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Key domains extra EU know-how assessment

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EXECUTIVE SUMMARY

The objective of Work Package (WP) 6, "Internationalization and Stakeholder Involvement," is to leverage the support of extra-EU organizations to enhance human resource development within the EU and beyond. To effectively manage both current and future nuclear technologies, a highly skilled and qualified workforce is essential. WP 1 has already identified a significant shortage of personnel in the nuclear industry, a gap that will only widen with anticipated developments.

Existing education and training (E&T) institutions within the EU are expected to struggle to supply the necessary workforce at the required pace. Additionally, the implementation of extra-EU technologies in various EU countries necessitates safe and competent operation, further underscoring the need for a robust and well-trained human resource base.

Within Task 6.1 important aspects are dealt with. Competence mapping is essential for identifying industry needs and gaps in the Education and Training (E&T) domain, particularly within the EU. This process helps to determine the necessary expertise required and highlights the shortages due to a lack of specialists or adequate infrastructure. Some regions, such as the US and Asia, are more advanced in key areas like Small Modular Reactors (SMRs). International organizations, including OECD-NEA with its NEST initiative, are fostering global cooperation to build competence.

Gap assessments in nuclear research and training will address gaps in nuclear E&T and supply specialists for these the E&T activities. Several new project opportunities have been identified within the EU, such as SMR reactor implementations in Poland and Romania and dealing with workforce attrition in CANDU reactors.

New nuclear builds, particularly from the French perspective, require a qualified workforce, especially for projects in non-EU countries. Advances in nuclear technologies and synergies with other energy sources create an environment ripe for exploring new capabilities in the nuclear sector.

The European Commission, particularly through EHRO-N and WP1 analyses, aims to quantify future competencies needed in the nuclear industry and assess the existing expertise pool. With the support of international organizations like OECD-NEA and JRC, a global expertise assessment will be conducted, followed by proposed E&T actions. OECD-NEA will also provide an overview of the status of nuclear education possibilities making use of its members.

Current deliverable addresses the identification of capabilities of Education and Training (E&T) institutions that are able to supplement the E&T programs found at EU level. The OECD Nuclear Energy Agency (OECD-NEA) will make use of its pool of members for providing this assessment with focus on extra EU members. The final target of the deliverable will be to propose targeted Education and Training (E&T) actions to fulfil identified gaps in the skills required for development, construction and safe running of provisioned and existing power plants (or new and existing NPP technologies).

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1 INTRODUCTION

Following the assessment of nuclear industry's needs identified in WP1, an assessment of E&T providers in support to those needs was performed. This was done by analysing a sample of institutions but also by making us of other EC funded projects where similar actions were conducted. Such projects, like TANDEM, were targeting to identify, for example, the E&T capabilities with respect to SMRs. Since SMRs are seen as a rather new alternative for energy production in the foreseen reduction of environmental impact of energy installations and since many of the new technologies are developed outside EU, making use of the results in the respective project is perceived as a natural use of results.

The recent attention focused on nuclear energy and its crucial role in our sustainable future, aiming to achieve a net-zero economy to combat climate change, has also brought to light issues concerning the necessity of a skilled workforce pipeline to sustain the nuclear renaissance. The NEA is actively addressing this concern and possesses a comprehensive overview of the training courses offered in its member countries, which play a pivotal role in developing the necessary skilled workforce for the future. The text below aim to highlight E&T activities on different topics provided by NEA countries.

2 ANALYSIS OF E&T ACTIVITIES IN OECD-NEA COUNTRIES COMPARED TO EU.

The analysis below is based on the curricula present at the OECD-NEA member institutions and that are listed in Annex 1.

The analysis is performed by nuclear topic and it is presented below.

Nuclear Engineering

Education and training initiatives in the field of nuclear engineering exhibit a widespread presence of bachelor's and master's programs across the majority of member countries within the NEA. In many instances, nuclear engineering is primarily offered as an undergraduate degree. Notable examples include Argentina, where institutions such as Universidad Nacional de General San Martin and Instituto Balseiro provide comprehensive programs in nuclear engineering at both the bachelor's and master's levels.

