment and income. It is, therefore, vital for the long-term prosperity of the community that all relevant social impacts are identified in advance to support the closure strategy and focus on effectively mitigating the negative impacts and increasing the potential benefits.

Nuclear decommissioning projects (NDPs) are especially complex because of their high costs and associated socio-economic and environmental impacts. They involve many stakeholders' activities at different scales, carry various uncertainties and are politically sensitive [1]. The NDP is a multi-step process, which will take several years and can be divided into three phases [2]:

- The announcement of the closure and preparation for the cessation;
- Decommissioning, which involves dismantling the facilities and proper disposing of any radioactive material;
- Remediation of the surrounding area, which enables safe reuse of the site for other nuclear, industrial or general purposes.

Each of these activities cause different social impacts in the hosting community. However, research on the societal aspects of nuclear decommissioning is still lacking and socioeconomic impacts of plant closure are not well understood, which hinders effective policymaking [3,4]. Failure to mitigate social impacts can result in major hindrances to NDPs.

According to the principles of Social Impact Assessment (SIA), a good practise to manage social impacts is the development of an indicator, which monitors the status or change over time [5]. Figure 1 summarises the implementation of the indicators within the SIA process. Indicators measure quantitatively and/or qualitatively a system condition and its progress toward or away from a particular benchmark or target. In other words, the indicator evaluates the change and thus facilitates the monitoring of possible changes in the affected regions. This will contribute to a better understanding of the consequences of closure of the nuclear power plant on host communities. Using indicators can help guide the regions through the transition process, by allowing measurement of progress (or lack thereof) of the social aspects related to these activities.

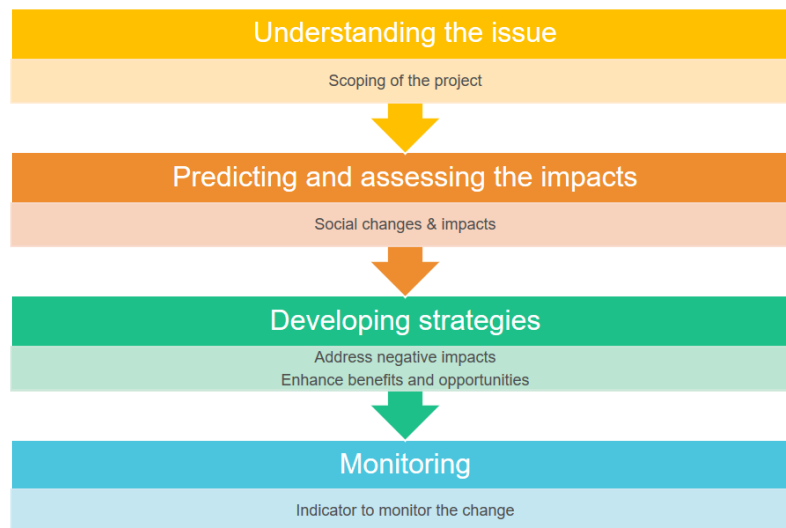


Figure 1: Framework for the indicator development according to the principles of SIA (adapted from [5])

Various organisations have developed indicators related fully or partly to nuclear energy, and some include indicators dealing with social impacts. For example, the International Atomic Energy Agency (IAEA) has developed a set of 30 indicators (EISDs) for sustainable development in energy sector [6]. However, these indicators have been developed to compare progress in sustainable energy development across countries and therefore entail a broad, national-level evaluation. Further, they are not specifically focused on nuclear energy impacts or NDPs. Hence, the social indicators are limited in scope and only cover certain social aspects of general energy development e.g. accessibility, affordability, nuclear waste management and accident fatalities. With the increase of usage of performance indicators in nuclear energy, the IAEA has also defined indicators for the development of nuclear energy, designed to assess the expansion of nuclear power programmes [7]. However, these relate to impacts on the macroeconomic level and therefore are not suited to measuring local impacts. Indicators especially for safety issues have also been developed [8,9], however their scope is limited to the power plant itself.

Stamford and Azapagic (2011) later elaborated on key IAEA energy indicators and proposed indicators for evaluating nuclear power plants based on a life cycle analysis [10].

These include impacts on the local community mainly related to the operational phase of the NPP. Many of the proposed indicators could possibly be adopted to the decommissioning process, however these have been developed in the UK context, and, while extensive, they were not developed with stakeholder participation and hence may not be appropriate in certain contexts.

