

Chapter X.

NUCLEAR POWER PROGRAM

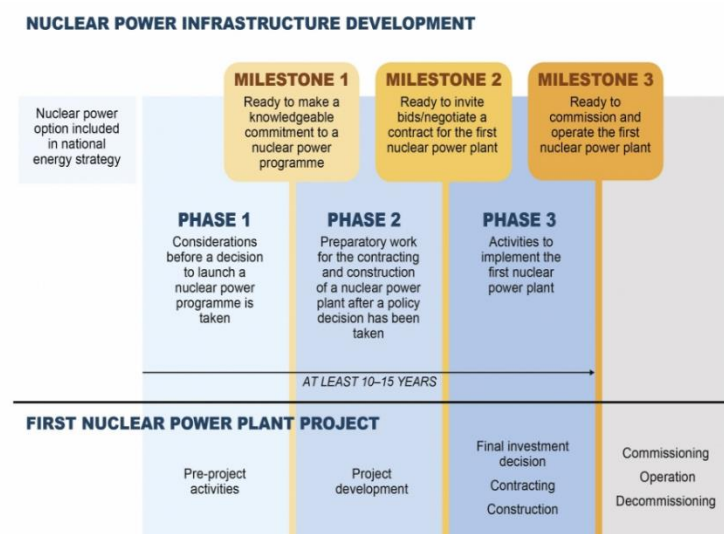
The Department of Energy (DOE) puts a premium on a sustainable future through an open technology approach for alternative energy sources for the country to provide greater energy security, stability, reliability and affordability. The vision for a low carbon future is anchored on a technology-neutral policy, to develop a diversified and balanced energy mix. As such, the DOE remains steadfast in its position of taking a calculated and scientific approach to tapping nuclear energy as a long-term fuel option for power generation given its technical and economic viability.

The DOE adopts the Milestones Approach in the Development of a National Infrastructure for Nuclear Power of the International Atomic Energy Agency (IAEA) which aims at assisting countries that are considering or planning their first nuclear power plant, and to help the Member States understand the commitments and obligations associated with developing a Nuclear Power Program (NPP)¹¹³. Likewise, the Milestones Approach provides the countries that already have nuclear power an opportunity to assess their preparedness for expansion.

A. ASSESSMENT

In 2016, the DOE, in partnership with the Philippine Nuclear Research Institute (PNRI), availed technical assistance from the IAEA¹¹⁴ to assess the possibility of the entry of nuclear power in the country under a technical cooperation project (IAEA TCP-PHI2011) titled, “Assessing the Development of Nuclear Power Program in the Philippines (Phase I)”.

Figure 85. IAEA's MILESTONE APPROACH IN THE DEVELOPMENT OF NATIONAL INFRASTRUCTURE OF NUCLEAR POWER PROGRAM



¹¹³ IAEA Nuclear Energy Series NG-G-3.1 Rev. 1

¹¹⁴ An inter-governmental agency for scientific and technical co-operation for the peaceful use of nuclear technology and nuclear power worldwide

In compliance with the mandate of the DOE, the Philippine Nuclear Energy Program Implementing Organization (NEPIO) was established on 24 October 2016 through Department Order (DO) 2016-10-0013. The creation of the NEPIO was one of the major recommendations during the IAEA's conference on the Prospects of Nuclear Power in the Asia Pacific region hosted by the Philippines in August 2016.

Following the IAEA's Milestones Approach, the establishment of the NEPIO places the Philippines in Phase 1 before Milestone 1 (Figure 85). The NEPIO is mandated to coordinate the works and activities of the organizations involved in nuclear infrastructure

development. It is headed by a DOE Undersecretary and Assistant Secretary as Chair and Vice-Chair, respectively. The NEPIO formed technical working groups (TWGs) headed by the concerned Bureau/Service Directors that are formed part of the Steering Committee's membership. This is to ensure the effective and timely implementation of its functions and responsibilities.

Each TWG is assigned with a specific task to work on the requirements of the 19 infrastructure that need to be considered before embarking on a nuclear power program (Figures 86 and 87).

