

10-2023

Women in Nuclear Power Programs: Case Studies from Africa

Jessica S. Burniske
Pacific Northwest National Laboratory

Chanel Chauvet-Maldonado
Pacific Northwest National Laboratory

Beth Kaboro
Kenya Nuclear Regulatory Authority

Madalina Man
Pacific Northwest National Laboratory

Susan Nalumansi
Atomic Energy Council of Uganda

Follow this and additional works at: <https://trace.tennessee.edu/ijns>



Part of the [International Law Commons](#)

Recommended Citation

Burniske, Jessica S.; Chauvet-Maldonado, Chanel; Kaboro, Beth; Man, Madalina; and Nalumansi, Susan (2023) "Women in Nuclear Power Programs: Case Studies from Africa," *International Journal of Nuclear Security*. Vol. 8: No. 2, Article 16.

<https://doi.org/10.7290/ijns609553>

Available at: <https://trace.tennessee.edu/ijns/vol8/iss2/16>

This article is brought to you freely and openly by Volunteer, Open-access, Library-hosted Journals (VOL Journals), published in partnership with The University of Tennessee (UT) University Libraries. This article has been accepted for inclusion in International Journal of Nuclear Security by an authorized editor. For more information, please visit <https://trace.tennessee.edu/ijns>.

Women in Nuclear Power Programs: Case Studies from Africa

Cover Page Footnote

The authors wish to extend their gratitude to colleagues from the nuclear security field who participated in interviews for this article, including Leyla Amur, James Conner, Rhonda Evans, Viviana Moreno, Dmitriy Nikonov, and Ana Raffo Caiado.

Women in Nuclear Power Programs: Case Studies from Africa

Jessica Burniske,¹ Chanel Chauvet-Maldonado,¹ Beth Kaboro,²
Madalina Man,¹ and Susan Nalumansi³

¹Pacific Northwest National Laboratory

²Kenya Nuclear Regulatory Authority

³Atomic Energy Council of Uganda

Abstract

Approximately 30 countries are considering, planning, or starting nuclear power programs, and nearly 20 more countries have expressed interest in nuclear power. Most of these countries are nuclear newcomers. According to the International Atomic Energy Agency (IAEA), a nuclear power program is a major undertaking requiring careful planning, preparation, and investments in institutions and human resources because of the safety, security, and safeguards requirements associated with the use of nuclear energy. The IAEA Milestones Approach states that states should follow three phases of development to establish the necessary infrastructure for a nuclear power program. Nuclear security is one of the 19 infrastructure issues considered throughout the three phases, alongside other infrastructure issues such as human resource development and legal and regulatory development.

Despite the number of countries operating or interested in developing nuclear power plants, women comprise less than a quarter of the nuclear sector workforce. New nuclear power programs require a skilled and diverse workforce to build the necessary infrastructure and sufficiently address nuclear security. The underrepresentation of women in the field affects competitiveness, effectiveness, and diversity, and new nuclear power programs represent an opportunity to advance gender equality in nuclear security. This paper analyzes existing international, regional, and national gender equality measures and describes how a country's nuclear power program can integrate those measures. It examines experiences from two Eastern Africa nuclear newcomers:

Kenya and Uganda. Finally, the paper presents recommendations and potential solutions to address gender equality in nuclear security.

Keywords: nuclear security, gender, gender equality, nuclear newcomers, IAEA

1. Introduction

The World Nuclear Association estimates that 30 countries in all regions of the world are presently considering, planning, or starting nuclear power programs [1]. In the 2022 “Climate Change and Nuclear Power Report,” the International Atomic Energy Agency (IAEA) projects an increase of 120% in nuclear energy production capacity for 2050 [2].¹ Additionally, the projections for nuclear electricity production on the African continent anticipate almost double an increase from 2021 to 2030 and more than a twelvefold increase by 2050 [3].

Recent studies estimate that women comprise only 20% [4]² of the nuclear workforce, whereas the percentage of women in nuclear security is even smaller [5].³ This very small representation of women in nuclear security is due partly to the filling of nuclear security roles with professionals from the military, law enforcement, intelligence agencies, and other security organizations—traditionally male-dominated fields—as well as the perception that men are better suited to fill the physical protection, guard force, and response responsibilities traditionally associated with the nuclear security regime [5].⁴

New nuclear power programs represent a critical opportunity to advance gender equality in the nuclear security domain as states work to build their nuclear workforces from the ground up; they can consider gender equality as a cornerstone of those efforts. These new nuclear programs also represent an opportunity to meet the objectives of the Women, Peace, and Security (WPS) agenda, first established by United Nations (UN) Security Council Resolution 1325, which calls for the equal inclusion of women in

¹ In the high case, the IAEA projects an increase in nuclear electrical generating capacity by approximately 23% by 2030 and more than double by 2050 compared with the 2021 capacity. In the low case, nuclear electrical generating capacity is projected to decline by 2% by 2030 and then increase by 3.5% by 2050. For a detailed analysis, see International Atomic Energy Agency; *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050*; Reference Data Series No. 1: Vienna, Austria, 2020. https://www-pub.iaea.org/MTCD/Publications/PDF/RDS-1-40_web.pdf (accessed 2023-04-17).

² The Organisation for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) published a study on gender balance in the nuclear sector, which estimates that “women comprise 24.9% of the nuclear workforce, based on data from 17 countries, and constitute only 20.6% of the STEM workforce and 18.3% of senior leadership roles.” See [4].

³ The 2019 World Institute for Nuclear Security Special Report, *Gender and Nuclear Security: Challenges and Opportunities*, estimates that the percentage of women within the nuclear security workforce is even smaller, and even more so within specific areas such as cybersecurity [5].

⁴ The report highlights that “Such statistics reflect that positions in the field of nuclear security have traditionally been filled by professionals drawn from the military, intelligence, State security apparatus and law enforcement. These fields have historically been dominated by men due to the perception that they are better able to fill the ‘guns, guards, and gates’ role of providing physical protection, guarding, and response” (p. 6) [5].

conflict resolution and peacebuilding processes, which includes the work of the nuclear security field [6].

This paper will explore how states may wish to consider gender equality in nuclear security as they build their nuclear workforces by examining two case studies. These case studies, along with related international, regional, and national efforts to achieve gender equality in nuclear security, inform the findings and recommendations of this paper. The recommendations consider efforts that states can make to help achieve greater gender equality in the nuclear security field, including actions such as using gender-inclusive language in job postings, defining key performance indicators, adopting leave policies that are responsive to the needs of all genders, instituting policies protecting whistleblowers and fighting against discrimination, and developing training and mentorship programs. The paper also reviews existing IAEA efforts to support nuclear newcomer states and provides recommendations and suggestions to the IAEA to consider gender parity in a systematic manner, with the potential to influence change in member states. The recommendations to the IAEA include the development of a cross-departmental support strategy that ensures the systematic consideration of gender into capacity building, educational, and technical support activities; amending the Milestones Approach to include gender equality; addressing gender equality as part of the IAEA's Nuclear Security Series (NSS) No. 19 [7]; and considering partnerships with other international organizations and nongovernmental organizations (NGOs) to increase educational and training opportunities for women.

2. Human Resources Considerations for New Nuclear Power Programs Based on the IAEA Milestones Approach

The IAEA Milestones Approach, combined with specific nuclear security guidance and related IAEA programs and efforts, enables nuclear newcomer states to closely collaborate with the IAEA at all steps in the process of developing an adequate nuclear security infrastructure, including in the context of human resource development for the nuclear power program. This section analyzes a number of IAEA guidance documents relevant to human resource development, as well as other tools and resources that may conceivably contribute to gender parity efforts in nuclear newcomer countries.

The IAEA works with roughly 20 member states from all geographical regions to help them in the development of their nuclear power programs based on the Milestones Approach described in IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1) [8]. The document is directed at decision-makers, senior managers, and advisers in government, industry, regulatory authorities, and other agencies, and it establishes three milestones in the development of the infrastructure necessary for a nuclear power program. It also describes actions for 19 nuclear infrastructure issues to be accomplished before each milestone is reached [8]. The 19 nuclear infrastructure issues include national position, nuclear safety, management, funding and financing, legal framework, safeguards, regulatory framework, radiation protection, electrical grid, human resource development, stakeholder involvement, site and supporting facilities, environmental planning, nuclear security, nuclear fuel cycle, radioactive waste management, industrial involvement, and procurement [8]. The publication identifies

nuclear security as a distinct nuclear infrastructure issue and encourages states to ensure that all the essential elements [9]⁵ for nuclear security are adequately addressed in all three phases of their nuclear power development efforts. The IAEA NSS publication No. 19 [7] further elaborates on the relevant guidance in the Milestones document and describes the nuclear security infrastructure recommended for a nuclear power program [7]. NSS No. 19 describes a comprehensive approach to nuclear security to prepare a state to deal with all nuclear security issues in a holistic manner in its nuclear power program efforts and establishes a suite of actions needed to be addressed in each of the three nuclear power development phases in synergy with the Milestones Approach [7].

