ORLEN SYNTHOS GREEN ENERGY'S NUCLEAR POWER DEPLOYMENT PROGRAM: BUILDING ORGANIZATIONAL AND HUMAN CAPACITY

KALEND, KATARZYNA
ORLEN Synthos Green Energy Sp. z o.o.
Warsaw, Poland
Email: katarzyna.kalend@osge.com

Abstract

Orlen Synthos Green Energy (OSGE) is a Polish company that implements a fleet of Small Modular Reactors (SMR) in Poland using the BWRX-300 technology provided by General Electric Hitachi Nuclear Energy (GEH). Poland is determined to decarbonize its energy mix with a significant share of nuclear technology, both large-scale and SMR. Poland has scarce resources for adequately qualified staff in the nuclear sector, and most Polish specialists have gained experience and competence abroad. To ensure the availability of qualified staff, there is an immediate need to develop educational and training programs certified by the Polish regulatory body – the National Atomic Energy Agency (PAA). OSGE also plans to build a Training Center to allow selected candidates to acquire the skills, knowledge, and experience necessary to safely operate future nuclear power plants. OSGE works closely with Ontario Power Generation (OPG), which plans to deploy FOAK (first of a kind) BWRX-300 in Darlington (Canada), Tennessee Valley Authority (TVA) and GE Hitachi - the provider of BWRX-300 technology. Thanks to this cooperation, OSGE can benefit from the experience and expertise of organizations with a long record track in the nuclear industry.

1. INTRODUCTION

Polish companies Synthos Green Energy and PKN Orlen signed an investment agreement to establish a joint venture company, ORLEN Synthos Green Energy (OSGE). OSGE's primary goal will be to prepare and commercialize the technology of Small Modular Reactors (SMRs), particularly the BWRX-300 reactors from GE Hitachi Nuclear Energy in Poland. This project is an opportunity to accelerate decarbonization and improve the country's energy security and economic growth, thanks to local supply chains. Poland's energy mix is based mainly on very aging hard coal and lignite (Fig.1).

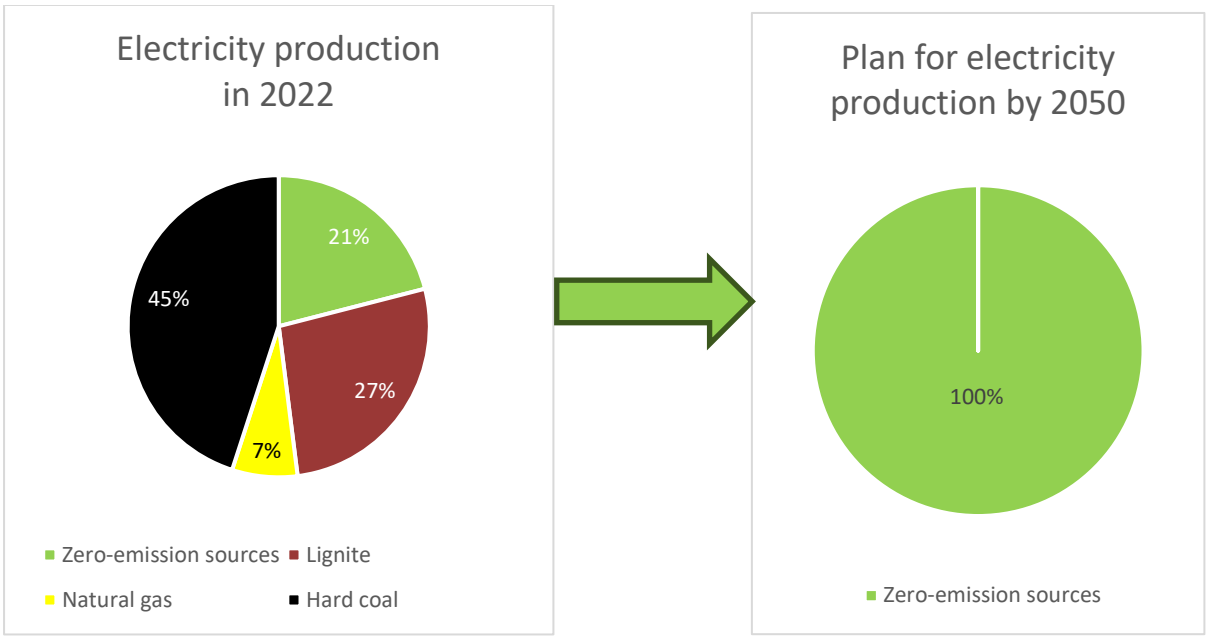

FIG. 1. Actual Poland's energy mix and plans for net-zero electricity production until 2050.

