Bridging the Gap: Women's Evolving Role in Nuclear Science

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Abstract

Nuclear science has played a transformative role in shaping societies, policies, and technologies for over a century. As the world turns to nuclear energy as a key solution to climate change and sustainable development, the nuclear sector should embrace an innovative, diverse, and inclusive workforce. The trailblazing journeys of pioneering women in nuclear science offer a powerful context for understanding women as bridge builders in a historically male-dominated field. Their groundbreaking work in nuclear and medical physics laid the foundations for modern innovations. While highlighting the contributions of pioneering female figures, this study aims to shed light on the structural dynamics that continue to influence women's participation in the nuclear sector. The paper also offers a way forward to promote inclusivity and equity through proposed changes at the grassroots level.

Keywords: Women in Nuclear, IAEA, UNESCO, STEM, Marie Sklodowska-Curie, Lise Meitner, Nuclear Energy, WiN Global, WiN IAEA.

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Introduction

The discovery of uranium by Martin Heinrich Klaproth in 1789 marked the beginning of progress in nuclear science. Over a century later, in 1895, Wilhelm Conrad Röntgen revolutionised scientific thought by discovering X-rays, opening a new window into invisible forms of energy. Just a year afterward, in 1896, the ground-breaking discovery of radioactive elements Radium (Ra) and Polonium by Maria Salomea Skłodowska Curie, alongside her husband Pierre Curie, paved the way for future developments in nuclear science.

What began as the study of invisible rays and previously unknown elements evolved into a vast field that now encompasses energy production, medicine, agriculture, space exploration, environmental protection, and many other applications. The twentieth century witnessed landmark achievements from the development of nuclear reactors and medical isotopes to the use of nuclear technology for peaceful purposes under international frameworks. This evolution is the result of the collaborative efforts of many scientists and engineers who carried out cutting-edge research in fusion energy, advanced reactors, and nuclear medicine. However, despite a remarkable contribution of many pioneering women to this evolution, such as Marie Curie, it remains a male-dominated field. As the world turns to nuclear science to deal with critical issues including climate change, global health, and energy security, there is a growing need to recognize the contribution of women and to work harder to achieve the goal of gender equality in this field.

For safe and effective application of nuclear technologies in today's rapidly advancing nuclear sector, more scientists and engineers are required to support new projects, advance research and development, and enforce effective regulation. While there is greater acknowledgment in general that women bring strength in the form of diverse and innovative perspectives to the nuclear sector, they are largely underrepresented in the nuclear sector, particularly in leadership roles. As a result, many countries around the world are losing access to a vast pool of talent. Various studies show that the lack

of female representation in the nuclear field is due to systemic discrimination that starts with unequal education opportunities. According to the World Bank Report, "[a]lthough girls often perform as well as or better than boys in math and science at the primary and secondary levels, they are underrepresented in some Science, Technology, Engineering, and Mathematics (STEM) subjects, particularly engineering and computer science, at the tertiary level."[1]

Despite these challenges, women have contributed significantly to the talent pool of science and technological development, especially in the nuclear field, as we learn from the revolutionary contributions of pioneering women like Marie Curie, Lise Meitner, and many others. Some other studies, such as Catalyst 2007[2] and Finish Business and Policy Forum EVA 2007[3] have shown that having women in leadership positions at the management and board level results in elevated organizational performance.

Despite the data proving women's important contribution, women are still underrepresented and make up only a fifth of the nuclear workforce at the global level.[4] This gender gap highlights the missed opportunities for innovation and growth, posing a threat to the long-term stainability of the nuclear workforce and the continued relevance of the field. In this context, bringing more women engineers, scientists, and leaders into the nuclear

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[1] Schomer, Inka, and Alicia Hammond. *Stepping up Women's STEM Careers in Infrastructure: An Overview of Promising Approaches*. ESMAP Paper. World Bank Group, 2020. https://documents1.worldbank.org/curated/en/192291594659003586/pdf/An-Overview-of-Promising-Approaches.pdf

[2] Catalyst, *Only Wrong Way Stop No Stopping: The Double-Bind Dilemma for Women in Leadership—Damned If You Do, Doomed If You Don't* (2007), https://assets.catalyst.org/1d656b05-9af0-422a-b5da-b25e01470102/The_Double_Bind_Dilemma_for_Women_in_Leadership_Damned_if_You_Do_Doomed_if_You_Dont_Original%20file.pdf