As part of the activities in Phase 1, the Energy Planning Studies (EPS) and Pre-Feasibility

Studies 2017 of Nuclear Infrastructure Issues (PFS 2017) were implemented under the IAEA TC-PHI2011 project. The studies support the assessment of the 19 infrastructure issues necessary for drafting the country's national position to embark on nuclear energy program.

ENERGY PLANNING STUDY FINDINGS

Without policy intervention for low carbon technology, coal continues to dominate the generation mix until 2050 (Figure 88) pushing the greenhouse gas emission (GHG) to increase significantly under the Business-As-Usual Scenario.

Figure 86. NEPIO COMPOSITION PER DO 2016-10-0013

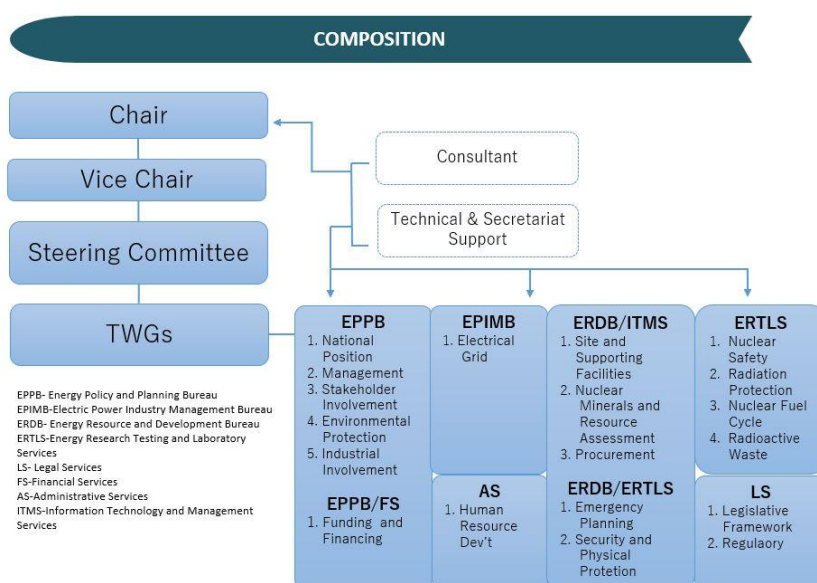
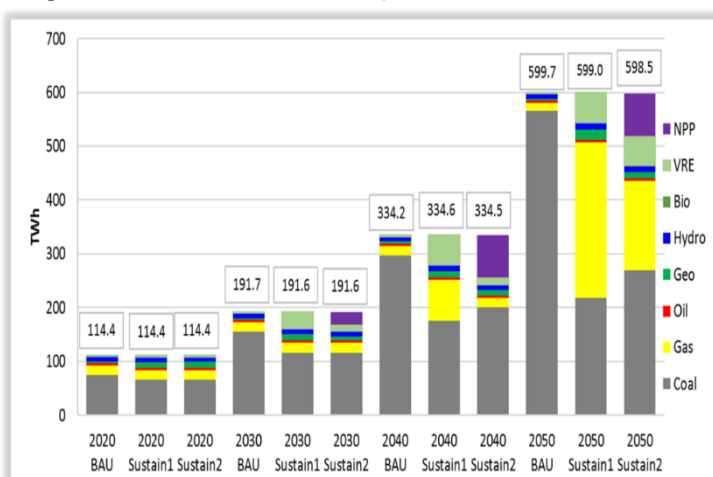


Figure 87. 19 INFRASTRUCTURE ISSUES OF THE IAEA'S MILESTONE APPROACH



Under a Sustainable Scenario 1 (Sustain1), the GHG emission reduces by 30.0 percent with LNG¹¹⁵ replacing coal by more than half of its share by 2050 coupled with the maximum utilization of renewable energy with over 20-gigawatt (GW) capacity by 2030. This results in an increase of the total installed capacity by 18.0 percent due to a higher capacity of variable RE with a lower capacity factor. Higher LNG importation impacts energy security thru increased dependence on imported fuel.

