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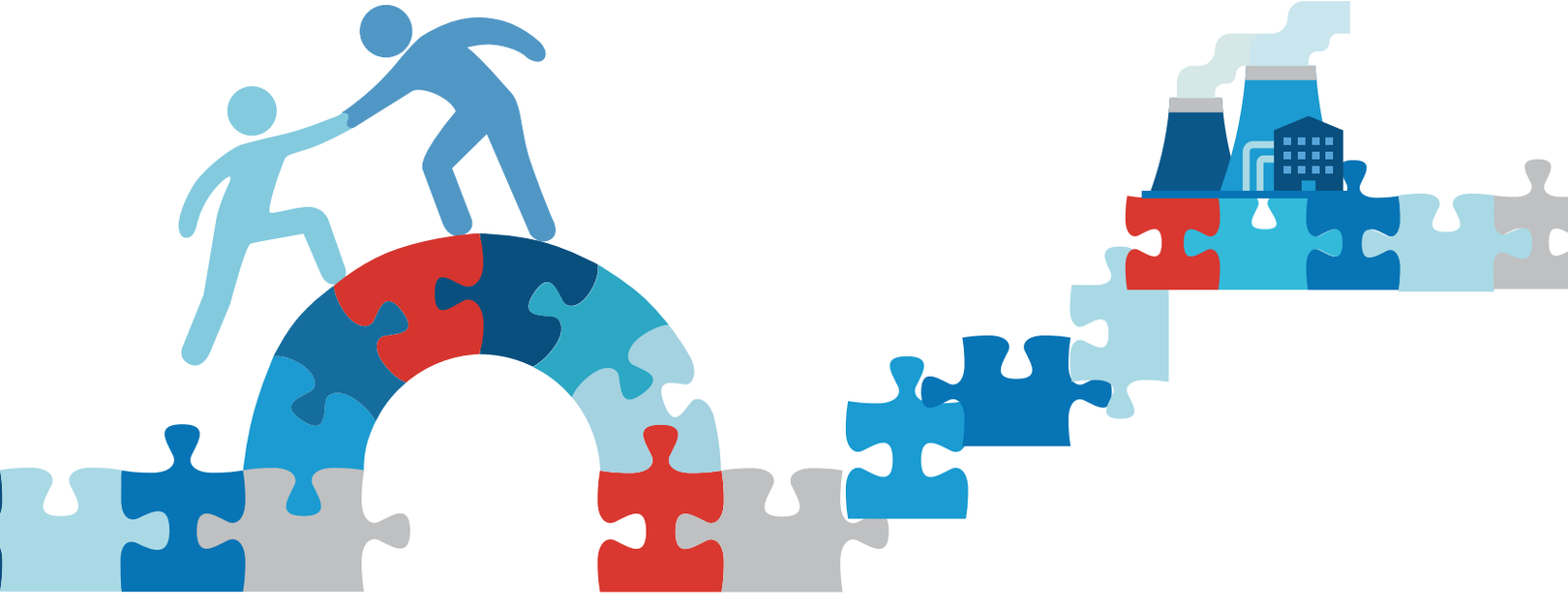
NUCLEAR INFRASTRUCTURE AND SUSTAINABLE DEVELOPMENT



Contents

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Contribution of nuclear infrastructure to the sustainable development of society

Application of nuclear technologies for peaceful use contributes to sustainable development and improves the standard of living of society. However, the competitiveness of projects of nuclear energy use or non-applications may decrease due to insufficient or untimely development of nuclear infrastructure.

According to the definition of sustainability introduced by the Brundtland Commission (World Commission on Environment and Development), sustainable development aims to meet present time requirements without threatening the possibility of subsequent generations to meet their needs in the future. The aims of nuclear infrastructure development for a Nuclear Power Plant (NPP) construction project or a Center for Nuclear Science and Technology (CNST) and the concept of sustainable development have the same direction. The timely development of the nuclear infrastructure is aimed at the successful and safe implementation of the NPP / CNST project throughout its entire life cycle.

In addition, nuclear infrastructure development makes a tangible contribution to the achievement of individual sustainable development goals identified by the UN working group in the publication “Transforming Our World: The 2030 Agenda for Sustainable Development”.

The contribution of nuclear infrastructure development to the achievement of sustainable development goal No. 4 “Education quality”

Launch of a national nuclear program requires large-scale development of human resources and human capital. In countries where the first NPP or CNST with a research reactor and laboratories are being built, special attention is paid to the system of personnel training and capacity building.

New educational institutes and programs are being developed, a new branch of education is being established, tied with the management, construction and operation of nuclear facilities.

New educational programs cover a wide range of areas: engineers, physicists, chemists, nuclear and radiation safety specialists, ecologists, electricians, power engineers, mechanics, automated control system specialists, and others.

Contribution of nuclear infrastructure development to the achievement of sustainable development goals No. 8 “Decent work and economic growth” and No. 9 “Industrialization, innovations and infrastructure”

When building an NPP or a CNST, localization is often suggested including manufacturing of equipment, services and materials from the national companies of the recipient country. This means an increase in the utilization of existing production capacities and the creation of new hi-tech industries.

Number of participants in the nuclear energy program is much larger than those who work at nuclear power plants, and includes those who provide nuclear security, emergency planning, energy system and regulatory framework, as well as others.

Given the macroeconomic impact, projects for the construction and operation of an NPP or CNST create a large number of jobs in related industries (construction, production of materials, service sector).

Decent work and economic growth are also related to the growth of innovation and scientific potential.
The construction and operation of a nuclear power plant or a nuclear fuel assembly creates a large number of highly skilled jobs, with wages averaging higher than wages in the region. The development of nuclear infrastructure for the safe and efficient implementation of NPP or CNST projects creates a “social elevator” for the country, improving the quality of life of a society.

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Contribution of nuclear infrastructure development to the achievement of sustainable development goal № 16 “Peace, justice and effective institutions”

One of the tasks of the nuclear infrastructure is to form a competent customer and increase the efficiency of activities — Atomic Energy Agency, an Operating Organization and Regulatory Body, as well as other organizations involved in the development of nuclear energy.

The development of an integrated management system increases the efficiency of interaction of organizations involved in the nuclear energy program, while the development of the legislative framework, as well as the involvement of all stakeholders in the development of the NPP / CNST project, allows the development of a nuclear energy program openly and taking into consideration public interest.

Contribution of nuclear infrastructure development to the achievement of sustainable development goal № 17 “Partnership for Sustainable Development”

The development of a nuclear infrastructure for an NPP or CNST project entails establishing of numerous partnerships by international organizations (including the IAEA), a vendor of nuclear technologies, service providers and other interested parties.

What is nuclear infrastructure? ✓
How and why to develop it?
This brochure is going to discuss these issues.

What is nuclear infrastructure?