While all of the abovementioned indicator sets may cover some important social aspects of nuclear power on some level, as we demonstrate, many are not specifically designed to capture the unique social impacts associated with nuclear closure and decommissioning on the local level, or else they unlikely to capture the context-specificity of the impacts in this regard. Context-specificity is of great importance when measuring social impacts, and impacts should ideally be defined in collaboration with affected groups [11].

Our objective is to develop indicators that specifically capture the social aspects related to the closure of nuclear power plants and thus support nuclear power plant decommissioning communities in their social impact monitoring plan. For this reason, the purpose of this research is to understand the social impacts of NDPs and take the first steps towards a framework of social indicators for the closure and decommissioning of the NPP. Our approach to indicator development generally follows the relevant guidelines for carrying out impact assessments [12] in particular SIA [5], and is also informed by the method for indicator development described in Shortall et al. [13]. However, it should be noted that we do not aim to carry out a project-level SIA, but rather to provide guidance at the policy level for social impacts that could be taken into account should an SIA (or similar undertaking) be carried out in the host community of the nuclear closure and decommissioning project.

## 2 METHOD

We organised a half-day online exploratory workshop with seven stakeholders with expertise in the social management of nuclear decommissioning and community representatives with direct experience in nuclear decommissioning. The workshop was organised around four predefined activities, where participants drew on their own experience and perspectives. The participatory setting of the meeting ensured the sharing of best practises and enhanced networking. Figure 2 shows the activities included in the workshop.

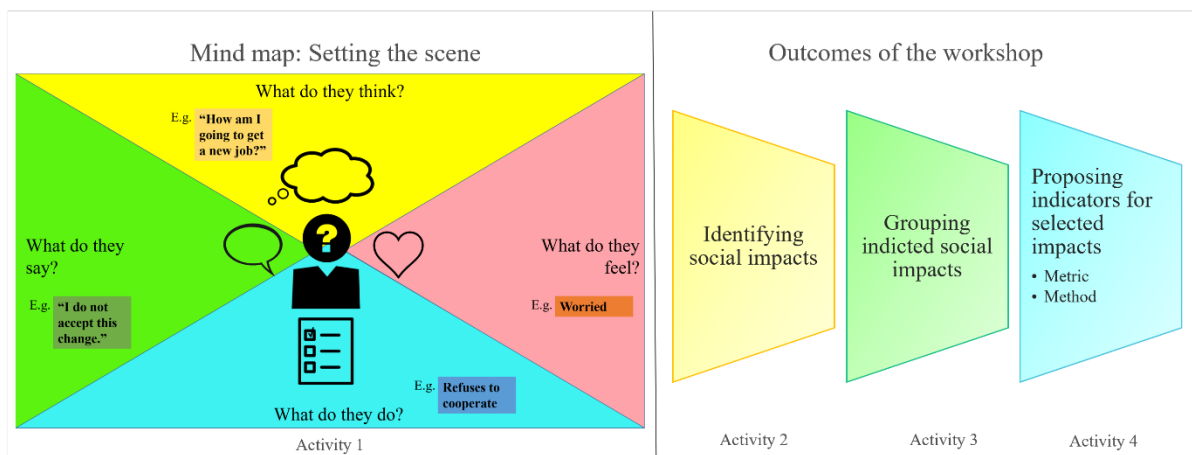


Figure 2: Summary of the carried out activities during the workshop

The practical exercises were carried out using Jamboard<sup>1</sup>, a digital interactive whiteboard developed by Google. The first activity was the empathy map, a popular agile design tool used to understand design needs by visualising what a selected person says, thinks, does and feels [14]. We used this tool to begin with, to help participants think from the perspective of the key community members impacted by NDPs. As this was a thought exercise without concrete outputs, no results are presented.

In the second activity, participants were asked, based on their expertise or experience, to identify the social impacts from the perspective of a community facing the potential closure of NPP. We did not provide any impacts in advance to avoid influencing the participants. We only reminded participants that the social impact is anything that impacts people's way of life, i.e. how they live, work, play and interact with one to other on a day-to-day basis [11]: culture, community, political systems, environment, health and well-being, personal and property rights, fears and aspirations, future aspirations for self and children. However, we asked them to focus on:

- Important impacts according to their experience in the field of nuclear closure and decommissioning;
- Both negative and positive impacts;
- Social impacts that they believe are often ignored.

