IAEA TECDOC SERIES

IAEA-TECDOC-1993

Case Studies on the Development of a Comprehensive Report to Support the Decision Making Process for a Nuclear Power Programme

IAEA
International Atomic Energy Agency

CASE STUDIES ON THE DEVELOPMENT OF A COMPREHENSIVE REPORT TO SUPPORT THE DECISION MAKING PROCESS FOR A NUCLEAR POWER PROGRAMME

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
COMOROS
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
NORTH MACEDONIA
NORWAY
OMAN
PAKISTAN
PALAU
PANAMA
PAPUA NEW GUINEA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
REPUBLIC OF MOLDOVA
ROMANIA
RUSSIAN FEDERATION
RWANDA
SAINT LUCIA
SAINT VINCENT AND THE GRENADINES
SAMOA
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
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-TECDOC-1993

CASE STUDIES ON THE DEVELOPMENT OF A COMPREHENSIVE REPORT TO SUPPORT THE DECISION MAKING PROCESS FOR A NUCLEAR POWER PROGRAMME

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2022

COPYRIGHT NOTICE

For further information on this publication, please contact:

Nuclear Infrastructure Development Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna, Austria
Email: Official.Mail@iaea.org

Printed by the IAEA in Austria
March 2022

IAEA Library Cataloguing in Publication Data

Names: International Atomic Energy Agency.
Title: Case studies on the development of a comprehensive report to support the decision making process for a nuclear power programme / International Atomic Energy Agency.
Description: Vienna : International Atomic Energy Agency, 2022. | Series: IAEA TECDOC series, ISSN 1011–4289 ; no. 1993 | Includes bibliographical references.
Identifiers: IAEAL 22-01483 | ISBN 978-92-0-101922-6 (paperback : alk. paper) | ISBN 978-92-0-101822-9 (pdf)
Subjects: LCSH: Nuclear energy — Decision making. | Nuclear energy — Case studies. | Nuclear energy — Government policy. | Nuclear energy — International cooperation.

FOREWORD

Launching a nuclear power programme is the sovereign decision of a country and constitutes a major undertaking requiring careful planning, preparation and investment in time, institutions, financing and human resources.

The IAEA has developed a three phase methodology to support the development of the national infrastructure required for a nuclear power programme in a Member State. Known as the IAEA's Milestones approach, this methodology enables a Member State to understand the various aspects that government and key stakeholders need to consider and implement for the nuclear power programme to be successful. The Milestones approach identifies 19 infrastructure issues to be addressed in each of the three phases.

Several organizations have roles and responsibilities in considering and implementing the required infrastructure, including different ministries, regulatory bodies, utilities, grid operators, research institutions and universities. The IAEA publication Milestones in the Development of a National Infrastructure for Nuclear Power (IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1)) emphasizes the need for a coordinating mechanism to align the actions of these organizations, referred to as the nuclear energy programme implementing organization (NEPIO).

In the Milestones approach, at the end of Phase 1 the NEPIO is responsible for preparing a comprehensive report that summarizes the prefeasibility studies undertaken during Phase 1 and for informing decision makers of the implications and commitments to be made when establishing a nuclear power programme.

This publication presents the experience of five Member States (Belarus, Ghana, Morocco, Poland and Romania) in developing a comprehensive report for a new or expanding nuclear power programme. The target readers of this publication are senior managers in the key organizations and decision makers involved in the development, approval and use of the comprehensive report.

This publication is the product of experts from several organizations in embarking countries or in countries expanding their nuclear power programme. The IAEA is grateful to all those who assisted in the drafting and review of this publication. The IAEA officer responsible for this publication was F. Bourdin of the Division of Nuclear Power.

EDITORIAL NOTE

This publication has been prepared from the original material as submitted by the contributors and has not been edited by the editorial staff of the IAEA. The views expressed remain the responsibility of the contributors and do not necessarily represent the views of the IAEA or its Member States.

Neither the IAEA nor its Member States assume any responsibility for consequences which may arise from the use of this publication. This publication does not address questions of responsibility, legal or otherwise, for acts or omissions on the part of any person.

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 authors are responsible for having obtained the necessary permission for the IAEA to reproduce, translate or use material from sources already protected by copyrights.

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

CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

Engaging in a nuclear power programme is a major undertaking with long-term implications for at least 100 years.

Key factors that may influence decision-makers in their commitment to a nuclear power programme are of different nature, including political, socio-economic, financial, environmental, technical, or public acceptance.

The IAEA Milestones Approach [1] provides a methodology that identifies nineteen (19) infrastructure issues to be considered in the three phases of development of the infrastructure for nuclear power (see Figure 1). The completion of a phase corresponds to the attainment of a specific milestone.

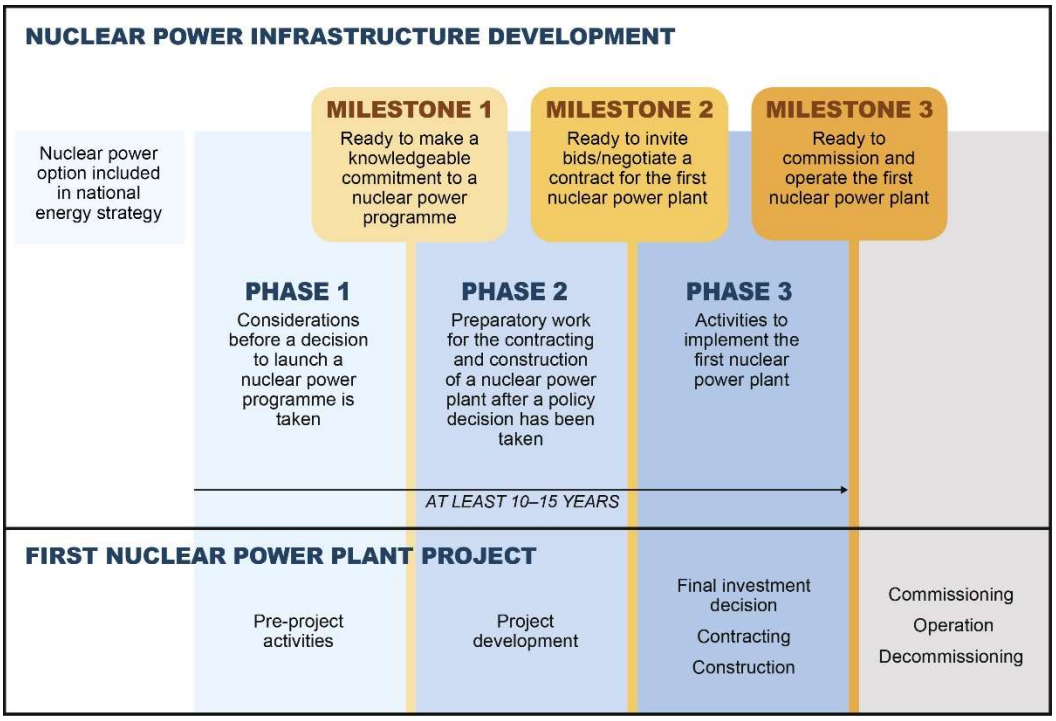

FIG. 1. Development of the infrastructure for a national nuclear power programme (reproduced from Ref. [1])

The need for a CR is referred in the Milestones publication (see Ref. [1]):

"At the end of Phase 1, the NEPIO should produce a comprehensive report that, should it recommend a positive national decision, defines and justifies a national strategy for nuclear power. Any pre-feasibility study done during Phase 1 can be a significant input to the comprehensive report, although it is important that the report fully address all 19 infrastructure issues." The CR provides the rationale and proposes the basic options for the nuclear power programme that will support the development of a national position. The Milestones Approach states that:

"The government should adopt a clear statement, which reflects broad political support, of its intent to develop a nuclear power programme, and it should communicate that intent locally, nationally, regionally and internationally. The rationale and strategy for pursuing such a programme should be based on a national energy policy supporting the desired economic development goals of the country and should identify the contribution that nuclear power will make to that policy. While nuclear energy is most often used to generate electricity, if there is an intention to develop nuclear powered desalination or process heat production, this should also be addressed in the statement."

1.2. OBJECTIVE

This publication is intended to support Member States that are developing CRs by sharing the experience of Member States that have already completed this process or are well advanced on this path.

1.3. SCOPE

The publication presents the experience of five Member States. Four of them are embarking countries (countries that are considering building their first nuclear power plants) and one is an expanding country (a country which is already operating nuclear power plants and is considering expanding its fleet).

The publication highlights similarities and differences in the approaches adopted, recognizing that there are several different ways and formats for developing a CR.

1.4. STRUCTURE

Section 2 provides an overview of the content of a CR as stated in the relevant IAEA publications.

Section 3 provides a high-level summary of the lessons learned through the Integrated Nuclear Infrastructure Review (INIR) services and assistance provided to Member States in support of the development of their national infrastructure for nuclear power.

Section 4 provides a discussion of the experiences of the contributing Member States in developing a CR to support the commitment of their government to embarking on a nuclear power programme or expanding an existing one.

Appendices 1 to 5 provide the contributions of selected Member States.

2. THE COMPREHENSIVE REPORT AND ITS CONTEXT

2.1. ROLE OF THE COMPREHENSIVE REPORT IN BUILDING A NATIONAL POSITION

The IAEA publication entitled *Building a National Position for a New Nuclear Power Programme* [2] identifies the CR in the broader context of building a national position. This is illustrated by Figure 2 showing the central role of the CR in summarizing the results of the energy planning studies and the pre-feasibility studies. Should the CR recommend proceeding with the nuclear power programme, it would be expected that it provides a plan (or roadmap) for the next steps of the programme.

Different approaches are adopted by Member States to develop and approve a CR based on NEPIO's mandate, the country's administrative system and its priorities. These differences will be presented in the next chapters of this document.

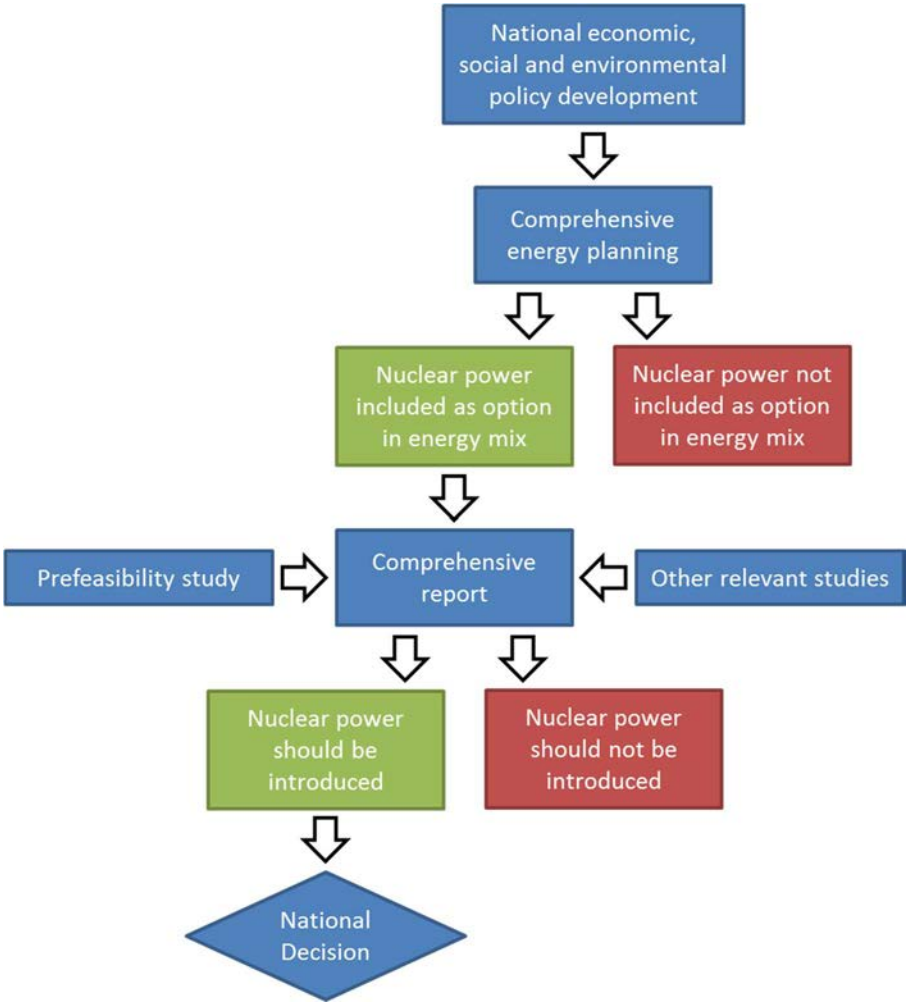

FIG. 2. Building a national position process (reproduced from Ref. [2])

2.2. CONTENT AND APPROVAL OF THE COMPREHENSIVE REPORT

The purpose of the CR is to provide guidance for the government's decision process, and, in this regard, the Milestones publication [1] sets out the expectations for the CR contents as follows:

"It should address:

- An analysis of energy demand and energy alternatives;
- An evaluation of the impacts of nuclear power on the national economy, for example gross domestic product and employment;
- A preliminary technology assessment to identify technologies that are consistent with national requirements;
- Consideration of siting possibilities and grid capacity;
- Consideration of financing options, ownership options and operator responsibilities;
- Consideration of long-term costs and obligations relating to spent fuel, radioactive waste and decommissioning;
- Consideration of possible human resource needs and external support needs of the regulatory body and owner/operator;
- Recognition that there remains a non-zero possibility of a severe accident, and the country will need to be able to deal with the consequences of such an accident;
- Consideration of the needs of each of the infrastructure issues and a plan for how they will be met in Phase 2.

The report should also address:

- The necessity of ensuring the safety, security, and peaceful use of radioactive material and nuclear facilities;
- Joining the appropriate international legal instruments;
- Developing a comprehensive legal framework;
- Having an effectively independent regulatory body;
- Planning for emergencies;
- Developing project management capabilities and human resources;
- Ensuring long term financial resources;
- Funding decommissioning and radioactive waste management;
- Ensuring domestic and international confidence by maintaining open, transparent, and timely communication."

In addition, the Comprehensive Report is expected to:

- Remind the national context justifying that nuclear power be considered in the energy mix;
- Draw on the results of the prefeasibility studies, thoroughly addressing a summary of the status of the country vis-à-vis the nineteen infrastructure issues of the Milestones Approach [1];
- Define and justify a national strategy for nuclear power;
- Include or reference an action plan to guide the implementation of the nuclear power programme, considering those areas where existing national capacities need to be enhanced, thus funded.

The Comprehensive Report is to be prepared under the auspices of the NEPIO, in consultation with the relevant ministries and organizations. Approval of the CR's conclusions may involve different entities (e.g. ad hoc committee, ministry of energy or cabinet of the prime minister) depending on the NEPIO's reporting lines and different approval mechanisms such as a vote in parliament, a decree of the executive power or a combination of them.

3. LESSONS LEARNED FROM INIR MISSIONS

The IAEA Integrated Nuclear Infrastructure Review (INIR) service provides an assessment of the status of the infrastructure for a nuclear power development in each of the three phases of the Milestones Approach [1]. The INIR assessment is based on a series of conditions defined in the IAEA publication entitled Evaluation of the Status of National Nuclear Infrastructure Development, No. NG-T-3.2 (Rev.1) (the evaluation methodology publication) [3]. The INIR guidelines [4] explain the overall process, including the sharing of responsibilities between the Member State and the IAEA.

As stated in the Evaluation Methodology publication, the content of the CR is expected to include the following:

"The end of Phase 1 report will clearly demonstrate whether there is an adequate understanding of the infrastructure that needs to be developed and will include viable plans for its introduction and identify resource requirements and timescales. The report will include plans for the development of organizations to undertake the role of regulator, owner, and operator. It is also essential that the report addresses the development of an appropriate management system and that the organizations involved recognize their responsibilities for safety, security, and safeguards."

Phase 1 INIR missions assess the status of development of the CR and the completeness of its content as part of the Issue 1: National Position (more specifically under Condition 1.3: National Strategy Defined) of the evaluation methodology [3].

The observations from conducted INIR missions are that:

- The format of the CR may vary from one country to another. In some cases, several documents exist instead of a single document. However, the objective of such report(s) is always similar, i.e. to provide decision-makers at government level with a good understanding of the key components of a nuclear power programme in a language appropriate for non-experts;
- The process for consulting, validating, and endorsing the CR before communicating the decision to the public varies and depends upon the attributions of the national authorities and institutions.