Medium-sized coal-fired units dominate the Polish energy system. Over the following decades, more than 200 obsolete units (Fig.2) will need to be replaced. Most run on coal, with a total capacity of 41 GW.

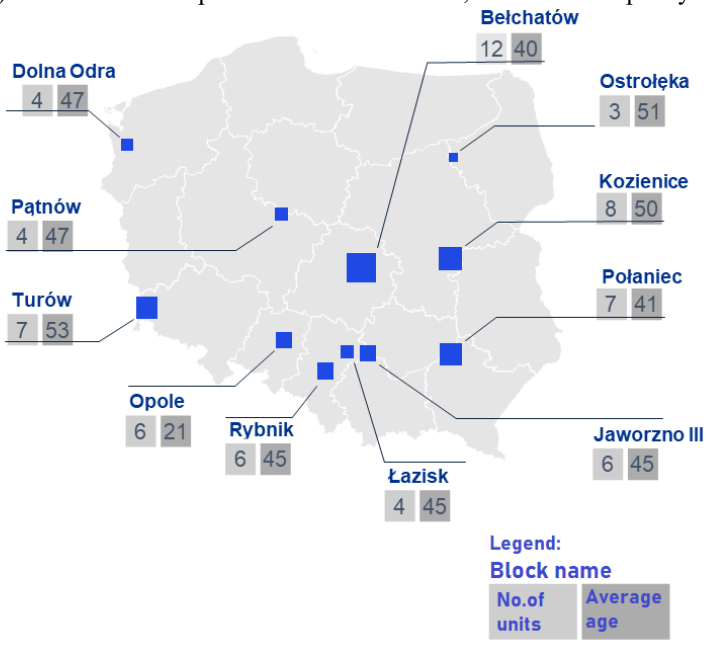

FIG. 2. Map of the largest Polish coal-fired power plants including number of blocks and average age [1].

The potential of BWRX-300 is expected to fulfill an energy gap of 14 GW or more (Fig.3.). This challenge results from the need to modernize and decarbonize the energy sector in Poland. Therefore, investing in modern technologies such as SMRs can be a key step towards sustainable and safe energy production and reducing greenhouse gas emissions. It is worth emphasizing that modernization of the energy sector is not only a matter of replacing units but also of developing new, low-emission technologies that will allow for achieving goals related to environmental protection and the country's energy security.