The National Atomic Energy Commission (CNEA) of Argentina, in collaboration with national universities, demonstrates its commitment to nuclear education through Academic Institutes such as the Balseiro Institute, Sabato Institute, and Dan Beninson Institute. These institutes offer a diverse range of nuclear-related programs at undergraduate, graduate, and doctoral levels, fostering a stimulating academic environment through small student intake, competitive selection processes, and collaboration with active scientists and technologists.

The Balseiro Institute, situated in Bariloche, is the oldest institute, offering the region's oldest Nuclear Engineering program since 1977. The Sabato Institute, located in Buenos

Aires, focuses on technology transfer, providing specialists for national and international industries. The Dan Beninson Institute, established in 2006, concentrates on nuclear technology in areas like reactors, nuclear power plants, and healthcare applications. In addition to academic institutes, CNEA contributes to education, training, and extension activities, collaborating with various organizations and running programs like the "Aprender Haciendo" (Learning by Doing) scholarship program. The commitment extends to regional cooperation, with CNEA serving as the Regional Training Centre for Nuclear Safety in Latin America and the Caribbean. Anticipating the need for personnel due to the installation of a nuclear power plant in Embalse, the National University of Córdoba (UNC) and CNEA signed an agreement in 1969. Under this agreement, the RA-0 Nuclear Reactor was installed at the Faculty of Exact, Physical, and Natural Sciences, aiming to train new technicians and professionals in the field of nuclear energy. After an interval of 11 years, during which the core of RA-0 was provided to the Peruvian Institute of Nuclear Energy (IPEN) as part of the RP-0 reactor within a training program, it returned to UNC in 1990. In 2013, the RA-0 laboratory became the Nuclear Technology University Centre (CUTEN), seeking incorporation into the Latin American Network for Education and Training in Nuclear Technology (LANENT). The center conducts laboratory practices for Biomedical Engineering and Electronic Engineering courses, provides training courses for nuclear sector companies and healthcare professionals using simulation practices and virtual reactors. It also supervises thesis projects, carries out outreach activities, professional internships, and teacher training courses. The collaboration with LANENT reinforces Argentina's nuclear education, extending its influence in Latin America and the Caribbean. Despite challenges, the ongoing process of curriculum and certificate homologation signifies a commitment to further regional integration.

Similarly, Japanese universities like Kyoto University and Nagoya University offer nuclear engineering programs, each with distinct focuses. For instance, Fukui University specializes in nuclear safety engineering, while Osaka University provides a Bachelor of Science in Quantum Energy Engineering.

In Korea, the Korea Nuclear International Cooperation Foundation (KONICOF) takes the lead by offering an education program covering all three educational stages—BSc, MSc, and PhD. Meanwhile, in Turkey, both Hacettepe University's Graduate School of Science and Engineering and Sinope University's Department of Nuclear Engineering offer programs spanning all educational levels.

Across the United States, numerous universities, including the University of California Berkeley, University of Florida, Louisiana State University provide comprehensive education and training opportunities in nuclear engineering at the BSc, MSc, and PhD levels. Some institutions, such as the University of Wisconsin, University of Michigan, and North Carolina State University, integrate nuclear engineering courses within broader physics, health physics, or radiological sciences programs.

In the United Kingdom, the path to nuclear engineering often starts at the undergraduate level with degrees in mechanical engineering, energy engineering, or chemical engineering. Specialized courses are then offered at the master's and doctoral levels, as exemplified by the University of Birmingham, University of Cambridge, University of

Central Lancashire, University of Derby, Cranfield University, and Imperial College London.

Ukraine's Lviv Polytechnic National University, National Technical University of Ukraine - Igor Sikorsky Kyiv Polytechnic Institute (KPI), and Odessa National Polytechnic University are the sole institutions offering nuclear engineering courses across all three levels of education in the country.

In contrast, many European Union countries primarily offer nuclear engineering programs at the BSc and MSc levels. In countries like Spain, Italy, Romania, and Poland, nuclear engineering is often integrated into broader courses such as power engineering, technical engineering, mechanical engineering, or energy engineering. In case of Romania, the establishment of the first Nuclear Power Plant class in 1967 marked a significant stride, signaling a pivotal moment in nuclear engineering development. In 1970, the Nuclear Power Plants Engineering Program, a comprehensive five-year initiative, further advanced the field. The transformative era of 2007 saw the adoption of the "Bologna" system, which led the creation of the two-year Nuclear Engineering Master program.