The Milestones document emphasizes that “A nuclear power program is a major undertaking requiring careful planning, preparation and investment in time, institutions and human resources...The required infrastructure includes not only facilities and equipment, but also the human and financial resources and the legal and regulatory framework within which the program will be carried out” [8]. Although nuclear security is described as a discrete nuclear infrastructure issue, the implementation of an effective nuclear security regime for nuclear energy production depends on a suite of other nuclear infrastructure issues, such as the legal and regulatory framework, and, in particular, human resource development.

Guidance on human resource development in the field of nuclear energy is established in several IAEA publications. Of particular importance is the Nuclear Energy Series document, “Human Resource Management for New Nuclear Power Programs,” which addresses the topic of human resource development in more detail than the Milestones publication and offers additional guidance related to each of the three phases of the Milestone Approach [10]. The publication also mentions specific considerations for nuclear security staffing. However, further guidance is provided in NSS No. 19, which recommends an assessment process for education and training needs for nuclear security, including an “examination of current capabilities of existing academic facilities and research and development centers as well as technical training institutions to provide training in area of technical, legal, and policy expertise related to nuclear security that will be required for the authorization, approval, operation and oversight of the national nuclear security infrastructure for the nuclear power program” [7]. Such an assessment would be used to inform a comprehensive plan for upgrading existing training facilities and academic institutions, and it would consider the potential for collaboration at the national and international levels [7]. Additionally, NSS No. 19 establishes a number of key actions for nuclear security human resource development at each of the three Milestone phases. The document recommends a full range assessment of nuclear security disciplines required for the nuclear power program,

⁵ NSS No. 20 establishes 12 essential elements for a nuclear security regime: state responsibility; identification and definition of nuclear security responsibilities; legislative and regulatory framework; international transport of nuclear material and other radioactive material; offenses and penalties including criminalization; international cooperation and assistance; identification and assessment of nuclear security threats; identification and assessment of targets and potential consequences; use of risk-informed approaches; detection of nuclear security events; planning for, preparedness for, and response to nuclear security events; and sustaining a nuclear security regime [9].

including the availability of those disciplines within the state. It further recommends the assessment of corresponding domestic educational capabilities and the extent to which the state can rely on external sources for education purposes. Specialized training needs for existing personnel should be identified by each competent authority, and related training plans should be developed. The document also recommends organizational strategies to attract, train, and retain adequate nuclear security expertise, as well as establishing qualification and accreditation programs for nuclear security personnel. In phase two, competent authorities should actively recruit staff and commence relevant education and training programs within appropriate institutions. Outside expertise should also be considered as a modality to augment domestic training programs. The publication encourages states to discuss options for regional training centers for nuclear security personnel with foreign counterparts and international organizations. In phase three, among other actions, competent authorities and operators should prepare and implement human resource management programs that address staffing, qualification, training, and succession management [7].

It is also important to mention that the IAEA, upon request from the member state, conducts Integrated Nuclear Infrastructure Review (INIR) missions, which are designed to assist member states in evaluating the status of their national infrastructure for the introduction of a nuclear power program. The INIR missions are typically conducted at the end of each phase in the nuclear power development program to evaluate the implementation of key actions in the Milestone document and assess the state's readiness to move to the next phase in the program. INIR missions are conducted using the methodology described in the IAEA Nuclear Energy Document on the Evaluation of the Status of National Nuclear Infrastructure Development [11]. The mission reviews all the nuclear infrastructure issues, including nuclear security and human resource development, and it provides recommendations and suggestions for improvement of the infrastructure for nuclear power development, as well as good practices. INIR mission reports are published on the IAEA's website [12],⁶ unless otherwise requested by the respective state. Key recommendations and priorities are captured by the state in its so-called Integrated Work Plan, which functions as a strategic planning framework that defines the IAEA's integrated activities to support the country's nuclear power infrastructure development [13].

Other relevant guidance for nuclear security human resource development⁷ for new nuclear power programs is established in other IAEA publications that are part of the NSS or the Nuclear Energy Series. Despite the relatively large number of documents addressing this topic, gender considerations are not addressed in any of the IAEA

⁶ Reference [12] includes all the INIR mission reports that states authorized the IAEA to make publicly available.

⁷ The following publications are of particular relevance: International Atomic Energy Agency, *Sustaining a Nuclear Security Regime*, IAEA Nuclear Security Series No. 30-G, IAEA, Vienna, 2018; International Atomic Energy Agency, *Building Capacity for Nuclear Security*, IAEA Nuclear Security Series No. 31-G, IAEA, Vienna, 2018; International Atomic Energy Agency, *Guide to Knowledge Management Strategies and Approaches in Nuclear Energy Organizations and Facilities*, IAEA Nuclear Energy Series No. NG-G-6.1, IAEA, Vienna, 2022; International Atomic Energy Agency, *Mentoring and Coaching for Knowledge Management in Nuclear Organizations*, IAEA-TECDOC-1999, IAEA, Vienna, 2022.

publications, nor is the value of female participation in nuclear security. Moreover, the value of a diverse workforce is not discussed, or even mentioned, in this suite of documentation.

As affirmed by all IAEA member states in the Nuclear Security Resolution adopted at the IAEA annual General Conference, the Agency plays a central role “in strengthening the nuclear security framework globally and in coordinating international activities in the field of nuclear security” [14]. In 2021 alone, the IAEA implemented 103 training events for more than 7,900 participants from 137 states and delivered e-learning activities, with over 1,500 users from 125 states [15]. This large number of activities and continued requests from member states led the IAEA to adopt a systematic tactic to training focused on building a sustainable approach in host countries and their respective institutions. To this point, the 2022 Nuclear Security Review emphasizes, “To address these requests and to help States establish and sustain national nuclear security regimes more broadly, the Agency has developed a comprehensive approach to its human resource development program. Training activities based on a systematic approach support States in providing managers and personnel with knowledge, skills and attitudes necessary to discharge their duties and perform their jobs in various areas in nuclear security” [16]. Some of the states that received nuclear security training are likely countries embarking on nuclear power for the first time and looking to increase their capacity-building activities to support the development of an adequate nuclear security workforce for their nuclear power programs.

In addition to capacity-building activities in nuclear security, the IAEA coordinates other international efforts that have the potential to contribute greatly to national efforts to establish sustainable strategies for a nuclear security workforce for new nuclear power programs. Of utmost importance to this study are the activities of the International Nuclear Security Education Network (INSEN) and the Nuclear Security Support Centers (NSSCs).

INSEN is a network of educational and research institutions that partner through the IAEA to promote sustainable nuclear security education. Established in 2010, INSEN now has 188 institutions involved in the network from 66 states, and it is composed of three working groups focusing on the following topics: exchange of information and development of teaching material for nuclear security education, faculty development and cooperation among universities, and the promotion of nuclear security education and of INSEN [17]. The last INSEN Annual Meeting was held in Vienna in July 2022, and its deliberations are described in the Chair Report [18]. In the opening address reproduced in the report, IAEA management stressed the IAEA and INSEN’s growing commitment to gender parity and highlighted initiatives such as the Marie Skłodowska-Curie Fellowship Program [19]⁸ and the Women in Nuclear Security Initiative (WINSI). Furthermore, the INSEN Annual Meeting included a panel discussion on gender equality in nuclear security and modalities to increase opportunities for women and

⁸ The Marie Skłodowska-Curie Fellowship Program was launched by the IAEA in 2020 with the aim to increase the number of women in the nuclear field and “supporting an inclusive workforce of both men and women who contribute to and drive global scientific and technological innovation” [19].

young girls to pursue an education in the nuclear field. Since 2016, these discussions have been a regular item on INSEN's agenda.