The gaps identified throughout the INIR missions conducted led to the following recommendations or suggestions (sample):

- "Appropriate national authorities should complete the update of the energy planning studies and ensure they encompass the projected timeframe in the roadmap for the nuclear power programme";

— "The NEPIO should complete the outstanding Phase 1 studies and compile the CR required for the government to make a knowledgeable commitment to a nuclear power programme";

— "The NEPIO should review and update as necessary the studies that form the basis for the commitment to embark on nuclear power programme";

— "The NEPIO should develop a master plan with a timeline indicating major activities to be conducted and identifying the organizations responsible for their implementation";

— "The NEPIO should develop a CR that includes a review and assessment of all nuclear infrastructure issues before committing significant expenditure on detailed project development".

4. SUMMARY OF COUNTRY CASE STUDIES

4.1. OVERVIEW

4.1.1. Case study data collection and analysis

A template for individual case studies was developed with headings and guide questions (referred to as 'points of interest' in this document) to elicit consistent information. Expert counterparts were identified in five embarking countries, in different phases of development of their nuclear power programmes, namely Belarus, Ghana, Morocco, Poland and Romania.

The experts were requested to provide information using the template about their country's experience in developing a CR.

The information gathered in the completed case study questionnaires was reviewed and analysed to identify common trends, differences, and notable lessons in each area of the questionnaire.

The five related case studies are included in this publication as separate appendices.

4.1.2. Status of comprehensive report and commitment to nuclear power in selected Member States' case study

The case study of **Belarus** (CR completed) reflects the approach of a country that developed its CR before the issuance of the Milestones publication [1]. Despite this fact, the topics covered in the CR and the approach adopted for its development are, to a large extent, aligned with the suggestions of the Milestones Approach. As one of the front-runners among embarking countries, Belarus' first unit was connected to the grid in November 2020.

The case studies from **Ghana** (CR completed) and **Morocco** (CR being developed) reflect the experience of two countries that are developing their CRs to support the decision-making process to be taken by their Governments in the coming years. The process to develop, approve and receive the endorsement of the CR by the Government was completed in the case of Ghana and is underway in the case of Morocco. Both countries benefited from the guidance provided in the IAEA's Milestones publication and the publication *Building a National Position for a New Nuclear Power Programme* [2].

In **Poland**, the CR (completed) is called Polish Nuclear Power Programme (PNPP). The PNPP was approved by the Council of Ministers in 2014. The PNPP was updated in 2020 to address economic changes in Poland as well as IAEA recommendations and EU regulations. Poland has already taken a decision to move forward with its nuclear power programme and, when this document was being developed, was already working to further strengthen the existing infrastructure and institutions leading the programme. A bidding process is in preparation.

Romania (CR completed) presents the perspective of a country expanding its nuclear power programme. After the construction of the first unit that started operation in December 1996, the programme was put on hold for several years. With the purpose of resuming the programme, Romania created an Inter-Ministerial Committee to update some of the studies and developed a concise CR focusing on the project feasibility and adjustments of the infrastructure, in particular the legislative aspects due to the adherence of Romania to the EU. Unit 2 of Cernavoda, subject to the case study, was built several years after Unit 1 and started commercial operation in 2007.

4.2. ROLES AND RESPONSIBILITIES FOR DEVELOPMENT OF A COMPREHENSIVE REPORT

4.2.1. Nature of the issue

The Milestones Approach [1] suggests that during Phase 1 of the development of the infrastructure for nuclear power:

— The country will analyse all infrastructure issues relevant to implementing a nuclear power programme. The purpose of the analysis, also called prefeasibility studies, is to develop an understanding of the commitments and infrastructure required for a nuclear power programme;

— A document called CR will be developed by the NEPIO summarizing the results of the prefeasibility studies aiming to inform the government and allow a knowledgeable commitment on whether embarking on a nuclear power programme.

4.2.2. Points of interest

The main points of interest are the following:

a) Which organizations were involved in the preparation of the CR and what were their respective roles?
b) Which mechanisms were used to review and approve the CR?

4.2.3. Observations from the case studies

All case studies show that some type of coordination mechanism was set up for the development of the CR.

In **Belarus**, the Sector of Nuclear Technology established within the Ministry of Energy acted as the NEPIO. With the support of the Joint Institute for Power and Nuclear Research SOSNY of the National Academy of Sciences, it prepared the *Nuclear Power Energy Development in the Republic of Belarus* report, which is similar to a CR. The draft CR was discussed at the

meeting of the Inter-Departmental Commission responsible for the coordination of the action plan for preparing the implementation of a nuclear power programme. This Commission consisted of high-level representatives of all bodies and organizations involved in the nuclear power programme. Then, the CR was presented and agreed at the plenary session of the Government of Belarus. Afterwards, it was sent to the Presidential Administration for further consideration and decision-making.

In **Ghana**, the role of the NEPIO is assigned to the Ghana Nuclear Power Programme Organization (GNPPO), established and hosted by the Ministry of Energy. The GNPPO Board is composed mainly of Directors/CEOs of a broad spectrum (27 organizations) of key national stakeholders (government, ministries, regulatory bodies, utilities, educational institutions, specialized agencies, etc.), and serves as the high-level decision-making body providing direction to and reviews of the work of the Technical Body. The Nuclear Power Institute (NPI), which leads the Technical Body, was tasked with developing and coordinating the CR development. Within NPI, a 6-member committee was set up for the collation of all inputs for the complete first draft of the CR. Following a review of the first draft, another 4-member committee restructured the CR and submitted for a review at ministerial level which entailed the Ministry of Energy (MoE) and the Ministry of Environment, Science, Technology and Innovation (MESTI). The CR was finalized after the ministerial-level review by the 4-member committee. The finalized CR was approved jointly by the Ministers of MoE and MESTI and submitted to the Government.

In **Morocco**, the development of the CR is the responsibility of the Committee on Nuclear Power and Sea Water Desalination (CRED), established under the oversight of the Ministry of Energy, Mines and Environment (MEME). The Committee is led by the National Centre for Energy and Nuclear Science and Technology (CNESTEN) and includes representatives of the Moroccan Agency for Nuclear and Radiological Safety and Security (AMSSNuR), the National Office of Electricity and Drinking Water (ONEE). the National Centre for Radioprotection (CNRP), the University of Fès and representatives from other stakeholders. A drafting group, composed of key representatives of the main organizations of the CRED (MEME, CNESTEN, ONEE and AMSSNuR), has been established to consolidate the summaries of the studies and strategies prepared by CRED's thematic working groups into a CR. In addition, a reading group, formed of senior/experienced staff of the CRED (CRED's President, ONEE's NPP Project Director, AMSSNuR's Director General, etc.), has been set up to review the first draft of the CR in a later stage. An external peer review is also being envisaged before submission of the first draft of the CR to CRED's parent Ministry.

In **Poland**, the Nuclear Energy Department at the Ministry of Climate and Environment developed the Polish Nuclear Power Program (PNPP) which is a document similar to a CR. Most ministries, the National Atomic Energy Agency (PAA) as the nuclear safety regulator, Polska Grupa Energetyczna S.A. (PGE), the largest power generating company in Poland, and other technical support organizations have been involved in the development and ongoing update of the PNPP. After evaluation of comments, remarks and opinions collected during a consultation process, the final draft was prepared and submitted for the approval to the governmental committees and finally to the Council of Ministers.

In **Romania**, an Inter-ministerial Committee, dedicated to coordinating the expansion of the existing nuclear power programme to the second unit of the Cernavoda Nuclear Power Plant, was established. This Committee, chaired by the Ministry of Economy, played the role of the NEPIO and was responsible for coordinating the work undertaken to develop the CR. The Committee was supported by two commissions: Technical Commission and Financial

Commission made of experts in the various fields to be considered for a nuclear power programme. Representatives of the NPP owner/operator and the Regulatory Body were members of these commissions. After approval in the plenary session of the Inter-ministerial Committee, the report was sent to the Government for approval. In the approval process, following discussions with the Prime Minister's office, no additional information was requested.

4.3. TIMELINE FOR THE DEVELOPMENT OF A COMPREHENSIVE REPORT

4.3.1. Nature of the issue

The Comprehensive Report is the culmination of a process that includes the completion of the prefeasibility studies summarizing the outputs. For coordination purposes, the compilation and review of data from different sources and stakeholders may require establishing a schedule that identifies the different steps and responsible organizations for drafting, reviewing (in particular, accuracy of the summary of the prefeasibility studies and clarity of the action plan proposed) and approving the CR by meeting the deadline for its submission to decision-makers.

4.3.2. Points of interest

The main points of interest are the following:

a) What was the time required for the CR development?
b) Was a schedule developed, that identifies the different steps in the elaboration, review, and approval of the CR?

4.3.3. Observations from the case studies

In **Belarus**, the development and approval of the CR took about two years, including the time dedicated to the prefeasibility studies and the complementary studies performed by the SOSNY Institute. The final report, “Nuclear Power Energy development in the Republic of Belarus”, acted as a CR at a period in time where this concept had not yet been introduced by the Agency.

Ghana started the development of the prefeasibility studies in 2015 and early defined a CR preparation plan which includes 4 steps: planning, preparation, review, and approval. This plan started to be implemented in 2019 and it took one year to have the CR prepared and reviewed before it was submitted to the government through an inter-ministerial meeting preceding a discussion at the Cabinet level in October 2020.

In **Morocco**, the approach includes the different stages related to support studies and strategies development (3 years), summaries of the studies and strategies (1 year) and integration of the summaries into a CR (1 year). This process started in 2016 and is planned to be finalized with the CR submission to CRED’s Parent Ministry (MEME) by Q4/2021. This process might terminate at this point or be extended to allow the CRED committee to answer potential enquiries or requests for additional studies from the Parent Ministry and other recipient ministries. A specific work-plan was developed by the drafting group to define responsibilities of the various contributors during the integration stage of the CR as well as for controlling the various versions of this report.

In **Poland**, the development of the PNPP took three years from mid–2010 to mid–2013 including public and cross-border consultations. It was then adopted by the Minister of

Economy before inter-ministerial consultations and its approval by the Council of Ministers in 2014. In 2018, the PNPP was updated following the same process and approved by the Council of Ministers in Oct 2020, to take into account major changes related to the energy policy, nuclear power programme implementation schedule and owner/operator positioning alignment with project financing scheme.

Considering the experience of infrastructure development for the first nuclear power unit (Cernavoda-1), **Romania** completed the CR in two years, of which one year was for support studies development and one year for the CR preparation, review and approval.

4.4. CONTENT OF THE COMPREHENSIVE REPORT

4.4.1. Nature of the issue

The IAEA Milestones publication [1] recommends that the report addresses all 19 infrastructure issues. The intent is to have a clear synthetic document with attached action plans that indicate precise deadlines and responsibilities.

4.4.2. Points of interest

The main points of interest are the following:

a) What are the main topics covered in the CR?
b) What format has been adopted for the CR e.g., a stand-alone document or a suite of reports or an executive summary with annexes?
c) What is the size of the CR?

4.4.3. Observations from the case studies

The case studies have shown that some topics were common to all CRs:

— Energy demand and alternatives;
— Impacts of nuclear power on the economy;
— Preliminary technology assessment;
— Relevance of safety, security, and safeguards for a nuclear power programme,
— Siting considerations;
— Funding needs and financing options;
— Obligations related to spent fuel, radioactive waste, and decommissioning;
— Human resource needs and external support;
— Required legal framework and regulatory frameworks;
— Planning for emergencies;
— Transparent and timely communication;
— Involvement of local industries;
— Plans for infrastructure development in Phase 2.

In **Belarus**, the CR was a stand-alone document. Each chapter includes relevant information and conclusions on the topic with suggestions on how to move forward. In total, the CR size is around 30 pages. Apart from the above-referred topics, the Belarus's CR also includes considerations about creation of relevant key organizations, costs and timeline of an NPP

construction, nuclear fuel, radioactive waste and spent fuel management and accommodation for NPP staff.

In **Ghana**, the CR was developed as a stand-alone report divided into eight (8) parts and thirty (30) chapters, of which the main decision-making relevant sections are the executive summary (25 pages), the conclusions and recommendations (12 pages) and the recommended actions for the Government (2 pages). Apart from the above-referred topics, the Ghana's CR also includes environmental considerations, analyses the possibilities offered by small modular reactors (SMRs) and provides a risk assessment of the Ghana's Nuclear Power Programme. As the CR was developed recently, there is a good alignment between the IAEA Milestones Approach and the various parts of the CR.

In **Morocco**, the CR will be a stand-alone document which includes a body text of around 95 pages supported by around 20 appendices and a similar number of references. The current draft report includes an executive summary that provides the decision-makers with a quick introduction to the content of the report and ends with a list of conclusions and recommendations and a proposed master plan for the next 10 to 20 years. The preliminary draft includes all above-referred topics.

In **Poland**, the structure of the PNPP document (similar to a CR) follows the model applicable to governmental documents. It covers all the above-referred topics and is aligned with the suggestions of the Milestones Approach [1].

In **Romania**, the CR is a concise document with an executive summary of 30 pages covering all key issues in detail and easy to read for decision-makers. Annexes to the CR, fifteen (15) pages, provide the relevant action plans, subject to the Government's approval. The table of contents of the CR covers most of the topics suggested by the Milestones Approach.

4.5. KEY MESSAGES FOR DECISION-MAKERS

4.5.1. Nature of the issue

The CR is an important document that aims at providing a sound basis to support decision-makers endorsing a strategy for the development of a national nuclear power programme and recognize the state funding required for the infrastructure development.

4.5.2. Points of interest

The main point of interest is the following:

a) Which topics in the CR are of particular importance for decision-makers at governmental level?

4.5.3. Observations from the case studies

Most case studies point out the socio-economic benefits of a nuclear power programme while recognizing the significant funding and financing efforts required and the national human resource development needed to deliver a safe and sustainable programme.

In **Belarus**, the CR considered the following aspects as key drivers for decision-making process: diversification of the country's energy resources and access to full project financing.

In **Ghana**, a dedicated chapter of the CR presents all the key issues for which governmental decisions are needed, mainly in the areas of power sector assessment, legal and regulatory framework, nuclear safety, security and safeguards, national participation and costs and economic rationale. In addition, another chapter includes a 12-point action plan to be considered by the Ghanaian Government should it decide to develop the first nuclear power project.

In **Morocco**, the CR considers several elements as potential key drivers for governmental decision:

- Geopolitical implications of the nuclear power programme (in particular, in relation to the necessity for the country to engage with neighbouring States as stakeholders and to establish lasting relationships with strategic vendor-countries);
- Opportunities and benefits of nuclear power in comparison with alternative options,
- Costs and benefits of the nuclear power programme (e.g. potential utilization of local uranium resources, security of energy supply, macroeconomic, social and environmental impacts);
- Availability of national resources and capabilities to support the programme (e.g. human resources, public finance, or local industries);
- Financing options, particularly through international financing mechanisms; and
- Stakeholders' engagement, including the level of support of the programme by the public.

In **Poland**, the topics included in the CR considered of particular importance in the decision-making include energy security, climate and environment, and economic aspects. Other elements such as human resources development, national/local industry; and the development of communication and social information strategies for nuclear power programme were also highlighted.

In **Romania**, following key aspects presented in the CR were used by the decision-makers in their decision to expand the nuclear programme: contribution of the nuclear energy programme to the economic and social development of the country (including enhancing capacity of local companies and doubling the quantity of nuclear fuel manufactured in the country) and safe management of radioactive waste resulting from the expansion of the nuclear programme.

4.6. DEVELOPMENT OF A COMPREHENSIVE REPORT – LESSONS LEARNED

4.6.1. Nature of the issue

This section is intended to share the lessons learned from Member States in developing a CR. Member States confronted to similar activities would hopefully learn from those experiences and would be able to better plan and implement the required activities.

4.6.2. Points of interest

These are the main points of interest:

a) What were the challenges faced in the development of the CR?
b) What could have been done differently?

4.6.3. Observations from the case studies

Several lessons can be drawn from the different case studies:

— The coordination role of the NEPIO is paramount in the process of developing a CR due to a large number of stakeholders involved. The NEPIO needs to provide guidance on content, style, length and ensure consistency of all contributions to the CR;

— A strong political leadership and support from the decision-makers is necessary at all stages of the CR development and engaging with them early is important to facilitate the future endorsement of the CR and subsequent national commitment;

— Government funding is needed for the prefeasibility studies and the preparation of the CR in Phase 1. The lack of funds may delay the conclusion of the necessary studies, and consequently the CR development;

— Reaching consensus on the CR's content and meeting key deadlines remain a challenge;

— IAEA support related to the development of nuclear infrastructure in Phase 1 of the programme can help to better understand and prepare a CR.

