THE ENVIRONMENTAL EFFECTIVENESS OF DIGITALIZATION OF THE NUCLEAR INDUSTRY

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Abstract—This paper discusses the environmental effectiveness of digitalization as exemplified in the nuclear industry. The paper analyzes one of the three most important factors of sustainable development, the environment. The analysis shows that the implementation of digital interfaces in various fields has produced a considerable improvement, which can be proven by the rising environmental rates of the nuclear industry. The paper describes a system for the implementation of environmental policy including the corporate data warehouse, automatic radiation monitoring system, object monitoring of subsoil condition, and Russian System for radioactive waste management. The introduction of computer interfaces has already proven to be effective and lead to reduction of emissions, discharges, and waste, which has made NPP operation much safer..

Keywords - Digitalization, Ecology, Environment, Environmental Activities, Environmental Safety, Environmental Efficiency.

Abbreviations used in the text

CDW	Corporate data warehouse
ARMS	Automatic radiation monitoring system
OMSC	Object monitoring of subsoil condition
RSRWM	Russian system for radioactive waste management
AIS	Automated information system
IARMS	Industrial automatic radiation monitoring system
NRHF	Nuclear and radiation hazardous facilities
CEMS	Complex environmental monitoring system
GEDP	Geoecological data packs
PIEM	Program of industrial environmental monitoring
ESO	Environmentally significant organization

Recently, Russia has launched a new national project—National Project "Ecology." The Project receives funding from both the federal government and major companies. Altogether, the Project budget is going to amount to 61.5 billion dollars. National Project "Ecology" encompasses 11 federal projects that are due to have been implemented by 2024.

The tasks that the Project faces are associated with the digitalization of primary processes and function of each corporation and each company. Within the framework of the Project, the responsibility for building an infrastructure for management of waste of 1 and 2 hazard classes rests with the Rosatom State Corporation.

The term 'digital economy' was coined in 1994. Researchers from Lomonosov Moscow State University (Moscow, Russia) believe that the meaning of the term is still vague, and other terms such as 'electronic economy,' 'new techno-economic paradigm,' 'API economy,' 'application economy,' 'creative industries,' etc. are used to denote the same thing. On the other hand, digitalization is a more specific term but still, it can be replaced by another one. For example, if conventional digitalization is replaced by some other new-generation analog technology, then the term 'API economy' will be more suitable. In its turn, a transition to a new, higher, level of an analog technology according to the law of the negation of the negation is quite possible; and in this case, the application of a programming interface will be more suitable.

While the European part of the world community sticks to the term digital economy, the American part represented by Deloitte, IBM, and some other companies prefers using the more technologically correct name for the phenomenon, API economy.

Digitalization means, first of all, a systematic approach, which is the main achievement of Rosatom's Environmental Agenda.

Moreover, Rosatom has adopted Strategic Program "Digital Rosatom" [1] encompassing 10 affiliated programs dealing with digitalization:

- Re-engineering and digitalization of processes of NPP construction
- Digital import phase-out
- Digital twin and emerging technologies
- Digitalization of primary processes and corporate functions
- Digital products, ecosystems of developers and partners
- Marketing and the image of "Digital Rosatom"
- Architecture, infrastructure. User experience
- Cybersecurity and process efficiency
- Digitalcompetences and culture
- Organizational changes as part of digital transformation

As of today, Rosatom's both the system for the implementation of the environmental policy and the system of environmental activities are ready for digitalization. Figure 1 below shows primary fields of the application of programming interfaces at Rosatom.