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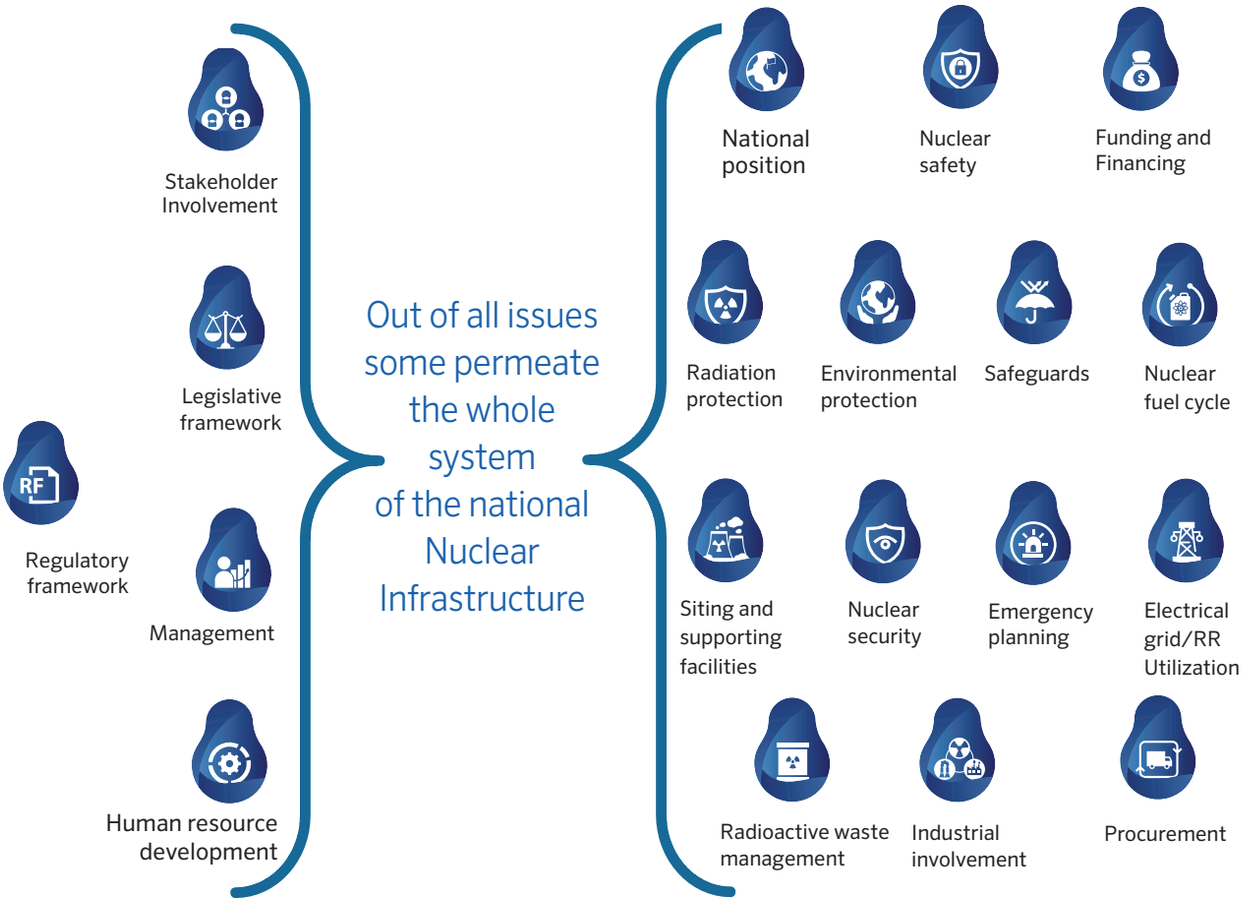
Nuclear infrastructure (NI) is a set of issues and conditions that provide state, institutional, political, legislative, managerial, organizational and administrative, regulatory and supervisory, scientific and technical, financial, personnel, industrial, social and public support to ensure safe and effective implementation of a national nuclear energy program (NEP).

The concept of nuclear infrastructure was formulated by the International Atomic Energy Agency (IAEA) in 2007 in the document "Milestones in the development of a national infrastructure for nuclear power". IAEA identifies 19 issues of nuclear infrastructure development.

Significance of the issues and their scope depends on the stage of the development of nuclear energy. The IAEA identifies three main stages.



Why do we need to develop nuclear infrastructure?

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Mature nuclear infrastructure is required for the safe and efficient implementation of the EPC contract, as well as the subsequent operation of nuclear power plants. High level of development of all NI issues is necessary for the licensing and NPP construction and operation. NI issues are reflected and covered in all key documents related to the design, construction and operation of nuclear power plants and their safety.

Nuclear infrastructure and capacity building: cost vs. value

COST

≤1% of NPP

to perform capacity building for:

- Unexperienced HR
- Insufficient management system (Government, Regulator, Operator)
- Lack of legislative & regulatory framework, understanding of licensing requirements
- Unprepared supply chain & Quality management
- Lessons learnt from previous NPP megaprojects

VALUE

ONE DAY due to shortfall in sales of electricity & revenue is worth 1 MLN USD

Additional costs:

- Delays in documents and equipment acceptance
- Re-design costs
- Equipment storage and conservation costs
- State loan return and use delays
- Idle (non use) of industrial capacities and personnel

The average NPP delay losses exceed nuclear infrastructure cost by a factor of 20 000

Rosatom and IAEA cooperation in nuclear infrastructure development

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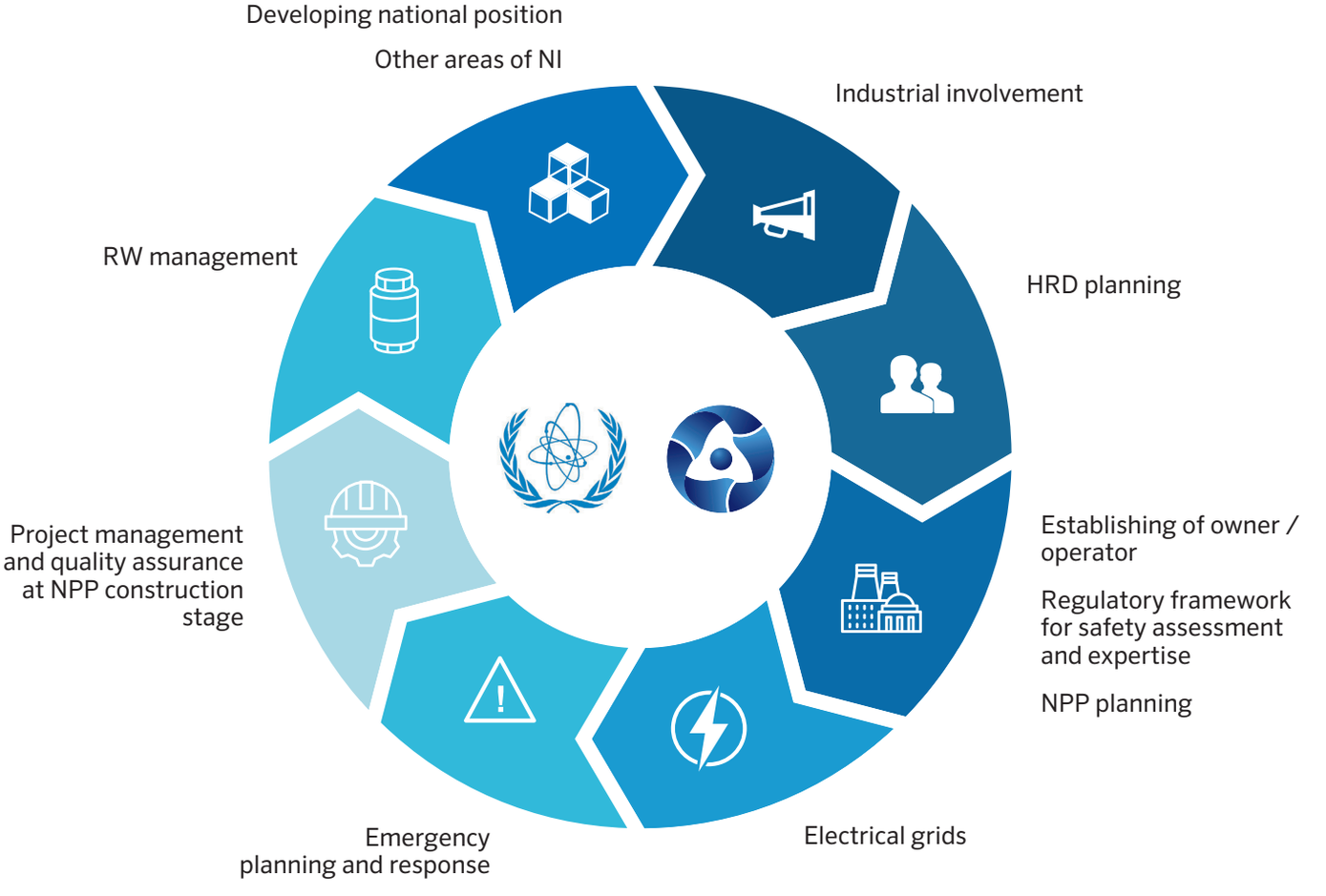
According to Russian Federation Government resolution* on the implementation of projects within the framework of the IAEA Technical Cooperation (TC) program, projects for the **development of nuclear infrastructure** are being implemented through Russia's financial contribution to IAEA. These projects cover professional staff training in the countries building or planning the construction of nuclear power plants through a system of trainings, seminars, workshops, scientific and technical visits to nuclear facilities.