APPENDIX I.
CASE STUDY: BELARUS

I.1. INTRODUCTION

More than 80% of the energy resources used in Belarus are imported, mainly from the Russian Federation. Seeking to diversify its energy production with a reliable low-carbon source, Belarus started a nuclear power programme in cooperation with the Russian Federation.

The political decision to launch a nuclear power programme was made in 2008 based on the report entitled *Nuclear Power Energy Development in the Republic of Belarus* (hereinafter referred to as CR) which was prepared in 2007.

The General Contract for the nuclear power plant (NPP) construction between the state company Directorate for Nuclear Power Plant Construction and the Russian company 'Atomstroyexport' was signed in July 2012. According to this contract, two 1170 MWe units (Russian VVER technology) were supposed to be constructed and put into operation during the period 2021-2022.

Activities to commission the first unit of the NPP began on 7 August 2020 when the first fuel was loaded into the reactor. The first unit was connected to the electrical grid in November 2020 and commercial operation started in June 2021.

I.2. ORGANIZATIONS INVOLVED IN THE COMPREHENSIVE REPORT PREPARATION

The CR was prepared by the Joint Institute for Power and Nuclear Research, SOSNY, and by the Ministry of Energy. The Nuclear Technology Sector in the Ministry of Energy was assigned the role of NEPIO in 2006.

SOSNY was founded in June 1965 and has a long experience in the nuclear field. Its first Director was the Academician Andrei Krasin who was one of the founders of the world's first NPP in Obninsk. SOSNY provides support to the nuclear power programme in the areas of nuclear power engineering, nuclear and radiation technologies and radioactive waste management. It has also the role to conduct fundamental and applied research in the fields of nuclear physics, elementary-particles physics and high-energy physics.

One of the objectives of NEPIO in Phase 1 was the familiarization of decision-makers, managers of future organizations and the scientific community with specific aspects to be considered in a nuclear power programme. This included the importance of developing a national strategy for the implementation of the nuclear power programme and the development of a CR. As part of this familiarization activities, visits were made to several countries operating nuclear power plants and topics such as nuclear safety, nuclear fuel cycle, waste management, recruitment and training, physical protection, project management and others were discussed.

I.3. TIMELINE OF KEY ACTIVITIES BEFORE THE COMPREHENSIVE REPORT CREATION

Key activities were conducted in the period 2006–2008 (Phase 1 of the Milestones Approach) before taking a final decision on the nuclear power programme, as shown in Table I.1.

TABLE I.1. BELARUS – KEY ACTIVITIES PRIOR TO DRAFTING THE COMPREHENSIVE REPORT

Date	Key activities
January 2006	State scientific program *Nuclear Technologies for the Economy of Belarus* for 2006–2010 was approved. In the framework of this program, the *Explanatory Note to the NPP Site Selection* report was prepared that includes a prefeasibility study.
July 2006	Action plan for preparing for a nuclear power programme implementation was approved and a relevant Inter-Departmental Commission (hereinafter referred to as IDC) was established to coordinate its implementation.
November 2006	Nuclear Technology Sector of the Ministry of Energy (the NEPIO) was established
March 2007	Preliminary IAEA's mission held to present the first steps and obligations to be taken if a country decides to embark on a nuclear power programme implementation
September 2007	Concept of energy security including a nuclear fuel in energy mix was adopted
October 2007	Report Nuclear Power Energy Development in the Republic of Belarus" (CR) completed
January 2008	High-level meeting with participation of decision-makers of the Republic of Belarus was held and the Resolution of the Security Council 'On Development of Nuclear Energy in the Republic of Belarus' approved

I.4. INPUTS FOR THE COMPREHENSIVE REPORT

Belarus started preparations to introduce nuclear power in the early 1980s but stopped the process after the Chernobyl accident in 1986. The site selection process was carried out during that time and re-evaluated for the selection of the current NPP site.

SOSNY, with the support of fifteen other organizations, prepared a report describing the status of the country's energy system and examined various scenarios for the development of the Belarus energy system in the future. The report provided a rationale to include nuclear power

into the Belarusian energy system with the main aim of diversifying the energy sources. The conclusions of the report laid the foundation for the development of the document entitled *Concept of Energy Security of the Republic of Belarus* that was later used for the CR preparation. The concept envisaged the construction of an NPP with two units of total power capacity of 2340 MWe with a target to strengthen national energy security and ensure diversification of the country's energy resources

In 2006, in order to make the decision to launch a nuclear power programme, the Council of Ministers approved an action plan for the nuclear power programme implementation. The plan included the establishment of a regulatory body, the development of the Atomic Law, site selection, technology assessment, identification of sources of financing, public information activities, etc.

In 2006, the Inter-Departmental Commission (IDC) was established to coordinate and supervise the implementation of the action plan. The IDC is headed by the Deputy Prime Minister and includes top-level officials from all relevant ministries and organizations involved into the nuclear power programme. The IDC was responsible to review and approve the CR.

The technology selection process benefitted from the existing nuclear power plant construction projects. Aspects which influenced the decision included reliability and safety, duration of construction phase, cost assessment, availability and reliability of fuel suppliers, radioactive waste management and spent nuclear fuel management. All these aspects were later included in the CR in Chapter entitled 'Selection of the NPP Project.

When it comes to other infrastructure development aspects, Belarus made a general assessment of most of them, noting that the Milestones methodology [1] was not available at that time. Nevertheless, most of the key nuclear infrastructure issues were addressed in the CR as one may see from the CR content described in the next section.

I.5. COMPREHENSIVE REPORT – TABLE OF CONTENT

Belarus performed the pre-feasibility studies before the issuance of the Milestones publication and no IAEA guidance was available at that time on the content of the CR.

Taking that into consideration, the following chapters constituted the Belarus CR:

- Necessity to build a NPP in Belarus;
- Works to be done for the nuclear power programme implementation;
- NPP site selection;
- NPP project selection;
- Creation of relevant key organizations;
- Human resource development for a nuclear power programme;
- Preliminary IAEA's mission;
- Legislation for an NPP programme;
- Price and timeline of an NPP construction;
- Nuclear fuel for NPP;
- Radioactive waste management and spent nuclear fuel management;
- Stakeholders' involvement and work with mass-media;
- Accommodation for the NPP staff.

Each chapter includes conclusions with suggestions for the implementation.

In total, the CR consists of around 30 pages.

I.6. KEY DRIVERS FOR DECISION-MAKING

The major driver for the nuclear power programme in Belarus was the diversification of energy sources in the energy mix. The nuclear option was justified by its reliability and safety records.

Another key element in the decision-making process was the possibility to have the project financed by the technology provider.

Considering all relevant factors, a Russian project with the VVER technology generation 3+, with two units and total capacity of 2340 MWe was chosen. The company Rosatom confirmed the readiness of the Russian Federation to provide a state export credit for the construction of the Belarusian NPP.

I.7. LESSONS LEARNED

The introduction of nuclear power is a complex undertaking requiring careful planning, preparation and investment in a sustainable infrastructure that provides legal, regulatory, technological, human, and industrial support to ensure that the technology is used in a safe and secure manner. That is why it is necessary to identify organizations with the relevant knowledge which can evaluate the current situation and a country's potential for a nuclear power programme.

It is crucial to carefully assess a necessity of a NPP construction and to estimate its benefits. It is also very important to consider the national capacity for a nuclear power programme implementation, including financial and human resources to ensure the programme launching, development and sustainable operation. The description and outcomes of such an assessment are worth being included in the CR.

Also, the CR is an appropriate vehicle to include important topic on public engagement during the key steps of nuclear facility life cycle. Belarusian experience confirms that the earlier an open and transparent public discussion about a nuclear power programme implementation including engagement with the neighbouring counties starts, the better.

The IAEA's support, from the very first steps, to Member States, which are considering or implementing nuclear power programmes is crucial. Requesting and conducting relevant IAEA missions before making a commitment to a nuclear power programme implementation (Phase 1 of the Milestones Approach) helps Member States to better prepare a CR report, and eventually, to make a knowledgeable decision about the NPP construction.

APPENDIX II.
CASE STUDY: GHANA

II.1. BACKGROUND

Ghana's present nuclear power programme is based on a fifteen-year roadmap starting from 2015 as depicted in Figure II.1. The programme is structured after the three phased approach as described in the IAEA Milestones publication. Phases 1, 2 and 3 have been planned for 3, 5 and 6 years respectively as programme planning, project feasibility and construction.

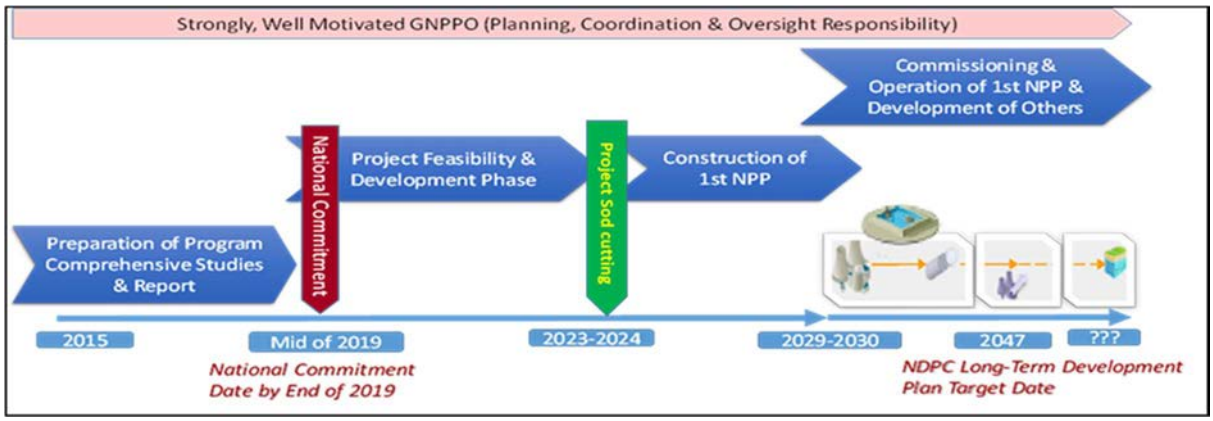

FIG. II.1. Ghana Nuclear Power Programme Roadmap (courtesy of GNPPO)

It is envisaged that by 2030, a total nuclear capacity of 700–1000 MW will be added to the national electrical grid. Ghana has completed and submitted the Ghana Nuclear Power Programme to the President and the Cabinet through the responsible ministries.

II.2. ROLES AND RESPONSIBILITIES

To appreciate Ghana's approach in developing its CR, it is important to understand the structure of the Nuclear Power Programme.

II.2.1. Structure of the Ghana's Nuclear Power Programme leading to the comprehensive report

In 2015, the Ghana Atomic Energy Commission (GAEC), which advises the Government on issues relating to nuclear energy, science and technology, established the Nuclear Power Institute (NPI) with a core mandate to develop and support capability to ensure the delivery of a sustainable nuclear energy programme in a safe, secure and efficient manner.

The Ghana Nuclear Power Programme Organization (GNPPO) was established in 2012 with representatives from 27 organizations. The GNPPO is hosted by the Ministry of Energy and chaired by the Deputy Minister of Energy responsible for Power.

To facilitate investigations for a knowledgeable commitment basis, these organizations were grouped into the following 8 working groups:

— Techno-economic Assessment, Financing and Procurement;
— Nuclear Power Plant Technology Assessment;
— Legal;

— Regulatory;
— Siting and Grid Infrastructure Assessment;
— Human Resource Development;
— Stakeholder Involvement;
— Environmental.

Initial coordination and work delivery challenges led to the restructuring of the GNPPO into two bodies: Technical Body and the Advisory and Approval Body (see Figure II.2).

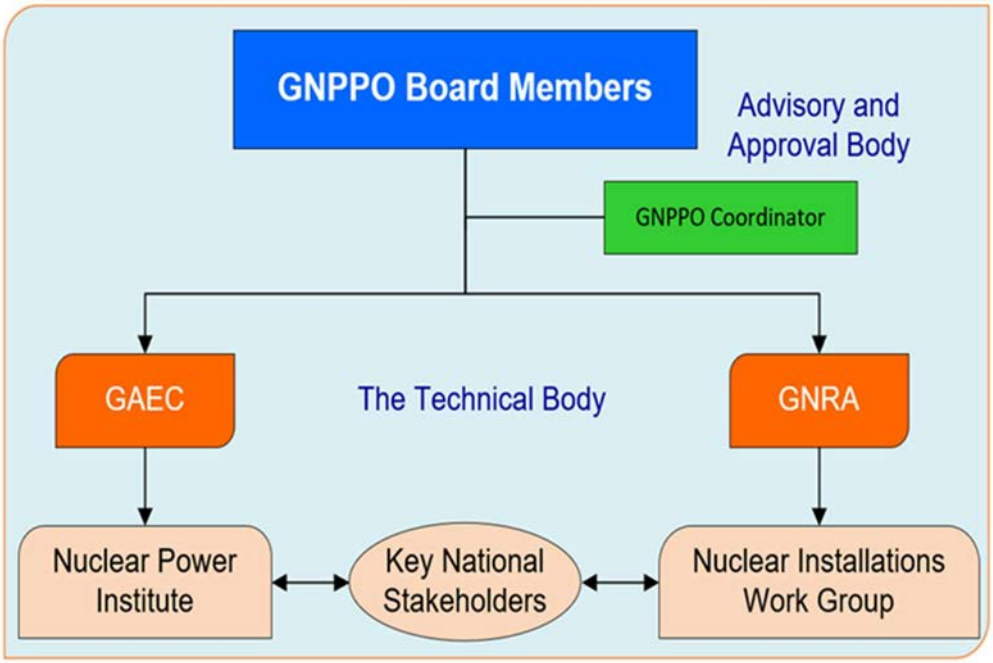

FIG. II.2. GNPPO's organizational structure (courtesy of GNPPO)

In the restructuring process, the Nuclear Power Institute (NPI) became the lead technical fulcrum to coordinate and deliver all necessary considerations that GNPPO, Ghana's NEPIO, needed to address to facilitate a national knowledgeable commitment to the programme. Preparation of a CR for the nuclear power programme became the primary target to enable a national commitment and to formalize the completion of Phase 1 of the Milestones Approach[1].

Through its five centres, NPI collaborated with the Government and private institutions to undertake several studies which successfully led to undertaking the IAEA Integrated Nuclear Infrastructure Review (INIR) and INIR follow-up missions, Site External Events and Design (SEED) review and other nuclear power programme related expert missions. Thus, no other organization was specifically made responsible for the delivery of the task; rather, NPI led the collaboration to get such needed task accomplished. For an example, NPI collaborated with the Ghana Grid Company Ltd. (GridCo) to conduct a preliminary electrical grid assessment for a 1000 MW plant. Hence, although GridCo is a member of the GNPPO, and conducted the main assessment, the responsibility was on NPI to get that work accomplished.

II.2.2. Collaboration on the National Nuclear Power Programme and the comprehensive report

Through the several collaborations, NPI have undertaken several planning studies that provided a strong foundation for the establishment of a national nuclear power programme. These productive engagements also facilitated the development of a Comprehensive Report.

Institutions that NPI collaborated with are listed in Table II.1.

TABLE II.1. GHANA'S NUCLEAR POWER PROGRAMME – INSTITUTIONAL COLLABORATIONS

Institution	**Key Issue of Collaboration**
Association of Ghana Industries	Industrial Involvement
Berock Ventures Ltd.*	Funding and Financing
Bui Power Authority	National Position
Cornerstone Capital Advisors Ltd.*	Funding and Financing, Risk Assessment
Energy Commission, SPPD	National Position
Engineering Services Provision Co. Ltd.*	Industrial Involvement
Environmental Protection Agency	Site and Environment
Forestry Commission of Ghana	Site and Environment
Geological Survey Authority	Site
Ghana Atomic Energy Commission	All areas
Ghana Grid Company Ltd.*	Electrical Grid
Ghana Institution of Engineering	Industrial and Stakeholder Involvement

TABLE II.1. GHANA'S NUCLEAR POWER PROGRAMME – INSTITUTIONAL COLLABORATIONS (cont.)