The IAEA also works with states to help them establish national NSSCs to strengthen the sustainability of their nuclear security regimes. NSS No. 20 describes in Essential Element 12 [20] key activities for sustaining a nuclear security regime: in particular, nuclear security culture, training, human resource development, equipment maintenance, and applying best practices and lessons learned. As indicated in TECDOC 1373 [21], the “concept for an NSSC integrates these functions into one or several related institutions to help ensure sustainability of the national nuclear security regime;” thus, an NSSC serves the following core functions: “human resource development, specifically through a national nuclear security training program; technical support services for nuclear security equipment lifecycle management; scientific support services for provision of expert advice, analysis, and research and development (R&D) for nuclear security” [21]. In light of these functions, an NSSC would serve as an important resource in a nuclear newcomer country working to establish a human resource development⁹ strategy for nuclear security [21]. The NSSC would not only provide a centralized training strategy but would also contribute to building domestic expertise in nuclear security equipment maintenance and in R&D activities. The International Network for Nuclear Security Training and Support Centers (NSSC Network) facilitates cooperation among NSSCs. The Network fosters, among other things, regional approaches to nuclear security training by encouraging, as appropriate, the use of NSSCs as regional training resources, thus maximizing resources and sharing best practices.

Other resources at the level of the IAEA, such as those offered through the IAEA's Technical Cooperation Program, can greatly contribute to a state's efforts to establish a nuclear security workforce for a new nuclear power program.

As described in this section, the Milestones Approach, combined with specific nuclear security guidance and related IAEA programs and efforts, enables the nuclear newcomer states to closely collaborate with the IAEA at all steps in the process of developing an adequate nuclear security infrastructure, including in the context of human resource development for the nuclear power program. This close collaboration brings opportunities for the IAEA to discuss gender parity considerations with the

⁹ TECDOC 1373 makes the following recommendations regarding human resource development (HRD) in section 2.2.1: “Effective management of human resources is both an essential component of, and one of the main challenges in, sustaining a national nuclear security regime. At a macro level, HRD services aim to improve the effective utilization of the workforce as a whole, including activities such as resource planning, succession management and generic training strategies. While an NSSC may be involved in such activities at the national level, most NSSC human resource development programs implemented by an NSSC are designed specifically to meet training needs and help bridge performance gaps of individual workers within organizations across the national nuclear security regime.” Section 5.1.1. further provides, “To further develop the competence of individuals for current and future roles within a State's nuclear security regime, the NSSC can work to optimize the State's training resources. This is accomplished by improving effectiveness through the use of job performance as the basis for training and the sharing of curriculum and training methods among competent authorities (and other States where possible)” (p. 3) [21].

nuclear newcomer country when supporting its efforts to build a nuclear security workforce. The INSEN and NSSC initiatives, with their regional and national foci, have great potential in bringing gender parity to the forefront of nuclear security education and training efforts and in creating sustainable and long-term strategies for increasing nuclear security education and training opportunities for women. These resources, if considered in conjunction with potential revisions to IAEA guidance documents, such as the publications related to the Milestones Approach in the Nuclear Energy Series, as well as the NSS No. 19 [7] and related publications in the NSS, may create a robust strategy that the IAEA could use to help increase gender parity efforts in the nuclear security workforce in nuclear newcomer countries. Such a strategy would resonate with IAEA commitments and member states' support toward gender parity asserted in the Nuclear Security Resolution [14], the Nuclear Security Plan [22], and other IAEA consensus documents.

3. International, Regional, and National Instruments Addressing Gender Equality

This section details a range of international, regional, and domestic instruments promoting gender equality, along with organizations and entities in the nuclear field that have developed policies or that carry out work and initiatives in support of gender equality. These related efforts illustrate the broad framework that exists to promote and support gender equality, as well as concrete measures that have been taken to advance gender equality in various fora.

a. International

United Nations Sustainable Development Goals

After years of effort, in 2015, the United Nations (UN) adopted a *2030 Agenda for Sustainable Development*, which contains 17 goals to achieve sustainable development across all UN member states. Among the 17 sustainable development goals (SDGs) is SDG 5 [23], which relates to gender equality. This goal expresses the need for countries to “achieve gender equality and empower all women and girls,” and it contains nine targets for countries to reach in order to achieve this goal of gender equality [23]. These targets include ending discrimination faced by women and girls, “ensur[ing] women’s full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and social life,” and for countries to “adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels” [23].

Countries commit to reporting on their progress toward these goals in annual reports. Recent data from UN member states have particularly emphasized the negative effects of the COVID-19 pandemic on gender equality. Notably, with regard to employment, the most recent summary of reporting indicates that although “90% [of countries] mandate nondiscrimination based on gender in employment, almost half continued to restrict women from working in certain jobs or industries” [23]. This finding indicates that at the global level, more efforts should be undertaken to reach the goals set forth by the SDGs, particularly with respect to gender equality. The challenges in realizing gender

equality are systemic, but certainly the effects are likely to permeate fields like nuclear security, where the workforce has been shown to be predominantly male [5].¹⁰

International Atomic Energy Agency

The IAEA has expressed its commitment to gender equality as a broad principle and to SDG 5 on gender equality [23] in particular. As IAEA Director General Rafael Mariano Grossi stated, “Gender equality and the empowerment of women lie at the heart of the Sustainable Development Goals, and they are vital to fully realizing the rights and potential of everyone. These fundamental aims must also inform our work at the IAEA” [24]. The IAEA has established WINSI, which aims to support gender equality within the IAEA’s Division of Nuclear Security and within the field more broadly. It also brings awareness to the role that the IAEA can contribute to bringing about gender equality, as well as highlighting challenges that women face in the field. WINSI has sponsored several events, both on its own and in partnership with universities, to discuss these key issues at the intersection of nuclear security and gender equality [25].

Additionally, a panel discussion at the 66th IAEA General Conference explored human resource strategies for achieving gender equality in nuclear organizations. Speakers connected the need for gender equality in the nuclear security field with the value that diverse teams bring to the workforce: “Diversity, including gender diversity, is beneficial for innovation,” said Margaret Doane, IAEA Deputy Director General and Head of the Department of Management, “and bringing together their varied experiences and world views, diverse teams are better able to understand problems and find solutions” [26]. Speakers at the panel also highlighted ways in which nuclear organizations could bring about greater gender equality in their workforces. For instance, Wendy Anyster, an organizational psychologist at Leadershipvine Ltd., explained, “Achieving success requires not only a change in our human resource practices, but also our ability to create an inclusive culture where we respond with curiosity and appreciation when diverse opinions, views, and ideas are voiced” [26]. Callum Thomas, CEO at Thomas Thor Associates, called for a “huge increase in time, effort, and funding invested [toward gender equality], as well as senior leaders to be held accountable for results” [26]. These high-profile discussions about the importance of gender equality in the nuclear field have brought greater attention to the issue, while offering suggestions of possible mitigation strategies to the lack of diversity in the field as a whole.

The IAEA General Conference adopted a resolution in 2022 in which the Eleventh Plenary Committee “[r]equests the Secretariat¹¹ to...promote workforce diversity, including gender equality and geographical diversity, in the context of its nuclear

¹⁰ “It is generally estimated that women comprise only 20 percent of the nuclear workforce. This figure is even smaller within the nuclear security workforce and smaller still in specific areas such as cybersecurity” (p. 6) [5].

¹¹ In response to this request, the Agency “will continue to enhance its efforts to increase the representation of women, while securing employees of the highest standards of efficiency, technical competence, and integrity, and to ensure equitable geographical distribution in the nuclear security field through its capacity building efforts, recognizing the importance of equal access to education and training” (p. 6) [22].

security activities, and encourages Member States to establish an inclusive workforce within their national security regimes” [14]. IAEA member states expressed high-level support toward gender equality in nuclear security at the International Conference on Nuclear Security: Sustaining and Strengthening Efforts in 2020 and committed in the Ministerial Declaration to “promote geographical diversity and gender equality, in the context of IAEA’s nuclear security activities, and encourage Member States to establish an inclusive workforce within their national security regimes, including ensuring equal access to education and training” [27].

