IAEA Nuclear Energy Series

No. NG-T-3.17

Strategic Environmental Assessment for Nuclear Power Programmes: Guidelines

IAEA
International Atomic Energy Agency

IAEA NUCLEAR ENERGY SERIES PUBLICATIONS

STRUCTURE OF THE IAEA NUCLEAR ENERGY SERIES

Under the terms of Articles III.A and VIII.C of its Statute, the IAEA is authorized to foster the exchange of scientific and technical information on the peaceful uses of atomic energy. The publications in the **IAEA Nuclear Energy Series** provide information in the areas of nuclear power, nuclear fuel cycle, radioactive waste management and decommissioning, and on general issues that are relevant to all of the above mentioned areas. The structure of the IAEA Nuclear Energy Series comprises three levels: **1 — Basic Principles and Objectives**; **2 — Guides**; and **3 — Technical Reports**.

The **Nuclear Energy Basic Principles** publication describes the rationale and vision for the peaceful uses of nuclear energy.

Nuclear Energy Series Objectives publications explain the expectations to be met in various areas at different stages of implementation.

Nuclear Energy Series Guides provide high level guidance on how to achieve the objectives related to the various topics and areas involving the peaceful uses of nuclear energy.

Nuclear Energy Series Technical Reports provide additional, more detailed information on activities related to the various areas dealt with in the IAEA Nuclear Energy Series.

The IAEA Nuclear Energy Series publications are coded as follows: **NG** — general; **NP** — nuclear power; **NF** — nuclear fuel; **NW** — radioactive waste management and decommissioning. In addition, the publications are available in English on the IAEA Internet site:

http://www.iaea.org/Publications/index.html

For further information, please contact the IAEA at PO Box 100, Vienna International Centre, 1400 Vienna, Austria.

All users of the IAEA Nuclear Energy Series publications are invited to inform the IAEA of experience in their use for the purpose of ensuring that they continue to meet user needs. Information may be provided via the IAEA Internet site, by post, at the address given above, or by email to Official.Mail@iaea.org.

STRATEGIC ENVIRONMENTAL ASSESSMENT FOR NUCLEAR POWER PROGRAMMES: GUIDELINES

The following States are Members of the International Atomic Energy Agency:

AFGHANISTAN
ALBANIA
ALGERIA
ANGOLA
ANTIGUA AND BARBUDA
ARGENTINA
ARMENIA
AUSTRALIA
AUSTRIA
AZERBAIJAN
BAHAMAS
BAHRAIN
BANGLADESH
BARBADOS
BELARUS
BELGIUM
BELIZE
BENIN
BOLIVIA, PLURINATIONAL STATE OF
BOSNIA AND HERZEGOVINA
BOTSWANA
BRAZIL
BRUNEI DARUSSALAM
BULGARIA
BURKINA FASO
BURUNDI
CAMBODIA
CAMEROON
CANADA
CENTRAL AFRICAN REPUBLIC
CHAD
CHILE
CHINA
COLOMBIA
CONGO
COSTA RICA
CÔTE D'IVOIRE
CROATIA
CUBA
CYPRUS
CZECH REPUBLIC
DEMOCRATIC REPUBLIC OF THE CONGO
DENMARK
DJIBOUTI
DOMINICA
DOMINICAN REPUBLIC
ECUADOR
EGYPT
EL SALVADOR
ERITREA
ESTONIA
ESWATINI
ETHIOPIA
FIJI
FINLAND
FRANCE
GABON
GEORGIA
GERMANY
GHANA
GREECE
GRENADA
GUATEMALA
GUYANA
HAITI
HOLY SEE
HONDURAS
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN, ISLAMIC REPUBLIC OF
IRAQ
IRELAND
ISRAEL
ITALY
JAMAICA
JAPAN
JORDAN
KAZAKHSTAN
KENYA
KOREA, REPUBLIC OF
KUWAIT
KYRGYZSTAN
LAO PEOPLE'S DEMOCRATIC REPUBLIC
LATVIA
LEBANON
LESOTHO
LIBERIA
LIBYA
LIECHTENSTEIN
LITHUANIA
LUXEMBOURG
MADAGASCAR
MALAWI
MALAYSIA
MALI
MALTA
MARSHALL ISLANDS
MAURITANIA
MAURITIUS
MEXICO
MONACO
MONGOLIA
MONTENEGRO
MOROCCO
MOZAMBIQUE
MYANMAR
NAMIBIA
NEPAL
NETHERLANDS
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
NORWAY
OMAN
PAKISTAN
PALAU
PANAMA
PAPUA NEW GUINEA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
REPUBLIC OF MOLDOVA
ROMANIA
RUSSIAN FEDERATION
RWANDA
SAINT VINCENT AND THE GRENADINES
SAN MARINO
SAUDI ARABIA
SENEGAL
SERBIA
SEYCHELLES
SIERRA LEONE
SINGAPORE
SLOVAKIA
SLOVENIA
SOUTH AFRICA
SPAIN
SRI LANKA
SUDAN
SWEDEN
SWITZERLAND
SYRIAN ARAB REPUBLIC
TAJIKISTAN
THAILAND
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
TOGO
TRINIDAD AND TOBAGO
TUNISIA
TURKEY
TURKMENISTAN
UGANDA
UKRAINE
UNITED ARAB EMIRATES
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED REPUBLIC OF TANZANIA
UNITED STATES OF AMERICA
URUGUAY
UZBEKISTAN
VANUATU
VENEZUELA, BOLIVARIAN REPUBLIC OF
VIET NAM
YEMEN
ZAMBIA
ZIMBABWE

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world''.

IAEA NUCLEAR ENERGY SERIES No. NG-T-3.17

STRATEGIC ENVIRONMENTAL ASSESSMENT FOR NUCLEAR POWER PROGRAMMES: GUIDELINES

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2018

COPYRIGHT NOTICE

Marketing and Sales Unit, Publishing Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna, Austria
fax: +43 1 26007 22529
tel.: +43 1 2600 22417
email: sales.publications@iaea.org
www.iaea.org/books

Printed by the IAEA in Austria
November 2018
STI/PUB/1815

IAEA Library Cataloguing in Publication Data

Names: International Atomic Energy Agency.
Title: Strategic environmental assessment for nuclear power programmes: guidelines / International Atomic Energy Agency.
Description: Vienna : International Atomic Energy Agency, 2018. | Series: IAEA nuclear energy series, ISSN 1995–7807 ; no. NG-T-3.17 | Includes bibliographical references.
Identifiers: IAEAL 18-01199 | ISBN 978–92–0–104418–1 (paperback : alk. paper)
Subjects: LCSH: Nuclear power plants — Environmental aspects. | Environmental impact analysis. | Nuclear energy — Environmental aspects.
Classification: UDC 621.039:504 | STI/PUB/1815

FOREWORD

One of the IAEA's statutory objectives is to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world." One way this objective is achieved is through the publication of a range of technical series. Two of these are the IAEA Nuclear Energy Series and the IAEA Safety Standards Series.

According to Article III.A.6 of the IAEA Statute, the safety standards establish "standards of safety for protection of health and minimization of danger to life and property". The safety standards include the Safety Fundamentals, Safety Requirements and Safety Guides. These standards are written primarily in a regulatory style, and are binding on the IAEA for its own programmes. The principal users are the regulatory bodies in Member States and other national authorities.

The IAEA Nuclear Energy Series comprises reports designed to encourage and assist R&D on, and application of, nuclear energy for peaceful uses. This includes practical examples to be used by owners and operators of utilities in Member States, implementing organizations, academia, and government officials, among others. This information is presented in guides, reports on technology status and advances, and best practices for peaceful uses of nuclear energy based on inputs from international experts. The IAEA Nuclear Energy Series complements the IAEA Safety Standards Series.

This publication is intended to provide support to responsible authorities and stakeholders engaged in strategic environmental assessment (SEA) for nuclear power programmes. SEA is a proactive decision support tool applied during the preparation of policies, plans and programmes. Its main objective is to avoid or mitigate any expected significant negative environmental impacts arising from these policies, plans and programmes, and, importantly, to enhance their positive environmental outcomes. This also includes social and economic impacts that are environmentally relevant. SEA is being applied in an increasing number of countries worldwide, to meet legal and other formal and informal requirements. Furthermore, development organizations and banks may have their own requirements to apply SEA when providing funding and support to countries that aim to prepare specific policies, plans and programmes.

Programmes are prepared in a diverse range of governance systems, reflecting different traditions and cultures. Thus, international guidelines need to adopt a generic approach that can be adapted to the specific circumstances of the country in which they are to be applied. Consequently, while these guidelines are as specific as possible, a 'one size fits all' approach is not pursued. Rather, a 'menu' is provided from which decision makers and stakeholders can choose when applying SEA, depending on the specific context.

These guidelines do not to provide guidance on assessing why nuclear energy could be an option for a country. The assumption is that this is not addressed at the programme level, but at an earlier stage, for example, through an SEA specifically targeting the energy policy of a country. Furthermore, these guidelines are not written following any particular formally defined approach (e.g. specific legislation), which would limit their application to countries bound by that specific approach. Rather, the guidelines broadly characterize an SEA on the basis of its focus on biophysical aspects and its impact on health, society and environmentally relevant economic considerations.

During the development of this publication, two expert group meetings were convened to gather inputs from external participants with extensive experience in environmental assessments. Additionally, a broad review process was carried out involving a diverse set of experts, comprising, for example, practitioners and experts involved in drafting legislation.

The contributions of the members of the expert group, particularly those of T. Fischer (United Kingdom), are gratefully acknowledged. The IAEA expresses its gratitude to the external reviewers, who provided comments in their personal capacity. The IAEA officers responsible for this publication were M. Welsch and A.I. Jalal of the Division of Planning, Information and Knowledge Management.

EDITORIAL NOTE

This publication has been edited by the editorial staff of the IAEA to the extent considered necessary for the reader's assistance. It does not address questions of responsibility, legal or otherwise, for acts or omissions on the part of any person.

Although great care has been taken to maintain the accuracy of information contained in this publication, neither the IAEA nor its Member States assume any responsibility for consequences which may arise from its use.

Guidance provided here, describing good practices, represents expert opinion but does not constitute recommendations made on the basis of a consensus of Member States.

The use of particular designations of countries or territories does not imply any judgement by the publisher, the IAEA, as to the legal status of such countries or territories, of their authorities and institutions or of the delimitation of their boundaries.

The mention of names of specific companies or products (whether or not indicated as registered) does not imply any intention to infringe proprietary rights, nor should it be construed as an endorsement or recommendation on the part of the IAEA.

The IAEA has no responsibility for the persistence or accuracy of URLs for external or third party Internet web sites referred to in this book and does not guarantee that any content on such web sites is, or will remain, accurate or appropriate.

CONTENTS

SUMMARY

Strategic environmental assessment (SEA) aims at avoiding or mitigating any expected significant negative environmental impacts and, importantly, at enhancing positive environmental and related sustainability outcomes of polices, plans and programmes. The guidelines in this publication have been prepared to support decision makers and other stakeholders in their attempts to conduct and contribute to such an SEA if applied to nuclear power programmes. Nuclear power programmes are prepared once a country has determined that additional energy supplies are needed and that nuclear power could play a role in meeting these needs. As such, the nuclear power programme responds to elements of an energy policy and aims to guide actual project implementation. An associated SEA will, therefore, focus on issues directly relevant to the development of nuclear energy. The underlying assumption of these guidelines is that impacts related to other issues, such as the wider energy mix and the role nuclear energy should play within it, are considered in other policies, plans and programmes, and their associated SEAs. They are thus outside the scope of these guidelines.

Subject to national legislative frameworks, an SEA would normally be conducted when developing a nuclear power programme, building on any preceding SEAs for national energy strategies, policies and any associated plans. Such an SEA for a nuclear power programme would then provide the framework for subsequent environmental impact assessments (EIAs). When considering a systematic approach to the development of nuclear energy, higher level SEAs for energy strategies, policies and plans focus on issues such as overall energy needs, the energy mix and, within this, the role of nuclear energy. Subsequent EIAs then focus on implementation details at the project level, when, for example, nuclear power plants or spent fuel storage facilities are to be constructed. In this context, the objectives and main focus of an SEA for a nuclear power programme depend on what is covered in those earlier SEAs, and may also be informed by related EIAs.

Once a decision has been taken that nuclear power could play a role in meeting the energy needs of a country, several areas related to nuclear power need to be considered for their relevance to a specific SEA. These areas have been combined into seven ‘nuclear power impact areas’ (see Section 3.2). The assessment of these impact areas should be guided by those environmental and related sustainability issues that are central to a nuclear power programme. These issues have been combined into eight ‘environmental impact themes’ (see Section 3.3), detailing infrastructure related environmental effects and wider impacts resulting from the programme, and also impacts on the programme. These environmental impact themes were defined for the purpose of these guidelines and are based on existing legislation and practices. As with the nuclear power impact areas, they will need to be adjusted to best suit the actual context an SEA is applied in. It is important that not only the impact on the themes but also the impact from them on nuclear power programmes be considered in an SEA.

The SEA process includes the following eight main components: screening, scoping, stakeholder engagement and public participation, assessment, SEA report, decision making, monitoring and wider follow-up, and quality review. The ‘heart’ of an SEA for a nuclear power programme is the assessment process, which is conducted in parallel to the preparation of the programme itself, closely connecting with it at various points in time. This is likely to take at least six months and may require one or more years for something as complex and, potentially, controversial as a nuclear power programme. The process needs to start as early as possible, ideally immediately after a decision has been made to prepare a nuclear power programme. This is required in order to be able to proactively influence the programme development.

Stakeholder engagement, including consultation with statutory and non-statutory bodies, as well as public participation, is a key component of SEA, as it helps identify and address stakeholder and public acceptance issues during the process of developing nuclear power programmes. SEA for nuclear power programmes can thus provide a platform for informed and fair public debates. A variety of methods can be used to encourage adequate stakeholder engagement and public participation in different application situations. This includes the development of an overall associated plan and a communication strategy that is adjusted to individual groups, from communities to institutions and the press/media. Given the time frame from the initial concept to the implementation of a nuclear power programme, it is important to consider whether and how the stance of the public and decision makers will change over time.

The SEA report is the main document used by all stakeholders (including the general public) that describes the environmental impacts of a nuclear power programme and the options identified within the SEA and the programme. The SEA report needs to focus on those issues that are relevant with respect to any expected significant

environmental and sustainability impacts of the different nuclear power programme options. It needs to be written in such a way that decision makers, stakeholders and the general public are able to understand it, and it needs to be accompanied by a distribution strategy, taking transboundary stakeholders into account.

Importantly, the SEA report is just one component of the SEA process, and not the final one. An SEA can only be considered effective if its findings feed into the decisions taken, and thus influence the subsequent developments. Continuous and comprehensive quality assurance, ideally by an external, unbiased body, can facilitate achievement of this objective.

1. INTRODUCTION

1.1. BACKGROUND

A key requirement for the peaceful use of nuclear energy is that its use be beneficial, responsible and sustainable, while ensuring protection of both the public and the environment [1]. Strategic environmental assessment (SEA) can be applied in line with this key requirement. SEA is a decision support tool that aims at assisting the preparation of environmentally sustainable policies, plans and programmes by (public) authorities. It, thereby, targets strategic levels and is meant to guide the subsequent development of projects.

One of the main purposes of SEA is to support the understanding of both potentially significant negative as well as positive environmental implications when implementing a nuclear power programme. It does this by identifying different development options (which, in some jurisdictions, may also be labelled as 'alternatives') and mitigation measures, and assessing their environmental impacts from the outset of the formulation of policies, plans and programmes. By identifying options that are not viable, SEA can help to significantly reduce the costs that would be associated with further pursuing them.[1] Furthermore, SEA provides a platform for effective communication with the public and other stakeholders, thereby offering opportunities for addressing the concerns that they may have.

For countries that are in the process of considering nuclear power as a part of their energy mix in national policy making, SEA is, thus, a crucial tool that needs to be applied at the policy and associated plan levels, followed by the programme level. These guidelines focus explicitly on the programme level.

Currently, SEA is formally required in about 60 countries, and there are experiences with its application in many others worldwide. The term 'strategic environmental assessment' was invented about 30 years ago, thus making it more recently established than 'environmental impact assessment' (EIA) for projects, which was put in place about 50 years ago [3]. As a consequence, there is still less experience with SEA than with EIA. Countries with formal requirements include those subject to international regulations, such as members of the European Union, which need to comply with European Commission Directive 2001/42/EC on the Assessment of the Effects of Certain Plans and Programmes on the Environment (EU SEA Directive) [4], or members of the United Nations that have ratified the United Nations Economic Commission for Europe (UNECE) Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context[2] (UNECE Protocol on SEA)[3][5].

Many other countries have other formal (sub-)national strategic assessment frameworks in place. However, not all of them explicitly refer to the assessment as an SEA. These countries include Australia, Bhutan, Brazil, Canada, Chile, China, Ghana, Kenya, the Republic of Korea, Malaysia, Pakistan (for Khyber Pakhtunkhwa Province), Thailand, Ukraine, the United States of America, Viet Nam and others. In addition to these national and international requirements, lenders may also impose SEA for sectoral financing, for example, to comply with the Equator Principles for financial institutions [6]. The Annex provides an overview of specific requirements for an SEA, as outlined in the EU SEA Directive [4], the UNECE Protocol on SEA [5] and selected national frameworks. Practical SEA examples in a development cooperation context are provided by the Organisation for Economic Co-operation and Development [7].

1.2. OBJECTIVE

While SEA is widely applied in general, only a small number of SEAs have been performed for nuclear power programmes (or subcomponents thereof; for example, spent fuel management strategies). Examples include SEAs in Germany, Poland, the United Arab Emirates and the United Kingdom [8–11]. Given the currently rather limited experience with SEA in the nuclear power sector, these guidelines aim to indicate what SEA for nuclear power programmes may constitute, building on the rich experiences with SEA outside of this sector. The guidelines aim to support those involved in the preparation of an SEA for nuclear power programmes. This includes new

[1] For England and Wales, savings of £15 million (€18 million) were reported during the period 2005–2010 through effectively coordinating environmental assessments in the area of flood risk management [2].

[2] This convention is also known as the Espoo Convention.

[3] As of September 2018, the protocol has 38 signatories and 32 parties, which includes the European Union and its Member States.

programmes and revisions to existing programmes, for example, when considering the construction of new reactors or the extension of the lifetime of existing reactors, or when developing or revising waste management and decommissioning strategies.

1.3. SCOPE

The underlying assumption of these guidelines is that an SEA has already been applied to the energy policy and associated plans and programmes, and that nuclear energy had been identified as one of the potentially suitable energy options.[4] If no SEA was conducted earlier for the energy policy, an SEA for a nuclear power programme will need to acknowledge this, but will not be able to fill the ensuing gap. Filling this gap goes beyond the scope of these guidelines, in particular with regard to the energy options considered in the SEA [13].

The guidelines have been prepared on the basis of the best available knowledge on how to apply SEA as an effective decision support tool. In this context, 'effective' means SEA being a tool which is able to support environmentally sustainable decisions that are transparent, fair and objective, and which aim at equitable and (to the extent possible) consensus based decisions, while adding scientific rigour to the decision making process.

These guidelines go beyond the minimum requirements found in most current legal texts. They do not aim at simply introducing a one-off assessment procedure. When engaging in SEA for a nuclear power programme, decisions are made on various important issues at different points in time and within varying national legal frameworks and practices governing policy, plan and programme making. These guidelines, therefore, acknowledge that a nuclear power programme SEA represents a highly complex decision making context, which requires a customized approach.

These guidelines are not written as a technical manual that a user can mechanically follow. Rather, the approach used in these guidelines is based on presenting suggestions and posing questions to those applying them, allowing them to develop a situation specific assessment approach. This will involve engaging in what, at times, will be challenging professional as well as public discussions.

In line with this spirit, these guidelines should not be used in a reactive manner, but rather in a proactive and creative way to ensure that SEA is applied as a process that accompanies and interacts with the development of a nuclear power programme and influences its structure. Further, these guidelines should not be considered static, and the IAEA appreciates any feedback on their usage and any suggested improvements.[5] This includes issues where guidance on the implementation of SEA would have been helpful but was not provided by these guidelines.

1.3.1. Framing SEA within the nuclear infrastructure development process

To support a country in developing the necessary infrastructure, the IAEA has published Milestones in the Development of a National Infrastructure for Nuclear Power [14]. It describes a three phased approach through which a number of different infrastructure issues are addressed. Figure 1 shows these phases and milestones in the development of nuclear energy and locates SEA for nuclear power programmes and subsequent EIAs within them (see Section 2.3.1 for a more detailed differentiation between SEA and EIA).

After the nuclear power option is included in a national energy strategy (which, ideally, should be subject to policy SEA (see Figs 2–5)), initially, during phase 1, further issues are considered before a decision is taken to launch a nuclear power programme at the end of phase 1. Such issues may include pre-feasibility studies on, for example, the impacts on the national economy or financing options.

The majority of the nuclear power programme SEA process is, therefore, clearly positioned within phase 1 of Fig. 1, while, for example, project specific assessments are part of EIA processes, which will largely be conducted during phase 2 (for further information on the EIA process for nuclear power projects, see Ref. [15]). However, SEA and EIA are linked in the sense that the SEA process at the end of phase 1 is expected to identify some of the projects that will require an EIA.

An SEA may also target the period after milestone 3. This can be the case when a nuclear power programme (or a subcomponent thereof) is adjusted or newly developed after nuclear power plants become operational. Reasons

[4] In this regard, the reader is referred to the IAEA publication Considerations to Launch a Nuclear Power Programme [12].

[5] Comments can be addressed to Official.Mail@iaea.org.

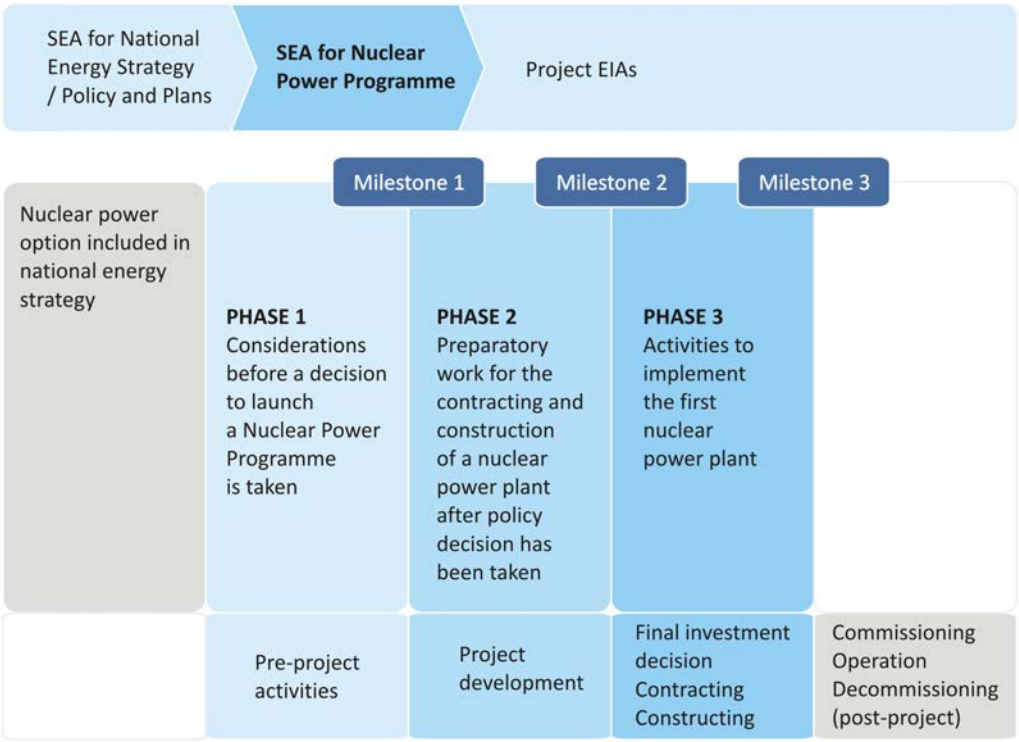


FIG. 1. Phases and milestones in the development of nuclear energy and associated SEA and EIA.

for this could be that an extension to the lifetime of power plants is being considered or that an updated and more detailed radioactive waste management strategy is being developed[6]. Across its three phases, Ref. [14] lists 19 infrastructure issues that should be addressed in the development of nuclear energy (see Table 1). A selection of those will be considered in an SEA for a nuclear power programme.

Reference [14] recommends that the nuclear energy programme implementing organization develop a comprehensive report at the end of phase 1. The SEA will directly inform related aspects of this comprehensive report, especially those relating to infrastructure issue 13 (environmental protection; see Table 1), which is a core issue for consideration in SEA. However, all of the issues listed in Table 1 may directly or indirectly have an impact on SEA and the scoping stage will clarify the issues to be addressed in each programme SEA. Depending on the specific circumstances, some will be of higher relevance and others may be excluded.

For the purpose of these guidelines, infrastructure issues will be implicitly considered through the following seven nuclear power impact areas:

(1) Main siting and technological considerations;
(2) Power plant construction, operation and decommissioning;
(3) Nuclear fuel cycle;
(4) Spent fuel management strategy/radioactive waste storage and disposal;
(5) Physical protection and security;
(6) Emergency preparedness and response;
(7) Wider physical infrastructure requirements.

These areas are key considerations for nuclear power programmes that will need to be adjusted on a case by case basis to suit the given circumstances. They are further elaborated on in Sections 3–6. The process of selecting what to include or exclude in SEA is explained in more detail in Section 4.3 in the scoping stage description.

[6] While radioactive waste management will also need to be covered in the overall nuclear power programme, an SEA is a continuous and multilayered process that evolves over time and requires adjustments accordingly (see Section 2.3).

TABLE 1. INFRASTRUCTURE ISSUES IN THE DEVELOPMENT OF NUCLEAR POWER [14]

Infrastructure issue number	Infrastructure issue
1	National position on nuclear energy
2	Nuclear safety
3	Management
4	Funding and financing
5	Legal framework
6	Safeguards
7	Regulatory framework
8	Radiation protection
9	Electrical grid
10	Human resource development
11	Stakeholder involvement
12	Site and supporting facilities
13	Environmental protection
14	Emergency planning
15	Nuclear security
16	Nuclear fuel cycle
17	Radioactive waste management
18	Industrial involvement
19	Procurement

1.4. STRUCTURE

While the initial sections explain the context and background of SEA for nuclear power programmes, from Section 3 onwards, these guidelines focus more concretely on how to perform an SEA and the various methodological aspects of SEA application.

The guidelines are divided into eight sections, starting with this introduction. Section 2 describes the context and the substantive focus of SEA, while in Section 3 the environmental and related sustainability issues to be considered in SEA for nuclear power programmes are provided. Next, an SEA methodology is introduced, consisting of four sections, describing the process for conducting an SEA (Section 4) and the associated stakeholder engagement and public participation (Section 5), assessment methods and associated data requirements (Section 6), as well as the structure of the SEA report, including a quality review checklist (Section 7). Finally, Section 8 consists of concluding remarks. The Annex presents requirements for SEA based on the EU SEA Directive [4] and the UNECE Protocol on SEA [5] as well as country experiences.

1.5. USERS

The guidelines are written for a wide range of actors and stakeholders. These include authorities responsible for the preparation and implementation of nuclear power programmes (including advisors and senior managers), as well as those in charge of conducting SEA. However, the audience of these guidelines also includes all other parties involved or interested in SEA, including industry; authorities in charge of regulations, public health, safety and the environment; consultation bodies; and the concerned public and media.

2. CONTEXT OF THE SEA

The political, social, environmental and economic context within which an SEA is conducted is key to the question as to how it should be applied. This includes underlying environmental and other policy objectives that are used as a basis for SEA. Furthermore, it includes the overall decision making framework (i.e. the portfolio of relevant policies, plans and programmes that should be consistent and compatible), which is important for deciding what to address when and where, as well as societal attitudes to both nuclear power and environmental issues. Importantly, SEA can only be effective in the presence of full political endorsement and 'buy-in'. It is thus important to critically review institutional capacity to conduct an SEA and, if necessary, address any identified shortcomings.