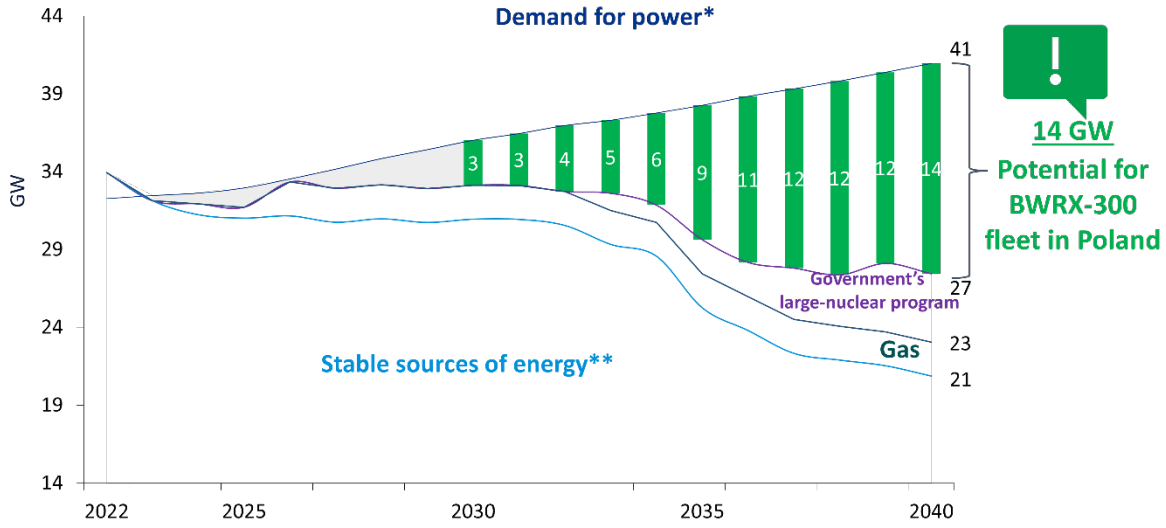

FIG.3. Potential for BWRX-300 - 14 GW electricity supply gap according to PEP 2040 from 2019. Source: PKN ORLEN & SGE analysis on the base of PEP 2040.

**Demand from district heating not included. ** Power capacity of coal sources of energy generation*

Poland faces essential challenges, such as ensuring necessary, stable energy and power supplies for society and a growing economy as an alternative to obsolete coal-fired power plants. The next task is to achieve climate neutrality at reasonable costs and reduce the power deficit in the energy system, which, according to the Polish

Energy Policy (PEP), may amount to approximately 14 GW by 2040. It is worth noting that the modernization and diversification of energy sources are key to the country's sustainable energy future.

Nuclear energy will play a crucial role in effectively addressing the challenges of meeting the future's energy needs and transitioning to a more sustainable future. This includes using large-scale reactors built as a part of government initiatives and the development of SMRs in which private entities like OSGE are investing.

OSGE, in particular, aims to contribute to the NET ZERO strategy by deploying a fleet of SMRs as a key component of the energy transition. However, the successful implementation of an SMR fleet requires an adequately trained and qualified workforce to operate the power plants. Unfortunately, Poland currently lacks the personnel with the specialized skills needed for this task.

Therefore, it is necessary to start training specialists as soon as possible to ensure a skilled workforce ready to operate SMRs. OSGE recognizes this need and has prioritized building its competencies by recruiting, training, and developing a highly qualified local nuclear workforce.

By taking proactive steps to invest in training and developing a workforce with the expertise needed to operate SMRs, Poland can place itself as a leader in transitioning to a more sustainable energy future powered by nuclear energy. This will not only help meet future challenges but also contribute to the overall success of the energy transition process.

The BWRX-300 nuclear reactor offers a proven technological solution for replacing aging coal-fired power plants, which typically have a capacity of around 300 MW. By siting the BWRX-300 reactors at these old coal plant locations, the benefits of existing infrastructure, such as proximity to the national power grid, can be utilized.

One of the key advantages of the BWRX-300 is its flexible load-follow mode of operation, which allows for adjustable grid stabilization. This means that the reactor can compensate for fluctuations in energy production from renewable sources, helping to maintain stability in the power grid. This flexibility is crucial as OSGE strives to increase the share of renewables in our energy mix, as it ensures a seamless transition without compromising reliability.

Moreover, introducing BWRX-300 reactors will lead to energy diversification, which brings a host of benefits to the society. In addition to providing clean and reliable electricity, nuclear energy can support district heating systems and industrial heat processes, contributing to overall energy efficiency and sustainability.

2. IMPORTANCE OF CAPACITY BUILDING

Capacity building in nuclear programs is crucial, because it ensures nuclear facilities' safe and secure operation. It involves personnel’s training in the fields of: technologies, best practices and building infrastructure to support nuclear activities. Without proper capacity building, there is a higher risk of accidents, security breaches, and non-compliance with international regulations. Therefore, investing in capacity building is essential for the long-term sustainability of nuclear programs.

According to IAEA’s guide, the term ‘capacity’ refers to an organization or individual with the competence (knowledge, skills, attitude) and capability (resources, authority, processes, equipment, means of deployment) needed to achieve their desired goal. Capacity building for nuclear power refers to a systematic approach using education, training, exercises, workforce management, and knowledge management to develop and continuously improve governmental, organizational and individual competencies and capabilities.