In relation to the last point, we wanted in particular to gather insights on impacts that are not covered by the indicators outlined in literature, such as mentioned in Introduction.

In the third activity, participants grouped the identified impacts into themes agreed in a group discussion. Again, no themes were proposed by the researchers in order not to influence the participants.

The fourth activity involved the development of the social impact indicators. Due to the large number of social impacts identified in the previous activity, the researchers chose one social impact per theme to focus on. Impacts without much existing literature on measurement were given priority. Together with the participants, we identified possibly metrics for the chosen impacts, as well as methods to measure progress. These included qualitative and/or quantitative metrics to measure progress or change in each social impact.

## 3 RESULTS

### 3.1 Identifying social impacts

In the first part of the workshop, participants identified the most relevant social impacts according to their experience. The social impacts discussed related to impacts of the project in particular on workers and on the community in general. Participants reported some positive impacts leading to opportunities and benefits for the community, negative impacts that should be reduced or mitigated, as well as impacts with uncertain outcomes, which may potentially evolve in both directions (positive and negative) or fluctuate over time.

For example, one of the identified impacts was population change. The population may be reduced if there is no further economic development in the area. There is a risk of the departure of the employees and families of the NPP and the closure of all directly and indirectly related business activities. It is therefore crucial to continue to ensure local employment and to

---

<sup>1</sup> <https://jamboard.google.com/>

support the economic development of the region. The implementation of new projects will take several years and may create a gap after the departure of the NPP staff and until new opportunities arise. This shows how important it is to monitor the progress of change over time and to develop appropriate measures accordingly.

### 3.2 Grouping social impacts into themes

Having set out the social impacts, we asked the participants to group them into themes in order to provide a better structure for future discussion. Figure 3 summarises the social impacts discussed in the workshop and their distribution into five proposed categories<sup>2</sup>. Participants easily divided social impacts into two themes: *Economy* and *Demography* without much discussion. The themes *Well-being* and *Political Consequences* were discussed at more length because some of the impacts were considered relevant to more than one theme. The last theme identified was *Environmental Sustainability*. Although environmental impact assessment is usually carried out separately, the workshop participants still mentioned it here because environmental change by default affects society and, according to the participants, is of great concern to the community. A distinction was made between sustainability in general, which covers all three economic, environmental and social dimensions, and environmental sustainability. However, the participants argued that nuclear power plants are one of the most sustainable ways of generating electricity and that potential future projects in the area could in fact have higher environmental impacts. A representative of local authorities pointed out that the future site development plan must provide for an economic development project with less environmental damage than the current NPP.

DEMOGRAPHY		ECONOMY		SOCIAL VALUE/ WELLBEING		POLITICAL CONSEQUENCES		ENVIRONMENTAL SUSTAINABILITY
Outmigration	Change in population	Loss of income	Changes in employment patterns	Increase of transport during the decommission	Visual improvement after land reclamation	Loss of trust in industry	Participatory process	Environmental changes
		Loss of emergency management	New investors	Risk perception	Opportunity for something new	Disappointment in policy makers		
		Reduction of tax income to the municipality	Business opportunities	Loss of community identity	Opportunity for modernization			
		Changes in employment patterns	Opportunity for circular economy	Loss of competences	Innovative projects			
		Commercial loss	Job opportunities	Loss of maintaining safety standards	Decrease in support by the operator to the local services			
		Decrease in property values	Changes in infrastructure	Increase in life uncertainty				

Figure 3: Discussed social impacts categorized according to themes

Interestingly, participants agreed that, in their experience, radiation exposure to the local population was not a major problem and the host community perceives that there is no longer a risk of exposure with the closure of the NPP. Only operational staff are aware that they may be exposed to an increase in radiation pollution during the decommissioning process. Local

<sup>2</sup> This paper only presents the outcomes of this workshop. This list in Figure 3 is an exact reproduction of what remained on the jamboard slide. However, we acknowledge that some more work will be needed to further expand this list and clarify the sub-categories.

representatives recalled the need to maintain radiological risk management until the site is fully rehabilitated. The only specific health problem that was briefly addressed at the workshop was the decrease of the health condition of the community and the stress caused by a possible lower quality of life.