World Institute for Nuclear Security

The World Institute for Nuclear Security (WINS) has developed a gender program and expressed a commitment to gender parity, which is a commitment toward an equal number of men and women working in the nuclear security field. Internally, WINS also aims to increase the representation of women at WINS events, as well as women subject-matter experts and trainers. The organization has also endeavored to increase the enrollment of women in the WINS Academy, a professional development program in nuclear security management [28]. WINS is mindful of the need to promote women within the field of nuclear security, and to this end, it publishes statistics on the following: percentages of female members; percentages of female candidates in their programs; and percentages of attendees at their events. Through its research, it has brought attention to challenges facing women in the nuclear security field, such as the gender pay gap, sexual harassment, discrimination, and the lack of the same training and professional development opportunities as men, among other challenges [5]. Notably, WINS has also offered solutions to those seeking to improve gender equality in nuclear security, ranging from efforts to promote nuclear security as a career to women entering the workforce to efforts to strengthen and bolster the support offered to women already in the field, as well as to increase their representation and amplify their voices [5].

Women in Nuclear Global

Women in Nuclear (WiN) Global convenes women from across the globe working in the nuclear energy and radiation fields. It maintains a roster of 35,000 members from 129 countries, which belong to international, regional, and domestic chapters [29]. It also organizes an annual conference, which provides an opportunity for the WiN Global chapters to assemble and discuss activities in their regions. WiN Global serves not only as a resource and source of connection and belonging for its members, but it also provides mentoring and other forms of support to its members and chapters to encourage their development and growth as part of the nuclear energy field.

b. Regional

Brief Overview of Broader Regional Efforts

Building off of a broad and robust international legal framework protecting the rights of women, many regional bodies have also adopted legal instruments that aim to give effect to the broader international legal framework and apply those rights in certain regional contexts. This analysis will focus primarily on Africa, as it is the location of the

two case studies that we will explore later in the paper, but like Africa, other regions have adopted legal measures to protect and enshrine the rights of women. Many of these legal instruments protect the right of women to work in fields of their choosing, to receive adequate training and education to succeed in those fields, and to receive equal pay for their work. In South America, for instance, the Additional Protocol to the Convention on Human Rights in the Area of Economic, Social, and Cultural Rights (Protocol of San Salvador) protects the “right of every worker to follow [her] vocation and to devote [herself] to the activity that best fulfills [her] expectations” [30]. The regional Association of Southeast Asian Nations has also called upon its 10 member states “to promote and implement the equitable and effective participation of women in all fields and at various levels of the political, economic, social, and cultural life of society at the national, regional, and international levels” [31]. In the European Union, states must ensure the equality of women and men “in all areas, including employment, work, and pay” [32].

Although other provisions of these regional legal instruments may be relevant for advancing the important role that women can play in the field of nuclear security, these provisions in particular protect the right of women across the world to participate in such work and to be treated equally and fairly during the course of their work. Although protections may be more or less robust at the national level, a strong connection exists between international legal instruments protecting gender equality and the right to work and regional instruments, which tend to incapsulate the same protections for women and their employment.

Africa

Protocol to the African Charter on Human and Peoples’ Rights on the Rights of Women in Africa. Similar to approaches adopted by other geographic areas, the African international and regional legal systems also contain robust legal protections for women. The Protocol to the African Charter on Human and Peoples’ Rights on the Rights of Women in Africa [33] aims to extend equal rights granted to women under the African Charter on Human and Peoples’ Rights [34] and to give further effect to international treaties protecting women’s rights, such as the Universal Declaration of Human Rights [35]; the International Covenant on Civil and Political Rights [36]; the International Covenant on Economic, Social, and Cultural Rights [37]; and the Convention on the Elimination of All Forms of Discrimination Against Women [38]. The Protocol also situates its efforts in light of the UN Security Council resolutions on Women, Peace, and Security (WPS), recognizing the vital role that women play in the fields of disarmament, arms control, conflict resolution, and reconciliation processes. The Protocol to the African Charter on Human and Peoples’ Rights on the Rights of Women in Africa requires state parties to take measures to ensure that women do not experience discrimination under the law or through social or cultural practices [33]. Among other things, it calls upon states to ensure that women have equal opportunities to work, advance their careers, and receive equal pay for their work [33].

East African Community Gender Policy (Including a Section on Women in Energy). The East African Community (EAC), comprising Burundi, the Democratic

Republic of the Congo, Kenya, Rwanda, South Sudan, Tanzania, and Uganda, has developed its own gender policy, noting that it views “[t]he promotion of gender equality and the empowerment of women [as] central to the mandate of the EAC and intrinsic to its development approach” [39]. The EAC views its gender policy as a powerful tool to “ensure that gender equality and the empowerment of women are integrated into every aspect of its work to eradicate poverty and reduce inequalities and exclusion” [39]. The gender policy also references the Treaty for the Establishment of the East African Community [40], which seeks to incorporate the importance of gender mainstreaming into the EAC’s laws, policies, and objectives, ensuring an equal role for women that is integrated throughout the work of the EAC. The policy recognizes that these efforts have “yielded commendable results” [39]. The EAC further aligns its efforts with the goals of the UN SDG on gender equality [23], emphasizing the interconnected and reinforcing nature of EAC’s gender policy on the broader goals established through the SDG on gender equality.

Although the *EAC Gender Policy* broadly supports the inclusion of women in trade, business, economic development, and employment more generally, it specifically includes a section on “gender, energy, and lighting,” recognizing the EAC’s commitment to “increase access to affordable energy for men and women in order to increase economic development and improve standards of living” [39]. As part of this commitment, the EAC calls upon member states to, among other things, “develop and implement frameworks which increase women and men’s equal participation and involvement in energy value chains” [39]. Furthermore, the EAC Secretariat is tasked with harmonizing legislation and developing best practices on gender and energy. Through this specific provision, the *EAC Gender Policy* specifically recognizes the critical role that women can play in the energy sector, including nuclear energy, and seeks to encourage the development of legislation, policies, and best practices to ensure equal participation and representation in the sector as a whole. The *EAC Gender Policy* also recognizes the critical role that women play as part of the UN Security Council’s WPS agenda, established first in Resolution 1325 [6], and that they play a valuable role in conflict prevention, which is clearly relevant to the role that nuclear security plays in preventing broader conflict from occurring [39].

These goals do not occur in a vacuum; rather, the EAC Secretariat is charged with reporting on the implementation status of the policy by member states, along with helping to enact relevant laws to mainstream gender into each member state’s legal framework and to build capacities within individual member states to incorporate elements of the *EAC Gender Policy* into their legal frameworks, policies, and practices [39].

Southern African Development Community Protocol on Gender and Development.

The Southern African Development Community (SADC), comprising the countries of Angola, Botswana, the Democratic Republic of the Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe, has adopted the *SADC Protocol on Gender and Development* [41]. The Protocol reaffirms the member states’ commitment to many

international legal instruments on gender equality, including the Convention on the Elimination of All Forms of Discrimination Against Women [38], the Beijing Declaration and its Platform for Action [42], and UN Security Council Resolution 1325 on WPS (establishing the WPS agenda) [6].

At the outset, the Protocol introduces the concept of gender mainstreaming, meaning that the experiences and concerns of women, men, girls, and boys should be “integral to the design, implementation, monitoring, and evaluation of policies and programs in all spheres so that they benefit equally” [41]. In general, the Protocol calls upon state parties to harmonize their laws, policies, strategies, and programs with relevant international legal instruments “for the purpose of ensuring gender equality and equity” [41]. In relation to employment, the Protocol calls upon state parties to, by 2015, “review, amend, and enact laws and policies that ensure men and women have equal access to wage employment in all sectors of the society” [41]. States must also ensure that women have “equal representation and participation in key decision-making positions in conflict resolution,” in accordance with UN Security Council Resolution 1325 [23, 41]. To document their compliance with the Protocol, state parties must submit reports to SADC every 2 years indicating the progress they have achieved in attaining the measures required under the Protocol [41].

Economic Community of West African States Policy for Gender Mainstreaming in Energy Access. The Economic Community of West African States, which includes 15 West African states,¹² has developed a Policy for Gender Mainstreaming in Energy Access. With the stated goal of ensuring that men and women have equal access to energy services, the policy also speaks directly to the inclusion of women in the energy field, specifying targets that member states should meet for the inclusion of women in the energy field. Among its goals includes increasing “women’s public-sector participation in energy-related technical fields and decision-making positions,” with a target of “at least 25% women in the public sector energy workforce by 2020 and an equal (50%/50%) gender balance by 2030” [43]. The policy notes certain constraints that could affect this goal and related objectives, including insufficient resources to promote science, technology, engineering, and mathematics (STEM)-related fields to women; a lack of targeted marketing of energy sector job opportunities to women; and a paucity of resources dedicated to making training and outreach more gender-sensitive. It calls on member states to invest in education and training for women in STEM fields, to enhance educational pathways to careers in the energy sector, and to create monetary and programmatic incentives for women to join the energy sector. Finally, the policy creates a monitoring plan and reporting template for member states to use as they aim to reach these ambitious targets in their own energy sectors.