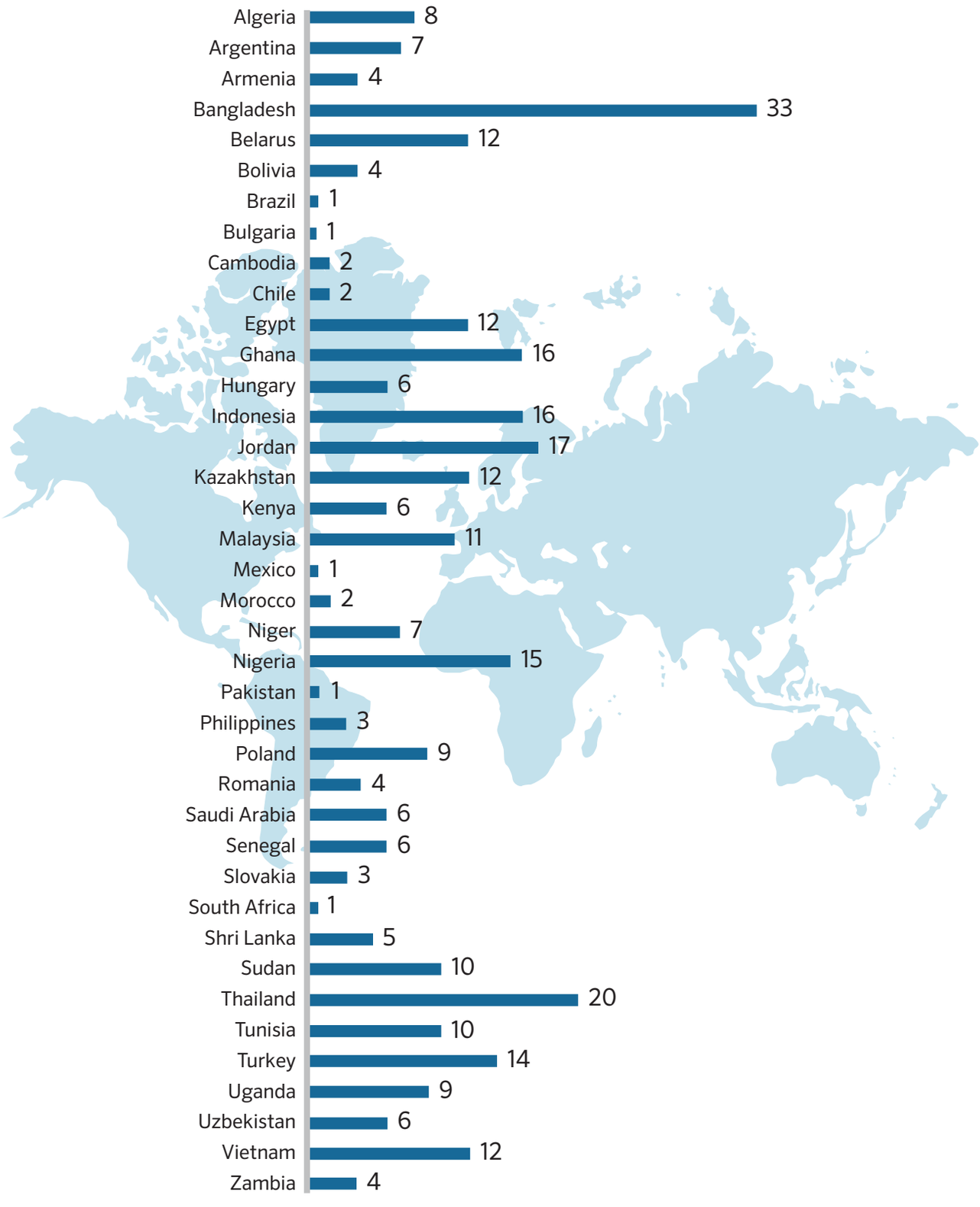
Areas of training



* RF Government Resolution of December 20, 2017 № 2871-r.

In 2017–2018 22 trainings were conducted, including 318 experts from 39 countries.

Participants from different countries in IAEA-Rosatom joint training activities



Mikhail Chudakov (IAEA Deputy Director General and Head of the Department of Nuclear Energy):

“Three SDGs in particular underscore the contribution of nuclear power towards energy for the future. These are Goal 7 — access to affordable and clean energy; Goal 9 — industry, innovation and infrastructure; and Goal 13 — climate action”.

Agneta Rising, Director General of World Nuclear Association.

«Nuclear energy is relevant to "almost all" of the 17 Sustainable Development Goals (SDGs) adopted by the United Nations General Assembly. Nuclear technologies are vital to help combat hunger and disease, and a lack of access to electricity has a profoundly detrimental impact on human health and the environment».

David Drury (Head of Knowledge Management in the Department of Nuclear Energy at the IAEA, Vienna):

“The agencies approach to developing a national infrastructure supports a number of the UNs Sustainable Development Goals including Goal 4 — helping member states with Quality Education programmes, Goal 9 and 11, helping to build national infrastructures and sustainable communities, as well as Goal 7 — Affordable and Clean Energy with nuclear energy as a primary low carbon electricity generator”.

Our support — 7 steps on establishing successful nuclear infrastructure — «Rosatom wheel»

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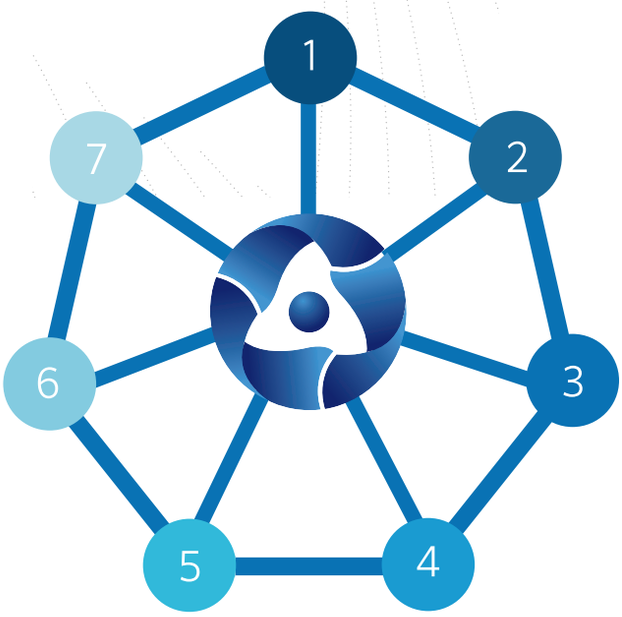
Nuclear infrastructure development is linked to EPC target schedule (please refer to the last double page spread).