[3] Annu Kotiranta, Anne Kovalainen, and Petri Rouvinen, *EVA Analysis: Female Leadership and Firm Profitability* (Finnish Business and Policy Forum, 2007), https://www.eva.fi/wp-content/uploads/files/2133_Analyysi_no_003_eng_FemaleLeadership.pdf

[4] Sara Kouchehbagh, "International Women's Day: Hundreds of Women Building a Career in Nuclear Gather at the IAEA," *International Atomic Energy Agency*, March 7, 2024, https://www.iaea.org/newscenter/news/international-womens-day-hundreds-of-women-building-a-career-in-nuclear-gather-at-the-iaea

workforce is crucial for maintaining the viability of the nuclear sector and its contribution to the society. Moreover, achieving gender-balanced leadership in laboratories, boardrooms, and on public stages is essential to ensure inclusivity. Diverse teams foster more innovative and collaborative approaches in research, gender balance in boardrooms leads to stronger governance, and public representation of leaders is essential for visibility and inspiration.

While addressing the gender gap in the nuclear sector is a moral imperative, it is also a strategic necessity. Global efforts are underway to transform the landscape of the nuclear workforce for women. At present, various international organizations like the International Atomic Energy Agency (IAEA), Nuclear Energy Agency (NEA), and other associations such as Women in Nuclear (WiN) and more, recognize the valuable role women have played in scientific discovery historically and the utilization of nuclear energy. Initiatives such as the Marie Sklodowska-Curie Fellowship Programme (MSCFP), the Lise Meitner Programme (LMP), and WiN are actively working to create a more inclusive, equitable workforce.

Based on the above premise, this paper aims to assess women's role in the development of nuclear science through a historical and analytical perspective. It highlights the trailblazing journeys of pioneering women in nuclear science. This paper aims to address three interconnected questions: Why does a gender gap still exist in the nuclear sector? What obstacles do women encounter when trying to enter, succeed, and remain in this field? How do the contributions of pioneering women and global initiatives shape a more inclusive future?

Trailblazing Journeys of Pioneering Women in Nuclear Science

From pioneering discoveries to leading advancements in nuclear science, medicine, and energy, women have played a vital role in shaping the field of nuclear science across generations. A closer look into the journeys of pioneering women who overcame gender based and other systemic barriers with their passion, dedication, and resilience informs us about some of the

persistent challenges that women face even today. The paths of these pioneering women were often marked by obstacles such as poor lab arrangements, institutional sexism, work-life balance, pay disparity, and underrepresentation. However, through sustained passion and determination, these women achieved ground-breaking contributions which paved the way for future generations of women aspiring to work in the nuclear sector.

As we speak of the female pioneers and the role models, a name that stands out amongst all is *Maria Salomea Skłodowska,* well known *as Marie Curie (1867 – 1934)*.[5] For over a century, she has been a role model for the scientific community—women and men alike—due to her groundbreaking contributions to the fields of physics and chemistry, particularly her discovery of radioactivity. Born and raised in Warsaw, she, along with her husband, studied the spontaneous radiations discovered by Becquerel, discovered elements polonium and radium, and developed methods for isolating radium, enabling its study and use in medicine. This discovery was recognized, and they both Curie and her husband, were awarded the Nobel Prize in Physics (1903). Later, Marie also received a Nobel Prize in Chemistry in 1911 for these discoveries. She was the first woman in nuclear physics to be awarded a Nobel Prize and the first individual to be awarded two Nobel Prizes in two different categories.

Marie proved to be a true symbol of sacrifice. She died in 1934 from an illness likely caused by prolonged exposure to radiation, leaving behind a profound legacy in science and medicine. Through her example and mentoring, including mentoring her daughter Irène Joliot Curie, who later won a Nobel Prize in Chemistry for discovering artificial radioactivity. She paved the way for women in scientific research, education, and leadership. Curie's life was marked by resilience, determination, and intellectual brilliance. Marie's partnership with her husband remains a powerful

[5] Jenny Rydén, "MARIE CURIE - NobelPrize.org," *NobelPrize.org*, April 29, 2025, https://www.nobelprize.org/stories/women-who-changed-science/marie-curie/4

testament to the strength of collaboration in scientific discovery and a gender-inclusive work environment.

Another pioneering woman in nuclear science is *Lise Meitner (1878-1968)*[6] also known as the woman who split the atoms. She was also among those who dedicated their lives to the pursuit of knowledge and became only the second woman in the University of Vienna's history to earn a PhD in Physics, which she completed in 1906. She worked with Otto Hahn for over thirty years in exploring the emerging science of radioactive decay and leading the ground-breaking discovery of nuclear fission. Later, however, in a classic case of gender discrimination, Hahn downplayed her role in the discovery and did not even include her name in the publication of the finding. Despite her crucial role, Hahn, who did the experimental work alone, received the Nobel Prize in Physics in 1944. Meitner was excluded, partly due to antisemitism and sexism, showing systemic bias and discrimination.