The context of SEA is further explored in this section. It starts by presenting the main objectives and focus of SEA in Section 2.1, before establishing when SEA is needed in Section 2.2. Section 2.3 positions SEA within the space between policies and projects, and discusses requirements regarding the regulatory framework and institutional capacity. The section concludes by introducing the components of the SEA process in Section 2.4.

2.1. OBJECTIVES AND MAIN FOCUS OF THE SEA

SEA is a proactive decision support tool, acting as a 'critical friend' to those involved in preparing strategies (i.e. policies, plans and programmes). It facilitates more transparent, accountable and, ultimately, more environmentally sustainable decision making above the project level. It, thus, supports the creation of a future in which decisions are widely respected and which is marked by mutual trust and respect. In this context, it does not simply assess the impacts of the proposed action (i.e. of a proposed policy, plan or programme) in a reactive manner — it does not just quantify emissions or resource use, for example. It is also not intended as a tool to justify a strategy which is already largely finalized. Rather, it aims at steering the thinking of those involved in policy, plan and programme making[7], with regard to alternative actions for achieving overall environmental aims and objectives, but without ignoring their economic and social implications. It investigates ways to avoid, reduce or otherwise mitigate negative impacts while enhancing positive outcomes, also taking indirect, cumulative, short to long term, synergistic, local, regional and global (including transboundary), as well as residual impacts into account.[8] The potential benefits meant to accrue from an SEA [16] are summarized below:

— Achieving environmentally sound and sustainable development;
— Strengthening policy, plan and programme making processes;
— Saving time and money by avoiding costly mistakes;
— Improving good governance and building public trust and confidence in decision making.

In many countries, SEA focuses mainly on biophysical aspects, with flora and fauna, air, water and soil being central to the assessment. There may be good reasons for this, such as a limited capacity to consider more aspects or a responsibility to look after certain issues only. However, in a time and age in which sustainable development is often the key development aim, environmental issues are also understood to include wider social aspects (e.g. those that are related to health or rights of minorities as well as institutional capacity) and, in this context, also publicly and environmentally relevant economic aspects, such as the potential costs and economic benefits of different options and associated mitigation measures. This should, however, not compromise the need for the SEA to be guided by environmental considerations.

[7] It should be noted that the terms 'plan' and 'programme' are not consistently defined across countries. For the purpose of these guidelines, when using the term 'plans and programmes' in combination, this implies no differentiation between the two terms and refers to the decision making level between policies and projects. In the context of nuclear power, the term 'programme' is used as outlined in detail in Ref. [14].

[8] An explanation of these types of impact can be found in Section 4.4.2.

2.2. WHEN IS AN SEA NEEDED?

While the need for an SEA may be prescribed in national legislation, with further details provided in implementing regulations, in general, it is suggested to conduct an SEA whenever significant negative environmental impacts are likely to occur as a consequence of a policy, plan or programme. For example, an SEA is recommended in the following cases:

— If a new nuclear power programme is initiated;
— If an existing nuclear power programme is extended by the construction of new reactors;
— If a waste management or decommissioning strategy is newly developed or significantly revised;
— If considering the extension of the lifetime of a reactor requires SEA or would profit from it.

An SEA may not be required if only very minor changes to an existing nuclear power infrastructure are intended (e.g. power upgrading or safety related improvements). Furthermore, results of an SEA will not be valid indefinitely, but only for a certain amount of time; there may be a need to revisit and revise the SEA in the case of a major policy change or other new developments.

The procedural stage at which a decision is made on whether or not to conduct the SEA is referred to as 'screening'. The first task to be addressed is to check national SEA legislation on whether an SEA is obligatory for a particular nuclear power programme. If this is the case, no screening may be necessary. Case by case screening means that a careful assessment is conducted of the development likely to occur and the possible magnitude of associated impacts (e.g. hectares of land use, quantity of emissions or risk characteristics).

While the decision to conduct SEA is based on the possibility of significant negative environmental impacts, when the SEA is actually conducted, both negative and positive environmental impacts should be assessed. Positive impacts, in particular, should be considered in the light of the likely impacts of other options (for nuclear power programmes, the saving of greenhouse gas emissions that would be generated by other power plant options). Some of these will be addressed when assessing the environmental impacts of energy options within the SEA targeting the policy level. The nuclear power programme SEA would then provide a summary of the main (positive and negative) outcomes of this associated policy level SEA.

It is important not to attempt to take all relevant decisions at once, but to take due account of the complexity of the task at stake. This has led to the development of a so-called 'systematic framework', the idea of tiered environmental assessments. In this context, ideally, individual environmental assessment processes are conducted at every point when decisions on the development of nuclear power are made (i.e. at policy, plan and programme tiers of different sectors and administrations). In this context, reference is made to Figs 1–5.

If there are no policy and associated plan level SEAs, the programme level SEA will need to acknowledge this, but will not be able to comprehensively address issues that should have been addressed at the policy and associated plan levels. Going beyond the programme level would make the SEA considerably more complex, and it is questionable whether this would result in an effective SEA. An extended SEA of this type is outside the scope of these guidelines, as pointed out in Section 1.3.

2.3. A FRAMEWORK FOR A MORE SYSTEMATIC APPROACH TO DECISION MAKING

SEA is a science and an art [17] in that it aims at bringing scientific rigour to decision making processes while acknowledging the political nature of those processes which they attempt to influence. In this context, the SEA mainly functions in the following two ways:

(1) To provide a framework for a more systematic approach to decision making;
(2) To establish a methodology, consisting of several components for evaluating environmental implications, to be followed in the SEA, as well as methods associated with these components.

The following two subsections provide more detail on (1) above. The components of the SEA process mentioned under (2) above are then introduced in Section 2.4.

2.3.1. Placing SEA for nuclear power programmes within the tiers of decision making

The SEA acts as a proactive decision support tool and as a framework for structuring decisions in a systematic way. The SEA will help those involved in policy, plan and programme processes to address all relevant decision making questions in a tiered environmental assessment system, ranging from the tiers of (i) policy SEAs over (ii) plan and programme SEAs to (iii) project EIAs (see Fig. 2). This can be understood as a strategic–operational continuum.

FIG. 2. Decision tiers across a strategic–operational continuum.

SEA and EIA processes performed at different tiers need to consistently refer to each other, as with environmental assessments that are applied across different administrative levels (e.g. national, provincial, regional, local) as well as across sectors (e.g. energy, transport, waste, land use).

Box 1 and Fig. 3 show differences and linkages between SEA and EIA approaches.

	SEA		EIA
Decision making level	**Policy**	**Plans & Programmes**	**Project**
Nature of action	Strategic, Conceptual	----------►	Immediate, operational
Scale of impacts	Large scale	----------►	Localised
Timescale	Long to medium term	----------►	Medium to short term
Key data sources	Existing data from e.g. state of environment reports	----------►	Field work based data
Type of data	More qualitative	----------►	More quantitative
Options	Area wide, technological, inter-modal	----------►	Specific location, design
Uncertainty and rigour	More uncertainty	----------►	More rigour
Role of assessor	Mediator for negotiations, determining norms / values	----------►	Advocate of values /norms, Implementer

FIG. 3. The strategic–operational continuum (key components).

BOX 1. DIFFERENCES AND LINKAGES BETWEEN SEA AND EIA APPROACHES

While there are a number of differences between SEA and EIA, there are no clear boundaries between them, and there is a gradual shift from strategic to operational thinking, from policy over plan and programme (SEA) to project (EIA). Policies are situated at the strategic end and projects at the operational end of what may be described as the strategic–operational continuum. Differences between an SEA and an EIA are outlined in Fig. 3 and can be described using a number of components, including:

— *The approach:* The SEA is an upstream proactive tool which assesses and informs development policies, plans and programmes, while the EIA assesses project proposals.
— *The nature of actions and outputs:* These range from conceptual and general at the SEA end of the continuum to specific at the operational EIA end.
— *The scale of impacts:* These range from macroscopic and more unclear at the policy level addressed by the SEA to more localized at the operational end addressed by the EIA.
— *The timescales of actions:* These tend to range from more medium to long term at the policy SEA end to more short to medium term at the operational EIA end.
— *Key data sources:* These range from existing in, for example, strategic state of the environment reports used for SEA to fieldwork and sample analysis used for EIA at the operational end.
— *Types of data:* These range from more aggregated at the strategic end (SEA) to more detailed at the operational end (EIA).
— *Options:* These range from political, area wide, technological, fiscal, institutional and economic at the strategic end (SEA) to specific locations, design and construction options at the operational end (EIA).
— *Uncertainty and rigour:* There is usually more uncertainty at the strategic end (SEA) and more rigour at the operational end (EIA).
— *Roles of assessors:* These range from mediators for discussions at the strategic end (e.g. in order to assess and influence policy development through the SEA) over advocates of agreed objectives and norms, to technicians for implementation of objectives at the operational end (EIA).

While it is unrealistic to assume that policies, plans, programmes and projects prepared at different points in time are fully consistent, deviations from established aims and objectives should always be made in a conscious manner and be explained. Decisions on different issues across sectors are taken at different tiers and levels. However, in many countries, it remains unclear which issues and associated assessment tasks should be addressed at a specific tier. This can result in important issues either remaining inadequately addressed or not being covered at all. Therefore, a clear understanding needs to be developed regarding all policies, plans, programmes and projects that are prepared at different administrative levels and which are relevant for the nuclear power programme. In this context, it is useful to map them in a matrix, showing both administrative levels and systematic decision tiers.

Figure 4 shows an outline of such a matrix, which can be useful to map the relevant policies, plans, programmes and projects, as well as their interdependencies. Reflecting these interdependencies, processes conducted at each level and tier should take account of, and consistently refer to, each other. They should not be understood in a top-down manner.

Furthermore, energy planning does not happen in isolation but is part of overall national sustainable development planning. It may affect, or be affected by, the planning processes of other sectors, such as spatial planning/land use and transport. Therefore, a multilayered approach needs to be applied, considering the policies, plans and programmes, and associated SEAs of non-energy sectors that may affect the design of a nuclear power programme. Related international conventions/treaties and national regulations designed to protect the public and the environment also need to be considered. These may focus on issues such as sustainable development, hazardous substances, mining, industry, wild life protection, and import and export or transit of materials. It is essential to develop a clear understanding of how these cross-sectoral requirements and strategies interact. Again, it is recommended that they be mapped early in the SEA process and that potential interactions be pointed out.

As stated in Section 1.1, these guidelines aim at one specific tier of decisions, namely nuclear power programmes. These are assumed to be prepared at the national administrative level. At this particular tier, the focus is not on why to consider nuclear power (as it is assumed that this has already been addressed earlier in a policy SEA), but rather on questions regarding how and where this could be implemented (i.e. based on which siting

criteria[9]) (see Fig. 5 and Table 2). Helping to define the framework to answer these questions will be at the heart of the subsequent sections.

2.3.2. Regulatory frameworks, institutional capacity and responsibilities

Together with the necessary political buy-in, the existence of an appropriate legislative and regulatory framework, and appropriate institutional capacity are key to being able to effectively lead and conduct SEA. In this context, a clear allocation of responsibilities is vital. Institutions in charge of SEA may differ, depending on the country or specific planning system. Table 2 provides an example of what issues may be addressed at different tiers and institutions in a systematic energy planning hierarchy. The particular questions addressed set the context and scope for the associated SEAs.

Working as a critical friend, the SEA will aim at evaluating how, when and where questions are addressed in the existing policy, plan, programme and project framework. Gaps with regard to questions that remain unaddressed will need to be identified. Those involved in conducting an SEA can then make suggestions on how such gaps may be addressed.

Legislation may give rise to the preparation of specific policies, plans, programmes and associated SEAs. Legislation may also define issues to be considered in an SEA and set the rules for wider engagement and public participation. When involved in an SEA, it is important to be aware of any constraints put on effective assessments by the existing legal and wider decision making framework. For example, in many countries, SEA is not accorded a proactive role, but is used strictly to test ideas brought forward by, for example, planners. Constraints need to be made explicit in the interests of transparency (Box 2).

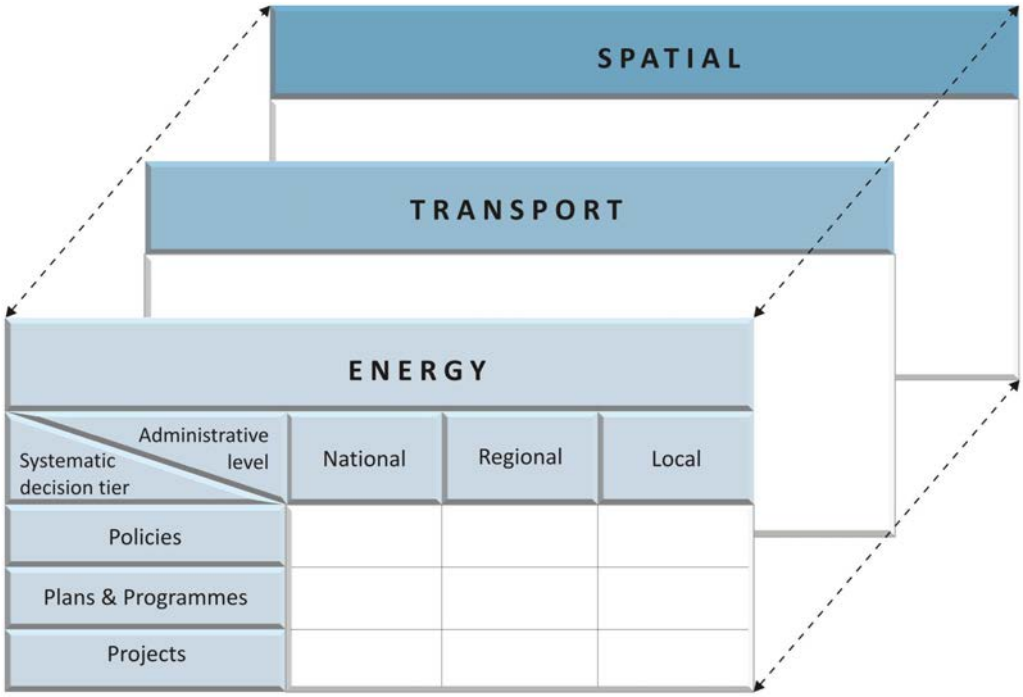
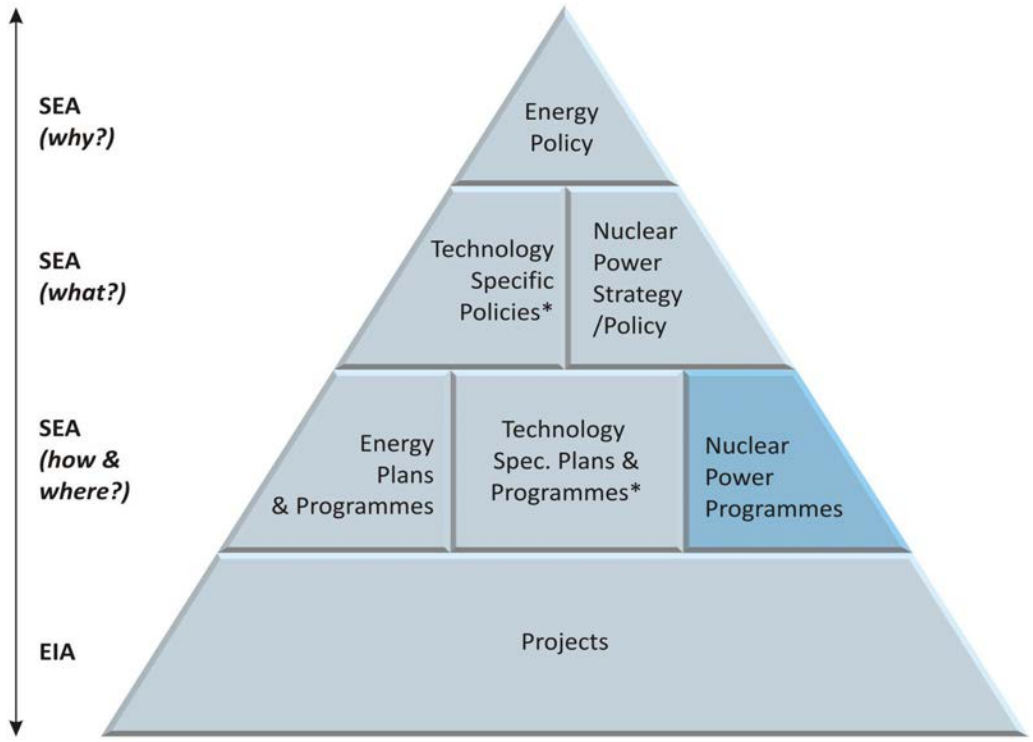


FIG. 4. Mapping the country framework across tiers and levels beyond the energy sector. It should be noted that three example layers are presented here. The actual layers are determined based on the country context.

[9] It should be noted that detailed assessments of individual sites form part of an EIA.



* There may be a range of energy policies, plans and programmes, including for various renewable and non-renewable energy sources.

Focus of guidelines.

Note: This pyramid does not reflect a top-down approach; rather, it indicates that there are usually more projects than plans and programmes, as well as more plans and programmes than policies.

FIG. 5. Energy decision tiers, questions to be addressed and focus of guidelines.

BOX 2. THE IMPORTANCE OF USING SEA AS A PROACTIVE DECISION SUPPORT TOOL

In order for SEA to be a beneficial decision support tool, it needs to be understood as being proactive, influencing decisions by generating new ideas for possible environmentally sustainable options and mitigation measures. It can only act as a critical friend if it is allowed to be more than just a tick box exercise on how a proposed action meets overall policy objectives. Any public decision normally comes with some trade-offs between different policy objectives. Those taking decisions usually have a remit to facilitate development in a certain area and may often place little emphasis on environmental issues and implications. SEA is an advocate tool of the environment and can provide solutions that are environmentally sustainable and may otherwise not be considered by decision makers.

Most of the issues and questions raised in Table 2 are generally covered in the decision making process, depending on how well an energy policy, plan, programme and project framework is developed in a particular country. Still, there could be several gaps in addressing all of these issues and questions in a systematic and transparent manner. As a consequence, SEAs for nuclear power programmes may need to fill these gaps and, therefore, become more complex.

A key issue in preparing energy policies, plans and programmes is the definition of clear objectives. The objectives at the programme level are ideally derived from the higher policy level. They are not subject to SEA but are used to set the thematic framework for the preparation of the programme and, thus, also for the SEA. Objectives for a nuclear power programme should give sufficient space to assess different strategic approaches, which is crucial to perform effective SEA. Therefore, the objectives should not exclude potential alternatives from the outset.

TABLE 2. ISSUES AND QUESTIONS TO BE ADDRESSED IN ENERGY AND NUCLEAR POWER PLANNING IN A SYSTEMATIC DECISION HIERARCHY

Tier	Issues and questions
Energy policies	— What is the likely future need for energy? What possibilities are there to reduce anticipated demand (e.g. by increasing energy efficiency)? — Is the existing capacity sufficient to satisfy the likely future energy need? What additional capacity may be needed, taking into account decisions on increasing efficiency? — How can anticipated future energy needs be met? What renewable and non-renewable energy options are there? — How may a realistic future energy mix look? Should nuclear power play a role in this? — If a decision is made to include nuclear power in the energy mix, what would be the optimal capacity installed? — What are the security concerns around nuclear power?
Nuclear power plans/ programmes	— How can the nuclear power programme be designed to maximize positive outcomes and minimize negative impacts? — What are the implications of the nuclear power programme with regard to associated wider (energy) infrastructure requirements? — What siting options are there? Which of them are likely to be suitable/unsuitable (in terms of population, seismicity, water availability, flora, fauna, physical infrastructure, physical protection and security, waste storage and disposal)?* — What site specific technology options are there across the fuel cycle and its associated nuclear facilities? Which options are the most beneficial and least detrimental?*
Projects	— What are the environmental, social and economic impacts of the specific power plant, including its associated fuel cycle, nuclear facilities and other resulting infrastructure development needs?

* These questions denote the focus of the present guidelines on SEA for nuclear power programmes.
Note: There is unlikely to be just one policy or plan or programme, but numerous ones, as indicated in Figs 2 and 3.

It is also important to involve the actors responsible for the various tiers of the decision framework when addressing issues and questions at one specific tier. For example, when preparing policies or plans and programmes, it is recommended that those responsible for deciding on their implementation through projects be closely involved in the process. Ownership and coordination of all those involved, from the local to (possibly) the international level, is a key issue for effective policy, plan and programme decision making, and for effective SEA. This includes, for example, national policy makers along with those implementing programmes at regional and local levels.

Depending on the country, the institutions in charge of the SEA process may vary. Building institutional capacity and topical linkages among institutions takes time and is unlikely to be achieved overnight. Central to such capacity building are human resources and the technical capacities to conduct an SEA and to allow effective preparation of policies, plans, programmes and projects.

2.4. COMPONENTS OF THE SEA PROCESS

As mentioned above, SEA helps to establish a methodology comprising several defined components. These are illustrated in Fig. 6, briefly introduced below and described in more detail in Section 4. A segment on specific methods and techniques to be used for the different components of SEA is provided in Section 6.

2.4.1. Screening: Is SEA necessary?

This decision is based on an initial evaluation of whether significant negative environmental impacts or risks inherent to an activity are likely to arise (see also Section 2.2). If conducting SEA for a nuclear power programme is a legal requirement, no screening would be required. Considering public perceptions of risks associated with a nuclear power programme, an SEA would normally be expected to be conducted whether or not it was legally

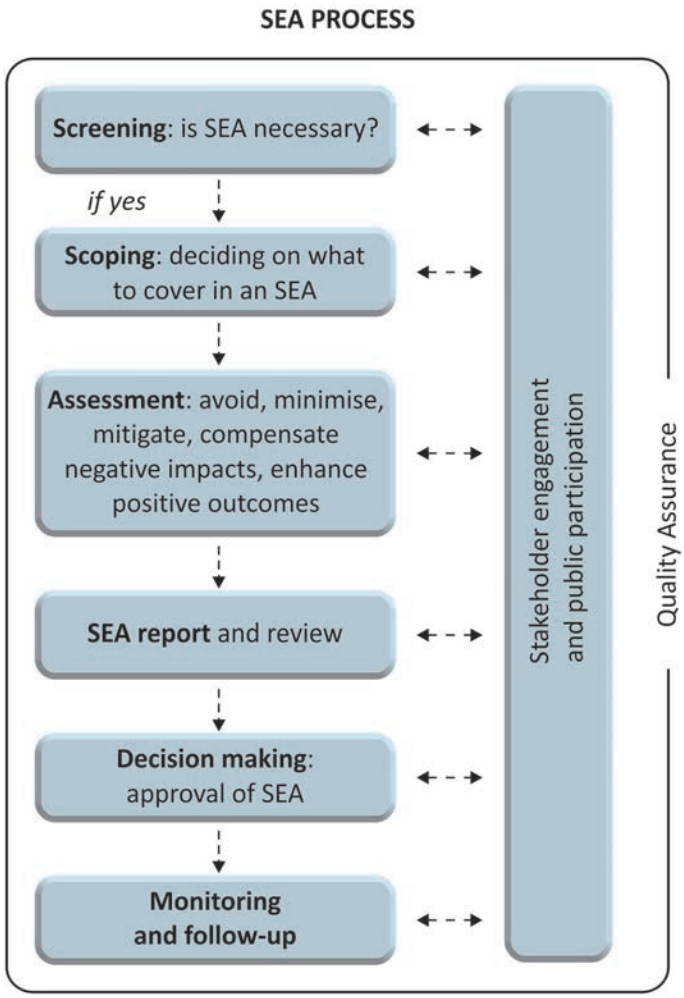


FIG. 6. Components of the SEA process.

mandated. Exceptions may include programmes that focus on some very minor changes, for example, to existing nuclear infrastructure only. It is suggested that interested stakeholders (e.g. ministries or environmental agencies) be involved in screening as early as possible.

The outcomes and suggested outputs of this component are:

— Decision on whether subsequent stages of the SEA need to be performed;
— Preparation of a screening report.

2.4.2. Scoping: Deciding what to cover in the SEA

This includes identifying environmental, social and environmentally relevant economic issues to be assessed. Furthermore, already at this stage, options or issues may be identified that should be assessed with regard to their potential to avoid, reduce or otherwise mitigate negative environmental impacts, and to enhance positive outcomes. An important outcome of scoping could be a process management checklist, which lists all procedural components of the SEA and allocates tasks and responsibilities, including anticipated time requirements.

Getting the scoping stage correct is of great importance for the overall success of the SEA, not only in terms of which issues and options to 'scope in', but also which ones to 'scope out' of the assessment. Not considering

relevant aspects (i.e. scoping out important issues) may mean that the SEA misses relevant impacts. Scoping in issues that are not important, on the other hand, may make the assessment unwieldy and difficult or even impossible to comprehend. Issues to be potentially considered are introduced in Section 3. Depending on the geographical scale of a programme, transboundary aspects will need to be considered. It is suggested to include consultations with statutory and non-statutory bodies, as well as public participation, as part of scoping.

The outcomes and suggested outputs of this component are:

— Transparently establishing and justifying issues and options to be considered in subsequent SEA stages;
— Preparation of a scoping report, including a process management checklist.

2.4.3. Stakeholder engagement: Engaging stakeholders and ensuring public participation

Engaging stakeholders (environmental, health and other authorities, statutory and non-statutory bodies, neighbouring countries) and wider participation of the general public is another key SEA component. Stakeholder engagement and public participation is recommended at least during scoping and also later when developing the SEA report, and may be informed by an engagement plan. Furthermore, it is advisable to give stakeholders and the general public a role in monitoring and follow-up. A more detailed discussion on stakeholder engagement and wider public participation is provided in Section 5.

The outcomes and suggested outputs of this component are:

— Providing opportunities for stakeholders and the general public to influence a transparent decision making process;
— Preparation of an engagement report (which may form part of the overall SEA report).

2.4.4. Assessment: Identifying and describing likely environmental (including health) effects; and avoiding, minimizing and mitigating significant negative impacts, and enhancing positive outcomes

Issues and options that are scoped in need to be evaluated with regard to the significant impacts likely to occur. This is normally an iterative process, each iteration taking into account factors such as the implications of mitigation measures and new or discarded options. The assessment stage, ultimately, aims to avoid, minimize and mitigate negative impacts and to enhance positive outcomes.

The outcomes and suggested outputs of this component are:

— Obtaining clarity on the best practical environmental option to take forward;
— Preparation of a summary of the assessment to be included in the SEA report.

2.4.5. SEA report

The SEA report is the main document produced during the SEA process. It summarizes the process itself and explains the main outcomes of the assessment with reference to the significant environmental impacts of different options and mitigation measures. It is recommended that the SEA report provide clear recommendations on how to proceed with the programme and, in this context, include aspects of monitoring and follow-up.

The outcome and suggested output of this component is the preparation of a report, summarizing the results of screening, scoping and assessment, as well as consultation and participation in a clear, simple and comprehensible manner.

2.4.6. Decision making: Consideration of the SEA

An SEA needs to influence actual decisions, not only for the programme it is applied to, but also for other policies, plans, programmes and projects. If SEA results are not taken into account in decisions taken, then the SEA is ineffectual in achieving its main aim, namely, to make development more environmentally sustainable. When taking a decision to proceed with a nuclear power programme, it is, therefore, advisable to include a justification of the decisions taken in the light of the suggestions made by the SEA.

The outcomes and suggested outputs of this component are:

— Effective consideration of the programme decision taken;
— Preparation of a report showing how the SEA influenced decision making, explaining how the suggestions made in the SEA report were or were not considered.

2.4.7. Monitoring and wider follow-up: Implementing decisions and checking predictions

Once the decision to proceed with a particular option is taken, subsequent developments need to be monitored in the light of the SEA recommendations. This includes, for example, whether mitigation measures agreed on in the decision making report are actually implemented at subsequent project stages. Furthermore, performance monitoring is required with regard to whether future impacts are in line with what was foreseen in the SEA. Corrective action should be taken if significant deviations occur from what was initially envisaged. This needs to be laid out in the SEA follow-up actions (see Section 4.7).