Nuclear Radioactive-Waste Management

Around the world, educational institutions and collaborative projects are taking strides to advance expertise in radioactive waste management. These initiatives underscore the global commitment to addressing the challenges associated with the safe and efficient handling of radioactive waste.

In South Korea, the Integrated Major Program in High-Level Waste Management at Seoul National University stands out as a significant project supported by the Korean Energy Technology Evaluation and Planning (KETEP). Launched in 2022 with a substantial 4.75-billion-won agreement, this program is dedicated to training professionals at both the master's and Ph.D. levels until 2026. The collaboration involves 14 majors from engineering and social science disciplines, reflecting Korea's strong commitment to tackling challenges in high-level waste management and solidifying its leadership in nuclear education.

From the United Kingdom, the University of Birmingham provides a master's program in Nuclear Decommissioning and Waste Management. This specialized curriculum ensures that students gain a comprehensive understanding of the complexities associated with handling and managing radioactive waste.

Across the EU countries, in France, the University of Montpellier offers a master's program in the Management of Nuclear Decommissioning and Valorisation of the Industrial Site. This program equips students with the knowledge and skills necessary for the responsible management and decommissioning of nuclear facilities.

Nuclear Safety, Security and Radioprotection

Education and training activities in the domains of nuclear safety, security, and radioprotection are crucial components of ensuring the responsible development and

utilization of nuclear technologies. Across various international institutions, a diverse range of programs are offered to cultivate expertise in these vital areas.

In Argentina, the prestigious Instituto Balseiro provides a master's program specifically dedicated to nuclear safety and security, addressing critical aspects of safeguarding nuclear technologies.

In South Korea, significant support for nuclear safety projects is extended by the Korean National Foundation (NRF) to universities. Additionally, the Korea Nuclear International Cooperation Foundation (KONICOF) and the Korea Foundation of Nuclear Safety (KoFONS) play instrumental roles in providing training and financial assistance for practical courses, emphasizing the importance of hands-on experience.

From the United Kingdom, the University of Central Lancashire in Preston and Burnley stands out for its master's program in Nuclear Safety, Security, and Safeguards, emphasizing a multidisciplinary approach to addressing the challenges associated with nuclear technologies.

In the United States, the University of Massachusetts Lowell offers master's programs in Radiological Science and Protection, as well as Security Studies with a focus on chemical, biological, nuclear, and explosive security. These programs equip students with the knowledge and skills needed to navigate the complexities of nuclear safety and security in diverse contexts.

Across EU countries, in Germany, the Centre for Radioprotection and Radioecology at Leibniz University Hannover offers Ph.D. programs focused on radioprotection and radioecology. Similarly, the University of Stuttgart and Dresden Technical University provide Ph.D. programs that centre around nuclear safety and security, ensuring a comprehensive academic approach to these critical subjects.

Nuclear Science and Technology

Turkey has positioned itself as a significant centre for nuclear science and technology education, providing a comprehensive array of programs ranging from master's to Ph.D. levels. Distinguished institutions such as Istanbul Technical University, Ege University Institute of Nuclear Sciences, and Ankara University actively contribute to the extensive educational initiatives in this critical field.

In Argentina, both the Universidad Nacional de General San Martin and the Instituto Balseiro offer robust master's and Ph.D. programs in nuclear science and technology. Meanwhile, in Mexico, the Universidad Autónoma del Estado de Mexico stands out for offering a Ph.D. program specifically focused on nuclear science and technology.

In the United Kingdom, the Nuclear Technology Education Consortium (NTEC) plays a pivotal role by offering part-time and full-time postgraduate courses in Nuclear Science & Technology. Established in 2005 through extensive consultations with the UK nuclear sector, including industry, regulators, government bodies, and educational institutions, NTEC addresses the country's projected nuclear skills requirements in areas such as decommissioning, reactor technology, fusion, and nuclear medicine. The consortium, comprising seven UK universities and higher education institutions, delivers flexible postgraduate training tailored to meet the industry's evolving needs.