Although nominated 48 times for Nobel Prizes in both Physics and Chemistry, Meitner never received the award, despite endorsements from renowned scientists like Bohr and Max Planck. Although the Nobel Committee never corrected its oversight, the error was partially addressed in 1966 when Lise Meitner, Otto Hahn, and Fritz Strassmann were jointly awarded the *Enrico Fermi Award*. Meitner's moral integrity did not allow her to work on the atomic bomb, and she courageously stated that "I will have nothing to do with a bomb." In recognition of her contributions, element 109 was named *Meitnerium (Mt)* in her honour in 1992.

During the same timeframe, another brilliant physicist was forging her path. Chien-Shiung Wu (1912-1997), often called the "First Lady of Physics," was a pioneering Chinese American physicist who made trailblazing

6 See Lise Meitner's Biography at Chemeurope.com, 2025, https://www.chemeurope.com/en/encyclopedia/Lise_Meitner.html

contributions to nuclear and particle physics.[7] While studying physics under Nobel Laureate Ernest Lawrence at UC Berkeley, she faced significant cross-cultural shock, adapting to a completely different society, environment, and language, all while pursuing advanced studies in physics. She joined the Manhattan Project in 1944, and there she worked on radiation detection and uranium enrichment for the atomic bomb. Wu's most famous contribution came in 1956, when she designed and executed an experiment disproving the law of conservation of parity in beta decay, confirming a theory proposed by Tsung-Dao Lee and Chen-Ning Yang. Although her experiment was critical to the discovery, only Lee and Yang received the Nobel Prize in Physics in 1957, while Wu was underrecognized – a pattern seen repeatedly in the treatment of women in science.

As nuclear science expanded beyond the laboratory, women like Edith Quimby were instrumental in applying nuclear technologies to improve public health, especially in cancer treatment and medical imaging. She introduced the "Quimby rules," which became the gold standard for placement of radioactive needles in radiotherapy until computerized methods emerged decades later. She also co-developed a "film-badge" system to monitor radiation exposure for workers, enhancing safety in labs and hospitals. In 1942, she joined Columbia University, where she became a full professor in 1954 and mentored future Nobel Laureate Rosalyn Yalow. There, her work helped establish nuclear medicine by radioactive isotopes for treating thyroid disease and diagnosing brain tumors. Quimby also contributed to research on radiation equivalence and cumulative exposure, helping assess long-term health impacts. She authored over 70 scientific papers and co-wrote the foundational textbook *Physical Foundation of Radiology.* Quimby's legacy lives on in the safer practices and principles of modern radiology and nuclear medicine. Her work not only saved lives but also helped transform a hazardous field into a scientifically rigorous and trusted branch of medical science.

7 National Park Service, "Dr. Chien-Shiung Wu, the First Lady of Physics (U.S. National Park Service)," January 23, 2020, https://www.nps.gov/people/dr-chien-shiung-wu-the-first-lady-of-physics.htm

Like her predecessors and contemporaries in the nuclear field, Leona Woods Marshall Libby (1919 – 1986)[8] a brilliant American physicist played a pivotal role in the development of nuclear science. Her exceptional skill in vacuum technology and reactor diagnostics earned her a place on Enrico Fermi's Manhattan Project team, making her the only woman present during the historic 1942 Chicago Pile-1 experiment, which achieved the first human-engineered, self-sustaining nuclear chain reaction. Woods contributed significantly to nuclear research by developing the boron trifluoride counter, a critical device for detecting neutron activity. She was also central to diagnosing Xeon poisoning in the Hanford B Reactor in 1944 – an unexpected obstacle that threatened plutonium production. Her insight helped identify the issue as xenon-135 build-up, allowing engineers to adjust the reactor's design. This ultimately enabled the production of plutonium used in both the Trinity Test and the "Fat Man" atomic bomb dropped on Nagasaki.

The remarkable devotion to research, visionary leadership, and ground-breaking achievements of these pioneering women have established them as enduring role models not only for women but for society, even in the twenty-first century. Diving into their personal and professional journey underlines that women in that era confronted persistent social norms, sexism, and institutional barriers that sought to dim their light, limit their opportunities, and recognition. The same challenges continue to impact women in today's nuclear sector, manifesting as workplace bias, lack of mentorship, work-life balance difficulties, and limited career advancement opportunities. The legacy of these remarkable women highlights both the progress made and the efforts still needed to create an inclusive environment in the nuclear workforce where all women can thrive.