The outcome and suggested output of this component is continuous monitoring and follow-up with regular reporting over an agreed period of time.

2.4.8. Quality assurance: Checking whether the SEA is of adequate quality

While listed last, SEA quality review is an overarching process that may start as early as SEA screening and then, subsequently, be applied to all SEA components. Quality review is part of SEA process management and should, ideally, be performed by an independent third party or person. A central part of it may focus on the SEA report (see Section 7). After considering the quality of the various documents and reports prepared during the SEA, quality review may also consider other issues, including, for example, the expertise of those responsible for conducting the SEA process, the quality of the SEA as a platform for open and fair debates, and its effectiveness in influencing decision making.

The outcome and suggested output of this component is quality assurance through reviews of the SEA process, as well as of SEA expertise, transparency and effectiveness (see Section 4.8).

3. ENVIRONMENTAL AND RELATED SUSTAINABILITY ISSUES

This section focuses on environmental and related sustainability issues associated with the development of nuclear energy. Principles of environmental protection and environmental development are at the heart of SEA. This goes beyond an assessment of sites suitable for nuclear facilities, such as power plants, and, in this context, the site specific technology used, and also includes the associated infrastructure which is reflected in the nuclear fuel cycle. This means that there is likely to be a wider geographical area to be considered, in particular if the whole fuel cycle is taken into account. In addition to the actual site, supporting facilities will need to be considered. Another key consideration will be requirements with regard to the electrical grid (i.e. whether the existing grid infrastructure would be sufficient and, if not, what would be required in terms of its further development). Where nuclear fuel will be coming from and where waste would be disposed of also need to be considered.

Central to these aspects is the consideration of the safety measures that are in place to minimize the risk of accidents, the physical protection and security of the materials and facilities, and the emergency preparedness and response at all steps of the nuclear fuel life cycle. While these issues need to be covered in the development of the nuclear power programme, assessing their environmental (including health) implications is a core task of the SEA.

In this context, it will be important to be clear about which options to include and which options to exclude early on during the scoping stage of the SEA (see Section 4.3). With regard to the geographical scope of impacts, while all are of a local and regional nature, some are also national or international, the latter depending on the locations of activities and facilities. The choice of options will have to be decided on in close collaboration with

stakeholders. Options need to be real, which means they should not be made up in order to support the development of a preconceived preferred option. Overall, the consideration of cumulative effects will be important.

This section starts by highlighting the relevance of safety considerations for the environmental sustainability of nuclear power programmes. It continues by introducing nuclear power impact areas — the technical and organizational areas within a nuclear power programme that may be addressed within the assessment (Section 3.2). It then describes the environmental impact themes (Section 3.3) that may be considered within each of the nuclear power impact areas. In this regard, guiding questions are presented that SEA may be able to answer (Section 3.4).

3.1. SAFETY CONSIDERATIONS

Generally speaking, the routine environmental and health risks associated with the operation of nuclear power plants are small. However, this changes if containment (i.e. keeping risks under control) fails. Given the potentially severe radiological consequences of an accident, safety considerations are, therefore, central to ensuring sustainability.

The key safety objective of a nuclear power programme is to protect the public and the wider biophysical environment from the harmful effects of ionizing radiation arising from nuclear material and nuclear facilities. In support of this objective, ten fundamental safety principles were formulated by the IAEA in 2006 [18]. These cover issues including responsibility for safety, protection of present and future generations, prevention of accidents, and emergency preparedness and response. On the basis of these safety principles, 14 requirements for leadership and management for safety were developed [19], such as demonstration of leadership for safety by managers or interaction with interested parties.

The safety objective with its principles and requirements governs the safety culture, supported by IAEA safety guides and requirements as published in the IAEA Safety Standards Series. The IAEA's Statute makes these standards binding on the IAEA in its own operations and also on States in relation to IAEA assisted operations. Furthermore, they can be used by Member States as a reference for their own national regulations. There are about 130 standards published. IAEA publications that cover issues of relevance for SEAs for nuclear power programmes include (but are not limited to):

— IAEA Safety Standards Series No. SSG-9, Seismic Hazards in Site Evaluation for Nuclear Installations [20];
— IAEA Safety Standards Series No. SSG-18, Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations [21];
— IAEA Safety Standards Series No. NS-G-3.1, External Human Induced Events in Site Evaluation for Nuclear Power Plants [22];
— IAEA Safety Standards Series No. NS-G-3.2, Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants [23];
— IAEA Safety Standards Series No. SSR-6 (Rev. 1), Regulations for the Safe Transport of Radioactive Material — 2018 Edition [24];
— IAEA Safety Standards Series No. WS-G-2.3, Regulatory Control of Radioactive Discharges to the Environment [25];
— IAEA Nuclear Energy Series No. NW-T-1.24, Options for Management of Spent Fuel and Radioactive Waste for Countries Developing New Nuclear Power Programmes [26].

Safety considerations are overarching across the nuclear power impact areas that are outlined in Section 3.2. It is important to emphasize that the SEA is not meant to replace the nuclear safety assessment, which is conducted as part of the nuclear power programme, nor does it replace any national nuclear safety regulations. Rather, the SEA aims to assess related issues and aspects for each of the nuclear power impact areas with regard to their environmental and related sustainability implications.

3.2. NUCLEAR POWER IMPACT AREAS

In the context of these guidelines, nuclear power impact areas refer to the technical and organizational areas within which environmental impact themes (see Section 3.3.) and related sustainability objectives need to be considered. They are approached here in terms of seven areas that relate to the infrastructure issues in the development of nuclear power (introduced in Table 1), as follows:[10]

(1) Main siting and technological considerations;
(2) Power plant construction, operation and decommissioning;
(3) Nuclear fuel cycle;
(4) Spent fuel management strategy/radioactive waste storage and disposal;
(5) Physical protection and security;
(6) Emergency preparedness and response;
(7) Wider physical infrastructure requirements.

When considering these impact areas, it is always important to consider the transport of nuclear material, especially across all steps of the nuclear fuel cycle. This can be a sensitive issue, in particular in those cases in which there are security concerns and when the public is critical of nuclear power.

For each impact area, a number of considerations are outlined. It is at the scoping stage (see Section 4.3) that decisions will need to be made about which of these nuclear power impact areas require consideration and at what level of detail. Some issues may also be marked for more detailed consideration later in a site specific EIA. Furthermore, the structure of the impact areas suggested in this section will need to be adjusted to best address the given circumstances of the nuclear power programme under consideration.

It is not envisaged that SEA outlines the strategies to address these categories in detail. For example, a strategy for physical protection and security is unlikely to be the result of SEA. However, as pointed out in Section 4, it is assumed that the SEA is conducted as a proactive tool in parallel with the process of designing a nuclear power programme, thereby engaging with this process at regular intervals.

3.2.1. Main siting and technological considerations

While the subsequent nuclear power impact areas investigate specific aspects and implications of siting and technological considerations in more detail, this first impact area addresses the main guiding considerations, such as proximity to cities or to the ocean, or reactor design. It may, thus, help narrow down possible sites or types of technology requiring further investigation (e.g. as part of an EIA). The following considerations are important with regard to identifying suitable sites for nuclear facilities, as well as suitable technological options:

— Sites registering low seismic activity are essential, considering environmental and related sustainability impacts.
— A balance needs to be struck between sites that reduce transmission losses (i.e. those in proximity to the users of the electricity generated) and those that minimize risk if there were to be an accident (i.e. those distant from population centres), taking into account their environmental and related sustainability impacts.
— Sites in areas in which populations are, potentially, more amenable to the environmental and related sustainability implications of nuclear energy tend to be more suitable.
— Generally, sites more suitable for development are those which have, comparatively, low environmental sensitivity with regard to their potential for significant adverse environmental impacts.
— Sites that have an existing infrastructure in place that results in, comparatively, fewer negative environmental impacts with regard to the need for additional supporting facilities (e.g. roads, access to the electrical grid, supply of raw materials and disposal) may be favourable. However, existing infrastructure should not be the sole reason for justifying any particular option.
— Furthermore, access to cooling water and related technology choices require consideration.

[10] It should be noted that impact areas 2–6 are all closely connected to area 1.

A nuclear power programme will need to consider various technology choices across all nuclear power impact areas. Technology considerations include, in particular, the reactor design, for which the technical and economic benefits of various design options need to be assessed. These include evolutionary designs that represent minor modifications to operational reactors, or innovative designs such as Generation IV reactors that may become commercially available options in the future [27].

The environmental implications of these technology choices should be reviewed and assessed within the SEA. The choices considered should build on the nuclear power programme development process. In this way, they would not need to assess reactor types that were, for good reason, already excluded. However, the SEA should also not limit itself to prescribed technology choices if technically feasible alternatives would better fulfil environmental objectives. In situations where technology choices have not yet been made, the SEA can support this process by proposing criteria for evaluating and choosing technology types. Close interaction between the nuclear power programme development and SEA processes is essential in this context (see Section 4.1).

3.2.2. Power plant construction, operation and decommissioning

Besides considering physical aspects (buildings and infrastructure) and the relevant steps of the nuclear fuel cycle, construction activities may cover substantial geographical areas and may extend over several years. It is, therefore, important to consider potential effects at the programme level, as follows:[11]

— The source of building materials and possible associated environmental impacts of their production and transport may be important, in particular if materials have to be transported over long distances.
— Emissions generated during construction (including noise, vibration and dust) may be harmful and significantly impact human health and the wider environment, which may influence the choice of site.
— Construction waste will need to be managed, including its disposal. Some sites may place substantially higher demands on waste management.
— The power plant design, construction methods and schedules may directly affect building material needs, emissions, the amount of waste produced and other environmental impacts.
— The potential for impacts on wildlife population and diversity and ensuing habitat loss through construction activities will need to be considered and avoided or, at least, mitigated.

Power plant operation is going to be a central aspect of SEA, as operation is expected to last for several decades. The following aspects (among others), thus, need to be considered:

— Safety, emergency and contingency considerations are of relevance when considering possible sites and technologies. For example, sites near settlements with only one access road may be unsuitable.
— Water consumption and discharges.
— Emissions (radiological and non-radiological) and associated activities.
— Waste management.

Power plant decommissioning is likely to require the development of specific policies, plans and programmes with their associated SEA.[12] Possible decommissioning aspects to be mentioned in a general nuclear power programme SEA (anticipating future dedicated decommissioning SEAs) include firm commitments to:

— Keep environmental impacts of decommissioning (including those on people's health) to a minimum;
— Ensure socioeconomic impacts are considered well before decommissioning starts;
— Work on a management strategy for storage or disposal of any radioactive material well before decommissioning starts;
— Develop a strategy for ensuring that funds will be available for safe decommissioning.

[11] It should be noted that similar considerations would be addressed at the project level for an EIA, although the level of detail would be different.

[12] If decommissioning of one single power plant is considered, this may also be an EIA.

3.2.3. Nuclear fuel cycle

Consideration of the steps of the nuclear fuel cycle and developing an understanding of their potential environmental and related sustainability implications are at the heart of identifying what an SEA needs to focus on. An SEA needs to consider the relevance of all of the steps in the nuclear fuel cycle for a particular nuclear power programme (see Fig. 7). This potentially spans front end activities (e.g. mining, conversion, enrichment and fuel fabrication) to back end activities (e.g. spent fuel management and disposal), along with other relevant action, such as associated infrastructure requirements.

Several of the front end steps can be outsourced and contracted from the nuclear technology supplier, thereby reducing associated national infrastructure requirements. This is less common for back end services, which are usually dealt with nationally. Only those steps of the fuel cycle that will be dealt with nationally are fully relevant for an SEA. However, responsible nuclear management requires that the environmental sustainability of those steps that are outsourced to other countries also receive some attention (e.g. mining and milling practices). Ensuring that the entire fuel cycle is considered will be important for choosing the preferred (technological) options.

Production facilities representing various steps of the fuel cycle will normally be placed at different locations. Potential negative environmental (including health) impacts should be taken into account at all of these locations. In this context, transport between sites, representing different steps of the fuel cycle, will also need to be addressed.

FIG. 7. The nuclear fuel cycle [28].

All steps of the fuel cycle are described in Ref. [28]. For a more in-depth discussion, the reader is referred to Ref. [29]. Furthermore, infrastructure issue 16 of Ref. [14] (see also Table 1) explicitly focuses on the nuclear fuel cycle and, thus, it is advisable that the SEA closely interact with this component of nuclear power programme development.

3.2.4. Spent fuel management strategy/radioactive waste storage and disposal

Radioactive waste is waste that contains, or is contaminated with, radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body. Radioactive waste refers to any such material which is not intended to be used in the future. As such, spent fuel may either be considered waste if it is to be disposed of, or it may potentially be considered a secondary raw material if stored in interim storage facilities for possible future reprocessing and fuel use. Spent fuel and radioactive waste management requires the preparation of a strategy addressing low, intermediate and high level wastes. Part of the SEA will need to focus on these types of waste and consider technical approaches to waste management, dependent on the radiological level. Spent fuel and radioactive waste management ranges from on-site interim storage to (possibly) permanent geological disposal. Associated transport will need to be considered for any of the assessed options.

Infrastructure issue 17 of Ref. [14] (see also Table 1) explicitly addresses radioactive waste management. Other considerations of the fuel cycle, which include spent fuel storage and potential reprocessing, also have direct implications on the spent fuel and radioactive waste management strategy (see Section 3.2.3). It is, therefore, recommended that the SEA and its evaluation of related environmental implications closely interact with the development of the nuclear power programme in these areas.

The IAEA maintains a radioactive waste and spent fuel management programme for establishing a proper safety framework, including a range of waste related safety standards. Reference [26] provides more detailed information on related options for countries developing new nuclear power programmes.

3.2.5. Physical protection and security

Physical protection refers to various measures aimed at protecting nuclear material and facilities. Security is a key element in managing nuclear power and associated facilities and activities during construction, operation and decommissioning. This also includes the treatment, storage and transport of nuclear material. Specific national guidelines for physical protection and security need to be developed and embedded within the corresponding legislative and regulatory framework.

The SEA may critically highlight the need for considering the environmental implications of the manifold security issues that vary according to the type of material[13] and which may relate to:

— Prevention of theft, including measures to locate and, where appropriate, recover nuclear material;
— Prevention of sabotage, terrorism and non-authorized access, and mitigating or minimizing the consequences of any such act of sabotage or terrorism;
— Prevention of illegal transfers or other malicious acts involving nuclear material or facilities.

Security also includes the response to any incidents that have occurred. While in-depth assessments of physical protection and security will be out of the scope of an SEA, different siting criteria may have different implications for the level of protection required and for the related supportive measures.

Infrastructure issue 15 (nuclear security) of Ref. [14] (see also Table 1) specifically requires the preparation of recommendations for nuclear security as part of the process of making a knowledgeable commitment to a nuclear power programme. The related environmental (including health) implications need to be considered in the SEA. A detailed discussion of the necessary measures to ensure this protection at nuclear facilities is provided in Ref. [31].

[13] As outlined, for example, for the transport of nuclear material in annex 1 of the Convention on the Physical Protection of Nuclear Material [30].

3.2.6. Emergency preparedness and response

Emergency preparedness targets the available capabilities to ensure an effective response to a nuclear emergency. These capabilities relate to, inter alia, involved institutions and their human capacities, and to related plans, tools, equipment and facilities. Emergency response aims at regaining control, mitigating any consequences and informing the public in the case of an emergency. This is outlined in more depth in Ref. [32].

The greatest risks of an emergency arising from nuclear reactors come from potential accidents, which can be due to:

— Technical and human error;
— Natural or environmental disasters affecting the nuclear power plant and its support structures.

Both need to be key considerations when choosing sites and technologies for nuclear facilities. Furthermore, environmental degradation may increase the impact of unusual natural events and should be taken into account. For example, deforestation may lead to instability of soils and slopes, and may worsen the impacts of flood events by facilitating mudslides. Figure 8 shows potential linkages between development, the environment and the manner in which a disaster event may unfold.

Similar to the previous impact area (physical protection and security), infrastructure issue 14 (emergency planning) of Ref. [14] (see also Table 1) requires an evaluation of a country's emergency preparedness and response, leading to the establishment of regulations governing all requirements to have emergency response plans. The SEA may feed into and support this process by considering the related environmental implications. An estimation of risks may be attempted when considering:

— Minor problems or breakdowns at one or various steps of the nuclear fuel cycle;
— Any potential major accidents.

In this context, emergency preparedness is usually adjusted based on the probability and severity of the associated impacts of an emergency.

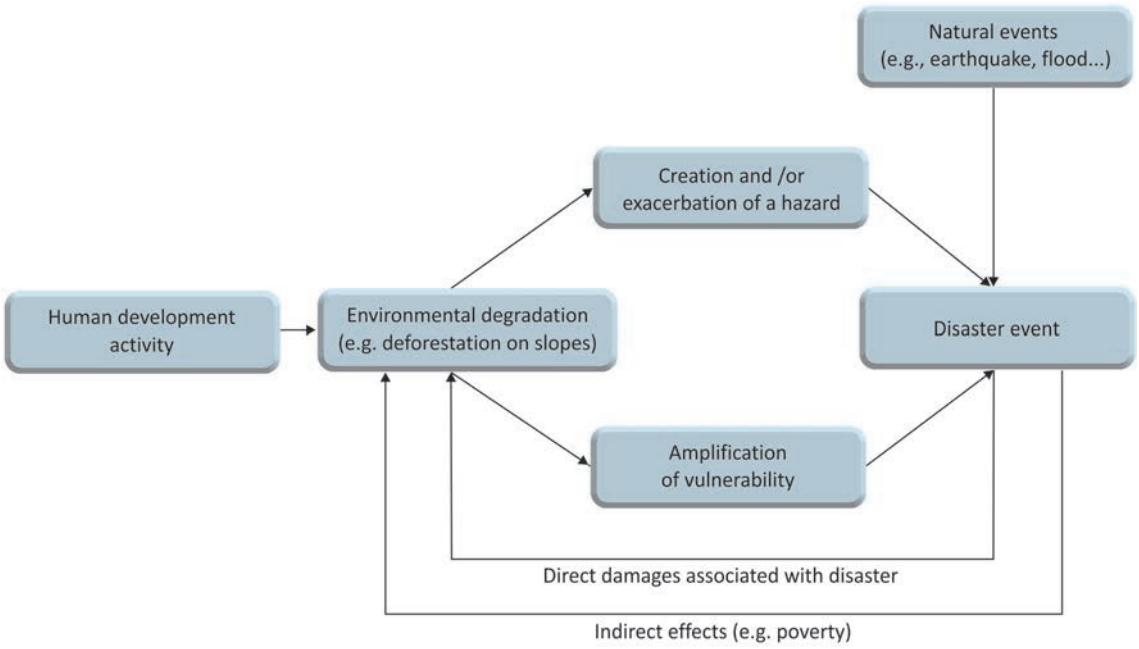


FIG. 8. Linkages between development, the environment and disaster (adapted from Ref. [33]).

3.2.7. Wider physical infrastructure requirements

Developing nuclear energy requires careful consideration of the suitability of the wider infrastructure. In this context, it is important that the SEA evaluate the significance of enhanced infrastructure requirements in the nuclear power programme. One possible approach includes:

(a) Supporting the assessment of the best sites for the development of nuclear energy from a grid point of view and assessing possible impacts when there is a need to adapt the existing electrical grid to accommodate nuclear power;
(b) Identifying, on the basis of this assessment, the preferred sites from a grid point of view;
(c) Comparing these preferred sites with those sites identified in Section 3.2.1.

In addition to the grid, other infrastructure may be directly affected and, therefore, needs to be assessed, following an approach similar to that outlined for the electrical grid. This may include, for example, accessibility through roads, railways or waterways, or housing for the local population and workers at a nuclear power plant, including provision of water and gas supply and sewage.

3.3. ENVIRONMENTAL IMPACT THEMES

For the purpose of these guidelines, eight environmental impact themes were chosen for consideration in an SEA for nuclear power programmes. These themes are based on current global practice in general (non-nuclear) SEA. This especially includes the environmental issues introduced in annex I of the EU SEA Directive [4], as this directive has been one of the main reference points for many SEA systems globally. Many of these themes are connected and also overlap, to some extent, but provide a different angle, from more infrastructure related environmental effects (regarding recipients and entities responsible for emissions) to wider impacts of the programme on society and external impacts on the programme. The eight themes are:

(1) Air, water, soil;
(2) Emissions (radiological and non-radiological), noise and vibration;
(3) Land, landscape, cultural heritage;
(4) Ecosystems;
(5) Climate change;
(6) Public health, well-being and safety;
(7) Economy (in connection with environmental implications) and society;
(8) Natural hazards.

It is important for any specific nuclear power programme that a customized approach be used and that any of these themes be adapted to the specific context and application.

These environmental impact themes are linked to impacts in various ways through activities associated with nuclear power programmes. In this instance, impact does not only mean ‘impact on’, but can also mean ‘impact from’ the environmental themes. The latter may include, for example, seismic activities. Another example is climate change, which can be an important consideration when designing reactors. For example, very hot weather periods (and associated warming of cooling water) can reduce the efficiency of the cooling process and, thereby, electricity generation. Impacts from the environmental themes on the nuclear power programme are usually analysed in detailed safety assessments, which evaluate potential radiological releases. An SEA may integrate the results of such assessments.

An important question arising when compiling the baseline of these environmental impact themes concerns the nature of information that may be readily available in a particular context and what information may have to be produced specifically for the purpose of the nuclear power programme. Furthermore, when dealing with actual impacts, it is important to consider both negative as well as positive impacts.

Key points for assessment in an SEA are potential environmental risks (both in terms of ‘impacts on’ and ‘impacts from’), as well as public acceptance issues and safety. In this regard, a stakeholder analysis establishing

the specific interests of stakeholders is also of relevance in SEAs (see also Section 5). In the following sections, the eight environmental impact themes are discussed in more detail.

3.3.1. Air, water, soil

With regard to potential impacts from nuclear energy activities on air, water and soil, potential exposure of human beings or wildlife may be considered in particular. Water, especially, has a number of aspects that may be of relevance for an SEA, including temperature, usage and wastewater. Also, there may be competition for water resources for, for example, hydropower, navigation, irrigation or household water supply. The impacts of related policies, plans and programmes will need to be assessed on a cumulative basis (i.e. by looking at the combined proposed measures).

3.3.2. Emissions (radiological and non-radiological), noise and vibration

Radiological emissions consist of electromagnetic radiation as well as particle radiation. In line with safety principles (see Section 3.1), nuclear power plants and associated activities are designed and operated to keep radioactive releases as low as reasonably achievable. To limit the risk of exposure to radiation, measures need to be taken to ensure that the risk of an accident with serious radiological consequences remains extremely low and that any radiological consequences are mitigated to the fullest extent practicable [34].

The need to consider conventional (non-radiological) emissions that may potentially affect air, water and soil has already been discussed. Noise and vibration may potentially affect human beings, as well as wildlife. As regards nuclear energy, emissions, noise and vibrations are most likely to be associated with mining activities and the construction of facilities (e.g. nuclear power plants). Furthermore, associated transport will lead to noise and other emissions.

3.3.3. Land, landscape, cultural heritage

There is a range of potential impacts on land use associated with nuclear power programmes. The site of a nuclear reactor alone can cover an area of about 20 ha. Nuclear facilities can, therefore, require significant amounts of land and, as a consequence, can have more or less significant ecological and landscape impacts, depending on where they are located and how they are designed. However, the greatest potential impact is usually associated with mining and with the associated dumping of mill tailings. Other land use and landscape impacts are caused by the associated infrastructure (e.g. the electrical grid supply and its pylons). However, the latter are not specific to nuclear energy, but are associated with all forms of electricity generation. Furthermore, cultural heritage may be considered in any SEA undertaken for a nuclear power programme. In this context, it may be investigated whether important sites of archaeological interest, for example, can be avoided. The rights of minorities in this context are also to be considered.

3.3.4. Ecosystems

Ecosystems encompass the flora and fauna, and their interactions with each other and with the environment. In this context, the SEA needs to take account of the potential radiological and non-radiological impacts on the composition and functioning of ecosystems, including their biodiversity as well as the services they provide to humans. This also requires consideration of the potential for loss of habitat.

Other impacts on ecosystems are associated with mining and the infrastructure needed for nuclear energy, including buildings and transmission lines. The SEA may explain where impacts from these activities are assessed and consider them when analysing options. The reader is referred to Ref. [35] for approaches to identifying, measuring and communicating the value of ecosystem services in an SEA.

3.3.5. Climate change

With reference to climate change mitigation, nuclear energy is considered to be an important potential low carbon energy option that can help to reduce greenhouse gas emissions. In this context, it is important that the SEA

not only focus on potential negative implications, but also take positive impacts into account. However, while running a nuclear power plant produces near zero greenhouse gas emissions, the mining and transport of materials, as well as the construction of infrastructure are examples of activities that release carbon emissions. Generally, it is advisable to apply a life cycle perspective.

The consideration of climate change adaptation (i.e. impacts from climate change) requires evaluation of the options to create a resilient infrastructure. In this context, potential impacts, such as heat waves or flooding at nuclear facilities, are to be taken into account, as well as indirect impacts of climate change on nuclear power plant operations (e.g. water availability). The reader is referred to Ref. [36] for a detailed discussion of climate change and nuclear power, and to Ref. [37] for approaches to address climate change adaptation in SEA.

3.3.6. Public health, well-being and safety

Public health, well-being and safety are key aspects for consideration in SEA for nuclear power programmes. With regard to physical determinants of health, radiological aspects are of particular importance. With its Simplified Approach for Estimating Impacts of Electricity Generation (SIMPACTS)[14], the IAEA provides a tool to assess the geographical distribution of public health implications during standard operations of a nuclear power plant. With regard to non-standard operations and for avoiding incidents and accidents, safety considerations in the development of nuclear energy require careful attention. Other aspects that may have an impact on physical health determinants include noise and emissions associated with mining, construction of facilities and transport.

When considering health in SEA, it is not only the physical determinants that require attention but also various social aspects. In this context, the 'health determinants' approach promoted by the World Health Organization can be applied (see annex A1.1 of Ref. [38]). As regards the development of nuclear energy, other health aspects that may need to be taken into account include mental health, as perceptions of threats posed by nuclear energy may have a very real impact on the health of local or regional populations. Existing epidemiological studies may provide a baseline in this case.

3.3.7. Economy (in connection with environmental implications) and society

In SEA, the economic effects of options and mitigation measures on society (rather than just on individuals or companies) may be considered to avoid recommending options with a very limited environmental benefit, but which have significantly higher costs. This may also enable a comparison of the indicative costs of an option and its wider economic impacts at local or regional levels. Further, economic and social effects of a nuclear power programme could also give rise to indirect environmental impacts.

Overall, however, the SEA needs to be guided by environmental considerations, and complementary economic assessments may be performed outside of the SEA process. In line with this, assessments of larger macroeconomic impacts, such as job creation, are usually associated with the policy level and are, thus, outside the scope of these guidelines (see Section 1.3).

The attitudes of society towards the environmental implications of nuclear power can play an important role when developing a nuclear power programme. Public concerns regarding nuclear energy need to be addressed early on in the process. Otherwise, the benefits for the economy and society may be outweighed by the associated challenges of addressing public concerns at a later stage.

While public concerns are a key issue to be considered in SEA for nuclear power programmes, its focus is not on whether nuclear energy is to be developed, but rather on the 'how' and 'where'. However, if that debate did not take place when looking at nuclear power at the policy level, there would be a need to consider this later, including at the nuclear power programme level.

The source of the nuclear material will also be a consideration when devising nuclear power programmes. In this context, the rights of minorities, such as indigenous peoples, should be taken into account, as well as the impact different activities may have on them and their environment (e.g. mining).

[14] https://www.iaea.org/topics/energy-planning/energy-modelling-tools

3.3.8. Natural hazards

The consideration of natural hazards is of key importance in SEA for nuclear power programmes, in particular with regard to the impacts from these hazards. Aspects to be considered may include the potential for seismic activity/earthquakes, hurricanes, tsunamis, landslides and/or mudslides and floods, including, for example, flooding of river basins or surface flooding.