Capacity building includes several key elements: education, training, exercises, awareness raising, workforce management, and knowledge management. Education, training, and exercise activities build capacity by facilitating the development of knowledge and skills and helping the new and existing professionals master principles and technologies. Building capacity for nuclear power, raising awareness and targeting multiple audiences can promote an understanding of the importance of developing the nuclear industry. Workforce management and knowledge management support the development, recruitment, and retention of personnel with the necessary competencies [2].

According to WANO’s “Roadmap to Operational Readiness,” knowing when to provide high-quality operational capability and capacity is critical to fulfilling OSGE’s obligations during the Operational Readiness process [3].

The purpose of training in the nuclear industry is to ensure that employees are competent and qualified to perform the duties of their position.

The Systematic Approach to Training (SAT) is being implemented to fulfill these requirements. SAT is the analysis, design, development, implementation, and evaluation model (ADDIE—Analysis, Design, Development, Implementation, Evaluation).

Each phase comes with its own set of procedural guidelines and forms. This provides a method of meeting employee training needs and ensuring that the right people receive the proper training at the right time. Through the training system, it can be demonstrated that all required safety-related knowledge, skills, and attributes have been achieved through a performance-based assessment and program evaluation process. Without an adequately utilized SAT process, there is a risk of missing essential training elements, and the facility's or its employees' status may not be reflected in training programs.

3. CHALLENGES FOR COUNTRIES EMBARKING NUCLEAR POWER

The challenges newcomer countries face in the nuclear industry concern various areas, i.e., legal regulations and cooperation with the regulator, new technologies, financing, qualified human resources (competitiveness for trained personnel), etc. When implementing a nuclear program, risks should always be considered and controlled. However, it is worth emphasizing that each challenge may be a unique opportunity and a benefit. In the face of the world's energy challenges and Europe, OSGE must use this opportunity to fit into the existing Polish power grid.

3.1. Cooperation with Polish authorities

Establishing interactions with the regulatory bodies at the very early stage is essential when starting nuclear power development. Work is underway to form an Engagement Plan with the National Atomic Energy Agency (PAA). The engagement plan aims primarily to build trust and competence on both sides. Engagement with the Polish authority and their oversight is essential for ensuring Poland's safe and secure nuclear energy use. Starting mutual interactions early ensures adherence to strict regulatory standards and best practices in the operation and maintenance of nuclear facilities. The expertise and oversight provided by PAA help to prevent accidents and ensure the protection of both the environment and the public.

OSGE works closely with the Office of Technical Inspection (UDT) to ensure the safety and compliance of technical devices used in nuclear facilities. UDT is an authority that enforces many legal acts about the safety of these devices to prevent potential accidents or hazards. OSGE's collaboration with UDT helps maintain high safety and regulation standards within the nuclear program. Close work also ensures that the supply chain of all technical devices will meet the requirements for safe operation in nuclear facilities.

Working closely with the relevant authorities ensures that OSGE’s nuclear energy program will develop and gradually improve responsibly and sustainably.

3.2. Modern nuclear technologies

Countries embarking on nuclear power, particularly with modern technologies like the BWRX-300, face challenges such as the technology's complexity and associated processes. Additionally, there are concerns over public perception and regulatory hurdles related to safety management. Ensuring a skilled workforce to operate and maintain these advanced nuclear reactors is also a significant challenge that must be addressed. In the case of BWRX-300, it’s not a revolutionary technology but an evolution of generations of GEH’s BWR reactors.

3.3. Financing

One of the significant challenges of nuclear power projects is a high level of financing. Development, construction and pre-operational testing of a nuclear power plant requires significant capital; finding investors willing to support such projects can be difficult. Additionally, the long-term nature of nuclear power investments can make securing financing even more complex, as lenders may be wary of the risks associated with such projects. Governments and industry stakeholders must work together to find innovative financing solutions to overcome these challenges and ensure the success of their nuclear power programs.

Financing SMRs may be easier with lower CAPEX than large-scale nuclear power programs, making private capital more interested and engaged in these projects. Sufficient funding for SMR projects requires active

interactions with specialized investment funds, cooperation with potential investors and finding an optimal mix of public and private funds.