Figure 88. EPS GENERATION MIX by Scenario



The second sustainable scenario option, Sustain2 includes nuclear power, displacing a portion of coal (Figure 89). Sustain2 exhibits a more diversified mix than the BAU and Sustain1 scenarios signifying a more secure and reliable mix. On the other hand, the system cost decreases as compared with the Sustain1 scenario. Also, the results show that NPP may come in as early as 2027.

Figure 89. EPS TOTAL INSTALLED CAPACITY MIX by Scenario

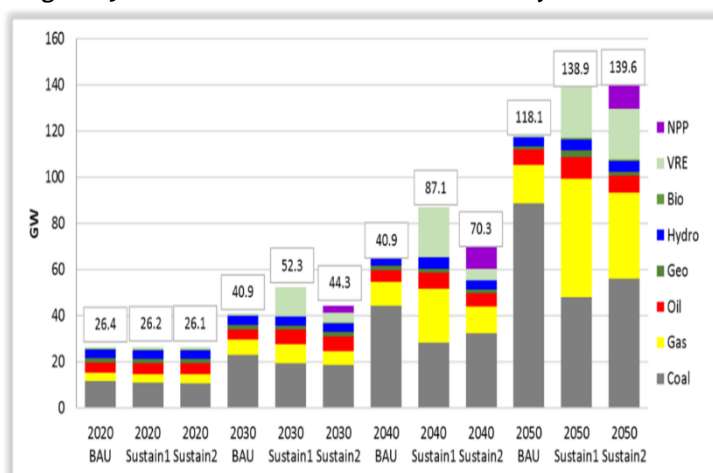
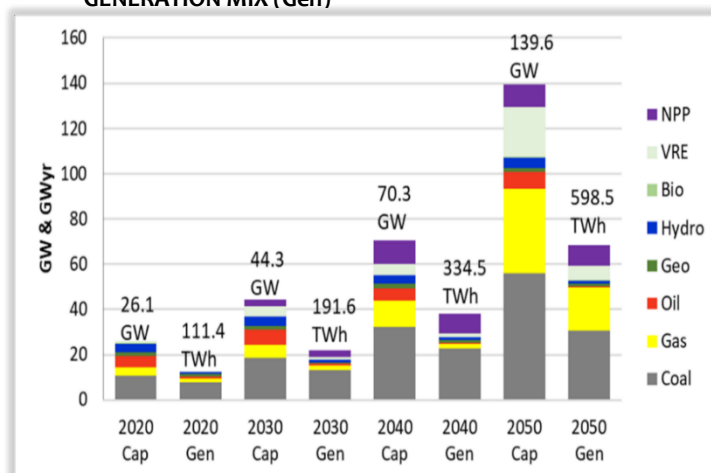


Figure 90. EPS RESULT: SUSTAIN II SCENARIO, CAPACITY MIX VS. GENERATION MIX (Gen)



Sensitivity Analysis

The study further simulated a sensitivity analysis to determine the factor affecting the entry of nuclear power generation in the power mix. Results show the following:

- 20.0 percent increase of nuclear power plant investment cost: delays the entry of nuclear power by 5 years, or moved to 2032.
- 20.0 percent decrease in electricity demand by 2030 and 30.0 percent by 2040 and onwards: delays the entry of nuclear power plant by 2 years or 2029.
- 20.0 percent decrease in LNG price: no impact
- 20.0 percent increase in investment cost of nuclear power plant and 20.0 decrease in demand by 2030 and 30.0 percent by 2040 and onwards, and combined with 20.0 percent decrease demand: delay the entry by 2 years or 2029.

¹¹⁵ Liquefied Natural Gas

- Variable renewables (VREs) with storage battery: complement the entry of inclusion of Small Modular Reactors (SMRs) within Visayas and Mindanao grids by 2042 and 2041, respectively, but delay the entry of a large reactor by 3 years or 2030.