Within the European Union, Romania has been a trailblazer in nuclear engineering education since 1957. The University of Pitesti has been instrumental in this journey, introducing specialized master's programs in Radioprotection and Nuclear Safety in 2002 and Nuclear Materials and Technologies in 2001. The implementation of the "Bologna" system in 2007 led to the establishment of a Nuclear Power and Technologies Bachelor program, followed by the introduction of a comprehensive four-year training program in Nuclear Energy and Technologies in 2015. This program, marking its second graduating class in 2020, exemplifies Romania's enduring commitment to nuclear education. In Czechia, the Czech Technical University in Prague offers a specialized program in the theory and technology of nuclear reactors, contributing to the global landscape of nuclear science and technology education.

In Italy, the Politecnico di Milano includes a track on nuclear science and technology as part of its Ph.D. program, while the Sapienza University offers courses at the master level.

3 COMPARATIVE ANALYSIS: COMPARISON OF EU COMPETENCIES WITH GLOBAL STANDARDS

The European Union (EU) nuclear industry is well-regarded for its robust regulatory frameworks, extensive research facilities, and applied research focus. However, when benchmarked against global standards, particularly those observed in leading nuclear nations such as the United States, Japan and South Korea, several gaps in expertise become evident. Global leaders in the nuclear sector often exhibit strengths in innovative nuclear technologies, advanced research methodologies, and comprehensive decommissioning expertise.

There could be identified several critical domains where the EU nuclear sector lacks expertise compared to international benchmarks:

- Innovative Nuclear Technologies: Countries like the United States and South Korea have made significant advancements in small modular reactors (SMRs) and other next-generation nuclear technologies. The EU needs to bolster its capabilities in these areas to remain competitive. This includes investing in research and development for these technologies and fostering partnerships with leading global institutions.

- Fundamental Research: The EU focus has been predominantly on applied research. There is a need to enhance fundamental research capabilities to foster breakthroughs in nuclear science. Increased funding for basic research and collaboration with top-tier research institutions globally can help bridge this gap.

- Decommissioning Expertise: While the EU has substantial decommissioning projects underway, countries such as Japan, with its extensive experience post-Fukushima, have developed more advanced techniques and methodologies. The EU could benefit from exchanging knowledge and best practices with countries that have advanced decommissioning projects.

- Multidisciplinary Skills: There is a growing need for professionals who can integrate technical nuclear knowledge with skills in digital technology, cybersecurity, and systems engineering. Developing multidisciplinary programs that combine nuclear engineering with these emerging fields is crucial for preparing a versatile workforce.

The data sources are usually reputable international bodies which have their data bases and collect information from their member states:

- OECD Nuclear Energy Agency (OECD-NEA): Provides comprehensive data on nuclear energy policies, technologies, and workforce trends globally. Their reports offer insights into global best practices and technological advancements in the nuclear sector.

- Joint Research Centre (JRC): The European Commission science and knowledge service, offering in-depth analysis and data on the EU nuclear sector. JRC reports help benchmark EU performance against global standards.

- International Atomic Energy Agency (IAEA): Offers global perspectives on nuclear safety, security, and technological advancements. IAEA guidelines and reports are critical for understanding international safety standards and technological trends.

- National Reports: Data from national reports of leading nuclear countries have also been used to benchmark EU competencies against global standards. These reports provide detailed insights into the nuclear strategies, technologies, and workforce developments of other nations.

As concluded in the reports in section 1 of this report future competencies needed in the nuclear industry should address the identified gaps and for future demands. Therefore, the EU nuclear industry should be focused on developing the following competencies:

Advanced Nuclear Technologies:

- Expertise in small modular reactors (SMRs) and next-generation reactors. SMRs offer flexible, scalable, and safer options for nuclear power generation, and developing expertise in this area will help the EU stay at the forefront of nuclear innovation.

- Development of capabilities in nuclear fusion research and technology. Fusion technology represents a potential future source of virtually limitless energy, and investing in this field can position the EU as a leader in groundbreaking energy solutions.