Institution	Key Issue of Collaboration
Ghana Statistical Services	Stakeholder Involvement
Hydrological Services Department	Site
Lands Commission	Site
Land Use and Spatial Planning Authority	Site
Ministry of Environment, Science, Technology, and Innovation	All areas
Ministry of Energy	All areas
National Disaster Management Organization	Emergency Planning
National Security Council Secretariat	Emergency Planning and Nuclear Security
National Development Planning Commission	National Position
Office of Attorney General and Ministry of Justice	Legal
Water Resources Commission	Site
Volta River Authority	National Position
Graduate School of Nuclear and Allied Sciences, Technical Universities	Human Resource Planning

* *Private companies*

II.2.3. Strategy for the Ghana Nuclear Programme and development of the comprehensive report

While acknowledging the enormous planning tasks of Phase 1, a framework was needed to produce a single knowledgeable commitment basis for the country to effectively close Phase 1 and if prudent, implement a nuclear power project feasibility as well as subsequent construction and operations phases. A coordinator was appointed to develop this framework which was

accepted for implementation. The framework addressed a strategy from planning to prepare the CR, coordination, write-up and the first level review, the second review and collation of CR draft, main draft review, presentation to select GNPPO Advisory, document finalisation, approval and submission to government. A brief description of this approach is presented hereafter.

II.2.3.1. Preparation plan

The framework for the development of a CR drew its background from the IAEA publication on *Building a National Position for a New Nuclear Power Programme*. The plan had a sole objective of how to prepare the CR.

The plan included a proposed table of content and acknowledged vital socioeconomic factors that the programme will have impact on.

A general schedule, format and processes were also developed. Responsibilities were assigned primarily to the five centres of NPI to collaborate with the Ministry of Energy, the Nuclear Regulatory Authority, and other stakeholders to get it completed. Communication regarding the CR development stages, draft and associated issues, were suggested to be frequent and clear between NPI and stakeholders. Suggestions on how to communicate decision on the CR and also budget related issues were included in the plan.

II.2.3.2. Coordination

Coordinator for the CR development held meetings with all contributors/writers to agree on proposed content breakdown and what would be expected for each chapter. The writers/contributors were mainly from NPI, NRA and other staff within GAEC who either directly undertook subject area/task under the programme development and/or liaised with other stakeholders (see Table II.1) to address whichever task accomplished.

The key understanding and context presented to the contributors was that the CR is not simply a summary of technical works done, rather as a decision-basis document, it ought to communicate rational and logic of both policy and technical status of the relevant subject/matter.

II.2.3.3. Write-up and review

Having agreed on the expectation of content for the CR, contributors submitted drafts to their respective Centre Managers for a first review before submission to the CR Coordinator for the next stage of collation and first complete draft review.

II.2.3.4. Collation and review

A committee was set up for collation of all inputs for the complete first draft of the CR. A 6-member committee reviewed all submitted drafts and collated the first CR draft over a 5-day retreat.

II.2.3.5. Draft comprehensive report and its finalization

The first CR draft was sent to the selected GNPPO Board members and some members of the stakeholders for review. This followed an established review process of the GNPPO. Following

receipt of extensive review comments, the draft CR was re-structured by a 4-member committee, three of whom were part of the committee that collated the first draft.

The four members of this committee were representatives from:

- Nuclear Power Institute, NPI-GAEC;
- Nuclear Power Ghana, NPG;
- Nuclear Regulatory Authority, NRA;
- Coordinator for the CR.

The restructured CR was submitted for a ministerial-level review which entailed the Ministry of Energy (MoE) and the Ministry of Environment, Science, Technology and Innovation (MESTI).

II.2.3.6. Review by GNPPO (selected stakeholders)

Ghana's nuclear power programme is primarily the responsibility of two ministries: MoE and MESTI. The GNPPO leadership organized a high level inter-ministerial meeting (dubbing a CR Executive Seminar), to present and discuss the CR before presenting it for approval and subsequently submitting it to the Government.

This inter-ministerial meeting was attended by:

- Minister, MESTI;
- Deputy Minister, MESTI;
- Special Advisor to the Minister, MESTI;
- Deputy Minister of Energy (Power), MoE;
- Deputy Minister of Energy (Finance and Infrastructure), MoE;
- Chief Director, MoE;
- Director, Renewable and Nuclear, MoE;
- Deputy Director, Nuclear and Alternative Energy, MoE;
- Director General, Ghana Atomic Energy Commission (Advisor to the Government on questions relating to nuclear energy, science and technology);
- Director General, Nuclear Regulatory Authority;
- Ag. Director, Nuclear Power Institute;
- Deputy Director, Nuclear Power Ghana;
- Coordinator, Programme's CR.

II.2.3.7. Completion of the CR

After the inter-ministerial meeting on the CR, the document was finalised and submitted to the Ministers of MESTI and MoE. The Ministers signed it for an onward submission to the Government.

II.2.3.8. Submission to the Government

The Minister, MESTI, led a briefing on the CR to the President of the Republic of Ghana. The CR was afterwards presented to the Cabinet's sub-committee on energy and subsequently to the Cabinet.

II.3. PROCEDURAL ARRANGEMENTS

All NPI's works are delivered according to several management system (MS) processes. Ghana's CR was therefore developed according to relevant processes of the established MS, with some modification to suit intended approach for the CR delivery. Processes established for the CR development were the following:

— Planning;
— Preparation;
— Review;
— Approval.

These four stages were considered in an overall Programme CR (PCR) development process illustrated in Figure II.3.

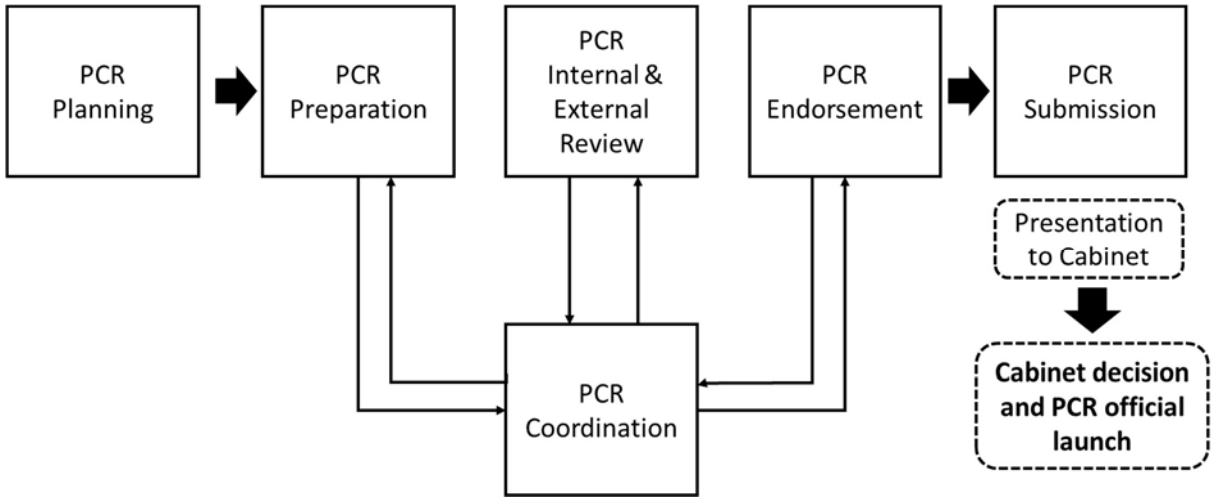

FIG. II.3. High-level process for the development of a PCR (Courtesy of GNPPO)

II.4. TIMELINE

The original schedule for development of Ghana's CR was January–December 2018. Although, the Plan for the CR preparation was completed in January 2018, it could not be executed due to delay in release of funds required for completion of some key activities for Candidate Site Selection. Other areas that needed to be finalised were financial analysis, electrical grid assessment report, human resources, and energy planning. The CR's framework was therefore postponed and executed effectively from January to December 2019. The first draft CR was compiled from 7 to 11 August 2019. The following three months were dedicated to an extensive review of the draft CR. In December 2019, the CR was restructured and subjected to the review at ministerial level.

The inter-ministerial meeting on the CR planned for March 2020 had to be postponed to June 2020 due to Covid19 impact on regular work plans and revised engagements of the target high level Government's officials. The Cabinet met to discuss the CR in October 2020.

II.5. INPUTS CONSIDERED

Ghana's CR was primarily developed as a standalone document for decision making. It is based on various reviews of government documents, policies, and technical reports of Phase 1 studies. These were accomplished through several engagements with stakeholders listed in Table 2.

II.6. TABLE OF CONTENT AND FORMAT

Ghana's CR was developed as an eight-part document with a total of 30 chapters. The 274 (cover-to-cover) paged document is a standalone, based on several studies. Some of these studies are separate documents but their main topics and conclusions have been clearly communicated in the CR.

The main sections of the CR relevant for the decision-making are the following:

— Executive summary (25 pages);
— Conclusions and recommendations (12 pages);
— Recommended action items for the Government (2 pages).

II.6.1. Content of Ghana's Comprehensive Report

— Contents;
— List of Tables;
— List of Figures;
— Acronyms;
— Executive Summary.

II.6.2. Structure of the Comprehensive Report

The table of content of Ghana's CR is provided below:

PART 1 INTRODUCTION

CHAPTER 1: NUCLEAR POWER DEVELOPMENT IN GHANA

1.1 Beginnings
1.2 Power Crises
1.3 Adzei-Bekoe Report
1.4 Government Action
1.5 Summary of Ghana's Nuclear Journey
1.6 Programme Comprehensive Report
1.7 Scope of the Programme Comprehensive Report

CHAPTER 2: GHANA AND NUCLEAR POWER

2.1 Country Profile and Ease of Doing Business
2.2 Nuclear Power Programme and Project
2.3 Objectives of Ghana's Nuclear Power Programme
2.4 Role and Justification for Nuclear in Energy Mix
2.5 Roadmap for Inclusion of Nuclear Energy in Electricity Generation Mix
2.6 Institutional Requirements for Nuclear Programme Development
2.7 Infrastructure Development - Phase 1 International Peer Review by IAEA

PART 2 POWER SECTOR ASSESSMENT

CHAPTER 3: NATIONAL ENERGY POLICY

3.1 Reliable Energy for Sustainable Development

PART 5 TECHNICAL CONSIDERATIONS

CHAPTER 13: SELECTION OF NUCLEAR REACTOR TECHNOLOGY

13.1 Description of Large Reactors under Consideration
13.2 Evaluation of Large Nuclear Reactor Technologies
13.3 Evaluation of Small Modular Reactors (SMRs) Technologies

CHAPTER 14: OPTIONS FOR FUEL CYCLE, RADIOACTIVE WASTE AND DECOMMISSIONING

14.1 Nuclear Fuel Cycle
14.2 Fuel Cycle Options Suitable to Ghana
14.3 Radioactive Waste
14.4 Decommissioning
14.5 Major Institutions involved in Waste Management and Decommissioning
14.6 Establishment of Radioactive Waste Management Authority

CHAPTER 15: SITE SELECTION FOR CONSTRUCTION OF A NUCLEAR POWER PLANT

15.1 Site Selection Process
15.2 Site Survey Studies
15.3 Looking Forward

CHAPTER 16: GRID TRANSMISSION SYSTEM TO SUPPORT NUCLEAR POWER PLANT

16.1 Transmission System
16.2 Basis of the Grid Assessment
16.3 Development of 2019 – 2030 Power System Model (Case_30_0: Base Case)
16.4 Case Studies for Inclusion of Nuclear Power Plant on the Grid
16.5 Transmission Investment Cost Estimates for Inclusion of Nuclear Power
16.6 Roadmap for Further Studies and Modifications to the Grid

CHAPTER 17: ENVIRONMENTAL PROTECTION CONSIDERATIONS

17.1 Legal and regulatory framework
17.2 EIA Process
17.3 Organizational Responsibilities

CHAPTER 18: HUMAN RESOURCE NEEDS FOR THE NUCLEAR PROGRAMME

18.1 Current Status of Human Resources in Ghana
18.2 Fields of Studies Relevant to Nuclear Power Programme
18.3 Progress in Human Resource Development
18.4 Basic Knowledge Requirement for Nuclear Power Programme Implementation
18.5 National Strategy for Human Resource Development
18.6 Continuous Learning
18.7 Remarks

PART 6 NATIONAL PARTICIPATION

CHAPTER 19: STAKEHOLDER INVOLVEMENT IN GHANA'S NUCLEAR POWER PROGRAMME

19.1 Overview of the Strategy
19.2 Country Case Studies
19.3 Key Stakeholders of the Nuclear Programme
19.4 Phase 1 Engagement Activities Undertaken
19.5 Critical Major Engagement Activities going on into Phase 2

CHAPTER 20: SURVEY OF PUBLIC PERCEPTION ON NUCLEAR POWER PROGRAMME

20.1 Manteaw Perception Survey
20.2 Selective Baseline Survey
20.3 Overall Survey Summary

CHAPTER 21: NATIONAL PARTICIPATION POLICY AND STRATEGY

21.1 Industrial Involvement Strategy
21.2 Assessment of Local Participation in the Oil and Gas
21.3 Existing Electricity Supply Industry Regulations (LI 2354, 2017)

PART 8 CONCLUSION AND RECOMMENDATION

CHAPTER 29: CONCLUSIONS AND RECOMMENDATIONS

29.1 Introduction
29.2 Power Sector Assessment
29.3 Legal and Regulatory Framework
29.4 Nuclear Safety, Security & Safeguards
29.5 Technical Considerations
29.6 National Participation
29.7 Cost and Economic Rationale

CHAPTER 30: RECOMMENDED GOVERNMENT ACTION ON THE PROGRAMME CR

30.1 Government Action Items
30.2 Expectation from Government on Programme CR

II.6.3. Addressing the 19 Infrastructure Issues of the Milestones Approach

The relevant aspects of the 19 infrastructure issues of the Milestones Approach [1] were addressed in various sections of the CR. It is important to note that, having undertaken a completely successful Integrated Nuclear Infrastructure Review (INIR) mission for Phase 1 of the programme development, such areas addressed in the CR were not focused on meeting conditions of the Milestones Approach. Rather, they reflect the progression for the nuclear programme implementation. Except for Procurement, the correspondence between the chapters of the CR and the infrastructure issues is shown in Table II.2.

TABLE II.2. GHANA: MILESTONE'S INFRASTRUCTURE ISSUES AND CORRESPONDING SECTIONS IN THE CR

Section of CR	Infrastructure Issue
Parts 1–2, Chapter 23	National Position
Chapters 6–7	Legal Framework
Chapter 8	Regulatory Framework
Chapter 9	Management
Chapter 10	Nuclear Safety, Security and Safeguards
Chapter 11	Emergency Planning
Chapter 12	Radiation Protection
Chapter 14	Nuclear Fuel Cycle and Radioactive Waste Management
Chapter 15	Site and Supporting Facilities
Chapter 16	Electrical Grid
Chapter 17	Environmental Protection
Chapter 18	Human Resource Development
Chapters 19–20	Stakeholder Involvement
Chapters 21–22	Industrial involvement
Chapters 25–27	Funding and Financing

II.7. KEY DRIVERS FOR DECISION-MAKING

Part 8 of the CR: 'Conclusion and Recommendation' presents two key issues: a 1-3 paragraph conclusion of all the chapters and recommended actions for the Government.

Chapter 29, made of 11 pages, presents all the key issues that require the Government's decision. In addition, Chapter 30 presents a 12-point action items for the Government, should the Government decide on developing the first nuclear power project.

The Government had already established both an independent regulator and a project organization for the first nuclear power plant following very positive signs of its feasibility. One of the areas highlighted in the CR for the Government's action was to sign on to three outstanding international conventions recommended in the Milestones Approach. These were:

— Vienna Convention on Civil Liability for Nuclear Damage;
— Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage;
— Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention.

Before the final submission of the CR, the Government signed on to these, thus, completing the necessary legal framework for Ghana's programme.

Approximately 30% of the Government's actions dwelt on more efficient coordination and funding for the GNPPO. Currently, the Government funds the programme through MESTI and MOE.

The CR has been submitted to the Cabinet and a decision is expected.

II.8. LESSONS LEARNED AND SUGGESTIONS

A major challenge in the development of the CR was having to work with no predefined template, standard, format or structure. It took lots of discussions, to eventually settle on what was finally produced. Another issue was the language style, however, with the agreed understanding that the document would not simply summarize technical works accomplished but rather communicate the rationale, this challenge was addressed.

The initial schedule of Ghana's CR development was postponed partly due to some technical delays in release of funds to complete some key studies. Another challenge was the workload of technical staff of the Ghana Grid Company Ltd. who were delivering the assessment of the grid. Their workload required longer timelines than they would have needed to complete the assessment.