8 Faith Bennett, "Leona Woods Marshall Libby," U.S. National Park Service, accessed July 2, 2025, https://www.nps.gov/articles/000/leona-woods-marshall-libby.htm

Challenges Faced by Women in Nuclear Science

Despite the trailblazing contributions of women in nuclear science over the century, the world is still struggling with gender equality in all fields, but more importantly, in STEM fields. According to the European Commission's analytical report "Addressing the gender gap in STEM education across educational levels, "despite significant advances in STEM education and a growing emphasis on gender equality in research and policy circles, women across Europe remain under-represented in STEM careers and among graduates majoring in STEM-related fields."[9] The report further highlights the main causes of gender imbalance that include lower self-efficacy, the role of family and the broader social context, societal stereotypes, non-inclusive curricula, certain teaching practices that reinforce stereotypes, as well as a lack of female role models in STEM.[10] Lack of equal educational opportunities feeds into further imbalance in female representation in employment and leadership roles. According to the World Economic Forum, despite an increase, women are largely underrepresented in STEM roles and comprise only 28.2% of the STEM global workforce in 2024, as compared to non-STEM roles, which is 47.3%.[11]

In a poll conducted by the author among a diverse group of women researchers in science, nuclear, and security studies from different parts of the world, about 88% of the women responded affirmatively to the question of gender-based discrimination in their workplace. Nearly 40% cited the workplace culture as the primary reason for persistent discrimination, 31% referred to general gender biases, 14.1 % marked work-life balance as a cause of discrimination, and 12 % marked the lack of advancement

9 Evagorou, Maria, Beatriz Puig, Dilek Bayram, and Hana Janečková. "Addressing the Gender Gap in STEM Education Across Educational Levels." *NESET report*. Luxembourg: Publications Office of the European Union, 2024. p.8. https://nesetweb.eu/wp-content/uploads/2024/05/NESET-AR02-Analytical-report-with-identifiers-1.pdf

10 Addressing the Gender Gap in STEM Education Across Educational Levels.

11 World Economic Forum, Global Gender Gap Report 2024 (Geneva: World Economic Forum, 2024), 8, https://www3.weforum.org/docs/WEF_GGGR_2024.pdf

opportunities as a primary cause of discrimination. Almost 02% cited other reasons.

The availability of comprehensive data on the challenges faced by women in nuclear sciences remains limited. Nonetheless, the report entitled "Gender Balance in the Nuclear Sector," published by the Nuclear Energy Agency Organization for Economic Cooperation and Development (OECD-NEA), stands as the first publicly available source that systematically addresses gender-based challenges in the nuclear workforce internationally.[12] In many organizations, such issues are not openly discussed due to institutional sensitivity, confidentiality restrictions, and limited transparency, limiting the scope of comparative analysis.

The report is based on the data collected from 96 nuclear organizations in 17 NEA member countries, such as Argentina, Australia, Belgium, Canada, France, Hungary, Italy, Japan, Korea, Norway, Poland, Romania, Slovenia, Spain, Sweden, and the United Kingdom. The report findings highlight the gender disparity as women make up less than a quarter (24.9%) of the overall nuclear sector workforce. It also emphasizes that only one-fifth (20.6%) of STEM roles in the nuclear sector are held by women, and women represent only 18.3% of senior leadership, highlighting a substantial gender gap.[13] This is because women often don't pursue careers in STEM due to gender stereotypes, dissatisfaction with the workplace culture, the lack of advancement opportunities, and the challenges presented by work-life balance.[14]

The NEA report highlights that while physical working conditions are equal to a greater extent, shortcomings in management's commitment to gender inclusion and inadequate institutional frameworks remain a persistent issue, particularly in leadership and decision-making representation. In that study,

[12] OECD Nuclear Energy Agency, Gender Balance in the Nuclear Sector (Paris: OECD Publishing, 2023), https://www.oecd.org/en/publications/gender-balance-in-the-nuclear-sector_f11a652d-en.html
[13] Gender Balance in the Nuclear Sector.
[14] Gender Balance.

fewer than 50% of women surveyed responded affirmatively to the question about whether the gender balance policies in their organizations helped them feel satisfied with their career and be optimistic about their prospects. Women in regulatory agencies, government entities, and fuel cycle organizations gave higher ratings to their employers, whereas women employed at the decommissioning sites and within original equipment manufacturers or nuclear supply chain organizations scored their employers lower.