3.3.9. Guiding questions

Table 3 identifies questions arising in SEAs for nuclear power programmes that may be relevant to the environmental impact themes introduced above. These may guide, in particular, the scoping exercise in the SEA.

TABLE 3. SELECTED QUESTIONS FOR SEA FOR NUCLEAR POWER PROGRAMMES

Environmental impact theme	Questions arising in the SEA
Air, water, soil	— Is any potential air, water/groundwater and soil contamination taken into account through, for example, construction or other associated activities? — Will any activities associated with the development of nuclear energy potentially impact: • Air quality? • Groundwater and surface water levels? • High quality soil (e.g. through removal or compaction)? — Is any relevant exposure of human communities, flora and fauna to potentially contaminated air, water and soil taken into account? — Are any possible positive effects on air, water and soil described (e.g. through substitution of other potentially more harmful energy options)? — Are any potential impacts from dust considered? — Will the nuclear power programme affect water availability or temperature? Will this affect the local climate or microclimate? — Are unusual weather events a key consideration?
Emissions (radiological and non-radiological), noise and vibration	— Are potentially radioactive emissions/discharges during routine operation considered? — Are non-radiological emissions during routine operations considered? — Are emergency and recovery plans in the case of non-routine discharge adequate? — Are emissions, noise and vibration considered for all relevant steps of the nuclear fuel cycle and associated action? — Are emissions, noise and vibrations considered from construction, operation and decommissioning of nuclear facilities? — Are emissions, noise and vibrations from other necessary constructions considered, including for roads, railways, water corridors or the electricity grid?
Land, landscape, cultural heritage	— Are land use, landscape and cultural heritage taken into account at every step of the nuclear cycle (including historic landscapes and buildings)? — Are any potentially significant negative impacts of mines, buildings and other infrastructure facilities on land use, landscape, seascape or cultural heritage (including tourism) considered? — Will access to open or other important spaces and areas be restricted or will their quality or quantity be affected? — Are any positive impacts considered, for example, by avoiding other more harmful energy options or by encouraging the conservation of historic buildings?
Ecosystems	— Will the nuclear power programme have any effects on: • Flora and fauna, including on any protected species, both terrestrial and marine? • Any designated sites or non-designated sites that are important for the protection and development of flora and fauna, both terrestrial and marine? • Services provided by ecosystems, such as providing food or water, regulating climate or natural hazards or providing habitats or cultural value? — Will any areas of biodiversity be affected?

TABLE 3. SELECTED QUESTIONS FOR SEA FOR NUCLEAR POWER PROGRAMMES (cont.)

Environmental impact theme	Questions arising in the SEA
Climate change	— Will the nuclear power programme lead to any changes in carbon dioxide emissions or other greenhouse gas emissions (both direct and indirect) with regard to alternative electricity supply options and is this considered in the SEA? — Does the SEA take adaptation to expected climate change and its risks into account and assess nuclear power programme options in the light of these, including, for example, changes regarding (the occurrence and magnitude of): • Heat waves? • Flooding? • Coastal or other erosion? • Water availability and temperature?
Public health, well-being and safety	— Are health and safety issues considered for all steps of the nuclear fuel cycle in the SEA? In this context, are there any existing baseline epidemiological studies that can be used? — Are all determinants of health considered, including those that are of a physical (environmental) nature, as well as those that are economic and social (e.g. behavioural and mental)? — Are health and safety aspects considered for the construction, operation and decommissioning stages of nuclear facilities?
Economy (in connection with environmental implications) and society	— Does the SEA take attitudes of local, regional and national and international communities to nuclear energy into account? — Does the SEA consider potential economic benefits and costs to society? — Does the SEA allow stakeholders and the general public to contribute to the process and does it provide feedback on how their concerns and questions have been addressed? — Are the rights of minorities (e.g. indigenous peoples) considered? — Are any positive or negative impacts on communities or minorities and indigenous peoples considered in the SEA?
Natural hazards	— Have potential seismic activities been considered? — Has the potential for flooding (river, sea, surface water) been considered? — Has the potential for landslides been considered? — Has the likelihood of extreme storms been considered (e.g. hurricanes, typhoons, cyclones)?
Cutting across all themes	— Are any potentially significant effects avoided, reduced, minimized or mitigated? — Have alternatives from all identified significant impacts been taken into account? — Are there any interactions of different environmental impact themes?

4. METHODOLOGY, PART 1: SEA PROCESS

This section explains the components of the SEA process, after outlining process management requirements. Furthermore, aspects of quality assurance are introduced in the final part of this section.

4.1. PROCESS MANAGEMENT

The SEA needs to be conducted in parallel with the process of designing a nuclear power programme and needs to engage with it at regular intervals, in line with the approach presented in Fig. 9. Full integration of both processes may be possible, depending on the importance given to SEA. If SEA has a weak status, then it is advisable to avoid full integration, as other issues are then likely to subsume the SEA and a lack of transparency is likely to

result. The process of preparing a nuclear power programme will normally take at least six months, but more likely several years, and will differ depending on the country and system in which it is applied.

While external experts may be engaged in the development of an SEA, it is essential that the process be led by a responsible and competent authority. The type of authority in charge will vary between different countries and could, for example, be an energy or environmental authority. However, in any case, it is recommended that an environmental authority play an important role in the SEA process, in particular in the SEA review and evaluation (see Section 4.8). Coordinating the parties involved will require effective process management. While it is advisable to assign a dedicated person (supported by others) to be responsible for the management of the process overall, an SEA process committee may fulfil an auditing function. Furthermore, it will be important to ensure that the processes and their interrelations are clearly understood by those involved. A process management checklist developed during scoping (see Section 4.3) will be a useful first step in this direction.

In this context, the team in charge of conducting the SEA will need to liaise closely with the team preparing the nuclear power programme. Both teams would ideally start preparation processes at the same time and run both processes in parallel. This means that any documentation prepared at the different decision stages could be released in combination and the parts may clearly refer to each other. For example, the screening decision may be published together with the decision to prepare a nuclear power programme. Furthermore, an SEA scoping report should be published alongside any nuclear power programme discussion papers. It is common practice for authorities to seek the views of the public and other stakeholders prior to the preparation of a draft programme. The SEA can contribute to this stage through the scoping report, which can also serve as a formal record of this stage of the nuclear power programme. The same applies to any documentation prepared at subsequent stages of the SEA process.

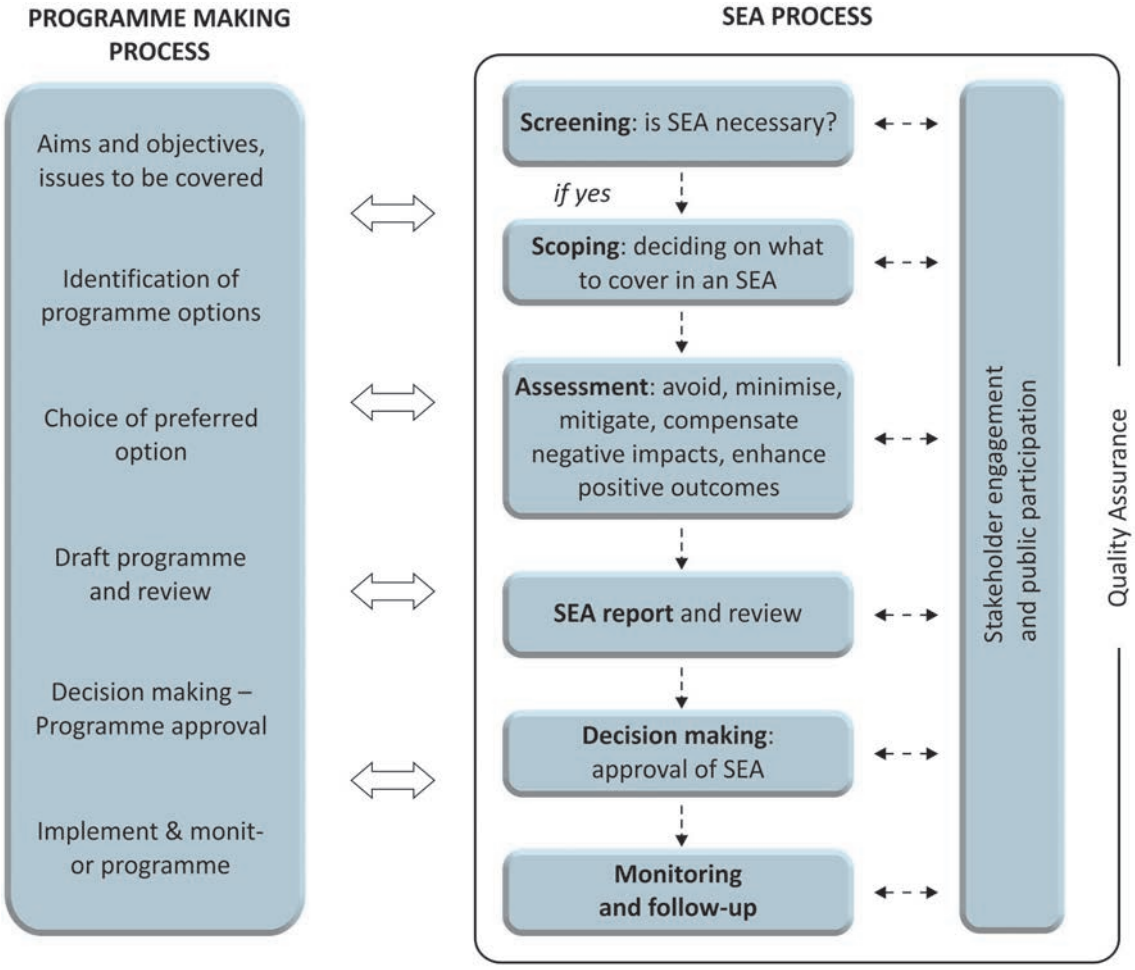


FIG. 9. SEA process and integration with nuclear power programme preparation.

It is important that a timeline be agreed on by both SEA and nuclear power programme preparation teams, and that this is released upfront. In this way, awareness of the essential role of both processes can be developed, in particular among stakeholders and, also, among the decision makers themselves. This is important as the attitudes of those involved have a great influence on the effectiveness of SEA overall. Briefing notes may be prepared to facilitate communication between those involved in the process (see Ref. [39]).

4.2. SCREENING

Screening is the initial action taken when considering whether or not to conduct an SEA for a nuclear power programme. It results in a decision that is based on likely significant impacts. Two main types of screening are differentiated and these may be used in combination:

(1) Screening based on inclusion or exclusion checklists/criteria;
(2) Case by case screening.

Inclusion or exclusion checklists/criteria may be based either on the specific types of programme requiring an SEA (such as a nuclear power programme for building a power plant, extending its lifetime or developing a strategy for radioactive waste management) or on environmental conditions when an SEA is necessary (i.e. in the case of an area with a specific protection status being affected). Checklists may be provided by legislative requirements. Inclusion checklists would identify policies, plans and programmes that require SEA, whereas exclusion checklists would identify those that do not.

If an SEA for a nuclear power programme (or a subcomponent thereof) is a legal requirement, no further screening is necessary. For an example of such an inclusion checklist, the reader is referred to article 4.2 and annexes I and II of the UNECE Protocol on SEA for a list of projects that may require SEA, and annex III for screening criteria [5].

If case by case screening is required, owing to the programme focusing only on some minor changes to existing nuclear infrastructure, this would require further information about the proposed nuclear power programme along with the potentially affected environment. In case by case screening, it is recommended to produce a short screening report, justifying whether or not to go ahead with the SEA. The responsibility for case by case screening would ideally be with an authority different to the one in charge of the nuclear power programme to avoid accusations of partiality in what is considered, in many countries, a sensitive issue. Screening needs to be conducted as early as possible and will profit from consultations with interested stakeholders.

Screening can have different outcomes, depending on the country in which it is conducted. In addition to ‘no SEA’ or ‘full SEA’, a decision may be made that further study is necessary to determine the level of SEA required or whether a more limited SEA is to be prepared, focusing on a number of selected issues only. Screening should result in a statement on the anticipated significant effects.

4.3. SCOPING

Scoping is the stage at which issues, impacts and options are determined which potentially will need to be considered at subsequent stages. It is a systematic exercise that establishes the boundaries and terms of reference for the SEA. There are legal requirements in most countries on what aspects must be considered and formally scoped in or out, including issues, options and impacts that require further study. With regard to nuclear power programmes, key options are likely to revolve around technical and site options. Importantly, there needs to be some flexibility in the SEA process to allow for issues to be scoped in or out, even after the scoping stage, if this turns out to be beneficial.

Scoping includes elements of both identification and prioritization (evaluation) of aspects to be included in the SEA. The latter facilitates a targeted use of resources for collecting the information necessary for decision making. As scoping places limits on the information to be gathered and analysed in SEA, it helps to focus the approach to be taken. The purpose of scoping can, therefore, be summarized as follows:

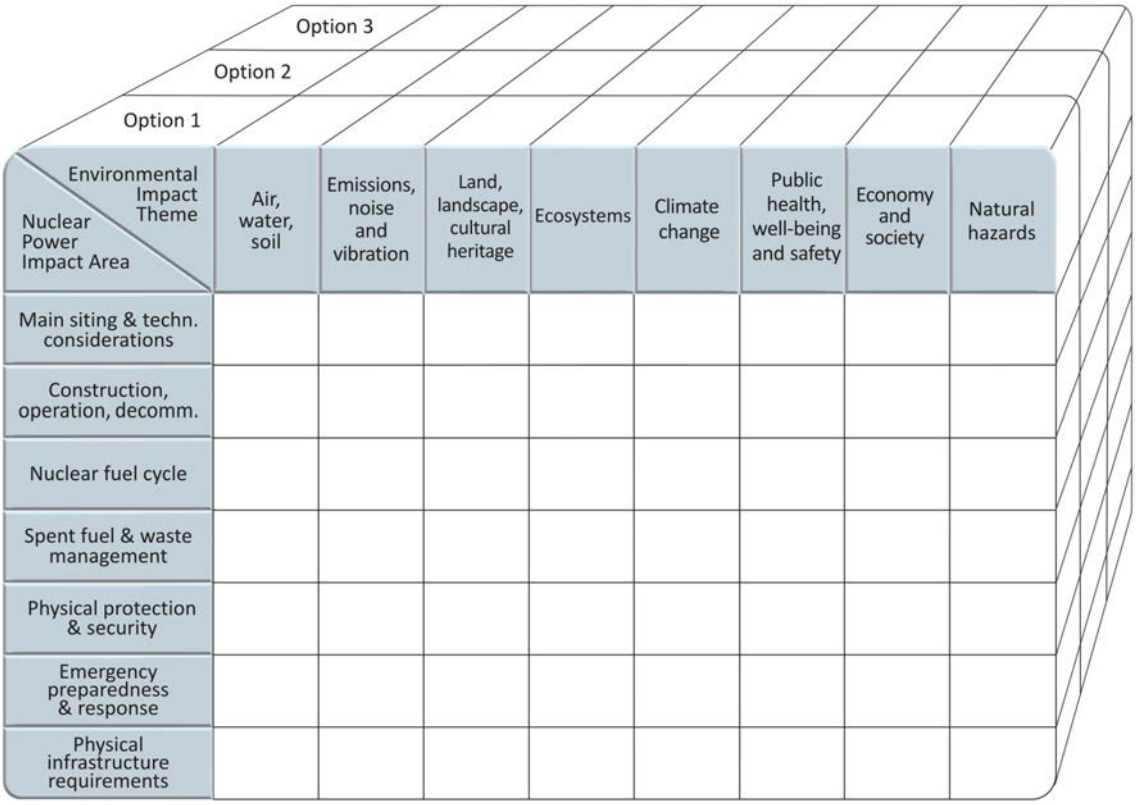
— To identify the important issues to be considered (including environmental baseline and assessment options);
— To determine appropriate time and space boundaries;
— To establish the information necessary for decision making;
— To anticipate the significant effects and factors to be studied in detail.

Section 3 defines nuclear power impact areas and introduces environmental impact themes that may be affected by these impact areas. At the scoping stage, all of these themes and areas should be covered in order to decide on their exclusion or inclusion and prioritization. While the nuclear power impact areas were singled out as key areas to be considered in nuclear power programmes, all infrastructure issues in Ref. [14] should be checked for relevance, as they may directly or indirectly affect the SEA process (see also Table 1). For example, procurement rules may indirectly have an environmental impact, as they could affect the environmental footprint of procured goods as well as safety standards. The same is true for funding and financing, as lending institutions may impose certain requirements regarding the SEA process.

Figure 10 introduces a scoping matrix, revolving around the eight environmental impact themes and seven nuclear power impact areas to be addressed in SEA (following on from Section 3). Such a matrix may be used during scoping to assign weights of importance to its elements (such as ++, +, o, –) and to support the prioritization process.

Scoping should take account of the nature of the programme together with specific national circumstances and requirements. Issues may be excluded because they have been or will be dealt with at other decision tiers, ranging from earlier policies, plans and programmes and their associated SEAs, to later projects and their associated EIAs. The scoping stage is, therefore, framed within the sequence of decision tiers between the conceptual and implementation stages (see Section 2.3).

A good balance needs to be achieved between issues that are to be considered and those that are not. Scoping in too many issues is problematic as this will make the SEA overly complicated and may, ultimately, confuse the issues involved. However, scoping out issues that may be relevant means that the SEA will fail to adequately address potentially significant impacts. In this context, the determination of what is likely to be ‘significant’ in



Note: Options are likely to mean different locations and type/technology of a nuclear power plant.

FIG. 10. Scoping matrix.

environmental terms is of central importance to scoping. There is a need to discuss how 'significant' in an SEA may be defined and what it comprises, possibly expressed through suitable environmental and sustainability indicators.

Achieving the right focus is of key importance and associated decisions need to be taken at the outset of an SEA considering all stakeholders involved (including environmental and health authorities as well as the general public). The public and other stakeholders usually decide on what they consider to be significant not only based on pure evidence, but also their perception of impacts. In the context of SEA, dealing with public perceptions is, therefore, as important as generating scientific evidence. Stakeholder and public involvement in scoping will add credibility and help justify why elements that some may consider important were excluded. It will facilitate a constructive and inclusive debate on what the key public and institutional concerns are.

It is very much in the interest of the body performing an SEA to engage key stakeholders (and potentially the general public) at an early stage to avoid later delays, criticism or misunderstanding in the engagement process as a result of different views regarding the focus of SEA, for example.

Important aspects to be considered in the scoping consultations are presented below (adapted from Ref. [40]):

— Identifying a list of main stakeholders and updating it during the process of developing the nuclear power programme and the associated SEA.
— Inviting stakeholders and the general public to contribute to scoping.
— Sending out information on the programme and the associated SEA; in this context, providing contact details for information and comment.
— Making information on the nuclear power programme and the associated SEA widely available, using a wide range of media.
— Collating and analysing responses, and taking them into account in planning the SEA.
— Writing back to each respondent thanking them for their input and explaining how their comments have been addressed.
— If appropriate, arranging meetings to discuss the issues raised.
— If there is considerable local interest in areas where potentially suitable sites have been identified, consideration should be given to holding a public exhibition or a community meeting during which the project is presented and expert staff are on hand to answer questions.
— If there are several groups with a common interest, consideration should be given to setting up a special forum to meet at regular intervals.
— Considering issuing regular newsletters to keep stakeholders up to date with events.
— Always recording the views expressed in consultations.

In addition to the identification and prioritization of aspects to be included in the SEA, a process management checklist should be prepared at the scoping stage to ensure the quality of the SEA process (see Table 7). This checklist should outline issues and tasks to be addressed during the subsequent stages of SEA, along with an allocation of tasks and responsibilities, and an indication of the likely time requirements and timeline.

Scoping is complete when all required work and studies to be included in the SEA have been specified (e.g. when a scoping report and the terms of reference for the SEA have been prepared; see Ref. [41]). A scoping report of good quality reduces both the risk of including inappropriate issues and aspects, and the risk of excluding those issues that should be addressed. It should be customized to meet the following objectives:

— To inform the public about a planned nuclear power programme;
— To identify the main concerns and societal values;
— To define reasonable and practical site and technology options to be addressed;
— To explain how the steps of the nuclear fuel cycle are relevant and will be considered;
— To focus on the important issues and significant impacts to be addressed;
— To define boundaries of the SEA in terms of time, space and subjects covered;
— To set requirements for the collection of baseline and other information;
— To point towards applicable indicators, target values and methods for assessing significant impacts (see Section 6);
— To establish the terms of reference for the SEA and to document them;

— To prepare an information package or circular explaining the proposal and the process, and to specify the role and contribution of stakeholders and the general public;
— To respond to new information and further issues raised by stakeholders and the general public during the scoping exercise.

Such a scoping report can then serve as the starting point for the subsequent assessment stage.

4.4. ASSESSMENT

The assessment stage should start with a description and an explanation of the proposed nuclear power programme, focusing on the information that is important for an SEA. This may be done through a draft SEA report (see Section 7). This description needs to clearly state the underlying objectives and the options considered within SEA, which may be different from those considered in the nuclear power programme.

4.4.1. Baseline environment

An assessment needs to start with a qualitative and quantitative description and analysis of the baseline environment, as well as of any other issues identified as being important during scoping, building on available data and assessments. In addition to biophysical aspects, this needs to include people and their socioeconomic environment, as well as their public health, well-being and safety. The specific aspects to be considered in this context depend on legal and other formal requirements, as well as on informal practices. Current and expected future environmental characteristics require evaluation, establishing their overall value as well as their sensitivity to potential impacts.

For an SEA, existing data from environmental databases, land registers and other environmental management and planning instruments will usually be the starting point. Other important sources are existing policies, plans and programmes, including spatial plans and other sectoral and development plans. When reviewing associated documents, it is important to check whether they are current.

The description of the baseline environment should emphasize existing environmental problems and constraints, and needs to pinpoint ecologically important and sensitive areas. It requires a prioritization of what is necessary to be able to judge the environmental implications of a nuclear power programme. Furthermore, any data issues that may affect the assessments need to be recorded, from unreliable data to assumptions used to fill data gaps (see Section 6.2).

4.4.2. Options and impacts

After having developed a basic understanding of the baseline environment, preliminary options to be considered in the assessment need to be described and explained. These options should be closely aligned with, but not limited to, what is considered in the parallel development of the nuclear power programme (see Fig. 9).

The SEA should aim to identify environmentally friendly options and clearly explain how these were chosen. Furthermore, one of the options to be included should be the zero option, representing the evolution of the environment without the implementation of the nuclear power programme. In this context, if considering alternative power system developments, the assumption (as presented in Section 1.3) is that the country has determined that nuclear power could play a role in meeting future energy demand, which was supported by a thorough energy systems analysis. The main options of the programme would, thus, revolve around the siting of nuclear facilities and technology choices. As such, the zero option would draw on, reference and summarize related preceding studies, and would only add a concise assessment of the environmental implications, as necessary.

Importantly, options should not be made up in order to support the development and selection of a preconceived winning option. In this context, stakeholder engagement and public participation should be used to decide upon viable options. Terms of reference for performing the SEA should ensure that there is sufficient room, both financially and temporally, to genuinely investigate these options.

The assessment of options includes the evaluation of their impact significance. This requires taking into account the value and the expected sensitivity of the potentially affected environment and the expected magnitude

of the likely change due to the nuclear power programme. In order to evaluate impact significance, an appropriate methodology needs to be chosen. In this context, applying a predefined methodology makes the SEA more transparent, reproducible and comparable (see Section 6). Figure 11 provides an overview of how the potential significance of environmental impacts is a combination of the sensitivity of the environmental receptor and the magnitude of change. It may be applied to the elements presented within the scoping matrix shown in Fig. 10.

The evaluation of impact significance is usually associated with environmental development and protection objectives. These can be based on regulations, guidelines or expert/public opinion. To be able to reach decisions on options and mitigation, knowledge of the significance of impacts is essential.

Results need to be presented for both positive and negative environmental impacts. In this context, different types of anticipated impact need to be taken into account, such as direct and indirect, cumulative, short term to long term, synergistic, local, regional and global (including transboundary), as well as residual impacts:

— *Direct impacts:* Impacts of a nuclear power programme that occur in the same space and time as the programme itself. They are also referred to as primary impacts.
— *Indirect impacts:* Impacts of a chain of activities that are associated with, or induced by, the nuclear power programme that may occur later in time or are affecting a broader area than that directly covered by the programme.
— *Cumulative impacts:* Resulting from the incremental effects of a nuclear power programme when added to other past, present or planned (future) actions. While these actions may have minor impacts when considered individually, they may be of significance once assessed in combination.
— *Short term to long term impacts:* Short term impacts are those that have a clear end and may be of significance for a few days, weeks or months only (e.g. construction of a nuclear power plant). Long term impacts are those associated with the long term operation of a nuclear power programme (e.g. the infrastructure and associated transport activities, or waste management).
— *Synergistic impacts:* Impacts that result from the interaction of different impacts of a nuclear power programme, or from the interactions of impacts of several policies, plans, programmes or projects within the same area, and that may turn out to be greater than their sum.
— *Local, regional and global impacts:* Impacts associated with a nuclear power programme that are of a local nature, such as noise and landscape impacts, and impacts that are of a regional nature, such as those that are transport related, and impacts that are potentially of a global scale, including the effects of a nuclear power programme on carbon emissions.
— *Residual impacts:* Those impacts that remain, together with all associated mitigation and other environmental management measures (e.g. permanent waste storage sites).

	Environmental Receptor Sensitivity			
Impact Magnitude	Negligible	Low	Moderate	High
Negligible	Not significant	Not significant	Low	Low
Low	Not significant	Low	Low to Moderate	Moderate
Moderate	Low	Low to Moderate	Moderate	High
High	Low	Moderate	High	High

FIG. 11. Evaluating potential impact significance.

Impacts can be determined qualitatively and, whenever possible, quantitatively. Certain impacts may be calculated and modelled while others may be estimated. Appropriate methods will need to be identified at the scoping stage and might have to be reassessed later on in the SEA process. Environmental impacts may affect various media owing to the complexity of causal chains. Monocausal relationships will be the exception rather than the rule and the chosen methodologies will need to reflect this. It is important that environmental impacts depend on the characteristics of the receiving environment as well as on the type of action giving rise to impacts. Examples of potential options and mitigation measures are provided in Table 4.

TABLE 4. EXAMPLES OF POTENTIAL OPTIONS AND MITIGATION MEASURES

Nuclear power impact areas	Options	Mitigation measures
Main siting and technological considerations	— Different siting criteria; — Different reactor types.	— Considering a different site or different types of site; — Changing construction and design at the same site; — Considering a different reactor type.
Power plant construction, operation and decommissioning	— Different construction materials; — Different designs (e.g. wet or dry cooling tower, hybrid cooling tower without plume); — Different transport options (modes and routes); — Different decommissioning options (e.g. future use of site for similar or other purposes).	— Considering less environmentally harmful construction materials; — Considering more environmentally sustainable transport options and routes; — Considering more environmentally sustainable decommissioning options.
Nuclear fuel cycle	— Import fuel; — Extract uranium from domestic mines; — Fuel leasing; — Reprocess uranium.	— Considering more environmentally sustainable fuel options and sources; — Choosing most knowledgeable companies.
Spent fuel management strategy or radioactive waste storage and disposal	— Store both low and high level wastes together in a deep geological repository; — Store low level waste in a landfill site; — Fuel leasing; — Agreement with foreign country to combine storage efforts.	— Considering decay storage to reduce radioactivity in low level waste; — Considering measures to reduce the amount of waste to be stored.
Physical protection and security	— Consider site options based on their implications for physical protection and security; — Consider different options of physical protection and security measures.	— Enabling design which can be better physically protected and secured.
Emergency preparedness and response	— Consider sites and operations (including transport) at which emergency preparedness and response is, comparatively, more secure.	— Reducing risk of accidents by learning from past experiences and adjusting the design accordingly; — Preparing emergency and response plans; — Undertaking a thorough risk assessment.
Wider physical infrastructure requirements	— Consider the physical infrastructure requirements for different sites.	— Looking at environmentally sustainable physical infrastructure options.