Rosatom assistance is integrated based on Rosatom expertise and track record supported by Rosatom's industry resources Integrated approach for 19+1 elements of NI

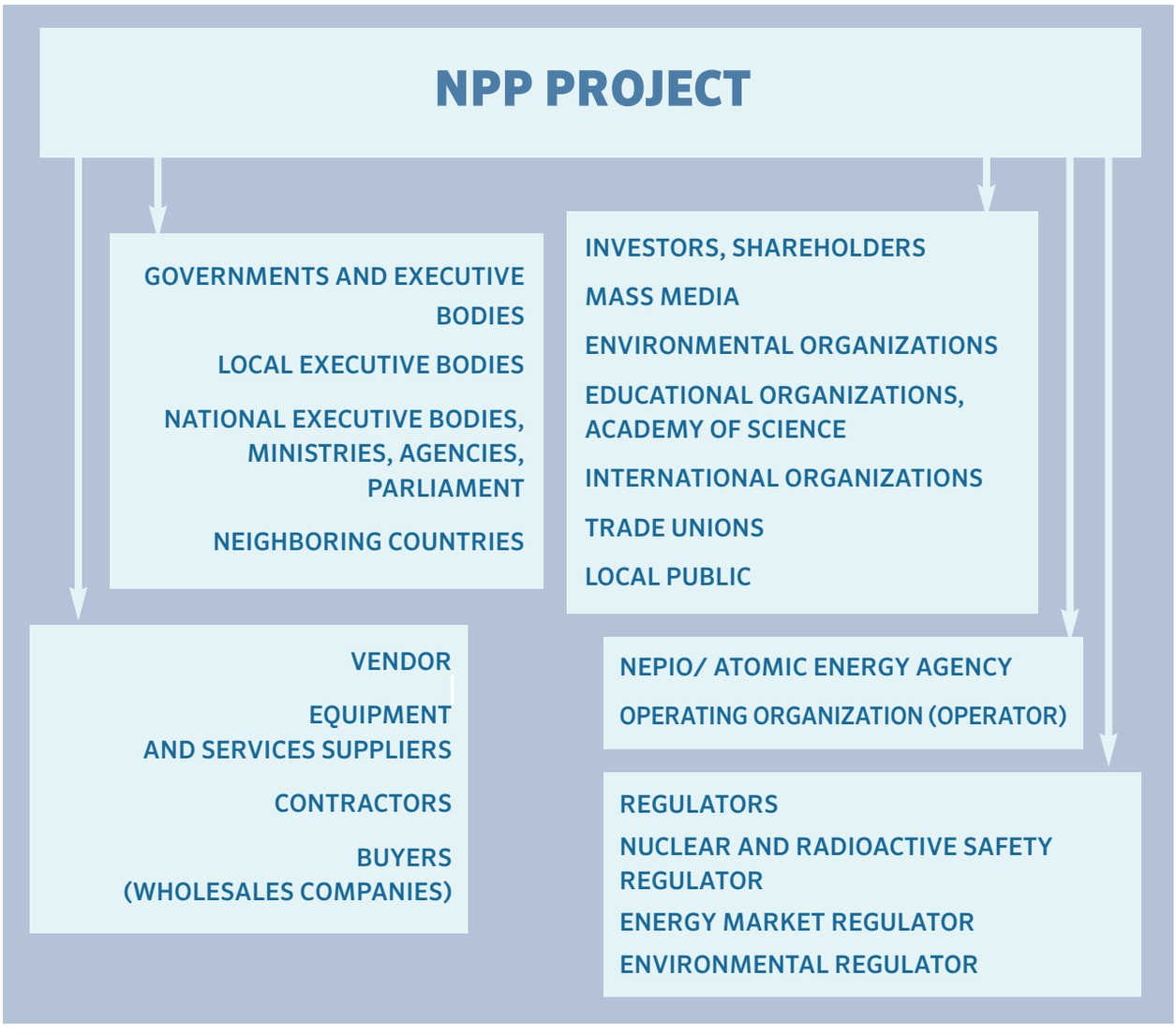


ISO-approach to nuclear infrastructure and capacity building (Rosatom's wheel)

1. Stakeholders map development. Responsibilities of the key ministries and agencies and their interactions with each other
2. Nuclear infrastructure assessment, Online SELF-ASSESSMENT
3. Comparing of status to target model
4. NI risk assessmen
5. Development of NI roadmap coordinated with EPC-CONTRACT
6. Support of NI development & CAPACITY BUILDING
7. Support of NI development & CAPACITY BUILDING

STEP 1.
Development of Nuclear power program stakeholders' map

Participants of a nuclear energy program — stakeholders — include a large number of ministries and agencies. Along with the key organizations — NEPIO/ Atomic Energy Agency, an Operating Organization and a Regulatory Body — these are the organizations that implement or influence the nuclear energy program.



Why is stakeholder involvement important?

It allows:

1. Make decisions in case of conflict of interest.
2. Reduce conflict of interest, identify common interests.
3. Reduce delays in the decision-making process and minimize the risks of changing decisions.

Development of stakeholders' map implies:

1. Identification of stakeholders — ministries and agencies that participate in the development of the nuclear energy program;
2. A description of their roles, areas of responsibility and tasks at each stage of the development of the nuclear energy program;

3. Refinement of interfaces (interagency relations) for each of the 19 issues of the nuclear infrastructure.

For each NI issue a key agency or ministry are identified as well as other organizations involved in the development of the NI issue, and their interactions and interfaces.

STEP 2.
NI assessment and self-assessment

The NI assessment is a comparison of the **current state of the national NI with the target NI model** for the safe and efficient implementation of the NPP project based on maturity and correspondence of terms and conditions (formulated with reference to the IAEA documents, international experience and Rosatom and other vendors experience and practice).

To achieve this goal, the recipient country needs professional support and peer review. We have developed a methodology and an electronic questionnaire on self-assessment to conduct an independent analysis of each of the issues of the nuclear infrastructure.

At the **assessment stage**, our highly qualified experts assess the current status of the nuclear infrastructure by interviewing interested parties and auditing organizations involved in implementing the nuclear program, as well as analysing the documents developed in the recipient country for each of the NI issues. For each of the issues, the assessment is carried out by experts of the organization directly responsible for the development of this issue in Rosatom State Corporation (the industry pool includes more than 100 experts).

NI assessment services help our partners prepare for the **IAEA Integrated Nuclear Infrastructure Review Mission (INIR mission and other missions).**

* IAEA Guideline NG-G-3.1 (Rev. 1) «Milestones in the Development of a National Infrastructure for Nuclear Power»; IAEA Guideline NP-T-5.1 «Specific Considerations And Milestones For A Research Reactor Project: IAEA Nuclear Energy Series NP-T-5.1»; IAEA Guideline NG-T-3.2 (Rev. 1) «Evaluation of the Status of National Nuclear Infrastructure Development».