### 3.3 Proposing indicators for selected impacts

Figure 4 summarises the outcome of the final exercise, where participants proposed indicators for four selected social impacts. The first impact discussed was an *opportunity for the circular economy*. One of the proposed indicators was the number of new businesses meeting certain circularity criteria. The criteria could be measured by the amount of material reused and/or by means of ecological footprint indicators or using other environmental impacts. An important argument is that the analysis should distinguish between long-term and short-term effects. It is important to consider this in the monitoring plan and to define the frequency and duration of each measurement. Another indicator for measuring opportunities for the circular economy could be a regular review of a municipality's budget to see how many companies use the incentives for the development the pre-defined circular economy criteria.

Impact	Metric	Method
Opportunity for circular economy	Number of companies fulfilling certain criteria for circularity	Evaluation of number of companies using the defined circularity criteria
	Quantities of reused material/land/infrastructure	Collect data on % of reused land, amount of reused materials
	Municipality funds invested for the strategies	Review of strategies
Population change	Availability of public facilities	Socio-demographic statistics
	Housing trends	Census
	Purchasing power of the population	Comparison to similar communities without NPP
Increased life uncertainty	Existing OECD indicators	Benchmark against other communities with NDPs
	Outreach to the community	Count social project to address uncertainty
	Uncertainty perception	Uncertainty models for qualitative analysis using perception parameters from focus groups
Disappointment in policy-makers		Empirical evidence through interviews
	Engagement in social media	Analysis of social media
	Representation level of local community in governing bodies (e.g. working groups)	Count participants in public meetings
	Engagement level	Assess level of dialog/mutual understanding in meetings
	Satisfaction about policy decisions	Opinion polls (before and after political decision)

Figure 4: Proposed indicators with metrics and methods for chosen social impacts

Possible indicators for *population change* were relatively straightforward, as many data are already available in statistics, such as age structure, availability of public facilities, household incomes or the purchasing power of the local population. However, participants noted that a good interpretation of the data is important. For example, local authorities observe a trend that housing prices are falling with outmigration. However, lower housing prices are an opportunity for young people. Their influx may counterbalance the trend, but the structure of the population may be different.

On the social impact of *increased life uncertainty*, participants suggested a comparison with progress in the well-being of other communities (as a benchmark) with the NDP using existing indicators developed by the Organization for Economic Co-operation and

Development (OECD). Another point raised was the use of experience gained from other NDP communities or measuring outreach to the community by analysing the number of social projects aimed at reducing uncertainty. Participants also had an interesting debate on how to measure the perception of uncertainty and concluded a possible combination of qualitative and quantitative methods. For example, focus groups could formulate community perception parameters on uncertainty, which could then be used in scientific uncertainty models, and combine with empirical evidence based on surveys.

The last social impact discussed was *disappointment in policy-makers*. The first idea for measurement was an analysis of social media to see community engagement and views. Participants drew attention to the difference between participation and an active role in decision-making and suggested also counting the active representation of the municipality in governing bodies such as working groups. The quantitative number of staff in the meetings could be complemented by a qualitative evaluation of the dialogues and mutual understanding at the meetings. Another indicator proposed was the measurement of improvements in the community's perception of policy decisions. This could be done through surveys carried out before, during and after the implementation of a decision. This would allow policy makers to reflect the results of surveys and seek better progress to the satisfaction of the community with their decisions.

### **3.4 Feedback from workshop participants**

We asked the participants about their experience of the workshop overall. In general, they found it very interesting and wished to be informed about follow up studies. Participants were very happy to see that we are considering the local level in our research and that they can contribute from the local level to this research and process. They particularly liked using the empathy mapping as a novel way to encourage thinking from the perspective of the community members. They also remarked that the interactive online tools helped maintain them focus. Most participants are open for future collaboration and/or to help put us in contact with host communities for possible future participatory meetings.

## **4 LIMITATION OF THE STUDY AND FUTURE WORK**

In this exploratory workshop, we collected inputs from a small group of stakeholders, mainly experts, during a limited time-period (half-day workshop). As such, this is a starting point for the development of social impact indicators and does not represent an exhaustive list of social impacts of NDPs. Future research will involve a thorough literature review in addition to participatory research, which should include more (and diverse) representatives from host communities. This is needed in order to further verify the proposed indicators and ensure a balanced perspective of the social impacts that are important for communities to take into consideration. Since social indicators are context-specific and sometimes subjective, we only aim to provide a framework and suggestions for indicators, which should always be validated by stakeholder input in each case. Further research should also verify that the indicators are easily interpretable and communicable, crosschecked and compared with other data and across contexts.