TABLE 5. EXAMPLE TABLE FOR SUMMARIZING MITIGATION OUTCOMES

Option	Type of potential impact	Magnitude of potential impacts	Significance of potential impact (i.e. sensitivity of environment)	Anticipated costs of option and possible mitigation, and potential responsibilities for implementation
1				
2				
3				

4.4.3. Mitigation measures

After describing the options available, identifying mitigation measures is another key stage in SEA to ensure the nuclear power programme is best aligned with the environment and related sustainability objectives. Mitigation in SEA seeks to prevent any significant negative impacts from occurring and to enhance positive outcomes. Its aims are, therefore:

— To support the development of measures for avoiding, or at the very least reducing, significant adverse impacts on the environment and society;
— To enhance beneficial effects, lowering costs for environmental protection and conserving natural resources;
— To create better opportunities for economic development through generating positive outcomes for environmental conservation, sustainable livelihoods and personal well-being.

Mitigation is, therefore, intended to improve protection of environmental assets, to encourage more prudent use of natural resources and ecosystems, and to avoid costly environmental damage. Mitigation can be depicted as a desirability hierarchy of aspects to be considered, with enhancement of positive outcomes, as well as avoidance of negative impacts, being accorded the highest priority. These objectives are followed by minimization and rectification of, and compensation for, negative impacts, as summarized in Fig. 12.

Enhancing positive outcomes and avoiding or minimizing impacts at the source are most desirable. This is the starting point for an SEA, which attempts to find the best possible siting and technology options. Rectification and compensation are viable mitigation measures at the EIA and project level. Table 4 provides examples of potential mitigation measures and Table 5 demonstrates how mitigation could be reported in an SEA report.

4.5. THE SEA REPORT

The SEA report is the main written output of the assessment. Its structure is explained in more detail in Section 7. Generally, the act of reporting does not only include the preparation of a written report, but needs to include meetings and other events to publicize and explain its content, results and recommendations, and to engage in a process of consultation. The latter is of particular importance, as an SEA does not take decisions, but rather supports decision makers in making good decisions as regards environmentally sustainable development. This needs to be taken into account in any stakeholder and public involvement strategy, which is further explained in Section 5. Work on the SEA report starts once a decision to conduct SEA for a nuclear power programme has been

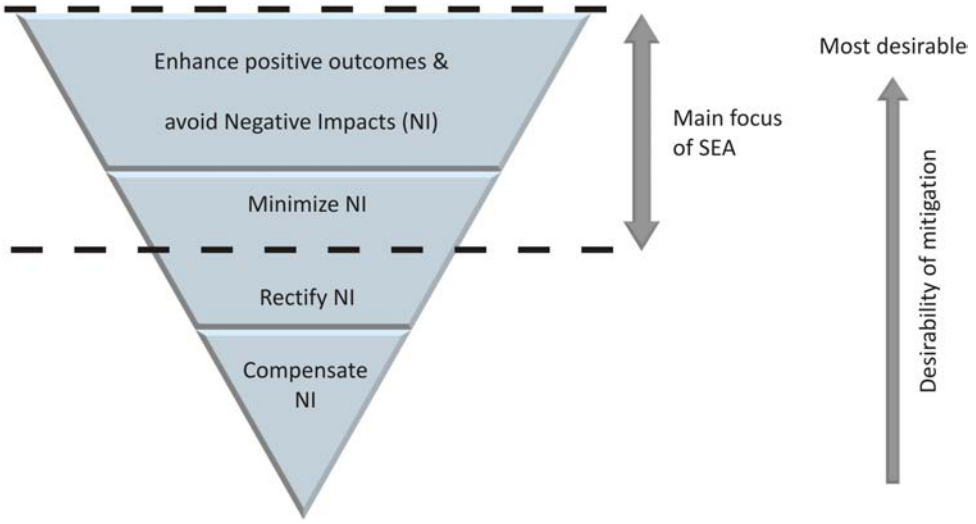


FIG. 12. Desirability of different types of mitigation measure in SEA.

taken, for example, on the basis of legal requirements or case by case screening. The scoping report is the first stage of reporting and the main SEA report should either incorporate the scoping report or present a summary of it. The SEA report will advance the objectives, options and issues to be considered and indicators identified during scoping, and explain whether and how they have changed.

The preparation of a sound SEA report is likely to take a minimum of 6 months and more likely one or more years. This time develops along the lines of the SEA process, starting with work on the scoping report and ending with a positive quality review. In this context, it is important that this does not mean that the SEA is delaying the process of developing and implementing the nuclear power programme. Rather, it is prepared in parallel to it, covering environmental issues in a participatory process, which would need to be carried out in any case. The part of the process requiring the longest period of time is stakeholder and wider public participation.

The SEA report should be reviewed and approved by the responsible environment authority, and should involve feedback and comments from a range of authorities and bodies. Reviewing and approving the SEA report should, therefore, not be the sole responsibility of the authority responsible for the preparation of the nuclear power programme SEA. Quality review of an SEA report is explained further in Section 4.8.

4.6. DECISION MAKING

The main aim of SEA is to effectively incorporate environmental and sustainability considerations into the nuclear power programme's decision making processes and, ultimately, to support decisions that result in more environmentally sustainable development. Thus, the SEA needs to consider how decision making can be influenced. This requires that the SEA be conducted in parallel with the nuclear power programme preparation process, but converging with it at various points along the preparation process (see Fig. 9).

In this context, the design of the SEA should be sensitive to the real characteristics of decision making, as real decision processes frequently divert from what has been planned upfront or what is set out in formal requirements. The SEA also needs to be flexible in order to be able to react to any changes or unforeseen developments. Furthermore, it should be understood that it is a support tool for a more effective decision framework (see Figs 2–5). Any oral or written explanations by decision makers on the decisions taken during the process should clearly state how the SEA was taken into account. In this context, as an important support document, the SEA report should be explicitly referred to in any decisions taken and in the documentation prepared to justify them.

While an effective SEA always requires its results to be considered in any decision making, there may also be legal or other formal requirements for justifying decisions, in the light of what the SEA is reporting. Here, it is important to closely follow those requirements when justifying decisions taken.

Furthermore, there is a need to effectively engage with stakeholders and the general public (see Section 5). Results, along with recommendations emerging from the SEA, need to be explained to decision makers and to other stakeholders in meetings, workshops and through other means. It is not adequate to simply submit a report; it is necessary to welcome feedback and to be open to amendments of the nuclear power programme. In this context, it is important that there be an engagement and communications strategy.

Finally, there should be a written justification of the programme decision taken (i.e. adoption of the programme). This should explain how the SEA was considered and what information needs to be provided after adoption.

4.7. MONITORING AND WIDER FOLLOW-UP

Monitoring consists of two main aspects: (i) monitoring compliance with what is set out in the SEA and in the nuclear power programme; and (ii) monitoring whether the actual impacts are in line with what was envisaged. In this context, the use of indicators is particularly useful.

Monitoring and wider follow-up mark a key stage in the SEA process, one which is frequently neglected or at times even ignored altogether. It is important that the implementation of the conditions agreed upon (and recorded in reports) during the nuclear power programme and the SEA preparation processes be monitored. This will ensure that the subsequent design and implementation of a nuclear power project with its EIA happens in line with the SEA.

Furthermore, there is a need to verify whether proposed mitigation measures are integrated into subsequent planning processes and that they result in the desired outcomes. Monitoring is also required to confirm whether future impacts are expected to be in line with initial estimates during an SEA. In this context, determining indicators, objectives, targets and methods will facilitate the measuring, monitoring and evaluation of the main actions to take in order to prevent, mitigate or compensate for the impacts resulting from the nuclear power programme.

If necessary, remedial action may be required, especially if actual developments differ from those predicted or planned. In SEAs, associated activities are frequently referred to as follow-up. In this sense, follow-up should allow for at least some adaptive management in the development of nuclear energy. This is supposed to help manage environmental risks and to support learning in the SEA process, along with learning from past experiences. Essential components of effective SEA follow-up are listed below:

— Follow-up needs to check *conformance* with terms and conditions laid out in the SEA.
— Follow-up needs to check the satisfactory environmental *performance* of nuclear power programme implementation, comparing and evaluating predicted with actual impacts.
— Follow-up needs to *manage* actual impacts that may be different from those that were predicted. This acknowledges uncertainties and a lack of full knowledge of environmental processes, and addressing this requires some flexibility.
— Follow-up needs to include *dissemination* of what is learned from following up the SEA.

Overall, the rationale for monitoring and wider follow-up is connected with the level of uncertainty inherent to the SEA. This is why monitoring and follow-up are an integral part of the SEA. In this context, feedback from follow-up should enable conscious learning from experience. The objectives of SEA monitoring and wider follow-up with regard to three key issues, controlling, learning and communicating, are listed below:

— *Controlling:* checking and adjusting the nuclear power programme for the purpose of controlling (environmental) risk.
— *Learning:* providing feedback to the SEA framework, process, predictions and actual effects.
— *Communicating:* about the environmental performance of the nuclear power programme.

Monitoring and wider follow-up are the main link between pre- and post-decision stages of various interdependent SEA processes. It is important that follow-up not just focus on one specific SEA for the nuclear power programme, but that the full decision framework is taken into account (see Figs 2–5). While the former can be referred to as micro-level follow-up, the latter would be viewed as macro-level follow-up.

The related activities have financial and human resource implications. It is, therefore, important that SEA monitoring and wider follow-up be integrated with other (possibly already existing) monitoring and auditing activities. Generally, the proponent of an SEA would be considered responsible for performing most activities involved in follow-up. Furthermore, the competent environmental authority should be involved, possibly as an auditor of associated activities. Finally, the general public (including affected and interested communities, and non-governmental organizations (NGOs)) should also be able to contribute.

Monitoring and follow-up activities can be organized in different ways. For example, there may be formal command and control requirements in place with the possibility of pursuing any breaches of what is expected from a legal perspective. Furthermore, there may be self-regulation by those responsible for a nuclear power programme, which, however, would have to be monitored by an independent body. Finally, public pressure may be a powerful driver in ensuring follow-up is being carried out.

Any activities associated with monitoring and follow-up should involve the preparation of a (post-decision) management plan with clearly defined actions, responsibilities, timelines and reporting requirements. The specific requirements should be set out in the main SEA report, which may also define indicators, targets and methods for monitoring and follow-up (see Section 6). In this context, transboundary aspects will also need to be considered.

Ideally, monitoring and follow-up activities proposed in the SEA will be integrated into the nuclear power programme and subsequent EIAs. The results of monitoring and follow-up should be made available to environmental, health and other authorities, as well as to the public, at defined intervals.

4.8. QUALITY ASSURANCE

The quality of SEA is determined through a number of aspects. A high quality decision making framework in which the SEA is applied, and which it tries to influence, is essential to ensure effective and efficient SEA. Furthermore, a high quality SEA process itself is vital. In order to ensure high quality, the proficiency of those involved in conducting the SEA process and in preparing the SEA report (which should also be of high quality) is important. SEA is supposed to increase transparency in decision making. Thus, the quality of SEA as a platform for open and fair debates is another aspect. Finally, SEA is only effective if it is able to influence decisions, and this is another quality aspect.

As SEA aims to effectively influence decisions, creating the correct context for achieving effectiveness is important. For this purpose, the following actions should be undertaken to ensure that SEA can be developed into an effective decision support tool:

— Conducting a preliminary audit on the adequacy of institutional arrangements for the preparation of the nuclear power programme and associated SEA;
— Conducting a preliminary audit on the capacity of both public and private sectors to prepare a nuclear power programme and associated SEA, and implement it;
— Verifying whether adequate resources (financial, temporal and human) are available to conduct a nuclear power programme SEA;
— Ascertaining whether there is sufficient political will to conduct a nuclear power programme SEA which can be used effectively in decision making;
— Ensuring that an effective communication and consultation strategy is in place for the SEA (in addition to the one for the nuclear power programme itself);
— Ensuring that decisions agreed on during SEA are binding with respect to ensuing decision making processes and implementation;
— Ensuring state of the art knowledge, methods and techniques are applied throughout the process;
— Ensuring that those preparing the nuclear power programme and the associated SEA are accountable;
— Ensuring that the SEA process is stakeholder driven, focused, iterative, flexible and adaptable;
— Ensuring the cost and time efficient generation of sufficient, reliable and usable information.

The main responsibility for ensuring the high quality of the SEA lies with those experts that are conducting it. Ultimately, the responsibility for ensuring the high quality of the SEA will, however, rest with the authority in charge of managing the SEA process. An external review can further contribute to achieving a high quality standard and also strengthen the credibility of the SEA with the stakeholders involved.

Table 6 summarizes specific components of SEA quality review, in addition to the overall criteria listed above, which are then explained in more detail in the following paragraphs. In order for quality assurance to work effectively, responsibilities need to be clearly defined. Thus, Table 6 also includes suggestions for quality review responsibilities. These need to be adjusted to individual national institutional frameworks.

Quality is closely associated with the focus and context of a nuclear power programme and the tiered decision making framework in which it is applied. This framework comprises interlinked levels, from the policy level down to the project level, and across policy areas to extend beyond energy (see Figs 2–5). In this context, clarity is required as to when and where different issues of nuclear energy development are to be addressed and how these refer to each other. This closely relates to the quality of the existing regulatory and institutional frameworks, and, within those, the roles that different administrations play. It further relates to the specific assessment tasks and types of impact to be considered at the levels of policies, plans and programmes, and at the project level [42].

At the level of energy and nuclear policies, questions on the design of the future energy system and its generation mix should be addressed. These will be inherently interdisciplinary, which means a large number of administrations will need to be involved. At the level of plans and programmes, the focus is on specific infrastructure requirements, based on the policy decisions taken. In this context, nuclear power programme SEAs mainly focus on the national and regional impacts of siting and technology issues. Objectives for the programme should be formulated accordingly and ensure sufficient space for the identification of alternatives (see Section 2.3.2). At the project level, EIA will assess impacts associated with a particular nuclear facility. The main focus, in this context,

TABLE 6. COMPONENTS OF SEA QUALITY REVIEW

Specific components of SEA quality review	Coverage and suggested responsibilities
Quality of the tiered decision making framework within which an SEA is applied and which it attempts to influence (see Fig. 5).	Coverage of 'why', 'what', 'how' and 'where' questions (e.g. the legislator may define what questions need to be answered at which administrative level).
Quality of the SEA process (see Table 7).	Coverage/comprehensiveness of all procedural stages (responsibility could lie with an authority in charge of programme approval/licensing).
Expertise and experience of those involved in conducting the SEA process and preparing the SEA report.	Qualification and ability should be explained in the main report (responsibility could lie with an environment ministry or agency).
Quality in the context of an SEA being a platform for open and fair debates (see also Table 12).	Debates conducted during the SEA process and reaction to these debates should be described in the main report (responsibility could lie with an authority in charge of programme approval/licensing).
Quality of the main SEA report (see Table 16).	Coverage/comprehensiveness with regard to legal and other requirements and comprehensible style (responsibility could lie with an environment authority).
Quality with regard to an ability to influence decisions (see Table 8).	Should be described in the main report (responsibility could lie with environment authorities and an authority in charge of programme approval/licensing).

should be on local impacts. The legislator is likely to play a key role in the allocation of assessment tasks to these different levels (i.e. policies, plans, programmes and projects).

An important task is to verify whether all relevant issues and tasks are adequately addressed. Table 7 provides an overview of important components to be considered in the quality review of the SEA process. This review is likely to be the responsibility of the environmental authority or any other body which is specifically in charge of SEA process quality assurance.

High quality is also essential when setting up the team of experts actively involved throughout the SEA process. This includes both those who conduct the SEA as well as any external assessors. By its very nature, SEA is an interdisciplinary task. This needs to be taken into account when setting up the teams involved, which should include experts from different disciplines and institutions. It is important that the key person in charge of this process be able to act as a moderator in the process and support an unbiased approach to SEA. This also includes ensuring that the SEA process is not dominated by a specific disciplinary approach. The expertise of those involved may be evaluated on the basis of criteria such as professional education and continuing professional development, but, most importantly, by their track record, demonstrating their practical experience with such interdisciplinary functions.

A checklist for the quality of SEA with regard to being a platform for open and fair debates is presented in Section 5 when discussing stakeholder engagement. Furthermore, a checklist for evaluating the nuclear power programme SEA report is presented in Section 7. With regard to SEA being able to influence decisions, Table 8 lists a number of quality elements.

TABLE 7. QUALITY OF THE SEA PROCESS

SEA stage	Important quality components
Screening	— Has screening been conducted according to specific national legal or other formal requirements and in reference to: • Inclusion and exclusion checklists? • Case specific considerations, based on the magnitude of the expected impact and sensitivity of the receiving environment? — Has case specific screening been conducted by a responsible environmental authority, with input from other key/interested stakeholders, if appropriate? — In case specific screening, has a short screening report been produced? — Has a clear screening decision been made by the responsible (environmental) authority, explaining that decision in the light of the available evidence?
Scoping	— Has scoping been formally conducted by the responsible (environmental) authority? In this context: • Have all relevant issues (i.e. the likely significant issues, impacts, technical and site options to be studied in detail — in line with the objectives of the programme) been scoped in? • Have all irrelevant issues been scoped out? • Have the appropriate temporal and spatial boundaries of the SEA been established? • Have the main stakeholders and their concerns and values been identified? — Has information necessary for the subsequent assessment been clearly established? — Has there been full stakeholder engagement and public participation during scoping and has this been clearly reported? — Has a scoping report been prepared, describing the results of scoping (e.g. using a scoping matrix), outlining the further stages of the SEA (including data requirements) and explaining how comments received were addressed?
Assessment	— Has the relevant baseline environment (i.e. those issues that were scoped in, including environmental problems and constraints) been described and has the information provided been used in the assessment? Or is an environmental baseline only presented without subsequently making any meaningful links with the actual assessment of impacts? — Have all relevant and realistic technical and site options (with respect to the predefined objective of the programme) and impacts been assessed with regard to their impact significance? — Have all relevant types of impact been considered in the SEA (direct, indirect, cumulative, short term and long term, synergistic, local, regional, global as well as residual)? — Have mitigation measures been clearly outlined? — Has an environmentally friendly and sustainable option been identified?
SEA report	— See Section 7.
Decision making	— Have the results of the SEA, as established in the SEA report, been explicitly considered in decision making? — Is the decision explained in the light of the findings of the SEA report? — Is the decision explained in the light of the comments from stakeholders and the general public?
Monitoring and wider follow-up	— Is there a published monitoring/follow-up action plan in place? — Are provisions formulated for compliance monitoring (i.e. with the consent decision)? — Are provisions formulated for conformance monitoring (i.e. whether actual impacts are in line with predictions)? — Are provisions formulated for performance management (i.e. is a plan for corrective action in place in the case that environmental impacts are significantly worse than predicted)? — Are mitigation measures considered in subsequent planning processes, such as EIA and project designs?

TABLE 8. QUALITY WITH REGARD TO BEING ABLE TO INFLUENCE DECISIONS

Influencing decision elements	Important quality components
Consideration of SEA results	Have decision makers justified their decisions in the light of the results of the SEA?
When, where and how has the SEA exerted influence	Has clear reference been made in the nuclear power programme to the SEA and have explanations been provided as to when, where and how it influenced it?
Post-decision management	Is there an obligation for establishing a (post-decision) management plan, following up on impacts and agreed actions?
Learning through SEA	In respect of the points made above, an important objective is to establish an SEA system which allows for knowledge acquisition through the SEA, the adjustment of the programme through the SEA and, potentially, also a change of behaviour. Has this been considered?

5. METHODOLOGY, PART 2: STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION

This section starts by focusing on the functions and effects of what will, subsequently, be termed 'adequate stakeholder engagement and public participation'. Thereafter, associated principles are explained (Section 5.2) before introducing associated methodologies and methods (Section 5.3). The section concludes by briefly outlining stakeholder and public grievance management frameworks and mechanisms (Section 5.4), and discusses the quality criteria for adequate and fair stakeholder engagement and public participation (Section 5.5).

5.1. FUNCTIONS AND EFFECTS OF ADEQUATE STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION

Benefits accruing from adequate stakeholder engagement and public participation in SEAs for nuclear power programmes are based on an enhanced quality of the decision making process. The main elements of adequate stakeholder engagement and public participation are:

— *Developing a common understanding:* To reach political decisions with all parties involved by being able to develop a common understanding of the matter. Authorities should understand social fears and concerns, and should aim to clarify complex technical questions and issues.
— *Developing mutual trust:* To build trust in public authorities by providing a forum in which any negative perceptions and emotions can be expressed and discussed.
— *Developing enhanced acceptance:* To enhance acceptance of public decisions and to allow development of an understanding for the reasons behind decisions.
— *Strengthening civil society:* To support the building of a civil society as well as to foster mutual respect between parties involved in the programming process.
— *Reconciling diverging views:* To aim at reconciling divergent viewpoints at an early stage while avoiding related delays at later stages in the implementation of the nuclear power programme.
— *Preparing a stakeholder engagement and public participation report:* To create transparency and to show how engagement influenced the programme making process and the associated SEA.

Adequate stakeholder engagement and public participation is critical for the successful implementation of nuclear power programmes because, if this is done well, it can help allay associated public concerns. Its key role is to facilitate interactions between nuclear power developers and various stakeholders during the SEA process and the development of the nuclear power programme. Engagement should allow all of the interested parties to disclose their expectations and fears, including their environmental worries and concerns for public health and

safety, protection of valued environmental heritage and transboundary impacts. The specific aims of stakeholder engagement and public participation include:

— Informing stakeholders and the general public about a proposed nuclear power programme and its SEA in order to raise public awareness on suggested objectives and interventions, and to encourage suggestions;
— Empowering stakeholders and the public by enabling them to actively engage in the processes of developing a nuclear power programme and associated SEA;
— Consulting stakeholders and the public, and gathering vital information on views, opinions and expertise regarding a proposed nuclear power programme and associated SEA;
— Attempting to build consensus with various stakeholder groups by ensuring that the public's aspirations, concerns and grievances are clearly understood and considered in the nuclear power programme and associated SEA processes;
— Negotiating and ensuring sustainable collaboration and partnership with relevant stakeholders in all aspects of the proposed nuclear power programme and associated SEA processes, including during the identification of alternatives and environmental mitigation options;
— Providing the public with an opportunity to contribute local knowledge.

Using suitable methods for engaging stakeholders and the public, and developing a clear understanding of their roles is, therefore, crucial. This includes individuals and governmental and non-governmental organizations, as well as private sector entities. In an SEA process, assessors may assume the role of moderators between different interests and act as facilitators of agreed objectives. In addition, those being consulted and invited to engage with the process need to be given sufficient time to read and comprehend all of the necessary documentation and to formulate responses.

Adequate stakeholder engagement and public participation may help resolve conflicts of interest by establishing the values of stakeholders and by taking them into account when evaluating options in the SEA. Ultimately, adequate engagement may engender an increase in public support for decisions made that are aligned with stakeholder and public expectations, preferences and knowledge. It can, thereby, reduce costs (not just to the environment but also to society and to developers) by leading to publicly acceptable solutions that help to avoid associated programming delays.

5.2. PRINCIPLES OF ADEQUATE STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION

Adequate stakeholder engagement and public participation in SEAs should respect a number of good governance principles. Besides an overall right to participate, this includes transparency and accountability of the programming process. The principles are detailed below:

— *Clear rules:* The nuclear power programme cannot be adopted before the SEA is concluded and the SEA cannot close before engagement is complete. The adopted SEA report should list the results of the engagement and explain how the points raised were addressed. Prior to any engagement, the rights of stakeholders and the public need to be clearly explained.
— *Early engagement and continuity of the engagement process:* Engagement should start early and be a planned and continuous process to ensure social acceptance. Those taking part in the engagement process have a right to receive a response to their concerns, both during the debate and in the form of documentation.
— *Comprehensiveness and inclusiveness:* Stakeholder engagement and public participation in SEAs need to address international, national, regional and local audiences. Engagement methods need to be adapted to reach representatives at each of these different levels; this includes, for example, the choice of language(s). Transparency is key and the conclusions collected at different levels and through different methods should be brought together in order to allow for a comprehensive assessment. All individuals wishing to take part in the stakeholder engagement should be allowed to do so and this process should embrace all interested groups of stakeholders and the public. In this context, efforts to engage groups perceived as disadvantaged or excluded are necessary.

— *Respect for the common good and interest:* Public interest in the environment, as well as in health, safety and overall values and beliefs should be fully respected. In this context, stakeholder engagement and public participation should take the interests of all into account, including those who have concerns as well as those who have positive attitudes towards nuclear power.
— *Integrity, openness and responsiveness:* Public authorities need to demonstrate integrity and should strive to ensure that the information presented to the stakeholders is true and that nothing has been kept hidden. This includes safety issues and risks, as well as uncertainties. Responsiveness and openness to concerns by stakeholders is a key ingredient of adequate stakeholder engagement and public participation.

The information presented in the SEA report needs to be reliable and should be prepared with due diligence. With this end in view, a quality review system for stakeholder engagement and public participation should be established. This may involve public review and should consider three principles: (i) the principle of documentation, (ii) the principle of third authority and (iii) the principle of optimization. These quality review principles are detailed below:

— *The principle of documentation:* It is important to document all phases of stakeholder engagement and public participation and to make this documentation publicly accessible. Methods for collecting and sharing documentation (e.g. public domains and printed reports) depend on the level of information and communication technology development in a country. Furthermore, the risk of information exclusion needs to be factored in.
— *The principle of third authority:* Even the best engagement process may not meet expectations if there is a lack of citizens' trust in the authorities preparing and implementing the nuclear power programme. It is, therefore, advisable to include collective entities as stakeholders, for example, NGOs as opinion leaders. An engagement group of opinion leaders may be established to voice opinions.
— *The principle of optimization:* The channels of communication employed in the engagement process should be adapted to the capabilities of the stakeholders and the public. Poorly chosen engagement channels can be equated to a lack of transparency in the process.

5.3. STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION PLANNING AND ASSOCIATED METHODS

Stakeholder engagement and public participation as an open platform for debate and information exchange is an advanced method of communication between authorities responsible for preparing programmes and others. When conducting an SEA, authorities should have a clear understanding of what they require from the engagement process. Stakeholder engagement and public participation should allow for any problems, weaknesses and threats, as well as opportunities and benefits, to be identified. Furthermore, it should also establish an indication of the proportion of stakeholders and the general public that think about the identified issues in a certain way.

Stakeholder mapping can be a particularly useful tool, and involves the identification of stakeholders based on their potential influence, attitude, position, background knowledge and interest in contributing to the SEA process. On the basis of such stakeholder mapping, the engagement methods and type of communication will need to be chosen to best engage with the various stakeholder groups (Table 9).

Table 10 provides practical examples for different stakeholder groups.

To ensure that stakeholder engagement and public participation is both adequate and effective, an engagement plan and communication strategy should be developed. This should include the following:

— Clear objectives for the engagement process;
— A comprehensive and transparent package of nuclear power programme information to be used during the engagement process;
— A comprehensive stakeholder analysis and mapping strategy for identification and clustering of various stakeholder groups, for example, as primary or directly affected stakeholders, secondary or indirectly affected stakeholders, elected representatives, institutional stakeholders, vulnerable groups, environmental groups, civil society and transboundary stakeholders;

— A description of engagement activities (e.g. house to house surveys, one on one interviews, public meetings, focus groups, dialogue workshops, referendums) and communication tools (e.g. leaflets, questionnaires);
— An outline of engagement venues, other related requirements and a timetable.

Effectiveness of engagement is determined by the selection of suitable methods and channels. These need to be adjusted to the subject of consultation (i.e. what is being addressed in the SEA) and to the various stakeholders, including who they are as well as their position and interests.