A lot of communication is needed between the NEPIO and policy makers before, during and after the development of the CR. This will enhance smooth understanding of the programme needs and facilitate taking and implementation of key decisions for success.

APPENDIX III.
CASE STUDY: MOROCCO

III.1. BACKGROUND

Morocco considers nuclear power as a potential energy generation option for the period beyond 2030. In line with this position, Morocco examines the feasibility of a nuclear power programme which might be implemented as an energy supply solution to meet the national energy demand in the long term.

The decision regarding this programme is expected to be taken by the relevant Moroccan authorities based on several considerations and inputs. One of the input documents is the CR which is being drafted by the Moroccan Committee on Nuclear Power and Sea Water Desalination (CRED). The CR is related to Phase 1 of the IAEA's Milestones Approach; it establishes the status of the national infrastructure for nuclear power by the end of Phase 1 and provides information and recommendations helpful for the national decision-making process on nuclear energy.

In the current pre-decision stage of the national nuclear power programme, many of the programme's characteristics are still preliminary.

Regarding the programme's timeline, there is no official roadmap for the introduction of nuclear power. However, the National Energy Strategy states that nuclear power is an energy option for the period beyond 2030. In addition, at the occasion of certain studies and analyses supporting the current phase (such as the Human Resource Development study), it was necessary to develop a preliminary version of the programme's roadmap as shown on Figure III.1.

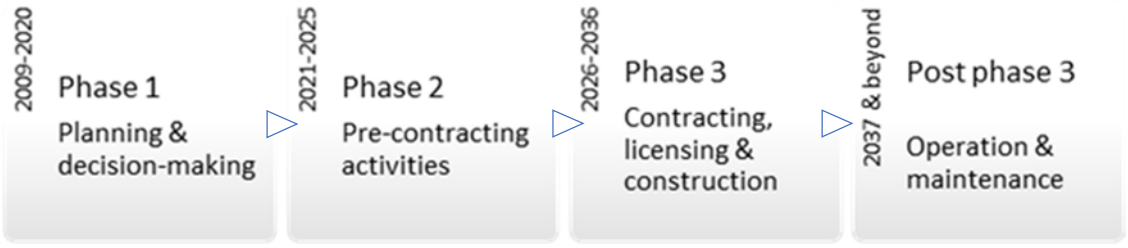

FIG. III.1. Provisional roadmap of the Moroccan nuclear power programme (Courtesy of the National Office of Electricity and Drinking Water (ONEE), Morocco)

Similar to the programme's roadmap, the planned electrical capacity is also not yet known at this stage. However, learning from the siting studies is that the accommodation capacity of the first qualified site (Sidi Boulbra site) is at least 4 reactors of 1000 MW unit-capacity. Therefore, if the economics of nuclear power is favourable, the electric capacity demand could be at least 4000 MW.

It should be noted that Morocco has a portfolio of other potential sites which might be studied more in depth at the request of the Moroccan competent authorities to increase the programme's potential capacity in case there is need in the future to expand the scope of the programme.

III.2. ROLES AND RESPONSIBILITIES

Since initiation of the studies for the Moroccan nuclear power programme in the mid-1980s, the programme activities (studies, investigations, etc.) were kept open to all national stakeholder-organizations having an interest in this programme.

Currently, the main involved organizations in these activities include:

- Moroccan Committee on Nuclear Power and Sea Water Desalination (CRED) acting as the pre-NEPIO organization since 2009. CRED Committee oversees the current activities covering analysis of the feasibility of the nuclear power option for Morocco and evaluation of its infrastructural requirements;
- Moroccan Agency for Nuclear and Radiological Safety and Security (AMSSNuR) created in 2014 and effectively in this role since 2016. This young regulatory agency regulates existing radiological activities in non-nuclear power sectors such as medicine, agriculture, and industry;
- National Office of Electricity and Drinking Water (ONEE), the national electric utility since 1963. ONEE is the current electrical utility and is the most likely organization to assume the role of the owner-operator in the future in case of a decision in favour of the nuclear power programme.

It should be mentioned that both ONEE and AMSSNuR are organizations of the CRED Committee which comprises also other national entities such as the parent Ministry (MEME). Figure III.2 shows the current composition of CRED:

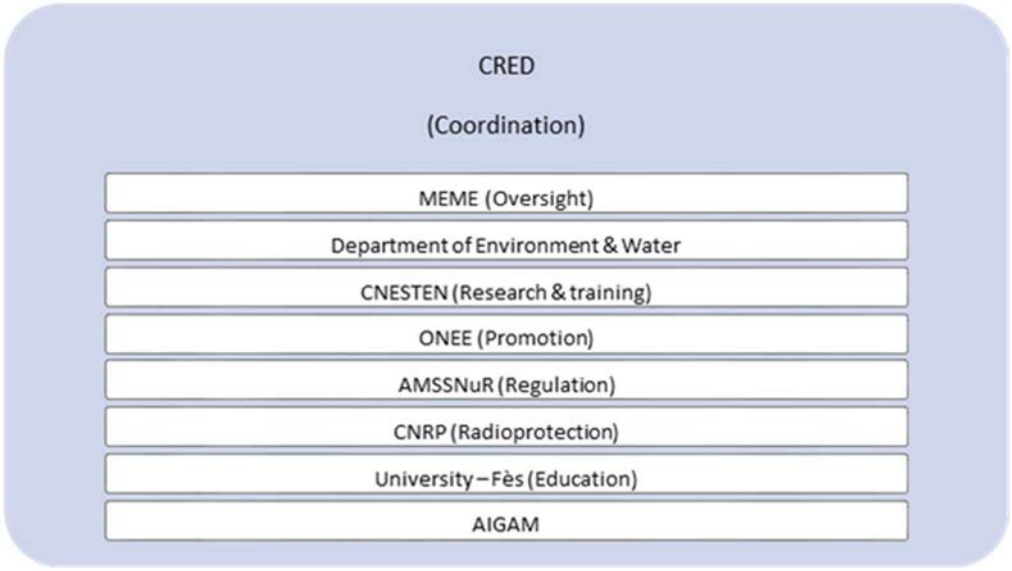

FIG. III.2. Organizational Structure of the CRED Committee (Courtesy of CRED)

III.3. PROCEDURAL ARRANGEMENTS

The activities supporting the Moroccan nuclear power programme consist of feasibility and infrastructure evaluation studies.

The first siting and techno-economic studies were performed by ONEE at two occasions in the periods 1984–1994 and 2003–2005. These studies were conducted with technical assistance of the IAEA and the French consultancy company SOFRATOME, with participation of several national organizations, notably in the siting related studies.

The siting studies resulted in the selection and qualification of Sidi Boulbra site. The technical studies were also encouraging as they identified several proven and commercially available power reactor designs. However, the findings of the economic evaluations did not enable a decision in favour of the introduction of nuclear power as these evaluations favoured the reference option (coal). Consequently, the decision concerning the first NPP project was postponed (this was particularly the case at the conclusion of the 1984–1994 studies).

Beginning 2009, Morocco started a new type of studies in the form of infrastructure evaluations for nuclear power. This new phase of studies is led by the CRED Committee. These evaluations included updates of key parts of the first site and feasibility studies given the importance of the outcomes of these studies for building the national position (Infrastructure Issue No. 1). It should be noted that prior to creation of the CRED Committee, regular updates of the early site and feasibility studies were also carried out by ONEE's NPP project team as part of its normal work activity.

So far, using national resources and competencies only, the CRED Committee was able to perform two infrastructure assessments which were reviewed by the IAEA during two major missions in 2010 and 2015. The 2015 mission corresponded to the Phase 1 INIR mission and was conducted in Rabat, 19–26 October 2015. It resulted in a positive overall assessment of the Moroccan infrastructure for nuclear power. In terms of outcome, this mission resulted in 17 Recommendations, 4 Suggestions and 4 Good Practices.

The studies and strategies supporting the Moroccan CR are outputs of the implementation of the CRED's Action Plan which was designed to respond to INIR mission recommendations and suggestions. Initially, this plan was designed to cover the period 2016–2019.

To execute this Action Plan, CRED adopted a dynamic structure built around 8 working groups (WGs) as illustrated by Figure III.3. The activity of the 8 WGs covers the main infrastructure areas concerned with the recommendations and suggestions of the INIR mission.

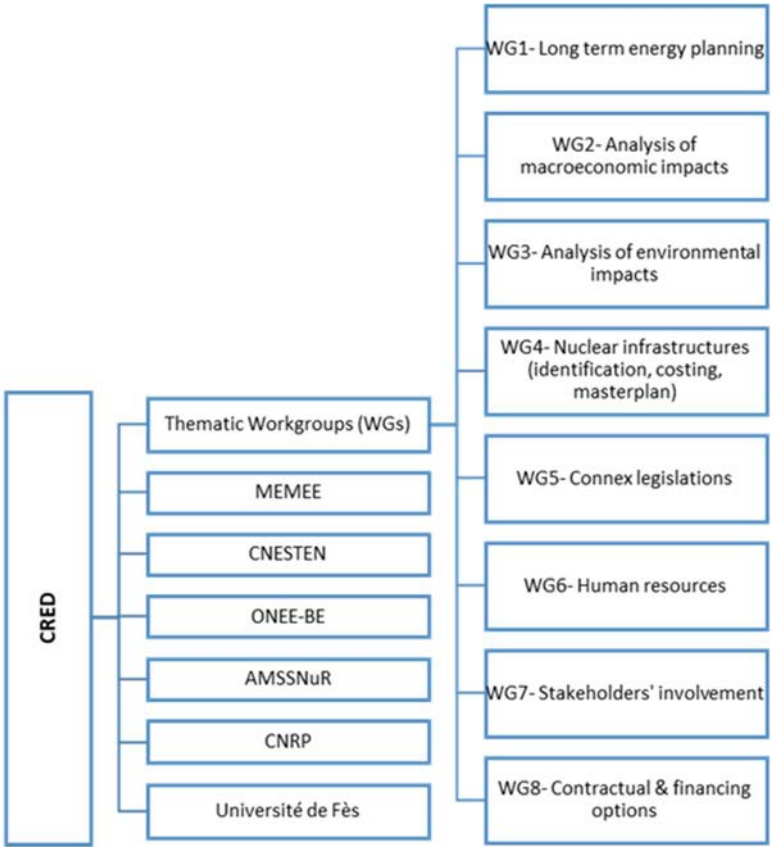

FIG. III.3. Operational structure of the CRED Committee (Courtesy of CRED)

Figure III.4 illustrates the CR development and related verification process. The following roles are illustrated:

— The activity of developing and summarizing the studies and strategies is performed at the level of the working groups;

— The activity of integrating the various summaries into the CR is done at the level of the 'Drafting Group';

— In addition to the 'Drafting Group', a 'Reading Group' was set-up to ensure a first internal review of the report. The Reading Group is composed of senior/experienced members of the CRED; they do not belong to the Drafting Group;

— The verification process provides also for an additional second external review of the report by the IAEA; however, this stage is subject to approval of the parent Ministry (MEME).

The final version of the CR will be submitted to the parent Ministry (MEME) to inform the decisions of this governmental department - and other competent Moroccan authorities - on the structure of the long-term energy mix of the country and whether nuclear power can be part of that mix or not.

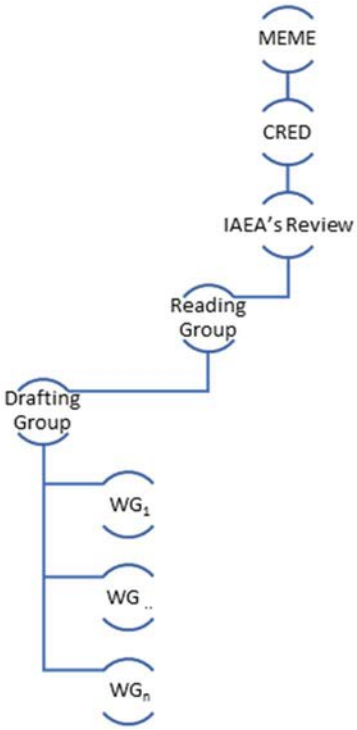

FIG. III.4. Development of the Moroccan CR and related verification process (Courtesy of ONEE)

III.4. TIMELINE

Drafting of the CR for Phase-1 was set as the goal of the CRED's Action Plan (2016–2019). This report is currently available in the form of a draft. The core text of the report consists of around 95 pages. The report is written in French and has an executive summary part written in French and Arabic. It is supported by a number of attachments in the form of summaries or complete reports of the main studies and strategies.

In broad terms, the development process of the Moroccan CR consisted of the following stages (Figure III.5):

- A 1st stage of around 3 years during which the studies and strategies forming the basis of the report were developed (being noted that some of these studies are still being completed or refined);
- A 2nd stage of around 1 year, during which summaries of the studies and strategies were prepared;
- An ongoing 3rd stage where the different summaries elaborated in stage n°2 are being integrated in a single report, which is, the CR.

The drafting process of the CR is expected to be finalized in the early quarter four of 2021.

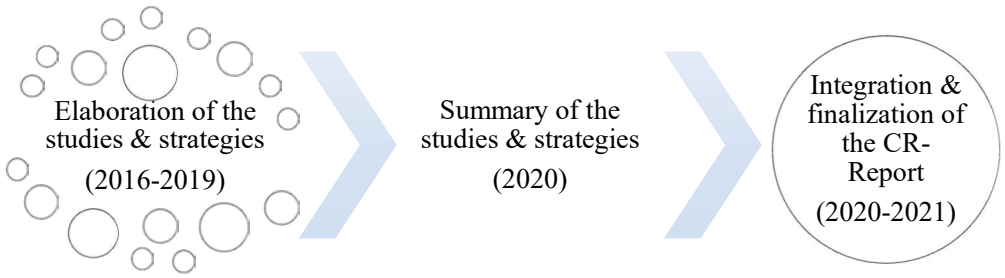

FIG. III.5. Schedule for development of the Moroccan CR (Courtesy of ONEE)

III.5. INPUTS CONSIDERED

Drafting the CR, the 'Drafting Group' used data and information drawn essentially from the following sources:

- Previous self-evaluation reports (SERs) developed by CRED (SER-2010, SER-2015);
- Reports of previous siting and techno-economic studies developed by ONEE (so-called SOFRATOME's studies) and their recent updates;
- Domestic information and publications describing the situation of the water and energy sectors in Morocco (data from ONEE's branches (ONEE-BE, ONEE-BO), national publications on challenges posed by climate change to the water and energy sectors, etc.);
- Reports of the recent complementary studies (CSs) and sectorial strategies (SSs) developed by the various working groups of the CRED;
- International public information describing the global status and development prospects of nuclear energy, non-electric applications of nuclear power, costs of nuclear energy, main nuclear vendors, and their reactor designs (information available on IAEA's website, vendors' websites, etc.).

III.6. TABLE OF CONTENT AND FORMAT

The question of the CR content was particularly difficult to settle among the members of the 'Drafting Group'.

During a national workshop held jointly with the IAEA in Casablanca, November 2019, national participants (most of whom are members of the 'Drafting Group') came up with two alternative structures for the CR:

- The first structure (which might be referred to as the 'Quantitative Structure') was proposed by representatives of ONEE. This structure was designed with the goal to

provide the national decision-makers (NDMs) with a complete picture of the costs and benefits associated with a nuclear power programme;

— The logic of this structure was to prepare an ultimate decision parameter (in the specific form of the 'economic net-present value' (E-NPV) of the programme) upon which NDMs can formulate their decision;

— The second structure (which could be referred to as the 'Qualitative Structure') was proposed mostly by representatives of the other organizations of the CRED. This structure had the advantage of providing a much fuller/informative picture, although in a descriptive/qualitative form, to the NDMs.

  This second structure can be best qualified as a mosaic of facts and information describing the needs and challenges of the country in the energy and water sectors; the situation, realities and prospects of the nuclear power industry; possible industrial applications of the nuclear power option for Morocco; advantages and risks of this option for Morocco; etc. Compared to the first structure, this second structure is more descriptive and puts less emphasis on costs and benefits aspects associated with the proposed nuclear power programme.

In view of the differences outlined above, the quantitative structure is suitable in decision-making situations where the goal is to enable a 'rational' decision on nuclear power, while the qualitative structure is more adapted for informing 'intuitive' decisions on nuclear energy.

Although different in terms of their logic, both structures would have a section on the infrastructure requirements of the nuclear power option.