## 5 CONCLUSIONS

This paper describes part of a larger study which has the goal of contributing to a better understanding of impacts of closing the NPPs on the hosting community and hence enhancing the benefits of projects to impacted communities. Such impacts should be defined well in advance, with specific consideration of different options for the post-closure period coherently with the local development plans and priorities. This paper presents the outcome of a participatory workshop organised as a first step in the development of indicators for the social impacts of NDPs. Seven participants with expertise on managing social impacts of NDPs, including a community representative took part. The workshop involved four activities: empathy mapping exercise, identification of social impacts, classification of social impacts into themes, and identification of metrics and methods for measuring the social impacts (i.e. indicators). Five preliminary thematic clusters of indicators were identified: demography, economic, social value / well-being, political consequences and environmental sustainability. We discussed in detail how to measure four selected social impacts: opportunity for circular economy, population change, increase in life uncertainty and disappointment in policy-maker. Further development of indicators will be carried out using a combination of literature review and additional participatory research including more host community representatives. We stress that closure planning must be a process negotiated with local communities and other stakeholders.

## ACKNOWLEDGMENTS

We extend our heartfelt thanks to those who helped organise the workshop, especially Ariane Liessens who did an excellent job of planning and facilitation. We are extremely grateful to the seven anonymous participants of the workshop who gave up their valuable time to help us in our research. We also thank to our colleagues, Franck Wastin and Kaisa Simola for the review of this paper and Anna Mengolini for her continued support of this research.

## REFERENCES

- [1] D.C. Invernizzi, G. Locatelli, N.J. Brookes, (2017), "Managing social challenges in the nuclear decommissioning industry: A responsible approach towards better performance", *International Journal of Project Management*, 35(7), 2017, pp. 1350-1364.
- [2] Nuclear Energy Agency, *The Decommissioning and Dismantling of Nuclear Facilities: Status, Approaches, Challenges*, OECD Publications, Paris, France, ISBN: 92-64-18488-0, 2002.
- [3] T. Perko, H. Monken-Fernandes, M. Martell, N. Zeleznik, P. O'Sullivan, "Societal constraints related to environmental remediation and decommissioning programmes", *Journal of Environmental Radioactivity*, 196, 2019, pp. 171–180.
- [4] The Nuclear Decommissioning Collaborative, *Socioeconomic Impacts from Nuclear Power Plant Closure and Decommissioning*, 2020.
- [5] F. Vanclay, A.M. Esteves, I. Aucamp, D. Franks, *Social Impact Assessment: Guidance for assessing and managing the social impacts of projects*, Fargo ND: International Association for Impact Assessment, 2015.



- [6] International Atomic Energy Agency, Energy indicators for sustainable development: guidelines and methodologies, Non-serial Publications, International Atomic Energy Agency, Vienna, 2005.
- [7] International Atomic Energy Agency, Indicators for Nuclear Power Development, IAEA Nuclear Energy Series No. NG-T-4.5, IAEA, Vienna, 2015.
- [8] E.M. Connelly, S.B. Van Hemel, P.M. Haas, Industry Based Performance Indicators For Nuclear Power Plants, Communications Technology Applications, Washington D.C., 1990.
- [9] International Atomic Energy Agency, Operational Safety Performance Indicators for Nuclear Power Plants, IAEA-TECDOC-1141, IAEA, Vienna, 2000.
- [10] L. Stamford, A. Azapagic, "Sustainability indicators for the assessment of nuclear power", *Energy*, 36(10), 2011, pp. 6037–6057.
- [11] F. Vanclay, "Conceptualising social impacts", *Environmental Impact Assessment Review*, 22(3), 2002, pp. 183–211.
- [12] International Association for Impact Assessment, What is Impact Assessment?, IAIA Publications, 2009.
- [13] R. Shortall, B. Davidsdottir, G. Axelsson, "Development of a sustainability assessment framework for geothermal energy projects", *Energy for Sustainable Development*, 27, 2015, pp. 28–45.
- [14] D. Gray, Empathy Mapping: Gamestorming, <https://gamestorming.com/empathy-mapping/>, 2017.