Furthermore, work-life challenges like family responsibilities, pregnancies, or maternity leaves are perceived to have a negative impact on the career; over 70% of the women surveyed in the NEA report overwhelmingly agree in the nuclear sector. One of the top five barriers, specifically related to nuclear sector, is that the career advancement in nuclear power plants is challenging for nursing mothers as well as for those with the young children because career progression in nuclear power plants involve roles that require on-call and shift work. The second barrier is that most of the nuclear facilities are in areas lacking spousal employment opportunities or inaccessible to family support. These barriers, concluded from the NEA survey, highlights the reasons behind lower female retention rates in non-management and junior management levels in the nuclear sector. The lower retention of mid-career women creates a bottleneck in the leadership pipeline, resulting in a smaller pool of skilled women who are eligible for progressively senior positions.[15]

The authors sought opinions from professional women from diverse backgrounds and different geographical locations working in nuclear science and nuclear policymaking on facing gender biases and discrimination in the work environment.[16] Many women pointed out the framing issue and shared that nuclear science is largely seen as a masculine policy domain, which by design leaves less or no space for women to thrive.

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[15] OECD, "*Joining Forces for Gender Equality*. Paris": OECD Publishing, 2023. https://www.oecd.org/en/publications/2023/05/joining-forces-for-gender-equality_bb1768d0.html

[16] Based on personal interviews conducted by the author with 10 female experts in nuclear science and nuclear policy, 2025.

One respondent shared that because of that thinking and mindset, male counterparts are given more credit and preferred for undertaking more visible roles, such as delivering presentations, when female team members have contributed equally or more in the actual presentation. Some other participants cited limited career advancement opportunities, unequal pay scales, and assumptions about lower leadership capabilities among women. Another participant highlighted fewer training opportunities, leading to limited career growth opportunities. They also highlighted the fact that in most cases, women have to put double the effort as compared to men to receive equal respect and acknowledgment. Some women highlighted discrimination even in companies and organizations that are making efforts to promote gender equality. One participant shared her experience where a company disregarded her qualifications and told her that they needed to hire a female to ensure gender balance, whereas her education and relevant experience matched the job description, but that was not seen as meeting the criteria. Some women highlighted their inability to command policy or make decisions independently despite being in a leadership role. They shared that this affects their ability to fully exercise their leadership role, affecting both accountability and initiative. Another participant cited societal barriers and limited opportunities at the beginning of her career that affected her professional growth, but at the same time acknowledged a supportive environment at her current appointment at an international organization.

In some other reports, female professionals shared personal and anecdotal experiences and highlighted some structural biases. For example, Rumina Velshi, Ex-President of the Canadian Nuclear Safety Commission (CNSC), spoke about her experience as a professional in the nuclear field in Canada and stated that "plant was not built ever expecting women to work there…there was no radiation protection clothing in women's sizes and no changing rooms for women."[17] While Canada has largely addressed these

[17] Nathalie Mikhailova and International Atomic Energy Agency "Women in the Nuclear Field Share Their Stories at International Women's Day Event." *IAEA*, March 7, 2019.

structural and organizational issues, as also acknowledged by Velshi, this remains a reality in various other countries to date.

Findings of the reports, polls, and interviews cited above underline the fact that gender discrimination and gender biases against women in general and those pursuing careers in nuclear science are systemic and start even during the educational phase. Some of the key issues, as reflected in the cumulative data, reflect that women continue to experience hostility, including sexual harassment, in STEM roles. Furthermore, workplace culture and stereotypes inhibit women's careers with biases about leadership characteristics, such as women are stereotyped as 'caretaker' and men as 'charge taker', and insufficient support for the professional development of women. Almost two-thirds of the females reported that stereotyping, microaggressions, or unconscious bias, and a male-dominated work culture that inhibits the full contribution of women negatively impact women's careers in the nuclear sector, thereby lowering the retention rate.