Africa Center for Science and International Security. Working closely with the Ghana Atomic Energy Commission, the Africa Center for Science and International Security (AFRICISIS) “envision[s] a safer, more secure and stable Africa that is obtaining

¹² The members of Economic Community of West African States include Benin, Burkina Faso, Cabo Verde, Cote d’Ivoire, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

maximum benefits from dual-use science and technology in the fields of nuclear science and technology and satellite applications” [44]. AFRICSIS also undertakes efforts to encourage more women to enter the field of nuclear security and to ensure that more women rise to positions of power and authority in the field. It accomplishes these aims in part by collaborating with other programs, such as WiN Global and the African Leadership Network, as well as offering training and engaging in additional efforts to increase awareness and visibility [5].

c. National

Kenya

Constitution, Clauses 27 and 175. Article 27 of Kenya’s Constitution [45] recognizes the equality of every person under the law. In particular, it specifies that women and men are entitled to equal treatment under the law, “including the right to equal opportunities in political, economic, cultural, and social spheres” [45]. It authorizes the state to take measures, including affirmative action programs and policies, to “redress any disadvantage suffered by individuals or groups because of past discrimination” [45]. It also specifies that at least one-third of the state’s legislative body shall be women. The inclusion of women within the legislative body means that Kenyan women will have a voice as the state enacts laws, policies, and procedures that could have an effect on the rights of women in the workplace and throughout society.

Article 175 of the Kenyan Constitution [45] also provides that county governments shall contain a membership of at least one-third women. Again, this requirement places women in a position to directly influence the laws, policies, and procedures that emanate from that local government bodies (although recognizing that one-third membership is not a majority, and efforts led by women, particularly toward gender equality, will need allies to succeed).

Uganda

Constitution, Articles 33 and 180(b). The Constitution of Uganda [46] contains several sections relevant to the inclusion of women in the field of nuclear security. Article 33 of the Constitution recognizes the rights of women, including the guarantee that “women shall have the right to equal treatment with men and that right shall include equal opportunities in political, economic, and social activities” [46]. Moreover, the Constitution under Articles 32 and 33 affords women “the right to affirmative action for the purpose of redressing the imbalances created by history, tradition, or custom” [46]. Moreover, laws, alongside cultures, customs, and traditions, that are “against the dignity, welfare, or interest of women or which undermine their status are prohibited by this Constitution” [46]. These articles clearly establish the right of women to seek equal opportunities in employment, including areas such as nuclear security, and, furthermore, to seek avenues for the redress of past wrongs that may have been experienced by women in these domains.

To increase the representation of women in local government councils, Article 180(b) [46] also establishes that one-third of the membership of local government councils

shall be reserved for women, which further integrates women into local governance structures that are responsible for exercising legislative and executive powers that affect women. Taken in tandem, these two provisions could substantially affect the ability of women to seek out opportunities and enact laws and policies that aim to achieve gender equality between men and women in Uganda, including in the nuclear energy sector, as well as other areas of employment.

National Gender Policy. In 2007, Uganda revised its National Gender Policy, confirming its “unequivocal commitment to take actions that will bring about more equal gender relations” [47]. The National Gender Policy aims “to establish a clear framework for identification, implementation, and coordination of interventions designed to achieve gender equality and women’s empowerment in Uganda” [47]. It calls upon the Ministry of Gender, Labor, and Social Development and other relevant government ministries to mainstream gender in their work. It also calls on the private sector to use affirmative action policies to help advance women in their organizations, and it generally seeks to improve women’s access to employment to help improve their livelihoods.

4. Case Studies

Two countries that are embarking on the development of nuclear power programs include Kenya and Uganda. These two African states have managed to abide by the Milestone Approach and adhere to a number of the international and regional instruments previously mentioned while prioritizing the input of women throughout the process of developing nuclear power capabilities. Given the efforts of these two countries, we have chosen to highlight the strengths and challenges that Kenya and Uganda have experienced in continuing to work to advance gender equality in the nuclear security domain.

a. Kenya

Regarding the gender composition of the Kenya Nuclear Regulatory Authority, women represent less than 20% of the technical officers in the nuclear regulatory body. Moreover, at the senior management level are 14 technical officers, and only 1 is a woman, who has provided insights into the field as noted throughout this section. Although certain technical officers work primarily in the Nuclear Security Department, it is also possible that they may have responsibilities outside that department and work in other areas.

Although Kenya is conscious of the need to advance women in the nuclear security sector, at present, women are underrepresented. This need is an area that should be addressed because of women’s potential to be strong leaders and the diversity of thought and experiences that they contribute to the field of nuclear security. Factors affecting the attraction and retention of women in the field should be addressed, however, particularly as cultural beliefs in Kenya are shifting. Women may be expected to take jobs that enable them to balance home and work responsibilities, particularly jobs that do not require travel. This belief conflicts with a number of responsibilities unique to working within the field of nuclear security, which may require employees to travel to conduct inspections of various facilities. Thus, the field may be less accessible

or perceived as a less attractive career to women who are expected to balance the cultural and societal expectations of maintaining a home as compared with other professions that are in harmony with these typically gendered expectations.

Kenya's Constitution [45], adopted in 2010, also addresses gender equality in several provisions, including its requirement that women comprise one-third of the country's legislative body, which means that women have a greater role in developing laws and policies that advance gender equality. Since the Constitution was adopted, progress has been made in this regard, with more women joining the nuclear security field. Policies and procedures in the nuclear sector are silent on the issue of gender, however, which could contribute to fewer women in the nuclear security field overall.

One way that senior leaders have considered addressing the lower number of women in nuclear security in Kenya involves adopting legislation to require a certain number or percentage of women in the field, compatible with its Constitution, which holds that affirmative action programs and policies may be implemented to "redress any disadvantage suffered by individuals or groups because of past discrimination" [45]. Given the historical lack of women serving in the field for a time, policies could be enacted in this regard pursuant to the constitutional clause. Additionally, to increase the number of women in the nuclear security field in Kenya, women could receive priority when being considered for senior management positions to help advance more women in the field. A fair and competitive recruitment process, both for entry into the field and for promotions, could also help to ensure the entry and advancement of women into the field of nuclear security.

Although women currently working in this sector remain optimistic, they indicated that cultural beliefs may need to continue to shift in favor of supporting women taking jobs in the field of nuclear security compared with "lighter" work that is more compatible with domestic duties [48]. They also indicated that cultural attitudes need to be improved toward ambitious women who "work twice as hard to achieve half of what men would" [48].

b. Uganda

In Uganda, women comprise approximately one-third of the nuclear security field. In the Atomic Energy Council, which serves as the regulatory body in Uganda, women comprise approximately one-half of the nuclear security field. Two of the women serving at the Atomic Energy Council are certified nuclear security professionals, and two are currently pursuing certification through the WINS program. According to women working in the nuclear security field in Uganda, factors contributing to a lack of women in the field in Uganda include the belief that nuclear security should be handled by the military, which contributes to a perception that women cannot work in the field [49].¹³ Some may also perceive nuclear security as related to specific subjects in the sciences (e.g., physics, chemistry, and biology) that are believed to be more difficult, and women may

¹³ Recent data on the number of women in the Ugandan military is limited, but a 2011 report indicates that 1,566 soldiers in the military are women, which is a figure believed to be less than 10% of the total soldiers in the military. See Reference [49].

not be perceived as capable or able to succeed in those subjects in the same way that men are perceived as capable or able to succeed. These perceptions can discourage women from seeking out opportunities in the nuclear security field. Additionally, Uganda has not included gender equality in any relevant policies related to the field of nuclear security.

Women are perceived as creative and innovative thinkers in Uganda, which are traits that enhance their contributions to responding to an ever-changing environment of nuclear security threats. To increase the number of women in the nuclear security field, women currently serving in the field believe that Uganda should continuously advocate for equality at all educational levels [48]. Uganda's government could provide additional support to young women and girls to seek an education, which could help contribute to the pipeline of women available and interested in a career in nuclear security. Women currently working in the nuclear security field in Uganda feel optimistic that government support for education would contribute to an increased number of women in nuclear security. Additionally, ensuring a fair and transparent recruitment process for jobs could also contribute to increased numbers of women in the field of nuclear security. Employers could consider offering incentives for those in leadership positions to help women advance in the field.