Fundamental and Applied Research:

- Strengthening research in nuclear physics, materials science, and radiochemistry. These areas are essential for advancing nuclear technology and ensuring the safety and efficiency of nuclear power plants.

- Enhancing collaboration between universities, research institutes, and industry. Such collaborations can drive innovation, facilitate technology transfer, and ensure that research efforts are aligned with industry needs.

Decommissioning and Waste Management:

- Advanced skills in decommissioning techniques and radioactive waste management. As many nuclear plants in the EU approach the end of their operational lives, effective decommissioning and waste management are critical.

- Training in innovative decommissioning technologies and practices. Keeping up with the latest decommissioning technologies will help ensure that the process is efficient, safe, and environmentally responsible.

Digital and Multidisciplinary Skills:

- Integration of digital technologies such as AI, machine learning, and big data analytics in nuclear operations. These technologies can enhance operational efficiency, safety, and predictive maintenance capabilities.

- Cross-disciplinary expertise combining nuclear engineering with cybersecurity, systems engineering, and environmental science. Developing professionals who can navigate and integrate multiple disciplines will be crucial for addressing complex nuclear challenges.

Regulatory and Safety Standards:

- Continual updating of skills to comply with evolving safety and regulatory frameworks. Ensuring that the workforce is well-versed in the latest regulations and safety protocols is vital for maintaining high safety standards.

- Training in international safety standards and best practices. Learning from global best practices can help the EU nuclear industry improve its safety and operational procedures.

The EU should invest in education and training initiatives, strengthen partnerships between industry and educational institutions, and promote lifelong learning to develop these competencies. By doing so, the EU can ensure it has a skilled and adaptable workforce capable of meeting the future challenges of the nuclear industry and maintaining its competitiveness on the global stage.

4 RECOMMENDATIONS

To address the identified gaps and prepare for future demands, the EU nuclear industry must focus on developing advanced nuclear technologies, fundamental and applied research, decommissioning and waste management skills, digital and multidisciplinary skills, and regulatory and safety standards. Expertise in small modular reactors (SMRs) and next-generation reactors is crucial. SMRs offer flexible, scalable, and safer options for nuclear power generation, and developing expertise in this area will help the EU stay at the forefront of nuclear innovation. Development of capabilities in nuclear fusion research and technology is also essential, as fusion technology represents a potential future source of virtually limitless energy, and investing in this field can position the EU as a leader in groundbreaking energy solutions.

Strengthening research in nuclear physics, materials science, and radiochemistry is necessary for advancing nuclear technology and ensuring the safety and efficiency of nuclear power plants. Enhancing collaboration between universities, research institutes, and industry can drive innovation, facilitate technology transfer, and ensure that research efforts are aligned with industry needs. Advanced skills in decommissioning techniques and radioactive waste management are critical as many nuclear plants in the EU approach the end of their operational lives. Effective decommissioning and waste management are essential for maintaining safety and environmental standards. Training in innovative decommissioning technologies and practices will help ensure that the process is efficient, safe, and environmentally responsible.

Integration of digital technologies such as AI, machine learning, and big data analytics in nuclear operations can enhance operational efficiency, safety, and predictive maintenance capabilities. Cross-disciplinary expertise combining nuclear engineering with cybersecurity, systems engineering, and environmental science is vital for addressing complex nuclear challenges. Continual updating of skills to comply with evolving safety and regulatory frameworks is crucial. Ensuring that the workforce is well-versed in the latest regulations and safety protocols is vital for maintaining high safety standards. Training in international safety standards and best practices is also important. Learning from global best practices can help the EU nuclear industry improve its safety and operational procedures.

Extra-EU approaches to education, particularly those in countries like the United States, Japan, and South Korea, can significantly contribute to growing nuclear expertise in the EU. These countries often have well-established nuclear education programs that emphasize a balance between theoretical knowledge and practical application. For instance, the United States has numerous universities with strong nuclear engineering programs that collaborate closely with national laboratories and industry, providing students with hands-on experience in cutting-edge research and technologies. Japan's experience with nuclear disaster management and decommissioning post-Fukushima offers valuable lessons and best practices that can enhance the EU's capabilities in these areas. South Korea's advancements in SMR technology and its integrated approach to nuclear education, which combines rigorous academic training with practical industry experience, can serve as a model for the EU to develop similar programs.