3.4. Qualified human resources

The requirement for highly qualified personnel for nuclear power plants is crucial to ensure the safety and efficient operation of these installations.

Implementing nuclear programs, especially innovative ones like OSGE's, requires trained personnel with specialized knowledge and skills. Providing qualified personnel is one of the most significant challenges facing emerging countries. OSGE's program is distinguished by its fleet, Coal-to-Nuclear approach, where numerous multiunit nuclear power plants are built in a staggered manner and operated simultaneously. That means large numbers of workforce need to be trained to operate nuclear reactors. However, there will also be an opportunity for vocational education or retraining called a "nuclearization" program for the existing employees of obsolete coal-fired power plants.

The possibility of using staff currently working in coal-fired power plants in nuclear power plants will significantly facilitate the process of recruiting and training required workforce. At the same time, it will provide many new jobs for the employees of the coal based energy sector. This strategy will ease the social aspects of the energy system transition.

4. CAPACITY BUILDING

Capacity building requires a strategy ensuring that organizations and individuals can achieve their full potential. By working together and sharing resources, expertise and best practices, partners can help each other develop the skills and knowledge needed to succeed in their respective fields. These collaborations can lead to more effective and efficient outcomes benefiting all parties involved. International cooperation can accelerate technological progress and bring innovative solutions to the market.

OSGE can achieve the set goals thanks to close cooperation with:

a) GE Hitachi, the vendor of the BWRX-300 reactor, a global leader in the nuclear market that builds nuclear reactors based on proven technologies from the 1950s,
b) Tennessee Valley Authority (TVA) - one of the largest nuclear energy companies in the USA having the strategy of BWRX-300 deployment and operation,
c) the Canadian energy company Ontario Power Generation (OPG), where the first BWRX-300 reactor (FOAK) will be built before 2030.

On June 2, 2023, OSGE and OPG signed a letter of intent in Darlington, near Toronto. OPG and its subsidiaries have expanded cooperation with OSGE in implementing and operating SMRs in Europe. The Canadian company will also support OSGE in building nuclear operator competencies for SMR projects in Europe and the UK.

OSGE also cooperates with Laurentis Energy Partners (LEP), an OPG group company that supports OSGE in developing an advanced project implementation schedule and work breakdown structure (WBS).

OSGE's and OPG's partnership covers several activities related to the development and implementation of SMRs, the operation and maintenance of the power plant, operator training, and the commissioning process of the nuclear power plant.

Three experienced developers are involved in the SMR deployment project, which means that the risk associated with the technology is also spread among three large companies.

4.1. Supporting nuclear education at Polish universities

Cooperation with Polish universities in developing nuclear power programs is crucial for leveraging expertise and knowledge in the field. By partnering with these institutions, OSGE can access cutting-edge research and technology to enhance the development of OSGE's nuclear power program. This cooperation will strengthen capabilities and foster competence building to provide the skilled workforce necessary to operate all planned nuclear power plants.

In January 2023, on the initiative of OSGE, PKN Orlen, the Ministry of Education and Science and six Polish technical universities a letter of intent was signed to establish a nuclear energy field of study. The agreement provides education for nuclear engineers. At the end of May 2023, three more universities joined the agreement. An agreement was signed between those universities, the Ministry of Education and Science and Orlen to create a consortium coordinating the development of education for the Polish nuclear energy industry.

In May 2023, OSGE and the Łukasiewicz Research Network signed an agreement on launching the European Center for Personnel Training for Nuclear Energy. The cooperation covers the launch of the Center itself and its further development, including support from research and development institutes that are part of the Łukasiewicz Research Network.

4.2. Joining the NET ZERO initiative

During COP28 in UAE, world leaders committed to reaching net zero emissions by 2050. This historic agreement marks a significant step towards combating climate change and creating a more sustainable future for our planet. The signing of NET ZERO at COP28 demonstrates global cooperation and a shared commitment to addressing the urgent issue of climate change.

During COP28 UAE, OSGE signed a declaration on transitioning away from all fossil fuels to enable the world to reach net zero by 2050. Also, during COP28, the President of Poland – Andrzej Duda, emphasized the role of OSGE's partnership with Emirates Nuclear Energy Corporation (ENEC), the nuclear operator in the UAE and host of COP28 UAE. ENEC has successfully constructed its first nuclear power plant in Barakah. OSGE will leverage ENEC’s experience in building and developing the fleet of small reactors BWRX-300.