Table 11 introduces guidelines for choosing the category of engagement method for different levels of engagement and stakeholder groups. In Table 11, these groups are divided according to three main geographical levels: international, national and regional/local. If need be, additional sectoral and regional levels can be established, depending on the specific planning traditions in a particular country. For additional guidance regarding transboundary consultation processes, article 10 of the UNECE Protocol on SEA [5] should be referred to.

Although this publication contains overall guidelines for stakeholder engagement and public participation, any specific SEA situation requires the design of a custom made engagement approach.

For further guidance, reference should be made to the Good Practice Recommendations on Public Participation in Strategic Environmental Assessment [43] and the Maastricht Recommendations on Promoting Effective Public Participation in Decision-making in Environmental Matters [44]. These were prepared under the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (also known as the Aarhus Convention) [45].

TABLE 9. CATEGORIES OF POSSIBLE ENGAGEMENT METHODS

Category	Engagement method
1	*Information:* Passive communication involving the sharing of information with stakeholders and the public (e.g. through mass media).
2	*Consultation:* Collection of feedback from stakeholders and the public on the nuclear power programme.
3	*Engagement:* Direct dialogue with stakeholders and the public, aimed at gathering opinions, observations and comments. This should involve a transparent communication of action that authorities intend to take in response.
4	*Cooperation:* Top level of participation, resulting in co-creation of the nuclear power programme report and the SEA.

TABLE 10. POSSIBLE ENGAGEMENT METHODS FOR DIFFERENT STAKEHOLDER GROUPS

Stakeholder group	Engagement method
The public, in general, and, specifically, local communities, including vulnerable groups and indigenous peoples	Print, mass and social media, including newspapers, radio broadcasts and Internet web site, SMS, emails, voice messages, public and focus group meetings, information centres
Institutional stakeholders (e.g. environmental and health authorities)	One on one interviews, dialogue meetings
Environmental groups	Dialogue workshop, focus group meetings, Internet web site, emails
Private sector and business community	Dialogue workshop, focus group meetings, emails
Transboundary stakeholders	Internet web site, emails, one on one interviews, transboundary public hearings

TABLE 11. METHODS FOR STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION IN DIFFERENT SITUATIONS

Description (in practice, this requires case specific stakeholder mapping)	Possible interest[a]	Possible impact[a]	Possible communication methods and action examples[b]
International level			
Authorities of other potentially affected countries: this includes any (direct or indirect) neighbouring countries and associated SEAs (both for land and maritime borders).	?	?	1–4: Bilateral meetings, documentation exchange
International institutions: bodies that issue opinions on compliance with existing international instruments (for European Union Member States, for example, this would include European Union bodies and institutions).	?	?	1 and 2: Meetings, documentation exchange, official notifications if required
Multilateral organizations such as the IAEA: this includes organizations with an advisory capacity in the implementation of the nuclear power programme and which provide guidance on regulations and safety standards.	?	?	1 and 2: Meetings, documentation exchange, requests for opinions
Foreign or international environmental organizations: this includes numerous political advocacy organizations and associations, representing the interest of the general public and activists that defend the rights of third parties, protect the environment and others.	?	?	1–3: Meetings, press releases, media appearances, submitting documentation
Mass media: this includes, for example, journalists whose media activity may have an impact on the image of the nuclear power programme and the SEA internationally, representing foreign or international newspapers and magazines covering economic or nuclear power issues.	?	?	1 and 2: Submitting briefs and data, information exchange, popular science publications, interviews with experts
Potential suppliers of equipment and services: this includes advanced technology developers and suppliers of the most important equipment, for example nuclear reactors (these may be chiefly foreign).	?	?	1–4: Technical talks, meetings
Potential investors, shareholders, financing institutions: institutions that may be interested in funding the nuclear power programme.	?	?	1–4: Technical talks, meetings
Society at the international level.	?	?	1 and 2: Information sharing through mass media and engagement with non-governmental organizations, preparation of information in a format typical of popular science

TABLE 11. METHODS FOR STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION IN DIFFERENT SITUATIONS (cont.)

Description (in practice, this requires case specific stakeholder mapping)	Possible interest[a]	Possible impact[a]	Possible communication methods and action examples[b]
National level			
Government and administrative bodies of the country concerned.	?	?	1–4: Press conferences, bilateral and multilateral meetings, including representatives at regional/local level
Environmental organizations: this includes numerous political advocacy organizations and associations representing the interests of citizens and/or activists defending the rights of third parties, protecting the environment, etc.	?	?	1–4: Meetings, press releases, media appearances, submitting documentation, public hearings
Research, scientific and educational institutions: this includes institutions that provide research and education services in the area of nuclear power.	?	?	1 and 2: Information exchange, public requests for submitting opinion (written or electronic consultation forms, polls, surveys)
Mass media: these can influence the programme by communicating information about it as well as on the attitude of the public, threats and opportunities.	?	?	1 and 2: Submitting briefs and data, information exchange, popular science publications, interviews with experts
Society at the national level: individuals or informal associations.	?	?	1–3: Information sharing through mass media and engagement with non-governmental organizations, preparation of information in a format typical of popular science, inviting them to comment on the formal SEA procedure, quantitative surveys, full surveys (e.g. a referendum)

TABLE 11. METHODS FOR STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION IN DIFFERENT SITUATIONS (cont.)

Description (in practice, this requires case specific stakeholder mapping)	Possible interest[a]	Possible impact[a]	Possible communication methods and action examples[b]
Regional/local level, addressed when dealing with specific siting options			
Local authorities: operating in the area where the project can be carried out or its effects can occur.	?	?	1–4: Bilateral/multilateral meetings, cooperation with experts, inclusion in focus groups, expert and popular science information, collective projects (civic workshops, conferences)
Local environmental organizations: including non-governmental organizations operating at the local/ regional level; their likely involvement in the SEA will result from their desire to protect the environment or from their opposition to nuclear power. Also included are associations representing the interest of citizens, environmentalists, or activists defending the rights of third parties, protecting the environment, etc.	?	?	1–4: Meetings, press releases, media appearances, submitting documentation, projects (civic workshops and conferences)
Mass media: can influence the SEA by communicating information about it as well as on the attitude of the public, threats and opportunities.	?	?	1 and 2: Submitting briefs and data, information exchange, popular science publications, interviews with experts, collective projects (civic workshops, conferences)
Social, cultural and educational institutions: this includes entities distinct from environmental non-governmental organizations, including institutions that operate in the area of the project's location and which may have an impact on it through influencing public opinion.	?	?	1–3: Meetings, press releases, media appearances, submitting documentation, collective projects (civic workshops, conferences)
Religious groups: separate legal entities classified as stakeholders because of their capacity to influence public opinion and which, thus, may have an impact on the nuclear power programme.	?	?	1–3: Meetings, press releases, media appearances, submitting documentation
Local community: this consists of local residents and, if applicable, minorities or indigenous communities. It combines persons of different professions, qualification and level of skill/ competence who are influenced (directly or indirectly) by the nuclear power programme and adopt different positions on it. They can become associated and voice their opposition in a non-formal manner (protest committees, demonstrations, pickets and others).	?	?	1–3: Meetings, conferences, press releases, media appearances, submitting documentation

[a] Expressed as 'high', 'moderate' or 'low', depending on the outcome of the stakeholder analysis.
[b] Numbers refer to the categories of engagement listed in Table 9.

TABLE 12. QUALITY OF SEA AS A PLATFORM FOR OPEN AND FAIR DEBATES

Element	Associated evaluation criteria
To achieve a high level of awareness of a nuclear power programme preparation process and SEA	— Information on intentions and plans is published widely in a range of different media, including written and broadcast media at different levels (e.g. national, regional, local), and dedicated spaces on the Internet.
To provide for adequate opportunities for open and fair debates at key stages of the process	— Physical meetings (which may be streamed on-line) and virtual meetings are held, at least at the scoping and reporting stages of the SEA.
To ensure accessible locations of venues for (public) debates and public hearings	— Those wanting to participate are able to reach the location, not just by private transport, but also by public transport, at a reasonable cost and within a reasonable amount of time.
To secure moderation	— Unbiased and skilled moderators are employed in debates and act according to strict rules for open and fair debates.
To set clear rules for debates	— Debates are first contextualized, resolving any unclear points; — The moderated debates are based on objective and unbiased arguments, not intimidation; — Arguments are checked for validity and truthfulness.
To engage in conflict reduction strategies	— Areas of conflict are identified in an unbiased manner; — Open and fair discussion on areas of conflict is encouraged and all those interested and potentially affected are given the opportunity to actively engage in these discussions.
To create an environment of trust	— Transparency is ensured throughout all stages of the nuclear power programme and associated SEA processes; — Integrity is established and maintained; — Visions, aims and objectives are clearly communicated, as well as underlying values; — All those contributing to debates are given equal status; — The focus is on shared, not personal issues; — Information is not withheld; — A consistent argument and approach is pursued.
To ensure the safety of those gathering and contributing to debates	— An environment is created in which people feel free to speak their mind without fear of intimidation or harassment; — Adequate security measures are in place at meetings; — Strict moderation rules are applied on any dedicated social media discussion groups.
To ensure transparency	— Written records of all engagement activities are provided; — A stakeholder engagement report is prepared.

5.4. GRIEVANCE MANAGEMENT

Stakeholder engagement and public participation should be positioned within existing frameworks for related grievance management. The framework should describe the process by which people affected by the nuclear power programme can convey their grievances for consideration and possible redress. This should include: (i) information on the procedures to follow to lodge a grievance, ideally published on information boards and on the web sites of local authorities, and (ii) grievance resolution protocols and time frames. The framework should cover both the development phase of the nuclear power programme with its SEA and the subsequent implementation phase of the programme. Furthermore, a mechanism should be in place to ensure responsiveness to any concerns and complaints, particularly from affected stakeholders and communities. The SEA should verify that such a grievance management framework is in place, ascertain that it is functional and initiate improvements, as necessary.

5.5. QUALITY CRITERIA FOR SEA BEING A PLATFORM OF OPEN AND FAIR DEBATES

Table 12 introduces elements of open and fair debates, and associated criteria. These can be used when evaluating the quality of an SEA with regard to this specific component of the SEA application.

6. METHODOLOGY, PART 3: ASSESSMENT METHODS AND DATA REQUIREMENTS

There are a number of methods that will be useful for supporting the assessment work performed during an SEA. While the use of specific methods in SEAs is often left to the discretion of practitioners, at times they are prescribed in regulation or suggested by guidelines (see, for example, Refs [40, 46–48]). When choosing methods, it is important to select those that are suitable for a specific situation and for which the necessary data are available. Furthermore, those methods that are chosen should allow for a logical organization of information in the SEA and enhance understanding of the issues at stake. In this context, simple and transparent methods (e.g. checklists) facilitate wider communication. A combination of methods should be used to highlight different issues from various perspectives. The outcome of one particular method should never be seen as the outcome of an SEA overall. Methods are applied to inform the SEA process, not to replace it. In this section, an outline of selected methods (Section 6.1) as well as associated challenges (Section 6.2) are presented, before a discussion on the applicability of these methods at different procedural stages of the SEA (Section 6.3).

6.1. OUTLINE OF SELECTED METHODS

A selection of 11 methods that may be useful for SEAs of nuclear power programmes are listed below:

(1) Literature and document reviews and analogues;
(2) Checklists;
(3) Indicators;
(4) Matrices;
(5) Networks;
(6) Multi-criteria analysis;
(7) Environmental cost–benefit analysis;
(8) Risk assessment;
(9) Overlay mapping;
(10) Expert opinion;
(11) Modelling and scenario analysis.

Although a comprehensive description of each of these methods is beyond the scope of these guidelines, outlines for them are provided. It is acknowledged that these methods are also common for EIAs. However, when used for SEA at the programme making level, they will be applied more strategically, which is likely to mean information provided will be less detailed and uncertainty will be higher.

6.1.1. Literature and document reviews and analogues

Literature review is concerned with the collection of information on specific types of action and their impacts, and is usually a starting point for identifying subsequent assessment needs and applicable methods. It may include reviews of the professional literature and of documents previously prepared in similar situations. It provides an overview of experience gained elsewhere from similar actions (including those from other jurisdictions, countries or regions). It is also frequently referred to as ‘analogues’ or ‘precedents’.

Analogues can be used in SEAs at different procedural stages, for example during impact identification (i.e. in screening and scoping), as well as for impact prediction and assessment (i.e. during the main assessment stage). Literature reviews may be particularly useful in identifying linkages between different aspects of the nuclear power programme and their environmental impacts. Observed impacts are taken as the basis for making judgements in a particular SEA. In this context, when referring to other practice cases, actual monitoring data should be the basis for providing a sound analogy to the possible impacts of a proposed development.

6.1.2. Checklists

Within SEA checklists, lists of environmental parameters are often used to check for possible impacts of proposed developments. The potential benefits of using checklists include:

— Applying a simple method for identifying relevant environmental issues for consideration in the SEA;
— Encouraging discussions on environmental issues to be considered in SEAs at an early stage;
— Representing the collective knowledge and judgement of those developing and completing the lists of environmental issues.

A simple method, such as a checklist, has limitations on what it can deliver. For example, checklists are not able to discover interdependencies or synergies between interacting environmental issues. In addition, they are not able to describe variations in environmental conditions. Finally, they do not readily provide information on specific data needs.

6.1.3. Indicators

Indicators comprise selected features or parameters of environmental issues, representing a broader measure of their quality or quantity. They may specifically refer to either numerical or categorized information which can be used to describe the behaviour of the baseline parameters and for predicting and assessing the environmental impacts. When used in an SEA for a nuclear power programme, indicators should represent the environmental impact themes introduced earlier in these guidelines (see Section 3.3). Only a limited number of indicators should be used (ideally below ten) and indicators should combine certain important issues in a meaningful way. For example, all climate change related emissions and actions should be combined in one ‘climate change’ indicator.

6.1.4. Matrices

A matrix may take the form of a two dimensional table for cross-referencing a list of actions with environmental impact parameters. Activities associated with different phases of nuclear power development can be listed along one axis (e.g. nuclear power programme impact areas), with environmental components listed along the other axis. Inputs into a matrix can either be qualitative or quantitative. Matrices may simply state the occurrence of an impact or focus on impact magnitude and significance. Quantitative estimates can be weighted, leading to overall ‘impact scores’. Matrices allow for a visual description of the relationship between different proposals being assessed, as well as for an identification of the impacts of different phases of a project. Figure 13 shows a simple impact matrix that can be used in SEAs for nuclear power programmes.

6.1.5. Networks

Networks are used to identify the structure, key elements and interactions in a given system by using aids, such as decision flow charts and loop analysis. A network diagram visually describes cause–effect chains (see Fig. 14). In this context, different levels of information can be displayed. The relative dependence of one factor on the condition of another may be indicated by various arrow widths and heights. Negative and positive feedback loops can also be identified, if the nature of the interrelationship is indicated.

	Different categories of sites				
Environmental impact themes	A	B	C	D	E
Ground, air, water, soil	+	+/-	…	…	…
Natural hazards	+/-	-	…	…	…
Land use, landscape, cultural heritage	++	-	…	…	…
Radiological emissions	+	+	…	…	…
Non-radio. emissions, noise, vibration	-	--	…	…	…
Ecosystems	+	-	…	…	…
Climate change	+	+	…	…	…
Economy	-	++	…	…	…
Health and safety	+	-	…	…	…

++ = impact positive; + = no conflict; +/- = could go either way; - = conflict / negative impact;
-- = significant negative impact of a high magnitude

FIG. 13. Simple impact matrix.

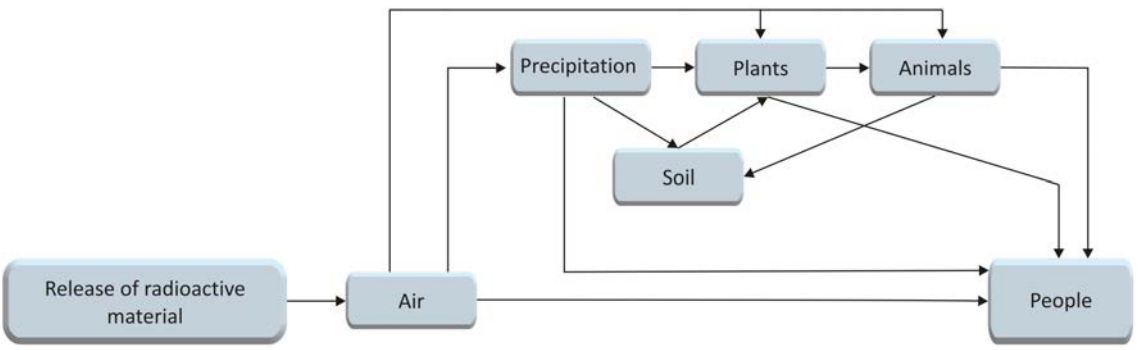


FIG. 14. Network showing potential paths following the release of radioactive material.

6.1.6. Multi-criteria analysis

Multi-criteria analysis, or multi-criteria decision analysis, is used to select the best option for achieving set targets or goals for a number of environmental (and potentially other) criteria. It is based on identifying positive or negative weights for criteria used for selecting between different options. Figure 15 shows the principle of multi-criteria analysis for SEAs for nuclear power programmes.

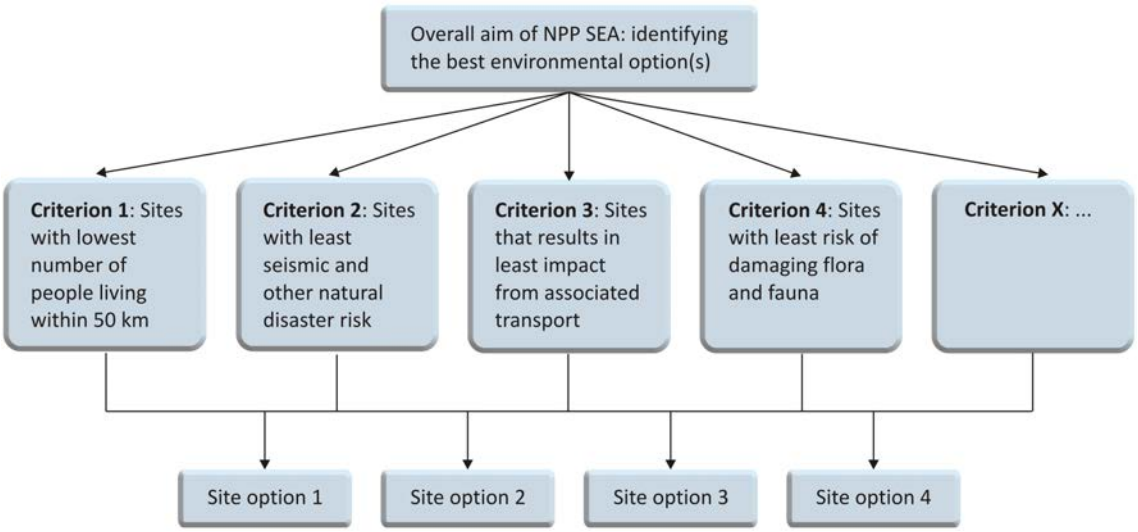
6.1.7. Environmental cost–benefit analysis

Environmental cost–benefit analysis aims at comparing the expected benefits of a nuclear power programme in monetary terms with the costs associated with its development. Cost–benefit analysis is commonly demanded in any investment decision making. Therefore, addressing cost aspects within the SEA has the advantage of being able to ensure a balanced approach by adequately addressing environmental aspects that may otherwise be omitted. Cost–benefit analysis works similarly to multi-criteria analysis, with the main difference being that results are expressed in monetary values rather than numbers. As with multi-criteria analysis, cost–benefit analysis is best used when comparing options with a number of environmental (and potentially other) criteria that are expressed in monetary terms or in terms of quantifiable indicators. This is difficult, as it is often not straightforward to clearly quantify environmental damage, such as that due to emissions or noise, and its impact on humans and wildlife. Problems in this context are similar to those associated with establishing ecosystem services.

6.1.8. Risk assessment

Risk assessment evaluates the potential risks of proposed actions. In the context of an SEA for a nuclear power programme, a risk assessment focuses on assessing the strategic risks of different site and associated technology options. Development trends that may undermine the objectives and quality standards of a nuclear power programme, thus generating potentially relevant damage and attendant costs, need to be included (e.g. a change in the political landscape or climate change). A risk assessment, in its simplest form, consists of a number of simple procedural steps, as follows:

— To identify risk factors (threats, vulnerability);
— To identify who or what could be harmed;
— To evaluate risks;



Note: Weights will usually be allocated to criteria depending on priorities (e.g. criterion 1 = 0.5; criterion 2 = 0.2, etc.); this will follow on from national policy and needs to be done in a transparent manner.

FIG. 15. Principle of multi-criteria analysis for SEAs for nuclear power programmes.

— To record risks and to devise risk management processes;
— To make a decision;
— To monitor and review.

A central element of a risk assessment can be an assessment matrix in which the severity of a risk (ranging from negligible to catastrophic) is compared with its probability (ranging from improbable to very high). A very high risk paired with potentially catastrophic outcomes would be something to be avoided, while negligible improbable risk outcomes would be sought. A risk assessment should result in a risk management process for the chosen SEA option.

6.1.9. Overlay mapping

Overlay mapping (through a geographic information system) is normally used to identify areas that are compatible with a proposed action. This technique is based on sets of maps of the affected area depicting environmental characteristics or themes (biophysical, social, aesthetic, or institutional performance indices such as level of corruption or budget execution) together with the effects of a nuclear power programme. When they are overlayed, the resulting maps provide for a composite characterization of impacts on a regional or local environment, based on map algebra. Impacts can be identified by noting the affected environmental characteristics within the boundary area of a nuclear power programme.

There are some limitations to using this method, including a tendency of maps to oversimplify issues. Furthermore, interrelationships between different environmental issues are not necessarily readily obtainable using traditional map overlays, which also cannot effectively describe changing dynamics (e.g. from ecosystems) over time. However, when used to compare different options on the basis of a defined set of environmental components, overlay maps can produce useful results. Figure 16 shows a simple overlay mapping example. Here, a corridor that would be assigned the lowest possible environmental impact is identified on the basis of a simple overlay of habitats, water bodies and areas of cultural interest. This could be useful, for example, when investigating suitable areas for new electricity transmission lines.

6.1.10. Expert opinion

Opinions and perspectives from recognized experts in relevant fields are often used in an attempt to resolve complex situations within relatively short time periods. In this context, consultations or workshops may be used. Consultations are frequently conducted with the help of questionnaires or guided interviews. Workshops may include structured meetings, for example, with a focus on problem solving and identifying alternatives or mitigation options, as well as prioritization exercises through Delphi exercises (i.e. facilitated, iterative rounds of expert discussions).

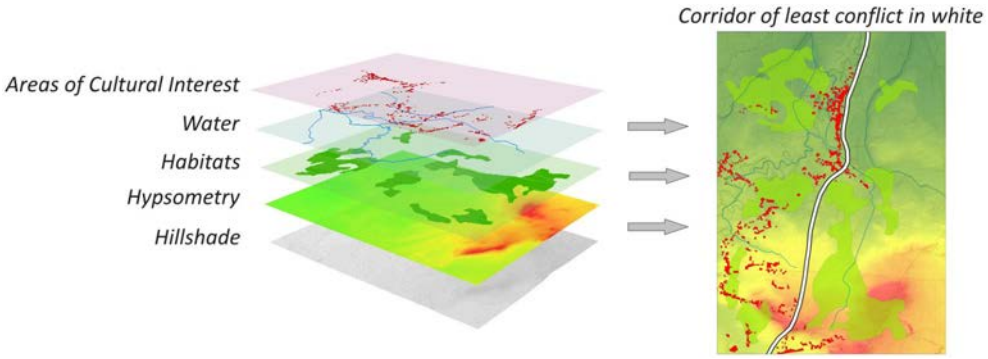


FIG. 16. Example of overlay mapping.

6.1.11. Modelling and scenario analysis

Both qualitative and quantitative modelling are commonly applied in SEA. The former refers to descriptive methods used to assess changes to the environmental components considered in SEA. It is a method usually based on expert opinion (i.e. professional judgement which is derived from experience). For example, an ecologist may reliably predict the impacts of infrastructure on a biotope, based on observation from other similar cases.

Quantitative modelling is based on the use of mathematical models that are applied for assessing expected changes to environmental components. They range from simple to very complex models (e.g. three dimensional computer based models) that may require extensive data input. In most cases, models are used for the description or prediction of changes in properties of the system over a time period. Quantitative modelling is most effective when environmental factors are easily quantifiable and can, thus, be easily integrated.

Examples of quantitative IAEA models[15] include the Model for Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE) and the Wien Automatic System Planning Package (WASP), both of which are used to assess energy and power system developments and aggregated emissions. SIMPACTS is used for assessing the geographical dispersion of emissions from a single (nuclear power) plant as well as the associated health implications.

These models are usually used for scenario analysis, which allows dealing with the numerous uncertainties involved when investigating potential environmental impacts decades into the future. Scenarios are usually set up to test hypotheses regarding socioeconomic, environmental and technological pathways. For example, they may include assumptions regarding the development of public acceptance towards nuclear energy, prices of alternative fuels and electricity market prices, climate change and operational requirements (e.g. owing to the variability introduced by increasing shares of renewables), together with shorter term assumptions regarding investment costs and construction time. Scenarios serve to combine these assumptions within a consistent framework. They are also sometimes referred to as ‘what if’ analysis (i.e. what would happen if a certain future scenario were to evolve). Usually, a number of scenarios are set up to best cover the range of uncertainties involved.

6.2. CHALLENGES OF SEA METHODS AND DATA REQUIREMENTS

While all methods introduced in this section can be useful in an SEA for nuclear power programmes, all have certain drawbacks in their application, as summarized in Table 13.

The more in-depth methods, in particular, are usually data intensive, and data gaps often constitute a limit to their applicability and, therefore, their robustness for decision making. In this context, methods and data may mutually influence each other. Sometimes, the absence of key data will result in the omission of a certain method; sometimes the benefits of a certain method will result in efforts to fill data gaps in one way or another. In addition to data gaps, the quality, reliability or accessibility of data may also be of concern.

As data gaps often occur, strategies to deal with them need to be formulated. In this context, it is important to identify the significance of data for the actual purpose of the assessment and to aim at addressing the identified gap accordingly. This may range from changing the method to delaying its application until data become available, from literature reviews and analogues to expert judgement (e.g. based on a stakeholder engagement process (see Section 5)), as well as additional analysis to generate data of a sufficiently high quality. The collection of primary data is likely to be out of the scope of most SEAs.

Whatever strategy is chosen, for the sake of transparency, it is important to record any data issues, such as unreliable data or assumptions used to fill data gaps, and to note their implications for the SEA in the SEA report (see Section 7). This may also include recommendations on how to proceed once currently missing data become available.

[15] https://www.iaea.org/topics/energy-planning/energy-modelling-tools

TABLE 13. DRAWBACKS OF SEA METHODS FOR NUCLEAR POWER PROGRAMMES

Method	Challenges
Literature and document reviews and analogues	— While different contexts may appear superficially similar and comparable, they may actually be quite different in reality; — What is presented in the older literature may be outdated; — Application may result in a simplistic approach that is not adjusted to the actual circumstances.
Checklists	— Certain issues and components may be difficult to put into a checklist; — Spatial information may not be integrated well; — Strategic issues may come with a considerable degree of uncertainty and more flexibility may be required than checklists can provide.
Indicators	— Depending on how indicators are designed, positives and negatives may cancel each other out; — Too many indicators may confuse rather than facilitate understanding; — Too few indicators may lead to an overly simplistic approach; — Unreliable or missing data may lead to misleading indicators.
Matrices	— Can lead to overly simplistic conclusions; — Can be repetitive and time consuming; — Different issues covered in matrices can come with very different units, data requirements and reliability.
Networks	— Can be inflexible when presenting problems; — Can be insufficiently multi-dimensional.
Multi-criteria analysis	— Can lead to an overly simplistic result (e.g. to one number); — Should only be used in comparative ways (e.g. when assessing different options) but never in absolute terms.
Environmental cost–benefit analysis	— Can lead to an overly simplistic result (e.g. to one monetary value); — Should only be used in comparative ways (e.g. when assessing different options); — Difficulties in allocating monetary values to environmental impacts, such as on ecosystem services.
Risk assessment	— Can be resource consuming and time consuming; — Can be overly mathematical.
Overlay mapping	— Often requires a large amount of spatial data that may not be available; — Only allows for spatial problems to be assessed; — Requires up to date and reliable data.
Expert opinion	— Experts may draw conclusions from past experience that do not apply to actual circumstances; — People may mistrust experts; — Experts may not have a specific or broad enough expertise to reliably judge a situation.
Modelling and scenario analysis	— Can be a ‘black box’ that is difficult to judge, even by external experts; — Is usually based on numerous assumptions, giving the modeller considerable control over the actual results of the model; — Can lead to overly simplistic results; — Can be incomprehensible to the general public; — One ‘wrong’ parameter can lead to a ‘wrong’ result.