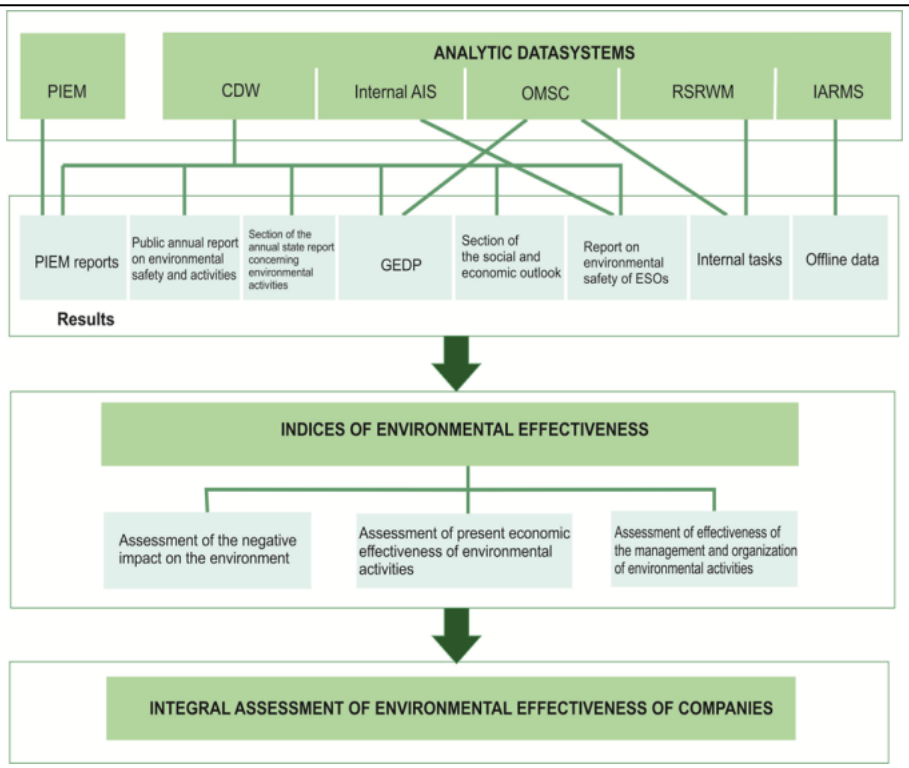


Fig. 1. Digitalization of the implementation of environmental activities conducted by Rosatom

It is a separate task for digitalization within the structure of Rosatom to employ competencies of the nuclear in the field of environmental protection in order to find a solution to one of the global environmental problems of today—the problem of waste.

The integral estimation of the efficiency of Rosatom's affiliated companies includes an assessment of the negative impact on the environment, an assessment of the present economic effectiveness of environmental activities, and an assessment of the competence of management and the effect of the organization of those activities.

In order to assess the efficiency of its environmental policy, Rosatom has developed a unified set of Industry Guidelines for Application of the Indices of Environmental Effectiveness build on documents of enterprise, national, and international levels as well as on modern scientific and methodological approach to the assessment of environmental effectiveness and recommendations contained in international standards on corporate and nonfinancial reporting concerning environmental aspects.

The successful implementation of its environmental policy by Rosatom's affiliated companies has allowed reducing the adverse impact on the environment resulting from production activities conducted by nuclear companies. Over the past five years, Rosatom managed to cut the amount of discharge of polluted wastewater and emissions of air pollutants by 1.3 times and to decrease the risk of generation of waste of 1st and 2nd hazard classes by 20 times. The amount of generated radioactive waste dropped 1.3 times (see Figure 2).

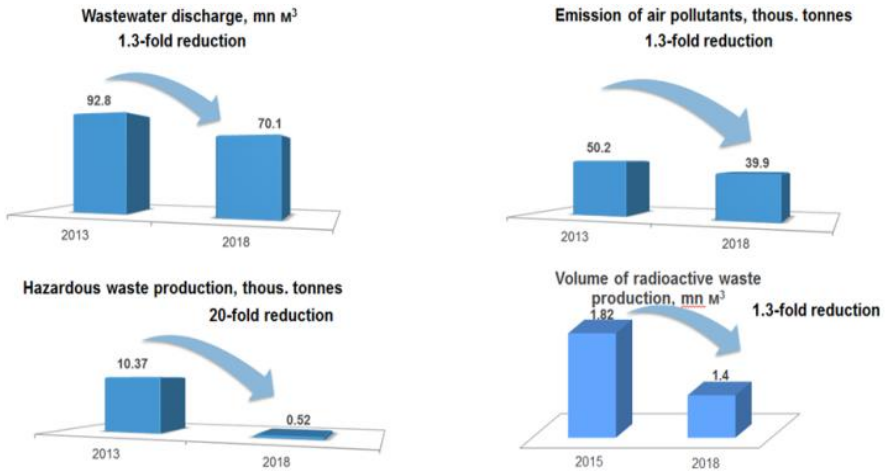


Fig. 2. Key results of the implementation of Rosatom's environmental activities (discharge, emission, waste)

All year round, Rosatom secures sustainable and safe work of its nuclear companies. There were detected no incidents of above-norm irradiation of personnel and no accidents leading to radiological consequences. The indices of environmental impact are well within the set limits.

Over the past two years, Russian NPPs suffered no nuclear events graded level 2 or above according to the INES (deviations of the 0 level and anomalies of the 1 level pose no hazard either for personnel of nuclear facilities or for the surrounding area, its environment, and population.) Moreover, there were detected no nuclear events graded level 1 according to the INES at Russian NPPs in 2017. Since over a decade, the effective median irradiation dose of personnel and the number of irradiated persons have been decreasing and maintained low.

In 2018, Rosatom's affiliated companies allocated more than 130 million dollars to the capital assets intended for environmental protection, which equalled to 5.8% of the whole amount countrywide. In relative terms, this is almost 20 times more than the cost of the adverse impact on the environment caused by nuclear. Figure 3 below shows the impact on the environment exerted by Rosatom's affiliates in 2018 compared to that created by all Russian companies together as well as Rosatom's share in funds invested in environmental protection.