STEP 3.
Comparing current status with NI target structure

The experience of Russian experts made it possible to develop a **target model of the status of nuclear infrastructure (NI)**. Comparison of the current status of country's nuclear infrastructure with the target model allows you to plan the country's nuclear energy program and develop steps for its implementation

NI target model allows to answer the questions:

WHO is responsible

WHAT is to be done

HOW it is supposed to be done

WHEN it is supposed to be done

in order for each NI development activity to reach target status for safe and efficient NPP project and program implementation

Target model for each NI element is structured the following way:

1. Targets, objectives and scope of responsibilities
2. Legal and regulatory basis
3. Organizational structures responsible for NI element implementation
4. NPP operator and stakeholders' organizational structures scope: staff (personnel) number and competences, HRD
5. Examples of nuclear power program management and regulation in Rosatom partner states
6. NI elements development roadmaps and maturity criteria

STEP 4.
NI related risks assessment

In practice, there is a possibility of failure to meet the schedule for the implementation of NPP or CNST projects due to insufficient nuclear infrastructure. In the very early stages of a nuclear project, it is extremely important to identify the risks of an immature nuclear infrastructure using the NI risk assessment methodology. Determining risks and the extent of their impact an NPP or CNST project allows to define measures to prevent the risk from being implemented or to mitigate the consequences of risk implementation and to reflect them in the NI development Roadmap.

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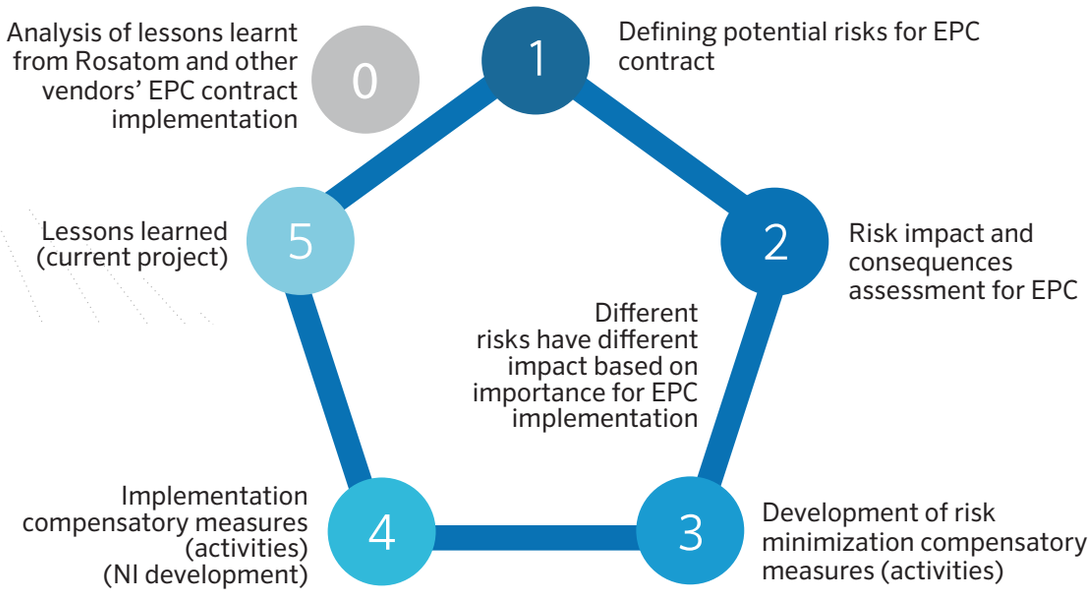
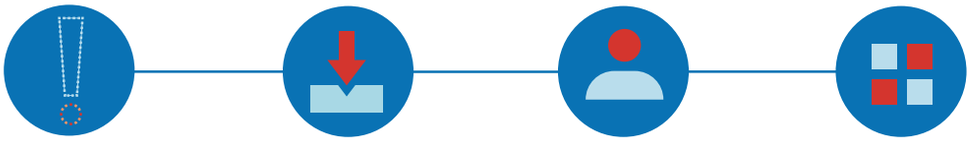
Process of identification and minimization of NI related risks influencing EPC contract



We provide our partners with our risk assessment methodology for all issues of NI, classifying them according to the following criteria:



Risk probability

Risk impact

Risk owner (e.g. NPP Owner, NPP Vendor, Government, etc.)

Consequences for the NPP projects characteristics systemized in four groups: project costs, quality, content/scope and terms

STEP 5.
NI roadmap development

According to the results of the NI status assessment, a Report with recommendations on the development of NI for each issue is developed, as well as the Roadmap for NI development (in MS Project), indicating the responsible executives and the schedule of activities linked to EPC contract.

The roadmap makes it possible to prioritize NI development and competence, as well as to determine in which areas the vendor's support is needed.

The roadmap is presented to support the development of the NPP construction project up to commissioning, and also includes operation of the nuclear power plant.

The roadmap is developed as a Gantt chart with a hierarchical structure of work for each NI issue in four levels of details: NI issue, the condition of the target status for NI issue, recommendation to achieve the appropriate maturity of NI issue, detail actions to implement the recommendations (when needed).

Specifying the responsible organisations and experts for NI Roadmap allows to identify the stages of development of key project stakeholders, as well as displaying interdepartmental cooperation in the NPP construction project, which objective is to follow the project schedule with priority of safety.

Roadmap allows for prioritization of NI and competences development activities and defining areas of vendor support.

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STEP 6.
Assistance in NI development

Rusatom Service services in NI assessment and development:

NI elements assessment and development (technology specific in depth assistance)

NI ASSESSMENT MISSION:
Model (target structure) of NI development.
NI assessments for each element of NI.

COMPETENCES DEVELOPMENT FOR NI:
Nuclear fundamentals for managers.
Special classes for experts.
Internships and training at Russian facilities, webinars.

DOCUMENTS' DEVELOPMENT:
Legal and regulatory documents.
Organization level documents.

CONSULTING:
Legal and regulatory audit, HRD audit, Adjustments and domestication of regulatory and legal basis (including providing regulations from vendor country regulatory body/technical support centers).
Implementing operating organization documents, preparing o perating organization for licensing, assisting in licensing, organizational structure optimization.