More flexibility, access to childcare, and upward career pathways compatible with parenthood are required to facilitate women in the nuclear sector. Furthermore, the lack of female leaders to serve as mentors and role models in the current era is another barrier in the nuclear sector. Moreover, socio-cultural perceptions that nuclear energy is a man's field are included in the top five barriers specific to the nuclear sector according to the NEA survey. These perceptions discourage many women from pursuing a career or progressing in the nuclear sector, also contributing to the gender gap in the nuclear sector. These barriers signify the underrepresentation of women in the nuclear sector.

https://www.iaea.org/newscenter/news/women-in-the-nuclear-field-share-their-stories-at-international-womens-day-event

Way forward

There has been significant progress in female representation in nuclear science in recent years. The IAEA, for instance, has championed gender equality over the years and achieved gender parity in 2025, by meeting the target of having women in half of the professional and higher-level positions, that is a 30% increase since 2019.[18] Other indicators also point to a positive shift in gender equality and inclusion. For example, the 2017–2022 review cycle of the meetings of the Nuclear Non-Proliferation Treaty (NPT) witnessed a significant increase in working papers and statements highlighting the importance of gender equality in the NPT.[19] The working paper submitted by Australia, Canada, Colombia, Ireland, Mexico, Namibia, Panama, the Philippines, Spain, Sweden, and the United Nations Institute for Disarmament Research called for gender mainstreaming in the Treaty on the Non-Proliferation of Nuclear Weapons.[20] Likewise, the Treaty on the Prohibition of Nuclear Weapons (TPNW) has picked up the debate in a more nuanced manner. In the clause mandating states parties to assist survivors of nuclear weapons use and testing, the TPNW has required a gender-sensitive approach. [21] In this way, it has addressed the gender issue from a technical lens, thereby giving further credence to this entire discussion.

While the IAEA has set a high standard and other international forums concerning nuclear science and policy are putting in place the effort and

[18] International Atomic Energy Agency (IAEA). "IAEA Board Briefed on Ukraine, Iran, Gender Parity, AI and More." *IAEA News Centre*, March 3, 2025. https://www.iaea.org/newscenter/news/iaea-board-briefed-on-ukraine-iran-gender-parity-ai-and-more

[19] Renata Hessmann Dalaqua, ed., *From the Margins to the Mainstream: Advancing Intersectional Gender Analysis of Nuclear Non-Proliferation and Disarmament* (Geneva, Switzerland: United Nations Institute for Disarmament Research, March 25, 2024), 10

[20] *From Pillars to Progress: Gender Mainstreaming in the Treaty on the Non-Proliferation of Nuclear Weapons,* Working Paper NPT/CONF.2020/WP.54, submitted to the 2020 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, 17 May 2022. https://undocs.org/NPT/CONF.2020/WP.54

[21] Singh, Nidhi, "Victim Assistance under the Treaty on the Prohibition of Nuclear Weapons," *Journal for Peace and Nuclear Disarmament* 3, no. 2 (2020): 265–82. https://doi.org/10.1080/25751654.2020.1856554

catching up, various countries and other organizations have to cover a long distance. Recognizing the importance of diversity in the workplace and overcoming the gender disparity in nuclear science, Gwen PerryJones the Executive Director of Operations Development at the Wylfa Newydd nuclear power plant in the United Kingdom rightly noted that "[a]lthough there are many talented and highly skilled women within the nuclear industry, we are still vastly under-represented. There is still work to do. Diversity in the workplace benefits us all, and I fully support initiatives that encourage women to enter the industry and help them see routes to senior positions."[22]

According to the United Nations Institute for Disarmament Research (UNIDIR) study, two main issues hinder progress in that regard. One, despite the significant developments, there are still many entities that do not recognize the importance of gender equality and gender perspectives. The second issue is equating gender with women or women's issues.[23]

In that regard, first and foremost, it is important to create awareness about the importance of gender equality and the need to adopt a gender sensitive approach. According to a study, "Examining 'Gender-Sensitive' Approaches to Nuclear Weapons Policy: a Study of the Non-Proliferation Treaty," gender sensitive approaches centre on the inclusion of women and women are constructed as a homogenous category of outsiders; and women's inclusion is understood mainly as a means of increasing institutional efficiency.[24] While this study discusses gender sensitivity from

[22] International Atomic Energy Agency (IAEA), "Toward Closing the Gender Gap in Nuclear Science," *IAEA News Centre*, February 11, 2019, https://www.iaea.org/newscenter/news/toward-closing-the-gender-gap-in-nuclear-science

[23] Renata Hessmann Dalaqua, ed., *From the Margins to the Mainstream: Advancing Intersectional Gender Analysis of Nuclear Non-Proliferation and Disarmament* (Geneva, Switzerland: United Nations Institute for Disarmament Research (UNIDIR), March 25, 2024), 10, https://unidir.org/wp-content/uploads/2024/03/UNIDIR_From_the_Margins_to_the_Mainstream_Advancing_Intersectional_Gender_Analysis_of_Nuclear_Non_Proliferation_and_Disarmament.pdf

[24] Laura Rose Brown and Laura Considine, "Examining 'Gender-Sensitive' Approaches to Nuclear Weapons Policy: A Study of the Non-Proliferation Treaty," *International Affairs* 98, no. 4 (July 2022): 1249–66, https://doi.org/10.1093/ia/iiac114, p:50

the perspective of the NPT, it is very much applicable in other organizations dealing with nuclear sciences.