In conclusion, the sensitivity analysis shows that the entry of nuclear power generation is feasible, although, it can be delayed depending on the level of electricity demand and investment cost.

Conclusion and Findings of Pre-Feasibility Studies on Infrastructure Issues

The assessment of the 19 infrastructure issues encompass the following major challenges and gaps needed to be addressed under Phase 1 of the Milestone Approach of IAEA:

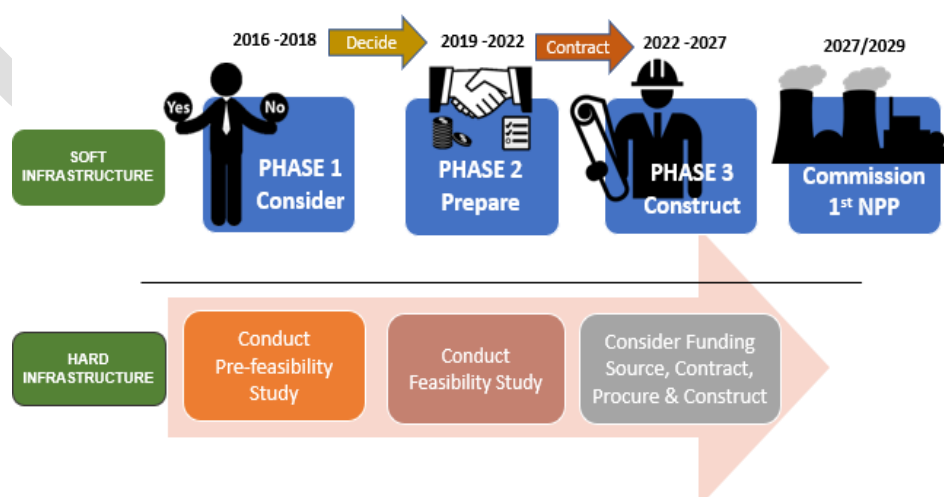
- Push for the passage of a comprehensive nuclear law with a provision for the establishment of a separate and independent nuclear regulatory authority that will ensure nuclear safety;
- Amend and review of the Electric Power Industry Reform Act (EPIRA) to provide for the inclusion of nuclear power in its provision (ownership, funding and financing aspects);
- Conduct of further study to consider the possible sites in the electric grid and assess its system impact, as well as guarantee environmental impact assessment during the licensing process;
- Stronger commitment among government agencies and other stakeholders in the public and private sectors;
- Mitigate the negative perception about nuclear energy that is still prevalent despite present technology and access to information through a broad-based and updated communication plan to address stakeholder issues;
- Develop/enhance knowledge and competence on nuclear safety of officials and professionals working on the nuclear power program (NEPIO, academe, regulatory body, and operator); and,
- Expand the coverage of the current national nuclear security plan (NNSP) to include the physical protection of nuclear power plants, including cyber-security.

B. PLANS AND PROGRAMS

NUCLEAR POWER PROGRAM (NPP) ROADMAP

Based on the earliest optimal entry of nuclear energy by 2027, and findings of the pre-feasibility studies, the NPP Roadmap has been established for the guidance in the implementation and timeline of activities of the NEPIO, as shown in **Figure 91**.

Figure 91. NPP ROADMAP



The NPP Roadmap has the three (3) phases as follows:

In **Phase 1**, the NEPIO conducts studies taking into account the considerations before launching an NPP. This includes the energy planning studies, pre-feasibility studies done by the NEPIO and the 19 infrastructure issues identified in the Milestone Approach (Figure 87). Those hard infrastructure issues include pre-development stage studies for NPP. The DOE hosted the IAEA peer review to assess the NEPIO undertakings for Phase 1.

The activities for 2019 to 2022 are set for **Phase 2** of the roadmap, as well as the milestone approach. The result of the peer review will pave the way for NEPIO to undertake preparations for a knowledgeable commitment for the NPP. After policy decision has been taken, the NEPIO will then prepare for establishing a management team, create an independent regulatory body that will ensure the safe, secure and peaceful use of nuclear power by ratifying related treaties and conventions, establish bilateral agreements with international suppliers, and develop policies, guidelines and procedures for procurement and contracting procedures. At the end of Phase 2, the NEPIO will need another peer review through IAEA to evaluating the country's Nuclear Power Program.