Because of the large data requirements of the quantitative structure, the 'Drafting Group' opted for an intermediate structure between the two candidate formats.

The table of content of the preliminary version of the CR is given below:

— **List of Acronyms, Abbreviations and Symbols;**
— **List of Tables and Figures;**
— **Executive Summary;**
— **Part I. Introduction;**
  I.1 Presentation of the CRED
  I.2 Presentation of CRED's work / reflection methodology (Milestones Approach)
— **Part II. Situation and Challenges of the Energy and Water Sectors in Morocco;**
  II.1 Situation and challenges of the energy sector
  II.2 Situation and challenges of the water sector
— **Part III. Global Status of Nuclear Energy and its Industrial Implications;**
  III.1 Global status of nuclear power
  III.2 Costs of nuclear energy
  III.3 Industrial applications of nuclear power of interest for Morocco & potential adoption roadmap
  III.4 Potential site and technology options
— **Part IV. Opportunities of the (Electro-) Nuclear Power Option for Morocco;**
  IV.1 Contribution to long-term supply of energy
  IV.2 Macro-economic impacts and social benefits
  IV.3 Environmental impacts

— **Part V. Infrastructure Requirements of Nuclear Power;**
  V.1 Infrastructure evaluation process (2009–2015)
  V.2 CRED's work organization and activities post-INIR mission (2016–2021)
  V.3 Current status of Morocco's infrastructure for nuclear power (2021)
— **Part VI. Conclusions;**
— **Part VII. Recommendations and Action Plan for the Next 10-20 Years;**
— **References;**
— **Appendices.**

III.7. KEY DRIVERS FOR DECISION-MAKING

As explained in the above section, in an ideal situation where all decision-enabling information would be available, the 'national position' regarding the nuclear power programme would be methodologically formulated following the rational type of decision-making processes based on a quantitative parameter (such as the E-NPV).

However, the reality of the governmental decision-making process is always far from this rational ideal situation. This is particularly true for the decisions of the energy sector involving the nuclear power option.

In fact, many non-conventional characteristics of this option complicate the decision-making exercise. These include:

— Technological complexity,
— Large scope of the involved supply chains,
— Plurality of involved actors (owner-operators, regulators, contractors, financiers, etc.),
— Strategic and geopolitical considerations associated with supply chain options,
— Large magnitude of involved costs (including the costs of a potential nuclear accident),
— Uncertainties surrounding costs,
— Long time-scales involved (in particular for completing construction activities and for the proper management of radioactive wastes and spent nuclear fuel),
— Need to associate the public and other interested parties, etc.

For all these considerations, the national decision-making process can only be of intuitive/sovereign nature.

In the case of Morocco, the following considerations (most of which are covered qualitatively or quantitatively in the CR) are expected to drive the future national decision-making process concerning the nuclear energy option:

— Geopolitical implications of the NPP programme (in particular, in relation to the necessity for the country to engage with neighbouring States as stakeholders and to establish lasting relationships through appropriate IGA agreements with strategic vendor-countries);
— Costs and benefits of the NP programme (including benefits associated with the potential utilization of local uranium resources, security of energy supply, macroeconomic, social, and environmental impacts, etc.);
— Availability of national resources to support the programme (e.g.: human resources, uranium, capable industries, or public finance);

— Technological complexity and possibilities of industrial localization.
— Financing possibilities particularly through international financing mechanisms;
— Other non-energy benefits of the programme;
— Stakeholders' engagement (including, the level of support of the public).

III.8. LESSONS LEARNED AND SUGGESTIONS

The drafting of the CR faced several challenges.

Some of these challenges were of general nature. Examples of these included the difficulty to reach group consensus on the report's content or to meet key deadlines. Such difficulties were caused essentially by the team-work nature of the drafting activity which required collaboration of multiple contributors coming from different entities and backgrounds (thus not having necessarily the same understanding of the issues under consideration and the work methodology). Also, differences in time management at the level of the participating organizations sometimes resulted in significant delays in preparing key input documents for the CR.

The Moroccan experience demonstrates the importance of the close involvement of the NEPIO's leadership in partially solving some of the above-mentioned challenges. In the case of Morocco, this involvement was ensured through regular reporting to the top management of the CRED on the progress made in the CR drafting process. In certain cases, CRED's leadership directly intervened to assist with advancement of the work on CR development. The Moroccan experience also suggests that the association of an international consultant to the activities of the NEPIO in Phase 1 might be necessary to overcome or even avoid some of the above-listed problems and probably others. However, the objective to develop local capabilities led Morocco not to opt for such a choice.

APPENDIX IV.
CASE STUDY: POLAND

IV.1. INTRODUCTION

Polish Nuclear Power Program (PNPP) was approved on 28 January 2014 by the Council of Ministers and constituted the basic document for the national decision. It plays in Poland the role of a Comprehensive Report. Preparation and submission to the Council of Ministers of the PNPP fulfils the obligations imposed on the Minister responsible for the energy sector under the Article 108 of the Polish Atomic Law. The validity of the PNPP of 2014 was originally envisioned for the period 2014–2024, likewise the Programs cost/expanses were estimated for this period.

On the 2nd October 2020 the Program was updated by the Government. The rationale for the implementation of nuclear power in Poland has not changed since the adoption of the first version of the Program in 2014. It rests on three pillars: (1) energy security; (2) climate and the environment; and (3) economy.

After five years of implementation there was a need to adjust the Program to the current conditions and circumstances, including new challenges which emerged in the last five years.

The update considered changes in the economic conditions in Poland and in the world market and it was adjusted to the changes of the national and international law. At the same time, it also follows the IAEA recommendations and EU regulations.

The most important modifications of the PNPP introduced in 2020 included:

- New investment timeframe with the first nuclear power plant of 1–1.5 GWe capacity commissioned around 2033;
- Selection of the same technology for all 6 nuclear power units planned for construction till 2043 (target 6–9 GWe);
- Modification of formal and legal conditions for the construction and operation of nuclear power plant;
- New business and operational model for the project;
- Bigger and extended role of the State in the Program;
- Strengthening the position of the National Atomic Energy Agency (NAEA) responsible for nuclear regulation in Poland;
- Reference to emerging new nuclear technologies (SMR and HTGR) and possibilities of their future development in Poland.

The preparation and implementation of the Program and its update has been coordinated by the Department of Nuclear Energy at the Ministry of Climate and Environment. Any deviation from the implementation of an objective of the document triggers a root cause analysis and results in taking corrective actions.

According to the Polish Atomic Law, the Program will be updated every four years, which will allow to regularly verify its assumptions and implementation cost data.

New economic and financial analysis will be undertaken, and a detailed overview of implemented activities will be considered in each update. The updated Program will be submitted by the NEPIO to the government for approval.

IV.2. BACKGROUND INFORMATION OF THE PROGRAM DEVELOPMENT

The PNPP is a complex document that describes the scope of the measures to be taken to effectively introduce nuclear power in Poland. As a document it plays a role of a CR as defined in the IAEA Milestones publication [1] and in the publication on *Building a National Position for a New Nuclear Power Programme* [2].

The PNPP contains all major elements of the CR defined in the aforementioned IAEA publications and describes:

- Broad economic justification (macroeconomic pre-feasibility study) for the construction and operation of nuclear power plants in Poland;
- The roles and responsibilities of the institutions competent for the implementation of the nuclear power programme as well as issues related to nuclear safety and radiological protection;
- The schedule for the construction of the country's first and second NPPs and the preparation of the regulatory, investments and organization framework for the whole project.

IV.3. ROLES AND RESPONSIBILITIES

Preparation of PNPP was carried out by the Nuclear Energy Department (NED) at the Ministry responsible for the energy sector in Poland. There were broad inter-governmental consultations during the whole process. At the beginning, NED identified the governmental institutions and agencies and major stakeholders to be engaged in the Program and them with request for the input and proposals to the Report.

After receiving the required input, the experts of NED prepared the first draft of the PNPP document. After approval by the management of the Ministry, the draft was submitted to the broad public consultations process, including transboundary consultations with neighbouring countries under the Espoo and Archus Conventions.

After thorough evaluation of comments, remarks and opinions collected during the consultation the final draft was prepared by the experts of NED and submitted for approval to the management of the Ministry, then to the various governmental committees and finally to the Council of Ministers.

Figure IV.1 shows the governmental institutions engaged in the preparation of the Report. These include all the most important economic and political governmental agencies such as the Ministry of Finance, the Ministry of Development, Labour and Technology, the Ministry of Infrastructure, the Office of the Government’s Plenipotentiary for Strategic Energy Infrastructure, the Ministry of Foreign Affairs, the Ministry of State Assets, the National Atomic Energy Agency (competent for nuclear safety), etc.

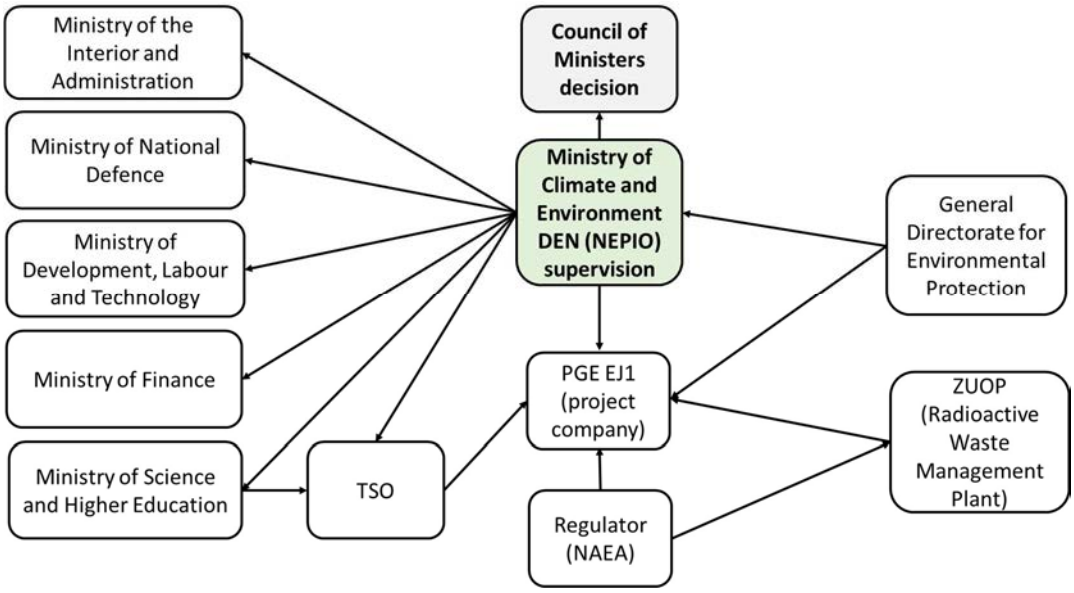

FIG. IV.1. Governmental institutions involved in the preparation of the Comprehensive Report (PNPP) (Courtesy of the Ministry of Climate and Environment, Poland)

IV.4. ROADMAP

The PNPP has its roots in 2005, when the Council of Ministers decided to include nuclear power in the *Energy Policy of Poland to 2025*[1] to diversify energy sources and reduce carbon dioxide and sulphur emissions.

Another document of a very high significance for further work on implementation of nuclear power in Poland was the Resolution of the Council of Ministers No. 4/2009 of 13 January 2009 finding it necessary to prepare the PNPP.

As a complementary document to the above resolution, on 11 August 2009 the Council of Ministers adopted the timeline for nuclear power. In 2011, on proposal from the Council of Ministers, the 'Sejm' (Parliament of Poland) adopted a package of acts enabling the construction of nuclear power plants in Poland (with only 1 vote against) and setting up the legal framework for the Program. The legislative package was widely consulted with the public at several stages (draft assumptions, draft act and regulations). The scope and content of the PNPP take into account the above-mentioned legislative package, international law and the EU regulations and the IAEA's recommendations.

In 2014, the Council of Ministers based on proposal of the Minister of Energy adopted the PNPP, after several rounds of in-depth and long public consultations, including two years cross-border consultations with the Polish neighbours.

Figure IV.2 illustrates the roadmap and development of the Program so far.

[1] Energy Policy of Poland to 2025, a document adopted by the Council of Ministers on 4 January 2005 (Monitor Polski [M.P.] No. 42, item 562).

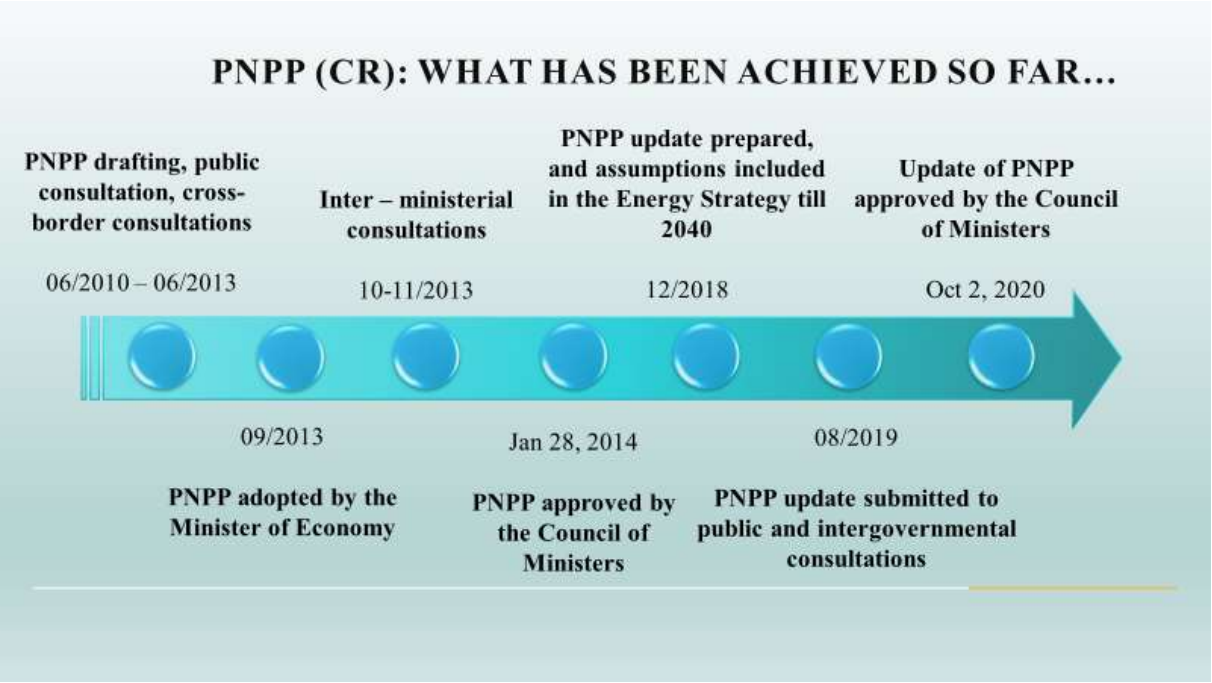

FIG. IV.2. Roadmap for the development of the PNPP
(Courtesy of the Ministry of Climate and Environment, Poland)

As it was mentioned before, the PNPP is consistent with the European Commission's 2018 strategy *A Clean Planet for All*[2]. The PNPP is also aligned with the objectives of the document entitled *European Green Deal* which will replace the *Europe 2020 Strategy* as the main strategic document for the European Union.

It takes into account the assumptions of the Energy Policy of Poland to 2030, implementing objective No. 4 of the Policy: diversification of the energy generation structure through the introduction of nuclear power. It is also consistent with the Energy Policy of Poland to 2040, implementing direction No. 5 of the Policy: Implementation of nuclear power (objective: reduction of the energy sector's emissions and ensuring operational security of the system). At the same time, implementation of nuclear power is one of the key measures in the 'energy security' dimension identified in the *National Energy and Climate Plan (NECP)*, submitted to the European Commission in December 2018.This measure is characterized by positive interaction with other NECP dimensions: 'reduction of emissions' and 'scientific research, innovation and competitiveness'.

In line with the roadmap updated in 2020, Figure IV.3 on the next page shows the investment implementation schedule.

[2] Communication from the Commission to the European Parliament, the European Council, the European Social and Economic Committee, the Committee of the Regions and the European Investment Bank of 28 November 2018, *A Clean Planet for All. A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy*, COM (2018) 773 final.