Secondly, there is a need to have an overhaul of the existing system, make space for a new gender sensitive approach, and address the structural issues, as highlighted and recommended by some of the participants interviewed for this study. The NEA study provides recommendations based on the "Attract, Retain, and Advance Framework" that aims for a long-term strategy for a reversal of existing negative trends and introduction of structural reforms to support the gender inclusive workforce in the nuclear industry.[25] To attract young women to the nuclear field, the study recommends introducing public communication campaigns to shape gender perceptions regarding careers in nuclear sector, illustrating the impact and social value of nuclear science and technology, while also highlighting attractive opportunities in nuclear careers. These campaigns should also promote women's leadership and remarkable contributions to the nuclear field, targeting both women and men to highlight how maintaining gender balance benefits the nuclear sector and enriches STEM fields.

The second pillar is to "retain" women by ensuring equal wages, showing increased flexibility regarding their family responsibilities outside work, providing them access to childcare and lactation facilities, and an integration program on their return from parental or family leave, along with eliminating harassment and build inclusive work environment. The third pillar is to support and empower women as leaders, increasing their contributions by requiring unconscious bias and inclusivity training for those who make hiring and promotion decisions, providing leadership and career advocacy training with targeted support for women, especially in STEM fields, and training managers to support and encourage the career development of diverse staff. This pillar also involves creating inclusive support systems, encouraging the career advancement of diverse staff, establishing inclusive resource groups and all-gender networks, including

[25] Nuclear Energy Agency (NEA), *Gender Balance in the Nuclear Sector* (Paris: OECD-NEA, 2023), 11, https://www.oecd-nea.org/jcms/pl_78831/gender-balance-in-the-nuclear-sector

male allies, and conducting regular pay equity reviews to ensure fair compensation based on experience and role.

Lastly, women's representation should not be framed only as a human rights issue.[26] As underscored by the European Institute for Gender Equality (EIGE), gender equality is also a precondition for sustainable development.[27] Despite improvements implemented in various countries and organizations, many women in the nuclear fields continue to face gender stereotypes, unconscious bias, and underrepresentation in leadership and technical roles, pay disparities, limited advancement opportunities, and workplace cultures that lack inclusivity. Issues such as pregnancy discrimination, sexual harassment, and difficulties balancing work and life further hinder retention and progression. Psychological challenges such as impostor syndrome and the long-term effects of unemployment scarring also impact career continuity.

Therefore, inclusivity, gender balance, and gender sensitivity must be incorporated in real essence, and it should not be a mere token representation, as also highlighted by some of the interview participants that they were either given certain positions without real authority or their role was only to meet the target of female representation. Ensuring gender equality, therefore, must remain a work in progress, and only a continuous push will evolve into an impactful change.

Global Initiatives to Enhance Women's Participation

There are several global initiatives that seek to enhance the participation of women in nuclear industry and improve current policies as well as the working environment.

[26] Muhammed Ali Alkış and Polina Sinovets, "Nuclear Security: Making Gender Equality a Working Reality," *International Journal of Nuclear Security* 8, no. 2 (2023): Article 9, https://doi.org/10.7290/ijns220431

[27] European Institute for Gender Equality, *Gender Equality*, June 17, 2025, https://eige.europa.eu/thesaurus/terms/1168

One such initiative is the Marie Sklodowska-Curie Fellowship Programme (MSCFP) launched by the IAEA's Director General, Rafael Mariano Grossi.[28] It is a pioneering initiative that seeks to bridge the gender gap in the nuclear field by empowering young women to pursue careers in this sector. Named after the physicist and twice Nobel Prize laureate Marie Skłodowska-Curie, the program aims to foster a more inclusive and diverse workforce, driving global scientific and technological innovation.

The MSCFP provides highly motivated female students with scholarships to pursue master's programs in nuclear-related studies at accredited universities. Additionally, selected students are offered an opportunity to gain hands-on experience through internships facilitated by the IAEA. This comprehensive approach enables students to acquire theoretical knowledge and practical skills, preparing them for successful careers in the nuclear field.