Leveraging these international educational approaches and resources can provide the EU with several benefits. By adopting comprehensive training programs that integrate advanced research methodologies and practical experience, the EU can enhance the skillset of its nuclear workforce. Collaborations with extra-EU universities can also facilitate knowledge exchange and the adoption of innovative technologies and best practices. These collaborations can be facilitated through joint research projects, academic exchanges, and international conferences, fostering a global network of nuclear expertise that can benefit the EU.

To support the development of these competencies, several education and training initiatives are recommended. Updating educational curricula to include the latest advancements in nuclear technology, safety standards, and multidisciplinary approaches is essential to ensure that graduates are equipped with relevant and up-to-date knowledge. Fostering strong partnerships between industry and academia can create programs tailored to the specific needs of the nuclear sector, providing practical experience and enhancing employability. Offering continuous learning opportunities for current professionals in the nuclear industry through workshops, certifications, and advanced degree programs can help them stay current with technological and regulatory changes. Encouraging more students to pursue careers in science, technology, engineering, and mathematics (STEM) fields through outreach programs, scholarships, and awareness campaigns can attract new talent to the nuclear sector.

Enhancing global collaboration and partnerships is also crucial. Establishing programs that facilitate the exchange of knowledge and best practices between EU and non-EU countries, such as joint research projects, academic exchanges, and international conferences, can help build a robust and skilled workforce. Actively participating in global nuclear networks and organizations such as the IAEA, OECD-NEA, and international nuclear research forums can provide opportunities for collaboration, learning, and influencing global nuclear policy. Engaging with international experts and institutions that lead in areas where the EU has identified gaps can accelerate the development of competencies and integrate global best practices into the EU nuclear industry.

By addressing these critical areas and leveraging both internal and external expertise, the EU can build a resilient and forward-looking nuclear workforce. This will not only ensure the safe and efficient operation of nuclear facilities but also position the EU as a leader in the global nuclear industry.

OECD-NEW have established a data base of the EU and extra-EU institutions and their research and education capabilities. A table below lists the differences between EU and extra-EU institutions and highlights the potential contributions that extra-EU institutions could bring to the EU. The table includes aspects such as the number of institutions, primary focus areas, research facilities and collaboration networks.

Table 1 Potential contribution of extra-EU institutions to EU

Aspect	EU Institutions	Extra-EU Institutions	Potential Contributions to EU
Number of Institutions	23	365	Increasing number of collaborative institutions
Primary Focus Areas	Diverse with a focus on applied research, engineering and regulatory frameworks	Often focused on innovative nuclear technologies and fundamental research	Introducing cutting-edge nuclear technologies and research methodologies
Research Facilities	Extensive facilities within EU regulations	Varied facilities with unique capabilities	Sharing access to unique and advanced research facilities
Collaboration Networks	Strong intra-EU collaborations	Potential for new international collaborations	Expanding global collaboration networks and knowledge exchange

5 PROPOSED EDUCATION AND TRAINING ACTIONS

Recommended Education and Training Initiatives should support the development of these competencies, several education and training initiatives are:

- Curriculum Development: Updating educational curricula to include the latest advancements in nuclear technology, safety standards, and multidisciplinary approaches. This ensures that graduates are equipped with relevant and up-to-date knowledge.

- Industry-Academia Collaboration: Fostering strong partnerships between industry and academia to create programs that are tailored to the specific needs of the nuclear sector. Internships, co-op programs, and industry-sponsored research projects can provide practical experience and enhance employability.

- Continuous Professional Development: Offering continuous learning opportunities for current professionals in the nuclear industry. This includes workshops, certifications, and advanced degree programs that help professionals stay current with technological and regulatory changes.

- Promoting STEM Education: Encouraging more students to pursue careers in science, technology, engineering, and mathematics (STEM) fields. Outreach programs, scholarships, and awareness campaigns can help attract new talent to the nuclear sector.