4.3. Cooperation with IAEA

Cooperation with the International Atomic Energy Agency (IAEA) is essential for ensuring nuclear technology's safe and peaceful use worldwide. By working with the IAEA, countries can strengthen their nuclear safety measures, enhance their security protocols and ensure compliance with international nuclear safeguards. Through cooperation with the IAEA, Member States can also benefit from access to technical expertise, training opportunities and shared resources to help advance their nuclear energy programs. OSGE also draws on these resources and participates in various specific and valuable training courses conducted by the IAEA.

5. TRAINING CENTER

Technical training is critical for achieving satisfactory operational performance of the reactor’s staff. In addition, the training system must comply with regulatory requirements and external assessment [3].

The European Center for the Development and Training in Nuclear Energy will address the urgent need for training nuclear energy personnel.

5.1. Training Center concept

- Center for full-scale SMR reactor simulators (BWRX-300) for training and qualification development of power plant personnel,
- Training center for manual and/or robotic reactor operation at:
  - full-scale model of the reactor chamber and fuel pool
  - mock-ups of the reactor tank
  - full-scale fuel reloading devices in the reactor core
- Virtual Reality (VR) laboratory for training and visualization of SMR elements (BWRX-300)
- Classrooms for training and support of SMR suppliers and customers, as well as for OSGE’s staff
- Cooperation with universities: a place for training academic staff and students
- A large section of public information about nuclear energy

5.2. Goal of the European Center for the Development and Training in Nuclear Energy

The main goal will be to provide qualified staff for the rapid development and safe operation of nuclear energy in Poland. The estimated target number of trained staff per year with the assumption of three-four units per site and fleet approach in deploying BWRX-300 is:

a) 100 reactor operators;
b) 250 engineers, chemists, and dosimetrists;
c) 50 emergency response personnel;
d) +200 people trained to develop the supply chain for nuclear energy.

5.3. Tasks of the Training Center

1. Training of qualified staff for the Polish and European nuclear energy sector,
2. Training of technical and management staff of power plants based on the proven BWRX-300 technology using a full-scale simulator and a Virtual Reality (VR) laboratory,
3. Certification of qualifications obtained for work in the nuclear energy sector,
4. Communication and public education aimed at building public understanding and support for nuclear energy.

Currently, OSGE employees participate in training conducted by the GE Hitachi Training Center in San Jose, USA, as part of the BWRX-300 Executive Training Seminar.

As technology develops, GEH, together with OPG and TVA, has created the Global Training Program (GTP). This program ensures a comprehensive approach, focusing not only on the provision of technology but also on the support in providing trained staff.

The main assumptions of the program are:

a) Operations, maintenance, radiation protection, chemistry, and engineering training programs must meet the requirements of multiple nuclear regulatory authorities (the highest standard benchmark).
b) Standard power plant design includes the analysis, design and development of these training programs as well as basic operating and maintenance procedures.
c) Regional/local changes will be necessary to adapt to linguistic and regulatory requirements.

Developing the GTP following the SAT methodology will cover training plans, programs, training materials, and procedures.

6. SUMMARY

The article "*ORLEN Synthos Green Energy's Nuclear Power Deployment Program: Building Organizational and Human Capacity*" discusses essential issues related to building organizational and human capacity under nuclear energy development programs. The need to invest in developing organizational structures and employee competencies to develop nuclear programs effectively is emphasized. The article also presents specific plans and strategies to increase organizational capabilities and improve staff skills related to nuclear energy. In summary, a consistent approach to building organizational and human capacity is encouraged as a key success factor in promoting the development of nuclear power.

REFERENCES

[1] Use of the BWRX-300 technology in Poland – benefits for the economy and local authorities, KPMG (2023).
[2] Building Capacity for Nuclear Security, Implementing Guide, Nuclear Security Series No. 31-G, IAEA, Vienna (2018).
[3] Fisher R., Roadmap to Operational Readiness, Rev. 1, WANO (2022).