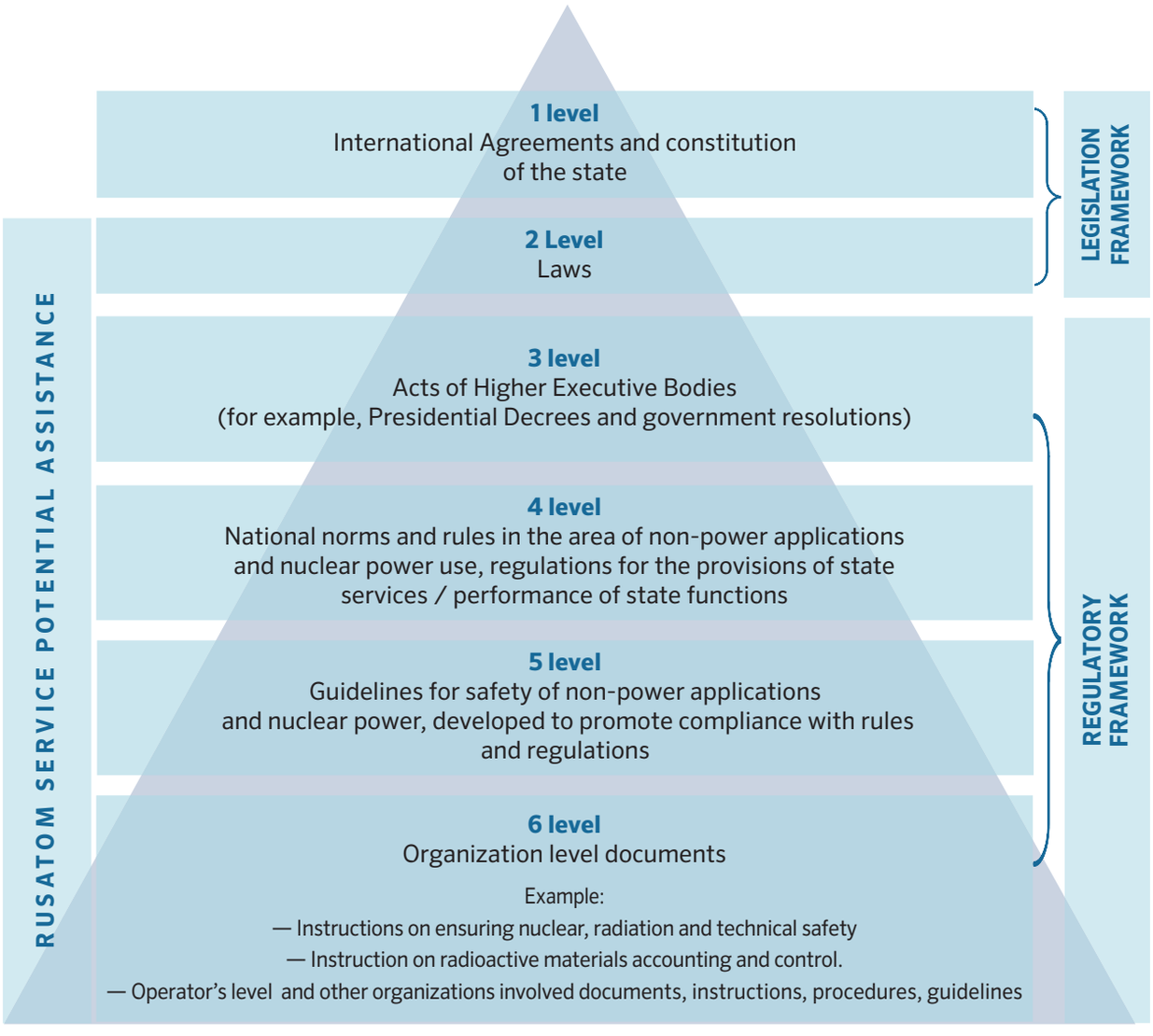
TECHNICAL SUPPORT CENTERS:
Emergency preparedness and response center.
Physical protection center.
Information center.
Training and simulation center.
Metrological center.

AREA 1.
Development of legal, regulatory, organizational level documents

A nuclear energy program should be based on an appropriate legal and regulatory framework that would allow for development of terms and conditions for the effective development of all issues of the nuclear infrastructure in accordance with safety requirements.

There are six main levels of legal documents, statutory documents, regulations and organisational level documents:

Legal and regulatory documents pyramid

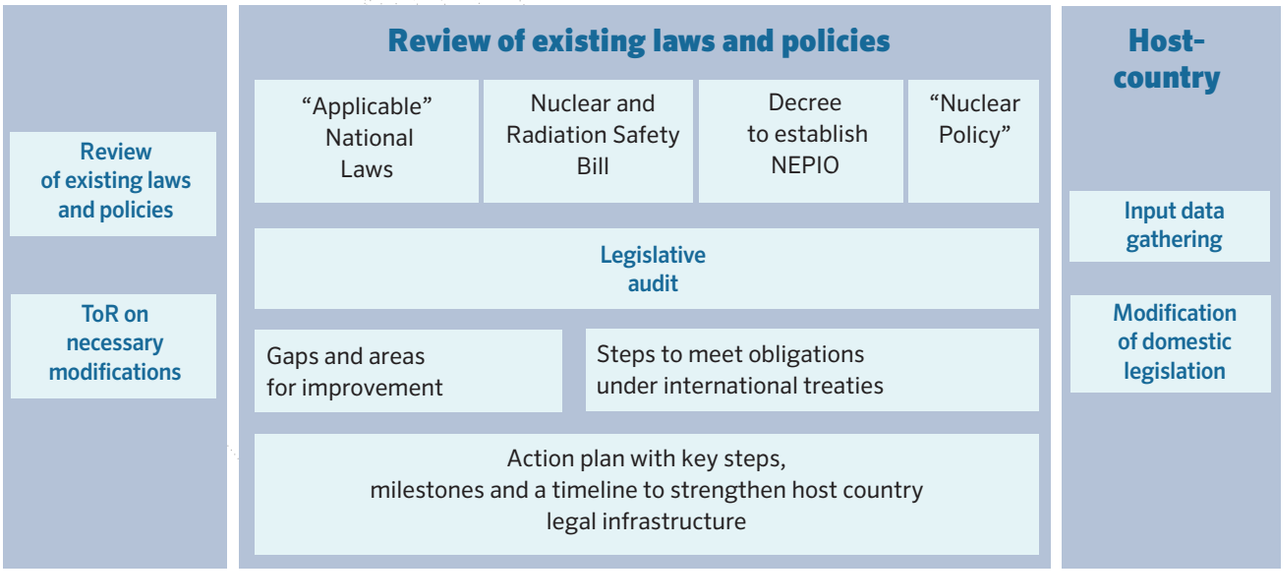


We assist in the development of levels 2–6 documents - both in drawing up a complete list of the required legal acts, regulations and organisational level documents, and in the development of individual documents.

We offer an analysis of existing legislation — both in the field of atomic energy and non-atomic legislation (for example, tax, labor, environmental and other), which in one way or another influences the development of nuclear energy projects.

The analysis of the adequacy and sufficiency of existing legal acts and the need to develop (amend) documents for the development, construction, and operation of NPP and regulation are carried out as part of a "legislative audit", which are resulted in recommendations for the revision and amendment of legislation, taking into account the requirements of international conventions on the peaceful uses of atomic energy and IAEA recommendations.

