# PEACEFUL USES OF NUCLEAR ENERGY IN LESS INDUSTRIALIZED COUNTRIES: CHALLENGES, OPPORTUNITIES, AND ACCEPTANCE

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## Abstract

While less industrialized countries may associate nuclear energy with weapons or with the adverse events that have taken place since the late 1970s, peaceful uses have significantly benefited society, and the opportunity for nuclear energy to play a substantially expanded role in generating clean and abundant electricity is well recognized. For example, in the U.S., where nuclear power accounts for 19% of electricity, even though U.S. public attitudes toward nuclear remain uncertain, a January 2022 Pew Research Center survey found that 35% of U.S. adults say the federal government should encourage the production of nuclear power, 26% say it should discourage it, and 37% say it should neither promote nor prevent it.

In addition to producing clean electricity, the peaceful use of nuclear energy has significantly improved human life in health, agriculture, food preservation, industry, and the understanding of our world and universe. Nuclear technology is used in the diagnosis and treatment of cancer and other diseases, radiography cameras, blood irradiators, and radio sterilization of biological tissues for the treatment of various conditions; it helps the development of scientific knowledge on the understanding and searches for a solution on environmental issues, like climate change and tracing of ecological impacts; in augmenting agricultural productivity and the elimination of food diseases, like reducing the threat of fruit flies in Latin America; and in for various industrial applications like radiography, flow measurement and leak detection in industry and mining, in dredging operations in ports, and space exploration, among many others. Not to mention the critical impact of nuclear energy programs on a solid workforce and the technological development of the countries that scale their capabilities.

For energy, nuclear has the opportunity to expand the supply of clean electricity generation. To achieve the deep decarbonization required to keep the average rise in global temperatures below 1.5°C, combating climate change without an increased role of nuclear power generation would be much more complicated. The IEA state that achieving the pace of $CO_2$ emissions reductions in line with the Paris Agreement is already a considerable challenge, as shown in the Sustainable Development Scenario. It requires significant increases in efficiency and renewable investment and an increase in nuclear power. Also, the World Nuclear Association notices that nuclear power plants, throughout their life cycle, produce about the same amount of carbon dioxide-equivalent emissions per unit of electricity as wind and one-third of the emissions per unit of electricity compared to solar. Further, with the technological and

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financial attributes of small modular reactors (S.M.R.), more countries and regions can gain the advantages of nuclear energy.

In this work, we unveil the opportunities and challenges within less industrialized countries to developing a plan and their capabilities to take advantage of peaceful uses of nuclear energy and power generation.

Some of the critical issues/questions we address in this work are:

- How should governments interact with civil society in analyzing and evaluating the peaceful uses of nuclear energy? How should the benefits and risks of peaceful uses of nuclear energy be communicated to civil society? What role has the scientific community here?
- What steps should countries take to build capacities to become ready to decide on building critical infrastructure for the peaceful uses of nuclear energy?
- How can IAEA and other industrialized countries support capacity building in less industrialized countries to be ready for a yes or no decision regarding nuclear energy?
- How important are the institutional framework and strong and independent regulatory and supervisory authorities in the nuclear industry for an atomic program's success and safe development?
- In many countries, institutions are weak, which can seriously threaten the success and safety of any nuclear energy program. How can governments and the international community protect from this risk by exposing the world industry to higher downside risk?
- How should we address the lack of human capital, scientists, and experts in the field?
- Is nuclear power a realistic and cost-effective solution for less industrialized countries, given significant upfront investment costs and construction periods? Is an S.M.R.s turn-on key a solution for less industrialized countries?
- Advantages and disadvantages of installing a turn-key S.M.R. v/s large-scale custom reactor, technology development, and capacity building.
- When building nuclear power infrastructure, upfront investments are significant compared to other power generation sources, such as solar or wind, which can develop. How can less developed countries secure access to finance, and what are its essential requirements?
- What are the critical characteristics of technology when deciding on the alternatives of nuclear technologies available in the market and future S.M.R.s?
- Should nuclear power generation be evaluated as a standalone project, only looking at a long-term reliable supply of cheap energy?
- Chernobyl, Three Mile Island, and Fukushima nuclear accidents marked a stopping point in many countries on their decision to implement a peaceful use of atomic energy program. How can we assure that safety standards, in a broad sense, have been enhanced to preclude future situations like the ones there? Should the safety standards depend on organization structure development and modernized reactor design?

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## Paper outline:

**Abstract**

**Introduction**

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**Chapter 2: Peaceful uses of Nuclear Energy**

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- **Health**
- **Agriculture**
- **Technology spillover effects**
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**Chapter 3: Challenges of implementing a N.E. program for peaceful uses**

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**Chapter 4: Conclusions**

**References**

## About the Authors:

**Jeffrey Binder** has had over a thirty-year career in applied energy technology as an engineering & scientific contributor and high-impact leader. His experiences include nuclear reactor technology, renewable energy, advanced/critical materials, and manufacturing technology. He has had multiple leadership roles, including Associate Laboratory Director for applied energy at Oak Ridge and Argonne National Laboratories, and the Founding Director of the University of Illinois Applied Research Institute. Dr. Binder has significant international experience in promoting nuclear and renewable energy technology. He has proposed, built, and led multiple technology development initiatives in nuclear reactor safety, fuel cycle, radioisotope production, advanced/critical materials, advanced energy systems, and manufacturing technology. Dr. Binder was a significant leader for the United States in supporting and solving nuclear safety and security issues following the Three Mile Island accident, the dissolution of the Soviet Union and following the Chornobyl accident, and the Fukushima accident in Japan.

He has a Ph. D. in nuclear engineering from the University of Illinois at Urbana-Champaign and an M.B.A. from the University of Chicago. He is the author or co-author of over 100 publications, articles, and conference submittals.

**Adam Cohen** is the President and C.E.O. of Associated Universities, Inc. (A.U.I.). Before joining A.U.I. in 2017, Dr. Cohen was finishing his term at Princeton University. Until May 2017, he served as the Deputy Under Secretary for Science and Energy at the U.S. Department of Energy (D.O.E.), overseeing basic science, applied energy research, technology development, and deployment efforts, including the stewardship of 13 of the 17 D.O.E. National Laboratories.

His experience includes nearly seven years as Deputy Director for Operations at the Princeton Plasma Physics Lab and 18 years at Argonne National Laboratory, where he held several positions, including Deputy Associate Director for Energy Sciences and Engineering and Deputy Director/Chief Operations Officer. He has served as head of the U.S. Delegation on the ITER Council, on the New Jersey Department of Environmental Protections' Oyster Creek Oversight Panel, and on the D.O.E. Laboratory Operations Board. Earlier in his career, he spent four years in the U.S. Navy as a submarine officer, and he worked at Babcock & Wilcox manufacturing nuclear fuel for research reactors.

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Also, he was president of several nuclear associations, such as the Latin America Section of the American Nuclear Association, ten years president of the Brazilian Nuclear Association, with participation in the World Nuclear Association and World Nuclear University.

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