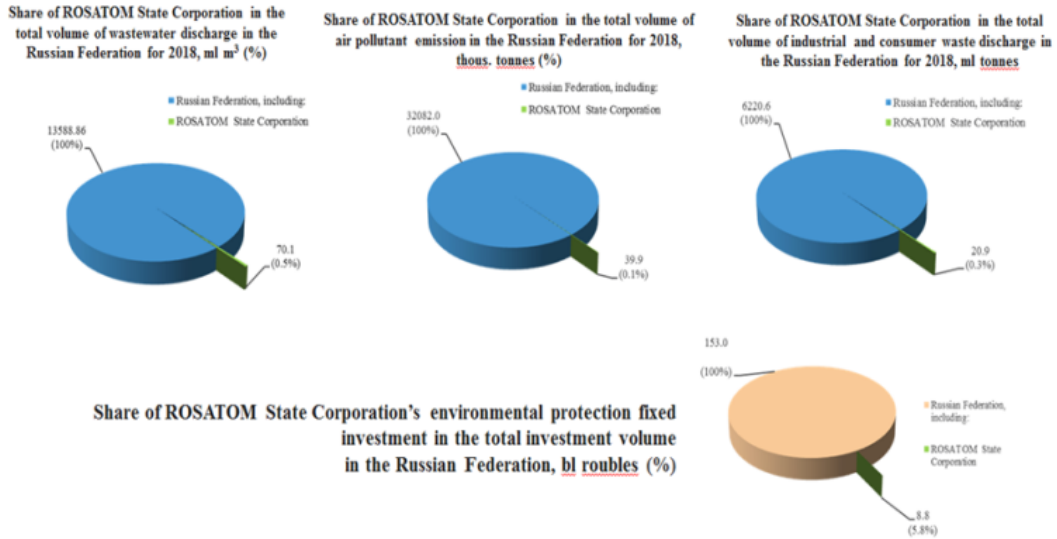


Fig. 3. The impact on the environment exerted by Rosatom's affiliates in 2018 compared to that created by all Russian companies together as well as Rosatom's share in funds invested into environmental protection

Among all Rosatom's programming interfaces, the following ones are the most advanced: CDW, ARMS, RSRWM, and internal AISs of Rosatom's affiliate companies.

The CDW is a component of digitalization. The CDW has just recently appeared and is still far from perfect, which does not allow for abandoning "manual" work on reports dealing with environmental statistics. Moreover, the CDW does not allow making quick flexible reports.

Rosatom's top systems are ARMS and RSRWM. Their availability complies with the world's best practice in the field of nuclear safety which means that there should be an infrastructure in place monitoring current situation online as well as there should be a system of tactical response to radiation accidents on the facility, regional, and national levels.

It is important to provide the population with timely updates on current radiation situation and actions necessary in case of emergency. This function is performed by Rosatom's industry ARMS (IARMS). The IARMS is designed to monitor radiation situation online, to detect timely the overriding of background radiation parameters at NRHFs, and to provide an efficient emergency response, which should drastically reduce potential damage from accidents and emergencies as well as secure the implementation of international agreements concerning radiation accident alerts. The IARMS successfully completes the tasks if faces.

In order to achieve full digitalization of environmental activities, each nuclear facility should be equipped with automated sensors detecting discharges and emissions (including nuclear); and data from the sensors should be entered into the Complex Environmental Monitoring System (CEMS.) The CEMS has been developed since 2018 [2]. One of the key components of the CEMS at Rosatom is geoecological data packs (GEDP).

Digitalization of waste management and especially of their transportation from places of origin to recycling and elimination sites are Rosatom's top priority in the field of digitalization. Rosatom promotes the establishment of a unified federal information system for the waste of 1st and 2nd hazard classes.

Another task relating to the digitalization of environmental activities is digitalization of regulatory activities. This concerns all industrial operators

including Rosatom. The nuclear industry incorporates about 300 enterprises, with each of them obliged to have between 10 and 37 licenses and permits. All of them are obtained through issuance and writing of innumerable papers, which amounts to 10,000 various documents.

The environmental effectiveness of the first steps made by Rosatom in the field of digitalization can be proven by its results for 2016, 2017, and 2018.

CONCLUSION

The example of the nuclear industry demonstrated the effectiveness of the digitalization of environmental activities such as the implementation of the IARMS, OMSC, RSRWM, etc. These systems allowed solving many tasks of Rosatom's Environmental Agenda, which can be supported by its strong performance in ensuring environmental safety and protection. At the same time,

It is imperative that companies computerize the collection of data concerning emissions, discharge, and waste at the origination point, digitalize centralized data storage, and make it easy to use them to implement environmental policy. Moreover, the intra-industry means of control and supervision should digitalized, the system of indices of environmental effectiveness should be enhanced. These tasks face all industries both at home and abroad.

REFERENCES

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