Legal audit. Developing legal and regulatory basis



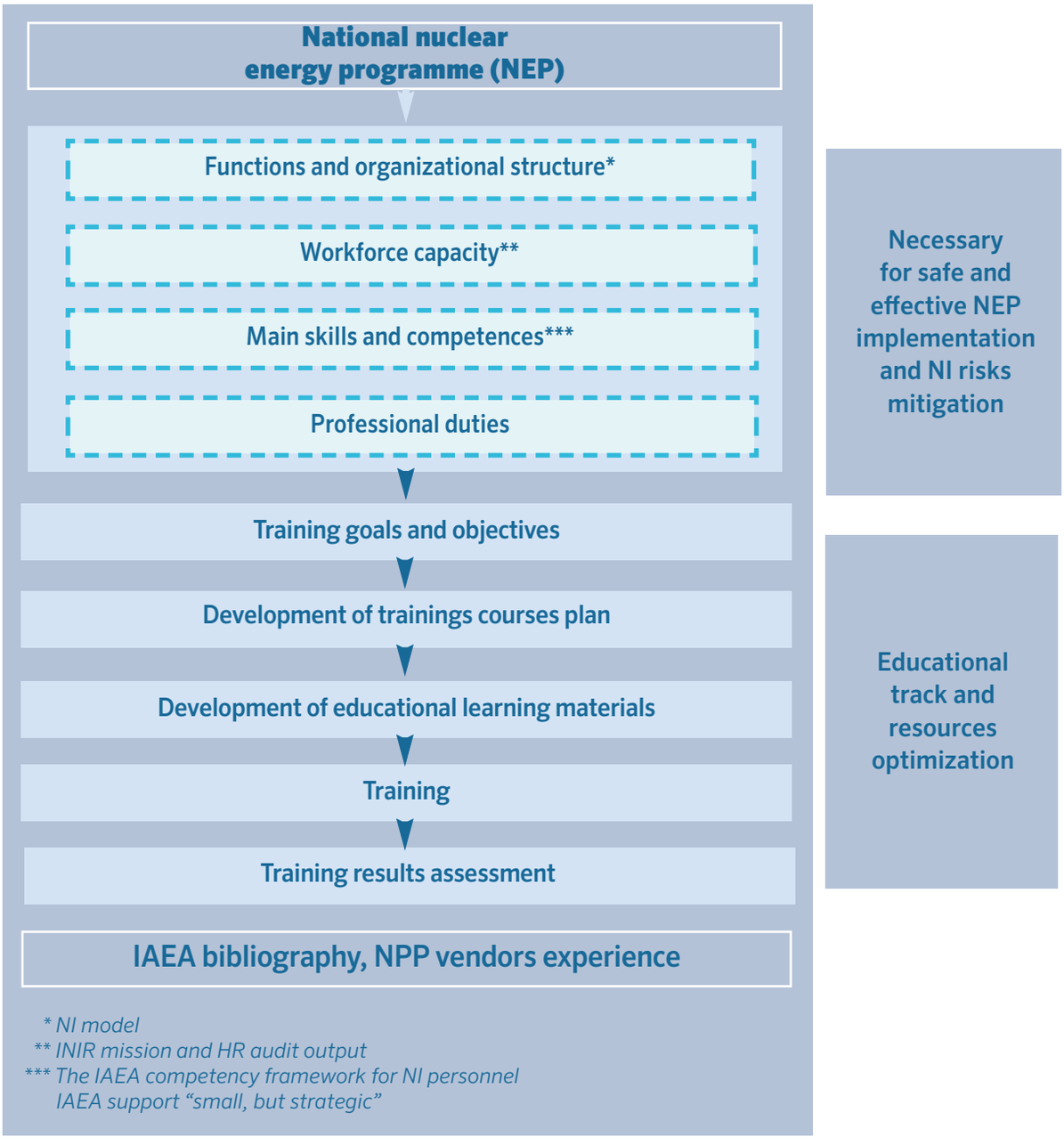
An important component of the development of the legal, regulatory and technical documentation base is the development / adaptation of documents of integrated management system (IMS):

1. IMS manuals (organizational structure, missions, goals, policies of the participants in the implementation of the nuclear energy program);
2. process guidelines (process objectives, process maps, functional matrix, job description provisions, risk management procedures);
3. process structures (scope of work, requirements, descriptions of procedures, job descriptions, etc.).

AREA 2.
Personnel training and capacity building

Development of personnel potential is a system task. It is important to start planning human resources in advance, as the planning process helps to optimize financial costs. Rusatom Service JSC provides human resource development services: from requirements assessment to maintaining qualifications, and offers a country HRD plan linked to NPP / CNST project construction schedule. The roadmap of trainings and development of NI personnel competencies is linked to NPP Project schedule.

Systematic approach to training of the nuclear infrastructure personnel (of stakeholders)



At each stage, prior to obtaining siting, construction and operation license, the relevant competencies of all participants of the nuclear energy program (NEPIO/ Atomic Energy Agency, an Operating Organization, a Regulatory Body, as well as other organizations involved in the development of nuclear energy) are required to be developed.

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The number of organizations involved in the implementation of the nuclear power program and the number of their personnel are progressively increasing depending on the stage of its development. As a result, the tasks in the field of education are also improving.

NI personnel training and objectives

PROJECT STAGES	KEY OBJECTIVES OF NI TRAINING	
Before siting license	**Developing competences in:** • Developing and adjusting legal and regulatory documents • HRD strategy • Integrated management system in operating organization and other organizations involved	**Up to 25 experts** (NEPIO, government, regulator)
Before construction license	**Developing competences in:** • Efficient interaction between an operating organization and a regulator • Ensuring physical protection and emergency planning, radiation management system and localization (industrial involvement)	**Up to 50 experts from** 10 agencies and organizations
Construction and preparation for operation	**Developing competences in:** • development procedures of conformity analysis for NPP design and operating documents • Testing of all NPP and NI systems (emergency planning, transport and nuclear security etc)	**Up to 200 experts from** 25 agencies and organizations

As part of the training, we offer various options for NI personnel training and capacity building:

1. Fundamental course on the NI model (36 hours for managers and 72 hours for experts);
2. Advanced training for each issue of NI (36 hours for each issue for experts and specialists);
3. Practical exercises in order to consolidate the obtained competencies: scientific and technical visits to nuclear enterprises, schools jointly with the IAEA.

For each training course we develop prospectus — a description of the course. Each prospectus contains the following information: objectives and training outcomes, training structure, recommendations on the target audience, necessary preparation for training, competences to be obtained as part of training, and the format of training.

AREA 3.
Technical support centers

Our comprehensive proposal for the development of nuclear infrastructure includes the organization of Technical Support Centers that ensure safety of the development of a nuclear energy program. For example, such Centers help to provide public awareness or emergency planning activities.

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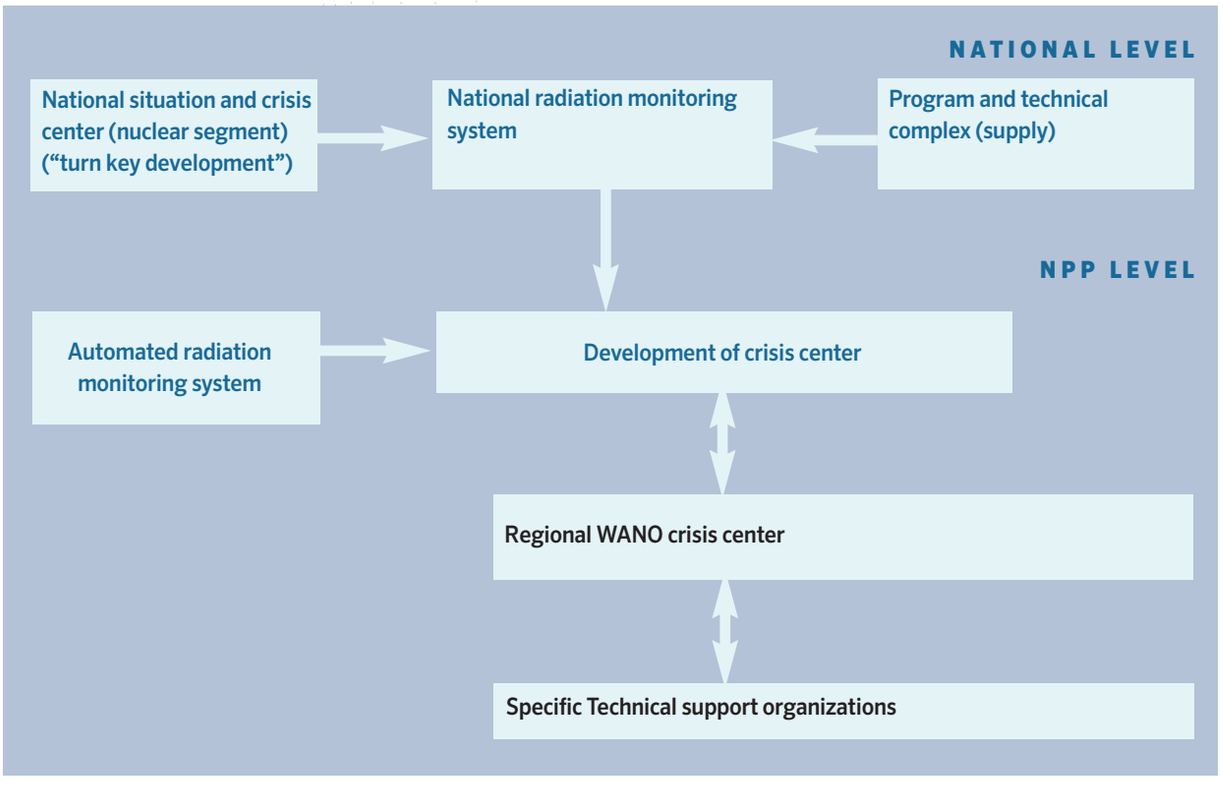
An example of emergency preparedness and response services package

