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Upscaling the non-power applications of atomic energy

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Background

1. Atomic energy, when channelled for peaceful purposes, can lead to groundbreaking innovations that save lives, lift people out of poverty, transform entire industries and bring to bear novel sustainable solutions to the world's most pressing challenges. However, breakthroughs in science and technology cannot attain their potential benefit unless they are put into practical use and scaled up to achieve the intended multiplier effect. While the power-related applications of atomic energy have already been scaled up and commercialized, non-power applications have not received the same attention and support.

2. Atomic energy has for years been the foundation of new technology in healthcare, food safety and security, agriculture, heritage conservation, environmental sustainability, education, resource management, and industry. In 2023 alone, the technical cooperation programme of the International Atomic Energy Agency (IAEA) provided support to over 150 countries through 1,100 projects.¹ Such projects tangibly contribute to helping countries meet the Sustainable Development Goals. Despite the potential, scaling up these technologies still requires more attention and focus to enhance utilization towards delivering their socioeconomic impact.

Looking at non-power applications through a different lens

3. Bearing in mind article IV of the Treaty on the Non-Proliferation of Nuclear Weapons and actions 47 to 54 of the 64-point action plan of the 2010 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons,

¹ International Atomic Energy Agency (2024). Technical Cooperation Report for 2023.



States Parties to the Treaty have a crucial role to play in promoting awareness of the many applications of nuclear technology beyond nuclear power. This awareness is expected to generate interest in applied research and development projects, industrial application and upscaling. In this regard, the involvement of industry in the technology development, financing, and uptake and utilization is critical. One of the more recent cross-cutting findings in the IAEA technical cooperation programme is that some technical cooperation projects stopped at the point where scaling-up, dissemination and visibility should have begun. Subsequently, there are opportunities to further increase the effectiveness, sustainability and visibility of the work of IAEA by investing more systematically in scaling up.² Notwithstanding the individual obligations of IAEA member States in supporting the technological cooperation programme, reframing the approach to non-power applications from a purely development-focused model to one that ensures commercial viability and competitiveness is crucial for long-term sustainability. Instead of viewing these applications solely as aid-driven or experimental projects, they should be designed with market demand, affordability, and scalability in mind. By prioritizing both commercial sustainability and social impact, non-power applications can transition from temporary solutions to self-sustaining industries that drive economic growth.

4. This paper is an attempt to advance the growing consciousness on non-power applications in order to promote awareness, upscaling and commercialization. It derives these principles from the declaration of the 2024 Ministerial Conference on Nuclear Science, Technology and Applications and the Technical Cooperation Programme, wherein IAEA member States recognized by consensus the growing need and demand for further utilization and upscaling of nuclear applications worldwide for peaceful purposes.³ The same Conference also called upon IAEA to support member States in their efforts to work together, on an interdisciplinary basis, with relevant partners, including academia, the private sector and international, regional and national development agencies, with the aim of bringing the results of research and development relating to the applications of nuclear science and technology to the end users, upscaling successful technical cooperation projects, and creating sustainability and socioeconomic impact.⁴ This paper envisions that, through attention on and engagement with non-power applications, they will eventually become as mainstreamed as nuclear power.

5. The conversation is not aimed at promoting nuclear applications at the expense of power applications. Rather, the narrative advocates that non-power applications reinforce power applications in helping nations achieve the Sustainable Development Goals and that both areas should receive adequate and proportional recognition, promotion and support. In actuality, non-power applications can provide a “soft entry” for nuclear power into a country if there is still a need for building human capital and political will and acceptance.

Programmes/projects on non-power applications

6. Non-power application projects can be found in many industries and sectors. Currently, IAEA is working with its member States in fields of activity in technical cooperation on non-power applications such as water resources management, marine, terrestrial and coastal environments, radioisotopes and radiation technology for industrial, healthcare and environmental applications, crop production, agricultural water and soil management, livestock production, insect pest control, food safety,

² IAEA (2024). Evaluation of Technical Cooperation Activities in 2024. Report by the Director of the Office of Internal Oversight Services.

³ See www.iaea.org/sites/default/files/24/11/ministerial-declaration-261124.pdf.