Enhancing global collaboration and partnerships is crucial for the growth and development of the EU nuclear industry. Establishing programs that facilitate the exchange of knowledge and best practices between EU and non-EU countries can significantly contribute to building a robust and skilled workforce. These programs can include joint research projects, academic exchanges, and international conferences, fostering a global network of nuclear expertise. Actively participating in global nuclear networks and organizations such as the IAEA, OECD-NEA, and international nuclear research forums provides opportunities for collaboration, learning, and influencing global nuclear policy. Engaging with international experts and institutions that lead in areas where the EU has identified gaps can accelerate the development of competencies and integrate global best practices into the EU nuclear industry. By leveraging these collaborative efforts, the EU can ensure the safe and efficient operation of its nuclear facilities and position itself as a leader in the global nuclear industry. This could be covered by:

- Knowledge Exchange Programs: Establishing programs that facilitate the exchange of knowledge and best practices between EU and non-EU countries. This can include joint research projects, academic exchanges, and international conferences.

- Participation in Global Networks: Actively participating in global nuclear networks and organizations such as the IAEA, OECD-NEA, and international nuclear research forums. These platforms provide opportunities for collaboration, learning, and influencing global nuclear policy.

- Leveraging International Expertise: Engaging with international experts and institutions that lead in areas where the EU has identified gaps. This can help accelerate

the development of competencies and integrate global best practices into the EU nuclear industry.

By addressing these critical areas and leveraging both internal and external expertise, the EU can build a resilient and forward-looking nuclear workforce. This will not only ensure the safe and efficient operation of nuclear facilities but also position the EU as a leader in the global nuclear industry.

ANNEX 1 – INSTITUTIONS REFERENCED AND THEIR CURRICULA

Argentina

Universidad Nacional de General San Martin	Nuclear Engineering (BSc, MSc) Nuclear Science and Technology (MSc, PhD)
Instituto Balseiro	Nuclear Engineering (BSc, MSc) Nuclear Safety and Security (MSc) Nuclear Science and Technology (MSc, PhD) Medical Physics (BSc) Diagnostic Imaging with specialisation in Nuclear Medicine (BSc) Specialisation in Nuclear Medicine Physics (MSc)
Sabato Institute	Nuclear programs focusing on technology transfer (BSc, MSc, PhD)
Dan Beninson Institute	Nuclear Medicine Technician (BSc) Radiation Therapy Physics
National University of Córdoba	Training program for nuclear technicians and professionals
The Nuclear Medicine School Foundation (FUESMEN)	Medical Physics Dosimetry Nuclear Medicine
Faculty of Pharmacy and Biochemistry (UBA)	Nuclear Medicine Technician (BSc) Medical Physics (MSc)
National University of La Plata	Medical Physics (BSc)
Favaloro University	Medical Physics with engineering focus (BSc)

Belgium

University of Ghent	Nuclear Fusion Science and Engineering Physics (MSc)

Bulgaria

Sofia University Kliment Ohridski	Fusion Science and Technology (MSc) Nuclear Medicine and Oncology (PhD)
University of Plovdiv	Nuclear Medicine and Oncology (PhD)

Czechia

Czech Technical University	Theory and Technology of Nuclear Reactors Physics and Technology of Nuclear Fusion (BSc, MSc)

France

University of Montpellier	Management of Nuclear Decommissioning and Valorisation of the Industrial Site (MSc)
Université Pierre et Marie Curie (UPMC)	Physics of Fusion and Plasmas (MSc)

Polytechnic School Paris Tech	Fusion Science (MSc)

Germany

Leibniz University Hannover	Radioprotection (PhD) Radioecology (PhD)
University of Stuttgart	Nuclear Safety and Security (PhD)
Dresden Technical University	Nuclear Safety and Security (PhD) Medical Radiation Sciences (MSc)
University of Augsburg	Experimental Plasma Physics (MSc)

Italy

Politecnico di Milano	Nuclear Science and Technology (PhD)
Sapienza University	Nuclear Science and Technology (MSc)
University of Padova	Nuclear Fission and Fusion Plants (MSc)

Japan

Kyoto University	Nuclear Engineering programs
Nagoya University	Nuclear Engineering programs
Fukui University	Nuclear Safety Engineering programs
Osaka University	Quantum Energy Engineering (BSc)