TABLE 14. USE OF METHODS AT DIFFERENT PROCEDURAL STAGES OF THE SEA

	Screening	Scoping	Assessment	SEA report	Decision making	Monitoring and wider follow-up
Analogues	✓	✓	✓	✓		
Checklists	✓	✓	✓	✓	✓	✓
Indicators	✓	✓	✓		✓	✓
Matrices	✓	✓	✓		✓	
Networks	✓	✓	✓			
Multi-criteria analysis			✓		✓	
Cost–benefit analysis			✓		✓	
Risk assessment			✓			
Overlay mapping			✓			
Expert opinion	✓	✓	✓	✓	✓	✓
Modelling			✓			

6.3. USE OF METHODS AT DIFFERENT PROCEDURAL STAGES OF SEA

While methods introduced in this section can be applied at different stages of an SEA process, certain methods are particularly useful for certain stages. What is important when choosing methods in any particular situation is to have a clear understanding of what the method is supposed to achieve (i.e. of its underlying dynamics and objectives) and also its data requirements. Another criterion for selecting a method is its suitability for the type of stakeholder that it should inform. Overly complicated or overly simplistic methods and associated results may unduly influence and, in a worst case scenario, manipulate those using the outcomes.

It is important to consider that no method is perfect and that data availability may also be an issue. The choice of methods should, therefore, be approached with regard to what is the most reasonable option. Furthermore, SEAs should never rely on one method only but should highlight issues and problems from various angles, using a range of methods. Useful methods in SEAs should lead to transparency and should not obscure the issues under consideration. Table 14 provides a simple overview of the stages at which methods are normally used and those for which they are particularly useful.

7. SEA REPORT

The main purpose of the SEA report for a nuclear power programme is to illustrate the main aspects considered during the assessment process and to summarize and communicate the agreements reached, concerns raised, outcomes obtained and recommendations given. As a rule, the report should be written in simple and comprehensible language, so that both experts and lay people can understand it. This is of key importance, as transparency is a rationale for conducting the SEA in the first place.

Furthermore, it is important that the different sections of the report have the appropriate length and that no section is either over emphasized or overlooked. For example, the general characteristics of nuclear power technologies should only be covered to the extent to which this is meaningful for an SEA. Otherwise, attention may be drawn away from the environmental and related sustainability issues. However, to ensure clarity about the assumptions made for assessing environmental impacts, further technical detail should be accessible and referred to, for example, in an annex to the SEA report, or in the document proposing the nuclear power programme.

On the basis of best practice, an SEA report dealing with such a complex matter as a nuclear power programme should be comprehensive and have no more than 500 pages, excluding any annexes, with an additional non-technical summary of no more than 10 pages.

The report should be prepared without bias, given the various and often divergent views of stakeholders. In this context, it is important to note that it should not be written in a defensive style, for example, when reacting to stakeholder criticism, as this may lead to the impression that the authors of the report were not entirely open to external suggestions.

With regard to a balanced report, Fig. 17 provides an indicative overview of the emphasis of each of its parts. The actual shares will need to be adjusted to best address the given circumstances.

This section first presents the main parts and the overall structure of an SEA report before providing guidance regarding its quality review in Section 7.2.

7.1. MAIN SECTIONS OF THE SEA REPORT

The SEA report is the main document used by all stakeholders regarding the environmental impacts of a nuclear power programme. It is also the main basis for keeping track of the measures agreed upon during implementation of the nuclear power programme, as well as during monitoring and follow-up. The different sections of an SEA report are introduced in this section, including the non-technical summary; introduction and background; nuclear power programme; SEA approach; environmental status/baseline; environmental assessment; stakeholder engagement and public participation; monitoring, evaluation and follow-up recommendations; as well as conclusions and recommendations, including next steps. Reflecting these constituent parts, an overview of the structure of an SEA report is provided in Box 3.

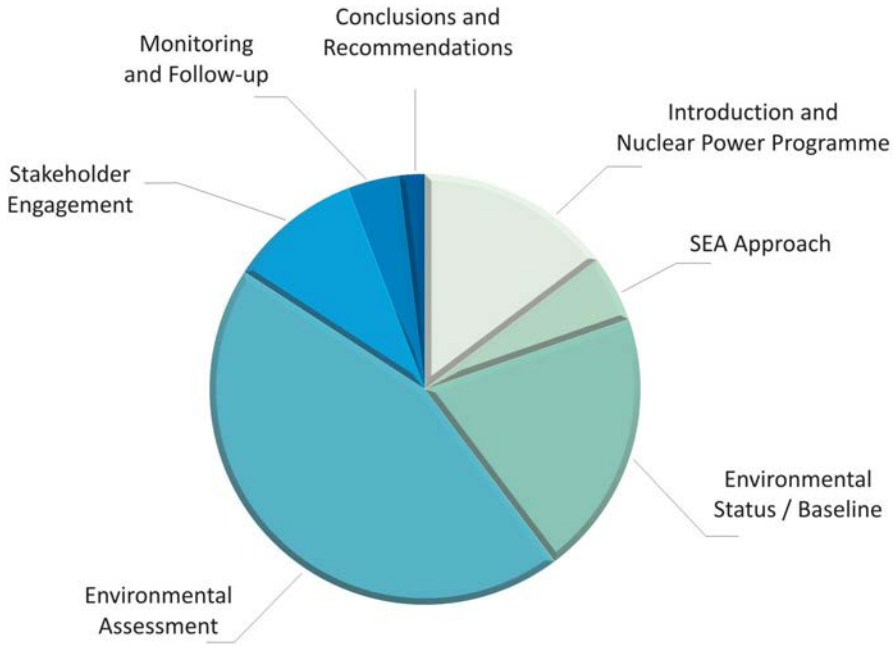


FIG. 17. Suggested approximate composition of an SEA report (excluding annexes).

7.1.1. Non-technical summary

The SEA report should start with a non-technical summary of the main aspects resulting from the SEA process. This should highlight the most relevant environmental and social considerations, and impacts identified during the consultation process. It should explain the resulting adjustments and mitigation measures for the preferred option arising from the SEA process and how SEA considerations have been reflected in the nuclear power programme.

The main features of the nuclear power programme and the findings of the SEA process should also be presented. These include the objectives of the nuclear power programme and the main criteria used during the screening and scoping phases to decide on why it should be subject to an SEA. The summary should also explain the benefits of an SEA, the requirements to undertake it in terms of legal frameworks, and the role of institutions, as well as the boundaries of the assessment itself.

The status of the environment and its development without the nuclear power programme (baseline) will be summarized with respect to environmental aspects having a significant potential to be affected, followed by the key findings of the assessment. Special consideration should be given to the main points raised during consultation. The summary should make reference to any quality review processes used during the SEA process (see Section 7.2). Furthermore, it should contain the main recommendations for monitoring, follow-up and the evaluation of the implementation of the key measures identified during the SEA process.

7.1.2. Introduction and background

This section lists and summarizes the energy policy and planning documents relevant to the nuclear power programme that were considered and analysed in the assessment. It positions the programme within this space, including relevant higher level decisions made previously. This section should also include reference to other, non-nuclear, yet relevant policies, plans and programmes, and associated SEAs (see Figs 2–5). This should include overall energy sector policies, in which nuclear energy has been identified as one of the preferred options. The SEA for the nuclear power programme either needs to be in line with the findings of such documents, such as the energy sector SEA, or, if it deviates from them, it should explain what has changed and the reason why.

7.1.3. Nuclear power programme

The SEA report needs to include a description of the nuclear power programme, its objectives and how it is meant contribute to the country's overall sustainable development objectives. This includes environmental objectives to ensure coherence with the country's environmental policies, regulations and multilateral agreements.

Furthermore, the report should describe the main aspects of the programme and the options considered when devising it, and what role the SEA played in this context, including issues such as potentially suitable sites and technologies. The implementation plans should also be explained. A very important part of this section is a brief explanation of how and why the selected nuclear power programme options were chosen. In this context, it is assumed that detailed information on technical aspects of the options assessed is provided in an annex or in the document proposing the nuclear power programme.

7.1.4. SEA approach

The SEA report should present a summary of the objectives of the SEA, including those of international and national legal and regulatory frameworks affecting the SEA for the nuclear power programme, and how these relate to the environmental and social priorities of other policies, plans, programmes and projects. The report should also describe how the processes used in developing the SEA, the nuclear power programme and any related decision making were linked and coordinated.

The SEA approach should describe the scope of the work and its boundaries, and introduce the methodology used (i.e. the assessment process followed and the methods applied) in undertaking the SEA as well as the options identified and analysed. Describing the scope of the work and its boundaries is especially important to clearly point out what was subject to this SEA and what was not. To support the related decisions taken, the SEA report should contain the scoping report (see Section 4.3) in an annex, signed by the relevant stakeholders that participated in

the SEA process. This is important, as a scoping report will contain the endorsement, with respect to the coverage (scope) of the SEA, of the representatives of the public and of the main stakeholders.

Furthermore, when describing the SEA approach, the quality review process of the SEA should also be explained. Quality review tables should be attached in an annex.

7.1.5. Environmental status/baseline

The SEA report should summarize the current status of those environmental aspects that could potentially be affected in a significant manner by the activities of the nuclear power programme and their likely evolution without it. Among these aspects, the report should present the environmental characteristics of areas likely to be affected, existing problems within these areas and the environmental protection objectives assigned to them. Special attention should be given to the environmental transboundary implications of the nuclear power programme.

7.1.6. Environmental assessment

In addition to the description of the environmental status, the report also needs to explain how the various environmental aspects will be impacted by the nuclear power programme. In this context, the report should cover the main topics identified during the assessment exercise, including all relevant effects (e.g. direct, indirect and cumulative). It is also important to establish which aspects are considered elsewhere in the energy and nuclear planning decision framework (see Figs 2–5).

The SEA report should also describe the (state of the art) methods with which effects were identified, prioritized and assessed. It is suggested that the assessment follow the structure across those nuclear power impact areas that were scoped in, as outlined in Section 3, addressing the relevant environmental impact themes for each of them. It should investigate: (i) baseline, (ii) impacts, (iii) options within the nuclear power sector and (iv) mitigation measures. In this context, it should also explain the reasons for selecting these options. This section of the SEA report should indicate the positive and negative aspects and impacts of each option, and provide recommendations. Throughout the assessment, this section should highlight any difficulties or uncertainties faced which may influence the assessment and its recommendations. This may include issues such as data quality or any constraints put on effective assessments by the existing decision framework. This section should pay special attention to transboundary issues.

7.1.7. Stakeholder engagement and public participation

The SEA report should summarize the engagement and participation process, including its objectives, main aspects, findings and consequences. This should include the results of initial stakeholder mapping (with regard to their influence, attitude/positioning and interests) and present the outreach strategy chosen to engage with each of the identified stakeholder groups. In this context, reference should be made to transboundary engagement processes. It should also include the issues raised and outcomes of the stakeholder engagement during the scoping, the assessment and the SEA report (see Section 5).

Once a decision on the nuclear power programme has been made, the SEA report should be accompanied by a post-decision statement which explains the reasons for adopting the programme in its final form in the light of other reasonable options. It should summarize where and how the recommendations of the SEA process were taken into account. This is one of the most important aspects of SEA, since it will only have been effective if it is able to influence the nuclear power programme. This includes an effective consideration of the main concerns of key stakeholders.

7.1.8. Monitoring, evaluation and follow-up recommendations

The SEA report should point out the main processes and approaches for future monitoring, evaluation and follow-up. This should include clearly specified actions, responsibilities and timelines. In this context, it should cover both conformance and performance monitoring (see Section 4.7). In the case of performance monitoring, a description of the indicators, targets and methods is useful to measure, monitor and evaluate whether predictions are in line with actual impacts. The report should also look into already existing monitoring arrangements and

evaluate whether and how they may be used in the context of the nuclear power programme, in order to avoid a duplication of effort.

7.1.9. Conclusions and recommendations, including next steps

In the conclusions, the SEA report should summarize its key findings and recommendations. It should outline the next steps, with regard to: (i) the overall SEA process, (ii) the future use of the SEA report and (iii) the potential need to update the report or its recommendations (e.g. upon availability of new or more accurate data, analyses or experience).

Box 3 provides an overview of the structure of an SEA report and the issues covered, following on from the previously introduced content of the SEA report. An SEA report that covers these issues and prioritizes relevant aspects of the nuclear power programme is likely to be a valuable tool for summarizing and communicating the agreements reached on how to deal with the concerns raised during the SEA process.

BOX 3. STRUCTURE OF SEA REPORT

Non-technical summary:
- Summarizing the key issues of the SEA.

Introduction and background:
- Mapping of energy policy and planning framework;
- Positioning of the nuclear power programme within this framework.

Nuclear power programme:
- Objectives of the nuclear power programme and description;
- Contribution towards sustainable development goals;
- Considerations within the nuclear power programme (e.g. site, technology).

SEA approach:
- Objectives of SEA;
- Environmental protection objectives;
- National and international legal and regulatory frameworks;
- Relationship to other relevant policies, plans, programmes and projects;
- Scope, boundaries and methodology of the SEA and options to be assessed;
- Quality review process;
- Coordination of the SEA and the development of the nuclear power programme.

Environmental status/baseline:
- Current state of those environmental aspects that are potentially significantly affected and their likely evolution without the programme;
- Existing problems within areas likely to be affected;
- Transboundary issues.

Environmental assessment:
- Scope of assessment, based on scoping report.
- Impacts on environmental issues and their significance, assessing:
  - Main siting and technological options considered;
  - Power plant construction, operation and decommissioning;
  - Nuclear fuel cycle;
  - Spent fuel management strategy/radioactive waste storage and disposal;
  - Physical protection and security;
  - Emergency preparedness and response;
  - Wider physical infrastructure requirements.

Stakeholder engagement and public participation:
- Objectives;
- Stakeholder mapping;

— Outreach strategy;
— Key issues raised during scoping, the assessments and on the draft report;
— Adjustments to the SEA process and the nuclear power programme.

Monitoring, evaluation and follow-up recommendations:
— Process and approaches for conformance and performance monitoring.

Conclusions and recommendations, including next steps

The SEA report is an important input to be considered when preparing and adopting the nuclear power programme. It should have a strong position in the mind of decision makers as it contains the agreements reached between stakeholders. It should be permanently consulted to ensure that the actions contained are implemented, evaluated and monitored, in order to take corrective actions if necessary. Ensuring the high quality of the report and its underlying processes is, therefore, of importance, as outlined in the following section.

7.2. SEA REPORT QUALITY REVIEW

As introduced in Section 4.8, an SEA report needs to fulfil a number of quality criteria. These relate to: its content and technical integrity; compliance with the scoping stage and legal and other regulatory requirements (including other relevant SEAs); the prediction of impacts (including the application of accepted/good practice methods); and how the SEA content is communicated to the stakeholders. A quality review needs to evaluate these criteria.

In this section, a review table is introduced which helps to assess the quality of an SEA report, and the information it provides and impacts it analyses. The main purpose of the quality review table is to allow evaluation of the report in a simple, effective and efficient way.

Quality review can be performed using a set of hierarchically arranged review topics. An overall report quality mark is assigned on the basis of the individual marks given to the nine suggested review areas. To facilitate the evaluation of these review areas, a set of quality criteria are provided for each of them. It is not advisable to assign marks using a mathematical approach (e.g. with weighting factors), as the omission of one important aspect alone could lead to an unsatisfactory SEA report. However, in this case, it may not be difficult to address this omission and, consequently, improve the quality of the report to an acceptable standard.

With regard to marking questions and review areas, quality grades need to be assigned. These could, for example, range from A (best possible grade) to F (worst possible grade), as presented in Table 15. Ideally, quality reviews are done by more than one reviewer and marks are subsequently compared. The reviewers would then confer and discuss their respective marks, with the aim of allocating agreed marks to review areas and to the overall quality of the report.

The review table that follows (Table 16) presents nine main review categories comprising some forty questions. These questions are, in part, derived from the EU SEA Directive [4] (see Annex). The review table can be adapted to any specific situation of application by changing the questions and review categories.

TABLE 15. SUGGESTED SEA REPORT QUALITY REVIEW SCORING SYSTEM

Grade	Description of grade
A	The work has generally been well performed with no important omissions
B	The work has been performed satisfactorily, with only minor omissions or inadequacies
C	The work is regarded as just satisfactory, despite some omissions or inadequacies
D	The work is regarded as well attempted but, on the whole, is unsatisfactory because of omissions or inadequacies
E	The work is unsatisfactory, revealing major omissions or inadequacies
F	The task was not attempted at all
n.a.	Not applicable

TABLE 16. SEA REPORT QUALITY REVIEW TABLE

Name of reviewer:
Name of SEA:

(1) Non-technical summary	**Grade**	**Comments**
The SEA report:		
Includes a non-technical summary which reports, in simple and clearly comprehensible language, the results of the SEA as portrayed in the SEA report, including options considered, impacts identified and mitigation measures introduced for the preferred option.		
Evaluation of section (1)		

(2) Introduction and background	**Grade**	**Comments**
The SEA report:		
Clearly maps out the energy policy and planning framework in the country in which the programme is prepared.		
Clearly positions the programme within the underlying energy policy and planning framework.		
States which other policies, plans, programmes and projects are relevant and their relationship to the programme.		
Evaluation of section (2)		

(3) Nuclear power programme	**Grade**	**Comments**
The SEA report:		
Clearly describes and explains the objectives of the programme.		
Explains how the programme contributes towards environmental and sustainable development objectives.		
Explains the scope of the programme (i.e. what categories of sites and technology are covered).		
Evaluation of section (3)		

(4) SEA approach	**Grade**	**Comments**
The SEA report:		
Clearly describes and explains the objectives of the SEA (e.g. environmental protection objectives).		
Clearly explains the national and international legal and regulatory frameworks governing the SEA.		
Explains the scope, boundaries and methodology of the SEA, along with the options that were assessed.		
Describes how the SEA and the nuclear power programme processes were coordinated (it is recommended that the SEA take place during the preparation of the programme and be conducted in parallel with it, converging at regular intervals).		
Outlines all important issues (e.g. the IAEA's 19 nuclear infrastructure issues [14]) that are addressed elsewhere.		
Evaluation of section (4)		

TABLE 16. SEA REPORT QUALITY REVIEW TABLE (cont.)

Name of reviewer:
Name of SEA:

(5) Environmental status/baseline	**Grade**	**Comments**
The SEA report: Provides relevant information on the present status of those environmental, economic and social issues that are expected to be significantly affected, and how they would develop in the absence of the nuclear power programme. Data gaps are also described. Provides information on any current environmental concerns, especially those affecting areas of environmental importance. Carefully considers and explains what issues of the environmental status in other countries need to be taken into account (transboundary issues). Evaluation of section (5)		

(6) Environmental assessment	**Grade**	**Comments**
The SEA report: Is in line with what was agreed in the scoping report. Deviations thereof are clearly explained and it is clear that stakeholders were aware of these deviations. Describes how reasonable mitigation and alternative technological and siting options were identified, considering the objectives and the geographical scope of the nuclear power programme. Provides information on the likely significant environmental impacts (magnitude of impact versus sensitivity of environment) of different options for each of the scoped in nuclear power impact areas, and for all relevant types of impact (see the points listed in Section 4.4.2) for each of the relevant environmental impact themes (see Section 3.3), and the interrelations between them. The impact areas may include: — Main siting and technological considerations; — Power plant construction, operation and decommissioning; — Nuclear fuel cycle strategies; — Spent fuel management strategies/radioactive waste storage and disposal; — Physical protection and security; — Emergency preparedness and response; — Wider physical infrastructure requirements. Provides information on the foreseen measures to avoid, reduce or otherwise mitigate any expected significant negative environmental impacts and related sustainability issues. Explains what residual impacts will remain after mitigation. Shows how state of the art knowledge and assessment methods were used. Evaluation of section (6)		

TABLE 16. SEA REPORT QUALITY REVIEW TABLE (cont.)

Name of reviewer:
Name of SEA:

(7) Stakeholder engagement and public participation	**Grade**	**Comments**
The SEA report:		
Describes how (and which) authorities and stakeholders and the public were consulted and explains the results of stakeholder mapping.		
Describes the outreach strategy and explains how the draft SEA report was made available to authorities and those members of the public likely to be affected or to have an interest in the programme.		
Confirms that these communication channels were adjusted to the stakeholder groups and enabled them to participate in the engagement process. Confirms that they were allowed to express their opinions within an appropriate time frame.		
Confirms that results of the consultation on the SEA were considered in decision making and what adjustments were made.		
Evaluation of section (7)		

(8) Monitoring and evaluation of follow-up recommendations	**Grade**	**Comments**
The SEA report:		
Describes the foreseen measures regarding both conformance and performance monitoring to ensure that the implementation of the nuclear power programme is in line with the SEA recommendations. Specifies what will be monitored by whom, how and when.		
In this context, investigates the possibility to use or adjust existing monitoring mechanisms to avoid duplication.		
Evaluation of section (8)		

(9) Presentation of information and results	**Grade**	**Comments**
The SEA report:		
Is included as a clearly distinguishable SEA section in the nuclear power programme or as a separate SEA report.		
Is well written and in language facilitating the engagement of relevant stakeholders.		
Provides information on any complications (such as technical issues, unreliable data or lack of know-how) and uncertainties faced when collecting and processing data and information.		
Once a decision on the nuclear power programme has been made, provides a statement summarizing how environmental considerations were taken into account in the programme, based on the SEA report and stakeholder consultations. Explains the programme in its final form with regard to the excluded alternative options that were assessed.		
Evaluation of section (9)		

Overall grade for SEA report

Any additional notes

8. CONCLUDING REMARKS

These guidelines offer a menu of options and methods for conducting customized SEA for nuclear power programmes. In this context, SEA is understood to be a decision support tool applied in assisting the preparation of a specific programme by ensuring its environmental sustainability. Based on an analysis of the context within which SEA is applied, it is also a tool to position a nuclear power programme within the wider energy decision framework, which usually consists of a range of associated policies, plans, programmes and projects.

An important underlying assumption of these guidelines is that nuclear energy was identified as an option in prior energy policy making, informed by an energy policy SEA. The main focus of a nuclear power programme SEA is, therefore, not on why nuclear energy is used, but rather on its implementation, based on programme specific aspects such as siting criteria and technologies. In this context, it aims to avoid or mitigate any expected significant negative environmental impacts and, importantly, to enhance positive environmental and related sustainability outcomes. It does so by assessing various implementation options and their implications across the entire nuclear fuel cycle, including the construction, operational and decommissioning stages of nuclear power generation. By identifying and removing those options that are unsustainable at a point in time at which only limited resources have been spent on their development, SEA helps save time and money.

When assessing the identified options, numerous methods can be applied. Choosing the right one will involve matching the complexity of the method with the specific situation to which it is applied. For example, simpler methods may be more transparent and, thus, facilitate wider communication. On the other hand, more advanced methods may allow analysis of more complex relationships, but their application and the interpretation of results may be limited to experts. When data availability is a concern, methods will have to be chosen accordingly. To ensure transparency and allow for later improvements, it is important to record in the SEA report any data gaps or situations in which unreliable data were used, and also the potential implications for the assessment. Whatever data and methods are used, they will just be one element of several supporting and informing the SEA process, such as a continuous stakeholder dialogue.

Through consideration and discussion of opinions proposed by stakeholders, such as authorities and the general public, early on in the process, SEA increases the overall transparency of decision making and helps decision makers to engender public trust. This reduces the risk of deadlock during decision making on individual subsequent projects, owing for example to local opposition. To achieve these benefits, SEA for nuclear power programmes has to provide a platform for informed and fair public debates. Considering the challenges associated with public debates, it is advisable to follow clear and strict rules with regard to the requirement to validate claims. A skilled SEA moderator is, therefore, key for achieving an effective SEA that can help reconcile conflicting objectives pursued by different administrations and sectors.

The main document referred to by all stakeholders is the SEA report. It is, therefore, important that it be accessible, both physically and with regard to the language used. This requires keeping its audience in mind, which comprises both lay people as well as experts. It is recommended that technical detail be provided only to the extent required for the reader to understand the environmental implications of the assessed options. Furthermore, the sections of the SEA report should be balanced and refer to each other. For example, the part describing the environmental baseline should not dominate others simply because related information was widely available. Instead, the focus should be on those environmental aspects that are expected to be significantly affected by the nuclear power programme.

SEA will only be effective if it is proactive, driving ideas for options and issues to be considered in a nuclear power programme. Thus, an SEA does not end once the SEA report is written. Rather, it needs to be demonstrated that SEA results fed into the decisions taken and that subsequent developments are in line with those decisions and the underlying SEA. This requires establishing an appropriate monitoring process that verifies the conformity of these subsequent developments with the SEA and checks whether future impacts are in line with what was foreseen in the SEA. The responsibility for overseeing the entire SEA process will vary between different countries and administrative levels. It can lie with, for example, an energy or an environmental authority. In any event, it is advisable that an environmental authority play a key role in conducting an SEA, in particular, in the associated SEA quality review and evaluation.

Quality assurance is a comprehensive exercise comprising multiple aspects, from the quality of the decision making framework and its institutions, to the quality of the process itself, including stakeholder engagement and

public participation, as well as the SEA report. Quality assurance further encompasses ensuring the expertise of those conducting the SEA as well as its ability to influence decisions and the subsequent project design. Quality assurance will be significantly more effective if it involves an external review by an unbiased body. This will also add to the credibility of the SEA process. The main responsibility for the quality of the SEA will, however, rest with those driving the process, comprising both the experts conducting it and the authority in charge of steering it.

In order to capitalize on its anticipated benefits, SEA needs to be applied as early as possible in the nuclear power programme development process and accompany that process in all stages of its preparation. It is important to note that the results of an SEA will not remain valid indefinitely, and that there may be a need to revisit and revise an SEA in the case of, for example, major policy or other changes.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Energy Basic Principles, IAEA Nuclear Energy Series No. NE-BP, IAEA, Vienna (2008).

[2] NUCLEAR DECOMMISSIONING AUTHORITY, Geological Disposal: A Strategy for Sustainability Appraisal and Environmental Assessment, Rep. NDA/RWMD/014, NDA, Harwell, United Kingdom (2009).

[3] FISCHER, T.B., Ed., Environmental Assessment (Critical Concepts in Built Environment), 4 vols, Routledge, London (2016) 1592 pp.

[4] EUROPEAN COMMISSION, Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the Assessment of the Effects of Certain Plans and Programmes on the Environment, Official Journal of the European Communities L 197 (2001) 30–37.

[5] UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context, UNECE, Kiev (2003).

[6] EQUATOR PRINCIPLES, The Equator Principles — A Financial Industry Benchmark for Determining, Assessing and Managing Environmental and Social Risk in Projects, Equator Principles Financial Institutions (2013).

[7] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, Strategic Environmental Assessment in Development Practice: A Review of Recent Experience, OECD, Paris (2012).

[8] OEKO-INSTITUT, Strategic Environmental Assessment of the National Programme for the Safe Management of Spent Fuel and Radioactive Waste, Oeko-Institut, Cologne (2015).

[9] EKOVERT ŁUKASZ SZKUDLAREK, Strategic Environmental Assessment Report for the Polish Nuclear Programme, Ministry of Economy, Warsaw (2014).