In accordance with Uganda's *National Gender Policy*, hiring practices could also incorporate elements of affirmative action to help increase the number of women represented in the nuclear security field. Uganda could also develop specific policies related to the nuclear profession that call for gender equality in the field and extend the concept of gender mainstreaming that is promoted in the *National Gender Policy* to the nuclear security field and related areas of work.

5. Findings and Recommendations

Countries embarking on nuclear power programs have an opportunity to further gender equality in the nuclear security sector as states work to assemble their nuclear workforces. With that said, a number of challenges to achieving gender equality exist in the nuclear security sector, ranging from a general lack of policies, as indicated by women working in the nuclear sectors in Kenya, to the effects of biases. Despite these obstacles, several recommendations can help remediate some of the challenges, specifically for states building nuclear power programs. Additionally, several notable international organizations, including the IAEA and WINS, among others, have noted the importance of gender equality in various guidance documents and mentorship and fellowship programs, in an effort to encourage states to achieve gender parity to achieve a robust nuclear security infrastructure. There are a number of ways in which these organizations can do more to advance gender equality efforts, especially for countries embarking on nuclear power.

Regarding common challenges identified in the case studies, there is generally a lack of policies in nuclear security organizations, especially for countries embarking on nuclear power, that address gender and gender-specific issues in the workplace [5]. Additionally, the policies that may be in place that address women may be unclear or

discriminatory in nature. For example, some organizations may exclude women from duties where radiation exposure is expected [48], and other organizations have not defined the process to return to work after parental leave [5]. As both Kenya and Uganda indicated, either a lack of policies or discrimination in the policies that are in place within a nuclear organization may be due in part to a lack of commitment to gender equality initiatives from senior management, which tends to be more male-dominated. To this point, a WINS study found that a lack of women in decision-making processes actually can lead to a systemic exclusion of women [5]. Thus, the underrepresentation of women in the nuclear sector, especially in management positions, is an issue that must be acknowledged and addressed to help obtain gender parity.

A key barrier to women's advancement in the nuclear sector specifically relates to a lack of transparency about the promotional process internal to the organization. Generally, women are not promoted because managers tend to underestimate their potential [50]. A 2021 Massachusetts Institute of Technology study found that women are 14% less likely to be promoted at a company in each year, in part because of the perception that women have less leadership potential than men [50]. Moreover, as indicated in the Kenya case study, women who have taken the initiative to contact management to learn more about how to navigate to the next level in their careers have encountered disapproving reactions and comments that encourage them to be grateful for where they are situated in the organization. Overall, ambition is a trait that is generally criticized in women yet celebrated in men, which has acted as another barrier to gender equality and gender parity in the workplace [51].

Other contributing factors tend to be more common across organizational structures, and the nuclear security sector is no exception. Unconscious bias, or the unintentional mental associations stemming from values, traditions, cultures, and experience based on gender [52], tend to lead to incorrect assessments of women in the workplace [52]. These so-called *assessments* tend to be based on gender stereotypes based on the traditional social roles of women and views of women as compassionate, kind, and helpful [52]. Other detrimental stereotypes that adversely affect women in the workplace relate to female leadership styles, where certain character attributes, such as assertiveness and confidence, are often thought of as masculine and are considered unlikeable and aggressive traits when exhibited in women [5].

Interviews with colleagues in the nuclear security sector indicated that hiring practices may also be discriminatory or be influenced by unconscious bias against women [53]. This issue can affect women's initial access into the field, even if they have comparable experience or education with male colleagues. Hiring represents one area where gender-sensitive policies and practices could be beneficial to increasing the number of women entering the field and could further serve to help retain women in the field once they enter it. One approach to developing such policies and practices is the notion of *gender equality by design*, in which gender considerations are integrated into the design of a nuclear security program from hiring to the provision of equipment suited for women's bodies and needs, training and education, and promotional opportunities. This

form of gender mainstreaming could serve to increase the number of women gaining access to and remaining in the nuclear security field, especially for countries embarking on nuclear power programs and seeking to build a nuclear security workforce.

In a similar vein, interviews with colleagues in the nuclear security sector also indicated that requirements for entry into the nuclear security field may be discriminatory toward women. For instance, some organizations have a *fitness for duty* requirement, in which the applicant may need to demonstrate certain physical abilities to be considered for a position in nuclear security. One such requirement, bench-pressing 100 lb, may be physically difficult for many female applicants and may serve to discriminate against women. Such a requirement may actually be irrelevant to the work being performed in the position, and such requirements could be eliminated to encourage more women to apply and could result in more women being considered for these positions. Equipment designed to protect individuals working in nuclear security may also be designed for a male's body and may not fit the typical woman's frame. These issues are aspects that need to be changed for the nuclear security field to be more inclusive of women.

a. Recommendations for States Building Nuclear Power Programs

Nuclear institutions could implement a number of measures to increase the number of women in the workforce and further advance gender equality. Regarding methods to attract female staff to the industry, nuclear power programs should reorient their focus to a series of additional measures outside of solely focusing on hiring and promoting women. As a starting point, in job postings, the nuclear sector should consider the using gender-inclusive language, such as *you*, *they*, or *them* in materials as opposed to defaulting to the male pronouns of *he* and *him*. For a sector that is already predominantly composed of men, gender-coded words could subtly influence who applies to a job. Thus, gender-neutral language is more inclusive of women and people that consider themselves to be at different points on the gender spectrum.

From an objective standpoint and regarding measures in place for employees, key performance indicators should be clearly defined for staff to identify the objectives that they are expected to achieve. Listing key performance indicators provides an impartial means by which management can evaluate staff in an equitable manner and, consequently, reward the staff that help the facility to achieve operational goals. Related policies at a nuclear facility should also be diverse and inclusive to avoid the perception of life events as only affecting one gender. For example, family and medical leave should be for both parents in the form of *parental leave* as opposed to *maternal leave*, which may be discriminatory. Ultimately, this type of language helps to combat implicit bias and accounts for nontraditional parental roles and family structures as opposed to putting the sole burden of parenting on a mother. Policies banning women exclusively from working in capacities in which they might be exposed to radiation should also be reassessed. Moreover, a policy on discrimination and protecting whistleblowers should be in force at a facility to guarantee that staff have a safe way to report inappropriate treatment in the workplace, including harassment and sexual discrimination, without facing retaliation in the form of firing, demotion, or denying promotion. To facilitate these

protections, a facility might consider adopting an anonymous hotline that staff can use to report issues related to harassment, gender discrimination, sexism, and retaliation.

Some other ways in which implicit gender bias could be managed is through periodic trainings for employees. Although this effort may not guarantee that attitudes may change, it is a step in the right direction toward ensuring that employees understand their biases and equip themselves with tools to understand and, hopefully, eliminate them.

Senior managers can also develop mentorship programs for female staff, which could also help to improve gender equality within the nuclear sector because the advice shared by more experienced staff to mentees can help to cultivate their confidence in the typically male-dominated nuclear sector. Senior managers can also use this mentorship opportunity to serve as an ally to women by working to further develop them into leaders and make use of their unique perspectives as women in this sector for consideration in facility-wide decisions. Some nuclear regulatory authorities have even gone as far as to create internship and scholarship opportunities for women studying nuclear science and engineering, as well as STEM-related subjects more broadly, to encourage more women to enter the field.¹⁴ Regarding the development of young talent, the IAEA has also adopted a similar approach to encourage gender equality in its member states and in developing young talent via its Marie Skłodowska-Curie Fellowship Programme. The program provides a scholarship to women pursuing a master's program in nuclear-related studies from an accredited university and a 12-month internship opportunity [54].

b. Recommendations to the IAEA

As previously mentioned, the IAEA has implemented a number of initiatives to promote and advance the involvement of women in the nuclear sector, including the Marie Skłodowska-Curie Fellowship Programme [54]¹⁵ and the Women in Nuclear Security Initiative (WINSI), which highlights the concerns, challenges, and achievements within the field of nuclear security through a series of workshops and webinars, among other programs. Based on the needs of countries embarking on nuclear power programs, the IAEA could also adopt additional measures to advance gender equality for countries either developing or operating a nuclear power program.