Korea

Korea Nuclear International Cooperation Foundation (KONICOF)	Nuclear Engineering (BSc, MSc, PhD)
Seoul National University	Integrated Major Program in High-Level Waste Management (MSc, PhD)

Mexico

Universidad Autónoma del Estado de Mexico	Nuclear Science and Technology (PhD) Nuclear Medecine (MSc)

Netherlands

Eindhoven University of Technology	Science and Technology of Nuclear Fusion (MSc) Applied Physics, Science and Technology of Nuclear Fusion (MSc)

Romania

University of Pitesti	Radioprotection and Nuclear Safety (MSc) Nuclear Materials and Technologies (MSc) Nuclear Power and Technologies (BSc)

Spain

Universidad Carlos III de Madrid	Fusion Science and Engineering (MSc, PhD)
Complutense University of Madrid	Fusion Science and Engineering (MSc, PhD) Nuclear Fusion Science and Engineering Physics (Erasmus Mundus) Plasma Physics and Nuclear Fusion (Erasmus Mundus) Nuclear and Particle Physics Applied to Medicine (PhD)

Sweden

Umeå University	Nuclear Medicine and Nuclear Physics (MSc)

Turkey

Hacettepe University	Nuclear Engineering (Bsc, MSc, PhD)
Sinop University	Nuclear Engineering (Bsc, MSc, PhD)
Istanbul Technical University	Nuclear Science and Technology (MSc, PhD)
Ege University Institute of Nuclear Sciences	Nuclear Science and Technology (MSc, PhD)
Ankara University	Nuclear Science and Technology (MSc, PhD)

Ukraine

Lviv Polytechnic National University	Nuclear Engineering (BSc, MSc, PhD)
National Technical University of Ukraine	Nuclear Engineering (BSc, MSc, PhD)
Odessa National Polytechnic University	Nuclear Engineering (BSc, MSc, PhD)
Vasyl Nazarovych Karazin Kharkiv National University	Experimental Nuclear Physics (BSc, MSc) Plasma Physics (BSc, MSc)

United Kingdom

University of Birmingham	Nuclear Engineering – specialised courses (MSc, PhD) Nuclear Decommissioning and Waste Management (MSc)
University of Cambridge	Nuclear Engineering – specialised courses (MSc, PhD)
University of Central Lancashire	Nuclear Engineering – specialised courses (MSc, PhD) Nuclear Safety, Security, and Safeguards (MSc)
University of Derby	Nuclear Engineering – specialised courses (MSc, PhD)
Cranfield University	Nuclear Engineering – specialised courses (MSc, PhD)
Imperial College London	Nuclear Engineering – specialised courses (MSc, PhD)
Nuclear Technology Education Consortium (NTEC)	Nuclear Science and Technology (MSc, PhD)
University of Oxford	Science and Technology of Fusion Energy (PhD)

University of Salford	Diagnostic Radiotherapy (BSc) Nuclear Medecine Imaging (PhD)
The Robert Gordon University, Aberdeen	Diagnostic Radiotherapy (BSc) Nuclear Medecine Imaging (PhD)
Swansea University	Healthcare Science (Nuclear Medecine) (BSc) Medical Raditation Physics (MSc) Clinical Science (Medical Physics) (MSc)
University of the West of England, Bristol	Diagnostic Radiography (BSc) Nuclear Medicine (MSc)
University of Strathclyde	Cancer Therapies (MSc)

United States

University of California Berkeley	Nuclear Engineering (Bsc, MSc, PhD)
University of Florida	Nuclear Engineering (Bsc, MSc, PhD)
Louisiana State University	Nuclear Engineering (Bsc, MSc, PhD)
University of Wisconsin	Nuclear engineering within broader physics programmes
University of Michigan	Nuclear engineering within broader physics programmes
North Carolina State University	Nuclear engineering within broader physics programmes
University of Massachusetts Lowell	Radiological Science and Protection (MSc) Security Studies with a focus on chemical, biological, nuclear, and explosive security (MSc)

6 REFERENCES

1. EC funded TANDEM project, Deliverable 6.1.

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