Nuclear Desalination: A Solution For The World’s Water Crisis – OpEd

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By Hafsa Azam

Water scarcity is rapidly emerging as one of the most serious global challenges of the twenty-first century. While nearly 70% of the planet is covered by water, less than 1% of it is suitable for human consumption. Population growth, urbanization, industrial expansion and climate change have intensified pressure on freshwater resources. According to the World Nuclear Association’s Report titled *Emergizing Development: Desalination,* published on 22 August 2025, more than two billion people currently lack reliable access to safe drinking water, and by 2050 nearly half of the world’s population is expected to live in water stressed regions.

The urgency of the problem is evident in both developed and developing states. Many countries in Middle East, North Africa and South Asia are experiencing severe groundwater depletion and prolonged droughts. As freshwater reserves shrink, governments and researchers are increasingly exploring large-scale desalination, the process of removing salt from seawater, as a viable solution. However, conventional desalination is extremely energy-intensive and often powered by fossil fuels, raising environmental and economic concerns. This is where nuclear desalination offers a transformative alternative.

The global water crisis is driven by several interconnected factors. Rapid population growth is the most obvious. According to the United Nation’s medium variant projection, the world’s population surpassed 8 billion in 2023, it could increase to 8.5 billion by 2030, 9.7 billion in 2050 and 10.3 billion in 2100. With rising living standards and expanding agricultural demand, water consumption continues to increase dramatically.

Climate change has also exacerbated water scarcity. Rising temperatures accelerate evaporation and disrupt rainfall patterns, leaving many regions vulnerable to recurring droughts. In arid regions, desalination has already become the backbone of urban water supply. According to the 2025 report of Food and Agriculture Organization of United Nations, desalination plays a critical role in meeting water needs across the Middle East. Approximately 70% of Saudi Arabia’s drinking water is supplied through desalination plants, while Oman depends on desalination for about 86% of its potable water. In the UAE, desalinated water accounts for roughly 42% of the national supply and Kuwait relies on it for nearly 90% of its drinking water. Overall, the Middle East produces around 40% of the world’s desalinated water, with a combined daily desalination capacity of nearly 28.96 million cubic meters, underscoring the region’s heavy reliance on this technology for water security.

According to the International Desalination Association (IDA) 2023, more than 20,000 desalination plants were operational globally and produced over 100 million cubic meters of freshwater per day. Despite this rapid expansion, desalination alone has not solved the problem.

According to the World Nuclear Association Report 2024, most desalination plants rely on fossil fuels such as natural gas or oil to power their operations. Reverse Osmosis, the widely used desalination technology, typically needs several kilowatt-hours of electricity to produce a single cubic meter of freshwater. This energy demand creates two major challenges. First, the cost of electricity significantly increases the price of desalinated water, making it difficult for low-income countries to adopt the technology at scale. Second, fossil-fuel-powered desalination contributes to greenhouse-gas emissions, further worsening impact of climate change.

According to research paper titled *Global Energy, Costs, and Emissions from Reverse Osmosis Desalination Under Future Water Scarcity,* written by Lorenzo Rosa, Paolo Gabrielli and Matteo Sangiorgio,published on 15 January 2026 by Elsevier, desalination plants generate between 493 to 850 million tons of carbon emissions each year globally, highlighting the environmental cost of current practices. As the world attempts to transition toward cleaner energy systems, relying heavily on fossil fuels for freshwater production is increasingly unsustainable.

Nuclear desalination offers a promising solution to this energy dilemma. According to the World Nuclear Association, nuclear desalination uses nuclear reactors to provide the heat or electricity required for desalination processes. Nuclear Power Plants (NPPs) generate vast amounts of energy, and much of this energy can be used efficiently to produce freshwater.

According to the World Nuclear Association’s report titled *Nuclear Power Technology Development,* published on 19 January 2026, there are two distillation methods that can be integrated with nuclear reactors. The first is thermal distillation, where heat from the reactor is used to evaporate seawater and condense it into freshwater. The second is Reverse Osmosis, where electricity generated by the reactor powers high-pressure pumps that force seawater through specialized membranes. Nuclear reactors provide a stable and reliable energy source for desalination plants because they can operate continuously for long period.