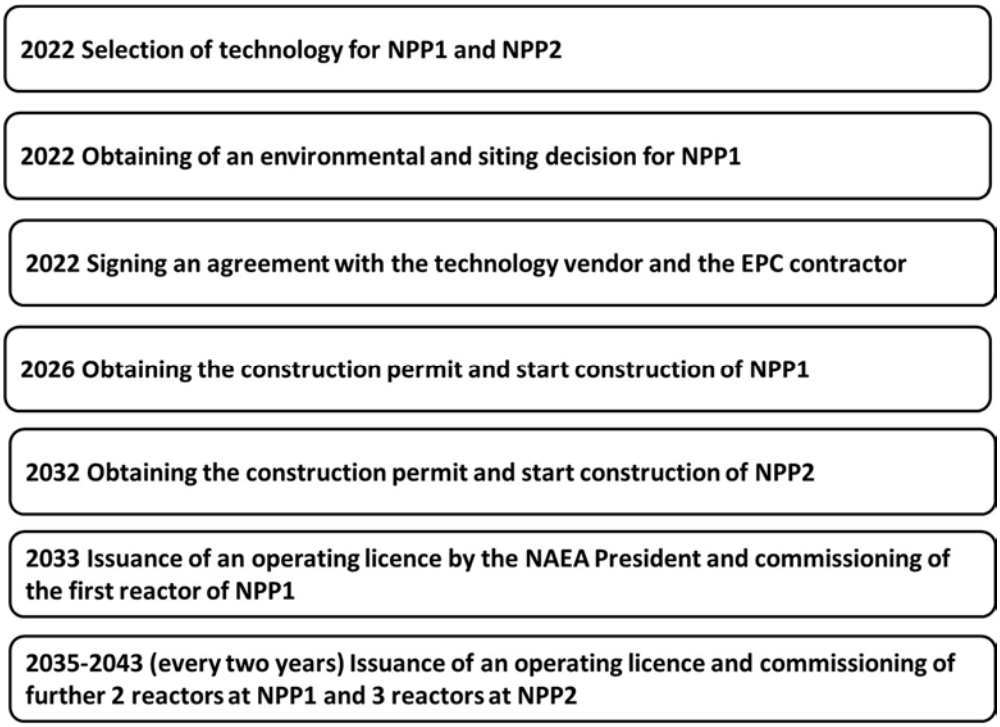

FIG. IV.3. Investment implementation schedule as of April 2021
(Courtesy of the Ministry of Climate and Environment, Poland)

IV.5. INPUTS CONSIDERED

The update of the PNPP was supported by various analyses and studies ordered by the NEPIO (NED, Ministry of Climate and Environment). The studies were prepared by the competent and qualified organizations (i.e. energy agencies, technical support organizations, and the National Grid Operator) which covered mostly the technology, safety, economics, and financing aspects of the Program. Some of those reports/studies were quoted and partially included in the Program and its update, and some attached to the PNPP document as its vital part.

The key economic analyses for the update of the Program were carried out in May 2020 by the Office of the Government Plenipotentiary for Strategic Energy Infrastructure and PSE S.A (Polish National Grid Operator). They were used by the Ministry of Climate as an economic justification for the Program. The analysis showed among other things that according to the total electricity cost account, provided that appropriate development conditions are ensured, nuclear power plants are among the lowest cost generating units in the 2050 perspective.

The cooperation with the IAEA played an important role in preparation of the PNPP and its guidance was taken into account.

To a large extent, the content of the PNPP follows and addresses the 19 infrastructure issues contained in the IAEA Milestones publication [1].

The results of the IAEA's INIR mission hosted by Poland in 2013, and the INIR follow-up mission in 2016, played an important role during the process of drafting the PNPP. Some recommendations and suggestions elaborated and raised by the missions were utilized in the final version of the PNPP.

An important role is also being played by the Integrated Work Plans (IWPs), which are reviewed and agreed with the IAEA every two years. The IWP helps Poland to effectively implement its Nuclear Power Program, by assistance in the preparation and evaluation of various activities included in the PNPP document and analyses/studies needed for the Program.

IV.6. OBJECTIVES AND CONTENT OT THE PROGRAM

IV.6.1. Objectives of the PNPP

The key goals of the Nuclear Program result from the Long-Term Energy Strategy of Poland. The most important objectives and assumptions of the Program are the following:

- Energy security: The introduction of nuclear power plants to the energy mix in Poland will reinforce the energy security mainly through the diversification of fuel base in Polish power system, the diversification of the directions of primary energy sources deliveries and replacing the high carbon-emission coal-fired power plants - operating in the base load of the system - with available and scalable emission-free units;
- Climate and environment: The Program confirms that, in the Polish context, nuclear energy will allow to radically decrease emission of greenhouse gases (GHG) from the power sector as well as low external environmental costs. The examples of industrialized and highly developed countries such as France and Sweden prove that nuclear energy contributes to effective, fast decarbonization of the power sector. Reduction of GHG emission is a one of key goal for the Polish Nuclear Power Program;
- Economic aspects: According to the PNPP, the nuclear power plants can reduce the increase in the energy costs for the recipients and even contribute to lowering the costs, taking into account the entire bill for the end user. That is because nuclear is one of the cheapest sources of energy, taking into consideration full range of costs associated with electricity generation (investment, systemic, network, environmental, health and other external costs).

The PNPP also addresses the following issues:

- Nuclear safety remains the priority at each stage of the implementation of the PNP Program which was underlined very strongly in the document. The significance of this area is so high that the entire new strategic document was devoted to it, entitled *Nuclear Safety and Radiological Protection Strategy*;
- Nuclear waste: the issue of handling radioactive waste and spent nuclear fuel was extensively described in the 2014 version of the PNPP. In the addition to it *The National Plan for Radioactive Waste and Spent Nuclear Fuel Management* was approved by the Government in 2015 and was recently updated by the Ministry of Climate and Environment and accepted by the Government in November 2020. The Plan is a strategic document for Poland in that respect.

Other important objectives of the Program include:

- Development of institutional background for nuclear power;
- Enhance and sustain social support for the development of nuclear power – for instance, through enhanced social knowledge in this area;
- Reinforce the national emergency service for radiation events with respect to the functioning of nuclear power, incl. through reinforcement of the national radiation monitoring system;
- Provision of qualified staffing for the development and functioning of nuclear power;
- Development of powerful and efficient research facilities for nuclear power;
- Enhance the innovation of the technological standard of Polish industry;
- Provide the conditions for reliable supplies of fuel to NPP(s);
- The National Power System (NPS) to be prepared for the development of nuclear power;
- Provide stable economic and financial conditions for the development of nuclear power.

The PNPP also addresses the priority tasks of the Government's administration that will enable to achieve the objectives of the PNPP. They have been grouped within five (5) basic areas:

- Human resources development;
- Infrastructural development;
- Support for the national industry;
- Reinforcing the nuclear safety regulator;
- Development of communication and social information strategies.

Apart from the above-mentioned areas the PNPP also contains:

- An evaluation of the impacts of nuclear power on the national economy, employment, GDP growth, innovation, industrial development;
- A preliminary technology assessment and justification for the selection of the reactor technology to the Polish Program;
- Information on the site selection process and necessary grid development;
- Consideration of financing and ownership options and criteria for a foreign partner selection for the Program execution;
- Description of technical and local infrastructure needed for the smooth construction process and operation of nuclear power plants;
- Plans for further development of a comprehensive legal framework for the construction and operation of nuclear power plants.

IV.6.2. Content of the PNPP

The PNPP consists of sixteen main chapters as presented below:

- ABBREVIATIONS AND ACRONYMS
- CHAPTER 1. INTRODUCTION
- CHAPTER 2. THE OBJECTIVES AND SCHEDULE OF THE PNPP
- CHAPTER 3. NUCLEAR POWER IN THE CONTEXT OF LONG-TERM ENERGY POLICY
- CHAPTER 4. ANALYSIS OF THE COSTS AND THE ECONOMIC RATIONALE BEHIND THE DEVELOPMENT OF NUCLEAR POWER

— CHAPTER 5. ORGANIZATION OF TASKS FOR IMPLEMENTATION OF THE PNPP
— CHAPTER 6. ENSURING THE CONDITIONS FOR THE SAFE USE OF NUCLEAR POWER
— CHAPTER 7. PNPP IMPLEMENTATION COSTS AND SOURCES OF FUNDING
— CHAPTER 8. CHOICE OF SITE
— CHAPTER 9. PREPARATION AND REQUIRED CHANGES OF NATIONAL TRANSMISSION SYSTEM
— CHAPTER 10. ENVIRONMENTAL PROTECTION
— CHAPTER 11. ENSURING SUPPLY OF SPECIALISED STAFF/HUMAN CAPITAL
— CHAPTER 12. TECHNICAL RESOURCES AND RESEARCH FACILITIES OF THE PNPP
— CHAPTER 13. SAFETY OF NUCLEAR FUEL SUPPLIES
— CHAPTER 14. ADMINISTRATION AND MANAGEMENT OF RADIOACTIVE MATERIALS ACROSS FUEL CYCLE
— CHAPTER 15. PARTICIPATION OF THE POLISH INDUSTRY IN THE PNPP
— CHAPTER 16. PUBLIC INFORMATION AND EDUCATION IN THE FIELDS OF NUCLEAR POWER AND DELIVERY OF PNPP

IV.7. LESSONS LEARNED FROM THE PREPARATION AND DEVELOPMENT OF THE PROGRAM.

The process of development of a complex document such as a CR encounters many challenges and problems during usually long-time frame for its preparation and final presentation to the decision makers – the government for the approval.

The Polish case confirmed that there are certain presumptions and conditions which enable successful conclusion of the work:

— Existing and approved by the Government's long-term energy policy, justifying introduction of nuclear power into energy mix;
— Strong political leadership and support from the decision makers at each stage of the CR development;
— Establishment of NEPIO or its substitute as a coordinating body with broad and strong mandate and direct access to the decision makers;
— Robust and effective cooperation between all major stakeholders in a country: NEPIO, the Nuclear Regulator, future investor–operator, Technical Support organization (TSO) and other regulatory and supervising institutions,
— Engagement at each stage of the process of competent and qualified consultants and energy experts, including academia, TSO, consulting and advising companies. In case there is a lack of such entities in embarking countries, involving foreign knowledgeable organizations in the process may help;
— Broad engagement of public and society during the final stage of development of the CR. It will increase public awareness and support to the CR and make it easier for the decision makers to undertake and approve positively the national decision on deploying nuclear power;

— Sufficient funding and allocation of resources for the development of the CR and the Program, including hiring competent staff for the NEPIO and other major stakeholders, and to support effective cooperation with the consultants and experts from the energy sector;
— Development of broad cooperation with the IAEA on various aspects of the Nuclear Power Program and with other international partners with competence and knowledge in nuclear sector.

IV.8. CONCLUSIONS

The recent update of the PNPP approved in October 2020 confirmed the important and strategic role of this document.

Taking into account the results of broad economic and financial analysis contained in the Program, the government of Poland decided to uphold its decision to deploy nuclear power as part of the clean energy transformation indispensable to achieve Poland's net zero emission climate objectives.

At the same time, thanks to nuclear power, it will be possible to diversify the structure of the Polish electricity generation capacity at a reasonable cost. Poland needs such a stable, reliable source of generation that will respond to the forecasted growing demand for electricity, which is inevitable taking into consideration upcoming electrification of transport and heating in Poland. At the same time nuclear power capacity will replace a significant part of the fleet of old coal-fired power plants, many of them reaching their lifetime soon.

APPENDIX V.
CASE STUDY: ROMANIA (CERNAVODA 2)

V.1. BACKGROUND

This case study refers to the CR related to the extension of existing national nuclear power programme and associated infrastructure, which was developed and approved by the Romanian Government in 2000.

Romania initiated their national nuclear power programme in 1970–1975, when the development of the national nuclear infrastructure began. The decision to build the first nuclear power unit in Cernavoda was adopted, the nuclear technology was selected (CANDU 6) and the necessary commercial contracts were signed in 1978.

The construction program of five CANDU 6 Units on the Cernavoda site started in 1980, but due to the lack of appropriate management was delayed, and later in 1990 stopped. In 1991, the Romanian Government decided to complete construction of Unit 1 only. Other units, at different stages of construction, are being kept on hold.

Unit 1 (705 MWe) entered in commercial operation in December 1996. Based on the successful operation of this Unit, the Romanian Government decided in 2001 to resume construction of Unit 2 (same nominal power as Unit 1), which began to produce electricity in November 2007. With these two nuclear units in operation, Cernavoda NPP meets every year around 20% of the national electricity needs.

There are two more nuclear units on the same Cernavoda site (Units 3 and 4), considered in the national energy strategy as potential projects to be completed by 2030.

The NPP owner shareholders approved in 2013 cessation of the Unit 5 construction due to non-conformance with the applicable requirements. The destination of the structures already built was changed for other activities of NPP owner (NPP site Emergency Control Centre).

V.2. ROLES AND RESPONSIBILITIES

After completion of Cernavoda Unit 1, the Government of Romania established the Inter-Ministerial Committee for Unit 2 Cernavoda for the analysis of the conditions for extension of the national nuclear power program and associated infrastructure, as per national energy strategy, as shown on Figure V.1.

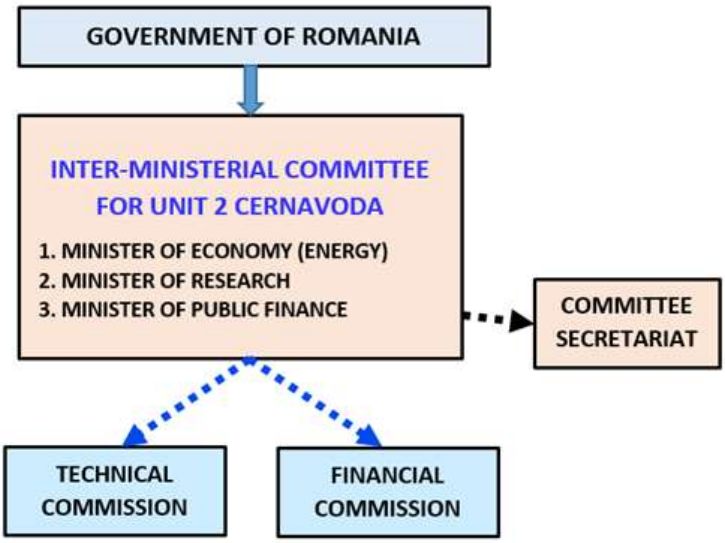

FIG. V.1. Organization of the Inter-Ministerial Committee for Unit 2 Cernavoda
(Courtesy of Consultanta Proiecte Nucleare SRL, Romania)

This Inter-Ministerial Committee was chaired by the Minister of Economy and consists of the Minister of Research and the Minister of Finance. It played the role of the NEPIO, ensuring coordination of all stakeholders involved in the national nuclear power program extension.

The Committee was supported by two commissions, for technical and financing aspects, respectively, composed of specialists and representatives of the different stakeholders.

The Technical Commission consisted of representatives of the Ministry of Economy, the National Electricity Grid operator, the competent Environmental Protection Agency, the Chamber of Commerce, as well as the NPP owner/operator and the Regulatory Body.

The Financial Commission consisted of representatives of the Ministry of Public Finance, the National Bank, the Export-Import Bank, as well as representatives of non-governmental organizations in the field of nuclear energy, radiation protection and environmental protection). Both commissions invited well-known experts in the field of nuclear energy, to receive their authorized advice.

A permanent Secretariat had the role to ensure smooth and rapid communication between the Committee, commissions and various ministries involved, as well as to draft the Committee's decisions and archive the documentation related to the Commissions' work.

The main objective of the Inter-Ministerial Committee was to obtain the approval of the Romanian Government (‘knowledgeable decision’) for the extension of the national nuclear power program and associated infrastructure requested for the completion of Cernavoda Unit 2.

To this end, it was decided to elaborate a programmatic document to present all the technical and financial issues related to the national infrastructure needs, jointly with the action plan to address the identified weaknesses. This document related to extension of the nuclear program was the equivalent of the CR defined in the IAEA Milestone Approach [1].

Preparation of this report was broken down as follows:

— The **Technical Commission**, led by the General Manager (CEO) of the NPP's owner/operator, was responsible for the development of the technical sections of the report, including all the infrastructure aspects to be considered in terms of planning and costs. The role of the Regulatory Body (RB) representatives was to explain and support the need to expand and reorganize the national safety infrastructure, corresponding to the expansion of the nuclear program, and measures to ensure an effectively independent RB through direct reporting to the Government;
— The **Financing Commission**, led by the Deputy Minister of Finance aware of the national budget and level of indebtedness, was tasked with identifying required funds for the infrastructure extension and alternatives for the project financing, including state budget participations, and with recommending the most appropriate solution.