Another initiative launched by the IAEA is the Lise Meitner Program (LMP).[29] This unique initiative is designed to support the career development of women already working in the nuclear sector, with a focus on the nuclear energy field. Named after the renowned Austrian-Swedish physicist Lise Meitner, the program aims to empower women professionals by providing them with opportunities to gain hands-on experience, expand their professional networks, and develop their skills in a dynamic and interactive environment.

The LMP offers visiting professionals the chance to participate in professional visits to various nuclear facilities, and the program's content is tailored to match the visiting professionals' profiles and interests, ensuring a personalized and enriching experience. The program generally spans two to four weeks, with 10 to 15 visiting professionals participating in each

[28] IAEA, *The Marie Sklodowska-Curie Fellowship Programme (MSCFP)*, 2025, https://www.iaea.org/services/key-programmes/together-for-more-women-in-nuclear/iaea-marie-sklodowska-curie-fellowship-programme
[29] IAEA, *The Lise Meitner Programme*, 2025, https://www.iaea.org/services/key-programmes/together-for-more-women-in-nuclear/lise-meitner-programme

cohort. The IAEA Member States and other donors fund LMP through extra-budgetary and in-kind contributions, ensuring that visiting professionals do not incur any financial costs.

WiN Global, a non-profit organization, has been a strong advocate for gender equality since its inception in 1992. With around 35,000 members and over 20 partners, WiN Global is a robust network with an active presence in more than 145 countries including Pakistan, and engagement with various international organizations. Furthermore, the association actively invests in defining nuclear policies and gender equality strategies in the nuclear sector.

As an international network of women professionals, it empowers members by creating opportunities for cross-cultural exchange, leadership development, and active participation in decision-making processes. By promoting the integration of a gender perspective, WiN ensures that women's unique needs, experiences, and insights are recognized and addressed. Additionally, WiN Global advocates for inclusive communication strategies to reshape public perception of nuclear energy, emphasizing the value of collective action for sustainable progress.[30]

As one of the active chapters of WiN Global, the Women in Nuclear IAEA, a group of 650+ volunteers working at the IAEA, has been instrumental in highlighting the needs of women working at the IAEA and promoting a supportive and inclusive workplace.[31] The WiN IAEA supports underrepresented groups in the nuclear and radiation fields, especially women and the younger generation, where their presence remains limited, by actively working towards its objective, i.e., peace.

As the world faces pressing challenges such as population growth, food insecurity, high energy demand, and climate change, the nuclear sector

[30] ANIMUS, "About WiN - Women in Nuclear," *Women in Nuclear*, May 21, 2024, https://win-global.org/about-win/
[31] "Women in Nuclear IAEA," 2025, https://win-iaea.org/

plays a vital role in addressing these issues. To drive innovation and progress, it is essential for nuclear organizations to "attract, maintain, and retain" a qualified and diverse workforce. A diverse workforce, where everyone can contribute equally and be recognized for their skills, expertise, and achievements, is crucial for the industry's success and sustainability.

Conclusion

From the splitting of the atom to the frontiers of fusion and producing nuclear energy to nuclear medicine, the journey of nuclear science has proven nuclear technology as a viable solution to contemporary challenges related to the socioeconomic growth of countries worldwide. With this realisation and acknowledging the importance of gender inclusivity, efforts should be made to engage more women in advancing this field. By prioritizing diversity, gender balance, and an inclusive working environment, the nuclear sector can build a strong, innovative, and productive workforce that is equipped to tackle the challenges of the future.

The contemporary challenges, like gender biases and stereotypes, are affecting women's choice of career in STEM roles, particularly in the nuclear sector. While pursuing a career in the nuclear sector brings challenges like limited representation in leadership, lack of mentorship, and maintaining work-life balance, the journeys of trailblazing women in nuclear science establish a foundation for aggressive policies to encourage girls in STEM education. The women in leadership roles exhibiting leadership qualities, such as resilience, curiosity, and brilliance, and breaking barriers, should be presented as role models for the next generations.

As there exists limited data on nuclear sector-specific challenges faced by women, there is a need to have more regional surveys to identify barriers that will help to assess workplace experiences and inform policies to promote gender equity and inclusion. The OECD-NEA report reveals that systematic gaps still exist, while also highlighting promising strategies, such as the "Attract, Retain, and Advance Framework", to close them. The

strategies are augmented through initiatives like the Marie Sklodowska-Curie Fellowship Program and the Lise Meitner Program by the IAEA and associations like WiN Global, WiN IAEA, and other national chapters, empowering young women in nuclear. These efforts should be strengthened through the support from international, regional, governmental, and national organizations, but also through the active contribution of each individual.