Although nuclear desalination is not widespread, several countries have already demonstrated its feasibility. World Nuclear Association’s report titled *Nuclear Power Technology Development,* published on 19 January 2026, also mentioned that, nuclear-powered desalination has been implemented in countries such as Japan, Pakistan, Kazakhstan and India. These projects have shown that combining nuclear power generation with desalination can significantly reduce costs while ensuring reliable water supply.

According to the IDA, nuclear desalination currently produces around 45 billion cubic meters of freshwater annually, representing roughly 5% of global desalinated water production. While this share remains modest, it highlights the growing role of nuclear technology in addressing water scarcity.

One of the most significant benefits of nuclear desalination is its environmental sustainability. Conventional desalination powered by fossil fuels generates substantial carbon emissions. In contrast, nuclear energy produces electricity without releasing carbon dioxide during operation. The World Nuclear Association’s report titled *Desalination*, published on 2 May 2024, suggests that desalination powered by nuclear reactors has a carbon footprint of about 50 grams of CO_2 per cubic meter of water, compared with 1,700 grams for natural gas and nearly 2,900 grams for coal-powered desalination. This reduction in emissions makes nuclear desalination an attractive option for countries seeking both water security and climate mitigation.

Advances in Small Modular Reactors (SMRs) could accelerates the adoption of nuclear desalination. According to the International Atomic Energy Agency (IAEA), SMRs are designed to be safer, more flexible and less expensive to build than traditional large-scale nuclear plants. According to Information Technology and Innovation Foundation (ITIF) report titled *Small Modular Reactors: A Realistic Approach to the Future of Nuclear Power,* published in April 2025, by pairing SMRs with desalination units, countries could deploy modular water-production facilities in coastal areas facing severe shortages.

Nuclear desalination in Pakistan is still at a developmental stage but holds strong potential for addressing the country’s growing water crisis. Initial efforts have been made at the Karachi Nuclear Power Plant (KANUPP) Complex, where a small-scale desalination plant demonstrated the feasibility of using nuclear energy to covert seawater into potable water. According to the World Nuclear Association, using Multi-Effect Distillation (MED) and Reverse Osmosis coupled with nuclear reactors, the KANUPP produced potable water, with capacity of 4,800 cubic meter per day. However, this remains limited to pilot-level operations. With increasing water stress driven by population growth, groundwater depletion, and climate change, especially in coastal cities such as Karachi and Gwadar, the need for sustainable and large-scale solution is becoming more urgent.

With support from the IAEA and the expansion of nuclear energy project such as Chashma Nuclear Power Plant Unit 5 (C-5), Pakistan has an opportunity to increase nuclear desalination capacity with its nuclear power infrastructure. Nuclear desalination can become a key component of Pakistan’s long-term strategy for water security and environmental sustainability.

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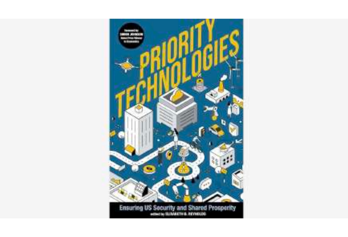

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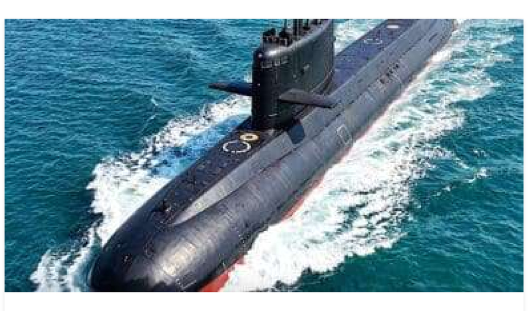

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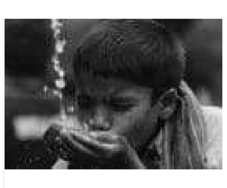

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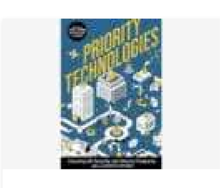

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