After approval in the plenary session of the Inter-Ministerial Committee, the report was sent to the Government for approval. In the approval process, following discussions with the prime minister's office, no additional information was requested. government discussed the report in a normal meeting, in which the project finalization was decided. The presence of the three ministers in the Inter-ministerial Committee created an atmosphere of trust, which facilitated the approval of the report by the Government albeit several members were not familiar with nuclear energy.

Note: No external consultants were involved in the drafting of the report itself.

V.3. PROCEDURAL ARRANGEMENTS

The Inter-Ministerial Committee was a temporary entity, especially created for the extension of the national nuclear power program until Unit 2 Cernavoda completion and introducing a full management system was not found necessary. However, the statute of the Committee and support commissions had established a number of management rules, including an internal procedure (work instruction), which detailed the requirements for the report development, based on the 4-element approach ('Plan, Do, Check, Act'). This procedure also included the detailed content of the CR and responsibilities inside the Inter-Ministerial Committee for CR preparation, review, and approval.

This procedure also specifies:

— The interactions on the CR content with other ministries or stakeholders who did not have representatives in the Inter-ministerial Committee. Interactions include letters of information, request for opinions or invitation at the Inter-ministerial Committee meetings;
— The rules and responsibilities for communicating with the public and the media on the extension of the national nuclear power programme.

V.4. TIMELINE

The main steps of CR development and the schedule for discussions, verifications and approval by the Romanian government are shown in Figure V.2.

Activities	Start date	Finish date	Schedule	Duration
Updating Pre-Feaseability Study	Jan 1998	Dec.1998		12 months
Development of CR	Jan. 1999	June 1999		6 months
Disscution on the CR	July 1999	Sept. 1999		2 months
Verifications of CR	Oct. 1999	Nov. 1999		2 months
Release of CR by IMC	-	Dec. 1999		1 month
Approval by government	-	Jan. 2000		1 month

FIG. V.2. Main steps for Cernavoda Unit 2 CR development and approval
(Courtesy of Consultanta Proiecte Nucleare SRL, Romania)

The sequences of national nuclear power infrastructure extension and project activities after CR approval are indicated in Figure V.3.

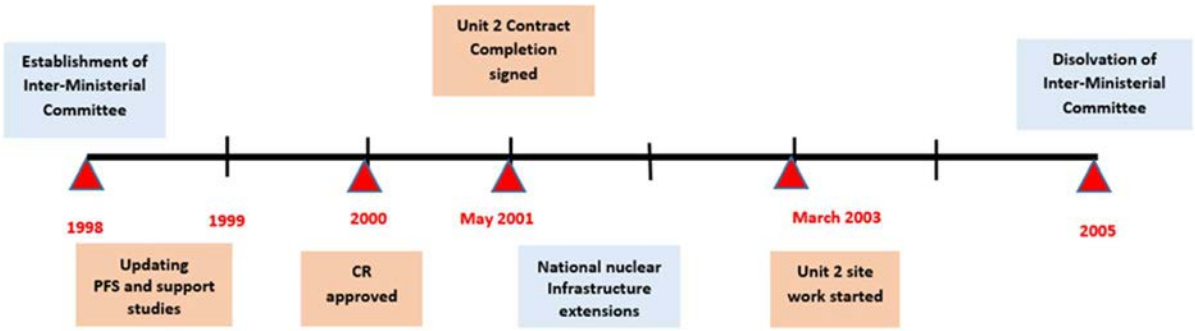

FIG. V.3. Effect of the CR approval on the evolution of Cernavoda Unit 2 Project
(Courtesy of Consultanta Proiecte Nucleare SRL, Romania)

Responsibilities for national nuclear power infrastructure expansion actions have been specifically allocated to ministries and national organizations involved in the nuclear power programme.

The NPP owner/operator closed the commercial contract in 17 months after CR approval by the Government.

The Inter-Ministerial Committee continued working on the necessary support for national infrastructure extension and project financing, obtained in March 2003, when the work on the site started. The Inter-Ministerial Committee was dissolved in 2005 when its mission terminated, and commissioning of Unit 2 started.

V.5. INPUTS CONSIDERED

Because a pre-feasibility study of the nuclear program in Romania had been carried out a long time ago, it was necessary, independently of the Inter-Ministerial Committee, to update some specific studies on:

— Strengthening the Regulatory Body for nuclear safety, security, and safeguards;
— Specific requirements for environmental protection, after integration in the European Union;
— Development of NPP owner/operator for an additional nuclear unit;
— National electrical grid improvements and reliability required for a new nuclear unit;
— Development of human resources according to the new requirements of the nuclear program, for all involved organizations;
— Capacity to ensure uranium and doubling the production of CANDU 6 nuclear fuel;
— The ability of the local industry to provide the necessary equipment/materials and specialized labour force, according to the new requirements.

These studies were outsourced and performed by local consultants, previously involved in the Pre-Feasibility study. The review of the updated studies was carried out by the Technical Commission and finally approved by the Inter-Ministerial Committee.
All these specific studies updating the former Pre-Feasibility Study, provided inputs for the CR prepared by the Inter-Ministerial Committee.

Other national strategies and studies were also considered, such as:

— National energy strategy, medium and long-term programmatic document, which established the development of the national energy system, including the national nuclear power programme;
— National strategies for Romania's integration into the European Union developed for different fields (e.g.: legal and regulatory frameworks, environmental protection, and social protection);
— Study of participation of the national industry in the realization of the nuclear energy program carried out by ROMATOM, the association nuclear industry in Romania.

These strategies were approved by the Romanian Government, some of them resulting from negotiations with the European Commission as part of Romania integration and alignment with the European requirements.

Note: International consultants contributed to the production of these inputs, providing their recognized international experience and expertise giving credibility to their work.

V.6. TABLE OF CONTENT AND FORMAT

The CR presented in this case study was an independent, clear, and concise document, making only references to the strategies and studies above mentioned. The body of the report consisted of an executive summary of 30 pages plus 15 pages of annexes including detailed action plans. The CR content for Cernavoda Unit 2 is presented in Table V.1, which also shows how the Milestones infrastructure issues were addressed, albeit the IAEA Milestones document did not exist at that time.

Table V.1. COMPREHENSIVE REPORT: CONTENT FOR PROGRAMME EXTENSION FOR CERNAVODA 2

No.	Cernavoda 2 CR Sections	Infrastructure Issue
0	Executive Summary	n/a
1	Contribution of Cernavoda 2 to Electricity Production in Romania and Framing in the National Energy Strategy	1. National Position
2	Performance of Cernavoda 1 and CANDU 6 Units in the World	n/a
3	Importance of Fulfilment of the Safety, Security, Safeguards Requirements and Role of the Government	3. Safety 6. Safeguard 15. Security
4	Main Technical-Economic Indicators of Cernavoda 2 (including requested Investment Capital (US $/installed MWe) and Predicted Electricity Price)	3. Management
5	Cernavoda 2 Proposed Contractual Approach (EPC)	3. Management
6	Proposed Cernavoda 2 Project Implementation Schedule	3. Management
7	Estimated Costs for Project Implementation and Other Activities Development, including Social Program in Cernavoda	4. Funding and Financing
8	Financial Plan (Equity from state Budget, Borrowed Loans with State Guarantees)	4. Funding and Financing
9	Specific Requirements for Romanian Legal Framework (Transition to UE Integration)	5. Legal Framework
10	Licensing Processes of Cernavoda 2 by National Regulators (NPP Site already Licensed)	7. Regulatory Framework
11	Emergency Planning at Local and National Levels	14. Emergency Planning
12	Other Authorisation, Permits, and Agreements from Romanian Authorities, including Environmental Agreement	13. Environmental Protection
13	Requirements for Electrical Grid Developments for Cernavoda 2 Integration in National Grid (Cernavoda 400 kV station)	9. Electrical Grid
14	Uranium and Nuclear Fuel CANDU 6 type requirements (Doubling the Fabrication Capacity in Romanian Nuclear Fuel Plant and Uranium Supply)	16. Nuclear Fuel Cycle
15	Radioactive Waste Management and Government Responsibilities	17. Radioactive Waste Management
16	Required Human Resources for Cerrnavoda 2 Implementation	10. HR Development
17	Public Information Plan	11. Stakeholders Involvement
18	Local Industry and Services Participation Plan for Cernavoda 2 (Evaluation of new Jobs in Cernavoda and National Industry)	18. Industrial Involvement
19	Conclusions	3. Management

Table V.1. COMPREHENSIVE REPORT: CONTENT FOR PROGRAMME EXTENSION FOR CERNAVODA 2 (cont.)

No.	**CERNAVODA 2 CR Sections**	**Infrastructure Issue**
	APPENDICES	
1	Technical-Economic Indicators of Cernavoda 2	3. Management
2	Level 1 Project Implementation Schedule (Main Milestones)	3. Management
3	Estimated Cost of Project and Other required Activities	4. Funding and Financing
4	Preliminary Financial Plan / Different Scenarios	4. Funding and Financing
5	Estimated Uranium Requirements	16. Nuclear Fuel Cycle
6	Human Resources Preliminary Plan	10. HR Development
7	Public Information Plan	11. Stakeholders Involvement

In its final form, the size of the CR is about 25 pages, which include an executive summary, a detailed presentation of the infrastructure issues subject to approval and an action plan with clear deadlines and responsibilities.

V.7. KEY DRIVERS FOR DECISION-MAKING

There were topics in the CR, which were of particular interest in the decision-making process at the government's level:

- Project contribution to the national electricity production;
- Technical-economic indicators;
- Nuclear infrastructure and project funding and financing approach;
- Doubling the local production capacity of CANDU 6 type nuclear fuel;
- Radioactive waste management and government responsibilities;
- Developments proposed in the national education system to ensure qualified human resources;
- Public information plan and public acceptance of nuclear power;
- Participation of the local industry with goods and services in the project completion and the number of new jobs;
- Benefits for the local community in Cernavoda and the city development.

The action plans attached to the CR (financial plan, human resources development, public information etc.) included a prioritization of the actions to be implemented, based on the previous experience and lessons learned from Cernavoda Unit 1 project. Actions were prioritized and an implementation deadline was proposed for each action, including the organization responsible for implementation. The report clearly included proposals regarding the government's role in financing the development of national nuclear infrastructure, mainly for the development of the necessary legislation and regulations, of Regulatory Body, of human resources needed for the national program and of the national electricity grid.

The elements of the national infrastructure that needed improvements (the national education system, the extension of the regulatory authority, environmental monitoring systems, etc.) were accepted to be funded directly by the government, from the state budget.

The participation of the NPP Owner/Operator and Regulatory Body representatives in the Inter-ministerial Committee with the experience and knowledge of the development of the nuclear power infrastructure for Cernavoda unit 1 was a beneficial element for drafting and finalizing the CR.

V.8. LESSONS LEARNED AND SUGGESTIONS

The participation of the NPP Owner/Operator and Regulatory Body representatives in the Inter-ministerial Committee, with the experience and knowledge in the development of the nuclear infrastructure necessary for Unit 1 Cernavoda, was a beneficial element for drafting and finalizing the CR.

The lessons learned in the process of preparing and approving the CR were as follows:

- The action plans included in the CR provided a clear picture of the timeline of the project and the infrastructure funding needs that the government will face should it decide to engage in the extension of a nuclear programme;
- The local experts are expected to make an important contribution to the CR development, supplying specific input data related to the nuclear power infrastructure and necessary interfaces with nuclear projects;
- The NEPIO members had different backgrounds and sometimes during the discussions, it was difficult to reach consensus in the development of the report;
- Some important subjects related to NPP contractual approach or financing (involving external loans with state guarantees) created large debates/discussions on the proposals to be included in the CR for government approval;
- Plans and policies for public information, stakeholders' involvement and local community compensation were well received and appreciated;
- NPP Owner and Regulatory Body representatives had a decisive role in development of the draft of CR and in the NEPIO final discussions, explaining the specific nuclear power issues;
- Keeping the CR language simple, without too many technical expressions specific to the nuclear power field, will facilitate understanding by non-specialists;
- Documentary visits of the NEPIO members to operational nuclear power plants were particularly useful for learning the specific aspects included in the CR.

The CR approved at the end of Phase 1 of the nuclear energy programme represents an important step in the development of the national nuclear power infrastructure. Following a government decision to proceed with a nuclear power programme, the policies and strategies could form the basis for the development of detailed action plans in Phase 2.

REFERENCES

[1] 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).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Building a National Position for a New Nuclear Power Programme, IAEA Nuclear Energy Series No. NG-T-3.14, IAEA, Vienna (2016).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Evaluation of the Status of National Nuclear Infrastructure Development, IAEA Nuclear Energy Series No. NG-T-3.2 (Rev. 1), IAEA, Vienna (2016).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Guidelines for Preparing and Conducting an Integrated Nuclear Infrastructure Review (INIR), IAEA Services Series No. 34, IAEA, Vienna (2017).

LIST OF ABBREVIATIONS

AMSSNuR	Agency for Nuclear & Radiological Safety and Security, Morocco (regulatory body)
CANDU	CANada Deuterium Uranium (Canadian pressurized heavy-water reactor)
CR	Comprehensive Report
CNESTEN	National Centre for Energy and Nuclear Science and Technology, Morocco
CRED	Committee on Nuclear Power and Sea Water Desalination, Morocco (NEPIO)
EU	European Union
GAEC	Ghana Atomic Energy Commission
GNPPO	Ghana Nuclear Power Programme Organization (NEPIO)
HTGR	High-Temperature Gas-cooled Reactor
INIR	Integrated Nuclear Infrastructure Review
IWP	Integrated Work Plan
MEME	Ministry of Energy, Mines and Environment, Morocco
MESTI	Ministry of Environment, Science, Technology and Innovation, Ghana
MoE	Ministry of Energy, Ghana
NAEA	National Atomic Energy Agency, Poland
NED	Nuclear Energy Department, Ministry of Climate and Environment, Poland
NEPIO	Nuclear Energy Programme Implementing Organization
NES	National Energy Strategy, Morocco
NPI	Nuclear Power Institute, Ghana
NRA	Nuclear Regulatory Authority, Ghana
ONEE	National Office of Electricity and Drinking Water, Morocco (owner/operator)
PAA	National Atomic Energy Agency, Poland (regulatory body)
PNPP	Polish Nuclear Power Programme (CR)
SER	Self-Evaluation Report
SMR	Small Modular Reactor
SOSNY	Joint Institute for Power and Nuclear Research of the National Academy of Sciences of Belarus
VVER	Water-cooled Water-moderated Power Reactor (Russian pressurised light water reactor)

CONTRIBUTORS TO DRAFTING AND REVIEW

Mr. Bastos, Jose	International Atomic Energy Agency
Mr. Bourdin, Frederic	International Atomic Energy Agency
Mr Drury, David	International Atomic Energy Agency
Ms. Dulinets, Liliya	Consultant (Belarus)
Mr. Kovachev, Milko	International Atomic Energy Agency
Mr. Kubacki, Zbigniew	Consultant (Poland)
Mr. Rotaru, Ioan	Consultant (Romania)
Mr Sitnikov, Andrey	International Atomic Energy Agency
Mr. Wordson, Daniel Agyeman	Consultant (Ghana)
Mr. Zair, Rachid	Consultant (Morocco)

Technical Meeting

Vienna, Austria: 29 September–1 October 2020

Consultants Meeting

Vienna, Austria: 23–25 March 2021

IAEA
International Atomic Energy Agency

No. 26

ORDERING LOCALLY

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.

NORTH AMERICA

Bernan / Rowman & Littlefield

15250 NBN Way, Blue Ridge Summit, PA 17214, USA
Telephone: +1 800 462 6420 • Fax: +1 800 338 4550

Email: orders@rowman.com • Web site: www.rowman.com/bernan

REST OF WORLD

Please contact your preferred local supplier, or our lead distributor:

Eurospan Group

Gray's Inn House
127 Clerkenwell Road
London EC1R 5DB
United Kingdom

Trade orders and enquiries:

Telephone: +44 (0)176 760 4972 • Fax: +44 (0)176 760 1640
Email: eurospan@turpin-distribution.com

Individual orders:

www.eurospanbookstore.com/iaea

For further information:

Telephone: +44 (0)207 240 0856 • Fax: +44 (0)207 379 0609
Email: info@eurospangroup.com • Web site: www.eurospangroup.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/publications

22-00420E

International Atomic Energy Agency
Vienna