The result of the evaluation at the end of Phase 2 will indicate the readiness to contract and construct a nuclear power project under Phase 3. At **Phase 3**, the role of the NEPIO will be lessened. The Technical Support Organizations will be established, and the Research and Development Programs will be set for implementation, while the independent regulatory body will have to start implementing its guidelines for its rules and regulations of putting-up a nuclear power project. At the end of this stage, a self-evaluation is needed to assess the programs and the readiness to commission and operate the first nuclear power plant.

The self-evaluation at the end of each phase means that the NEPIO and the IAEA take into account all issues that may hinder a nuclear power program before the construction of a nuclear power plant.

IMPLEMENTATION OF KEY ACTIVITIES FOR 2018-2019

A. Establishing the National Position

The NEPIO submitted the recommendation for a **“National Position to Embark on a Nuclear Power Program”** to the Office of the President in April 2018. The national position was based on the Energy Planning Studies and Pre-Feasibility Studies, which evaluated the status of the 19 nuclear infrastructure issues in the Philippines. Among the action agenda for the President includes in the national position are the following:

1. Declare that the Philippines is open to nuclear power and ready to embark on a Nuclear Power Program;
2. Certify as urgent the approval of a Comprehensive Nuclear Law or any equivalent law to establish a separate and independent nuclear regulatory authority; and,
3. Issue an Executive Order to expand the current composition of the NEPIO to include other relevant government agencies, academe and representatives from the private sector.

A "National Position" is a technical term used in developing a nuclear power program that serves as the premise statement of a country's preliminary position and evaluation subject to validation by addressing the 19 infrastructure issues or gaps based on IAEA standards. If

the issues are addressed and validation is successful, the position will be elevated as a "National Decision" which would then be the backbone of a Nuclear Power Program (NPP).

A National Position must necessarily lay-down the economic, social, political environmental and national energy directions of a country; commitment to safe, secure and peaceful development of nuclear power program; recognition of international and national legal arrangements including the establishment of an independent regulatory body with the commitment to cooperate with the international community, including the IAEA, to ensure a safe, secure, transparent and peaceful nuclear power program; strengthening stakeholders' involvement and; a recommendation. This will likewise lead to a National Policy Recommendation to put a determination or closure on the BNPP rehabilitation and construction of new nuclear power plants.

B. Self- and Peer Evaluation of the NPP Phase 1

Having done the studies for Phase 1 and submitted the recommendation for a national position to the Office of the President, the NEPIO saw the need to conduct a Self- and Peer Evaluation of Phase 1 activities to assess whether the program is ready to move to Phase 2. In this regard, the NEPIO requested a peer review, or the so-called "Integrated Nuclear Infrastructure Review (INIR) Mission" and submitted the Self-Evaluation Report (SER) to IAEA on 31 October 2018, a prerequisite for the conduct of INIR Mission. SER is a summary of all the studies and activities implemented by the NEPIO- TWGs in Phase 1. The preparation of SER and the conduct of INIR was supported by the TC-PHI2012 project of IAEA.



Photo taken during the opening program of the INIR Missions Phase 1 which was participated in by Secretary Alfonso G. Cusi (3rd from left, in front), followed by Dir. Dohee Hans of IAEA, Milko Kovachev, the Team Leader for the IAEA INIR Mission Team, and NEPIO members led by the NEPIO Chair Undersecretary Donato D. Marcos

The Philippines hosted the INIR Mission Phase 1 on 11-17 December 2018 in Shangri-La Manila and attended by 13 experts commissioned and funded by IAEA. It evaluated the status of the national infrastructure issues in Phase I of the IAEA's Milestone Approach. Further, the review identified areas needing actions to achieve the Milestone goal in Phase I. The IAEA team also provided recommendations and suggestions which can be used by the government and national stakeholder institutions in the preparation of an action plan addressing the gaps identified in the review.