Emergency preparedness and response



Stages of providing NI assistance in emergency preparedness and response:

1. Development / adjustment of the national legislative and regulatory framework in the field of nuclear energy necessary for the establishment and operation of the emergency preparedness and response system.
2. Designing an infrastructure project for an emergency preparedness and response system integrated with a nuclear power plant project or research reactor.
3. Creation of infrastructure for the emergency preparedness and response system, including the construction and acquisition of facilities, documentation development, personnel training.
4. Accompanying and supporting the operation of the National Radiation Monitoring and Emergency Response System (optional).

Integrative character of our services implies the continuous support of our partners.

STEP 7.
Analysis of the results, supporting and corrective measures

The process of nuclear infrastructure development is a continuous activity. In the process of implementing the Roadmap for its development, it is important to analyse the effectiveness of carrying out activities to support of the development of nuclear infrastructure, taking into account NPP / CNST construction schedule — both at the country level and at the level of the NPP or CNST projects.

Following the outcomes of this analysis, adjustments and revisions to the roadmap are proposed, allowing to continue development of the nuclear infrastructure, given its current status and in order for maintaining its status staff competencies at a high level. Revisions are supposed to be applied at least once a year.

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About us

Rusatom Service JSC is a subsidiary of the Rosatom State Corporation and is a member of the electric power division. It was established in 2011 to provide full range of services for foreign NPPs including nuclear infrastructure development in Rosatom partner countries.

Rusatom Service JSC is capable to offer a unique comprehensive solution for nuclear infrastructure and competences development with support of the whole Russian nuclear industry. Nowadays, Rosatom encompasses more than 300 enterprises and organisations with the workforce above 250.000. Its leading edge stems from a number of competitive strengths, one of which is assets and competences at hand in all nuclear segments.

Rosatom State Corporation incorporates companies from all stages of the technological chain, such as uranium mining and enrichment, nuclear fuel fabrication, equipment manufacture and engineering, operation of nuclear power plants, and management of spent nuclear fuel and nuclear waste.

Taking into account the importance of global sustainable development, the necessity to meet global electricity demand we are ready to support our partners by sharing our best practices, experience and competences. To provide our facilitation we engage experts and scientific and technical support organizations.

MILESTONES	MILESTONE 1 A political decision is made on including nuclear option in the energy mix	Decision on Nuclear energy program made	MILESTONE 2 The country is ready for the tender/negotiations with the vendor	NPP contract signed	MILESTONE 3 The country is ready for NPP operation
NUCLEAR POWER PROGRAM DEVELOPMENT	Establishing NEPIO. Prefeasibility study and feasibility study on including nuclear option in the energy strategy	Establishing Atomic Energy Agency and the Regulatory body Developing nuclear energy program	Joining international conventions. Developing nuclear energy legislation. Joining IGA on peaceful use of nuclear energy with the vendor	Establishing tenders. Start of negotiations with the vendor. Signing IGA/ construction contract with the vendor for the first NPP	Grids' upgrade. Financing NPP construction
NI DEVELOPMENT	Developing national position	Developing national requirements for nuclear energy	Conducting assessment of national NI. Developing and improving of NI	Developing and improving of NI. NI personnel training	Establishing technical support centers
NPP/ CNST CONSTRUCTION PROJECT	–	Developing national technological requirements for the first NPP.	Developing tender specifications / TOR for NPP construction	Conducting tender/ negotiations with the vendor. Obtaining site license	Establishing operating organization Construction license obtained Operation license

~ 10–15 years

~ 7 years

NPP project

Site permit

FOR SITE PERMIT

- Siting and site survey
- Siting report for priority site
- Establishing operating organization (operator)
- Environmental monitoring
- Environmental Impact Assessment (EIA)
- Public hearings
- QAP (general and site selection)
- Developing regulatory docs
- Operator training
- Regulator training

Construction permit

FOR CONSTRUCTION PERMIT

- Site preparation (site specific engineering surveys)
- Site parameters report
- Site Physical protection (PP)
- Developing regulatory documents
- PSAR (Preliminary Safety Analysis Report)
- PSA (I level)
- QAP general
- QAP construction
- Industry involvement and localization

Construction

Operation license

FOR OPERATION LICENSE

- FSAR (P)
- Training for operating personnel program
- PSA (II level)
- QAP (commissioning)
- QAP (operation)
- Emergency plan
- Technological procedure of operation
- Reactor start up program
- Program of operation
- Nuclear Materials A&C System
- Nuclear security and PP system
- Data on operating staff, experience and licenses
- Personnel training plan

Operation

- FSAR (F)
- Personnel training
- Fuel transportation
- Maintenance
- RW and SNF management

Decommissioning

Decommissioning license

FOR DECOMMISSIONING LICENSE

- Decommissioning program
- Radiation investigation (examination)
- QAP (decommissioning)
- Radiation control
- Emergency plan for decommissioning, PP documents, design
- List of documents for decommissioning license

Abbreviations

A&C System — accounting and control system

NEPIO — nuclear energy programme implementing organization

CMP — construction management project

EIA — environmental impact assessment

EPC — Engineering, procurement and construction

FSAR — Final Safety Analysis Report

FSAR (P) — Final Safety Analysis Report (preliminary)

FSAR (F) — Final Safety Analysis Report (final)

IGA — intergovernmental agreement

PSAR — preliminary safety analysis report

PSA — Probabilistic Safety Analysis

PP — physical protection

PRA — probability risk assessment

QAP — quality assurance program for nuclear power facilities

QAP (G) — quality assurance program for nuclear facilities (general)

QAP (C) — quality assurance program for nuclear power facilities (construction)

QMS — quality management system

TOR — terms of reference

SNF — Spent Nuclear Fuel

RW — radioactive waste

RWM — radioactive waste management

NS and PP — Nuclear Security and Physical Protection

NI status website (Russian, English, Spanish)
Self-assessment for foreign partners
Portal for Rosatom experts

Instagram
Facebook

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