IAEA General Conference resolutions, Board of Governors decisions, the Ministerial Declaration adopted at the International Conferences for Nuclear Security, and other consensus documents clearly illustrate IAEA member states' support and commitment

¹⁴ For instance, the Kenya Nuclear Regulatory Authority (KNRA) offers KNRA internships to students. See Kenya Nuclear Regulatory Authority, *Careers*, <https://knra.co.ke/careers/> (accessed 2023-04-19).

¹⁵ Most notably, the IAEA has recently launched the Lise Meitner Program, which is a visiting professional program aimed at boosting women's career development in the nuclear sector, particularly in the nuclear energy field. The program includes professional visits to nuclear facilities, research centers, scientific institutions, laboratories, and industry. The program offers women an opportunity to expand on individual professional relationships with a wide range of leaders and experts in the field of nuclear energy. See Reference [54].

toward increasing the representation of women in nuclear security and in the nuclear sector at large. In line with these undertakings expressed by the international community, the IAEA should consider implementing a more far-reaching strategy to support gender parity in the nuclear security workforce in nuclear newcomer countries. We recommend several key actions. First, a cross-departmental support strategy based on the Milestones Approach and the Integrated Workplan would ensure the systematic consideration of gender equality efforts into capacity-building activities, education opportunities, and technical support assistance, all predicated on existing human resource development guidance and publications relevant to strengthening nuclear security in nuclear newcomer countries. A cross-departmental strategy would also maximize the potential that international and regional networks have—in particular, INSEN and NSSC—as well as WiN and WINSI.

Second, the Milestones Approach should be amended to include gender equality as one of the Nuclear Infrastructure Issues, or at least as a key action to be addressed under the Human Resource Development Issue. As addressed at the outset of this paper, the Milestones Approach outlines, in three phases, the commitments associated with developing a nuclear power program [55]. The Approach details 19 nuclear infrastructure issues that should be addressed and requires the completion of specific steps during each of the phases when developing the necessary infrastructure to support a nuclear power program. To reiterate, the current 19 nuclear infrastructure issues include National Position, Nuclear Safety, Management, Funding and Financing, Legal Framework, Safeguards, Radiation Protection, Regulatory Framework, Electrical Grid, Human Resource Development, Stakeholder Involvement, Site and Supporting Facilities, Environmental Protection, Emergency Planning, Nuclear Security, Nuclear Fuel Cycle, Radioactive Waste Management, Industrial Environment, and Procurement. None of the nuclear infrastructure issues addresses gender—not even tangentially. This lack of acknowledgment is an issue of concern because of the previously mentioned challenges that women typically endure in nuclear facilities. Thus, if the IAEA were to amend the nuclear infrastructure issues to include gender equality, then it would ensure that countries embarking on nuclear power will prioritize the promotion and protection of women in this initiative. This amendment could take place in the form of enacting policies against discrimination and requiring a reporting hotline within the nuclear sector, as well as the establishment of mentorship and internship opportunities. The inclusion of gender equality as a Nuclear Infrastructure Issue would also have the potential to create sustainable and long-term nuclear security education and training opportunities for women in nuclear newcomer states.

Similarly, gender equality should also be addressed in IAEA NSS No. 19 [7] by including key actions to increase the representation of women in nuclear security at each of the three phases in a nuclear power program. The IAEA should also consider including topics related to gender, such as the prioritization of the concept at nuclear facilities, in relevant guidance for countries embarking on nuclear power programs, such as NSS 31-G on “Building Capacity for Nuclear Security” [56]. NSS 31-G discusses a state’s responsibility to develop a nuclear security regime by building the capacity of the organization via a series of measures, such as education and the training of staff. It fails

to identify the need to develop women in nuclear security, nor does it outline the measures that could promote the inclusion of women in the field. IAEA NSS guides are often referenced by countries either embarking on nuclear power or already operating in this field to build capacity, so if the IAEA highlighted gender-related concerns in these guides, then gender equality would be identified as a matter of priority for states as well.

Third, the IAEA should consider close partnerships with other international organizations and NGOs to increase nuclear education and training opportunities for women. For example, the IAEA could consider partnering with the Organisation for Economic Co-operation and Development Nuclear Energy Agency (NEA) to identify opportunities for collaborative efforts through NEA's Gender Balance Task Group [57].¹⁶ The IAEA may consider similar partnerships with regional organizations, such as SADC or EAC, to bring regional attention to this topic and create strategies that closely resonate with or enhance other regional efforts.

6. Conclusion

For countries embarking on nuclear power programs, it is essential that they consider the inclusion of women in substantial roles throughout the process because a highly skilled and diverse workforce in nuclear security is considered to be most effective in maintaining and securing nuclear material. With that said, women comprise roughly 20% of the nuclear workforce, and their rates of participation is even less in senior management positions and in developing countries more broadly. This low percentage of women is due in part to the number of barriers that women typically encounter upon entry into the nuclear sector; a host of challenges that they endure while working within the field, including gender bias and discrimination; and a lack of policies and trainings in place that help to protect women from this bias and discrimination.

To prioritize gender equality for nuclear newcomers and increase their rates of participation, the IAEA Milestones Approach, which outlines the key considerations for countries embarking on nuclear power, should be amended to identify gender equality as one of the nuclear infrastructure issues. IAEA NSS guidance documents relevant to building capacity for nuclear power programs should also emphasize the importance of gender balance within the nuclear security sector via recommendations that states should consider when developing their nuclear programs. The IAEA should also consider partnerships with other organizations to develop protocols and measures that states can adopt to encourage and ensure gender equality. These efforts taken in conjunction with gender equality values enshrined in international, regional, and national instruments relevant to the nuclear sector to achieve gender equality will help to

¹⁶ The Nuclear Energy Agency (NEA) Steering Committee for Nuclear Energy has recently agreed on a policy framework for improving gender balance in the nuclear energy industry. The NEA will work with its member countries toward the formal adoption of these policies, as Director-General William Magwood noted at the International Ministerial Conference on Nuclear Power in the 21st Century in Washington, DC, in October 2022. Of note is that the NEA has a more limited membership than the IAEA because its focus is cooperation among countries with advanced nuclear technology infrastructures. Nevertheless, the adoption of such gender balance policies by its member states would have beneficial effects on related IAEA efforts in those countries and beyond [57].

improve the levels of participation and the retention of women within the field of nuclear security.

7. References

1. World Nuclear Association. *Emerging Nuclear Energy Countries*. <https://world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx>.
2. Cometto, M.; Contri, P.; Gulerce, Z.; Lazerwitz, B.; Magne, B.; Tot, M.; Turton, H.; van Heek, A. *Climate Change and Nuclear Power 2022: Securing Clean Energy for Climate Resilience*; International Atomic Energy Agency: Vienna, 2022. <https://www.iaea.org/sites/default/files/iaea-ccnp2022-body-web.pdf> (accessed 2023-04-17).
3. International Atomic Energy Agency. *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050*; Reference Data Series No. 1; International Atomic Energy Agency: Vienna, 2020. https://www-pub.iaea.org/MTCD/Publications/PDF/RDS-1-40_web.pdf (accessed 2023-04-17).
4. Nuclear Energy Agency. *Gender Balance in the Nuclear Sector*; OECD Publishing: Paris, 2023. https://www.oecd-neo.org/jcms/pl_78831/gender-balance-in-the-nuclear-sector (accessed 2023-04-18).
5. World Institute for Nuclear Security. *Gender and Nuclear Security: Challenges and Opportunities*; WINS Special Report Series; World Institute for Nuclear Security: Vienna, 2019.
6. United Nations Security Council. Security Council Resolution on Women and Peace and Security; S/RES/1325; United Nations: New York, 2000.
7. International Atomic Energy Agency. *Establishing the Nuclear Security Infrastructure for a Nuclear Power Program*; IAEA Nuclear Security Series No. 19; International Atomic Energy Agency: Vienna, 2013.
8. International Atomic Energy Agency. *Milestones in the Development of a National Infrastructure for Nuclear Power*; IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1); International Atomic Energy Agency: Vienna, 2015.
9. International Atomic Energy Agency. *Objective and Essential Elements of a State's Nuclear Security Regime*; IAEA Nuclear Security Series No. 20; International Atomic Energy Agency: Vienna, 2013.
10. International Atomic Energy Agency. *Milestones in the Development of a National Infrastructure for Nuclear Power*, IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1); International Atomic Energy Agency: Vienna, 2015.
11. International Atomic Energy Agency. *Evaluation of the Status of National Nuclear Infrastructure Development*; IAEA Nuclear Energy Series No. NG-T-3.2 (Rev. 1); International Atomic Energy Agency: Vienna, 2016.
12. International Atomic Energy Agency. *Integrated Nuclear Infrastructure Review (INIR)*. <https://www.iaea.org/services/review-missions/integrated-nuclear-infrastructure-review-inir> (accessed 2023-04-18).
13. International Atomic Energy Agency. *Integrated Work Plan*. 2020. <https://www.iaea.org/sites/default/files/20/10/integrated-work-plan-an-isrs->