[10] PAUL C. RIZZO ASSOCIATES, Strategic Environmental Assessment (SEA) — Proposed Nuclear Power Plant Complex, Western Region, Abu Dhabi Emirate, UAE, Project No. 08-4075, Vol. 1, Paul C. Rizzo Associates, Abu Dhabi (2010).

[11] INSTITUTE OF ENVIRONMENTAL MANAGEMENT AND ASSESSMENT, Special Report, The State of Environmental Impact Assessment Practice in the UK, IEMA, Lincoln (2011).

[12] INTERNATIONAL ATOMIC ENERGY AGENCY, Considerations to Launch a Nuclear Power Programme, IAEA, Vienna (2007).

[13] FISCHER, T.B., Theory and Practice of Strategic Environmental Assessment — Towards a More Systematic Approach, Earthscan, London (2007).

[14] INTERNATIONAL ATOMIC ENERGY AGENCY, Milestones in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1), IAEA, Vienna (2015).

[15] INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes, IAEA Nuclear Energy Series No. NG-T-3.11, IAEA, Vienna (2014).

[16] UNITED NATIONS DEVELOPMENT PROGRAMME, Benefits of a Strategic Environmental Assessment, UNDP (2003).

[17] KENNEDY, W.V., Environmental Impact Assessment in North America, Western Europe: What has worked where, how and why? Int. Environ. Reporter **11** (1988) 257–262.

[18] EUROPEAN ATOMIC ENERGY COMMUNITY, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006).

[19] INTERNATIONAL ATOMIC ENERGY AGENCY, Leadership and Management for Safety, IAEA Safety Standards Series No. GSR Part 2, IAEA, Vienna (2016).

[20] INTERNATIONAL ATOMIC ENERGY AGENCY, Seismic Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSG-9, IAEA, Vienna (2010).

[21] INTERNATIONAL ATOMIC ENERGY AGENCY, WORLD METEOROLOGICAL ORGANIZATION, Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSG-18, IAEA, Vienna (2011).

[22] INTERNATIONAL ATOMIC ENERGY AGENCY, External Human Induced Events in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.1, IAEA, Vienna (2002).

[23] INTERNATIONAL ATOMIC ENERGY AGENCY, Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.2, IAEA, Vienna (2002).

[24] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 2018 Edition, IAEA Safety Standards Series No. SSR-6 (Rev. 1), IAEA, Vienna (2018).

[25] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulatory Control of Radioactive Discharges to the Environment, IAEA Safety Standard Series No. WS-G-2.3, IAEA, Vienna (2000).
[26] INTERNATIONAL ATOMIC ENERGY AGENCY, Options for Management of Spent Fuel and Radioactive Waste for Countries Developing New Nuclear Power Programmes, IAEA Nuclear Energy Series No. NW-T-1.24, IAEA,Vienna (2013).
[27] Nuclear Technology Review 2016, GC(60)/INF/2, IAEA, Vienna (2016).
[28] INTERNATIONAL ATOMIC ENERGY AGENCY, Getting to the Core of The Nuclear Fuel Cycle — From the Mining of Uranium to the Disposal of Nuclear Waste, IAEA, Vienna (2012).
[29] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Fuel Cycle Information System — A Directory of Nuclear Fuel Cycle Facilities: 2009 Edition, IAEA-TECDOC-1613, IAEA, Vienna (2009).
[30] Convention on the Physical Protection of Nuclear Material, INFCIRC 274, IAEA, Vienna (1979).
[31] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5), IAEA Nuclear Security Series No. 13, IAEA, Vienna (2011).
[32] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, PREPARATORY COMMISSION FOR THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standard Series No. GSR Part 7, IAEA, Vienna (2015).
[33] GORE, T., FISCHER, T.B., Uncovering the factors that can support and impede post-disaster EIA practice in developing countries: The case of Aceh Province, Indonesia, Environ. Impact Assess. Rev. **44** (2014) 67–75.
[34] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Design, IAEA Safety Standards Series No. SSR-2/1 (Rev. 1), IAEA, Vienna (2016).
[35] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, Strategic Environmental Assessment and Ecosystem Services — SEA Toolkit, OECD, Paris (2010).
[36] INTERNATIONAL ATOMIC ENERGY AGENCY, Climate Change and Nuclear Power 2016, IAEA, Vienna (2016).
[37] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, Strategic Environmental Assessment and Adaptation to Climate Change — SEA Toolkit, OECD, Paris (2010).
[38] UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, Resource Manual to Support Application of the Protocol on Strategic Environmental Assessment, United Nations, Geneva (2011).
[39] CROAL, P., GIBSON, R.B., ALTON, C., BROWNLIE, S., WINDIBANK, E., A decision-maker's tool for sustainability-centred strategic environmental assessment, J. Environ. Assess. Policy Manag. **12** (2010) 1–27.
[40] EUROPEAN COMMISSION, The SEA Manual: A Sourcebook on Strategic Environmental Assessment of Transport Infrastructure Plans and Programmes, European Commission, Brussels (2005).
[41] RPS, National Wastewater Sludge Management Plan, Strategic Environmental Assessment Scoping Report, RPS (2015).
[42] FISCHER, T.B., Strategic environmental assessment and transport planning: Towards a generic framework for evaluating practice and developing guidance, Impact Assess. Project Appraisal **24** (2006) 183–197.
[43] UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, Good Practice Recommendations on Public Participation in Strategic Environmental Assessment, United Nations, Geneva (2015).
[44] UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, Maastricht Recommendations on Promoting Effective Public Participation in Decision-making in Environmental Matters, United Nations, Geneva (2015).
[45] UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, United Nations, Geneva (1998).
[46] ENVIRONMENTAL PROTECTION AGENCY, GISEA Manual — Improving the Evidence Base in SEA (GONZÁLEZ, A., Ed.), EPA, Wexford (2015).
[47] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, Applying Strategic Environmental Assessment — Good Practice Guidance for Development Co-operation, OECD, Paris (2006).
[48] OFFICE OF THE DEPUTY PRIME MINISTER, A Practical Guide to the Strategic Environmental Assessment Directive, ODPM, London (2005).

Annex

REQUIREMENTS FOR SEA AND COUNTRY EXPERIENCES

A–1. EU SEA DIRECTIVE AND UNECE PROTOCOL ON SEA

Given their similarities, this section combines and compares selected requirements for strategic environmental assessment (SEA) based on both European Union (EU) Directive 2001/42/EC on Assessment of the Effects of Certain Plans and Programmes on the Environment (EU SEA Directive) [A–1], and the United Nations Economic Commission for Europe (UNECE) Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context (UNECE Protocol on SEA) [A–2]. In addition, text in this section is taken from EU Directive 2011/92/EU [A–3], as amended by EU Directive 2014/52/EU [A–4], on environmental impact assessment (EIA), and from EU Directive 92/43/EEC (Habitat Directive) [A–5], to which the EU SEA Directive refers.

The EU SEA Directive [A–1], as any other EU Directive, is binding with regard to the results to be achieved, but leaves the choice of form and methods to Member States. It is required to be transposed into national legislation of EU Member States. Signing United Nations conventions and protocols to conventions demonstrates the support of a party to later ratify it, and only at this point do they become legally binding.

For both the EU SEA Directive [A–1] and the UNECE Protocol on SEA [A–2], SEA shall be carried out for plans and programmes which are likely to have significant environmental effects. According to the UNECE Protocol on SEA [A–2], this also explicitly includes health effects. Further, it also provides a non-mandatory framework for application of SEA to policies and legislation.

For both the EU SEA Directive [A–1] and the UNECE Protocol on SEA [A–2], SEA shall address plans and programmes which set the framework for future development consent for, for example, energy or waste management projects, such as:

- "Thermal power stations and other combustion installations with a heat output of 300 megawatts or more and nuclear power stations and other nuclear reactors (except research installations for the production and conversion of fissionable and fertile materials, whose maximum power does not exceed 1 kilowatt continuous thermal load)" [A–2];
- "Waste-disposal installations for the incineration, chemical treatment or landfill of toxic and dangerous wastes" [A–2];
- "Installations solely designed for the production or enrichment of nuclear fuels, for the reprocessing of irradiated nuclear fuels or for the storage, disposal and processing of radioactive waste" [A–2].

Further, both the EU SEA Directive [A–1] and the UNECE Protocol on SEA [A–2] refer to the following point, which in the latter is, however, limited to plans and programmes which set the framework for future development consent for projects that require an EIA under national legislation:

- "Deep drillings (in particular geothermal drilling, drilling for the storage of nuclear waste material, drilling for water supplies), with the exception of drillings for investigating the stability of the soil" [A–2].

The UNECE Protocol on SEA [A–2] further explicitly mentions:

- "Construction of overhead electrical power lines with a voltage of 220 kilovolts or more and a length of 15 kilometres or more and other projects for the transmission of electrical energy by overhead cables."

In this context, the EU SEA Directive [A–1] more generally refers to industrial installations for carrying gas, steam and hot water; transmission of electrical energy by overhead cables.

The UNECE Protocol on SEA [A–2] further explicitly refers to:

— "the dismantling or decommissioning of…[nuclear] power stations or reactors (except research installations for the production and conversion of fissionable and fertile materials whose maximum power does not exceed 1 kilowatt continuous thermal load)".

The EU SEA Directive [A–1] refers to the Habitat Directive [A–5], which — as it is an EU regulation — is not mentioned in the UNECE Protocol on SEA [A–2]. The Habitat Directive [A–5] aims to promote biodiversity and to ensure the conservation of a wide range of rare, threatened or endemic animal and plant species. It establishes the Natura 2000 networks of nature protection areas. The EU SEA Directive [A–1] requires SEA to be performed for plans and programmes which, in view of the likely significant effect on sites, have been determined to require an assessment pursuant to the Habitat Directive [A–5].

The following are common to both the EU SEA Directive [A–1] and the UNECE Protocol on SEA [A–2]:

— SEA is required for any other plans and programmes which Member States/Parties determine are likely to have significant environmental effects (including health for the UNECE Protocol on SEA [A–2]). This shall be determined either through case by case examination or by specifying types of plans and programmes or by combining both approaches (considering the criteria determining the likely significance of effects as listed in the EU SEA Directive [A–1]). The related conclusion of Member States/Parties, including reasons for not requiring an environmental assessment, shall be made available to the public.
— Plans and programmes which determine the use of small areas at local level and minor modifications to plans and programmes shall require an environmental assessment only where the Member States/Parties determine that they are likely to have significant environmental effects. Excluded are plans and programmes the sole purpose of which is to serve national defence or civil emergency, and financial or budget plans and programmes.

A–2. SELECTED EXAMPLES OF NATIONAL REGULATIONS AND PRACTICES

A–2.1. National Environmental Policy Act, United States of America

The National Environmental Policy Act of the United States of America of 1969 (amended 2000) points to the continuing responsibility of the Federal Government to use all practicable means to improve and coordinate Federal plans, functions, programmes and resources to fulfil the responsibilities of each generation as trustee of the environment for succeeding generations. The act requires that all agencies of the Federal Government utilize a systematic, interdisciplinary approach drawing on natural and social sciences and environmental design arts in cases when planning and decision making may have an impact on the environment. Further, they shall ensure that presently unquantified environmental values are given appropriate consideration in decision making along with economic and technical considerations.

Whenever proposed legislation and other major Federal actions significantly affect the quality of the human environment, a detailed statement is required describing: the environmental impact, any unavoidable adverse environmental effects, alternatives to the proposed action, the relationship between local environmental short term uses and long term productivity, and any irreversible and irretrievable commitments of resources. The act further refers to support for related international cooperation, information sharing, the use of ecological information when planning and developing resource oriented projects, and the identification of alternatives for unresolved conflicting resource uses.

A–2.2. Environment Protection and Biodiversity Conservation Act, Australia

Australia's Environment Protection and Biodiversity Conservation Act of 1999 prohibits action that has, or is likely to have, a significant impact on the environment, unless the minister gives approval or decides that approval is not needed. The minister may further agree that an assessment of the impacts of actions resulting under a policy, plan or programme is required. This refers to action affecting a declared World Heritage property,

a national heritage place, a declared Ramsar wetland, listed threatened and migratory species, or the marine environment. It specifically points to the protection of the environment from nuclear actions, which refer to: (i) establishing or significantly modifying a nuclear facility (including research reactors and production of nuclear materials for industrial or medical use); (ii) transport of spent nuclear fuel or radioactive waste products arising from reprocessing; (iii) establishing or significantly modifying a facility for storing radioactive waste products arising from reprocessing; (iv) mining or milling uranium ore; (v) establishing or significantly modifying a large scale disposal facility for radioactive waste; or (vi) decommissioning or rehabilitating any nuclear facility.

A–2.3. Law of the People's Republic of China on Evaluation of Environmental Effects

Evaluation of environmental effects as referred to in the Law of the People's Republic of China on Evaluation of Environmental Effects of 2002 consists of: the analysis, prediction and assessment of possible environmental effects after implementation of plans and construction projects; ways put forth and measures for preventing or mitigating the adverse effects on the environment; and the methods and systems applied for follow-up monitoring. When making arrangements for formulating plans for the utilization of land, the environmental effects need to be evaluated in this process and an explanation of the effects needs to be given in the plan.

A–2.4. SEA practice in Kenya

SEA was first introduced through the Environmental (Impact Assessment and Audit) Regulations of 2003. These regulations required that it be determined which proposals for public policies, plans and programmes were the most environmentally friendly and cost effective when implemented individually or in combination with others. However, initially related efforts focused on EIAs and environmental audits that were also introduced with this regulation, and the first SEA was performed in 2005.

In 2014, the National Environment Management Authority launched the National Guidelines for Strategic Environmental Assessment in Kenya to give direction on how SEA is to be conducted in practice in Kenya. In the section on screening, in addition to significant environmental effects, a range of other criteria are highlighted, such as: health, safety and politically contentious issues; cumulative and transboundary effects; uncertainty in predictions; or indirect effects through affecting the behaviour of third parties.

In 2015, Kenya amended its Environmental Management and Co-ordination Act of 1999 with Section 57A to specifically require SEA for all polices, plans and programmes that are determined to be likely to have significant effects on the environment. Aligned with this amended act, the draft Environmental (Strategic Assessment, Integrated Impact Assessment and Audit) Regulations, 2017 will repeal the Environmental (Impact Assessment and Audit) Regulations, 2003 once enacted.

As of 2016, close to 50 SEAs have been, or are being conducted, including the SEA for Kenya's Nuclear Power Programme which was initiated by the Kenya Nuclear Electricity Board in May 2016.

A–2.5. The Khyber Pakhtunkhwa Environmental Protection Act, Pakistan

With the Khyber Pakhtunkhwa Environmental Protection Act of 2014, the Khyber Pakhtunkhwa province of Pakistan established a legal foundation for SEA. It empowers the Government to ask for SEA to be carried out for any plan or policy likely to have an adverse impact on the environment. It specifically points to issues such as land use and water use management, transport and infrastructure, waste and, more generally, socioeconomic development. It further states that Government agencies and local authorities may be asked to conduct SEA and submit a related statement to the Khyber Pakhtunkhwa Environmental Protection Agency. This agency will then be in charge of a stakeholder engagement process, reviewing received comments and advising Government agencies and local authorities on any required modifications of the plan or policy. Further, this agency is supposed to maintain publicly accessible registers for SEA reports and the related decisions taken.

A–2.6. Law No. 32/2009 on Environmental Protection and Management, Indonesia

Law No. 32/2009 on Environmental Protection and Management of Indonesia lists SEA as one of several instruments to prevent environmental pollution and/or damage, together with, for example, EIA, quality standards

or related legislation. Articles 15–18 oblige the Government and regional governments to apply SEA and its results to ensure the principles of sustainable development form the basis for the development of policies, plans and programmes in a region. The law explicitly refers to spatial planning and mid-term to long term development planning, but also, more generally, to all decision making processes with the potential to cause environmental impacts or risks. An SEA shall assess, among other things, environmental impacts, risks and resilience, ecosystem services, biodiversity, the efficiency of natural resource utilization, and the vulnerability to climate change and related adaptation potential. SEA needs to formulate alternatives and recommend possibilities for improvements. The law further explicitly refers to the need for involving communities and stakeholders. An example for SEA in Indonesia includes the Masterplan for Acceleration and Expansion of Indonesia's Economic Development (SEA MP3EI), which also implicitly assesses energy related aspects.

A–2.7. Law for the Protection and Development of the Environment, United Arab Emirates

Federal Law No. 24 of the United Arab Emirates of 1999 aims at protecting and conserving the quality and natural balance of the environment. Further, it aims at controlling and avoiding harmful effects from economic, agricultural, industrial, development or other programmes aiming to improve life standards. It refers to the consideration of present and future generations when developing natural resources and conserving biological diversity. While this law does not specifically refer to SEA, it is in line with the established standards of conduct for the promotion of environmentally sound management practices for the development of infrastructure projects of the Environment Agency — Abu Dhabi. In this context, it details that the Environment Agency may require SEA when the development of the design for the proposed project is not yet finalized or when environmental baseline data are not yet available. While the SEA precedes the EIA, there is no specific reference to SEA for policy, plans and programmes.

REFERENCES TO ANNEX

[A–1] EUROPEAN COMMISSION, Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the Assessment of the Effects of Certain Plans and Programmes on the Environment, Official Journal of the European Communities L 197 (2001) 30–37.

[A–2] UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context, UNECE, Kiev (2003).

[A–3] EUROPEAN COMMISSION, Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the Assessment of the Effects of Certain Public and Private Projects on the Environment, Official Journal of the European Union L 26/1 (2011).

[A–4] EUROPEAN COMMISSION, Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 Amending Directive 2011/92/EU on the Assessment of the Effects of Certain Public and Private Projects on the Environment, Official Journal of the European Union L 124/1 (2014).

[A–5] EUROPEAN COMMISSION, Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, Official Journal L 206 (1992) 7–50.

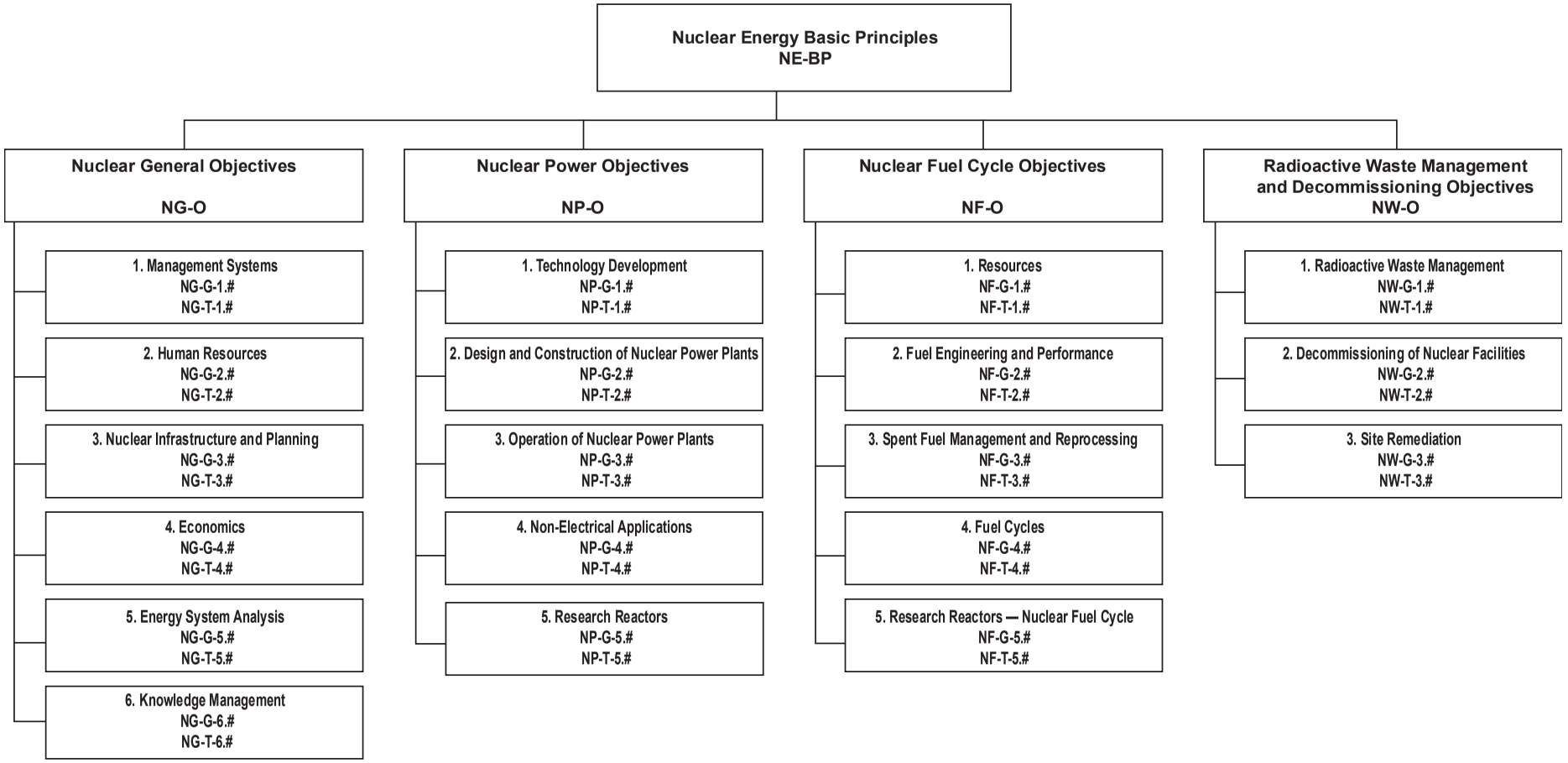
CONTRIBUTORS TO DRAFTING AND REVIEW

Athar, G.R.	Pakistan Atomic Energy Commission, Pakistan
Aulavuo, T.	United Nations Economic Commission for Europe
Bond, A.	University of East Anglia, United Kingdom
Bonilla, M.	Unidad de Planeación Minero Energética, Colombia
Chrobak, G.	ekovert Łukasz Szkudlarek, Poland
Croal, P.	Environmental Consultant, Canada
Fischer, T.B.	University of Liverpool, United Kingdom
Haladyj, A.	The John Paul II Catholic University of Lublin, Poland
Jalal, A.I.	International Atomic Energy Agency
Kallenbach-Herbert, B.	OEko-Institut, Germany
Kremlis, G.	European Commission
Magné, B.	International Atomic Energy Agency
Monken-Fernandes, H.	International Atomic Energy Agency
Montaño, M.	University of Sao Paulo, Brazil
Mwaura, F.	University of Nairobi, Kenya
Novakova, M.	European Commission
Parvez, A.	National Command Authority, Pakistan
Phaneuf, M.	International Atomic Energy Agency
Platzer-Schneider, U.	Federal Ministry of Agriculture, Forestry, Environment and Water Management, Austria
Smutny, M.	United Nations Economic Commission for Europe
Sternath, F.	RaumUmwelt Planungs-GmbH, Austria
Subki, H.	International Atomic Energy Agency
Szkudlarek, Ł.	ekovert Łukasz Szkudlarek, Poland
Tomšić, Ž.	University of Zagreb, Croatia
Van Heek, A.	International Atomic Energy Agency
Welsch, M.	International Atomic Energy Agency

Consultants Meetings

Vienna, Austria: 8–10 March 2016; 14–16 September 2016

Structure of the IAEA Nuclear Energy Series



Key

BP: Basic Principles
O: Objectives
G: Guides
T: Technical Reports
Nos 1-6: Topic designations
#: Guide or Report number (1, 2, 3, 4, etc.)

Examples

NG-G-3.1: Nuclear General (**NG**), Guide, Nuclear Infrastructure and Planning (topic **3**), **#1**
NP-T-5.4: Nuclear Power (**NP**), Report (**T**), Research Reactors (topic **5**), **#4**
NF-T-3.6: Nuclear Fuel (**NF**), Report (**T**), Spent Fuel Management and Reprocessing (topic **3**), **#6**
NW-G-1.1: Radioactive Waste Management and Decommissioning (**NW**), Guide, Radioactive Waste (topic **1**), **#1**

IAEA
International Atomic Energy Agency

No. 25

ORDERING LOCALLY

In the following countries, IAEA priced publications may be purchased from the sources listed below or from major local booksellers.

Orders for unpriced publications should be made directly to the IAEA. The contact details are given at the end of this list.

CANADA

Renouf Publishing Co. Ltd

22-1010 Polytek Street, Ottawa, ON K1J 9J1, CANADA
Telephone: +1 613 745 2665 • Fax: +1 643 745 7660
Email: order@renoufbooks.com • Web site: www.renoufbooks.com

Bernan / Rowman & Littlefield

15200 NBN Way, Blue Ridge Summit, PA 17214, USA
Tel: +1 800 462 6420 • Fax: +1 800 338 4550
Email: orders@rowman.com Web site: www.rowman.com/bernan

CZECH REPUBLIC

Suweco CZ, s.r.o.

Sestupná 153/11, 162 00 Prague 6, CZECH REPUBLIC
Telephone: +420 242 459 205 • Fax: +420 284 821 646
Email: nakup@suweco.cz • Web site: www.suweco.cz

FRANCE

Form-Edit

5 rue Janssen, PO Box 25, 75921 Paris CEDEX, FRANCE
Telephone: +33 1 42 01 49 49 • Fax: +33 1 42 01 90 90
Email: formedit@formedit.fr • Web site: www.form-edit.com

GERMANY

Goethe Buchhandlung Teubig GmbH

Schweitzer Fachinformationen
Willstätterstrasse 15, 40549 Düsseldorf, GERMANY
Telephone: +49 (0) 211 49 874 015 • Fax: +49 (0) 211 49 874 28
Email: kundenbetreuung.goethe@schweitzer-online.de • Web site: www.goethebuch.de

INDIA

Allied Publishers

1st Floor, Dubash House, 15, J.N. Heredi Marg, Ballard Estate, Mumbai 400001, INDIA
Telephone: +91 22 4212 6930/31/69 • Fax: +91 22 2261 7928
Email: alliedpl@vsnl.com • Web site: www.alliedpublishers.com

Bookwell

3/79 Nirankari, Delhi 110009, INDIA
Telephone: +91 11 2760 1283/4536
Email: bkwell@nde.vsnl.net.in • Web site: www.bookwellindia.com

ITALY

Libreria Scientifica "AEIOU"

Via Vincenzo Maria Coronelli 6, 20146 Milan, ITALY
Telephone: +39 02 48 95 45 52 • Fax: +39 02 48 95 45 48
Email: info@libreriaaeiou.eu • Web site: www.libreriaaeiou.eu

JAPAN

Maruzen-Yushodo Co., Ltd

10-10 Yotsuyasakamachi, Shinjuku-ku, Tokyo 160-0002, JAPAN
Telephone: +81 3 4335 9312 • Fax: +81 3 4335 9364
Email: bookimport@maruzen.co.jp • Web site: www.maruzen.co.jp

RUSSIAN FEDERATION

Scientific and Engineering Centre for Nuclear and Radiation Safety

107140, Moscow, Malaya Krasnoselskaya st. 2/8, bld. 5, RUSSIAN FEDERATION
Telephone: +7 499 264 00 03 • Fax: +7 499 264 28 59
Email: secnrs@secnrs.ru • Web site: www.secnrs.ru

UNITED STATES OF AMERICA

Bernan / Rowman & Littlefield

15200 NBN Way, Blue Ridge Summit, PA 17214, USA
Tel: +1 800 462 6420 • Fax: +1 800 338 4550
Email: orders@rowman.com • Web site: www.rowman.com/bernan

Renouf Publishing Co. Ltd

812 Proctor Avenue, Ogdensburg, NY 13669-2205, USA
Telephone: +1 888 551 7470 • Fax: +1 888 551 7471
Email: orders@renoufbooks.com • Web site: www.renoufbooks.com

Orders for both priced and unpriced publications may be addressed directly to:

Marketing and Sales Unit
International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Telephone: +43 1 2600 22529 or 22530 • Fax: +43 1 26007 22529
Email: sales.publications@iaea.org • Web site: www.iaea.org/books

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA
ISBN 978–92–0–104418-1
ISSN 1995–7807