⁴ Ibid.

comprehensive cancer control, radiation oncology in cancer management, nuclear medicine and diagnostic imaging, radioisotope and radiopharmaceutical production for medical applications, dosimetry and medical physics, and nutrition for improved health.⁵ IAEA and its member States have also launched initiatives aimed at addressing contemporary problems through the peaceful non-power applications of atomic energy such as, but not limited to, the Atoms4Food sterile insect technique, the Rays of Hope initiative, Nuclear Technology for Controlling Plastic Pollution (NUTEC Plastics), the Peaceful Uses Initiative, the Zoonotic Diseases Integrated Action (ZODIAC) initiative, the Global Network of Isotope-enabled Water Analysis Laboratories, Atoms for Heritage, the Asian Network for Education in Nuclear Technology and the International Nuclear Science and Technology Academy.^{6,7,8,9,10,11} Given their ubiquity and presence especially in sectors of basic needs, non-power applications have the potential to make a direct, significant and long-lasting impact in people's lives through the sectors that they help to develop.

Advantages of existing regional and interregional cooperation mechanisms

7. IAEA, as of 2025, is also coordinating 165 coordinated research projects, many of which involve the non-power applications of atomic energy. Coordinated research projects bring together around 10–15 research institutions from various countries at different stages of economic development. These institutions work together for 3–5 years to develop new technologies that are aimed at eventually being transferred for further development and use in member States through the technical cooperation programme. Various success stories have emerged from these coordinated research projects, an example of which is the Atoms4Food sterile insect technique, which started as a coordinated research project but was then applied in technical cooperation projects across Africa, Asia and Latin America. There are also notable regional coordination projects such as the Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific, the African Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology, the Cooperative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology and the Regional Cooperation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean that serve to help coordinate nuclear applications projects, including non-power applications, in various regions. The presence of regional and interregional structures of cooperation makes it easier for States to share best practice and collaborate on solutions to common challenges. If viewed through a commercial lens, these same structures allow multiple countries to develop scientifically sound and commercially viable products that can be adopted at scale by various industries. This highlights the immense potential of products and services developed from non-power applications.

Financing of and investment in non-power applications

8. The growing interest in non-power applications has resulted in an increase in the number of non-power applications in various fields that are still at the pilot or

⁵ See https://govatom.iaea.org/GovAtom%20Documents/2024/GOV-2024-2420240429144628/GOV-2024-24-TC%20Report%202023%20_CORRECTED.pdf and https://pcmf.iaea.org/DesktopModules/PCMF/docs/2017_18_Docs/other/FoA_descriptions_E.pdf.

⁶ See www.iaea.org/services/networks/glowal.

⁷ See www.iaea.org/newscenter/news/preserving-cultural-and-natural-heritage-with-the-help-of-nuclear-techniques.

⁸ See www.iaea.org/topics/sterile-insect-technique.

⁹ See www.iaea.org/services/key-programmes/programme-of-action-for-cancer-therapy-pact.

¹⁰ See www.iaea.org/services/zodiac.

¹¹ See www.iaea.org/services/key-programmes/nutec-plastics.

early stages of technological readiness.¹² Unfunded projects (also known as footnote-a/ projects) at IAEA have been increasing in the past few years, with a significant number of these projects being non-power applications. Consistent with the findings and recommendations of IAEA for its technical cooperation projects, there is a need to ensure that successful technical cooperation projects covering non-power applications actually benefit end users at scale. There are a number of commercial advantages in investing in non-power applications. They are generally smaller in scale and have relatively low risk and capital expenditure demands, take a shorter time for end users to adopt and deploy, can have both immediate and long-term social impact, and allow for active support from organizations from different industries. There is thus a need to ensure that industry is both aware of these new technologies and is willing to invest in them.

Food for thought: ways forward through partnerships with industry

9. Maximizing the non-power applications of atomic energy entails a multifaceted approach. The following measures can be considered by States Parties to help ensure that non-power applications are successfully upscaled:

- (a) Work towards raising general public awareness of non-power applications and their potential contribution to socioeconomic development;
- (b) Encourage more public-private partnerships to provide support for collaborative regional or interregional initiatives, including for outputs of coordinated research projects;
- (c) Promote industrial uptake of novel products, services or solutions generated through nuclear technology;
- (d) Utilize a coordinated national approach to nuclear applications, including the use of country programme frameworks, where applicable, to ensure that non-power projects are synchronized with the country's industries as well as its long-term economic and development goals;
- (e) Support and encourage multisectoral participation in international conferences and meetings organized by IAEA and its member States;
- (f) Promote the viability and scalability of non-power projects and encourage closer involvement of international financial institutions, development agencies, industry, academia and research institutions, where applicable;
- (g) Increase engagement in regional and interregional partnerships dedicated to the peaceful uses of nuclear energy. These can serve as effective encompassing vehicles not only for the promotion of non-power applications but also for partnership and resource mobilization.

¹² See www.iso.org/obp/ui/en/#iso:std:iso:16290:ed-1:v1:en.