The key benefits of an INIR Mission include:

1. Providing the Member States with an opportunity to evaluate their NPP based on the Milestones publication;
2. Drawing attention to areas requiring additional work;
3. Providing a forum for peer discussions and exchange of experiences on infrastructure development; and,
4. Making available to senior officials of the host Member State, an independent peer review report on the status of the infrastructure for NPP.



Sec. Alfonso G. Cusi giving his welcome remarks to the IAEA delegates and NEPIO members at the Shangri-La Manila on 11 December 2018

Hand-over of the Official INIR Mission for Phase I Report



Energy Secretary Alfonso G. Cusi (center-left) formally receives the copy of the official Phase 1 INIR Mission Report from IAEA Deputy Director-General Mikhail Chudakov (center-right) at the Hand-Over Ceremony held on 30 October 2019 at the F1 Hotel in Taguig City. Other officials in photo are (L-R) DOE-NEPIO Vice Chairperson Assistant Secretary Gerardo D. Erguiza Jr., DOE-NEPIO Chair Undersecretary Donato D. Marcos, Philippine Ambassador to Austria Maria Cleofe R. Natividad, PNRI Director Dr. Carlo A. Arcilla, and IAEA NIDS Head Milko Kovachev.

On 30 October 2019, the IAEA represented by Deputy Director Mikhail Chudakov and Nuclear Infrastructure Development Section (NIDS) Head Milko Kovachev turned over the official INIR Mission Report for Phase I to the Philippine government through the Energy Secretary Alfonso G. Cusi and NEPIO Chairperson Undersecretary

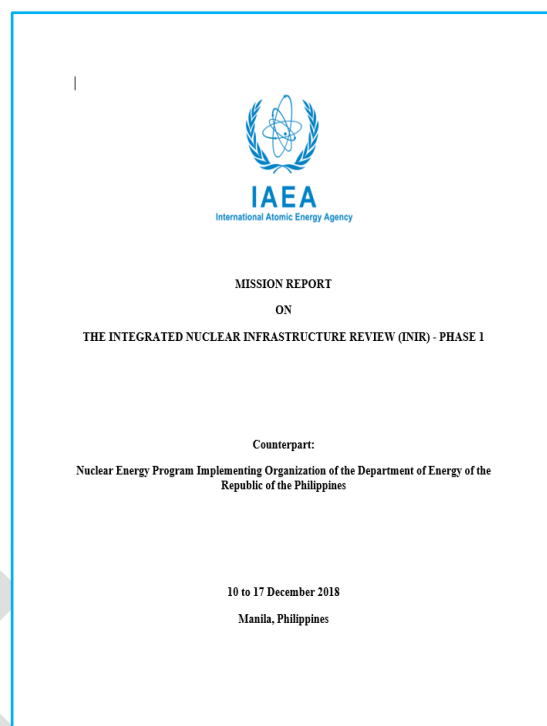
Donato D. Marcos. The ceremony was held in F1 Hotel, BGC, Taguig City and attended by representatives from different government agencies, academe, and media.

It was concluded by the IAEA INIR team that the Philippines is committed to a systematic approach in finalizing its nuclear power strategy and completing the associated infrastructure development. The country likewise recognizes the importance of open and transparent public communication and the need to include a broader range of stakeholders in preparations to introduce nuclear power. Currently, the DOE-NEPIO has conducted stakeholders' involvement and the public perception survey.

Key Areas for Further Action

1. The Philippines needs to involve a broader range of stakeholders in completing the work required to enable a national commitment to introduce nuclear power.
2. The Philippines needs to develop a legal and regulatory framework that ensures and demonstrates a commitment to safety, security and non-proliferation.
3. The Philippines needs to further develop its understanding of and enhance its approaches to several issues related to a future nuclear power project.

The NEPIO is strengthening the capacity of its technical personnel through collaboration with international agencies. It is also strengthening the stakeholders' involvement through the development of a Comprehensive Public Communication Plan on Nuclear Energy from the results of the recently conducted Public Perception Survey on Nuclear in the Philippines.