- [strategic-planning-framework-to-support-member-states-in-introducing-nuclear-power.pdf](#) (accessed 2023-04-18).
14. International Atomic Energy Agency. *Nuclear Security Resolution adopted on 30 September 2022 during the eleventh plenary meeting*; GC(66)/RES/7; International Atomic Energy Agency: Vienna, 2022.
<https://www.iaea.org/sites/default/files/gc/gc66-res7.pdf> (accessed 2023-04-18).
 15. International Atomic Energy Agency. *IAEA Annual Report 2021*; GC(66)/4; International Atomic Energy Agency: Vienna, 2022.
<https://www.iaea.org/sites/default/files/publications/reports/2021/gc66-4.pdf> (accessed 2023-04-18).
 16. International Atomic Energy Agency. *Nuclear Security Review 2022*; GC(66)/INF/5; International Atomic Energy Agency: Vienna, 2022.
 17. International Atomic Energy Agency. *International Nuclear Security Education Network (INSEN)*. <https://www.iaea.org/services/networks/insen> (accessed 2023-04-18).
 18. International Nuclear Security Education Network. *Annual Meeting of the International Nuclear Security Education Network (INSEN): Chair's Report*; Vienna, 2022. <https://www.iaea.org/sites/default/files/22/11/insen-chair-report-2022.pdf> (accessed 2023-04-18).
 19. International Atomic Energy Agency. *IAEA Marie Skłodowska-Curie Fellowship Programme*. <https://www.iaea.org/services/key-programmes/iaea-marie-sklodowska-curie-fellowship-programme> (accessed 2023-04-18).
 20. International Atomic Energy Agency. *Objective and Essential Elements of a State's Nuclear Security Regime*; IAEA Nuclear Security Series No. 20; International Atomic Energy Agency: Vienna, 2013.
 21. International Atomic Energy Agency. *Establishing and Operating a National Nuclear Security Support Centre*; Non-serial Publications; International Atomic Energy Agency: Vienna, 2020.
 22. International Atomic Energy Agency. *Nuclear Security Plan 2022-2025: Report by the Director General*; GC(65)/24; International Atomic Energy Agency: Vienna, 2021.
 23. United Nations, Department of Economic and Social Affairs: Sustainable Development. *Goals: 5. Achieve gender equality and empower all women and girls*. <https://sdgs.un.org/goals/goal5> (accessed 2023-04-18).
 24. International Atomic Energy Agency. *Gender at the IAEA*. <https://www.iaea.org/about/overview/gender-at-the-iaea> (accessed 2023-04-18).
 25. International Atomic Energy Agency. *Women in Nuclear Security Initiative (WINSI)*. <https://www.iaea.org/about/overview/gender-at-the-iaea/women-in-nuclear-security-initiative-winsi> (accessed 2023-04-18).
 26. Liu, Z. *Bringing More Women to Nuclear—Human Resource Strategies for Gender Equality in Nuclear Organizations*. 2022.
<https://www.iaea.org/newscenter/news/bringing-more-women-to-nuclear-human-resource-strategies-for-gender-equality-in-nuclear-organizations> (accessed 2023-04-18).
 27. International Atomic Energy Agency. *International Conference on Nuclear Security: Sustaining and Strengthening Efforts*, 10–14 February 2020: Ministerial

- Declaration, 2020. International Atomic Energy Agency.
<https://www.iaea.org/sites/default/files/20/02/cn-278-ministerial-declaration.pdf>
(accessed 2023-04-18).
28. World Institute for Nuclear Security. *Gender Programme*.
<https://www.wins.org/gender/> (accessed 2023-04-18).
29. Women in Nuclear Global. *Home page*. <https://win-global.org/> (accessed 2023-04-18).
30. Organization of American States. Additional Protocol to the Convention on Human Rights in the Area of Economic, Social, and Cultural Rights (Protocol of San Salvador). 1988.
31. Association of Southeast Asian Nations. Declaration of the Advancement of Women in the ASEAN Region Bangkok, Thailand, 5 July 1988. 1988.
32. European Union. *EU Charter of Fundamental Rights*, Title III, *Equality*, Article 23—Equality between women and men. European Union Agency for Fundamental Rights.
33. African Union. Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa. 2003.
34. Organization of African Unity. African Charter on Human and Peoples' Rights. 1981.
35. United Nations. Universal Declaration of Human Rights. 1948.
36. United Nations. International Covenant on Civil and Political Rights. 1966.
37. United Nations. International Covenant on Economic, Social, and Cultural Rights. 1966.
38. United Nations. Convention on the Elimination of All Forms of Discrimination Against Women. 1979.
39. East African Community. East African Community Gender Policy. 2018.
40. East African Community. Treaty for the Establishment of the East African Community. 1999.
41. Southern African Development Community. *SADC Protocol on Gender and Development*. 2008.
42. The Fourth World Conference on Women. Beijing Declaration and its Platform for Action. 1995.
43. Economic Community of West African States. ECOWAS Policy for Gender Mainstreaming in Energy Access.
44. Africa Center for Science and International Security (AFRICISIS). *About Us*.
<https://africisis.org/about-us/> (accessed 2023-04-18).
45. Government of Kenya. *Constitution of Kenya*. 2010.
46. Government of Uganda. *Constitution of Uganda*. 1995.
47. Government of Uganda. *The Uganda Gender Policy*. 2007.
<https://faolex.fao.org/docs/pdf/uga163564.pdf> (accessed 2023-04-18).
48. Man, M.; Nalumansi, S.; Kaboro, B.; Chauvet-Maldonado, C.; Burniske, J. S. Questionnaire.
49. Global Network of Women Peacebuilders. *Security Council Resolution 1325: Civil Society Monitoring Report 2011—Uganda*. https://gnwp.org/wp-content/uploads/Uganda_0.pdf (accessed 2023-04-18).

50. Benson, A.; Li, D.; Shue, K. *“Potential” and the Gender Promotional Gap*, 2022. <https://danielle-li.github.io/assets/docs/PotentialAndTheGenderPromotionGap.pdf> (accessed 2023-04-19).
51. Lewis, M. A. *Why Qualified Ambitious Women Get Overlooked for Promotions*. LinkedIn, 2021. <https://www.linkedin.com/pulse/why-qualified-ambitious-women-get-overlooked-dr-madeline-ann-lewis> (accessed 2023-04-19).
52. Bureau for Employers’ Activities (ACT/EMP). *ACT/EMP Research Note—Breaking Barriers: Unconscious Gender Bias in the Workplace*. International Labour Organization, 2017. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_601276.pdf (accessed 2023-04-19).
53. Man, M.; Nalumansi, S.; Kaboro, B.; Chauvet-Maldonado, C.; Burniske, J. S. Interviews with colleagues from World Institute for Nuclear Security, the Institute of Nuclear Materials Management, and colleagues formerly at the International Atomic Energy Agency, including with the Technical Cooperation program, Nuclear Security Support Centers, and the International Nuclear Security Education Network.
54. International Atomic Energy Agency. *Information for Applicants: Lise Meitner Programme*. <https://www.iaea.org/services/key-programmes/lise-meitner-programme/information-for-applicants> (accessed 2023-04-19).
55. International Atomic Energy Agency. *Milestones in the Development of a National Infrastructure for Nuclear Power*; IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1); International Atomic Energy Agency: Vienna, 2015.
56. International Atomic Energy Agency. *Building Capacity for Nuclear Security*; IAEA Nuclear Security Series No. 31-G; International Atomic Energy Agency: Vienna, 2018.
57. Nuclear Energy Agency. *Steering Committee Agrees to Gender Balance Policy Framework*. 2022. https://www.oecd-neo.org/jcms/pl_75219/steering-committee-agrees-to-gender-balance-policy-framework (accessed 2023-04-18).