C. Public Perception Survey on Nuclear Energy

The DOE, in coordination with the Social Weather Stations (SWS), conducted a public perception survey on the use of nuclear energy in the country from 27 April – 12 May 2019.

Objective. The purpose of the survey is to provide a scientifically established basis on the acceptability of nuclear energy for power generation in the country in support of the proposed Executive Order (EO) for the country to embark on an NPP to be submitted by the DOE to the President. Likewise, the survey aimed to provide scientifically acquired information in the preparation of the Comprehensive Communication Plan and Strategy in the engagement of the public and other stakeholders for the development of NPP.

Methodology. The survey involved face-to-face interviews with 4,250 Filipino adults aged 18 and above nationwide and covered 17 study regions. The target population was the non-institutionalized population aged 18 and above who are Filipino citizens and currently residing in the Philippines.

Findings. The survey results indicated that nuclear energy should be entrenched in the energy mix. Generally, the results impart that nuclear energy brings more benefits than risks.

The survey showed positive or favorable perception with 79.0 percent approval/acceptability for possible use (and rehabilitation) of the Bataan Nuclear Power Plant (BNPP) and 65.0 approval/acceptability of building a new nuclear power plant. Further, the survey revealed that 70.0 percent of the respondents prefer to source the

money for the construction of a nuclear power plant from the government funds, a good indicator that nuclear energy is acceptable.

The majority of the respondents expressed interest to learn more about Nuclear Energy. The preferred primary means of communication to reach the general public based on the result of the survey are television, internet, social media, radio, and Information, Education and Communication (IEC) campaign.

D. Integrated Work Plan (IWP) for the Nuclear Power Program

The Consultancy Meeting for the IWP of the Philippines was held in Vienna, Austria last 12-15 November 2019 and attended by a delegation from DOE-NEPIO, DOST and DOST-PNRI.

Its main objective is to review the Philippines' IWP to organize and prioritize future cooperation in the field of nuclear power infrastructure development with the IAEA.

The Integrated Work Plan (IWP) as defined by the IAEA is a strategic document describing the relevant activities delivered by the Agency to support nuclear infrastructure development in a specific Member State. An IWP covers a period of 2 to 3 years and identifies activities implemented through Technical Cooperation (TC) projects as well as direct assistance activities from the relevant Agency technical departments and the Office of Legal Affairs (OLA). IWP will be reviewed and updated once a year in a joint meeting of the Member State and Agency Core Team.



E. Joint Pre-Feasibility Study (FS) for the Deployment of SMR in CEZA, Philippines

Last 27-28 February 2019, the members of the DOE-NEPIO Steering Committee and Technical Working Group (TWG) members held a Kick-off Meeting with representatives of Korea Hydro & Nuclear Power (KHNP).

The Kick-off meeting covers presentation on the Small Modular Reactor (SMR) Technology presented by experts from Korea Atomic Energy Research Institute (KAERI) and King Abdullah City for Atomic and Renewable Energy (K.A.CARE), Working Group (WG) for the Study Team, DOE representatives update and discussion on important key points to consider in the development of a nuclear power program such as Human Resource, Public Acceptability, Law & Regulation and Site Selection.

This is the preliminary exchange of information between the DOE and KHNP on its plan to collaborate on a Pre-Feasibility Study on SMR. Later, the DOE and KHNP were joined by the Cagayan Economic Zone Authority (CEZA) with its site in Sta. Ana, Cagayan as possible host of the SMR.



Sr. Undersecretary Jesus Cristino P. Posadas (middle) NEPIO Vice-Chair Assistant Secretary Gerardo D. Erguiza Jr. (left) and KHNP VP Lim Seung Yeol during the SMART Pre-FS turn over.

The “Pre-Feasibility Study for “SMART” Deployment in the Philippine Cagayan Economic Zone” was drafted through combined efforts of the NEPIO TWGs, CEZA and KHNP. SMART is an acronym for System-integrated Modular Advanced Reactor Technology. The purpose of the Pre-FS is to review the feasibility of SMART construction in the Cagayan Economic Zone (CEZ). It plans to transform CEZ into a hub for trade, commerce, financial, technology and leisure area. To be able to make this possible it will need a stable supply of power without the large-scale transmission lines and incognizant with the national energy policy, the construction of an SMR is being proposed.

This is also in line with the Memorandum of Understanding (MOU) between the DOE and KHNP signed on 27 July 2018 for comprehensive cooperation on the establishment of infrastructure for possible nuclear energy projects in the Philippines. As part of the site supporting activities enveloped in the Pre-FS, a site characteristic survey was conducted by experts and responsible managers and technical staff from KHNP and DOE in March 2019 in Cagayan.

Prior to the site visit, the Siting TWG of the DOE-NEPIO also conducted a Field Verification Survey and Ocular Inspection of the Proposed Sites in Sta. Ana, Cagayan using Preliminary Siting Criteria.

Lastly, the final version of the Pre-FS on SMART Deployment in the Philippines was turned over last December 2019.

DEVELOPMENT IN THE NUCLEAR POWER PROGRAM ACTIVITIES IN 2020

A. The 10th Nuclear Energy Cooperation Sub-Sector Network Annual Meeting

The Philippines Chaired the 10th Nuclear Energy Cooperation Sub-Sector Network Annual Meeting held virtually last 23 June 2020. The meeting discussed the progress and plans of NEC-SSN for APAEC Phase I: 2016-2020 where the Member States agreed and adopted the key strategy, outcome-based strategies, action plans and annual priorities for the APAEC

Phase II: 2021-2025 and conversed the plans and proposal of dialogue partners and international organizations.

B. Executive Order 116 s. 2020

Executive Order 116 s. 2020 entitled “Directing a Study for the Adoption of a National Position on Nuclear Energy Program, Constituting a Nuclear Energy Program Inter-Agency Committee, and for Other Purposes was signed by President Rodrigo Duterte last 24 July 2020. Through this EO, the government shall conduct a study for the adoption of a National Position on nuclear energy program in accordance with pertinent IAEA guidelines, relevant laws, rules and regulations. Also, the Nuclear Energy Program-Inter-Agency Committee (NEP-IAC) shall be composed of the following agencies and offices:

Chairperson: Department of Energy (DOE)
Vice-Chairperson: Department of Science and Technology (DOST)
Members: Department of Environment and Natural Resources (DENR)
Department of Interior and Local Government (DILG)
Department of Finance (DOF)
Department of Foreign Affairs (DFA)
National Economic and Development Authority (NEDA)
National Power Corporation (NPC)
National Transmission Corporation (Transco)
Philippine Nuclear Research Institute (PNRI)
Philippine Institute of Volcanology and Seismology (PHIVOLCS)

DRIVERS AND BARRIERS for NPP

The challenges identified in the development of the Nuclear Power Program are:

1. Approval of the national position on the NPP. While the Executive Order (EO) to expand the membership of the NEPIO to a multi-sectoral composite team was enacted through EO 116 s. 2020, the government still needs to conduct a study to support the national position.
2. Establishment of an Independent Regulatory Body through a Comprehensive Nuclear Law. The NEPIO supports the passage of the Comprehensive Nuclear Bill to pave the way for an encompassing legislative and regulatory framework to address the issues and demands for nuclear safety and security.
3. Public acceptance for a nuclear power plant. A broad-based and updated communication plan should be developed to address stakeholder issues to effectively manage and change the negative perception about nuclear energy, which is still prevalent despite the present technology and access to information.
4. Signing and ratification of relevant international instruments. While the Philippines is a Party to most of the relevant international instruments, the country should ratify the following important conventions/treaties, specifically related to the Convention on Nuclear Safety: (1) Joint Convention on the Safety Management of Spent Fuel and Safety Management of Radioactive Waste; and, (2) Amendment to the Convention on the Physical Protection of Nuclear Materials.